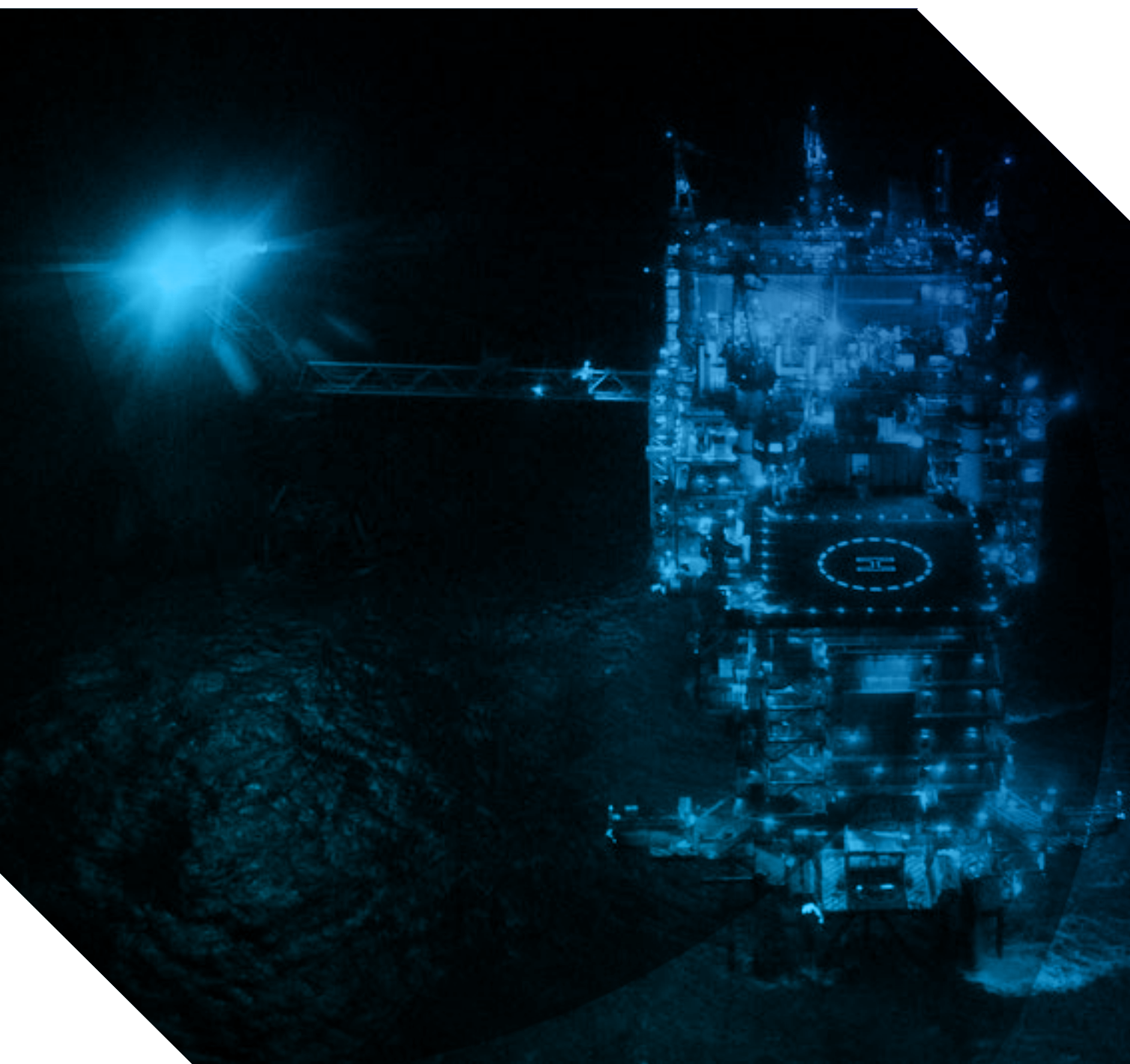


Civil Aviation Authority – Safety review of offshore public transport helicopter operations in support of the exploitation of oil and gas

CAP 1145



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20 February 2014

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Executive summary

The safety of those who rely on offshore helicopter flights is the Civil Aviation Authority's (CAA) absolute priority. The steps detailed in this report will result in significant improvements in safety for those flying to and from offshore sites in the UK and potentially worldwide. We will monitor and report publicly on the progress of all actions and recommendations.

Offshore helicopter services provide a vital link to ensure the viability of the UK's oil and gas industry. They transfer the majority of the workforce to and from offshore installations in an open sea environment that is both challenging and hazardous.

Recent accidents have understandably given rise to serious concerns, particularly with offshore workers who rely so heavily on these helicopter flights. We therefore initiated this review in September 2013 to examine thoroughly the risks and hazards of operating in the North Sea and consider how these can be managed more effectively.

The CAA decided to conduct the review in conjunction with the Norwegian Civil Aviation Authority (NCAA) and the European Aviation Safety Agency (EASA) so that a comparison could be made of any safety or operational differences. An independent peer review group was appointed to challenge the work of the review team to ensure that the objectives of the review were appropriate and being met.

In gathering evidence for the review we have engaged with employee representative groups of pilots and the offshore workforce, the oil and gas industry, helicopter operators, manufacturers, government and regulatory bodies and other experts in the field, as well as analysing available data and reports.

There were a total of 25 UK offshore helicopter accidents between 1992 and 2013, equating to 1.35 accidents per 100,000 flying hours; seven involved fatalities. Whilst the collective aim is to prevent accident occurrence, it is unrealistic to expect they can be eliminated altogether. Therefore, the protection of passengers and crew following an accident formed an essential part of the review.

The CAA has identified actions to improve the survivability of accidents that include:

- Prohibiting helicopter flights in the most severe sea conditions, except in response to an emergency, so that the chance of a ditched helicopter capsizing is reduced and a rescue can be safely undertaken (effective 01 June 2014).
- Imposing restrictions on helicopter flights in serious sea conditions relative to the sea conditions that the helicopter has been certificated to (effective 01 September 2014 – to be in place prior to winter sea conditions)
- Only allowing passengers to be seated next to push out window exits (effective 01 June 2014), unless all passengers have enhanced emergency breathing equipment or the helicopter is fitted with side floats.

The review also identified training and ongoing skills of aircrew as another key factor in the prevention of accidents. In common with commercial airline operations, the review found

that loss of control associated with the sophistication and automation of modern aircraft and helicopters is an issue requiring attention.

Harmonisation of training and procedures for pilots in these areas is recommended as well as improvements on how the two pilots work together to monitor the flight. There will also be a review of the instrument flying training that pilots receive.

The process of preventing accidents starts by establishing high technical design standards that enable safe products through a robust certification process with high production and maintenance standards. The root cause of three of the last five UK North Sea accidents has been failure of a critical part within the helicopter main gearbox transmission. The review therefore recommends that EASA's helicopter design requirements should be enhanced. The review also calls for improved information exchange between manufacturer, maintainer, operator, design authority and regulators, such as the UK CAA, to ensure that the design assumptions are validated in-service and that offshore helicopters continue to meet acceptable design and maintenance standards.

The report indicates that accident causes related to maintenance is small by comparison to design. However, maintenance error is an area that is worthy of further analysis and action to ensure that wherever possible we minimise the effects of human error and improve engineer and organisation performance.

Improving maintenance standards is a CAA priority and all parties need to take a new approach if real and lasting benefits are to be truly realised. This approach would seek improvements by a cultural change that focuses on behaviours and attitudes to ensure that the highest standards are the norm, a safety culture that is not only preached but applied and a low tolerance of non compliance, short cuts and repeat findings.

Part of the review was a comparison between offshore operations in the UK and in Norway. While the UK experienced more accidents between 1992 and 2013 the joint UK / Norwegian review team did not identify any material differences in operations, maintenance practices or regulation that could account for this. The actions and recommendations in this report will improve safety in the offshore environment.

We will implement changes directly under our control and engage directly with other organisations and bodies, such as the European Aviation Safety Agency (EASA), to make sure changes happen. A number of the recommendations are beyond the CAA's powers to enforce but we would expect a positive safety culture within the oil and gas industry and operators mean they will be actioned. We will monitor and report publicly on the progress of all actions and recommendations.

A new offshore helicopter safety forum will be established by the CAA to drive forward the recommendations and actions identified. It will also work for a substantial, and continuing, improvement in the safety of offshore helicopter operations and liaise with Norway to share experiences and best practice.

The CAA would like to take this opportunity to thank all those who gave their time and considerable knowledge and expertise to help shape this final review which we believe will strengthen the safety of offshore operations in the UK and potentially worldwide.

SECTION A

CHAPTER 1

Introduction and background

Introduction

- 1.1 Although there has been considerable effort by operators, the offshore industry and regulators to minimize the risk of North Sea helicopter operations, there have been five accidents in the past four years, two of which tragically resulted in fatalities.
- 1.2 As the UK's specialist aviation regulator, and given the absolute primacy of the safety of the passengers and crew involved in such operations, the Civil Aviation Authority (CAA) announced on 24 September 2013 that a review of offshore helicopter operations in the North Sea would be instigated. This review was to study current operations, previous incidents and accidents and offshore helicopter flying in other countries to make recommendations aimed at improving the overall safety of offshore flying.
- 1.3 The CAA decided to conduct the review in conjunction with the Norwegian Civil Aviation Authority (NCAA) and the European Aviation Safety Agency (EASA) so that a comparison could be made of any safety or operational differences. An independent peer review group was appointed to challenge the work of the review team to ensure that the objectives of the review were appropriate and being met.
- 1.4 The Terms of Reference (TOR) for the review required that it should study current operations, previous incidents and accidents and offshore helicopter flying in other countries in order to make recommendations aimed at improving the safety of offshore flying. The TOR are detailed at Annex A. In the context of this report, 'Offshore' means operations or activities conducted in support of or in connection with the offshore exploitation of mineral resources including gas.
- 1.5 The CAA notes that other bodies, including Unite the Union (Unite), the European Helicopter Operators Committee (EHOC) and the Transport Select Committee, have indicated that they will conduct reviews into matters associated with the safety of offshore helicopter operations. The CAA will seek to assist in all of these activities.

Background

- 1.6 Helicopter operations in support of the oil and gas industry over the open seas on the UK Continental Shelf (UKCS) began in earnest in the mid to late 1960s.

The exploration and extraction of oil and gas expanded dramatically from that time and the use of helicopters to support the movement of people and material grew proportionally. Across Europe, 11 member states use 230 helicopters of 10 different types, from three manufacturers, for offshore operations. Of these, Norway and the UK operate nearly 70% of the total fleet and 95% of helicopters with more than 18 passenger seats (S-92, EC225 and AS332)¹. Helicopter operations are now further extending into support for renewable energy sources, such as wind farms. Although this activity is not examined in this report, many of the recommendations will be relevant to these new areas.

1.7 The UK and Norway offshore environments can be extremely demanding, for both aviation and maritime transport; to achieve safe operations in all conditions can be highly challenging. Between 1976 and 2013, the UK has experienced 73 offshore helicopter accidents of which 13 included fatalities. These accidents have been, or are being, investigated and reported on by the Air Accidents Investigation Branch, by law the UK's air accident investigator, and responded to by the CAA and other organisations as appropriate. The CAA does not have any privileged access to investigation information but maintains close liaison with the AAIB. The review has therefore not looked at the causes of accidents subject to ongoing AAIB investigations but has recognised published information.

1.8 Previous reports and reviews covering North Sea operations include:

- A review of helicopter airworthiness by the Helicopter Airworthiness Review Panel (HARP) of the Airworthiness Review Board (ARB) published in 1984;
- The Review of Helicopter Offshore Safety and Survival (RHOSS) in 1994 following the accident involving an AS332L Super Puma at the Cormorant Alpha platform in the East Shetland Basin in 1992 published in [CAP 641](#);
- Reviews One and Two into Helicopter Safety on the Norwegian Continental Shelf by the Norwegian Ministry of Transport and Communication in 2000-2002;
- The UK Health and Safety Executive (HSE) Helicopter Safety Record in 2004;
- A series of helicopter safety studies, covering the periods 1966-1990, 1990-1998 and 1998-2009, by the research organisation [SINTEF](#) for the Norwegian Oil Industry and Norwegian Civil Aviation Authority; and
- Various safety reviews by Oil & Gas UK, the trade association for the UK industry.

These studies are referred to in this report.

1.9 In examining all reportable UK offshore public transport helicopter accidents during the period 1976 to 2013, the main causal factors of these accidents were operational (pilot performance), technical (rotor and transmission failures) and

¹ [EASA NPA 2013-10](#) Helicopter Offshore Operations

environmental (lightning strikes). These factors have been similarly identified/classified by other international studies into the safety of offshore operations and will be examined in this review.

- 1.10 Set against this background, there has been a considerable amount of energy and research invested during the development of offshore operations by regulatory authorities, helicopter manufacturers, helicopter operators and the oil and gas industry into minimising the risks associated with such operations. Alongside this, the regulatory framework for helicopter specifications and operations has been developed using lessons learned from events and occurrences. Additionally, the International Oil and Gas Producers Association (OGP) has established guidelines which it provides to its members to apply in contracts with helicopter operators conducting offshore operations. These guidelines set requirements both at the international level and, through transposition, at a national level; for example, the UK Offshore Oil and Gas Industry Association (Oil & Gas UK) produce guidelines for use in offshore operations on the UKCS.

Aim

- 1.11 The aim of this review is to provide an expert status report to the CAA Board on the overall assessment of current safety performance of UK offshore helicopter operations and to take action or make recommendations to improve safety and survivability of passengers and crew with the ultimate target of minimising the likelihood of fatal accidents.
- 1.12 Throughout the report, safety interventions have been identified. The CAA has assumed activities that fall within its scope as Actions, and made Recommendations to other parties. Expectations have also been used in several recommendations to expand the possibilities for safety interventions beyond basic regulation. It is anticipated that all participants share this desire and will actively embrace their role in improving the safety of the industry.
- 1.13 In the context of this report, these terms are:
- Action – the CAA has identified a specific activity that it will undertake.
 - Recommendation – the CAA has identified an activity that needs to be undertaken by other parties, to whom a Recommendation is directed.
 - ◆ Expect – a recommendation where the CAA has identified an activity that would permit opportunities for nominated parties to take a leading role and make significant safety improvements without further regulatory intervention.

CHAPTER 2

The offshore industry and regulatory framework

- 2.1 The importance of the oil and gas industry to the economy of both the UK and Norway is clearly very significant. The use of helicopters to support the industry is essential and therefore the safety and resilience of these helicopter operations is key.

The offshore industry - UK

- 2.2 The UK Continental Shelf Act 1964 made provision for the exploration and exploitation of the UKCS. Seismic exploration and the first oil well followed later that year. Despite almost 50 years of exploitation, it is estimated that 40% of UKCS oil and gas reserves are still to be extracted², and that the UK could still be producing significant amounts of oil and gas for decades to come. The dynamics of the industry have changed from the 1970s and 1980s when a small number of very large fields dominated UKCS production, to today where production comes from a much larger number of fields, most of which are considerably smaller in size³. The major disaster to the Piper Alpha platform in 1988 provided the impetus for a thorough review of safety in the industry and the implementation of many safety improvements.
- 2.3 The offshore oil and gas industry could not operate efficiently without helicopters⁴. There are currently 228 helideck-equipped fixed installations and approximately 50-100 mobile helidecks in the UKCS⁵. The industry core workforce (those spending 100+ nights per year offshore) in 2012 was 25,760. As a measure of related helicopter activity, in the same year, just over 141,000 sectors were flown, consuming 86,000 flight hours and over a million passengers were carried. The majority of these passengers would be those flying regularly as part of their shift pattern.
- 2.4 Three UK helicopter companies operate approximately 95 aircraft in support of the exploitation of oil and gas around the UK: Bristow Helicopters Ltd; Bond Offshore Helicopters Ltd; and CHC Scotia Ltd. The main operating bases are: Aberdeen; Sumburgh; Scatsta; Norwich; North Denes; Humberside; and Blackpool. Three other UK helicopter companies regularly operate to offshore locations on a much smaller scale in support of renewable energy projects and marine navigation facilities.

2 [Oil & Gas UK](#)

3 2013 Oil & Gas UK [Economic Report](#)

4 2013 Oil & Gas UK [Health & Safety Report](#)

5 CAA (2013). Estimate

2.5 The UK oil and gas industry is represented by several bodies whose aims are to promote the efficiency and safety of the industry and whose members cover the whole spectrum of organisations that are involved. It is through these bodies that much of the overall safety of offshore operations is determined. These bodies include:

▪ **Oil & Gas UK**

- ◆ the leading representative body for the UK offshore oil and gas industry
- ◆ a not-for-profit organisation, established in April 2007 out of the former UK Offshore Operators Association (UKOOA)
- ◆ aims are to strengthen the long-term health of the offshore oil and gas industry in the UK by working closely with companies across the sector, governments and all other stakeholders to address the issues that affect the industry
- ◆ has working groups to support its aims including the Aviation Safety Technical Group (ASTG). Membership of this group comprises representatives of the CAA, the HSE, OGP, NATS⁶, the helicopter operators and selected oil and gas companies

▪ **Step change in safety**

- ◆ a member-based organisation which includes operators and contractors from the UK oil and gas supply chain
- ◆ established in 1997 when key trade associations decided that a “step change” in health and safety performance was required to meet the industry’s aspirations
- ◆ has working groups to support its aims including the Helicopter Safety Steering Group (HSSG)

▪ **The HSSG**

- ◆ its purpose is to act on behalf of the industry to steer priorities and be a focal point on helicopter safety matters
- ◆ has representatives from the helicopter operators, oil and gas operators and contractors, offshore trade unions, the pilots’ union British Airline Pilots Association (BALPA), the HSE, the CAA and Oil & Gas UK
- ◆ supported by the ASTG, which provides technical advice and guidance

6 [NATS](#) – provider of air traffic control services in UK

The offshore industry - Norway

- 2.6 The Ekofisk field was discovered in 1969, and has since contributed greatly to the economic prosperity of Norway. Forty years after oil production started on Ekofisk, the State's petroleum-financed pension fund has grown to more than £900 billion. Today the industry employs more than 200,000 people, and accounts for more than a third of the State's revenues. Around 90% of the profits from the industry goes to the State and are responsible for substantial value creation and employment, with significant positive local and regional effects. The main Norwegian oil company is Statoil whose majority shareholder is the Norwegian Government.
- 2.7 There are about 100 helideck-equipped fixed installations and approximately 20-40 mobile helidecks on the Norwegian Continental Shelf (NCS). As a measure of related helicopter activity, in 2012, approximately 57,000 flight hours were flown and about 850,000 passengers carried. Four Norwegian helicopter companies operate approximately 55 aircraft in support of the exploitation of oil and gas on the NCS: Bristow Norway; CHC Helikopter Service; Blueway; and Norsk Helikopterservice. Main operating bases are: Stavanger, Bergen, Brønnøysund, Hammerfest, and Kristiansund.
- 2.8 The Norwegian Oil and Gas Association (Norwegian Oil and Gas) is the professional body and employer's association for oil and supplier companies engaged in the field of exploration and production of oil and gas on the NCS. Norwegian Oil and Gas works to solve common challenges for its members and to strengthen competitiveness of the Norwegian oil and gas industry. The tripartite cooperation between the State, trade unions and the industry is considered a strength and forms the basis for the safety work on the NCS.
- 2.9 Following the Norwegian Government safety reviews in 2000-2002, the Committee for Helicopter Safety on the NCS was established to pursue offshore safety initiatives. The committee, whose aim is to work for a substantial improvement of the helicopter safety on the NCS, is chaired by a representative of the N-CAA and its members are drawn from the relevant authorities, helicopter operators, Air Traffic Service (ATS) providers, trade unions and industry. The committee has no executive powers but reports directly to the Ministry for Transport and the Director N-CAA.
- 2.10 Whilst the UK CAA participates in industry committees that together fulfil a similar remit, there is no single equivalent body in the UK. The UK's regulatory philosophy is founded on the absolute responsibility for safety resting with the helicopter operator, nevertheless, comparison with the Norwegian governance structure leads us to conclude that a stronger CAA leadership role should be established based on the Norwegian model. Commitment to cooperation between the two committees should be sought so that mutual benefits and outcomes are achieved. Likewise, cooperation with the other national authorities associated with European offshore operations should be established on a firmer footing.

- 2.11 Therefore the CAA intends to establish and lead a new offshore helicopter safety forum to drive forward the recommendations and actions identified within this report, and to:
- work for a substantial, and continuing, improvement in the safety of offshore helicopter operations.
 - provide an opportunity to review progress of all recommendations and actions arising from this review and other related safety reports.
 - liaise with Norway, and other NAAs with offshore interests, to share experiences and 'best practice'.

Action:

- A1 *The CAA will establish and lead a new offshore operations safety forum to work for a substantial improvement in the safety of helicopter operations on the UK continental shelf. (Delivery Q3/2014)*

Regulatory framework

- 2.12 The UK offshore oil and gas industry operates within a complex array of regulatory frameworks associated with each function and subject area. For offshore aviation, the main regulations cover aviation safety for air operations and health and safety at the interface with the oil platforms. The interaction and applicability of these regulations is important but complex; they are briefly described below.
- 2.13 The responsibility for regulating UK offshore health and safety and aviation operational safety rests with the Health and Safety Executive (HSE) and the CAA respectively. In order to promote co-operation and minimise duplication of effort a Memorandum of Understanding (MoU) has been established between the two organisations. The MoU aims to ensure coordination of policy issues, enforcement activity and investigation in respect of aircraft and the systems in which they operate. The MoU outlines the legislative framework under which the two organisations work and has a specific annex for Offshore Operations. The interface for offshore helicopter operational safety occurs on the helideck and in connection with the operation of facilities necessary to support safe operations on or in the vicinity of the installation. Full details of the relevant annex to the MoU are discussed at Annex E.
- 2.14 Aviation safety regulation within the UK is currently evolving from a national model to a pan-European model. Under these arrangements, rulemaking and the provision of regulations have been transferred from Member States to the European Union and its agency EASA. Aircraft initial certification and continued airworthiness have been the responsibility of EASA since 2003 and, more recently, European legislation has included engineer and then pilot licensing.

- 2.15 Currently in the UK, transportation of passengers or cargo by helicopters for remuneration or other valuable consideration is considered to be Public Transport (PT) and to conduct such flights legally operators must hold an Air Operator's Certificate (AOC) in accordance with the requirements of the [UK Air Navigation Order](#) (ANO). However, [Commission Regulation \(EU\) 965/2012](#) for air operations (EASA Ops), affecting the Commercial Air Transport (CAT) of passengers and cargo, will apply across the EU from 28 October 2014. This will supersede national regulations, bring a standardised regulatory framework for all Member States, and should remove any differences in application or interpretation of the rules.

Table 1: Aviation Safety – Functions and Responsibilities

Body / Agent	Role in Safety
European Union / European Aviation Safety Agency (EASA)	Determines European legal requirements for aviation domain, including Air Operations and Airworthiness
UK Civil Aviation Authority (CAA)	Responsible for UK aviation safety oversight within European or national regulatory regime. (Overlapping responsibilities interface at the helideck defined within Memorandum of Understanding with HSE)
Health & Safety Executive (HSE)	Regulates to reduce work-related death and serious injury in the workplace
Commercial Helicopter Operator	Responsible for safety of own operations within regulatory requirements

- 2.16 The aviation and health and safety regulations in Norway are applied in a similar way to the UK. Although Norway is not a member of the EU, it is a full EASA Member State and part of the European Economic Area (EEA), and will be bound by that agreement to apply EASA Ops at a national level. The relevant governmental bodies are the Norwegian Maritime Directorate and the Petroleum Safety Authority Norway which is closest to the UK HSE in this area.
- 2.17 The CAA oversight of AOC operators covers flight operations, aircraft maintenance, aerodromes and air traffic control. Audits and inspections take place on a rolling schedule at each company headquarters and at all operating bases against specific requirements informed by best practice. The inspection schedule is risk-based and determined against previous company performance, and the oversight will be varied accordingly. Many aspects, including management arrangements, company procedures, training and records are assessed. Close liaison is maintained with each operator between formal visits.

- 2.18 CAA inspecting staff are qualified and experienced personnel of all disciplines, trained in auditing techniques and, in the case of flight operations assessments, regularly fly on offshore flights to ensure safe practices are employed and that company procedures are being followed. Where any action is required, the operator must resolve these issues within an agreed timescale. Significant findings are required to be resolved immediately. Regulatory tools for diminished safety performance include an On Notice Procedure, temporary suspension or, ultimately, revocation of an approval. The Flight Operations Inspectors (FOI) provide oversight of 50 helicopter AOC companies, of which three are offshore operators in support of oil and gas, together with search and rescue and police operators, flight crew standardisation tasks and significant support to external projects.
- 2.19 The CAA is moving to a performance-based approach to safety regulation in order to protect the UK aviation community and the general public by identifying the highest aviation risks and ensuring that they are managed effectively. This is aligned with the approach to Safety Management Systems (SMS), which identify safety risks and generate the actions to address and manage those risks. The implementation of SMS is an integral part of EASA Ops which operators will be required to comply with; many companies have already embraced these systems in advance of the regulations coming into force and are seeing the benefits.
- 2.20 The principles of oversight explained above are matched in Norway by the N-CAA where they apply the same requirements in the oversight of 22 helicopter companies, of which four are offshore operators.

Regulatory support and development

- 2.21 The CAA hosts a periodic joint offshore liaison group of National Aviation Authorities (NAA) involving Norway, Denmark, Belgium, Holland, Germany, Ireland and EASA, where information on operating practices is exchanged. An informal agreement exists for the CAA to attend audits/inspections by these NAAs when conducted with their operators in the UK. In addition, the CAA maintains close links with the oil and gas industry, as members of the HSSG and ASTG, and manages a collaborative safety research committee (the Helicopter Safety Research Management Committee (HSRMC)) to focus efforts to best benefit and to influence other research where possible such as that undertaken by EASA.
- 2.22 Regulatory development is conducted at both national and European levels depending on the subject in hand. Increasingly requirements are being addressed by European legislation with EASA leading on developing the necessary regulations, with Member State input. Three EASA rule making tasks (RMT) dealing with offshore issues are currently underway and may be influenced by this review:
- [RMT.0409/0410](#), Helicopter Offshore Operations (HOFO);
 - [RMT.0120](#), Ditching Occupant Survivability; and
 - [RMT.0302/0515](#), Helicopter Height/Velocity Limitation.

CHAPTER 3

The review process

- 3.1 The scope of the review was based on statistical analysis of reportable occurrences and review of historical reports, studies and research. This focused the work into the following areas: protection of passengers and crew; operations; and, airworthiness topics. The detailed scope within operations and airworthiness was based upon the causal factors identified by the analysis. The principal discussion, conclusions and recommendations are contained within the main body of this report, with further detail and analysis provided and referenced in related annexes.
- 3.2 The analysis section details the analysis and review of UK and Norwegian accident and incident data and relevant UK, Norwegian and worldwide accident reports. The CAA has led a large number of research projects aimed at improving helicopter and offshore safety; a summary of these projects and their impact is included in the report.
- 3.3 The review into passenger protection and operations was enhanced by a series of stakeholder interviews and written submissions provided by BALPA and Oil & Gas UK. Input from the N-CAA allowed comparisons to be made. Some of the evidence gathered is necessarily subjective in nature and hence requires additional study to obtain objective evidence. The annexes provide further information and observation on some of these matters.
- 3.4 The airworthiness review focused on a detailed analysis of information from accident reports and Mandatory Occurrence Report (MOR) data. This identified specific technical issues which were investigated leading to subsequent recommendations. The airworthiness data and reporting of technical issues is more objective in nature than for operations and hence deemed a suitable approach for this topic. As the helicopters flown in the Norwegian sector are the same types as in the UK sector and are subject to the same regulations by EASA, there was less of a need for any specific airworthiness comparison with Norway.
- 3.5 The review was led by the CAA's Head of Flight Operations, Captain Robert Jones, a highly experienced commercial helicopter pilot, and completed by CAA experts in helicopter operations, helicopter training, air traffic management, survivability and airworthiness as detailed in the Terms of Reference at Annex A. The review team has been actively supported by the N-CAA and EASA during the whole process. Independence has been established by the use of a Challenge Team (CT) chaired by Rear Admiral Simon Charlier, a highly experienced operational helicopter pilot and latterly the Director (Operations) of the Military Aviation Authority. The other members of the CT were:

Mr Gary Cox	Transport for Scotland
Mr Jim Lyons	Independent helicopter expert
Mr Peter Norton	Chief Executive British Helicopter Association
Mr Felipe Nascimento	Imperial College London

- 3.6 Review meetings were held initially with the N-CAA and EASA to highlight areas for comparison which were then studied in detail by the team. A draft report was written and then reviewed by the Challenge Team who provided valuable feedback, advice and an opportunity to debate a number of issues. This final report incorporates comments made by the Challenge Team. The review team is grateful for the information and time given by all stakeholders in the review and their willingness to help. Full details of the stakeholders interviewed, Challenge Team members and a summary of the Challenge Team meeting can be found in Annex B.
- 3.7 This report highlights various areas for action and makes appropriate recommendations. The CAA will incorporate its actions into the appropriate safety or business plan and ensure that progress is tracked and notified as necessary. The CAA expects that where recommendations are made to other organisations, they will be given the appropriate attention based on safety and moral obligations rather than awaiting specific regulatory intervention.



SECTION B: ANALYSIS

CHAPTER 4

Occurrence investigation

- 4.1 The responsibility for the investigations of civil accidents and serious incidents within the UK and its overseas territories rests with the UK Air Accidents Investigation Branch (AAIB), a part of the Department for Transport. Similarly, the independent Accident Investigation Board (AIB) in Norway conducts their investigations. Both adhere to the International Civil Aviation Organization (ICAO) Annex 13 principles and EU legislation. In both countries accident investigation and subsequent safety regulation are kept distinct. It is important that their respective independence from each other is maintained.
- 4.2 Following investigations, the AAIB addresses Safety Recommendations to appropriate organisations which could include the CAA, EASA, aircraft manufacturers or operators. Addressees must respond as to how they intend to act on the recommendations which are intended to prevent a recurrence of what in the AAIB's opinion caused the accident. The AAIB tracks these actions and reports their status through its published Annual Safety Report. The CAA responds to the safety recommendations directed to it through its Follow-up Action on Occurrence Reports (FACTOR) which are published.
- 4.3 In the UK the Mandatory Occurrence Reporting Scheme contributes to the improvement of flight safety by ensuring that relevant information on safety is reported to the CAA and used to develop safety policy. The sole objective of occurrence reporting is the prevention of accidents and incidents and not to attribute blame or liability. Mandatory occurrence reporting is an EU requirement⁷ and Mandatory Occurrence Reports (MOR) must be forwarded to the CAA by various organisations, including AOC holders, and voluntary reporting is encouraged.
- 4.4 A reportable occurrence in relation to an aircraft is defined as:
Any incident which endangers or which, if not corrected, would endanger an aircraft, its occupants or any other person.
- 4.5 The CAA has established a suite of safety performance indicators (SPIs), predominantly based on accident and MOR data, that are monitored in support of one of its key strategic objectives, i.e. to enhance aviation safety performance by pursuing targeted and continuous improvements in systems, culture, processes and capability. Whilst these SPIs currently monitor safety performance for significant issues associated with large commercial air transport aeroplane

⁷ [EU Directive 2003/42/EC](#) dated 13 June 2003 on occurrence reporting in civil aviation

operations, the same principles can be extended to other aviation sectors such as public transport helicopter operations, business aviation and general aviation.

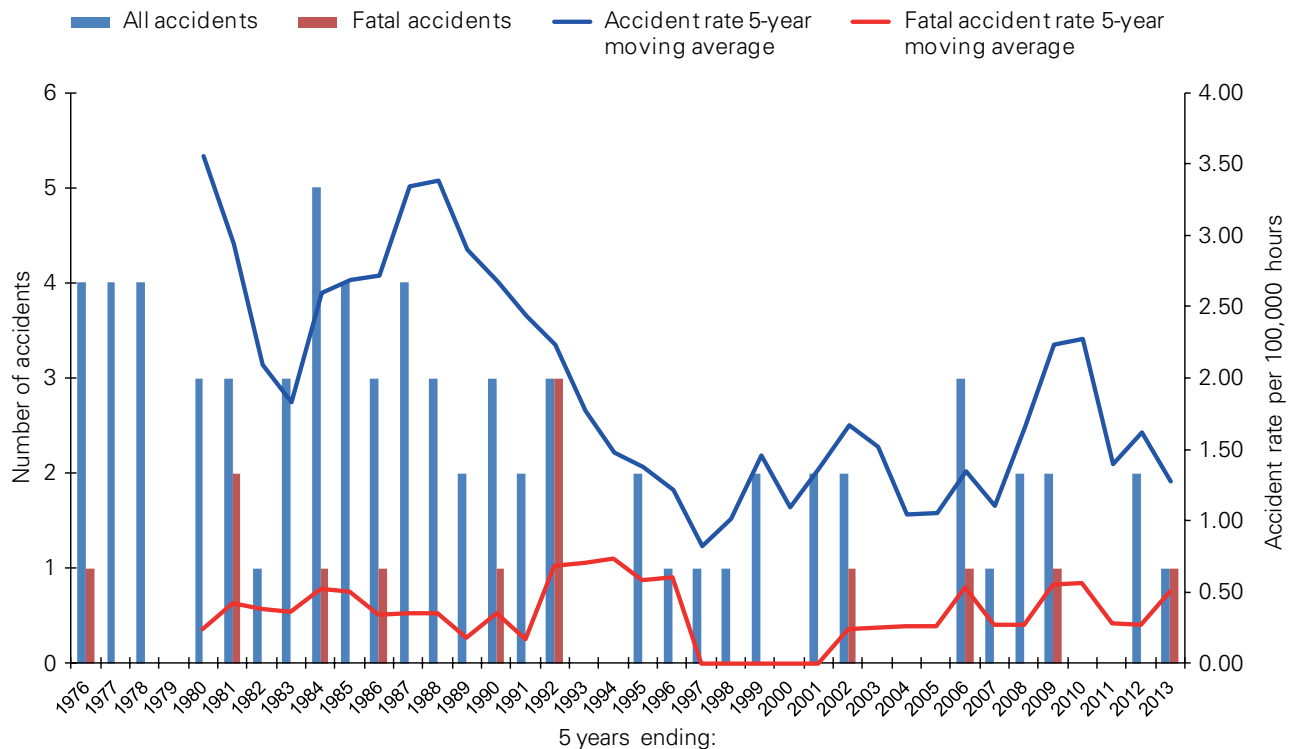
- 4.6 The SPIs include traditional lagging indicators, which evaluate events that have already occurred, and leading indicators, which measure activities that are expected to manage and improve safety performance (for example, the proportion of pilots that have undergone monitoring skills training). Measures of precursor events, which can be thought of as 'near misses', are also being developed through the analysis of lower severity MORs and Flight Data Monitoring (FDM) algorithms (for example, low airspeed events as a precursor to loss of control).
- 4.7 FDM is the systematic and pro-active use of digital flight data taken from routine operations to improve aviation safety within a non-punitive and just safety culture. FDM programmes assist an operator in identifying and addressing operational risks. Although not yet mandated for helicopters, the CAA and industry have been actively promoting and developing the programme for several years. Perhaps due to the lack of a requirement and the somewhat complex nature of helicopter operations, the rate of progress has not allowed the full potential to be realised yet. However, the developing EASA proposal for offshore helicopter approvals is expected to require an FDM programme for commercial air transport operations.
- 4.8 In December 2013, the CAA established a North Sea Helicopter Flight Data Monitoring (HFDM) user group with the helicopter industry, involving Bond, Bristow and CHC, as the next step in promoting and utilising this powerful tool. The group will facilitate the generation and sharing of safety information on offshore helicopter operations and drive forward the concept. This will mainly comprise of information derived from FDM data, and will allow a more comprehensive picture of offshore helicopter safety performance to be identified. The intention is to work with the three operators in 2014 to develop a safety performance dashboard for offshore helicopter operations and promote a continuous improvement cycle.

Action:

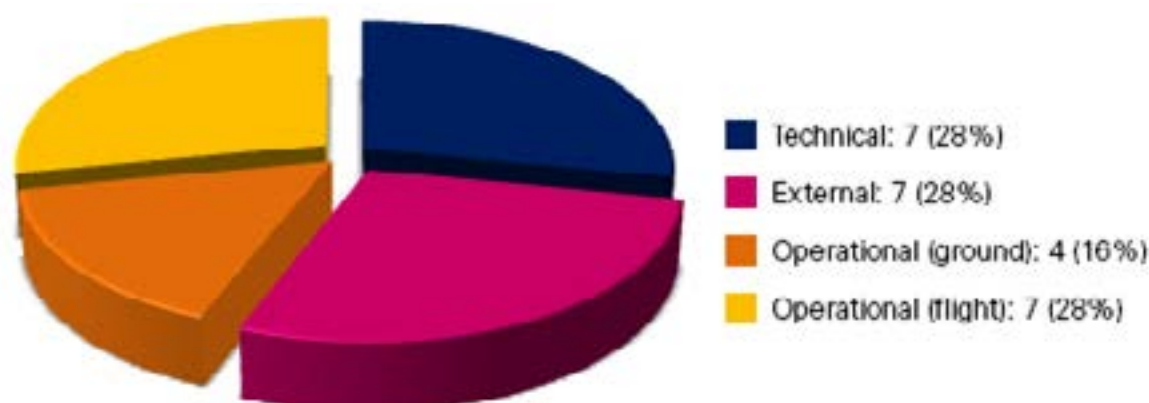
- A2 *The CAA will accelerate its work with industry to develop and apply Safety Performance Indicators to improve the effectiveness of helicopter operators' Flight Data Monitoring programmes. (Delivery Q3/2014)*

CHAPTER 5**Accident review**

- 5.1 In response to an apparent decrease in the safety performance of offshore helicopter operations following a ditching in May 2012, an internal CAA review of all UK offshore public transport helicopter reportable accidents during the period 1976 to 2012 was carried out for the CAA's Safety Action Group and subsequently presented to the CAA Board in October 2013. The review covered the period from the start of the MOR scheme in 1976 to the end of 2012 (the last full year of data at the time of this review).
- 5.2 The review focused on accidents as this data set is known to be robust and complete, and also provided an objective means of constraining the review to a manageable size while still retaining most of the high profile occurrences. The accidents were further restricted to operations directly associated with offshore oil and gas activities; the accidents included were agreed with Oil & Gas UK in order that the scope of their own safety review would be consistent with the CAA's.
- 5.3 The full report is contained in Annex C. The remainder of this section presents a summary of the review which has been updated to include 2013, comprising only the fatal accident at Sumburgh on 23 August. The rate data for 2013 is based on an estimate of hours flown as the definitive data is not yet available. The investigation is ongoing, but the cause of the accident in 2013 is believed to lie in the operational (flight) group.
- 5.4 The overall results presented in Figure 1 below. Five year moving averages are used to smooth the accident rate per flight hour data and help to identify any underlying trends. Plots based on accident rates per flight sector were also produced but, in the interests of brevity, are not presented as they did not identify any different patterns in the data.

Figure 1: Chronology of reportable accidents (rate per 100,000 flight hours)

- 5.5 The variation in the 'all accident' rate throughout the period is largely driven by variations in the technical cause accident rate. The operational and external cause accident rates are relatively constant, and the reduction in the 'all accident' rate from the early 1990s is driven by the corresponding reduction in the technical cause rate. The reduction in the technical cause rate accidents in the early 1990s is coincident and consistent with the introduction of Health & Usage Monitoring Systems (HUMS).
- 5.6 The characteristics of the underlying data change significantly from the early 1990s with operational, technical and external cause accident rates converging and stabilising (see Figure C4 in Annex C). Consequently, the period from 1992 to the end of 2012 is considered to be most representative of current operations and therefore formed the main focus of the review.
- 5.7 There were a total of 25 reportable UK offshore helicopter accidents during the period 1992 to 2013. The overall accident rate is just over one per year. This equates to 1.35 accidents per 100,000 flight hours or 0.66 per 100,000 flight sectors. The breakdown of the accidents during the period 1992 to 2013 by top level grouping is presented in Figure 2 below.

Figure 2: Offshore helicopter accidents for the period 1992 to 2013 by grouping

- 5.8 Overall, operational causes of accidents (flight and ground combined) dominate, accounting for 11 out of the 25 (44%) accidents. Technical and external cause accidents each account for seven out of the 25 (28%) accidents.
- 5.9 Most of the operational causes of accidents (73%) related to pilot performance issues such as flight crew perception and decision making (see Annex C for more detail). Most technical cause accidents (86%) related to rotor and transmission failures, and there is evidence of a tendency towards faults caused by deficiencies in the design and/or certification process in newer aircraft; this is explained further in Section F – Airworthiness and in Annex F. Most external cause accidents (86%) relate to lightning strikes.
- 5.10 The analysis reported here was necessarily performed on a comparatively limited data set. The sample size could be increased by extending the analysis to lower risk occurrences, however, care would need to be taken in relation to operational occurrences where under-reporting is believed to exist. Under reporting could result in a misleading picture and misdirection of attention and resources. For operational cause accidents, the helicopter operators' FDM programmes are considered to represent the best source of information. Although the flight data recorders (FDR) used for accident investigation are mandated, the everyday use of FDR information via FDM is not currently required for helicopters. The CAA therefore has no right of access to the voluntary programmes that have relatively recently been implemented by the helicopter operators. However, the HFDM user group, as mentioned at paragraph 4.7, will facilitate access to this valuable source of information.
- 5.11 The analysis was extended by reviewing accidents involving offshore helicopter types engaged in onshore operations or operating in other areas around the world. This exercise, briefly covered in Part 21 and reported in Section 3 of Annex F, covered the period 1992 to 2012 and focused on technical cause accidents as operational and external cause accidents could be influenced by operating

culture and environment. Results indicate design issues to be the cause in the vast majority (83%) of the relevant accidents reviewed.

- 5.12 The fatal accident rate was stable throughout the period 1976 to 2013 at just over one every three years. This equates to 0.37 per 100,000 flight hours or 0.17 per 100,000 sectors. Of the 25 reportable accidents during the period 1992 to 2013, seven (25%) involved fatalities. The fatal accidents comprise five (71%) operational cause accidents and two (29%) due to technical causes; there have been no external cause fatal accidents. The main cause of operational fatal accidents (75%) is pilot performance issues, and the cause of both technical fatal accidents (100%) is rotor and transmission failures.
- 5.13 The 13 fatal accidents during the period 1976 to 2013 resulted in a total of 119 fatalities which, on average, equates to 70% of the occupants. The seven fatal accidents during the period 1992 to 2013 resulted in a total of 51 fatalities which, on average, equates to 71% of the occupants. Technical accidents have almost always been more severe than operational accidents in terms of fatalities, both as an absolute number and expressed as a proportion of the total number of occupants. This may be related to the tendency for technical accidents to occur at relatively high altitudes and speeds compared to operational accidents, where the prospects of survival in the event of an impact are reduced.
- 5.14 Another way of measuring safety performance in respect of fatal accidents is that of mortality risk, which is the probability of a passenger not surviving a randomly chosen flight. At 0.5 per million flights, the mortality risk for offshore helicopter occupants is 10 times higher than for jet Commercial Air Transport (CAT) passengers. Due to the more complex nature of the aircraft used and the more hazardous operating environment, it is not considered realistic to expect the level of safety of offshore helicopter operations to match that of jet transport operations. Nevertheless, it is the view of the CAA that significant scope for improvement does exist and it is the aim of the actions and recommendations in this offshore review is to realise those improvements.

Actions:

- A3 *The CAA will analyse lower risk occurrences (i.e. serious incidents and incidents) for the main areas of risk, technical and external cause occurrences in particular, in order to increase the 'resolution' of the analysis. This analysis will take the form of a rolling annual review of the last five years of occurrence reports. (Delivery Q3/2014)*
- A4 *The CAA will work with the helicopter operators via the newly established Helicopter Flight Data Monitoring (HFDM) User Group to obtain further objective information on operational issues from the operators' FDM programmes. (Delivery Q4/2014)*

CHAPTER 6

Comparison with Norway

6.1 The UK occurrence data was compared to the equivalent data for Norwegian offshore helicopter operations. The comparison was constrained by the data that was readily available from Norway; however, the following conclusions were drawn:

- In the period 1992 to 2012, the Norwegians suffered 1 fatal accident against 6 in the UK sector. In terms of the fatal accident rate this equates to:

	Number of fatal accidents	Hours	Fatal accident rate per 100,000 hrs
UK	6	1,754,512	0.34
Norway	1	926,926	0.11

- ◆ Although the accident rates may, at face value, appear to indicate a difference in level of safety performance between Norwegian and UK operations, the application of a range of statistical tests indicates that the difference is not statistically significant.
- Overall, comparison of the Norwegian and UK occurrence data indicates similar patterns. In particular:
 - ◆ The occurrence data for the period 2008 to 2012 is dominated by technical issues, System/Component Failure – Non-Powerplant being by far the dominant code in both the UK and Norwegian data sets.
- Notable differences, however, are:
 - ◆ Norway began its MOR programme in 2007.
 - ◆ From 2008 onwards, the rate of occurrence reporting has been higher in Norway than in the UK. This could reflect a higher rate of actual occurrences or it could be indicative of a better reporting culture which might be expected following the introduction of a formal reporting system.
 - ◆ For the period 2008 to 2012, the 'Operations – Flight' and 'Operations – Ground' accident cause groups are reversed with 'Operations –Ground' dominating in Norway. The CAA is unaware of any explanation for this feature in the data.

6.2 Further details are presented in Annex C.

CHAPTER 7

Review of AAIB reports

- 7.1 Following the concerns stated in Chapter 4, a review of AAIB accident investigation reports from 1992 to 2013 was undertaken to establish the status of any Safety Recommendations that had been made to the CAA associated with offshore operations or relevant occurrences to helicopter types similar to those used offshore. Additionally, reports from Norwegian and other foreign countries' AIBs, associated with similar offshore helicopter types and environments, were sought, and in all over 140 reports were referenced and reviewed by the team.
- 7.2 The purpose of the review was to look for causal factors and assess the closure statements for their relevance and completeness. Of the worldwide accidents that were relevant to this environment, an examination of the causal factors revealed that most were a combination of those found in the accident review (Chapter 5), and followed similar trends.
- 7.3 Although all recommendations made to the CAA are reviewed and responded to individually, the review identified that this review process made it difficult to establish the completeness and effectiveness of the responses and actions undertaken. Along with the gathering of all relevant in-service data, it is considered that a structured management system that collates, reviews and analyses all such data, and draws upon the experience of other similar bodies such as the North Sea NAAs, EASA and the AAIB, should be formed.

Recommendations:

- R1 *It is recommended that EASA leads the development of a management system that provides a structured review of all accident and serious incident reports and recommendations of helicopters operating offshore or events which could have led to a ditching if the helicopter had been over water. This should be done in collaboration with other North Sea NAAs and the CAA to ensure a cohesive assessment of both accident causes (looking for trends) and remedies (looking for suitability and effectiveness) in order to prevent the segregated nature of accident reviews and ensure there is continuity to the safety reviews.*
- R2 *It is recommended that EASA involve NAAs annually in a forum to agree and exchange information on the performance of safety actions taken in line with accident and serious incident investigation recommendations and potential other improvements that could be adopted, where appropriate.*

Airworthiness review

- 7.4 An airworthiness analysis of the causal factors in recent accidents on the UKCS was conducted. This revealed that where steps have been taken to eliminate certain features from the specific item that had failed, equivalent action should also be taken by manufacturers where similar features arise in their total product line. The review noted that in one accident there was only one maintenance opportunity that could have detected the problem and prevented the accident. In large transport aeroplanes it would be expected that at least two or three maintenance interventions would have the potential to detect component degradation prior to failure.
- 7.5 Recent offshore rotorcraft accidents also highlighted specific features that contributed to the failure of the component. Once highlighted by the investigation the rotorcraft manufacturer has taken steps to eliminate these features from the specific item; however, action should also be taken where similar features exist in the manufacturer's total product line.

Recommendations:

- R3 *It is recommended that EASA introduces procedures to monitor and track the efficiency and reliability of maintenance interventions when these are used during the certification activity to assure the safety target of the rotorcraft.*
- R4 *It is recommended that EASA ensures that the Type Certificate Holder completes a design review following a failure or malfunction of a component or system on any other similar feature on that aircraft type or any other type in their product line and defines appropriate corrective actions as deemed necessary.*

Operations review

- 7.6 The operations review team also reviewed the safety recommendations addressed to the CAA relating to operations and training from the 24 UK offshore accidents in the period 1992-2012 with a view to assessing the status of the CAA responses and where possible the outcomes. Sixteen of the accident reports revealed 40 operational-based safety recommendations varying from one per accident to 11 for one alone. Many of the responses to these recommendations resulted in letters to operators or similar action with unclear outcomes. With improving analysis techniques, as described in 4.5, the work of the new offshore helicopter safety forum and the possibility introduced by Recommendation R1, it is anticipated that there will be a significant improvement in the assessment and achievement of safety interventions.

SECTION C: PASSENGER SAFETY AND SURVIVABILITY

CHAPTER 8

Background

- 8.1 The safety of the UK citizen forms the core of the CAA's activities as a safety regulator. In view of the context of the Offshore Review, this Section focuses on the protection of passengers in the event of an air accident and does not consider Health and Safety at Work issues. The full report on the review of this aspect of offshore helicopter operations is contained in Annex D together with the arrangements for aeronautical search and rescue (SAR) in UK and neighbouring waters. The remainder of this Section comprises a summary of the review.
- 8.2 Whilst priority will continue to be given to addressing the causes of accidents, in view of the complexity of the aircraft concerned and the inherently hazardous environment in which they operate, it is unrealistic to expect to be able to prevent all offshore helicopter accidents. This review therefore focuses on mitigating the consequences of accidents in terms of protecting passengers and crew against injury or death.

CHAPTER 9**Ditching and water impact**

- 9.1 For the vast majority of the time during offshore operations, the helicopter is flying over open water. Any technical failure preventing continued safe flight or any contact with the surface due to operational failures or external factors will very likely result in the helicopter arriving in the sea. Such eventualities are already addressed in the airworthiness and operational rules, but there are long-standing issues which the CAA has been attempting to address for a number of years, initially via the Joint Aviation Authorities (JAA) and currently via EASA.
- 9.2 The key issues are:
- a) The sea-keeping performance required of ditched helicopters (i.e. sea conditions which the helicopter is designed and certificated to withstand) is inadequate for the wave climate in 'hostile' sea areas such as the North Sea leading to an excessive risk of capsize post ditching.
 - b) The certification requirements do not address water impacts, leading to inadequate post-crash operability of emergency flotation systems; helicopters almost always rapidly capsize and/or sink in the event of a water impact.
 - c) The time required to escape from a flooded and usually inverted helicopter cabin will exceed the ability of at least some of the occupants to hold their breath.
 - d) There are no regulatory restrictions on operations over sea conditions where a reasonable prospect of safe rescue cannot be assured.
- 9.3 During the period from 1976 to the end of 2012 there were a total of 12 ditchings and 16 water impacts in the UK sector. Although none of the ditchings resulted in fatalities, a safety assessment performed using established aviation criteria (EASA Certification Specification 27 & 29.1309) indicates that loss of life as a result of post-ditching capsize in hostile sea areas such as the North Sea is to be expected. The safety assessment is reproduced in Appendix 2 to Annex D.
- 9.4 As regards water impacts, seven of the 16 were considered to be non-survivable, i.e. there were no survivors or only a very small number of the occupants survived. Of the 38 fatalities that resulted from the nine survivable water impacts, 31 failed to escape from the helicopter. For these 31 fatalities, the main cause of death was drowning, with only three of the deaths due to incapacitation. This echoes the results of larger studies (see CAA Paper 2005/06), which also found that the main cause of death is drowning. Six of the seven that managed to escape from the helicopter then perished in adverse sea conditions (sea state 7) before they could be rescued. A further survivable water impact

occurred in 2013 involving 4 fatalities; this has not been included in the analysis as the investigation is ongoing at the time of this review.

9.5 As a result of these accidents, a number of opportunities for improvement have been identified and a series of joint industry reviews have taken place. The key initiatives have been:

- Helicopter Airworthiness Review Panel – HARP Report (CAP 491), 1984.
- Review of Helicopter Offshore Safety and Survival – RHOSS Report (CAP 641), 1995.
- JAA Helicopter Offshore Safety and Survival (HOSS) Working Group – HOSS/ WP-99/8.5 (published as Appendix F to [CAA Paper 2005/06](#)).
- JAA / Federal Aviation Administration (FAA) Joint Harmonisation Working Group (JHWG) on Water Impact, Ditching Design & Crash-worthiness Working Group (WIDDCWG) – Report (published as Appendix G to CAA Paper 2005/06).
- EASA Helicopter Ditching, Water Impact & Survivability Workshop, December 2011.
- EASA Ditching & Survivability Rule Making Task RMT.0120 (27 & 29.008), launched October 2012.

9.6 At the time of HARP, British Civil Airworthiness Requirements (BCAR) were in force, but by the time of the RHOSS report the design requirements had been harmonised across Europe into Joint Aviation Requirements (JAR) and simultaneously with the North American Federal Aviation Requirements (FAR). While the industry benefited from harmonised requirements, it also resulted in a degree of dilution of the requirements and a reduced ability of the UK to effect improvements. As a result of the RHOSS report, the joint working groups eventually achieved agreement on the need to address this area of the requirements. The JAA Rotorcraft Steering Group (RSG) subsequently reviewed all of the findings and categorised them as either: changes to the advisory material; changes to the rules; or areas in need of further research. Some changes to the advisory material were made, but progress was interrupted by the transfer of responsibility for airworthiness to the then new EASA in September 2003. EASA did undertake to progress the work and it was initially listed on their 2005/2007 Future Rulemaking Plan. However, this was subsequently delayed due to the need to undertake further work on the side-floating concept, which was performed by Eurocopter under contract to EASA during 2007/2008.

9.7 Starting in 2006, industry, with the support of authorities (including the FAA and EASA), initiated a review of all rotorcraft safety under the International Helicopter Safety Team / European Helicopter Safety Team. One of the aims was to establish the causes of rotorcraft accidents and to prioritise intervention

strategies to make the biggest gains in safety. By 2011, ditching/water impact was identified in the top-ten list of future rulemaking initiatives. A workshop precursor to the RMT was organised by EASA and took place in December 2011, with the aim of gathering information and scoping the rulemaking task. The RMT itself, which is currently addressing the rule changes, was formally started by EASA in October 2012.

- 9.8 Under the current EASA RMT, a Notice of Proposed Amendment to the rules is scheduled to be published in mid-2014. In its published rulemaking programme 2014-2017, EASA has indicated that the task will be completed in 2016 with publication of new design standards. Although there is presently good agreement on a range of improvements to the rules and advisory material within the RMT working group in respect of new applications for certification (i.e. new helicopter designs), the proposals may be moderated in terms of safety improvement impact by the Regulatory Impact Assessment (RIA) and industry consultation phases. There is further uncertainty regarding how many of the improvements will be mandated for retrospective application to the existing fleet and the timescale of the RMT is, itself, a matter of concern in as much as anything that it does deliver will be in the medium to long term.
- 9.9 Although the current rules and advisory material leave significant room for improvement, the oil and gas industry has voluntarily introduced some worthwhile improvements in the form of helicopter Automatic Float Deployment Systems (AFDS) and Emergency Breathing Systems (EBS).
- An AFDS significantly improves the post-crash operability of the helicopter Emergency Floatation System (EFS), has demonstrated its ability to save lives and has been recommended for inclusion in the requirements by the UK AAIB after the crash in 2009 (G-REDU).
 - An EBS mitigates the consequences of capsizing by extending the underwater survival time of occupants and is issued to passengers by the oil and gas companies. Independent research commissioned by the CAA that has culminated in the production of a draft performance specification ([CAP 1034](#)) implies, however, that the form of EBS presently deployed is likely to be effective only in the case of ditching where it can be deployed in good time and prior to submersion, i.e. the EBS currently deployed is likely to only meet the CAP 1034 Category 'B' standard. It is unlikely to be adequate in the event of a water impact where deployment at very short or no notice and/or underwater is likely to be required, i.e. the CAP 1034 Category 'A' standard.
- 9.10 In view of the uncertain outcome of the EASA RMT and the timescales of any safety improvements that it does deliver, the CAA is of the view that consideration of further measures in advance of the EASA final decision is warranted to address the weaknesses identified in paragraph 9.2 above. Adopting this approach ensures that life-saving improvements to the aircraft and/or survival equipment would be introduced sooner and would help to reinforce

the EASA RMT proposals. In particular, the passage of the RIA would be facilitated by effectively reducing the cost to industry of the introduction of the regulatory changes. This would make inclusion in the requirements and a level playing field for all European helicopter operators more likely. The measures and the supporting rationale are described in paragraphs 9.11 through 9.15 below.

- 9.11 Regarding the sea keeping performance required of ditched helicopters (paragraph 9.2(a)), the emergency floatation system (EFS) is usually described in a supplement to the Aircraft Flight Manual but is currently not addressed in the Limitations section. Following the standard aviation system safety analysis methodology, in view of the historic ditching rate (3.4 per million flight hours) and the likely consequences of post-ditching capsizes ('hazardous'), in order to minimise the probability of post ditching capsizes operations should be prohibited when the sea conditions at the offshore location that the helicopter is operating to/from exceed its certificated ditching performance.
- 9.12 Owing to deficiencies in the way in which compliance with the ditching requirements is presently demonstrated, it is possible that the ditching performance of current helicopters in real sea conditions will be less than that claimed. A conservative approach, in respect of the proposed operational limitation would therefore be to downgrade the claimed seakeeping performance of existing helicopters by one sea state unless or until evidence of testing equivalent to the new guidance proposed by independent experts to the EASA RMT is presented and accepted. Table 1 below illustrates the likely impact of this restriction on North Sea operations in terms of all year average figures.

Table 2: Impact of restricting operations to certificated helicopter ditching performance

Operating Area	Helicopter Ditching Performance (Sea State)			
	3	4	5	6
	% Operations Lost			
Average all areas	61.8	27.7	8.55	1.4
Northern North Sea / West of Shetlands (avg. routes A & B*)	66.4	33.8	12.2	2.4
Mid North Sea (avg. routes C & D*)	55.0	19.8	4.3	0.4
Southern North Sea (avg. routes E & F*)	64.0	29.7	9.2	1.4

* See [CAA Paper 2005/06](#), Appendix E1.

- 9.13 In respect of addressing survivable water impacts (paragraph 9.2(b)), prevention of capsizing is considered to be impractical hence it is necessary to, instead, mitigate the consequences. The first concern is that the helicopter does not sink as this will seriously reduce the prospects of safe egress. Research has established that this is best achieved by improving the crash-worthiness of the EFS, i.e. by ensuring that the EFS is armed and activated, and that there is sufficient redundancy in the system to allow for a degree of impact damage. The following measures are required to achieve this outcome:
- a) Operating procedures should require the EFS to be armed for all overwater departures and arrivals, and consideration should also be given to modifying the AFDS already fitted to provide an automatic arming/disarming function to ensure that the EFS is deployed in all water impacts.
 - b) Fitment of the side-floating helicopter scheme; the additional floatation unit(s) required to provide the reversionary side-floating attitude also provide sufficient redundancy to allow for the partial failure of the 'standard' floats.
- 9.14 As regards the mismatch between escape time from a submerged helicopter cabin and breath hold time (paragraph 9.2(c)), it has been demonstrated that escape time for occupants who have to await the egress of another prior to making their own escape will very likely exceed breath hold times in the water temperatures expected in the North Sea. This could be addressed by any one of the following measures:
- a) Introducing an operational restriction allowing only passenger seats adjacent to push-out window emergency exits to be occupied from where escape time from a capsized helicopter is commensurate with breath hold time; or
 - b) Increasing underwater survival time by deploying EBS. In order to cater for survivable water impacts as well as ditchings, the EBS would need to meet the Category 'A' performance specification contained in CAP 1034, i.e. the EBS must be deployable underwater in a time period commensurate with likely breath hold time (see paragraph 9.9 above); or
 - c) Fitment of the side-floating helicopter scheme which ensures that an air gap is retained within the cabin post capsizing, removing the time pressure to escape and providing escape routes above the water level to facilitate egress.

With reference to Annex D (see paragraph 3.3.3.4), escape time can also be affected by a number of factors including ease of exit location and operation, and exit size in relation to passenger body size (including survival equipment). Escape time could be reduced by:

- d) Installing hand holds next to windows to improve exit location, assist operation of push-out windows and help overcome the effects of buoyancy.
- e) Standardising and improving the operation/marketing/lighting of push-out window emergency exits.
- f) Applying a restriction to passenger size commensurate with push-out window exit size (see [EASA CS 29.807](#) for details).

Regarding measure (f), increasing the size of the push-out window exits (or any other exit) on an existing helicopter is generally impractical, but the same result in terms of compatibility between exit size and passenger size could be achieved by applying a restriction to the latter.

- 9.15 With regard to ensuring reasonable prospect of safe rescue (paragraph 9.2(d)), there is no consistent or recognised standard across all helicopter operators, although life rafts are designed to cope with conditions up to sea state 6 (but may be very difficult to deploy in wind speeds normally associated with sea state 6). One operator allows the flight crew to make their own decision regarding whether to launch, but most rely on the declaration by the safety boat at the destination that there is a “good prospect of recovery” from the sea in the event of a ditching. This generally implies a significant wave height of less than 7 metres which equates to a limit of sea state 7. For sea states at the higher end of this range recovery would be reliant on use of the Dacon Scoop, a mechanical device that utilises a net to ‘fish’ the survivor out of the water, which is not favoured by flight crews. Offshore helicopter operations in Canada take place in similar if not worse sea conditions; Transport Canada is in the process of introducing a sea state 6 limitation. Taking all factors into consideration, the CAA is of the view that offshore operations should be prohibited when the sea conditions exceed sea state 6⁸.

In addition, the CAA believes that the following EASA RMT proposals are relevant to survival following egress and serious consideration should be given to implementation in advance of the EASA final decision:

- a) Ensure that external life rafts can be released by survivors in the sea in all foreseeable helicopter floating attitudes.
- b) Ensure that all life jacket/immersion suit combinations are capable of self-righting.

- 9.16 Summarising the content of paragraphs 9.11 through 9.15, passenger safety and survival is maximised by:
- a) preventing capsizing following a ditching (because measures to mitigate capsizing are unlikely to be 100% effective);

⁸ The World Meteorological Organisation definition of sea state 6 is a significant wave height of 4 to 6 metres.

- b) preventing sinking following a survivable water impact (because the prospects of successful egress are significantly reduced in the event of sinking);
- c) mitigating the consequences of capsize (post ditching and post water impact) by addressing the mismatch between escape time and breath hold time;
- d) mitigating the consequences of capsize (post ditching and post water impact) by reducing escape time;
- e) ensuring that passengers can survive and be rescued following egress.

9.17 The key measures that could be deployed in order to improve passenger safety and survival together with the scope of their effect and estimates of their relative cost and lead times are detailed and discussed further in Annex D. However, in view of the objective of both supporting the ongoing work of EASA RMT.0120 and providing interim solutions pending the EASA final decision in 2016, the following strategy has been determined:

- a) With effect from 01 June 2014, all offshore helicopter operations are to be prohibited when the sea conditions at the intended offshore location which the helicopter is operating to/from exceed sea state 6.
- b) With effect from 01 September 2014, operations are to be prohibited when the sea conditions at the intended offshore location which the helicopter is operating to/from exceed the certificated ditching performance of the helicopter. This measure will effectively supersede (a) above and will entail the helicopter operators establishing the realistic sea keeping performance of their aircraft types.
- c) With effect from 01 June 2014, helicopter operators' operating procedures will require the EFS to be armed for all overwater departures and arrivals.
- d) With effect from 01 June 2014, helicopter operators are to ensure that for all offshore helicopter operations only passenger seats adjacent to push-out window emergency exits are to be occupied. This restriction will not apply when either:
 - i) EBS meeting CAP 1034 Category 'A' performance specification is worn by all passengers; or
 - ii) side-floating EFS is fitted.
- e) With effect from 01 April 2016, helicopter operators are to ensure that for all offshore helicopter operations all occupants (passengers and crew) wear EBS that meets the CAP 1034 Category 'A' performance specification. This restriction will not apply when the helicopter is equipped with side-floating EFS.

- f) With effect from 01 April 2015, helicopter operators are to ensure that only passengers with a body size (including all required safety and survival equipment) commensurate with push-out window exit size are carried on offshore helicopter flights.

None of the above restrictions are to apply to offshore helicopter flights conducted in direct response to an offshore emergency.

9.18 The timescales and associated rationale for the measures listed in paragraph 9.17 above are as follows:

- a) Prohibit offshore operations when sea conditions exceed sea state 6 (paragraph 9.17 (a)) - this restriction can be implemented with a very short lead time; a modest period of notice is considered appropriate, however, in order to allow for any training and/or promulgation of procedures leading to an implementation date of 01 June 2014. The initial impact will be ameliorated to some extent by the calmer sea conditions during the summer months.
- b) Prohibit offshore operations when sea conditions exceed the certificated sea keeping performance of the helicopter (paragraph 9.17 (b)) – due time needs to be allowed for the helicopter operators to establish the realistic ditching performance of their helicopter types. That means either obtaining evidence of testing equivalent to the new guidance proposed by independent experts to the EASA RMT to support the claimed sea keeping performance, or downgrading the claimed sea keeping performance by one sea state. The implementation date of 01 September 2014 coincides with the onset of heavier sea conditions hence exposure during the interim period is limited.
- c) Revise operating procedures to require the EFS to be armed for all overwater departures and arrivals (paragraph 9.17 (c)) – this measure can be implemented with a very short lead time; a modest period of notice is considered appropriate, however, in order to allow for operations manuals to be updated and any required flight crew notices to be produced and issued, hence the implementation date of 01 June 2014.
- d) Only passenger seats adjacent to push-out window emergency exits are to be occupied on all offshore helicopter operations (paragraph 9.17 (d)) – this restriction can be implemented with a very short lead time; a modest period of notice is considered appropriate, however, in order to allow for schedules to be adjusted and any other provision/planning required to be instigated in order to mitigate the consequences. Since the side-floating helicopter scheme represents a medium to long lead time measure, this restriction can most expeditiously be removed by the deployment of CAP 1034 Category 'A' EBS. It is expected that Category 'A' EBS could be introduced within a period of one to two years.

- e) Requiring the deployment of CAP 1034 Category 'A' EBS (paragraph 9.17 (e)) this will alleviate seating restrictions and provide all occupants with similar protection for underwater escape. Introducing the requirement from 01 April 2016, allows reasonable time for procurement, training and introduction. It is anticipated that those helicopter types most affected by the seating restrictions would introduce the requirement first in order to recover load capacity. The requirement may be relieved by the introduction of the side-floating scheme.
- f) Restricting passengers to a body size (including all required safety and survival equipment) commensurate with push-out window exit size on all offshore helicopter flights (paragraph 9.17 (f)) – this is considered to be a short lead time measure although some notice will reasonably be required in order to establish an appropriate metric and associated limit, and to implement a scheme to measure the offshore workforce. It is anticipated that body size will form an additional requirement for qualification for working offshore. An implementation date of 01 April 2015 is therefore considered appropriate.

9.19 In addition to the measures listed in paragraph 9.17 above, the CAA expects Oil & Gas UK to require their contracting helicopter operators to implement the following key items from the EASA RMT.0120 (27 & 29.008) draft NPA:

- a) Fitment of the side-floating helicopter scheme.
- b) Implement automatic arming/disarming of Emergency Floatation Equipment.
- c) Install hand holds next to all push-out window emergency exits.
- d) Standardise push-out window emergency exit operation/marketing/lighting across all offshore helicopter types.
- e) Ensure that external life rafts can be released by survivors in the sea in all foreseeable helicopter floating attitudes.
- f) Ensure that all life jacket/immersion suit combinations are capable of self-righting.

9.20 Another existing oil and gas industry safety initiative is the offshore safety and survival training that it mandates for its employees who travel on offshore helicopters. The training standards are established by the Offshore Petroleum Industry Training Organisation (OPITO), the oil and gas industry focal point for training and workforce development. This has been reviewed and a number of potential improvements have been identified and the CAA would expect them to be applied. These include:

- Improving the fidelity of the training in respect of environmental factors such as wind, waves, precipitation, and lighting level.

- Improving the fidelity of the training in respect of including escapes through 'worst case' exits and cross-cabin escapes.
- Increasing the frequency of refresher training; this is presently every four years which is widely regarded by experts as being inadequate.
- Including exposure of trainees to representative examples, in role and type, of real helicopters.

9.21 At present, however, no passenger training other than the pre-flight video briefing (currently being revised to clarify EBS capabilities in response to the Safety Action contained in [AAIB Special Bulletin S1-2014](#)) is required under aviation requirements. Provided that the training given is not counter-productive, it could be argued that there are no grounds for criticising what is provided. If safety and survival training is considered to be essential, then EASA should make it a requirement and would need to determine the form, format and frequency of training required. This matter should be considered by the EASA RMT.

Actions:

- A5 *With effect from 01 June 2014, the CAA will prohibit helicopter operators from conducting offshore flights, except in response to an offshore emergency, if the sea state at the offshore location that the helicopter is operating to/from exceeds sea state 6 in order to ensure a good prospect of recovery of survivors.*
- A6 *With effect from 01 September 2014, the CAA will prohibit helicopter operators from conducting offshore flights, except in response to an offshore emergency, if the sea state at the offshore location that the helicopter is operating to/from exceeds the certificated ditching performance of the helicopter.*
- A7 *With effect from 01 June 2014, the CAA will require helicopter operators to amend their operational procedures to ensure that Emergency Floatation Systems are armed for all overwater departures and arrivals.*
- A8 *With effect from 01 June 2014, the CAA will prohibit the occupation of passenger seats not adjacent to push-out window emergency exits during offshore helicopter operations, except in response to an offshore emergency, unless the consequences of capsizing are mitigated by at least one of the following:*
- a) *all passengers are wearing Emergency Breathing Systems that meet Category 'A' of the specification detailed in CAP 1034 in order to increase underwater survival time;*
 - b) *fitment of the side-floating helicopter scheme in order to remove the time pressure to escape.*
- A9 *With effect from 01 April 2015, the CAA will prohibit helicopter operators from carrying passengers on offshore flights, except in response to an offshore emergency, whose body size, including required safety and survival equipment, is incompatible with push-out window emergency exit size.*

A10 *With effect from 01 April 2016, the CAA will prohibit helicopter operators from conducting offshore helicopter operations, except in response to an offshore emergency, unless all occupants wear Emergency Breathing Systems that meet Category 'A' of the specification detailed in CAP 1034 in order to increase underwater survival time. This restriction will not apply when the helicopter is equipped with the side-floating helicopter scheme.*

Recommendations:

R5 *The CAA expects that offshore helicopter operators will address the following key items from the EASA RMT.0120 (27 & 29.008) draft NPA without delay:*

- *Fitment of the side-floating helicopter scheme.*
- *Implementation of automatic arming/disarming of Emergency Floatation Equipment.*
- *Installation of hand holds next to all push-out window emergency exits.*
- *Standardisation of push-out window emergency exit operation/marketing/lighting across all offshore helicopter types.*
- *Ensure that external life rafts can be released by survivors in the sea in all foreseeable helicopter floating attitudes.*
- *Ensure that all life jacket/immersion suit combinations are capable of self-righting.*

R6 *It is recommended that the EASA Helicopter Ditching and Survivability RMT.0120 consider making safety and survival training for offshore passengers a requirement.*

R7 *The CAA expects that OPITO will review and enhance its safety and survival training standards with regard to the fidelity and frequency of training provided. (Delivery Q4/2014)*

CHAPTER 10**Fire-fighting**

- 10.1 In general, post-crash fire is a major hazard in all aviation accidents, and is exacerbated where access to the crash site is limited, such as at offshore installations. Although no post-crash fire on an offshore platform is known to have occurred during UK operations, major fire with consequential loss of the helicopter has been witnessed in some crashes at foreign offshore installations (e.g. Temena E, South China Sea, 1985) and post-crash fires have featured in onshore accidents. It therefore constitutes an entirely foreseeable event which should be considered and mitigation measures put in place.
- 10.2 An additional issue at offshore installations is the fact that they are regarded as unlicensed operating sites. Helicopter operators are required to satisfy themselves that each helideck they operate to is 'suitable for the purpose', and they discharge their duty of care through an inspection programme undertaken on their behalf by the Helideck Certification Agency (HCA), as discussed in further detail in Section 14. HCA inspect helidecks and related facilities as being fit for purpose against the standards and best practice contained in UK Civil Aviation Publication [CAP 437](#) (Standards for Offshore Helicopter Landing Areas). With regard to Rescue and Fire Fighting Services (RFFS), these are regarded as generally being satisfactory at manned installations.
- 10.3 In response to concerns raised within the industry, however, the CAA has conducted a review of the minimum scales of fire-fighting media that would be appropriate for existing Normally Unattended Installation (NUI) assets operating on the UKCS. The results of the review, conducted with reference to sources of UK best practice, are detailed in Appendix D of CAP 437. It is evident that the current RFFS arrangements on fixed NUI platforms on the UKCS are inadequate to address all likely and reasonably foreseeable fire situations that may be encountered during routine offshore helicopter operations. The CAA issued a letter to industry dated 01 July 2011 (reproduced in CAP 437 at Appendix D) that required 116 named NUIs to have their existing fire-fighting arrangements upgraded to implement systems for the automatic and efficient delivery of foam capable of discharging at high rates of application and for durations that are effective in addressing a helicopter fire situation. To date the industry has instead concentrated on alternative options rather than taking any positive compliance action against the CAA letter and it seems unlikely that the required upgrades will be implemented within the detailed timeframe. The CAA expects the oil and gas industry to incorporate the fire fighting provisions detailed in CAP 437 without further delay. The CAA also expects the helicopter operators to apply the risk-reduction methodology of CAP 437 to ensure that the foreseeable event of a crash with fire is appropriately mitigated.

Recommendations:

- R8 *The CAA expects the oil and gas industry to incorporate the fire-fighting provisions detailed in CAP 437 (Standards for Offshore Helicopter Landing Areas) for Normally Unattended Installations without further delay. (Delivery Q3/2014)*
- R9 *The CAA expects the offshore helicopter operators to apply the risk-reduction methodology detailed in CAP 437 (Standards for Offshore Helicopter Landing Areas) for operations to Normally Unattended Installations to ensure that the foreseeable event of a crash with fire is appropriately mitigated. (Delivery Q3/2014)*

SECTION D: OPERATIONS

CHAPTER 11

Background

- 11.1 Three major UK offshore helicopter companies operate in support of the offshore oil and gas industry: Bond Offshore Helicopters Ltd; Bristow Helicopters Ltd; and CHC Scotia Ltd. All have their headquarters in Aberdeen. Smaller-scale elements of foreign operators from Belgium and Denmark are also based in the UK and are active in this sector, with oversight from their own national authority.
- 11.2 For this part of the review, the CAA considered: organisational aspects of the helicopter operators, including their management of safety; the underlying commercial environment; operations to offshore helidecks; operational procedures; air traffic management and offshore communications; weather and meteorology; and pilot training and performance.
- 11.3 CAA staff spoke to helicopter operators at management and supervisory level, as well as to individual employees fulfilling various functions. All three Accountable Managers were interviewed, as were company Safety Managers, crew training post holders and senior training staff. CAA inspectors also visited simulator training providers at Aberdeen and Farnborough.
- 11.4 The CAA invited and received input from the Health & Safety Executive, Oil & Gas UK (via the Helicopter Task Group), OGP, and the pilots' and offshore workers' unions. In addition, some individual expert comment was received. (See Annexes D and E.)
- 11.5 For information, the following table illustrates aircraft operated, operating bases and pilot numbers as reported in November 2013:

Table 3: UK Operator details

		Bond Offshore Helicopters Ltd	Bristow Helicopters Ltd	CHC Scotia Ltd	Totals
Aircraft	S92	2 on wet lease	18	6	26
	EC225	3	10	9	22
	AS332 L/L1		7	6	13
	AS332 L2	6 (2 dedicated to Search and Rescue - SAR)		x	6
	AW139	5	2	9	16
	SA365 N3	3			3
	S-76C++		6		6
	EC155		1		1
	S-61		2		2
		Totals	19	46	30
Bases		Aberdeen	Aberdeen	Aberdeen	
		Humberside	Humberside	Humberside	
		Norwich	Norwich	North Denes	
		Sumburgh	Sumburgh (SAR)	Sumburgh	
		Blackpool	Netherlands	Lee on Solent (SAR)	
		Miller Platform (SAR)	Scatsta Stornoway (SAR)	Portland (SAR)	
Pilots		150	230	190+	570

CHAPTER 12**Helicopter operators - organisational matters**

Safety management systems

- 12.1 Requirements for the management of safety are changing. Currently, an operator must establish an accident prevention and flight safety programme, but the CAA is engaged with operators in the development of a Safety Management System (SMS) that will form part of a wider 'management system' and which will be required to meet new European standards by October 2014. The three offshore operators have already implemented an SMS for customer contractual purposes ahead of this regulatory change: Bond Offshore's has been running since 2009; Bristow's since 2007; and CHC's since 2004. Whilst each of the operators identified their top five risks, there was no immediate correlation reflecting a common offshore operations theme; this indicates that further evolution is required before a common sector risk profile is recognised in operators' SMS.
- 12.2 The ICAO timescale guidance suggests five years for an SMS to become effective, and one indicator of the maturity of an SMS is the focus and range of Safety Performance Indicators (SPI). There was evidence that SPIs needed to be developed by the operators and the CAA will continue to engage actively with SMS development.

Action:

- A11 *The CAA will organise and chair an operator symposium on Safety Management to identify generic hazards, mitigations and Safety Performance Indicators for offshore operations. (Delivery Q2/2014)*
- 12.3 The operators were keen to share safety data and standards with each other and, at the time of the review, such an initiative was beginning (the Joint Operators' Review). The CAA welcomes this initiative, which holds considerable promise for safety improvements across the industry, and will support proposals for new rulemaking wherever possible.

Operator resilience

- 12.4 Following the second EC225 Super Puma ditching in October 2012, the CAA applied restrictions to Public Transport flights over a hostile environment (see Annex H) with this type of aircraft, and these had a major impact on the helicopter operators' ability to meet the demands of the oil and gas industry. Whilst return-to-service arrangements for this type of aircraft were in progress, the AS332 L2 accident in August 2013 occurred, leading to a short-lived voluntary industry suspension of all Super Puma operations. The decision by industry to subsequently recommence flights was supported by the CAA.
- 12.5 Despite the major stresses of these circumstances, the offshore helicopter operators were able to cope with the consequences. Shorter-term redeployment of other helicopter types occurred (with consequent staff re-training), and a longer-term industry desire to vary the types of helicopter used has become evident. Deployment plans for different helicopter types have in fact already been evolving. Even with the operational restrictions affecting the EC225 Super Puma after October 2012, it is likely that the AS332 fleet would have been significantly reduced by planned replacement with newer types. New aircraft, such as the Sikorsky S92, were delivered earlier than planned and others, such as the AgustaWestland AW189 or Eurocopter EC175, may also be used in future.
- 12.6 The reintroduction of older technology aircraft in greater numbers to cope with the EC225 restrictions has limited range and capacity, and crews' annual flying rates have generally increased. In discussions with operators, a noticeable increase in air traffic related incidents, such as altitude deviations, was attributed to an influx of crews less familiar with Aberdeen-based operations (though mitigations such as call signs that identify associated crews have been introduced).

CHAPTER 13**Commercial aspects**

Contracts

- 13.1 All the helicopter operators reported that customer influence in operational matters was too extensive. The perception that contracts are offered at too short a timescale and awarded on lowest cost is also prevalent. The CAA considers that this may reduce a helicopter operator's capacity to recruit and train for a new commitment, and may challenge standards in the drive for a successful bid.
- 13.2 It is noted that some customers include spare aircraft capacity in their helicopter support contracts, but where this does not occur, managers, crews and engineers may feel under significant commercial pressure to provide the same level of service.
- 13.3 The commercial environment has also created a lack of standardised operational procedures through varying customer requirements applied through contracts. Pilot experience levels, different passenger loads and different weather minima for airborne radar approaches are examples of where there are differences between customer requirements. Some contractual penalties for non-compliance may also be imposed (e.g. for late departure). The CAA concludes that this lack of standardisation may inhibit the helicopter operators' ability to conduct a more balanced operation in accordance with safety priorities.

Recommendation:

- R10 It is recommended that offshore helicopter operators identify a set of 'best practice' standard procedures and engage with their customers to agree how these may be incorporated into contractual requirements. (Delivery Q1/2015)*
- 13.4 Through their wider organisations, all three UK operators have relationships with the Norwegian helicopter operators. Whilst there is more State presence and influence in the offshore industry in Norway, there appeared to be little difference in helicopters, equipment or procedures because of the desire for harmonisation within regional organisations. The presence of greater numbers of customer organisations in the UK sector, however, produces a notable audit and inspection commitment by the customer for the helicopter operators (one operator cites over 100 audits in one year). The CAA has previously noted the level of distraction that helicopter functional managers are subjected to by this activity, and recognises that the matter has been under discussion by the industry for some time. This is discussed in the Oil & Gas UK *Guidelines for the Management of Aviation Operations* at Section B3 paragraph 6. This was also recognised as a feature in discussion with the OGP representative. In contrast,

the Norwegian sector operates a 'pooled' audit scheme that tempers this commitment.

Recommendation:

R11 The CAA expects that the oil and gas industry will review its audit and inspection practices to harmonise and pool audit schemes to reduce the impact on helicopter operators following the principles described in the Oil & Gas UK Guidelines for the Management of Aviation Operations. (Delivery Q1/2015)

Globalisation

- 13.5 All three UK operators are part of wider multi-national parent groups, created through acquisition. Bond Offshore Helicopters Ltd is part of the Bond Aviation Group which includes Bond Air Services Ltd, an Australian operator and Norsk Helikopterservice, and which is owned by a European parent, Avincis. Bristow Helicopters Ltd, which has other elements in the UK, Norway and the Netherlands, is part of the Bristow Group Inc headquartered in Houston, USA. CHC Scotia Ltd is part of Canadian-based CHC Helicopters with operators in the UK, Norway and the Netherlands.
- 13.6 All three UK companies stated that these wider relationships improve standards through a larger pool of safety reporting and resource. All three companies stated unequivocally that the UK operating company has primacy in all things to do with compliance and safety within the AOC.
- 13.7 The CAA recognises the commercial drivers for international business, but notes the potential for tensions between the direct safety accountability and management control within the AOC operating company and the wider global organisation. The CAA will enhance its activity to ensure that aviation safety responsibilities and accountabilities are clearly demonstrated by the AOC management of the UK operating company.

CHAPTER 14**Operations to helidecks**

- 14.1 The [JAR-OPS 3](#) regime followed by the UK does not require helidecks to be licensed. Nevertheless, the helicopter operator is required to ensure that a particular helideck is adequate for the type of helicopter and the operation concerned. The Norwegian approach is different in that legally-based standards are set on a national footing (BSL D 51) with, for example, a minimum helideck size equivalent to 1.25 times the greatest dimension of the helicopter. In the UK, offshore helicopter operators have established the Helideck Certification Agency (HCA) to conduct independent inspections of helidecks on their behalf, and details of individual decks are published in a Helideck Limitations List (HLL). The HCA uses CAP 437 as their standard, although the provisions of CAP 437, including fire-fighting equipment, lighting and facilities (covering the suitability of the deck environment), are not mandated by any UK legislation. (CAP 437 has been referenced in the draft content of EASA's forthcoming Specific Approval for Helicopter Offshore Operations.)
- 14.2 As the helideck inspection is a 'snap-shot' of the health of the helideck and its environs, the continuing 'fit-for-purpose' condition of the helideck and its ancillary equipment are therefore seen as a matter for the installation management. Most platforms and vessels are permanently manned, and so are able to provide trained personnel to operate fire equipment, refuel the helicopter and provide passenger handling services for all movements.
- 14.3 The minimum recommended helideck size in CAP 437 is no less than the overall length of the helicopter and the ability of the structure to take the dynamic loads imposed by the helicopter operation must also be considered. In recent years, new helicopter types have been introduced to the UK sector and, on the basis of safety cases prepared on behalf of helicopter manufacturers, have been permitted to operate on older helidecks that were built for smaller and/or lighter types. There are currently up to 56 helideck operations on the UKCS that do not fully meet the recommended national criteria. Helicopter operators have underwritten such operations with accepted risk assessments. However, the desirable outcome is that, where practicable, such helidecks be upgraded to meet the appropriate standard for the conduct of flights in the modern era. The CAA will therefore work with the industry to review what improvements should be made.

Action:

- A12 *The CAA will review whether operations should continue at helidecks where the overall dimensions and/or loading values as notified for the helideck are insufficient to accommodate the helicopter types in use and take the necessary action. (Delivery Q3/2014)*

- 14.4 A particular category of helideck, the Normally Unattended Installation (NUI), does not have trained personnel in attendance on the helideck when the helicopter first lands and finally departs. The NUI therefore presents particular issues in terms of helideck safety and adequate provision of fire-fighting equipment. This has been discussed previously at paragraph 10.3.
- 14.5 Approaches to a NUI at night are particularly challenging because the only visual reference may be a basic 'ring of lights' on the landing platform with no additional aids to highlight the superstructure beneath. In this case the landing area can give the appearance that it is 'floating in space'. CAP 437 details the new CAA helideck lighting standard for a lit "H" and a touchdown/positioning marking circle which provides a dramatic improvement over traditional floodlighting and is being adopted throughout the industry (by mid-2018). CAP 437 also recommends the provision for the illumination of the platform legs to assist with the pilots' depth perception to mitigate the appearance of the helideck 'floating in space'. The CAA understands that the provision of floodlighting to illuminate the main structure or 'legs' of the platform has by no means been universally applied for NUI operations; consequently the CAA will strengthen the standards in CAP 437 to ensure this obvious safety benefit is taken up by every NUI duty holder. NUIs frequently become havens for sea birds and may be fouled by guano which obscures deck markings, degrades the friction surface and introduces a threat to the health and wellbeing of both passengers and crew.
- 14.6 The CAA's drive to certificate helidecks has received the support of the helicopter operators who also view a tighter control of the helideck and its environment as a positive step towards raising safety on the helideck. Certification directly by the CAA or through an appropriately qualified entity would provide the framework for raising the standards on helidecks. This is discussed further at Annex E.

Action:

- A13 *The CAA intends to assume responsibility for the certification of UK helidecks and will consult with industry to achieve this. (Delivery Q1/2015)*

CHAPTER 15

Operational procedures

Standard operating procedures

- 15.1 JAR-OPS 3 and EASA Ops require the aircraft operator to establish its Standard Operating Procedures (SOPs) for use by flight crew. These procedures are the method that enables flight crew to operate safely on a day-to-day basis. To be effective the SOPs must be specific and robust in reflecting not only the operational task but also the capabilities of the crew and aircraft. Without defined SOPs crews will operate to a normalised condition of best practice until an unforeseen event occurs exposing the lack of defence offered by well constructed procedures. The regulatory requirement leads to SOPs being operator specific but the offshore industry could benefit by the sharing of such material thereby helping to establish a more standardised methodology in setting SOPs for each helicopter type operated.

Flight following

- 15.2 Operating rules do not currently require flight following (maintaining operator contact with aircraft to monitor flight progress) for offshore operations. Recognising the safety benefit of such systems, all three operators voluntarily use some method of flight following, either by satellite phone, Skytrack or Blue Sky. Most of these systems are GPS based tracking systems that present a real-time pictorial display of the operating area and the location of the helicopters.
- 15.3 The CAA has introduced the following requirement, further supported by advisory material, into the HOFO RMT which will see it adopted across all Members States' offshore operators:
"SPA.HOFO.125" Flight following system
An operator shall use a monitored flight following system for offshore operations in a hostile environment from the time the helicopter departs until it arrives at its final destination."

'Exposure' approval

- 15.4 As most twin-engine helicopter types cannot always continue flight on one engine during the take-off or landing phases at a helideck, the possibility of a forced landing is factored into operations. A conditional 'exposure' approval, issued by the CAA in accordance with JAR-OPS 3, alleviates the requirement for a safe forced landing in these circumstances. At present, this approval is issued for an aircraft type, but regulations allow for consideration of the aircraft type and the type of operation.

- 15.5 There is scope for improving the safety of a forced landing by considering the offshore activity holistically and by controlling the approval accordingly. Thus an unstable deck, at night, in poor weather, or a NUI, at night, with no fire-fighting equipment and a guano-covered deck in light winds might add up to a cumulative risk that becomes unacceptable.

Action:

- A14 *The CAA will review the conditions applicable to the issue of offshore 'exposure' approvals with a view to making them appropriate to the intended types of operation. (Delivery Q3/2014)*

CHAPTER 16**Air traffic management and offshore communications**

- 16.1 The Air Traffic Control (ATC) operations and environment within the North Sea and Irish Sea sectors were reviewed in conjunction with the main ATC service providers and helicopter operators. The review additionally considered the areas where the UK operation differed from that provided in Norway.
- 16.2 Over recent years, significant improvements in surveillance radar and radio coverage within the UK North Sea environment have been developed and put in place. This has had a significant effect in enhancing the service ATC providers are able to deliver during the en-route phase of flight, to and from the oil and gas platforms.
- 16.3 The airspace in the offshore areas of the London and Scottish Flight Information Regions (FIRs) from East Anglia in the south to the East Shetlands Basin in the north extends from the surface to at least 10,000 ft and is principally Class G (uncontrolled airspace), within which are established numerous military operated airspace areas (Danger Areas, Managed Danger Areas, Aerial Tactic Areas), the Aberdeen and Anglia Offshore Safety Areas (OSA) and two networks (North and South) of Helicopter Main Routes (HMRs), each of which have implications for helicopter operations in the en-route phase of flight. In association with the transition from en-route phase to arrival/departure phase of flight at offshore destinations Helicopter Traffic Zones (HTZ) are established in the Southern North Sea as a means of notification of helicopter activity engaged in platform approaches, departures and extensive uncontrolled inter-platform transit flying. Inter-platform flying by civil helicopters within HTZs contained within the Anglia OSA will normally be conducted on the company or oil/gas field discrete radio frequency with 'blind' transmissions being made to notify other users of activity. HTZs consist of the airspace from sea level to 2,000 ft contained within specific lateral dimensions that are notified via aeronautical charts and documents.
- 16.4 The Norwegian airspace arrangements differ from the UK in respect of the offshore operation by utilising a higher classification of airspace but which requires the provision of an ATC surveillance capability in order to be managed. This difference was analysed and in light of the significant reduction in UK military operations within the North Sea sectors, combined with the current civil/military operator understandings and the absence of evidence to suggest otherwise, it was deemed that the current UK airspace arrangements for the en-route phase of flight are satisfactory.

- 16.5 During the final phase of flight as the helicopter approaches the rig for landing, communication is transferred from ATC to the helideck radio operators, based on board the rig. The UK infrastructure does not support the provision of an ATC service to standards expected onshore to deck level, or the provision of such a service when helicopters make short shuttle flights between platforms within the oil/gas fields. While there is no direct evidence to suggest the current arrangements are unsafe, or unsatisfactory, in order to better understand operations during this phase of flight and the services which are provided, the CAA intends to commission a focused report to review offshore communication, handling and flight monitoring procedures from an ATC perspective.

Action:

- A15 *The CAA will commission a report to review offshore communication, handling and flight monitoring procedures from an air traffic control perspective and act on its outcomes. (Delivery Q4/2014)*

CHAPTER 17**Weather and meteorology**

- 17.1 International Civil Aviation Organization Standards and Recommended Practices in Annex 3, require States to “establish, or arrange for the establishment of, aeronautical meteorological stations on off-shore structures or at other points of significance in support of helicopter operations to off-shore structures” and to provide “meteorological information for pre-flight planning and in-flight re-planning by operators of helicopters flying to offshore structures”
- 17.2 The CAA has published guidance in CAP 437 on the meteorological information to be provided from an offshore installation. CAP 437 details the meteorological instrumentation that should be installed and the information needed for the pre-flight weather report, provided to the offshore helicopter operators, as well as the radio message for transmission to helicopters en route. In addition, the CAA ensures that the content of offshore Met observer training courses cover all relevant aspects of offshore observing.
- 17.3 Since 2010 over 1,300 Offshore Met Observers have been trained and certificated in order to provide observations to helicopter operators. The oil and gas industry’s discrete system (Helimet) provides an additional source of valuable information but, according to comments made by flight crews, can suffer reliability issues. There remains a challenge to improve the quality of the current weather conditions reported to support offshore helicopter operations. The key steps to achieve this will be:
- Installation of automated sensors for the reporting of cloud height and visibility at more offshore platforms especially on mobile platforms, since of the 228 fixed platforms in the North Sea only 2 installations currently have flight restrictions imposed due to lack of the required Met equipment.
 - Greater sharing of weather information using a real-time web-based system.
 - Ongoing ab initio and refresher training of Offshore Met Observers.
- 17.4 In respect of forecasts, the Met Office provides a specialist offshore helicopter weather briefing service via a web-based system, which provides flight crews with an area forecast covering weather, wind, cloud, icing and turbulence predictions. More recently the Met Office has developed a capability to forecast the threat of triggered lightning, which is where the presence of a helicopter in a charged region of the atmosphere is thought to trigger a lightning discharge under particular atmospheric conditions. The development work has been welcomed by the operators, since triggered lightning has been a particular issue in the North Sea. The benefits of the triggered lightning trials, currently still in progress, are recognised and considered valuable.

- 17.5 A number of installations in the Norwegian sector provide local weather reports, METARs and forecasts (TAFs) since most are manned by fully qualified Met Observers. This is further discussed at Annex E.

CHAPTER 18**Pilot training and performance**

- 18.1 There have been a number of accidents and near-accidents involving the loss of control of a helicopter. Indeed, such occurrences are confined neither to the offshore sector, nor indeed to helicopters:
- In 2005 the AAIB investigated a fatal Piper Aztec accident in the Caribbean and concluded that the pilot's lack of appreciation of the difficulty of a manoeuvre in complete darkness and his spatial disorientation were causal factors.
 - In 2006 a Dauphin⁹ helicopter was lost in Morecombe Bay after a night approach in poor weather when the crew aborted the attempt to land and the commander assumed control. Though initial recovery actions were correct, the helicopter subsequently descended and impacted the sea. It was believed that the limited visual cues available suggested a problem in assessing the correct descent angle. It was noted that an appropriate synthetic training device was available, but not used.
 - In 2009 an EC225¹⁰ flew into the sea whilst approaching a North Sea helideck at night in reduced visibility. It was determined that neither crew member was aware that the helicopter was descending towards the surface. This was probably due to illusions, combined with both pilots being focused on the platform and not monitoring the flight instruments.
 - In 2011, a Sikorsky S-92A¹¹ took off from a vessel at sea for St. John's International Airport, Canada. After engaging the go-around mode of the automatic flight control system, the pitch attitude increased to approximately 23° nose-up while in instrument meteorological conditions and a rapid loss of airspeed occurred. From a maximum altitude of 541 feet above sea level, the helicopter descended towards the water in a nose-high attitude at low indicated airspeed. The descent was arrested 38 feet above the surface of the water and the aircraft recovered to the airfield.
 - In worldwide offshore helicopter operations conducted between 1997 and 2011, there were 18 additional cases of controlled flight into terrain or water (CFITW), 30 pilot procedure-related accidents, 28 obstacle strikes, and 11 pilot-related serious incidents investigated by national accident investigation authorities.¹²

9 AAIB [Accident Report AAR 7/2008](#) - Aerospatiale SA365N, G-BLUN, 27 December 2006

10 AAIB [Accident Report AAR 1/2011](#) - Eurocopter EC225 LP Super Puma, G-REDU, 18 February 2009

11 Transportation Safety Board of Canada (TSB) Aviation [Investigation Report A11H0001](#), Sikorsky S-92A, CGQCH, 23 July 2011

12 Helicopter Accident Analysis. The Journal of Navigation, 67, 145-161, F A C NASCIMENTO, A MAJUMDAR, & OCHIENG, W. Y. 2014

- 18.2 These occurrences, and others in the UK and around the world, highlight the critical importance that must be placed on training and pilot performance, especially given the demands of operating modern helicopters with sophisticated automation in the offshore sector. Two pilots must operate effectively together as a crew. The CAA acknowledges the recent release of an FAA report¹³ into 'flight deck automation' which describes important work in this area, and will review this in association with actions and recommendations contained within this Review Report.
- 18.3 The principles of Crew Resource Management (CRM) and Human Factors (HF) are well understood within the aviation industry and are an integral part of personnel recurrent training and checking programmes. Often referred to as the non-technical element of pilot training, they sit intertwined with the technical subject matter of flight training and application of SOPs. However, HF issues continue to appear in most incidents and accidents as both causal and contributory factors ranging from basic crew interaction to their interpretation of highly complex flight displays and autopilot systems. Whilst this part of the review focuses upon the current pilot training and performance programme and the specific technical findings raised by interview and inspection, there continues to be an underlying thread throughout of HF involvement. All recommendations and actions must therefore be viewed as having both a technical and non-technical standpoint.

Pilot training

- 18.4 A commercial pilot is required to be type-rated on the particular helicopter that he/she is to operate in the offshore environment. In basic terms this qualification route starts with aircraft type rating training completed at an Approved Training Organisation (ATO) followed by the company's Operator Conversion Course (OCC). The OCC identifies any company differences in the aircraft type, SOPs and specific role so that the pilot can enter a focused phase of on-the-job training, ultimately leading to unsupervised line flying. The associated operator's training programme and type rating training/checking programme are approved by the CAA. The basic type training requirements, as defined by the [EASA Aircrew Regulation](#) (flight crew licensing requirements), are generic, but may be modified by the Operational Suitability Data (OSD) document for the specific type (originally referred to as the Operational Evaluation Board (OEB)). The OSD details the manufacturer's mandatory and recommended syllabus for type rating training and identifies areas that may offer training credits based upon commonality or difference between type variants, or highlight Training Areas of Special Emphasis (TASE). Currently, the emphasis is given to the aircraft handling

13 'Operational Use of Flight Path Management Systems', Final Report of the Performance-based operations Aviation Rulemaking Committee/Commercial Aviation Safety Team, Flight Deck Automation Working Group, 5 September 2013

aspects of the type, mainly the Pilot Flying (PF) role. However, as technology has advanced so has the trend to provide more automation. In many cases this automation is now so significant that the aircraft is built around that concept with the pilots interacting through it. EASA are in the process of conducting an OSD 'catch-up' process for all EASA-certified types without such a document, and all new types must be subject to that process.

- 18.5 Aircraft manufacturers have differing design concepts and autopilot operating philosophies such that each aircraft type must be flown in a manner that may be very different to a pilot's previous experience. Current requirements do not adequately specify the necessity for a thorough understanding of the manufacturer's philosophy for operation of complex autopilot systems; nor do they define the appropriate modes, establish optimum use of the autopilot (AP) or prepare crews well for conducting the Monitoring Pilot role. Approved Training Organisations and helicopter AOC holders should adopt the aircraft manufacturers' operating philosophies and recommended practices, where available, within their type syllabi and current training and checking programmes with particular emphasis on automation. This information should also be reflected in instructor guidance so that specific learning points for the automated systems are addressed in a standard manner.

Recommendations:

- R12 *It is recommended that EASA require helicopter manufacturers, in conjunction with the major operators of the type and NAAs, to review their recommended training material so that pilots are better prepared for operating modern highly complex aircraft.*
- R13 *It is recommended that Approved Training Organisations and helicopter AOC holders adopt the aircraft manufacturers' operating philosophies and recommended practices, where available, within their type syllabi and current training and checking programmes with particular emphasis on automation. This information should also be reflected in instructor guidance so that specific learning points for the automated systems are addressed in a standard manner. (Delivery Q3/2014)*

Pilot duties

- 18.6 JAR-OPS 3 and the forthcoming EASA Ops require operators to define specific duties for flight crew during all phases of flight. This includes those duties specific to both the PF and Pilot Monitoring (PM). The duties associated with the PM role generally identify specific SOPs and verbal calls along with generalised guidance on flight path monitoring. There is little guidance in aviation literature, however, on how to train for the task of flight path monitoring, especially when related to a specific type. The CAA has recently published its work on Monitoring Matters as part of its safety review which appears on the CAA website and has been sent to all examiners in DVD format. The CAA is already working with industry to develop monitoring skills training material.

Recommendation:

- R14 *It is recommended that Approved Training Organisations and helicopter AOC holders review their type rating syllabi and recurrent training programmes to ensure that Standard Operating Procedures and monitoring pilot techniques are included at all appropriate stages of the type rating course, operator conversion courses and recurrent training/checking. (Delivery Q3/2014)*

Training material

- 18.7 In meeting type certification requirements, helicopter manufacturers provide Rotorcraft Flight Manuals (RFM). Additionally, those manufacturers with their own ATOs provide type training in line with their operating philosophies. Currently very little written material is provided to operators or ATOs to implement that operating philosophy within type training syllabi. As a consequence, helicopter ATOs and AOC holders develop best practice for use in training material and operations manuals relying upon the experience and knowledge of key personnel in the industry, who may or may not be liaising with the manufacturer. The consequence is that current knowledge is generally handed down in a third-party fashion rather than obtained directly from source. Within the aeroplane industry the larger manufacturers define their recommended SOPs in documents such as the Flight Crew Operating Manual and the Flight Crew Training Manual. These provide a standard for ATOs and AOC holders; a practice that should be adopted by the helicopter community.
- 18.8 A number of respondents, who have had previous airline experience, supported this view and stated that offshore SOPs were generally not as robust or rigid as those experienced in their previous aeroplane employment; this is to be expected to some extent due to the far more flexible nature of helicopter operations. During their aeroplane training the emphasis upon the prescribed SOPs, and associated duties, was experienced from day one but helicopter type rating and operator conversion courses were more orientated to the practicalities of flying the new type as the PF using operator-derived SOPs. The current

requirement is for operators to establish their SOPs but, without manufacturer-developed recommended practices, neither the operator nor the regulator have material upon which to base their operations manuals or subsequent approval.

Recommendation:

- R15 *It is recommended that Approved Training Organisations and helicopter AOC holders review their training syllabi to ensure that the correct use and emphasis upon Standard Operating Procedures is impressed upon crews throughout all stages of flight and simulator training. (Delivery Q4/2014)*
- 18.9 It was evident from most parties interviewed that they felt Part-FCL and JAR-OPS 3/ EASA Ops training/checking requirements are heavily biased to runway-based one engine inoperative flight and that this does not adequately prepare a pilot for the environment in which the type(s) are to be operated. Likewise the annual licence proficiency check and 6-monthly operator proficiency check perpetuates this historical focus. Whilst the operator conversion course is the method to prepare a pilot for line operations, the end product should reflect the offshore operating environment. To that end, a number of parties suggested the possibility of an offshore rating and/or to mirror the flexibility offered to aeroplanes within their rule set by establishing an Alternative Training and Qualification Programme (ATQP). The latter would allow the operator to draw upon the Flight Data Monitoring (FDM) programme by focusing upon the issues raised during line operations and using them in a modified training and checking regime. ATQP requires the identification of training and checking needs which are then broken down into individual competencies required of the crew so that specific performance standards can be assessed. It follows that this style of competency-based training could also be adopted into the operator's OCC where the basic licensing requirements are augmented with operator-specific training from the application of SOPs to equipment-specific elements such as the use of Traffic Collision Avoidance Systems and Airborne Radar Approaches.

Recommendations:

- R16 *It is recommended that Approved Training Organisations and helicopter AOC holders address with aircraft manufacturers any shortfall in the Operational Suitability Data training syllabi for those destined to operate the type offshore. (Delivery Q1/2015)*
- R17 *It is recommended that AOC holders, in conjunction with the CAA, develop an Alternative Means of Compliance to introduce the option of Alternative Training and Qualification Programme, as permitted for aeroplanes in accordance with ORO.FC.A.245. (Delivery Q1/2015)*

Pilot automation dependency

- 18.10 Many people starting their flying careers in the offshore industry are taught basic instrument flying skills as part of their Commercial Pilot's Licence (CPL) at overseas flying schools approved for EASA training conducted under very benign weather environments far removed from that encountered on the North Sea. This training is conducted in simple analogue instrumented aircraft (round dials) and then candidates possibly undertake a basic ICAO initial Instrument Rating (IR) that allows some training credit towards an EASA IR. These simple single-engine piston aircraft may not have flight control trim systems fitted or basic autopilot assistance and much, if not all, of the training is conducted clear of cloud. These candidates then undertake EASA Part-FCL IR training, many of whom will do so in a light twin helicopter, again with analogue (round dial) instrumentation, before progressing to the offshore industry where they will most likely operate an Electronic Flight Instrument System (EFIS) equipped aircraft with significant assistance provided by automation. It is felt that the underlying limited instrument flying skill set of some of these candidates may be introducing latent problems when managing and using these more complex systems.
- 18.11 There is a well recognised dichotomy affecting both aeroplane and helicopter operators known as 'automation dependency' which affects those who operate these highly complex types. This has been reinforced by BALPA who expressed concerns about new helicopter pilots joining the industry who rely too much on automated systems, and tend to focus on managing the systems rather than flying the aircraft.
- 18.12 Whilst operators may implement SOPs that require optimum use of autopilot functionality there still remains a need to ensure flight crews can manage a manual flight situation. This may not be manifested until manual flight control is suddenly needed as is the case of an autopilot failure or recovery from an undemanded aircraft attitude.

Actions:

- A16 *The CAA will, with industry, review the instrument flying training element for all EFIS-equipped offshore helicopter type rating courses to be satisfied that candidates have a firm understanding of the displays and techniques required for basic instrument flight. The CAA will propose to EASA any necessary improvements to the syllabus requirements. (Delivery Q4/2014)*
- A17 *The CAA will review all helicopter AOC recurrent training programmes to ensure that basic instrument flight skills are maintained so that crews can readily deal with manual flight if required. (Delivery Q2/2014)*

Instructor training

18.13 The industry employs Type Rating Instructors (TRI) and Synthetic Flying Instructors (SFI) in preparing a candidate for type rating test and in the provision of recurrent training. Approved training syllabi, Flight Synthetic Training Devices (FSTDs) and aircraft are used in converting new pilots to their first highly complex type. The knowledge base provided to a TRI/SFI giving type-related training is different to that given to an ab initio Flying Instructor (FI) or Instrument Rating Instructor (IRI) who are primarily focused upon the underlying basic flying skills. At present the training of a tutor to teach new instructors on an SFI/TRI course is not mandated. More emphasis could be given to provision of instruction, training and the suitability of training syllabi. Such a focus would benefit both the helicopter and the aeroplane industry. For those individuals who are qualified as SFIs it was also felt that exposure to the real aircraft in its operating environment would be invaluable.

Action:

A18 *The CAA will review the requirement for instructor tutor training and, if appropriate, make proposals to EASA to incorporate within Part-Aircrew. (Delivery Q4/2014)*

Recommendation:

R18 *It is recommended that Approved Training Organisations work with AOC holders to ensure that their Synthetic Flying Instructors have current operational knowledge of the type(s) on which they instruct. (Delivery Q4/2014)*

Loss of control

18.14 The CAA has conducted a review into the safety of large UK commercial air transport aeroplane operations and where significant safety issues were identified, following analyses of global fatal accidents and high-risk occurrences, work groups were formed for each of them. One particular work stream was formed to work with aircraft operators, training organisations and other industry stakeholders to establish the key risks that lead to loss of control, and to recommend strategies for monitoring and reducing these risks within a target acceptance level. This was achieved by drawing on a broad spectrum of expertise from within the CAA, industry and other aviation organisations to review current literature, examine accident and serious occurrence data, brainstorm issues that may lead to loss of control and recommend actions to avoid or mitigate loss of control events in the future. As part of the literature review the 'Loss of Control Task Force' considered and incorporated the relevant recommendations that were developed from the CAA SPI2 Working Group. The subsequent report was published in May 2010 citing in its executive summary the following relevant recommendations:

- Develop type-specific Licence Skills Tests
- Extend the use of ATQP to smaller operators
- Enhance the manner in which automation is trained on complex and highly automated aircraft types
- Set up an industry working group to consider how monitoring skills may be better trained and assessed
- Enhance the current regulatory minimum requirements for a pilot undergoing a Multi Pilot Licence (MPL) course
- Promote training in the manual flying skills needed to recover from loss of control
- Equip simulators with better data on the aircraft handling characteristics when close to the edges of the flight envelope
- Improve the use of Operational Flight Data Monitoring (OFDM) data to help provide better understanding of the precursors to a loss of control event.

Whilst the purpose, scope, participation and output of the initial review was driven by the needs of large public transport aeroplanes, much of the work could also be used to benefit the safety of offshore and other helicopter operations.

Action:

A19 *The CAA will examine the output of its review into the safety of large UK commercial air transport aeroplane operations for relevance and applicability to ensure that any appropriate safety initiatives have been extended to the offshore helicopter environment. (Delivery Q4/2014)*

Examination assessment

18.15 A review was conducted of the narrative section of the 'examiner assessment of competency' reports for the last 5 years to ascertain any common findings in either the examiner being reported upon, or their candidates under test/check. Of note were a number of reports indicating a lack of autopilot mode awareness shown by the candidate pilots. Another trend indicated that some examiners become focused on the technical aspects of the flying pilot skill set and perhaps do not drive home the underlying company SOPs for both flight crew. Likewise, a number of reports indicated comments relating to monitoring skills in general and specific to the Pilot Monitoring. It was also felt that for pilots undertaking type rating and recurrent training that training records document a pass/fail, but also contain a narrative. This would benefit the candidate, the next instructor/examiner and training department in addressing training/checking needs, and for standardisation and trending purposes.

Action:

A20 *The CAA will amend its examiner assessment protocols (CAA Standards Document 24) to require specific 'de-identified' candidate performance indicators so that any trends in common failings are visible for proactive attention. (Delivery Q4/2014)*

Recommendation:

R19 *It is recommended that Approved Training Organisations and helicopter AOC holders establish a requirement for training record narratives. (Delivery Q3/2014)*

Pilot helideck operational experience

18.16 Under current requirements (JAR-OPS 3) and the forthcoming EASA Ops, there are no explicit requirements for pilot recency in helideck operations. The oil and gas industry, however, considers that recency standards are essential and places contractual obligations on helicopter operators to meet them. The CAA agrees with this approach and will implement standards and progress this in line with the related EASA HOFO rulemaking task proposals pending full implementation.

Action:

A21 *The CAA will review the pilot recency requirements for helideck operations that have been incorporated into the draft requirements for the EASA Ops Specific Approval for Offshore Helicopter Operations and require operators to implement them to an agreed schedule. (Delivery Q3/2014)*

18.17 Helidecks are in operation by day and night in most weathers. A particular concern that emerged during discussions with crews is operation to bow-mounted decks on vessels at night because of the lack of visual references to assist judgement of position, altitude and rate of closure. Often, the non-handling or monitoring pilot will be unsighted and the handling pilot will be reliant on the natural horizon, if available, for attitude reference. Owing to these factors, the requirement for such operations and the operational procedures used should be reviewed.

Action:

A22 *The CAA will review helicopter operators' safety cases for night operations to bow decks to assess operator procedures and mitigations and determine whether such operations should continue. (Delivery Q2/2014)*

SECTION E: AIRWORTHINESS

CHAPTER 19

Airworthiness scope

- 19.1 The intention of the Airworthiness Section of this review is to assess the status and effectiveness of the current process that maintains airworthiness and safety in offshore helicopter operations. From the review, several recommendations are made to improve the current process or introduce new processes that will lead to an enhanced level of safety.
- 19.2 To focus and structure this element of the review, the helicopter types have been allocated a ranking.
1. Types which are currently in service and which potentially have a long life, large or growing fleets, providing support for offshore operations.
 2. Types which are in service which have potentially reducing fleets providing support for offshore operations.
 3. Types which have or may be phased out or have smaller fleet numbers providing support for offshore operations.
 4. Types which only currently operate in the Search And Rescue role or have been phased out.
- 19.3 The ranking is not intended to limit the review of any particular type but, depending on the subject reviewed, specialist engineering judgement has been used to determine which factors are included at this stage. The review in Annex F Sections 2 and 3 was initially carried out on the rank 1 helicopters. After discussions with the operators this has been extended to the rank 2 helicopters and the results will be published at a later date. There will be further discussion if there is any benefit in extending the review to any of the other types.

Table 4: Helicopter types

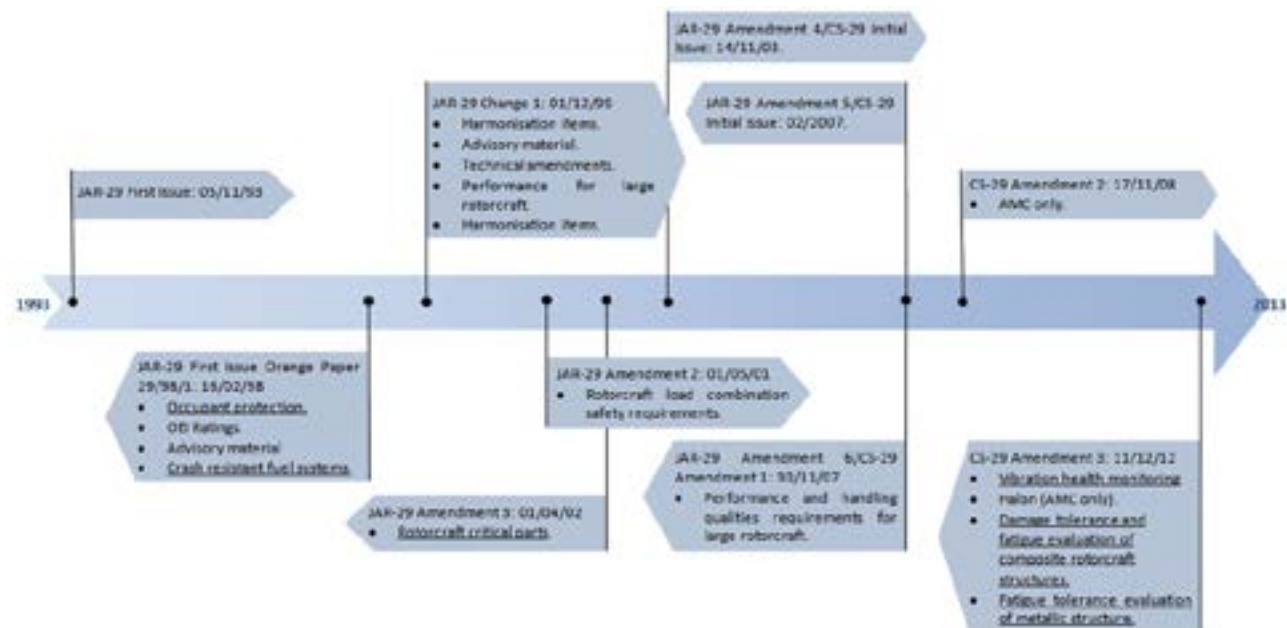
	Type	Rank	Entry into operations	UK Fleet size inc SAR (Nov 13)
a	AgustaWestland AW139	1	2005	16
b	Eurocopter EC225 LP	1	2005	22
c	Sikorsky S-92	1	2005	26
d	Eurocopter AS332 L2	2	1998	6
e	Eurocopter SA365 C (N3)	2	1979 (2009)	0 (3)
f	Sikorsky S-76 C++	2	2006	6
g	Eurocopter AS332 L & L1	3	1982	13
h	Sikorsky S-76 A ++	3	1980	0
i	Eurocopter EC155	3	2007	1
j	Sikorsky S-61	4	Pre-1975	2

CHAPTER 20

Certification requirement development

- 20.1 This chapter provides a baseline for the Certification Specifications (CS) achieved by the aircraft types that operate in the North Sea. A brief history of these standards is provided and a brief description of what has changed as they have developed through the 1990s to the present day. A summary 'timeline' is given below, with the information reduced to just the titles of the Notice of Proposed Amendments (NPAs) and with those changes of particular relevance to offshore operation highlighted by underlining>.
- 20.2 It is important to note that not all helicopters operating in the North Sea are certificated to the latest standard of requirements. Many are 'derivatives' whose original certification basis may have been set many years prior to their entry into service, it being associated with an original version of the helicopter type.

Figure 3: History of airworthiness certification standards



- 20.3 A review of published information on in-service types does not provide a complete picture of the certification requirements with which they were obliged to comply. The level of the detail for the certification bases of the various types provided in the US or European Type Certificate Data Sheets (TCDS) is such that only the top level published requirement material is mentioned, and not the precise means by which it was achieved or what assumptions were made in the compliance finding process.

20.4 Detailed compliance information, not least the assumptions made and the interpretation of the requirement material, is not in the public domain due to it often being of 'commercial in confidence' nature.

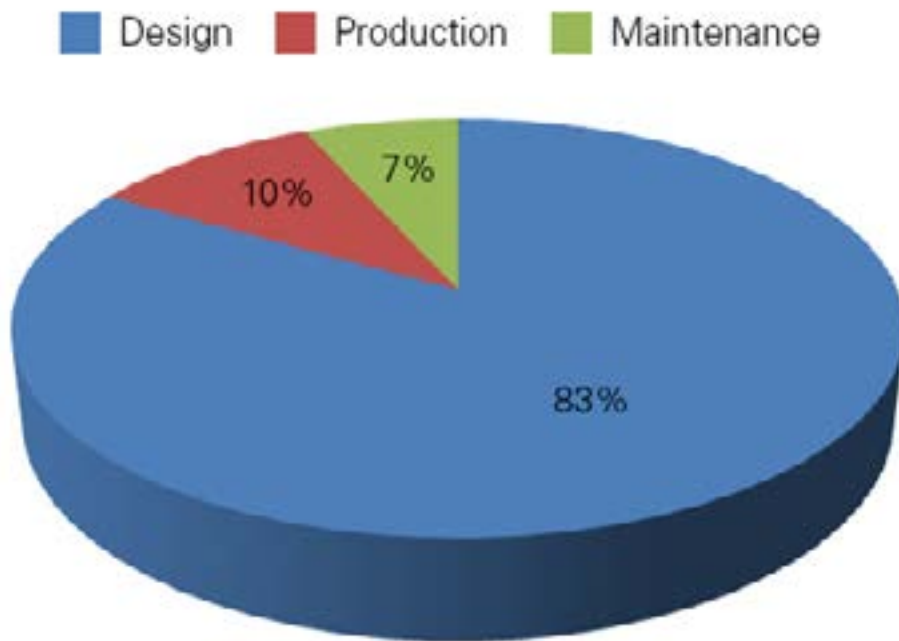
20.5 In support of the CAA introducing new aircraft types onto its Register and managing in-service issues, improved access to continued airworthiness matters / hot topics would greatly enhance these processes and promote wider awareness of continued and continuing airworthiness subjects. This could be best achieved by enhancing the ongoing dialogue with EASA.

Action:

A23 *The CAA will continue to develop its working relationship with EASA, in particular in the areas of sharing airworthiness information and the management of operator inservice issues. This will be achieved by periodic meetings and reviews with the appropriate EASA and CAA technical staff. (Delivery ongoing)*

CHAPTER 21**Extended review of accident reports**

- 21.1 In addition to the analysis of accident reports reported in Chapter 5 (accidents that occurred offshore between 1976 and 2012) a further and separate review has been made of over 100 accidents to helicopter types that have operated or continue to operate offshore (refer to Annex F Section 5). Of these accidents, 50 have been prioritised as either having occurred in the North Sea or having a cause that could have required a ditching if it had occurred offshore. Also, of these 50 reports, focusing only on the technical events (taking out the operational and environmental) gives a sample of some 30 accidents where the primary cause has been assessed as within the airworthiness domain.
- 21.2 Figure 4 below gives a schematic picture of how the technical causes of these accidents can be partitioned into their general subject areas. It should be noted that this data differs from that discussed in Section C and Annex C because the range of accident reports considered in this element of the review included reports worldwide, as opposed to only those associated directly with the UKCS operation. From the data in Annex C, there is a clear step change in the accident rate that coincided with the introduction of Health and Usage Monitoring Systems (HUMS) in offshore operations.
- 21.3 The technical general descriptions are:
- Design - the cause was related to a failure in some aspect of the design, which when changed, for example by modification or amendment to instructional information, should prevent a recurrence of the incident
 - Maintenance - related to some failure in the maintenance of the aircraft, such as bolts not being replaced in a fairing, this therefore includes Engineer Performance
 - Production - Components / parts / fabrications not conforming to the design drawing or other deviations in the process.

Figure 4: Causal factors

21.4 This group has not been ranked according to their severity, and they range from minor incidents to catastrophic accidents. From this high level review, although it is clear that causes arising from design aspects account for the major share of the target group of accidents, it is not possible at this time, therefore, in lieu of a more detailed analysis, to draw specific conclusions as to the real contribution made by design causes to offshore safety. Of the events attributed to design causes, the top five areas that have contributed are:

- Main Gear Box and transmission system - 20%
- Electrical - 20%
- Engines - 15%
- Horizontal Stabiliser - 11%
- Main Rotor Blade - 11%

CHAPTER 22**Failures advising 'land immediately'**

- 22.1 The purpose of this part of the review was to identify potential failure conditions (system components) which could result in 'land immediately' (LI) Rotorcraft Flight Manual (RFM) required action and to review system reliability associated with such failures. The relevance of this exercise was to identify where a command to land immediately would probably result in a ditching, when undertaking offshore operations.
- 22.2 Initially, this exercise only looked at the rank 1 helicopter types (see paragraph 19.2). From this the current manufacturers' RFMs and RFM supplements were reviewed in order to determine conditions where component or system failure would lead to an instruction to land immediately.
- 22.3 The first element of this part of the review identified issues regarding an apparent high rate of engine fire warnings and the inconsistent behaviour of flight crews to the RFM instructions which could lead to a potential ditching. Recommendations are therefore made to address the reasons for the warnings and the implications on crew behaviours.
- 22.4 It was also noted that the consequence of failures that cause a need for autorotation (such as tail rotor failure) was not consistently addressed/described in the RFM or clearly addressed in assumptions made for certification. CAA Paper 2003/1 discusses the research work undertaken on Helicopter Tail Rotor Failures and concluded that it is possible that the entry into autorotation may not be successful in some conditions due to the extreme sideslip. Following such an event, the EC225 and S-92 cannot maintain powered flight and immediate entry to autorotation is required. The recommendations from this CAA paper should be reviewed to determine how well they have been taken forward.
- 22.5 The second element of this work, i.e. to review the system reliability, could not be completed as it requires detailed input from manufacturers, the FAA and EASA. This review would be best completed by the manufacturer, using certification documentation (System Safety Assessment, Failure Mode and Effects Analysis etc.) that would be required for this detailed analysis and reviewed by the appropriate authority or State of Design.

Recommendations:

- R20 *It is recommended that EASA /Type Certificate Holders confirm the number of false engine fire warnings on offshore helicopters, investigate the reasons for them and determine what actions to take to address this important safety issue.*
- R21 *It is recommended that the helicopter Type Certificate Holder identify all major components or systems that lead to a land immediately condition to ensure themselves that the actual reliability data available from the operators is validating the assumptions made at the time of certification. This review should be overseen by the regulator for the State of Design. (Delivery Q1/2015)*

Actions:

- A24 *The CAA will review CAA Paper 2003/1 (Helicopter Tail Rotor Failures) to determine how well the recommendations have been taken forward and to assess if further action is necessary. The conclusions of this review will be discussed with EASA. (Delivery Q3/2014)*
- A25 *The CAA will review the human performance aspects of flight crew responses to engine bay fire warnings, specifically within the offshore operations environment. (Delivery Q3/2014)*

CHAPTER 23**Specialist review of MOR data**

23.1 MORs provide a valuable source of data when assessing the health of helicopter systems and components over a specific period of time. As such, to provide that health check for this review and as mentioned above, an engineering specialist assessment of almost 550 MORs between 2008 and 2013 has been carried out and a prime system failure for each identified. One significant issue was the number of MORs related to fire. The majority of the 'Fire' categorised MORs relate to spurious warnings. This seems to be having an effect on the way that Fire warnings are being treated in service. This has been addressed in Recommendation 20 above. All other MOR reports cover a wide variety of causes, were low in numbers and no common trends were identified. It is, however, advisable that such a review be continued at regular intervals and correlated against offshore operator. An action to undertake this is therefore made.

Action:

A26 *CAA Airworthiness will meet with offshore operators periodically to compare the trends of MORs with operator inservice difficulty / reliability data to ensure that the complete risk picture is captured, addressed and that the desired outcomes are being achieved. (Delivery Q2/2014)*

CHAPTER 24**Critical parts**

- 24.1 This chapter provides an overview of critical parts on a helicopter, how they are defined, what the requirement basis and history is and a review of some design, production and maintenance aspects, with specific reference to a number of helicopter types operating in the North Sea. A “Critical Part” is a part whose failure could be catastrophic, where a catastrophe is considered as an inability to carry out a descent to a safe landing assuming a suitable landing surface is available. In offshore operations this assumption may not be true and so is an important area of review for this Report. The Instructions for Continued Airworthiness (ICA) and Overhaul Manuals should clearly identify critical parts and include the required maintenance and overhaul instructions.
- 24.2 The “Critical Parts” requirement concept can be traced back to British Civil Airworthiness Requirements (BCAR) Section G November 1975, transitioning through to JAR 29.602 and finally CS-29.602. Prior to October 1999, the US requirements did not include Critical Parts, but FAR 29 (FAA Regulation) and CS-29 have since been harmonised. Critical parts are not unique to helicopters. They have been part of engine certification for many years. However, the requirements differ in a number of important areas, and best practice would suggest a similar approach be taken for both sets of requirements.
- 24.3 The Airworthiness Limitations Section lists parts that have a Service Life Limit (SLL) established during the fatigue substantiation of the rotorcraft. For some transmission components the SLL does not dictate the actual in-service life of the component and recent experience has shown that some manufacturers have some critical part components that are removed from service after relatively short service exposure in comparison to the declared life, which may mean there is no possibility of attaining the established fatigue life. Life monitoring as practised in Certification Specifications for Engines (CS-E) would help to identify a more realistic life and ensure design assumptions remain correct.
- 24.4 Advisory material (FAA AC 29-2C) in the certification requirements notes that for a safe landing at sea, “ditching” in a sea state of 4 is assumed. In the northern North Sea, sea state 4 is annually exceeded 36% of the time, in winter it is exceeded 65% of the time. Thus it should not be assumed that a safe landing will always be possible. One option would be to amend this assumption and certificate to a higher sea state (as some helicopter manufacturers have done). However, whilst this approach will raise the standard it is unlikely to fully address all potential sea states/conditions. Another option would be to reduce the likelihood of the need to carry out a ditching. In order to minimise landing in conditions in excess of sea state 4 (or above a higher certification level), an

assessment of items that could result in a need to make a ditching would mean that more parts and failure modes might need to be classified as critical, or existing parts may need to have greater reliability; for example by more robust controls and/or improved maintenance activities.

- 24.5 A review was undertaken of the maintenance instructions provided for the rank 1 helicopter types flying in the North Sea. Differences were found between them all, in areas such as identification of critical parts and handling instructions which may not provide the level of control of these parts as assumed by the certification process.
- 24.6 With regard to the specific hazards associated with offshore operations, the CAA recommends that EASA should consider developing regulations that could be applied to helicopters which carry out such operations to improve safety outcomes. This should include engine and helicopter operational reliability systems, similar to those used for Extended Operations and All Weather Operations for aeroplanes.

Recommendations:

- R22 *It is recommended that EASA initiate a rulemaking task to adopt the critical parts life monitoring and assessment requirements of Certification Specifications for Engines (CS-E) for large transport rotorcraft, currently subject to CS-29, including retrospective application. This should cover at least for the following areas:*
- i) Residual stress assessments*
 - ii) Vibratory stress measurements*
 - iii) Manufacturing plan*
 - iv) Laboratory examination of time expired part*
- R23 *It is recommended that EASA revise CS29.602 for large transport rotorcraft intended to operate over hostile sea conditions for extended periods of time, to ensure the failure mode effects and criticality analysis process used to identify critical parts recognises that a safe ditching may not always be possible.*
- R24 *It is recommended that EASA provide additional guidance material to improve standardisation in approach to the classification of critical parts to minimise inconsistencies in the instructions for continuing airworthiness and where appropriate to require revisions to existing Instructions for Continued Airworthiness.*
- R25 *It is recommended that EASA consider developing requirements that could be applied to helicopters which carry out Offshore Operations in hazardous environments in a similar fashion to those used for aeroplane Extended Operations and All Weather Operations.*

CHAPTER 25

Vibration health monitoring and controlled service introduction

- 25.1 Vibration Health Monitoring (VHM) is an established, mature method to aid the monitoring of transmission health. This is done by assessing vibration indicators against a series of fixed and learned thresholds. The adoption of health monitoring, initially as a CAA Additional Airworthiness Directive in 1999, came about as a result of recommendations from the AAIB following several incidents and accidents in the North Sea. It was developed as a monitoring tool to aid in maintenance.
- 25.2 A review carried out in the mid-1990s estimated that VHM could aid in detection of about 70% of those failure modes which the system was designed to monitor (reference: [CAP 753](#) Helicopter Vibration Health Monitoring). For transmissions, these modes are generally associated with detection of bearing wear, shaft out of balance and gear meshing changes.
- 25.3 In order to assess system effectiveness, aircraft are required to undergo a Controlled Service Introduction (CSI) to assess overall system performance. It was clear from a review of our oversight of the operators' VHM systems that some problems persist. A more focused approach needs to be taken by the CAA to ensure that the operators' VHM procedures are effective, and reflect recent changes to CAP 753.
- 25.4 EASA Certification Specifications for large helicopters (CS-29) now incorporates requirements for the use of VHM. The material used by EASA is largely drawn from guidance material previously published by the CAA, and the requirements are also based on the use of the system as an aid to maintenance personnel for fault finding. Also, as the UK Helicopter Health Monitoring Advisory Group (HHMAG) drafted the VHM specification which has been used to provide the changes to CS-29, we would recommend that the basis of this group be re-established to provide a forum for discussion for best practice and developments on VHM. This forum should include NAAs, operators and VHM manufacturers.
- 25.5 Instances have arisen where maintenance staff and VHM analysts have found inconsistencies in the way VHM alerting systems work between the different helicopter types. This could be confusing for staff working across various types. CAP 753 should be reviewed to clarify alert generation and management, to ensure it is consistent and a system of amber/red warning thresholds is established to allow maintenance staff to identify the severity of the alert.

Actions:

- A27 *The CAA will focus on Vibration Health Monitoring (VHM) download procedures, system/component reliability, the handling of VHM management of alerts and defects during audits of UK offshore operators. (Delivery Q2/2014)*
- A28 *The CAA will review CAP 753 to clarify alert generation and management, to ensure it is consistent and a system of amber/red warning thresholds is established to allow maintenance staff to identify the severity of the alert. (Delivery Q4/2014)*

Recommendations:

- R26 *It is recommended that EASA establish a forum for discussion for best practice and developments on Vibration Health Monitoring (VHM). This forum should include NAAs, operators and VHM manufacturers. The CAA expects that this could be achieved by the end of 2014.*
- R27 *It is recommended that EASA review AMC 29.1465 to clarify alert generation and management, to ensure it is consistent and a system of amber/red warning thresholds is established to allow maintenance staff to identify the severity of the alert.*

CHAPTER 26

Continuing airworthiness across the operators for the north sea fleet

- 26.1 It is a requirement that all commercial aircraft operators hold an EASA Part-M Sub-part G approval in order to hold an Air Operator's Certificate. Part-M and UK legislation require Maintenance Programmes that are based on the manufacturer's recommendations. The new AgustaWestland AW189 helicopter, which is due to start deliveries early in 2014, has maintenance requirements established on the Maintenance Steering Group 3 procedures. This process is widely used by large transport aeroplanes and should produce more effective and efficient maintenance requirements.
- 26.2 The UK offshore operators are parts of global groups of organisations and contract various maintenance activities and a limited amount of continuing airworthiness management activity to other parts of their groups, in Norway and the Netherlands. All of the operators have "power by the hour" arrangements (i.e. for a fixed sum per flying hour, a complete maintenance support and accessory replacement service is provided) with the various manufacturers and in one case use their Norwegian partner to provide this arrangement. The VHM guidance document (CAP 753) was amended in August 2012 to address a UK AAIB recommendation which recommended that operators include a process to receive detailed component condition reports (strip reports) in a timely manner to allow effective feedback as to the operation of the VHM system. Operators have amended their contracts to reflect the UK AAIB recommendation; however, the CAA was advised of continuing difficulties in obtaining strip reports for defective items into which they felt more investigation was required. The operation of this CAA requirement needs to be reviewed to ensure that potential important safety information is not lost.

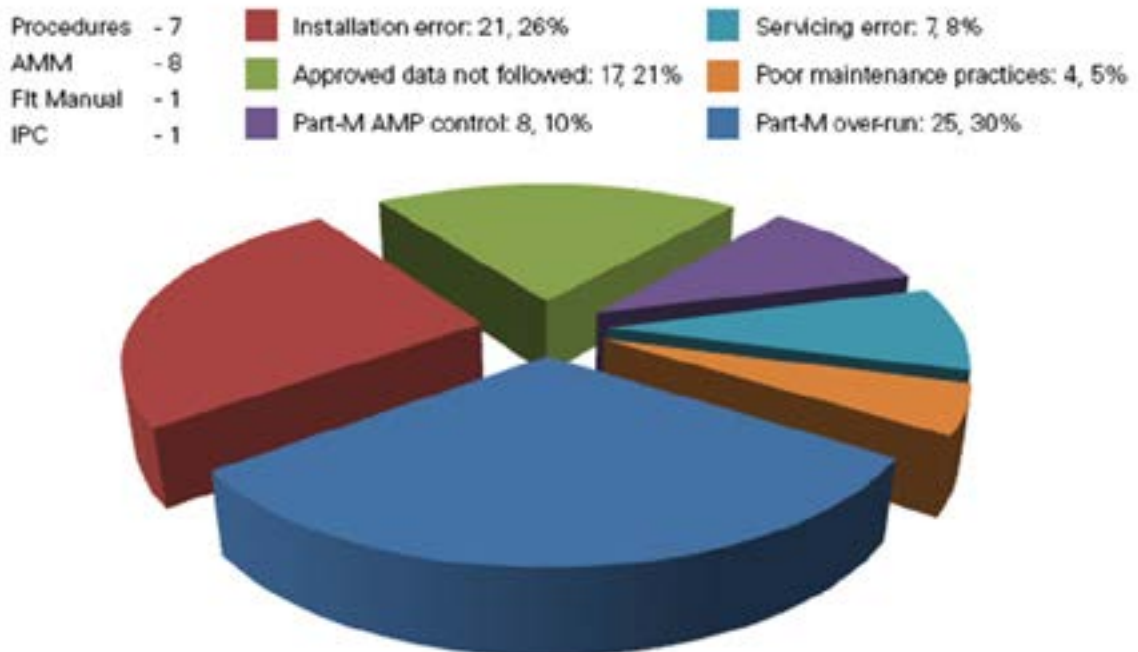
Action:

- A29 *The CAA will work with operators and their contracted engine and component maintainers to review processes that define when strip reports are required and determine necessary improvements to assure these are provided and thus ensure that potential safety information is not lost. (Delivery Q2/2014)*

Human factors errors

- 26.3 All helicopter certifying staff are required to hold EASA Part-66 licences. This requires that training is carried out by an EASA Part-147 approved organisation. The operators all provide human factors training to their staff that includes interactive sessions as well as a variety of other means. Only one currently sub-contracts this to a third-party organisation, along with its Norwegian sister company.
- 26.4 The CAA has been carrying out a wider review of MOR data between 2005 and 2011. This has been assessed by Confidential Human Factors Incident Reporting Programme (CHIRP) personnel, to identify and extract maintenance error occurrences from the data. The chart below indicates that Part-M overrun has the largest number of reported errors (30%). These are typically life-controlled items which have overrun their scheduled replacement date. However, this is a relatively small number of errors in comparison to the large number of life-controlled items managed on helicopters. The next issue identified is installation error (26%), of which over half were related to errors that would have been subjected to either a second inspection by an independent person, or a duplicate or independent inspection.

Figure 5: MOR Human Factors Errors reported in the North Sea organisations



- 26.5 It is clear from Figure 5 that the safety and quality system within the approved maintenance and continuing airworthiness approvals has an important part to play in reducing human error. Some of the contributing factors that affect human error include: distraction, lack of knowledge, lack of communication, complacency, lack of team work, fatigue, lack of resources, pressure, lack of assertiveness, stress, and lack of awareness. Human Factors training alone is not considered sufficient to minimise maintenance error. Most of the above can be attributed to the safety culture and associated behaviours of the organisation.
- 26.6 Improving maintenance standards is a CAA priority and all parties need to take a new approach if real and lasting benefits are to be truly realised. This approach would seek improvements by a cultural change that focuses on behaviours and attitudes to ensure that the highest standards are the norm, a safety culture that is not only preached but applied and a low tolerance of non compliance, short cuts and repeat findings.
- 26.7 The CAA believes that improving maintenance standards and reducing maintenance error can be assisted by removing and simplifying processes and procedures. Underpinning this is improving and fully following procedures / maintenance manual instructions, adequately breaking down tasks / sub-tasks and ensuring that all maintenance tasks are fully documented and accurately reflect what was actually carried out. It is therefore considered that the CAA needs to work with industry to further review the underlying causes of non-compliance, and thereby improve organisation and engineer safety and performance.

Actions:

- A30 *The CAA will carry out a further review of Human Factors Maintenance Error data referred to in this report and publish the results to seek improvements in this important area. (Delivery Q4/2014)*
- A31 *The CAA will form an Offshore Maintenance Standards Improvement Team with the offshore helicopter operators with the objective of reviewing the findings at Annex F to the CAA Strategic Review of the Safety of Offshore Helicopter Operations and making proposals to achieve a step change in maintenance standards. (Team constituted Q3/2014 reporting Q1/2015)*

SECTION F: HELICOPTER SAFETY RESEARCH

CHAPTER 27

Research overview

- 27.1 This Section provides an overview of the offshore helicopter safety research initiatives that have come from previous reviews and other related initiatives, and in response to AAIB Safety Recommendations contained in reports on offshore helicopter accidents. The full report on the review of this aspect of offshore helicopter operations is contained in Annex G. The remainder of this Section comprises a summary of the review.
- 27.2 Since the late 1980s, the CAA has been leading a programme of research aimed at improving the safety of offshore helicopter operations. The programme originated from the joint CAA/Industry review of helicopter airworthiness by the Helicopter Airworthiness Review Panel (HARP), which was commissioned in 1982 and reported its findings in CAP 491 in 1984. This study led to a number of research projects and other reviews which, in turn, led to further research projects and a well-founded data-driven programme of work for improving offshore helicopter safety. A total of around 20 major safety issues have been investigated covering airworthiness and operational issues, and covering helicopters and helidecks. This programme of work has been jointly funded and monitored with the industry by the UK CAA run Helicopter Safety Research Management Committee (HSRMC). The membership of the HSRMC comprises the UK helicopter operators (BHA), the European Helicopter Association (EHA), EASA, the UK Ministry of Defence, HCA, Oil & Gas UK, helicopter manufacturers (AgustaWestland), the Norwegian and other European NAAs with offshore helicopter interests, Norwegian Oil and Gas, the Canadian oil industry (C-NLOPB), and Danish Offshore Natural Gas (DONG) representing the offshore wind energy sector.
- 27.3 HARP essentially comprised a review of the helicopter airworthiness requirements with a view to identifying where new technology would enable the introduction of enhanced standards. It included a review of accidents and incidents and its recommendations were influenced by the Safety Recommendations in the corresponding UK AAIB reports. HARP, and the subsequent studies that it gave rise to, also acted as a catalyst for further initiatives, some of which would have been considered proactive at the time work started. More recent accidents and the resulting UK AAIB Safety Recommendations have added impetus to these projects and have helped to support the voluntary implementation of the research results by the industry.

Key areas of research

27.4 Key current areas of research are:

- Health and Usage Monitoring Systems (HUMS) – development and improvement of equipment that enables technical faults to be detected before they become a hazard to flight safety.
- Helicopter ditching and water impact - leading to improved emergency floatation systems and a specification for emergency breathing systems that make helicopters easier and safer to escape from after a ditching or water impact.
- Helicopter operations to moving helidecks – development of new, scientifically derived operating limits which are directly related to the risk of the helicopter tipping or sliding while landed on a moving helideck.
- Helideck lighting - development and demonstration of a new lighting scheme to improve visual cueing and reduce the risk of pilot disorientation during operations at night.
- Helicopter flight data monitoring – routine analysis of flight recorder data to monitor and correct the operation of the aircraft in terms of compliance with flight manual limitations, good practice and airmanship.
- Instrument guidance for offshore approaches - new equipment and procedures using Differential GPS (DGPS) to improve the safety of offshore operations in conditions of low visibility and at night by delivering the helicopter in a stable condition at a point from which it can be expected to be safely flown to the helideck by the pilot.
- Helicopter Terrain Awareness Warning Systems – modification of existing equipment to increase warning times available to pilots in the event of an impending impact with the sea, and reduce the ‘nuisance’ alerts prevalent in current systems.
- Helicopter triggered lightning strike forecasting – development of a new helicopter ‘triggered’ lightning forecasting system to help helicopter operators plan their flights to avoid high risk areas.

Addressing technical cause accidents

27.5 The largest and arguably most significant area of research has been HUMS which potentially addresses the top technical accident causes. HUMS comprises the collection and analysis of vibration data which is then analysed to detect defects before they compromise flight safety. HUMS was voluntarily introduced by the industry with funding from the offshore oil and gas companies in the early 1990s following the CAA-run in-service trials. There was a significant reduction in the accident rate due to technical causes around this time and it is considered reasonable to assume that HUMS was largely responsible. That said,

there is room for improvement in HUMS and the latest research on advanced data analysis techniques is being introduced, voluntarily by the industry and again with funding from the offshore oil and gas companies. HUMS has only been applied to transmissions and its extension to rotors is being progressed, currently via participation in the AgustaWestland Rotorcraft Technology Validation Programme part-funded by the UK Government Technology Strategy Board.

Addressing operational cause accidents

- 27.6 Some proactive research has also been undertaken, the most notable example of which is the application of Flight Data Monitoring (FDM) to offshore helicopter operations. This research project resulted in the voluntary implementation of the scheme at all of the UK offshore helicopter operators and its addition as a Recommended Practice for Flight Data Recorder (FDR) equipped helicopters in ICAO Annex 6 Part III. Through the routine analysis of aircraft FDR data, the monitoring of pilot performance in terms of compliance with operational standards and good airmanship, FDM has the capability of reducing the number of accidents due to operational causes. Adverse trends are detected and corrective measures such as revised procedures and/or training applied which are then automatically monitored for effectiveness by the continuous, closed loop FDM process.
- 27.7 Operational accidents are also being addressed through a number of targeted projects such as the introduction of a new helideck lighting system developed under a CAA-led research project. This new scheme directly addresses two of the more recent accidents (G-BLUN in 2006 and G-REDU in 2009), one of which involved fatalities. The retrofit of this equipment was launched in early 2013, supported by the offshore oil and gas industry. Also close to roll-out is the initial, interim version of the new Helideck Monitoring System (HMS) to support operations to moving helidecks. Based on an analysis of the associated MORs, this equipment is expected to directly address around two thirds of the related accidents and incidents and will lay the foundations for future upgrades, by software update, as and when the research progresses.

Addressing external cause accidents

27.8 Lightning strikes represent the main source of external cause accidents to offshore helicopters. Helicopters have the ability to 'trigger' lightning strikes which is evidenced, amongst other factors, by strike rates significantly higher than could be expected by chance alone. A helicopter triggered lightning forecasting system has been developed by the UK Met Office under a CAA-led research project. The system has shown significant promise and is presently undergoing final in-service trials with the UK offshore helicopter operators. As the implementation of the system for the trials is identical to that for continuous use in service, no additional action or effort is required on successful completion of the research, currently expected by April 2014.

Mitigation of accidents

27.8 Notwithstanding the good progress that has been made with the initiatives to help prevent accidents, it is not realistic to expect that there will never be any accidents. A major area of the research programme has therefore been directed at mitigating the consequences of accidents. Since offshore operations take place almost entirely over the sea, the main focus for this work has been post-ditching and water impact survivability. Aspects addressed have included improvements to the performance and crash-worthiness of helicopter emergency floatation systems, measures to facilitate escape from a capsized helicopter, and improvements to personal protective equipment such as emergency breathing systems and survival equipment. All of this work is being taken forward under the current EASA Rule Making Task on helicopter ditching and occupant survivability, but it is hoped that implementation can be expedited on a voluntary basis via Oil & Gas UK.

Summary

27.9 A number of the current projects still have some way to go before they will produce results that can be considered for implementation. For others the research is essentially complete and the focus has switched to promoting and supporting implementation by producing and publishing guidance material, influencing the industry and, where appropriate, by lobbying for changes to the aviation rules at EASA. Good progress has been made, but there is still work to do.

Actions:

A32 *The CAA will:*

- *promote and support the implementation of the results of the research on helideck lighting, operations to moving helidecks, Differential GPS-guided offshore approaches and helicopter terrain awareness warning systems;*
- *seek to ensure funding for the research on operations to moving helidecks, Differential GPS-guided offshore approaches and helicopter terrain awareness warning systems to allow timely progress to completion and once completed promote and support the implementation of the results. (Delivery ongoing)*

Recommendations:

R28 *It is recommended that the UK Met Office and the helicopter operators fully implement the triggered lightning forecasting system, subject to satisfactory performance during the present in-service trials. (Delivery Q3/2014)*

R29 *It is recommended that the offshore oil and gas industry, helicopter operators, helicopter manufacturers and regulators:*

- *Enhance their support of the helicopter safety research programme*

- *establish a less labour intensive, more regularised arrangement between participating organisations for the funding of research projects*
- *establish, via Oil & Gas UK, a faster and more focused approach to implementation of successful research projects. This should be in addition to and in advance of the enhancement of the aviation rules and guidance material.*

SECTION G

CHAPTER 28

Conclusion

- 28.1 The safety of offshore helicopter operations has been the subject of considerable and continuous work conducted internationally by operators, the offshore industry and regulators. Despite this effort there have been five accidents in the North Sea area over the past four years, two of which tragically resulted in fatalities.
- 28.2 The CAA has undertaken a systematic analysis of the safety performance of helicopter operations on the UK Continental Shelf. This has involved assessing the current risks to safety performance paying particular attention to the causal factors associated with previous accidents; reviewing of previous accident and applicable incident documentation, including any from similar international operations; reviewing the scope and development of current regulations and emerging technological advancements; and making recommendations for improvements in safety performance.
- 28.3 The CAA would like to take this opportunity to thank all those who gave their time and considerable knowledge and expertise to help shape this final review which we believe will strengthen the safety of offshore operations in the UK and potentially worldwide.

Safety performance

- 28.4 Based on the evidence gathered we believe that the UK offshore helicopter operations are of an equivalent level of safety to similar operations throughout the world. That includes operations in Norway where a specific comparison was performed in conjunction with the Norwegian CAA.
- 28.5 The review studied accident data from 1976 with particular emphasis on data from 1992 onwards as this is most representative of the current operations. There were a total of 25 UK offshore helicopter accidents between 1992 and 2013 equating to 1.35 accidents per 100,000 flying hours. Seven of these accidents were fatal and resulted in 51 deaths. A comparison with data from Norway over the same period showed that, although they suffered only one fatal accident, no significant statistical difference exists between the two operations.

Actions and recommendations

- 28.6 Our review has nonetheless identified a number of recommendations and proposed actions to further improve safety levels.
- 28.7 The tables below outline the key recommendations and actions and a proposed timeline for their introduction.
- 28.8 Some of the key actions and recommendations are aimed at improving the survivability of passengers and crew following an accident. While prevention of accidents is our main focus, it must be acknowledged that it is unrealistic to expect an accident never to occur, particularly when considering the challenging and hazardous oversea environment where these flights are routinely conducted.
- 28.9 Several of the recommendations require physical modification of helicopters and therefore represent longer-term improvements. Immediate mitigation is provided, however, through an operational restriction on UK operators that will stop operations in certain poor weather situations. Other measures, such as improved survival equipment, will take effect in the short to medium term and it is expected that most if not all of the measures introduced as a result of this review will be underpinned by the output of the EASA Rule Making Task on helicopter ditching occupant survivability which is due in 2016.

Next steps

- 28.10 Several of the actions that the CAA has committed to are already being put in place. Others will be tracked through our business planning and safety plan process to ensure they are implemented promptly and with proper oversight. Progress with these requirements will be monitored and publicised by the CAA.
- 28.11 Other recommendations fall into two main areas – those for the UK industry (oil and gas organisations and UK operators) to implement and those for EASA to consider.
- 28.12 A new CAA-led governance body for offshore operations, incorporating the key organisations from across the industry, will be established as quickly as possible; this will replicate the “best practice” model derived from the gap analysis collaboration carried out with the Norwegian CAA. This will allow us to monitor the progress of recommendations to the UK industry and oversee their introduction and provide an opportunity to share information and knowledge with that body, the Committee for Helicopter Safety on the NCS.
- 28.13 For recommendations to be taken forward on a Europe-wide basis through EASA, the CAA will engage directly with EASA to ensure that a high priority is placed on this work.

SECTION H**CHAPTER 29****Actions and recommendations**

- 29.1 The following is a consolidated list of actions and recommendations identified and assigned within this report.
- 29.2 CAA Actions: An outline timescale for the CAA actions is given below including the quarter by which the action is due to be completed; i.e. Q1/2014 is January – March 2014.

Action		Delivery
A1	The CAA will establish and lead a new offshore operations safety forum to work for a substantial improvement in the safety of helicopter operations on the UK continental shelf.	Q3/2014
A2	The CAA will accelerate its work with industry to develop and apply Safety Performance Indicators to improve the effectiveness of helicopter operators' Flight Data Monitoring programmes.	Q3/2014
A3	The CAA will analyse lower risk occurrences (i.e. serious incidents and incidents) for the main areas of risk, technical and external cause occurrences in particular, in order to increase the 'resolution' of the analysis. This analysis will take the form of a rolling annual review of the last five years of occurrence reports.	Q3/2014
A4	The CAA will work with the helicopter operators via the newly established Helicopter Flight Data Monitoring (FDM) User Group to obtain further objective information on operational issues from the FDM programme.	Q4/2014
A5	With effect from 01 June 2014, the CAA will prohibit helicopter operators from conducting offshore flights, except in response to an offshore emergency, if the sea state at the offshore location that the helicopter is operating to/from exceeds sea state 6 in order to ensure a good prospect of recovery of survivors.	01 Jun 14
A6	With effect from 01 September 2014, the CAA will prohibit helicopter operators from conducting offshore flights, except in response to an offshore emergency, if the sea state at the offshore location that the helicopter is operating to/from exceeds the certificated ditching performance of the helicopter.	01 Sep 14
A7	With effect from 01 June 2014, the CAA will require helicopter operators to amend their operational procedures to ensure that Emergency Floatation Systems are armed for all over-water departures and arrivals	01 Jun 14

Action	Delivery
<p>A8 With effect from 01 June 2014, the CAA will prohibit the occupation of passenger seats not adjacent to push-out window emergency exits during offshore helicopter operations, except in response to an offshore emergency, unless the consequences of capsizing are mitigated by at least one of the following:</p> <ul style="list-style-type: none"> a) all passengers on offshore flights wearing Emergency Breathing Systems that meet Category 'A' of the specification detailed in CAP 1034 in order to increase underwater survival time; b) fitment of the side-floating helicopter scheme in order to remove the time pressure to escape. 	01 Jun 14
<p>A9 With effect from 01 April 2015, the CAA will prohibit helicopter operators from carrying passengers on offshore flights, except in response to an offshore emergency, whose body size, including required safety and survival equipment, is incompatible with push-out window emergency exit size.</p>	01 Apr 15
<p>A10 With effect from 01 April 2016, the CAA will prohibit helicopter operators from conducting offshore helicopter operations, except in response to an offshore emergency, unless all occupants wear Emergency Breathing Systems that meet Category 'A' of the specification detailed in CAP 1034 in order to increase underwater survival time. This restriction will not apply when the helicopter is equipped with the side-floating helicopter scheme.</p>	01 Apr 16
<p>A11 The CAA will organise and chair an operator symposium on Safety Management to identify generic hazards, mitigations and Safety Performance Indicators for offshore operations.</p>	Q2/2014
<p>A12 The CAA will review whether operations should continue at helidecks where the overall dimensions and/or loading values as notified for the helideck are insufficient to accommodate the helicopter types in use and take the necessary action.</p>	Q3/2014
<p>A13 The CAA intends to assume responsibility for the certification of UK helidecks and will consult with industry to achieve this.</p>	Q1/2015
<p>A14 The CAA will review the conditions applicable to the issue of offshore 'exposure' approvals with a view to making them appropriate to the intended types of operation.</p>	Q3/2014
<p>A15 The CAA will commission a report to review offshore communication, handling and flight monitoring procedures from an air traffic control perspective and act on its outcomes.</p>	Q4/2014
<p>A16 The CAA will, with industry, review the instrument flying training element for all EFIS-equipped offshore helicopter type rating courses to be satisfied that candidates have a firm understanding of the displays and techniques required for basic instrument flight. The CAA will propose to EASA any necessary improvements to the syllabus requirements.</p>	Q4/2014

Action		Delivery
A17	The CAA will review all helicopter AOC recurrent training programmes to ensure that basic instrument flight skills are maintained so that crews can readily deal with manual flight if required.	Q2/2014
A18	The CAA will review the requirement for instructor tutor training and, if appropriate, make proposals to EASA to incorporate within Part-Aircrew.	Q4/2014
A19	The CAA will examine the output of its review into the safety of large UK commercial air transport aeroplane operations for relevance and applicability to ensure that any appropriate safety initiatives have been extended to the offshore helicopter environment.	Q4/2014
A20	The CAA will amend its examiner assessment protocols (CAA Standards Document 24) to require specific 'de-identified' candidate performance indicators so that any trends in common failings are visible for proactive attention.	Q4/2014
A21	The CAA will review the pilot recency requirements for helideck operations that have been incorporated into the draft requirements for the EASA Ops Specific Approval for Offshore Helicopter Operations and require operators to implement them to an agreed schedule.	Q3/2014
A22	The CAA will review helicopter operators' safety cases for night operations to bow decks to assess operator procedures and mitigations and determine whether such operations should continue.	Q2/2014
A23	The CAA will continue to develop its working relationship with EASA, in particular in the areas of sharing airworthiness information and the management of operator in-service issues. This will be achieved by periodic meetings and reviews with the appropriate EASA and CAA technical staff.	Ongoing
A24	The CAA will review CAA Paper 2003/1 (Helicopter Tail Rotor Failures) to determine how well the recommendations have been taken forward and to assess if further action is necessary. The conclusions of this review will be discussed with EASA.	Q3/2014
A25	The CAA will review the human performance aspects of flight crew responses to engine bay fire warnings, specifically within the offshore operations environment.	Q3/2014
A26	CAA Airworthiness will meet with offshore operators periodically to compare the trends of MORs with operator inservice difficulty / reliability data to ensure that the complete risk picture is captured, addressed and that the desired outcomes are being achieved.	Q2/2014
A27	The CAA will focus on Vibration Health Monitoring (VHM) download procedures, system/component reliability, the handling of VHM management of alerts and defects during audits of UK offshore operators.	Q2/2014
A28	The CAA will review CAP 753 to clarify alert generation and management, to ensure it is consistent and a system of amber/red warning thresholds is established to allow maintenance staff to identify the severity of the alert.	Q4/2014

Action		Delivery
A29	The CAA will work with operators and their contracted engine and component maintainers to review processes that define when strip reports are required and determine necessary improvements to assure these are provided and thus ensure that potential safety information is not lost.	Q2/2014
A30	The CAA will carry out a further review of Human Factors Maintenance Error data referred to in this report and publish the results to seek improvements in this important area.	Q4/2014
A31	The CAA will form an Offshore Maintenance Standards Improvement Team with the offshore helicopter operators with the objective of reviewing the findings at Annex F to the CAA Strategic Review of the Safety of Offshore Helicopter Operations and making proposals to achieve a step change in maintenance standards.	Q3/2014 Report Q1/2015
A32	<p>The CAA will:</p> <ul style="list-style-type: none"> ▪ promote and support the implementation of the results of the research on helideck lighting, operations to moving helidecks, Differential GPS-guided offshore approaches and helicopter terrain awareness warning systems; ▪ seek to ensure funding for the research on operations to moving helidecks, Differential GPS-guided offshore approaches and helicopter terrain awareness warning systems to allow timely progress to completion and once completed promote and support the implementation of the results. 	Ongoing

29.3 Recommendations to EASA

R1	It is recommended that EASA leads the development of a management system that provides a structured review of all accident and serious incident reports and recommendations of helicopters operating offshore or events which could have led to a ditching if the helicopter had been over water. This should be done in collaboration with other North Sea NAAs and the CAA to ensure a cohesive assessment of both accident causes (looking for trends) and remedies (looking for suitability and effectiveness) in order to prevent the segregated nature of accident reviews and ensure there is continuity to the safety reviews.
R2	It is recommended that EASA involve NAAs annually in a forum to agree and exchange information on the performance of safety actions taken in line with accident and serious incident investigation recommendations and potential other improvements that could be adopted, where appropriate.
R3	It is recommended that EASA introduces procedures to monitor and track the efficiency and reliability of maintenance interventions when these are used during the certification activity to assure the safety target of the rotorcraft.
R4	It is recommended that EASA ensures that the Type Certificate Holder completes a design review following a failure or malfunction of a component or system on any other similar feature on that aircraft type or any other type in their product line and defines appropriate corrective actions as deemed necessary.
R6	It is recommended that the EASA Helicopter Ditching and Survivability RMT.0120 consider making safety and survival training for offshore passengers a requirement.
R12	It is recommended that EASA require helicopter manufacturers, in conjunction with the major operators of the type and NAAs, to review their recommended training material so that pilots are better prepared for operating modern highly complex helicopters.
R20	It is recommended that EASA /Type Certificate Holder confirm the number of false engine fire warnings on offshore helicopters, investigate the reasons for them and determine what actions to take to address this important safety issue.
R22	It is recommended that EASA initiate a rulemaking task to adopt the critical parts life monitoring and assessment requirements of Certification Specifications for Engines (CS-E) for large transport rotorcraft, currently subject to CS-29, including retrospective application. This should cover at least for the following areas: <ul style="list-style-type: none"> i) Residual stress assessments ii) Vibratory stress measurements iii) Manufacturing plan iv) Laboratory examination of time expired part
R23	It is recommended that EASA revise CS-29.602 for large transport rotorcraft intended to operate over hostile sea conditions for extended periods of time, to ensure the failure mode effects and criticality analysis process used to identify critical parts recognises that a safe ditching may not always be possible.

R24	It is recommended that EASA provide additional guidance material to improve standardisation in approach to the classification of critical parts to minimise inconsistencies in the instructions for continuing airworthiness and where appropriate to require revisions to existing Instructions for Continued Airworthiness.
R25	It is recommended that EASA consider developing requirements that could be applied to helicopters which carry out Offshore Operations in hazardous environments in a similar fashion to those used for aeroplane Extended Operations and All Weather Operations.
R26	It is recommended that EASA establish a forum for discussion for best practice and developments on Vibration Health Monitoring (VHM). This forum should include NAAs, operators and VHM manufacturers. The CAA expects that this could be achieved by the end of 2014.
R27	It is recommended that EASA review AMC 29.1465 to clarify alert generation and management, to ensure it is consistent and a system of amber/red warning thresholds is established to allow maintenance staff to identify the severity of the alert.

29.4 **Recommendations to the Helicopter Industry:**

- Helicopter Operators (AOC Holders)
- Helicopter Maintenance Organisations
- Air Training Organisations (ATOs)
- Helicopter Manufacturers

Recommendation	Delivery expected
<p>R5 CAA expects that offshore helicopter operators will address the following key items from the EASA RMT.0120 (27 & 29.008) draft NPA without delay:</p> <ul style="list-style-type: none"> ▪ Fitment of the side-floating helicopter scheme. ▪ Implementation of automatic arming/disarming of Emergency Floatation Equipment. ▪ Installation of hand holds next to all push-out window emergency exits. ▪ Standardisation of push-out window emergency exit operation/markings/lighting across all offshore helicopter types. ▪ Ensure that external life rafts can be released by survivors in the sea in all foreseeable helicopter floating attitudes. ▪ Ensure that all life jacket/immersion suit combinations are capable of self-righting 	A/R

Recommendation	Delivery expected
R9 The CAA expects the offshore helicopter operators to apply the risk-reduction methodology detailed in CAP 437 (Standards for Offshore Helicopter Landing Areas) for operations to Normally Unattended Installations to ensure that the foreseeable event of a crash with fire is appropriately mitigated.	Q3/2014
R10 It is recommended that offshore helicopter operators identify a set of 'best practice' standard procedures and engage with their customers to agree how these may be incorporated into contractual requirements.	Q1/2015
R13 It is recommended that Approved Training Organisations and helicopter AOC holders adopt the aircraft manufacturers' operating philosophies and recommended practices, where available, within their type syllabi and current training and checking programmes with particular emphasis on automation. This information should also be reflected in instructor guidance so that specific learning points for the automated systems are addressed in a standard manner.	Q3/2014
R14 It is recommended that Approved Training Organisations and helicopter AOC holders review their type rating syllabi and recurrent training programmes to ensure that Standard Operating Procedures and monitoring pilot techniques are included at all appropriate stages of the type rating course, operator conversion courses and recurrent training/checking.	Q3/2014
R15 It is recommended that Approved Training Organisations and helicopter AOC holders review their training syllabi to ensure that the correct use and emphasis upon Standard Operating Procedures is impressed upon crews throughout all stages of flight and simulator training.	Q4/2014
R16 It is recommended that Approved Training Organisations and helicopter AOC holders address with aircraft manufacturers any shortfall in the Operational Suitability Data training syllabi for those destined to operate the type offshore.	Q1/2015
R17 It is recommended that AOC holders, in conjunction with the CAA, develop an Alternative Means of Compliance to introduce the option of Alternative Training and Qualification Programme, as permitted for aeroplanes in accordance with ORO.FC.A.245.	Q1/2015
R18 It is recommended that Approved Training Organisations work with AOC holders to ensure that their Synthetic Flying Instructors have current operational knowledge of the type(s) on which they instruct.	Q4/2014
R19 It is recommended that Approved Training Organisations and helicopter AOC holders establish a requirement for training record narratives.	Q3/2014

Recommendation	Delivery expected
R21 It is recommended that the helicopter Type Certificate Holder identify all major components or systems that lead to a land immediately condition to ensure themselves that the actual reliability data available from the operators is validating the assumptions made at the time of certification. This review should be overseen by the regulator for the State of Design.	Q1/2015
R28 It is recommended that the UK Met Office and the helicopter operators fully implement the triggered lightning forecasting system, subject to satisfactory performance during the present in-service trials.	Q3/2014

29.5 Recommendations to the Oil and Gas Industry:

R7	The CAA expects that OPITO will review and enhance its safety and survival training standards with regard to the fidelity and frequency of training provided.	Q4/2014
R8	The CAA expects the oil and gas industry to incorporate the fire-fighting provisions detailed in CAP 437 (Standards for Offshore Helicopter Landing Areas) for Normally Unattended Installations without further delay.	Q3/2014
R11	The CAA expects that the oil and gas industry will review its audit and inspection practices to harmonise and pool audit schemes to reduce the impact on helicopter operators following the principles described in the Oil & Gas UK Guidelines for the Management of Aviation Operations.	Q1/2015

29.6 Recommendations to all:

R29	It is recommended that the offshore oil and gas industry, helicopter operators, helicopter manufacturers and regulators: <ul style="list-style-type: none"> ■ continue to support the helicopter safety research programme ■ establish a less labour intensive, more regularised arrangement between participating organisations for the funding of research projects ■ establish, via Oil & Gas UK, a faster and more focused approach to implementation of successful research projects. This should be in addition to and in advance of the enhancement of the aviation rules and guidance material.
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Annexes to: **Civil Aviation Authority - Strategic Safety Review of Offshore Public Transport Helicopter Operations in Support of the Exploitation of Oil and Gas**

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Annex A Terms of Reference

To Mark Swan, Group Director SARG
cc Bob Jones, Head of Flight Operations

23 September 2013

CAA Strategic Safety Review of UK Offshore Public Transport Helicopter Operations in Support of the Exploitation of Oil and Gas in the North Sea Area

1 Background

- 1.1 An internal review¹ of all reportable UK offshore public transport helicopter accidents (MOR Grade A or B) during the period 1976 to 2012 has recently been prepared and delivered to the CAA Safety Action Group (SAG) and will subsequently be submitted to the CAA Board. The review established that the main causal factors of these accidents were operational (pilot performance), technical (rotor and transmission failures) and environmental (lightning strikes) factors. In addition, several other international reviews² have been conducted into the safety of offshore operations and these have included similar conclusions. A separate rule making task is also underway by EASA into a specific approval for helicopter offshore operations and the Notice of Proposed Amendment 2013/10³ was published in June 2013 for consultation.
- 1.2 Set against this background and given the considerable amount of effort that has been invested by both regulatory authorities and operators into minimising the risks to safe operations in the North Sea, nevertheless, a total of five accidents (two of which tragically involved fatalities) have occurred in the last four years. Given that these accidents have involved the main causal factors mentioned above, other than lightning strikes, an urgent review of the overall safety performance levels that currently exist in the North Sea operational context is required. The UK CAA, in conjunction with EASA, the Norwegian aviation authority and an independent peer review group, will undertake such a review and prepare a report for the consideration of the CAA Board with a view to gaining its endorsement of recommendations to improve the safety performance of all operations in the North Sea.

2 Objective and Scope

- 2.1 The objective of the review is to conduct a systematic analysis of safety performance regarding the totality of the helicopter operations in the North Sea; assess the current risks to performance paying particular attention to the causal factors that have contributed to previous accidents; undertake a comprehensive review of all previous accident and incident documentation, including any from similar international environments; review the scope and development of current regulations and emerging technological advancements; give an expert status report to the CAA Board on the overall assessment of current safety performance with recommendations for improvements covering the following specific areas:
- a. The Operational Command and Control arrangements pertaining for each offshore operator.

- Operator's organisation with respect to structure, resilience, competence, safety management.
- b. Capabilities for North Sea operating environment.
 - Capability of operators to resource and manage full scope of operational requirements. Suitability of helidecks and associated requirements.
- c. Protection of passengers and crews
 - Suitability of protection measures for passengers and crews in terms of both their life support and that afforded by the aircraft and its systems taking into consideration any ongoing rule making or research projects. Capability of the SAR/recovery structure for NS operations to respond to an accident.
- d. Training and pilot performance
 - Training syllabus, pilot requirements and experience levels, use of simulation and additional requirements necessary for the environment.
- e. Airworthiness (in conjunction with EASA)
 - Overall review of design requirements, continuing airworthiness, emerging technological advances and research development.
- f. Operational resilience
 - Ability of operators to conduct resilient, secure and sustainable operation given the demands of current and future operational environment.

3 Review Team Composition

- 3.1 Captain Robert Jones, HFO, working with Mr Geir Hamre of the Norwegian CAA, will lead the review, which will commence on 23 September 2013. Other members are listed at paragraph 4.1.1.
- 3.2 A team of suitably qualified advisers comprising Rear Admiral S Charlier, Mr J Lyons, Mr P Norton, Mr F Nascimento and a member of Scottish Transport Committee will provide independent challenge during the process and will undertake a review of the final report prior to submission to the CAA Board.

4 Methodology

- 4.1 A two staged approach will be taken to this work comprising the following elements:
- 4.1.1 Stage 1
- Review all relevant material to inform a baseline assessment of the current performance levels of safety of offshore operations in the UK sector of the Continental Shelf.
 - In partnership with Norwegian and EASA (to be confirmed) colleagues, review all relevant material with regard to the safety performance of offshore operations in the North Sea using a gap analysis to capture best practice.

- Identify areas for further consideration.
- Complete review of all subject matter.
- Prepare draft conclusions and recommendations.
- Consolidate interim findings for Stage 2.
- Personnel involved in this phase include:

CAA:

- Mr J Clark
- Mr A Eagles
- Captain C Armstrong
- Captain R Newson
- Captain R Greenwood
- Captain M McDougall
- Mr D Howson
- Mr J McColl
- Mr B Pattinson
- Mr K Payne
- Mr J Nicholson
- Mr D Marino
- Mr J Waites
- Miss R Jaeger

External:

- Mr G Hamre - CAA Norway
- Mr Ornulf Lien – CAA Norway
- EASA representative)

A sample of key external stakeholders will also be consulted including:

- DfT (England and Scotland)
- Norwegian NAA
- UK Oil & Gas
- Norwegian Oil & Gas
- UK Offshore helicopter operators
- Norwegian Offshore helicopter operators
- Step Change in Safety
- Helicopter Safety Steering Group
- The Committee for Helicopter Safety on the Norwegian Continental Shelf
- Statoil
- BHA
- UK Military

The output of Stage 1 will be a consolidation of the review work in a draft report.

4.1.2 Stage 2

- Completion of draft final report

- Conduct peer review.
- Consider peer review comments and consolidate final report.
- Complete final report.

The output of Stage 2 will be the Final Report.

5 Deliverables and Milestones

- 5.1 The key deliverables of the review will be an analysis of safety performance, the associated risks to said performance, a gap analysis evidencing best international practice, and a statement and assessment of interim findings by the end of December 2013. A Final Report, post peer review by an expert challenge team, will then be submitted to the CAA Board in early 2014.

6 Report Distribution

- 6.1 The Final Report will be distributed to: Mark Swan, Group Director SARG; Bob Jones, Head of Flight Operations; Geir Hamre CAA Norway; Andrew Haines, CAA Chief Executive.

¹ CAA Analysis of Offshore Helicopter Reportable Accidents 1976-2012.
[CAA HSRMC Presentation](#)

²

- a. HSS-3 Helicopter Safety Study 3. Report by SINTEF Technology and Society, Trondheim, Norway on behalf of BP, ConocoPhillips, Eni, GDF SUEZ, Marathon, Nexen, the Norwegian Civil Aviation Authority, Shell, Statoil and Total.
[SINTEF HSS3 Report](#)
- b. UK Offshore Commercial Air Transport Helicopter Safety Record (1981-2010), Oil and Gas UK. Oil & Gas UK Helicopter Safety Report
- c. IADC/SPE 98672 Helicopter Safety in the Oil and Gas Business. A paper prepared and presented at the IADC/SPE Drilling Conference held in Miami, Florida, USA 21-23 February 2006. Authors: E. Clark and C. Edwards, formerly with Shell Aircraft Intl., P. Perry, Consultant/Shell Aircraft Intl., and G. Campbell and M. Stevens, Shell Aircraft Intl.
- d. Research work by Mr Felipe Nascimento Imperial College London.
[Felipe Nascimento papers](#)

³ EASA NPA 2013/10 – Helicopter Offshore Operations
[NPA 2013-10 HOFO](#)

Annex B Review Methodology

1 Review Team

1.1 In addition to the CAA personnel, the following external parties supported this review:

Norwegian CAA:

- Geir Hamre, Head of Helicopter Section
- Ørnulf Lien, Flight Operations Inspector

European Aviation Safety Agency (EASA):

- Representatives from the following departments:
 - Standardisation
 - Certification – products and Operational Suitability
 - Operational Suitability - Rotorcraft/Balloon
 - Rulemaking – Flight Standards
 - Safety Analysis and Research

Challenge Team Members:

- Chair, Rear Admiral Simon Charlier
- Gary Cox, Transport for Scotland
- Jim Lyons
- Felipe Nascimento, Imperial College London
- Peter Norton, Chief Executive, British Helicopter Association

2 Information Gathered

2.1 Written materials in the formats of reports, guidelines and operator working documents were used as part of this review. These include:

- Civil Aviation Publications including the Helicopter Airworthiness Review Panel (HARP) Report CAP 491, 1984 and Review of Helicopter Offshore Safety and Survival (RHOSS) working group, which reported its findings in CAP 641 in 1995.
- CAA guidelines such as CAP 437 –Standards for Offshore Helicopter Landing Areas.
- CAA Audit Reports.
- Norwegian Ministry of Transport reviews 1 and 2 into Helicopter Safety on the NCS 2000-2002.
- Norwegian SINTEF Reports.
- Oil and Gas Producers Aircraft Management Guidelines.
- Oil & Gas UK guidelines for the management of aviation operations.
- 066-Norwegian Oil and Gas recommended guidelines.

- Oil & Gas UK Helicopter Safety Record (1981-2010).
- Operator Safety Management Systems.
- Helicopter Operator and training operator Standard Operating Procedures (SOPs).
- Helicopter Flight Manuals.
- Training providers' 'examiner assessment of competency' reports and Aviation Safety Reports (ASRs).

2.2 A number of stakeholders were contacted and either interviewed or provided written submission to the team. Notes were taken from each meeting and where an opinion or view has been referred to in the report, the accuracy of the statement has been confirmed with the interviewee. External written submissions have not been checked for factual accuracy.

2.3 The review received written submissions on behalf of the following organisations:

- BALPA
- Helicopter Safety Steering Group

3 Persons Interviewed as Part of the Review

Table B1 Details of Persons Interviewed

Company / Organisation	Name	Role / Job Title
Aberdeen ATC (NATS)	John Miller	General Manager Aberdeen ATC
Aberdeen ATC (NATS)	Brian Hill	Interim Manager Aberdeen ATC
Air Accidents Investigation Branch	Keith Conradi	Chief Inspector
Aviation Safety Technical Group	Robert Paterson	Chair
AVINOR	Stein Løken Clason	Adviser/Offshore Specialist
Bond Offshore Helicopters Ltd	Luke Farajallah	Accountable Manager
Bond Offshore Helicopters Ltd	Darren Beaumont	Safety Manager
Bond Offshore Helicopters Ltd	Capt S Godfrey	Crew Training Post holder
Bristow Helicopters Ltd	Mike Imlach	Accountable Manager
Bristow Helicopters Ltd	Ian Taylor	Safety Manager
Bristow Helicopters Ltd	Capt P Quick	Crew Training Post holder
Bristow Norway	Jim Urianstad	NPH Flight Operations
Bristow Norway	Caspar Cappelen Smith	Chief Pilot Stavanger
CAE ABZ	Capt J Brimble	Head of Training
CHC Scotia Ltd	Mark Abbey	Accountable Manager
CHC Scotia Ltd	Lorraine Hodgson	Safety Manager
CHC Helicopters	Capt S Finken	Crew Training Post holder

Company / Organisation	Name	Role / Job Title
CHC Helikopter Service	Tor Andreas Horne	NPH Flight Operations
FSI Farnborough	Capt D Lord	D/Head of Training
Health and Safety Executive	James Munroe	Operations Manager, HID Energy Division - Offshore
Helicopter Safety Steering Group	Les Linklater	Chair
Helideck Certification Agency	Alex Knight	General Manager and Senior Helideck Inspectors
International Oil and Gas Producers Association (OGP)	Mark Stevens	Chair of the OGP Aviation Committee (ASC)
Maritime & Coastguard Agency	Dougie MacDonald	Head of Aviation Operations
Norwegian Oil and Gas Association's professional network for aviation	Erik Hamremoen	Chairman, Manager Flight Safety, STATOIL
Norwegian Oil and Gas Association's professional network for aviation	Sverre J Austrheim	Member, Aviation Advisor/ ConocoPhillips Norway
Oil & Gas UK	Robert Paterson	Health, Safety & Employment Issues Director
RMT	Jake Molloy	Lead Union Spokesperson on North Sea Operations
The British Airline Pilots' Association	Tony Ridley and Derek Whatling	Chair, BALPA Helicopter Affairs Committee
Unite	John Taylor	Lead Union Spokesperson on North Sea Operations

Annex C Review of Accidents

1 Introduction

1.1 The accident review covers the period from the instigation of the MOR scheme in 1976 up to the end of 2012 (the last full year of data at the time of this review). The review was restricted to accidents for the following reasons:

- Accidents are normally thoroughly investigated which usually results in sufficient information being available for them to be properly assessed and accurately classified.
- A robust and internationally accepted accident definition exists in ICAO Annex 13; grading of less severe occurrences can be more subjective.
- It was expected that this approach would provide an objective way of constraining the review to a manageable size while still retaining most of the 'high profile' occurrences.
- If lower grade occurrences were to be included, there is a risk of the analysis being distorted by under reporting; this cannot occur with accidents.

1.2 The accidents were further restricted to operations directly associated with offshore oil and gas activities; the accidents included were agreed with Oil & Gas UK in order that the scope of their own safety review would be consistent with the CAA's.

1.3 The overall accident statistics for the period 1976 to 2012 are as follows:

- All accidents:
 - 72 accidents,
 - 1.95 per year (i.e. approx. 2 per year),
 - 2.09 per 100,000 flight hours,
 - 0.96 per 100,000 sectors (i.e. one every 104,167 flights).
- Fatal accidents:
 - 12 fatal accidents,
 - 0.32 per year (i.e. approx. 1 every 3 years),
 - 0.35 per 100,000 flight hours,
 - 0.16 per 100,000 sectors (i.e. one every 625,000 flights).

1.4 A list of the accidents included in the analysis is presented in Appendix 1.

Note: The flight hours and sectors data used for this study was supplied by JBA Ltd., who collected the data on behalf of and under contract to Oil & Gas UK Ltd.

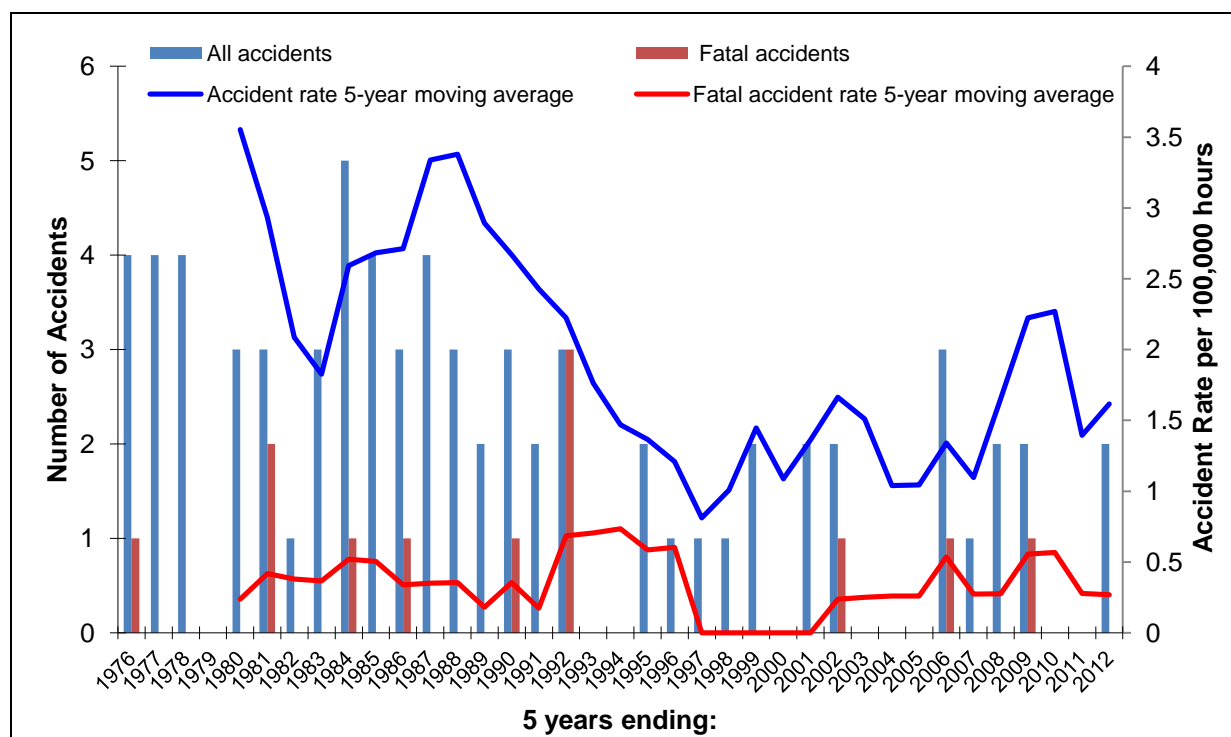
2 Chronology of Accidents (1976 – 2012)

2.1 The accident rates per 100,000 flight hours for all accidents (blue line) and for fatal accidents (red line) for the review period are presented in the form of five-year moving averages in Figure C1. Five year moving averages are used to smooth the data and help to identify any underlying trends, but it should be noted

that the rate for any particular year is consequently affected by the preceding four years.

- 2.2 The accidents are presented as rates per flight hour in order to remove the effect of exposure; a rise in the number of accidents could reflect an increase in flying activity rather than a reduction in safety performance. The accident rate in the 1970s was very high, but gradually decreased thereafter reaching a minimum in 1997. Since then, however, there has been a slight upward trend. The fatal accident rate appears to have been relatively constant over the entire period.
- 2.3 Plots based on rates per sector did not identify any different patterns in the data and so are not presented; the variation in sector length does not appear to be significant in this data set.
- 2.4 The numbers of all accidents (blue columns) and fatal accidents (red columns) for each year of the review period are also presented for information/completeness.

Figure C1 Chronology of reportable accidents (rate per 100,000 flight hours)



3 Classification of Accidents (1976 – 2012)

- 3.1 It is generally desirable to use a standard taxonomy for classifying accidents in order that the results can be compared with other studies, e.g. similar operations in other parts of the world. However, it can be the case that accident data sets do not fit standard taxonomies very well (i.e. insufficient/inappropriate codes available) which can affect the results, e.g. the taxonomies drive the results rather than the data due to ‘forcing’ the data into the taxonomy.
- 3.2 In this case, the CAST/ICAO Common Taxonomy Team (CICTT) scheme⁴ was used and was found to work very well. It is therefore considered that the results are truly representative of the source data.
- 3.3 As permitted by the CICTT scheme, the codes were also consolidated into a number of operational groupings as follows:

- **Operations (Ground)**

Evacuation	EVAC
Fire/Smoke (Post-impact)	F-POST
Ground Collision	GCOL
Loss of Control (Ground)	LOC-G
Ground Handling	RAMP
Runway Excursion	RE
Runway Incursion (Vehicle, Aircraft or Person)	RI-VAP
Undershoot/Overshoot	USOS

- **Operations (Flight)**

Abrupt Manoeuvre	AMAN
Abnormal Runway Contact	ARC
Air Traffic Management	ATM
Cabin Safety Events	CABIN
Controlled Flight Into Terrain	CFIT
Collisions during Take-Off and Landing	CTOL
Fuel related	FUEL
Loss of Control (In flight)	LOC-I
Loss of Separation / Mid-Air Collision	MAC
Unintended flight in IMC	UIMC

- **Technical**

Fire/Smoke (Non-Impact)	F-NI
System/Component Failure/Malfunction (Non-Powerplant)	SCF-NP
System/Component Failure/Malfunction (Powerplant)	SCF-PP

- **External**

Aerodrome	ADRM
Bird Strike	BIRD
Icing	ICE
Security	SEC
Turbulence	TURB
Windshear or Thunderstorm	WSTRW

- **Not Applicable**

External Load related	EXTL
Glider Towing related	GTOW
Low Altitude operations	LALT
Loss of Lifting conditions In flight	LOLI
Other	OTHR
Runway Incursion (Animal)	RI-A
Unknown	UNK

3.4 The results of the classification are presented in Figure C2 and Figure C3. The very high proportion of SCF-NP (system/component failure non-powerplant) is very apparent, but this should be viewed in the context of the very broad scope of this code. Nevertheless, technical accidents do represent the largest single grouping (even larger than operational flight and ground combined) and account for 46% of the accidents during this period.

Figure C2 Offshore helicopter accidents for the period 1976 to 2012 by CICTT operational groupings

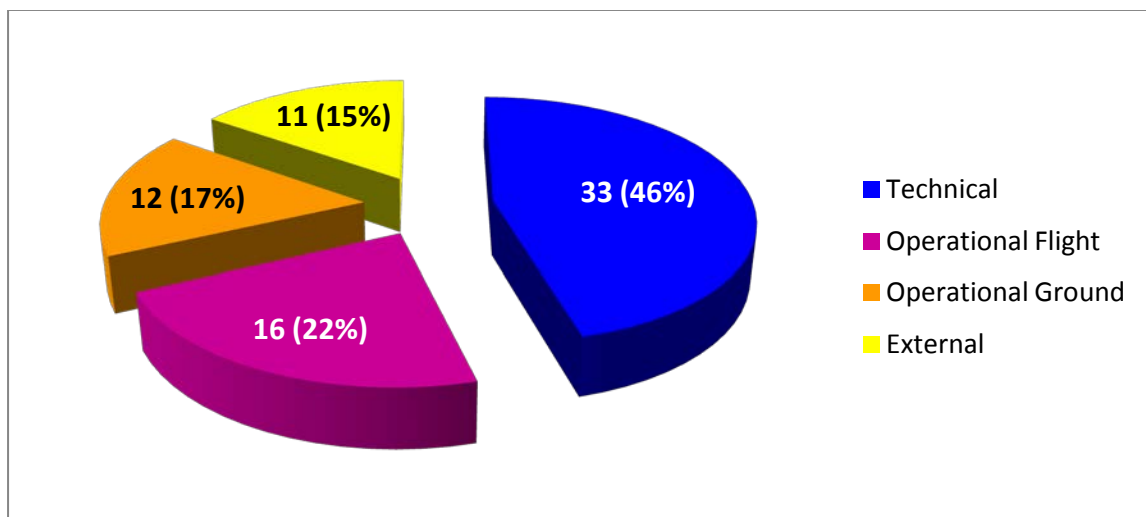
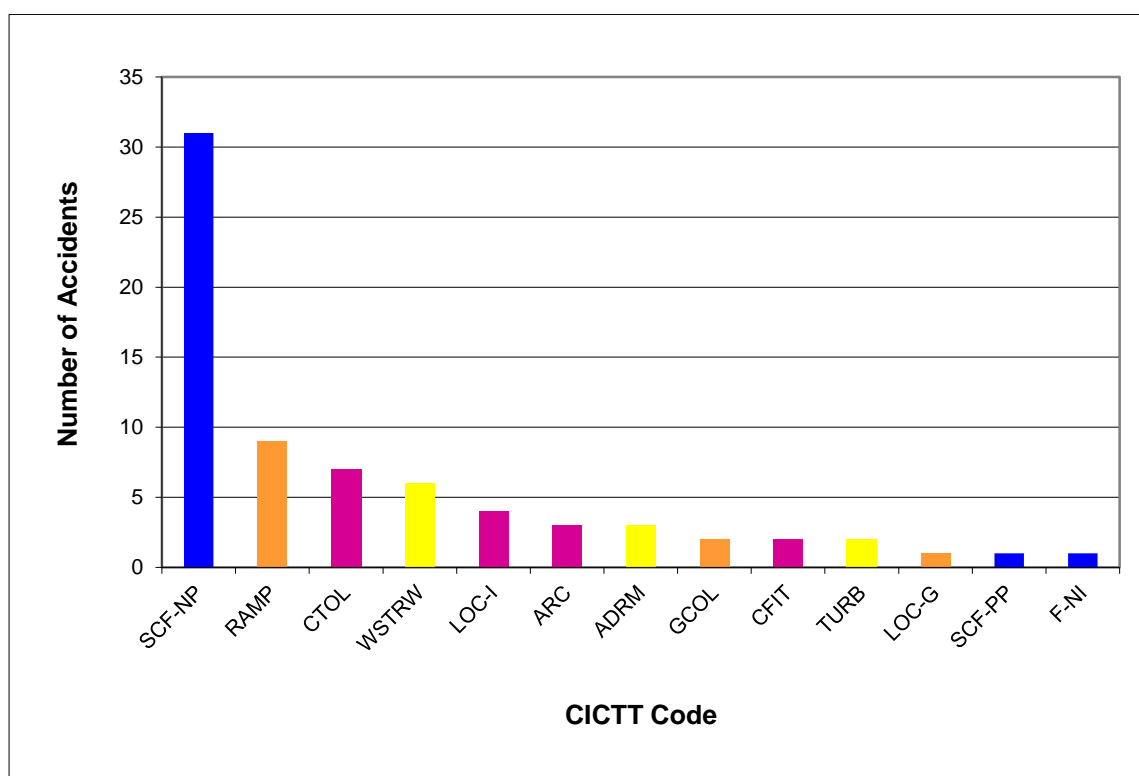


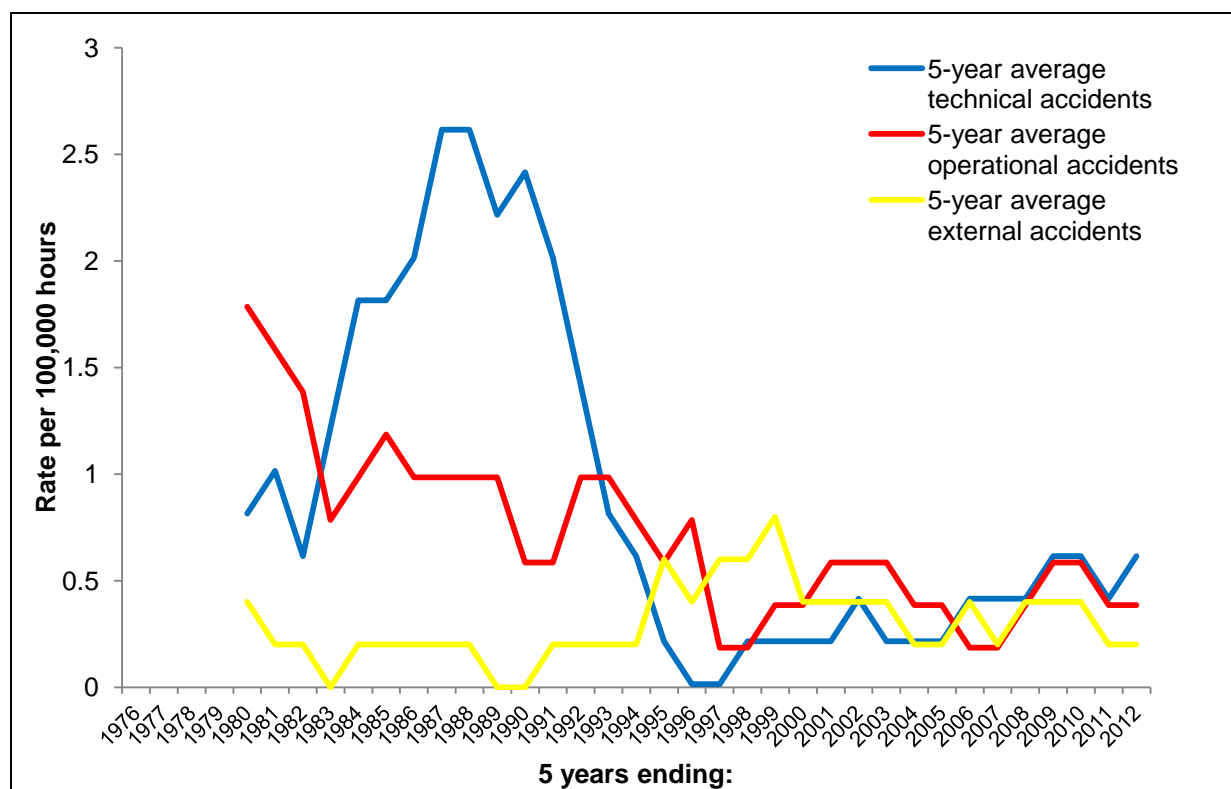
Figure C3 CICTT classification of offshore helicopter accidents for the period 1976 to 2012
(NB: Colour coding per Figure C2)



4 Chronology of Accidents by Group (1976 – 2012)

- 4.1 The chronology of the groupings is plotted in Figure C4 in the form of five-year moving averages. Note that the two operational groups (flight and ground) have been combined for simplicity.
- 4.2 A marked decrease in technical accidents around the early 1990s is immediately apparent which coincides with the introduction of Health and Usage Monitoring Systems (HUMS). Following the decrease to zero in 1997, however, there is a steady rise in technical accidents. Since operational and external cause accident rates show no overall trend during this period, it would appear that the upward trend in technical accidents is responsible for the overall rise in the accident rate over the last 15 years (see Figure C1).
- 4.3 Also of note is the step up in external accidents from 1995 onwards which coincides with the lightning strike to G-TIGK in 1995. This strike was especially severe and a catastrophic outcome was only narrowly avoided. As will be presented later, the majority (86%) of external cause accidents are related to lightning strikes which have occurred at a relatively steady rate over the entire period. It is thought, therefore, that the increased awareness of the potential consequences of lightning strikes following the G-TIGK strike in 1995 may have led to higher grades being awarded to the associated MORs, and that this could explain the step.

Figure C4 Chronology of offshore helicopter accidents for the period 1976 to 2012 by CICTT operational groups (5-year moving averages)



4.4 The problem with analysing relatively small data sets such as that for the UK offshore helicopter operation is that of balancing relevance and sample size. If the analysis extends too far into the past then its relevance to current operations may be questionable; this could be due to factors such as the retirement of obsolete aircraft types and the introduction of new operating procedures. On the other hand, if only data from very recent years is included then sample size is likely to be insufficient to draw any meaningful conclusions. Considering the total period from 1976 to 2012, the pattern of accidents in terms of both rate and composition for the period from 1992 to 2012 appears to be relatively stable and is therefore considered to be representative of current operations.

5 Analysis of Accidents (1992 – 2012)

5.1 As stated in Section 4, the period from 1992 to 2012 is considered to be representative of current operations and therefore forms the basis for the more detailed analysis that follows. The overall accident statistics for the period 1992 to 2012 are as follows:

- All accidents:
 - 24 accidents,
 - 1.14 per year (i.e. approx. one per year),
 - 1.37 per 100,000 flight hours,
 - 0.65 per 100,000 sectors (i.e. one every 153,846 flights).
- Fatal accidents:
 - 6 fatal accidents,

- 0.29 per year (i.e. approx. one every 3 years),
- 0.34 per 100,000 flight hours,
- 0.16 per 100,000 sectors (i.e. one every 625,000 flights).

5.2 With reference to Section 1, the annual accident rate for this period is approximately half that of the period from 1976 to 2012 and the rates per 100,000 flight hours and per 100,000 sectors are one third less. In terms of fatal accidents, however, the annual rate and rates per flight hour and sector are similar.

5.3 The results of the classification for this period are presented in Figure C5 and Figure C6 below.

Figure C5 Offshore helicopter accidents for the period 1992 to 2012 by CICTT operational groupings

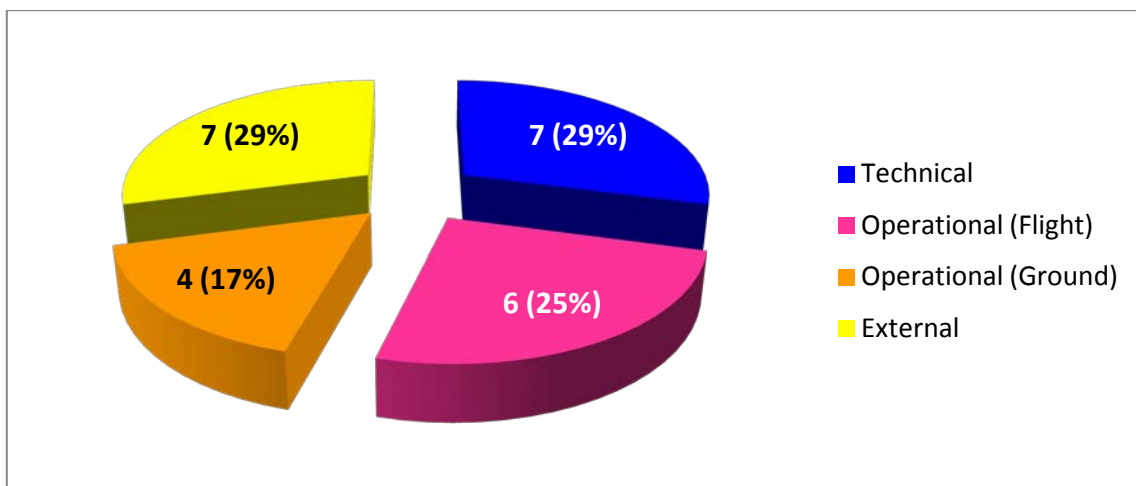
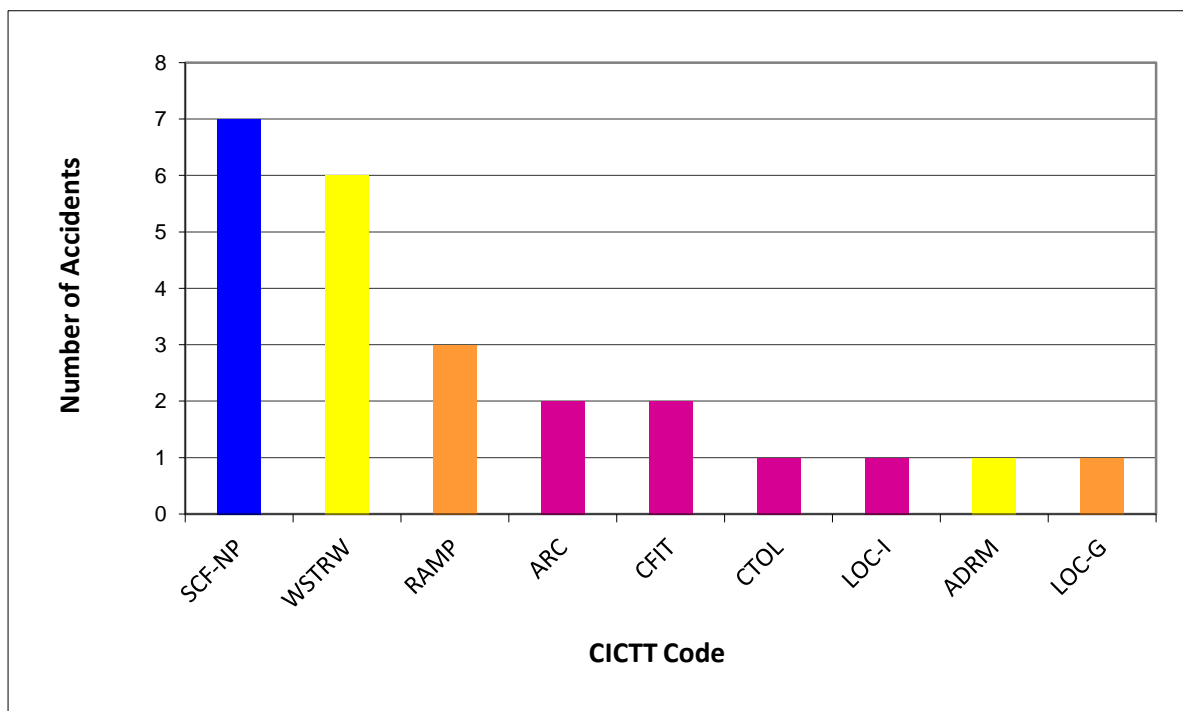


Figure C6 CICTT classification of offshore helicopter accidents for the period 1992 to 2012 (NB: Colour coding per Figure C5)



- 5.4 Comparing these results with those for the period 1976 to 2012 (see Figure C2 and Figure C3), SCF-NP (system/component failure non-powerplant) is again the most common code. Also of note is the large number of WSTRW (windshear or thunderstorm) accidents and the corresponding increase in the proportion of these from 8.3% of the total number of accidents (1976 to 2012) to 25% (1992 to 2012). This is mainly because all of the lightning strike accidents occurred during the latter period, i.e. post the G-TIGK accident in 1995.
- 5.5 Taking the operational groupings as a whole, however, operational (flight and ground combined) dominate accounting for 10 out of 24 (42%) of the accidents. Technical and external cause accidents each account for seven out of 24 (29%) of the accidents.

6 Analysis of Accident Groups (1992 – 2012)

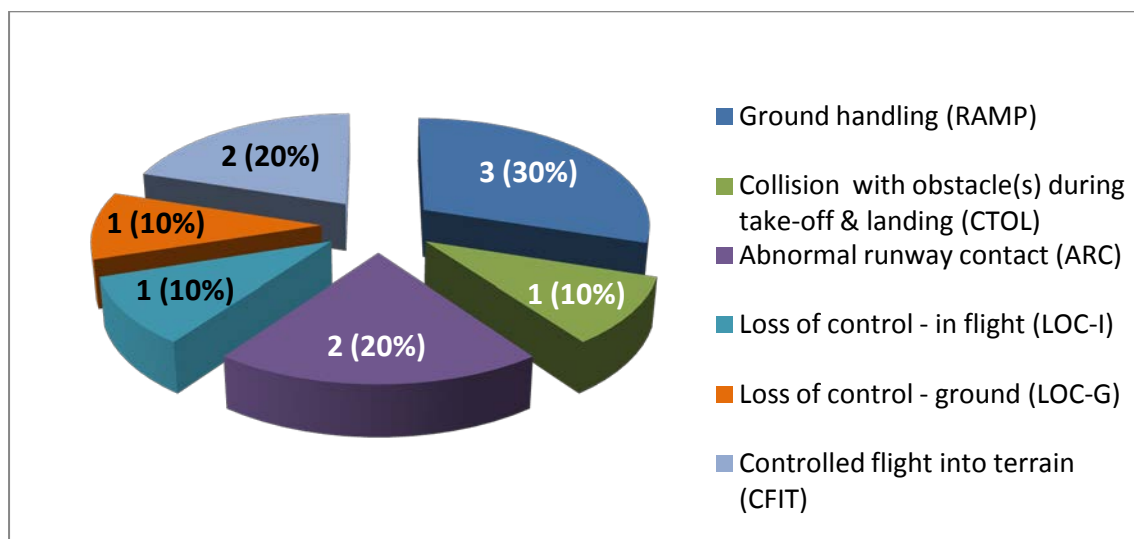
6.1 Introduction

- 6.1.1 In this Section the three accident groups of operational (flight and ground), technical and external are explored in more detail. Note that the analysis is restricted to the period 1992 to 2012 in the interests of balancing relevance with data sample size as explained in Section 4 above.

6.2 Operational Accidents

- 6.2.1 Operational causes accounted for 10 out of 24 (42%) of the accidents during the period 1992 to 2012. The classification of these accidents by CICTT occurrence code is shown in Figure C7 below.

Figure C7 CICTT classification of operational cause offshore helicopter accidents for the period 1992 to 2012



- 6.2.2 The largest single category is ground handling (RAMP), of which most (two out of the three) relate to operations to moving decks where the issue is the lack of appropriate operating criteria (G-BOND, 18/04/1992 and G-BKZE, 10/11/2001). The research into operations to moving helidecks is addressing this issue. The third (G-BLEZ, 22/09/1992) involved a fatal rotor strike to a ground crew member on a non-moving helideck for which no definitive explanation could be found.
- 6.2.3 The remaining seven operational accidents cover a range of accident scenarios but all involve a flight crew performance related factor. The classification of these

accidents by Accident Analysis Group Causal and Circumstantial Factors (see Appendix 2) is presented in Table C1 below.

Table C1 AAG Causal and Circumstantial Factors classification of pilot performance accidents for the period 1992 to 2012

Code		Sub-Code		Count
10.9	Flight Crew Human Performance	10.9.1	Disorientation or visual illusion	2
10.10	Flight Crew Perception and Decision Making	10.10.2	Poor professional judgement or airmanship	2
		10.10.5	Omission of action or inappropriate action	2
10.11	Flight Crew Situational Awareness	10.11.1	Lack of positional awareness – in air	1

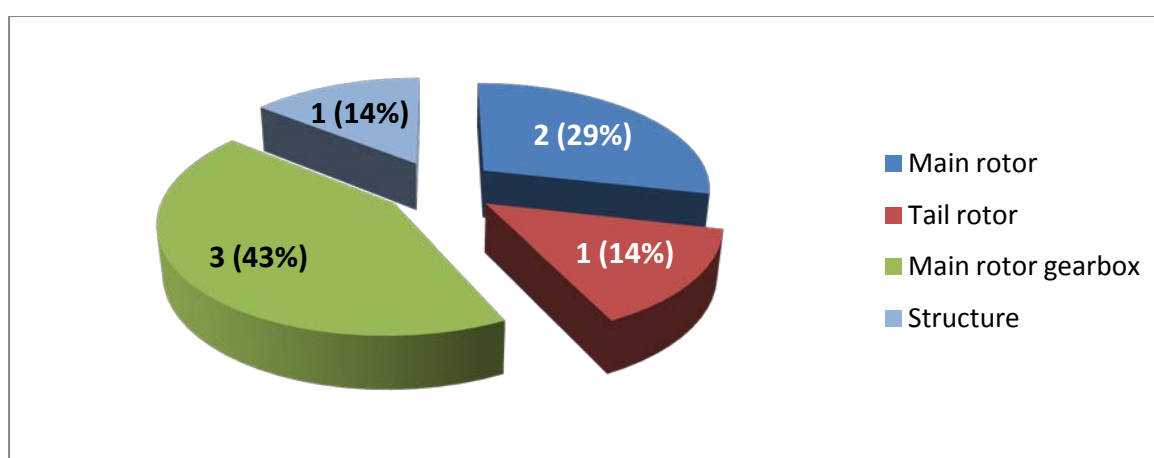
- 6.2.4 The two Flight Crew Human Performance (Code 10.9) accidents relate to disorientation or visual illusion and both occurred during approaches to offshore platforms at night and in conditions of poor visibility. Both resulted in water impacts, one of which (G-BLUN, 27/12/2006) was non-survivable (seven fatalities) but, fortuitously, there were no fatalities in the second (G-REDU, 18/02/2009). The research into helideck lighting, GPS-guided approaches and helicopter terrain awareness warning systems is helping to significantly improve safety in this area.
- 6.2.5 Flight Crew Perception and Decision Making (Code 10.10) accounted for four of the seven pilot performance accidents which were split equally between “poor professional judgement or airmanship” and “omission of action or inappropriate action”. The former involved a poor choice of flight path which resulted in a fatal accident (G-TIGH, 14/03/1992, 11 fatalities), and poor ground handling which resulted in a roll-over (G-TIGT, 04/01/1996). The latter were associated with failure to lower the undercarriage (G-PUMH, 23/07/1999), and pulling the collective lever instead of the parking brake (G-BMAL, 12/07/2001).
- 6.2.6 The Flight Crew Situational Awareness (Code 10.11) accident (G-BKXD, 09/03/2008) involved the tail rotor striking an obstacle adjacent to the helideck. There had been a further two such accidents during the period 1976 to 1991 (G-BHOH, 18/11/1980 and G-BEWL, 25/07/1990), one of which resulted in six fatalities.
- 6.2.7 It is difficult to define effective interventions for some crew performance factors based on small sample sizes such as this. One approach to gaining a better understanding of the underlying factors would be to analyse lower grade occurrences such as serious incidents and incidents. However, it is believed that occurrences involving pilot performance issues in particular are significantly under reported, and this could result in an incomplete or distorted picture.
- 6.2.8 Another or an additional approach would be to utilize the helicopter operators’ Flight Data Monitoring (FDM) programmes where objective data covering virtually all flying is collected and analysed. Problems are identified, corrective actions are taken and, since the process runs continuously, the effectiveness of the actions are automatically monitored. It should be noted that FDM identifies only the symptoms of operational deficiencies and not the causes, but this is

compensated for by the closed loop process. FDM programmes have been in place at the helicopter operators for a number of years, but there may be scope for improving their effectiveness in relation to the safety risks which underlie the accident experience.

6.3 Technical Accidents

6.3.1 Technical causes accounted for seven out of 24 (29%) of the accidents during the period 1992 to 2012. The CICTT classification scheme is not especially discriminating where technical accidents are concerned and, in fact, all seven accidents are associated with the same code of SCF-NP (system/component failure non-powerplant). In order to gain further insight, these seven accidents were classified according to which system/component failed to cause the accident. The results are presented in Figure C8 below.

Figure C8 Classification of technical cause offshore helicopter accidents by failed system/component for the period 1992 to 2012.



6.3.2 Rotors and transmission account for all but one of the technical cause accidents, which is perhaps unsurprising in view of the criticality of these systems.

6.3.3 The main rotor gearboxes of offshore helicopters are all monitored by HUMS. Although of undoubted benefit, HUMS is not perfect and some sections of the gearbox are harder to monitor than others. One of the failures (G-REDL, 01/04/2009) was in an epicyclic stage which are very challenging to health monitor due to their mechanical complexity and number of gears turning at the same speed. The other two, virtually identical failures (G-REDW, 10/05/2012 and G-CHCN, 22/10/2012) were in the shaft that drives the oil pumps. This shaft is only lightly loaded resulting in relatively weak reactions in the vibration signatures to defects making detection more difficult. Nevertheless, room for improvement in the analysis of HUMS data for transmissions has been identified and enhanced analysis techniques have been developed and demonstrated (i.e. Advanced Anomaly Detection – AAD) under a CAA research project. This technology is presently being introduced under a voluntary initiative led by Oil & Gas UK.

6.3.4 Although offshore helicopters are fitted with rotor track and balance systems, this does not constitute health monitoring. In fact there have been examples of track and balance adjustments masking developing rotor defects. The extension of HUMS to rotors is currently work in progress. Presently, the only initiative in place is the privately funded Rotorcraft Technology Validation Programme at AgustaWestland. The CAA has sight of this work under a non-disclosure agreement with AgustaWestland.

- 6.3.5 Another way of viewing the technical cause accidents is from the perspective of which aspect(s) of the overall manufacturing and maintenance process did not perform as well as they should have. Specifically these are design/certification (D/C), manufacturing (Mfr.), maintenance (Maint.) and continued/continuing airworthiness (CAW) and their implication in the seven accidents is detailed in Table C2 below. Note that the instances of shortfalls in the various areas are labelled according to whether they were considered to be causal (✓) or contributory (*) factors in the accident by the investigators.

Table C2 Overall process failures implicated in technical cause accidents for the period 1992 to 2012. (NB: STR = structure, MR = main rotor, TR = tail rotor, MRGB = main rotor gearbox, ✓ = causal factor, * = contributory factor.)

Accident				D/C	Mfr.	Maint.	CAW
Aircraft Reg.	Date	A/C Type	System				
G-BWMG	28/01/1998	AS332 L	STR			✓	
G-BJVX	16/07/2002	S-76A	MR		✓	✓	
G-PUMI	13/10/2006	AS332 L	MR			✓	
G-CHCK	23/04/2007	S-92A	TR	✓	✓		
G-REDL	01/04/2009	AS332 L2	MRGB	*		*	✓
G-REDW	10/05/2012	EC225	MRGB	✓	✓		
G-CHCN	22/10/2012	EC225	MRGB	✓			

- 6.3.6 Of particular note is the number of instances of design issues on the newer helicopter types and, although the sample size here is quite small, there have been other design related occurrences outside of the UK offshore operating area, e.g. in Canada (lack of MRGB 30 minute run-dry capability on S-92) and in Norway (lack of isolation between MRGB oil pumps on S-92). In all of these cases, the failures were in mechanical/structural components. This is, perhaps, surprising to see in the latest, state-of-the-art helicopters given the range of modern design aids now available, and improvements in technology and technical expertise.
- 6.3.7 As in the case of operational accidents, the small sample of technical accidents available for study is limiting. Analysis of lower grade occurrences such as serious incidents and incidents may provide greater insight; under reporting is believed to be less of an issue with technical cause occurrences. In view of the need to constrain the analysis to a manageable size and also to ensure that the information is representative of current operations, it is suggested that this analysis take the form of a rolling annual review of the last five years of occurrence reports.
- 6.3.8 Alternatively, or in addition, the analysis could be extended to offshore helicopter types engaged in onshore operations or operating in other areas around the world. An analysis of this form has been performed and is reported in Section 3 of Annex F. It is noted that the results indicate the design issues to be the cause in the vast majority (83%) of the relevant accidents reviewed.

6.4 External Accidents

6.4.1 External causes accounted for seven out of 24 (29%) of the accidents during the period 1992 to 2012. All but two of these accidents related to lightning strikes; the remaining accidents involved encounters with a water spout (G-TIGB, 28/02/2002) and with an exhaust plume from a platform-based gas turbine (G-AYOM, 18/08/1995).

6.4.2 The statistics of the external accidents are therefore driven by the incidence of lightning strikes. As noted in Section 4, the evidence suggests that lightning strike occurrences were under-graded prior to 1995. Despite the fact that lightning strikes have occurred at a steady rate of around two per year since 1976, none were graded as accidents until after the strike to G-TIGK in 1995. Since there is no evidence of any other factor(s) that could influence the lightning strike accident rate, it is strongly suspected that the only parameter that has changed is the way that these occurrences are graded.

6.4.3 All reported lightning strike occurrences have already been analysed in connection with the CAA research project to develop a triggered lightning forecasting system which is presently undergoing final in-service trials. No further data analysis is therefore considered to be necessary.

7 Analysis of Fatal Accidents

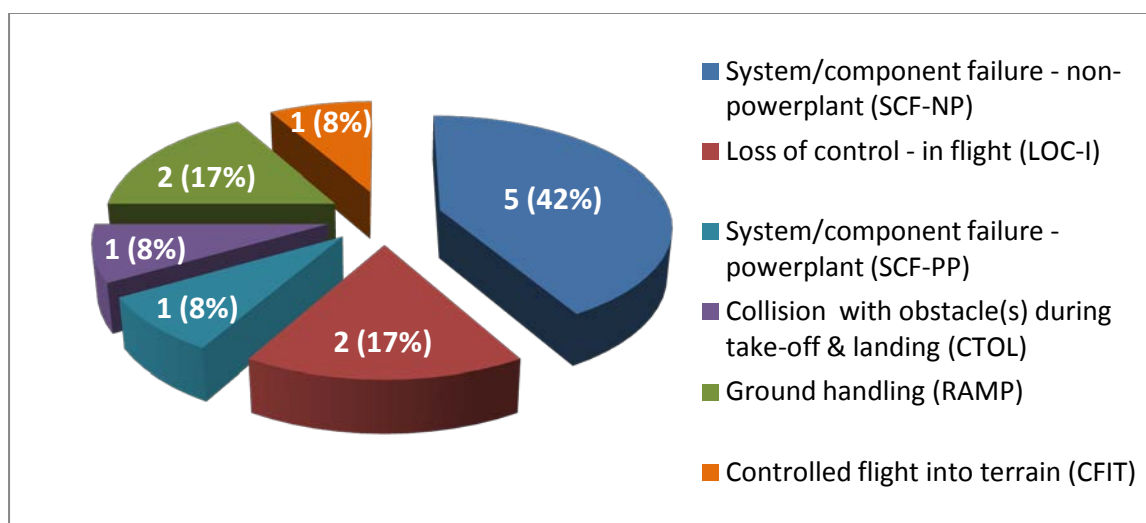
7.1 Introduction

7.1.1 Although the difference in outcome between a fatal accident and a non-fatal accident can often be due only to providence, because of their severity and the seriousness of the consequences it is not unusual for fatal accidents to receive special attention. Notwithstanding the approach taken in Sections 5 and 6, therefore, and in view of the relatively small numbers involved, all 12 of the fatal accidents covering the entire period of 1976 to 2012 are considered here.

7.2 Classification of Fatal Accidents

7.2.1 The classification of the fatal accidents by CICTT occurrence code is presented in Figure C9 below.

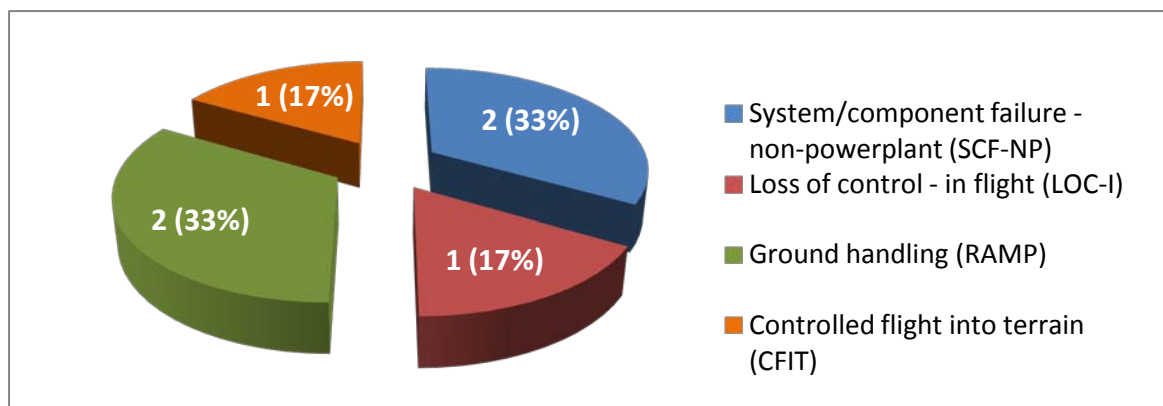
Figure C9 CICTT classification of fatal offshore helicopter accidents for the period 1976 to 2012



7.2.2 It is immediately apparent that SCF-NP (system/component failure non-powerplant) accidents dominate, as is the case for all accidents over the same period (see Figure C3). The same considerations apply, however, and applying the CICTT operational groupings of Section 3 shows an even split between technical and operational accidents, and no external cause fatal accidents.

7.2.3 For completeness the classification of the fatal accidents by CICTT occurrence code for the more recent period of 1992 to 2012 is presented in Figure C10 below.

Figure C10 CICTT classification of fatal offshore helicopter accidents for the period 1992 to 2012



7.2.4 This suggests the same shift in emphasis from technical cause accidents to operational cause accidents seen in the data for all accidents, although it should be noted that three of the operational cause fatal accidents occurred on the boundary of the period in 1992. As ever, care is needed when working with small sample sizes.

7.3 Fatalities

7.3.1 Another way of viewing fatal accidents is by the number of fatalities caused. The severity of a fatal accident is often judged on the basis of how many lives are lost, but that can be as much a reflection of the number of occupants that happened to be on board as it is the severity of the accident. The data on fatalities is presented in Table C3 below.

Table C3 Analysis of fatalities for the period 1976 to 2012. (*NB: Calculated by taking the average of the % fatalities; calculating these figures by dividing the total fatalities by the total persons on board gives 89% for technical accidents and 49% for operational accidents.)

CICTT Operational Grouping	Accident		Fatalities	Persons on Board	Fatalities (%)
	Aircraft Reg.	Date			
Technical	G-BCRU	21/04/1976	1	10	10
	G-ASWI	13/08/1981	13	13	100
	G-BJJR	20/11/1984	2	2	100
	G-BWFC	06/11/1986	45	47	96
	G-BJVX	16/07/2002	11	11	100

CICTT Operational Grouping	Accident		Fatalities	Persons on Board	Fatalities (%)
	Aircraft Reg.	Date			
	G-REDL	01/04/2009	16	16	100
	Total fatalities		88	Avg. % fatalities	84*
Operational (flight)	G-BIJF	12/08/1981	1	14	7
	G-BEWL	25/07/1990	6	13	46
	G-TIGH	14/03/1992	11	17	65
	G-BLUN	27/12/2006	7	7	100
	Total fatalities		25	Avg. % fatalities	55*
Operational (ground)	G-BOND	18/04/1992	1	N/A	N/A
	G-BLEZ	22/09/1992	1	N/A	N/A
	Total fatalities		2	Avg. % fatalities	N/A

7.3.2 As can readily be seen, technical accidents have accounted for significantly more fatalities than operational accidents (88 vs 27). Although 45 fatalities unusually resulted from a single technical accident, even removing this accident still leaves a significantly higher number (43 vs 27). Viewing the fatalities from the perspective of proportion of occupants indicates that technical cause accidents tend to be more severe; the average proportion of fatalities in technical accidents was 84%, and 55% for operational accidents (not counting the two ground personnel fatalities as the concept of occupants is not applicable).

7.3.3 The apparently greater severity of technical accidents may be due to the tendency for them to occur at greater heights and speeds (e.g. G-ASWI, G-BWFC, G-BJVX and G-REDL) compared to operational accidents (e.g. G-BEWL and G-TIGH) where the prospects of survival in the event of an impact are reduced.

7.3.4 Overall, therefore, although there is evidence of a shift in emphasis from technical to operational cause accidents post 1992 and the introduction of HUMS, technical cause accidents tend to be more severe and account for more fatalities. This would suggest that equal attention should be paid to both technical and operational cause accidents.

7.3.5 It is also worth mentioning that, although there have been no external cause fatal accidents to date, there have been some very near misses (e.g. G-TIGK lightning strike on 19/01/1995). It is therefore considered that there is no room for complacency and that external cause accidents must also be treated seriously.

7.4 Mortality

7.4.1 While fatal accident rates are an established and useful measure of aviation safety performance, they do not distinguish between an accident that kills one passenger among 100, and another that kills everyone onboard. Use of fatality rates goes some way to addressing this, but it could still be argued that an accident that kills 50 out of 300 should not automatically assume more importance than one that kills all 40 persons onboard. Barnett⁵ argues that mortality risk, which is the probability of a passenger not surviving a randomly

chosen flight, could be a more appropriate measure. This statistic ignores the length and duration of a flight, which are unrelated to mortality risk, and weights each accident by the proportion of passengers killed. An accident that kills everyone onboard is counted as one fatal accident, whereas one that kills a quarter of the passengers is counted as the equivalent of one quarter of a fatal accident.

7.4.2 Table C4 below shows the mortality risk for offshore helicopter flights expressed in two ways: (1) the number of randomly chosen passenger flights it would take, on average, for an offshore helicopter occupant to be killed; (2) the number of years that would pass if such a flight was taken every day. For the purposes of this study, the mortality statistic was applied to both passengers and flight crew members.

Table C4 Comparison of mortality risks between offshore helicopter and large CAT fixed-wing aircraft operations

2002 to 2011	Number of flights	Number of Years
Offshore Helicopter Flights	0.5 million	1,277
All CAT Passenger Aeroplane Flights	3.1 million	8,505
Jet CAT Passenger Aeroplane Flights	5.0 million	13,573

7.4.3 As a comparison, the mortality risks for large Commercial Air Transport (CAT) passenger flights on fixed-wing aircraft have been included. These are taken from CAP 1036⁶ and cover all CAT aeroplane flights (i.e. including turboprop aeroplanes), and those conducted by jet aeroplanes only. Note that the offshore helicopter statistics have been calculated for the same time period (2002 to 2011) in order that they may be correctly compared.

7.4.4 As can be seen, the mortality risk for offshore helicopter occupants is an order of magnitude higher than for jet CAT passengers. Due to the more complex nature of the aircraft used and the more hazardous operating environment, it is not considered realistic to expect the level of safety of offshore helicopter operations to match that of jet transport operations. Nevertheless, it is the view of the CAA that significant scope for improvement does exist and it is the aim of the actions and recommendations in the offshore review is to realise those improvements.

8 Comparison with Norwegian Occurrence Data

8.1 Introduction

8.1.1 Norwegian offshore helicopter operations utilise only helicopter types in use in the UK, mostly take place in essentially the same operating environment (some Norwegian operations take place in the Barents Sea which is climatically more severe than the northern North Sea), and operate to the same rules utilising similar procedures. It is therefore considered to be of interest to compare occurrence data.

8.1.2 The comparison of all occurrences is limited to the period 2003 to 2012, due to the availability of occurrence data from Norway.

8.1.3 The analysis of occurrence categories focuses on the period 2008 to 2012 due to the unrepresentatively low number of reported occurrences in Norway prior to this period (see Table C6).

8.2 Fatal Accidents During the Period 1992 to 2012

8.2.1 Fatal accident rates were calculated for offshore helicopters operated by Norway and the UK for the period 1992 to 2012. These are shown below in Table C5 below.

Table C5 Fatal Accident Rates for Norwegian and UK offshore helicopters (1992 – 2012)

	Number of Fatal Accidents	Hours	Fatal Accident Rate (pmh)
UK	6	1,754,512	3.42
Norway	1	926,926	1.08

8.2.2 Applying the Chi Square test and the Poisson Ratio test, there is no evidence, at a 95% level of confidence, that there is a statistically significant difference between the fatal accident rates for UK and Norwegian offshore operations.

8.2.3 Although a more robust comparison might be obtained by repeating the Chi Square test on all reportable accidents, examination of the data suggests significant differences in the classification of accidents between the UK and Norway such that any direct comparison would likely be very misleading. For example, a proportion of lightning strikes are classified as accidents in the UK but none are in Norway despite the annual lightning strike rates being similar. The Norwegian occurrence data would need to be reviewed and checked for consistency with the UK data prior to performing any such comparison

8.3 All Occurrences During the Period 2003 to 2012

8.3.1 Occurrence data was available from the Norwegian CAA for the period 2003 to 2012. Table C6 below shows the number of events reported for each sector together with the corresponding hours flown.

Table C6 Norwegian and UK Occurrence Data

Year	No. of Events Reported		Hours Flown	
	Norwegian CAA	UK CAA	Norway	UK
2003	5	223	44,233	73,139
2004	8	149	41,786	69,674
2005	3	148	43,559	76,919
2006	3	208	44,815	71,755
2007	123	229	44,940	73,236
2008	293	224	43,087	70,924
2009	352	319	47,231	67,000
2010	556	293	52,651	69,662
2011	427	253	53,862	77,610
2012	356	216	57,160	86,133

Note 1: The following were removed from the dataset by the Norwegian CAA before submission to the UK CAA:

- 300 ATM/CNS occurrences
- 20 Runway Incursions
- 63 occurrences taking place at mainland aerodromes (i.e. not offshore)
- 23 cabin occurrences related to medical emergencies or unruly passengers
- 13 laser occurrences

Note 2: The UK data include all events involving helicopters operated by UK Bond Offshore Helicopters, Bristow Helicopters and CHC Scotia.

8.3.2 EC Directive 2003/42/EC on Occurrence Reporting sets occurrence reporting requirements at a European Level. Although the directive was issued in 2003, EU states were required to comply by July 2005; the directive, and a new reporting tool, was introduced in Norway in mid-2007. This change in the reporting requirement explains the low numbers of reports during the period 2003 to 2006 in Norway. By comparison, there has been an MOR scheme in place in the UK since 1976, which very likely explains the relatively consistent number of reports throughout the period.

8.3.3 It is notable that, from 2008 onwards, despite having a much smaller fleet (in 2012, there were 56 offshore helicopters in operation in Norway compared to 95 in operation in the UK), there have been more occurrence reports for Norwegian operations than the UK sector. This could reflect a greater occurrence rate or it could be indicative of a better reporting culture. In view of the smaller size of the Norwegian operation, it is the CAA's opinion that the latter explanation is more plausible.

8.4 All Occurrences During the Period 2008 to 2012

8.4.1 In recognition of the likely under reporting in Norway during the period 2003 to 2007, Figure C11 and Figure C12 present breakdowns of the occurrences by CICTT code for Norwegian and UK operations, respectively, for the period 2008 to 2012.

Figure C11 Norwegian occurrence categories for the period 2008 – 2012 (NB: Colour coding per Figure C13 and C14)

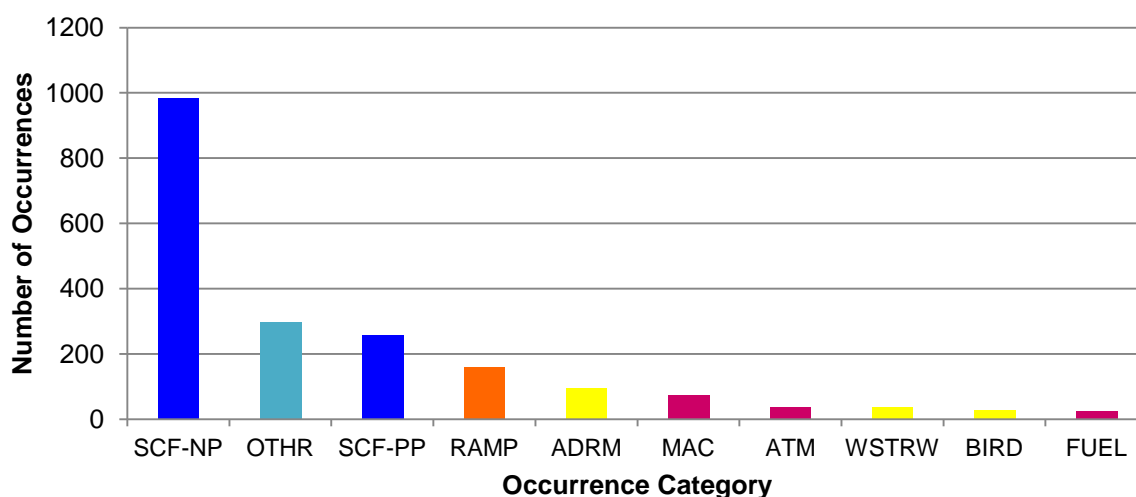
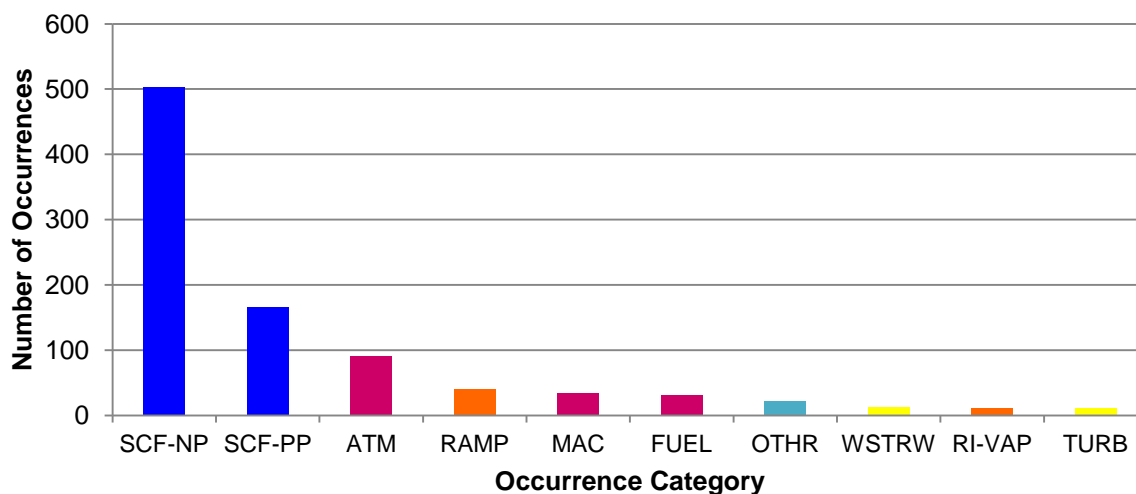


Figure C12 UK occurrence categories for the period 2008 – 2012 (NB: Colour coding per Figure C13 and C14)



8.4.2 Note that both the Norwegian and UK occurrence data was supplied already coded to CICTT but, unlike the analysis reported in Sections 3 through 7, each occurrence could be allocated more than one CICTT code, and some occurrences were not coded. Hence, in both the UK and Norwegian data sets the total number of CICTT codes is different to the total number of occurrences.

8.4.3 For both sectors, 'System/Component Failure – Non-Powerplant' (SCF-NP) was the most commonly assigned occurrence category. The second most commonly assigned occurrence category for Norway was 'Other' (OTHR). This category included, but was not limited to, level busts, infringements, incorrect/misread charts/information, callsign confusion, and ash encounters. For the UK the second most commonly assigned occurrence category was 'System/Component Failure – Powerplant' (SCF-PP).

8.4.4 Using the same grouping as in Section 3, the occurrence categories have been grouped into 'Technical', 'Operational – Flight', 'Operational – Ground', 'External', and 'Not Applicable'. Figures C13 and C14 show the results for Norwegian and UK data respectively. Note that, in this case, the data is presented as a percentage of the total number of CICTT codes rather than total number of occurrences; this is considered to represent the most robust comparison that can be made with the data available.

Figure C13 Occurrence Category Groups for Norwegian Events for the period 2008 – 2012

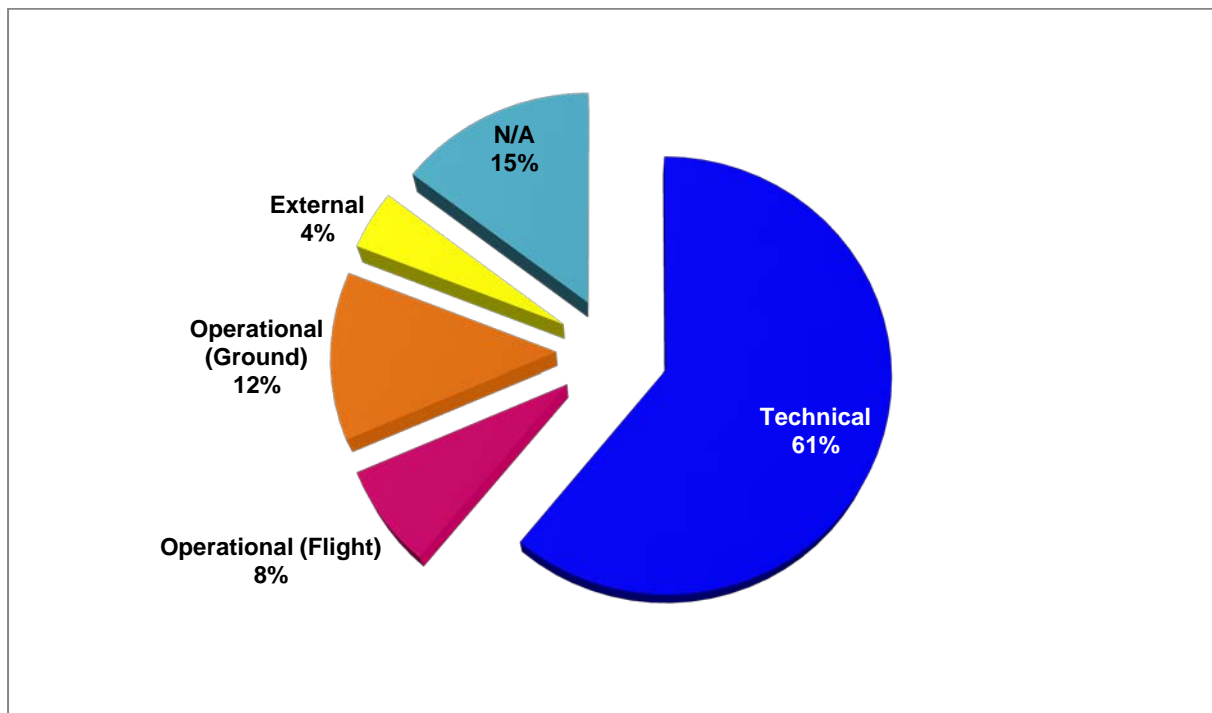
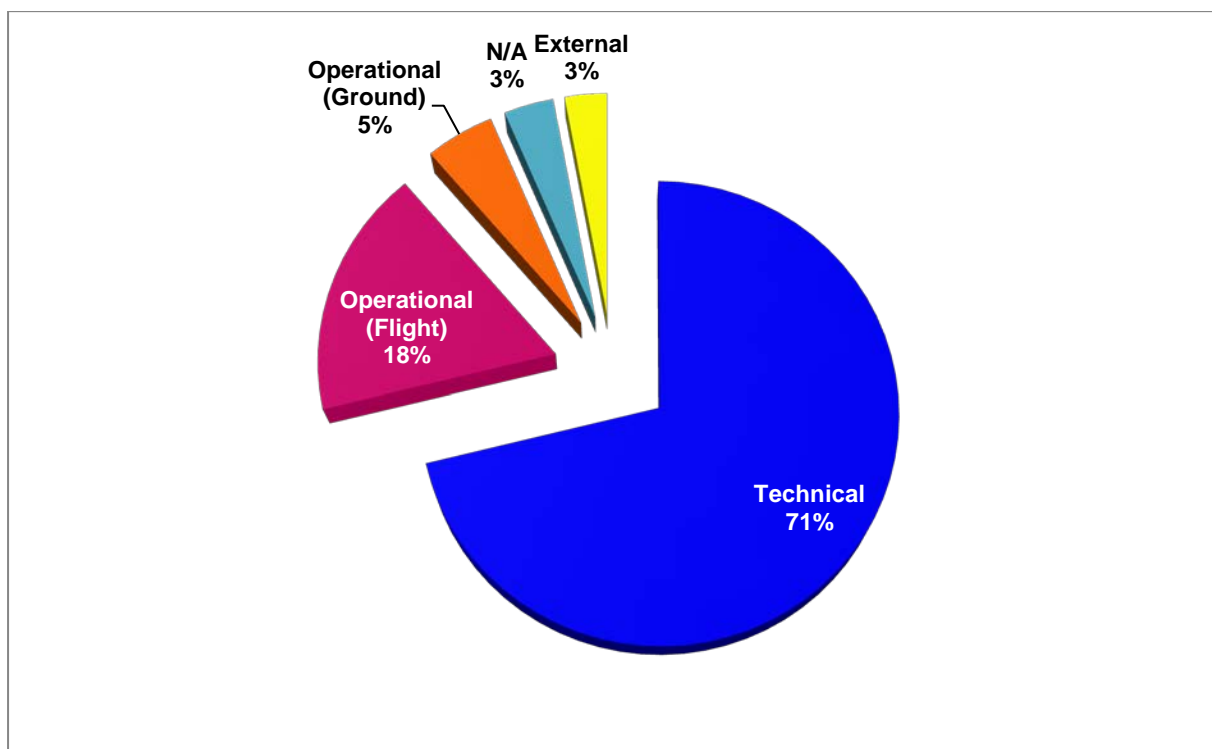


Figure C14 Occurrence Category Groups for UK Events for the period 2008 – 2012



8.4.5 For the Norwegian data presented in Figure C13, of the 1984 occurrences, 1905 occurrences had one CICTT code, and 79 had two codes. Therefore, the pie chart shows the groupings as a percentage of 2063 (1905 + (79 x 2)).

8.4.6 For the UK data presented in Figure C14, of the 1294 occurrences, 419 had no code, 803 had one code, and 72 had two codes. Therefore, the pie chart shows the groupings as a percentage of 947 (803 + (72 x 2)).

8.4.7 As can readily be seen, the breakdowns for the UK and Norway are quite similar with technical accidents dominating both data sets. One noticeable difference, however, is the inversion between Operations – Flight and Operations – Ground; the CAA is unaware of any explanation for this feature in the data.

9 Conclusions from Accident Analysis

The following overall conclusions are drawn:

9.1 Accidents During the Period 1976 to 2012

- There were a total of 72 reportable offshore helicopter accidents during the period 1976 to 2012.
- The overall accident rate is approximately two per year. This equates to two accidents per 100,000 flight hours or one per 100,000 sectors.
- There is a marked change in the composition and rate of accidents in the early 1990s, coincident and consistent with the introduction of HUMS, which continues to the end of the analysis period at the end of 2012.
- The period 1992 to 2012 is considered to be of most relevance to current operations.

9.2 Accidents During the Period 1992 to 2012

- There were a total of 24 reportable offshore helicopter accidents during the period 1992 to 2012.
- The overall accident rate is approximately one per year. This equates to 1.3 accidents per 100,000 flight hours or 0.67 per 100,000 sectors.
- The largest single cause of accidents is operational (42%), most of which (70%) relate to pilot performance issues such as flight crew perception and decision making.
- Technical and external cause accidents form the joint second largest causes of accidents (29% each).
- Most technical cause accidents (86%) relate to rotor and transmission failures, and there is evidence of a tendency towards design/certification issues in newer aircraft.
- Most external cause accidents (86%) relate to lightning strikes.

9.3 Fatal Accidents

- Of the 72 reportable accidents during the period 1976 to 2012, 12 (17%) involved fatalities.
- The fatal accident rate is stable throughout the period 1976 to 2012 at just under one every 3 years. This equates to 0.35 per 100,000 flight hours or 0.16 per 100,000 sectors.
- Of the 24 reportable accidents during the period 1992 to 2012, six (25%) involved fatalities, and the rates for the shorter period are very similar to those for the period 1976 to 2012.

- The fatal accidents are evenly distributed between operational and technical causes.
- The main cause of operational fatal accidents (67%) is pilot performance issues.
- The main cause of technical fatal accidents (67%) is rotor and transmission failures.
- There have been no external cause fatal accidents.

9.4 Fatalities

- The 12 fatal accidents during the period 1976 to 2012 resulted in a total of 115 fatalities of which two involved a fatality to a ground crew member only. On average, this equates to 72% of the occupants.
- The 6 fatal accidents during the period 1992 to 2012 resulted in a total of 47 fatalities of which two involved a fatality to a ground crew member only. On average, this equates to 91% of the occupants.
- Technical accidents have almost always been more severe than operational accidents in terms of fatalities, both as an absolute number and expressed as a proportion of the total number of occupants.
- The mortality risk for offshore helicopter occupants is an order of magnitude higher than for jet CAT passengers.

9.5 Comparison with Norwegian Operations

- Overall, comparison of the Norwegian and UK occurrence data indicates similar patterns. In particular:
 - In terms of the fatal accident rate from 1992 to 2012, and based on a Chi-Square test at a 95% level of confidence, there is no statistically significant difference between Norwegian and UK operations.
 - The occurrence data for the period 2008 to 2012 is dominated by technical issues, System/Component Failure – Non-Powerplant being by far the dominant CICTT code in both data sets.
- Notable differences, however, are:
 - From 2008 onwards, the rate of occurrence reporting is significantly greater in Norway than in the UK. It is the CAA's view that this is likely to be indicative of a better reporting culture.
 - For the period 2008 to 2012, the Operations – Flight and Operations – Ground CICTT groups are reversed with Operations – Ground dominating in Norway.

10 Recommendations and Actions

10.1 Recommendations

The following recommendations are made:

- In order to address the external cause accidents, the UK Met Office and the helicopter operators should fully implement the triggered lightning forecasting system, subject to satisfactory performance during the present in-service trials.

10.2 Actions

The following actions are proposed to address the operational and technical cause accidents:

- The CAA will promote and support the implementation of the results of the research on helideck lighting and, when completed, operations to moving helidecks, DGPS-guided offshore approaches and helicopter terrain awareness warning systems.
- The CAA will seek to ensure that the research on operations to moving helidecks, DGPS-guided offshore approaches and helicopter terrain awareness warning systems is adequately resourced to allow timely progress to completion.
- The CAA will seek access to the helicopter operators' Flight Data Monitoring (FDM) programmes via the newly established Helicopter FDM User Group in order to obtain further objective information on operational issues, especially those relating to pilot performance.
- The CAA will analyse lower risk occurrences (i.e. serious incidents and incidents) for the main areas of risk, technical cause occurrences in particular, in order to increase the 'resolution' of the analysis. This analysis will take the form of a rolling annual review of the last five years of occurrence reports.

⁴ ICAO Common Taxonomy Team – Aviation Occurrence Categories, Definitions and Usage Notes October 2011 (4.2).

<http://intlaviationstandards.org/Documents/OccurrenceCategoryDefinitions.pdf>

⁵ Barnett, A. and Wang, A.; Passenger Mortality Risk Estimates Provide Estimates about Airline Safety, Flight Safety Digest, April 2000, p. 1-12, Flight Safety Foundation.

⁶ CAP 1036, Global Fatal Accident Review 2002 to 2011, CAA June 2013.

Appendix 1 to Annex C: List of Accidents

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/Bulletin Ref.	Headline	CICTT Group	CICTT Code	CICTT Breakdown
1976	08/03/1976	G-ATSC	Westland Wessex Mk60	North Sea	197600922	11/76	Double engine surge due to ingestion of engine cover. A/C Ditched in North Sea. 14 POB - All rescued.	Operational (G)	RAMP	Pilot error - 10.7.2
	21/04/1976	G-BCRU	Sikorsky S-58 ET	Forties Field - Highland 1	197601718	6/77	Tail Rotor detached. A/C fell onto barge during forced landing and was destroyed by impact and fire. 10 POB - 1 Fatality.	Technical	SCF-NP	Tail rotor - 2.1
	06/07/1976	G-BBUD	Sikorsky S-61N	Norscott Yard, Lerwick	197602991		Aircraft became enveloped in dust during the flare and a hard landing ensued. Zero visibility. 2 POB - No injuries.	External	ADRM	Aerodrome - 7.7
	12/07/1976	G-AZRF	Sikorsky S-61N	Sumburgh (SUM)	197603066		Whilst taxiing Main Rotor Struck Tail Rotor of adjacent A/C due to Marshalling Error. 18 POB - No injuries.	Operational (G)	GCOL	Pilot error - 10.11.2
1977	17/05/1977	G-AYOM	Sikorsky S-61N	Aberdeen (ADN)	197701867		Right main landing gear retracted due to short circuit in retraction disconnect mechanism caused by moisture ingress. 2 POB - No injuries.	Technical	SCF-NP	U/C - 2.3
	11/09/1977	G-BDIL	Bell 212	North Sea - Brent Spar	197703547		No: 2 engine oil pressure warning illuminated on rig approach. Pilot initiated immediate landing. As he did so the Tailrotor struck cable extending from jib of adjacent crane. 10 POB (Est) - No injuries.	Operational (F)	CTOL	Pilot error - 10.10.5

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/Bulletin Ref.	Headline	CICTT Group	CICTT Code	CICTT Breakdown
1977	01/10/1977	G-BBHN	Sikorsky S-61	North Sea	197703770	8/78	Crew became aware of increasing loud noise (similar to loose blade tape) accompanied by severe vibration from area of main rotor. Fore & aft control movement subsequently became restricted so ditching carried out. 3 POB - All rescued.	Technical	SCF-NP	Main rotor - 2.1
	14/11/1977	G-BAKB	Sikorsky S-61N	Lerwick	197704427		Engine fire warning in cruise. Routine fire drills and precautionary OEI landing initiated. On landing touched down slightly short of helipad striking tailwheel on a rock pulling tailwheel from its mounting. 18 POB - No injuries.	Operational (F)	CTOL	Pilot error - 10.8.1
1978	16/02/1978	G-BCXO	Bolkow Bo 105	North Sea - Forties 'C'	197800937		Aircraft caught in downdraught as it was landing. Before pilot reacted Tail Rotor struck and became entangled in perimeter safety net. 5 POB - No injuries.	External	TURB	Helideck environment - 11.1a
	17/02/1978	G-BCDE	Sikorsky S-58ET	Southern North Sea - Ekofisk	197800570		While flying at 4000' and shortly after entering cloud, sudden loss of control experienced which resulted in rapid spinning descent to 3000'. On regaining control, heavy vibration so diverted to nearest platform. 12 POB - No injuries.	Operational (F)	LOC-I	Pilot error - 10.9.1
	17/04/1978	G-BFJX	Aerospatiale AS330 J	Sumburgh (SUM)	197801353		As the A/C lifted off it pitched up and rolled to the right. Crew unable to regain control and tail rotor struck the ground. 12 POB - No injuries.	Operational (F)	LOC-I	Pilot error - 10.8.1

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/Bulletin Ref.	Headline	CICTT Group	CICTT Code	CICTT Breakdown
1978	24/10/1978	G-AWFX	Sikorsky S-61	North Sea - Bideford Dolphin	197804428		Aircraft landed with undercarriage retracted. A/C had been recalled to rig after take-off due to another A/C Mayday. 18 POB - No injuries.	Operational (F)	ARC	Pilot error - 10.10.5
1980	31/07/1980	G-BEID	Sikorsky S-61N	North Sea	198002823	14/80	A/C ditched due to high MRGB oil temp and low pressure. 15 POB - All rescued.	Technical	SCF-NP	MRGB - 2.3
	18/11/1980	G-BHOH	Sikorsky S-61N	North Sea - Sedco 707	198004297		As pilot was manoeuvring A/C to land in strong winds, the tail rotor struck part of the rig structure (handrails) about 20 feet above the helideck. All T/R blades broken but no other damage incurred. 18 POB - No injuries.	Operational (F)	CTOL	Pilot error - 10.11.1
	28/12/1980	G-BHPA	Sikorsky S-61N	North Sea - Comorant 'A'	198004764		On start-up a passenger's safety helmet was blown into the main rotor by a strong gust of wind. The main rotor "sailed" and struck cabin roof. 20 POB - No injuries.	Operational (G)	RAMP	Blade sailing
1981	16/01/1981	G-BGXY	Sikorsky S-76	Aberdeen (ADN)	198100125		As the aircraft taxied for take-off, smoke (from rotor brake fire) began to enter cabin. An emergency evacuation was completed successfully. 11 POB - No injuries.	Technical	F-NI	Main rotor - 2.3
	12/08/1981	G-BIJF	Bell 212	North Sea - Near Dunlin	198102469	10/82	Loss of control in flight, followed by fast descent into the sea. 14 POB - 1 Fatality.	Operational (F)	LOC-I	Pilot error - 10.9.1
	13/08/1981	G-ASWI	Westland Wessex Mk 60	North Sea - Off Bacton	198102509	4/83	A/C Crashed into sea following loss of engine power to main rotor gearbox. All 13 POB Killed.	Technical	SCF-PP	Engine - 2.1

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/Bulletin Ref.	Headline	CICTT Group	CICTT Code	CICTT Breakdown
1982	28/03/1982	G-BHOH	Sikorsky S-61	North Sea - Thistle 'A'	198200777		As A/C approached helideck it developed an excessive rate of descent and on landing, struck helideck perimeter safety net. 20 POB - No injuries.	Operational (F)	CTOL	Pilot error - 10.8.1
1983	21/02/1983	G-BWFC	Boeing BV234	Aberdeen (ADN)	198300406	7/84	A fire broke out in the No. 1 engine following disintegration of the transmission shaft to the combining gearbox due to failure of the input shaft main roller bearing. 45 POB - No injuries.	Technical	SCF-NP	MRGB - 2.3
	11/03/1983	G-ASNL	Sikorsky S-61	North Sea - Nr. Claymore	198300534	4/85	Uncontained failure of Main Gearbox. Mayday Call. Precautionary landing on sea. 17 POB - All rescued.	Technical	SCF-NP	MRGB - 2.3
	04/07/1983	G-TIGD	Aerospatiale AS332 L1	Aberdeen (ADN)	198301758	4/84	During final approach a loud bang was heard followed by severe vibration at 200'. Pilot intended run on landing at 40-50 kt but unable to control A/C as it yawed port and struck the runway on its starboard side. 18 POB - 3 seriously injured.	Technical	SCF-NP	Tail rotor - 2.1
1984	06/04/1984	G-BFER	Bell 212	North Sea - Treasure Finder	198401139		A sudden windshift just before touchdown caused A/C to land heavily on the helideck damaging the main skid and the underside of the tail boom. 10 POB - No injuries.	External	TURB	Helideck environment - 11.1a
	02/05/1984	G-BISO	Boeing BV234	North Sea - En-route	198401115	5/87	A controlled ditching was carried out after the loss of Nr2 hydraulic pressure caused a flying control malfunction. 47 POB - All rescued.	Technical	SCF-NP	Flight controls - 2.1

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/Bulletin Ref.	Headline	CICTT Group	CICTT Code	CICTT Breakdown
1984	24/07/1984	G-AZOM	Bolkow Bo 105	Southern N Sea - En-route	198402165	3/85	A loss of Tail Rotor control occurred due to the failure of the rear Bendix shaft upper coupling. Pilot attempted a controlled ditching but A/C began to rotate and, after striking the water, rolled inverted. 2 POB - All rescued.	Technical	SCF-NP	Flight Controls - 2.1
	29/09/1984	G-BLDY	Bell 212	North Sea - N.Cormorant	198403146		On start-up in 30kt wind main rotor struck tailboom on first pass. ? POB - ? Injuries.	Operational (G)	RAMP	Blade sailing
	20/11/1984	G-BJJR	Bell 212	Southern North Sea - Cecil Provine JU	198403749	1/87	As A/C approached an offshore platform, a loud bang was heard and the aircraft was seen to roll rapidly to stbd and dive into the sea. 2 POB - 2 Fatalities.	Technical	SCF-NP	Unknown
1985	14/08/1985	G-BKFN	Bell 214ST	En-route - Over Belmedie	198502747		MR Blade Drag Brace assembly failed causing sudden and extreme vibration. Distress call and immediate rapid descent for run-on landing. 18 POB - No injuries.	Technical	SCF-NP	Main rotor - 2.1
	15/08/1985	G-BFPF	Sikorsky S-61N	Aberdeen (ADN)	198502796		Undercarriage inadvertently retracted whilst on ground with rotors turning. 18 POB - No injuries.	Operational (G)	RAMP	Pilot error - 10.10.5
	23/11/1985	G-BCEA	Sikorsky S-61N	Sumburgh (SUM)	198504069		Main Rotor Blade struck steel supports of unlit sign close to hangar. 20 POB - No injuries.	Operational (G)	GCOL	Pilot error - 10.11.2
	02/12/1985	G-BIHH	Sikorsky S-61N	North Sea - MCP 01	198504154		Horizontal stabilizer struck radio mast during take-off. 18 POB - No injuries.	Operational (F)	CTOL	Pilot error - 10.11.1
1986	12/01/1986	G-BFVV	Aerospatiale SA365 N	Irish Sea - Morecambe Bay	198600088		Main Rotor Blade attachment failed causing severe vibration. 8 POB - No injuries.	Technical	SCF-NP	Main rotor - 2.3

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/Bulletin Ref.	Headline	CICTT Group	CICTT Code	CICTT Breakdown
1986	15/05/1986	G-BKFN	Bell 214ST	North Sea - En-Route	198601451	9/87	A/C Ditched due to Collective Control malfunction. 16 POB - All rescued.	Technical	SCF-NP	Flight controls - 2.3
	06/11/1986	G-BWFC	Boeing BV234LR	North Sea - Off Sumburgh	198603733	2/88	A/C crashed in sea 1.5 miles off Sumburgh and sank. 47 POB - 45 Fatalities.	Technical	SCF-NP	MRGB - 2.1
1987	19/03/1987	G-TIGE	Aerospatiale AS332 L1	Aberdeen (ADN)	198700528		Disembarking PAX tripped and fell from A/C door. 18 POB - Injury sustained (broken collar bone).	Operational (G)	RAMP	3rd party - 6.3
	20/05/1987	G-BKZH	Aerospatiale AS332 L1	North Sea - near Unst	198701123	9/88	Sudden sever vibration. Tail rotor blade and tail boom damaged by detached fairing. A/C Diversion and Run-on landing. 18 POB - No injuries.	Technical	SCF-NP	Tail rotor - 2.1
	26/06/1987	G-TIGC	Aerospatiale AS332 L1	North Sea - En-route	198701523	7/88	Horizontal stabilizer spar failed in flight. A/C Diversion. 18 POB - No injuries.	Technical	SCF-NP	Structure - 2.1
	08/07/1987	G-PUMD	Aerospatiale AS332 L1	North Sea - En-route	198701639		Main rotor frequency adaptor separated in flight causing severe vibration. Mayday and SAR deployed. A/C Diversion. 18 POB - No injuries.	Technical	SCF-NP	Main rotor - 2.3
1988	13/07/1988	G-BEID	Sikorsky S-61N	North Sea - En-route	198802141	3/90	Engine fire warning. A/C ditched, burned and sank. 21 POB - All rescued.	Technical	SCF-NP	Engine - 2.3
	10/11/1988	G-BDES	Sikorsky S-61N	North Sea - En-route	198803819	1/90	Low gearbox oil pressure warning accompanied by vibration. A/C ditched, inverted and sank. 13 POB - All rescued.	Technical	SCF-NP	MRGB - 2.3

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/Bulletin Ref.	Headline	CICTT Group	CICTT Code	CICTT Breakdown
1988	19/12/1988	G-BLZJ	Aerospatiale AS332 L1	Aberdeen (ADN)	198804313		Landing gear unsafe warning. A/C returned and nose landing gear collapsed on landing. 18 POB - No injuries.	Technical	SCF-NP	U/C - 2.3
1989	11/05/1989	G-BJFJ	Sikorsky S-61N	Sumburgh (SUM)	198901536		Whining noise and loud bang. No: 1 Drive Shaft into Main Gearbox failed. 20 POB - No injuries.	Technical	SCF-NP	MRGB - 2.3
	15/12/1989	G-BNSH	Sikorsky S-76	Southern North Sea - Humberside	198905000	5/90	Smoke inside A/C. No: 1 & 2 engine bay insulation overheated. 3 POB - No injuries.	Operational (G)	RAMP	Pilot error - 10.7.2
1990	25/07/1990	G-BEWL	Sikorsky S-61N	North Sea - Brent Spar	199003279	2/91	Tail Rotor struck rig structure. A/C fell into the sea and sank. 6 Fatalities.	Operational (F)	CTOL	Pilot error - 10.11.1
	09/10/1990	G-BCLD	Sikorsky S-61		199004530	12/91	No: 1 Input Drive train failed. No: 1 Engine shutdown on overspeed. Single engine landing. ? POB - No injuries.	Technical	SCF-NP	MRGB - 2.3
	24/12/1990	G-BKFN	Bell 214ST	North Sea - En-route	199005539	9/91	Severe vibration in the cruise. Decreased as speed reduced. A/C diverted. Tail boom vertical fin fwd spar cracked. 14 POB - No injuries.	Technical	SCF-NP	Structure - 2.3
1991	30/06/1991	G-BTBD	Bolkow Bo 105	North Sea - MS Tiree	199102112	9/91	A/C was on a ship's helideck with rotors running while pilot prepared for take-off into a 240 deg / 15 kt wind. A large canvas sheet from a pile of stores on edge of helideck lifted and entered main rotor. 5 POB - No injuries.	External	ADRM	Environment - 11.2

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/Bulletin Ref.	Headline	CICTT Group	CICTT Code	CICTT Breakdown
1991	02/10/1991	G-BKJD	Bell 214ST	North Sea - En-route	199103671	1/92	Severe vibration. Pan Call and diverted to nearby rig and landed safely. Tail Rotor counterweight assembly sheared. 6 POB - No injuries.	Technical	SCF-NP	Tail rotor - 2.3
1992	14/03/1992	G-TIGH	Aerospatiale AS332 L1	North Sea - Comorant 'A'	199200749	2/93	A/C crashed into sea. 17 POB - 11 Fatalities.	Operational (F)	LOC-I	Pilot error - 10.10.2
	18/04/1992	G-BOND	Sikorsky S-76	North Sea - MS Mayo	199201223	11/92	Main rotor blade struck and killed HLO during rotors running turnaround on rig supply vessel helideck. 3 POB - 1 Fatality (external).	Operational (G)	RAMP	Deck motion
	22/09/1992	G-BLEZ	Aerospatiale SA332 N	Southern North Sea - Viking 'B'	199203893	1/93	Helideck crew member struck and killed by main rotor blade. Minor damage to rotor blade tips. 6 POB - 1 Fatality (external).	Operational (G)	RAMP	3rd party - 6.3
1995	19/01/1995	G-TIGK	Aerospatiale AS332 L1	North Sea - Near Brae 'A'	199500167	2/97	Lightning strike to tail rotor. A/C ditched following loss of tail rotor control. Occupants evacuated into liferaft. 18 POB - All rescued.	External	WSTRW	Environment - 11.1d
	18/08/1995	G-AYOM	Sikorsky S-61N	North Sea - Claymore CAP	199503569	3/96	Hard landing on helideck. Main rotor blade struck tailboom. Substantial damage. 16 POB - No injuries.	External	ADRM	Helideck environment - 7.2
1996	04/01/1996	G-TIGT	Aerospatiale AS332 L1	Aberdeen (ADN)	199600011	6/96	After disembarking pax, A/C taxied forward, started to turn and rolled onto its side. Substantial damage. 2 POB - No injuries.	Operational (G)	LOC-G	Pilot error - 10.10.2
1997	12/12/1997	G-BWZX	Aerospatiale AS332 L1	North Sea - En-route	199706451	11/99	Lightning strike. A/c landed safely on ship. Blade tips & rotor hub burnt. 11 POB - No injuries.	External	WSTRW	Lightning strike

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/Bulletin Ref.	Headline	CICTT Group	CICTT Code	CICTT Breakdown
1998	28/01/1998	G-BWMG	Aerospatiale AS332 L	North Sea - En-route	199800373	8/98	Horizontal stabiliser separated in flight. A/C pitched down 35deg. Mayday. Control regained, diverted and landed safely. 12 POB - No injuries.	Technical	SCF-NP	Structure - 2.1
1999	23/07/1999	G-PUMH	Aerospatiale AS332 L1	Kirkwall - Orkney	199904878	11/99	Landing gear retracted on touchdown. 19 POB - No injuries.	Operational (F)	ARC	Pilot error - 10.10.5
	17/11/1999	G-BHBF	Sikorsky S-76	North Sea - En-route	199907917	3/2001	Lightning strike followed by burning smell in cockpit. Mayday call. Aircraft returned and landed safely. 2 POB - No injuries.	External	WSTRW	Lightning strike
2001	12/07/2001	G-BMAL	Sikorsky S-76A+	Southern North Sea - North Denes	200104756	10/2001	Heavy landing - Pilot pulled collective lever instead of parking brake. 2 POB - No injuries.	Operational (F)	ARC	Pilot error - 10.10.5
	10/11/2001	G-BKZE	Aerospatiale AS332 L1	West of Shetlands - West Navion	200107711	3/04	Drilling vessel motion caused the aircraft to topple onto its side during rotors running refuel. Substantial damage. 2 POB - 1 serious injury.	Operational (G)	RAMP	Deck motion
2002	28/02/2002	G-TIGB	Aerospatiale AS332 L1	North Sea - En-route	200201255	08/2003	During a severe turbulence encounter the tail rotor blades struck the tail pylon. The flight continued and the aircraft landed safely. 2+ ? POB - No injuries.	External	WSTRW	Water spout
	16/07/2002	G-BJVX	Sikorsky S-76A (Mod)	Southern North Sea - Nr. Santa Fe Monarch rig	200204900	1/05	The aircraft crashed into the sea and was destroyed following the failure of a main rotor blade. 11 POB - All killed.	Technical	SCF-NP	Main rotor - 2.1
2006	03/03/2006	G-CHCG	Eurocopter AS332 L2	North Sea - 104 NM NE of ADN	200601702	01/2007	Lightning damage to 1 Main Rotor and 1 Tail Rotor Blade and 3 Servos. 13 POB - No injuries.	External	WSTRW	Lightning strike

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/Bulletin Ref.	Headline	CICTT Group	CICTT Code	CICTT Breakdown
2006	13/10/2006	G-PUMI	Aerospatiale AS332	Aberdeen (ADN)	200609321	12/2010	Take-off rejected due to severe vibration following loud bang. Main rotor head spindle fractured. 13 POB - No injuries.	Technical	SCF-NP	Main rotor - 2.3
	27/12/2006	G-BLUN	Eurocopter AS365 N2	Irish Sea - Morecambe Bay	200611599	07/2008	Helicopter seen to descend into sea close to offshore platform. 7 POB - All killed.	Operational (F)	CFIT	Pilot error - 10.9.1
2007	23/04/2007	G-CHCK	Sikorsky S-92	North Sea - En-route	200703444	4/2008	PAN declared due to severe vibration. Precautionary descent and diversion carried out. Tail rotor blade pivot bearing detached due to bearing retainer disbond. 17 POB - No injuries.	Technical	SCF-NP	Tail rotor - 2.1
2008	22/02/2008	G-REDM	Eurocopter AS332 L2	North Sea - En-route	200801715	9/2008	Lightning strike. A/C landed safely with damage to main rotor. 2='10' Pole adjacent to the helideck was in the Obstruction Free Zone but had not been reported as an obstacle. Report passed to BHAB via Holland. 2+? POB - No injuries.	External	WSTRW	Lightning strike
	09/03/2008	G-BKXD	Eurocopter AS365 N	Southern North Sea - Leman 27A	200802294	7/2008	Whilst manoeuvring helicopter to land on helideck the Fenestrom tail fairing struck the guard rails of a deck mounted crane. 7 POB - No injuries.	Operational (F)	CTOL	Pilot error - 10.11.1
2009	18/02/2009	G-REDU	Eurocopter EC225	Central North Sea - ETAP	200901483	01/2011	A/c descended into the sea close to offshore platform. A/c remained afloat but tail cone separated and sank. 18 POB - All rescued.	Operational (F)	CFIT	Pilot error - 10.9.1
	01/04/2009	G-REDL	Eurocopter AS332 L2	North Sea - Nr. Peterhead	200903003	02/2011	A/C crashed into sea following gearbox failure and rotor head separation. 16 POB - All killed.	Technical	SCF-NP	MRGB - 2.1

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/Bulletin Ref.	Headline	CICTT Group	CICTT Code	CICTT Breakdown
2012	10/05/2012	G-REDW	Eurocopter EC225	North Sea - En-route 20 NM east of Aberdeen	201204951	S2/2012	Pilot reported a gear problem and intention to ditch in the North Sea. Reported as gearbox oil pressure warning. AAIB Field investigation and damage to be advised. 14 POB - All rescued.	Technical	SCF-NP	MRGB - 2.3
	22/10/2012	G-CHCN	Eurocopter EC225	North Sea – 30 NM south of Sumburgh	201212866	S6/2012	A/C Ditched following indications of MRGB lubrication failure. 19 POB - All rescued.	Technical	SCF-NP	MRGB - 2.3

Appendix 2 to Annex C: Accident Analysis Group Causal and Circumstantial Factors

Allocate **A** for **Causal** and
B for **Circumstantial**

Level of Confidence:
High, Medium, Low, Insufficient Information

Version 10

Group	Code	Description
Aircraft Design	1.1	Design shortcomings (including documentation that forms part of the approved design standard)
	1.2	Structural overload
	1.3	Corrosion or fatigue
	1.4	Overload failure
	1.5	Flutter
	1.6	Aircraft becomes uncontrollable
Aircraft System /Components	2.1	System/component failure - affecting controllability
	2.2	System/component failure - flight deck information
	2.3	System/component failure - other
	2.4	Fire due to aircraft systems
	2.5	Unable to maintain speed or height or achieve scheduled performance
	2.6	Manufacturing/production defect
	2.7	Non-fitment of presently available safety equipment (GPWS, EGPWS, TCAS, windshear warning, etc.)
	2.8	Failure or inadequacy of aircraft safety equipment
	2.9	Pre-existing inoperative aircraft systems (for example inoperative thrust reverser known about prior to flight)
Engine	3.1	Engine failure / malfunction or loss of thrust
	3.2	Propeller failure
	3.3	Damage due to non-containment
	3.4	Fuel contamination
	3.5	Engine failure simulated
	3.6	Engine fire or overheat
	3.7	Manufacturing/production defect (engine)
Maintenance	4.1	Failure to carry-out due maintenance
	4.2	Maintenance or repair error
	4.3	maintenance or repair oversight
	4.4	inadequate maintenance or repair
	4.5	Unapproved modification
	4.6	Bogus parts
	4.7	Lack of or inadequate qualification, training or experience
	4.8	Planning
	4.9	Competence
	4.10	Human performance (e.g. fatigue)
	4.11	Perception and Decision-making
	4.12	Situational Awareness
	4.13	Use of automation/tools/equipment
ATC	5.1	ATC Equipment fault - control centre or tower
	5.2	ATC equipment fault - navigation
	5.3	Inadequate procedures
	5.4	Incorrect or inadequate instruction or advice
	5.5	Misunderstood or missed communication
	5.6	Failure to provide separation - air
	5.7	Failure to provide separation - ground

Group	Code	Description
ATC (Continued)	5.8	Standard separation not adequate
	5.9	Wake turbulence - loss of separation
	5.10	Runway condition unknown to crew
	5.11	Lack of ATC
	5.12	Lack of ground aids
	5.13	Non-fitment of presently available ATC system or equipment (e.g. MSAW)
	5.14	Non-precision approach flown
	5.15	Lack of or inadequate qualification, training or experience
	5.16	Controller Preparation
	5.17	Controller Competence
	5.18	Controller Human performance
3rd Party	6.1	Incorrect, inadequate or misleading information to crew
	6.2	Caused by other aircraft or vehicle
	6.3	Unsafe action by other personnel (not associated with operation of aircraft, ATC or airport)
Aerodrome	7.1	Design - RESA, intersecting runways, taxiway layout, ramp size
	7.2	Location / aerodrome environment - surrounding terrain, altitude (inc. density altitude), obstacles, wildlife
	7.3a	Inadequate aerodrome support - RFFS and other airfield cover
	7.3b	Inadequate signals, signs, markings (e.g. in the case of a runway incursion)
	7.4	Incorrect performance of ancillary equipment
	7.5	Inadequate / unavailable equipment - snow clearance, stand entry guidance, perimeter fence...
	7.6	Inadequate or incorrect airport departure or arrival procedure design
	7.7	Contaminated operational areas (runway, taxiway etc)
	7.8	Safety features not to national or international standards (e.g. RESA)
	7.9	Slow response time (e.g. RFFS, Ambulance, on airfield only)
	7.10	Poor management of fuel installations on aerodrome
	7.11	Planning
	7.12	Competence
	7.13	Human performance (e.g. fatigue)
	7.14	Perception and Decision-making
7.15	Situational Awareness	
7.16	Use of automation/tools/equipment	
Ramp	8.1	Loading error (e.g. load insecure, incorrectly distributed, inaccurately measured, external door not secured)
	8.2	Dangerous goods error (incorrectly stowed/packaged, not notified, prohibited from carriage, counterfeit goods)
	8.3	Dangerous goods (correctly carried)
	8.4	Ramp rash
	8.5	Incorrect fuel uplift
Cabin	9.1	Evacuation difficulties
	9.2	Fire/Smoke in cabin
	9.3	unsecured objects
	9.4	Non-adherence to cabin safety procedures
	9.5	Post-crash fire
	9.6	Lack of or inadequate qualification, training or experience
Airline	10.1	Time allocated to task by company inadequate
	10.2	Other commercial pressure
	10.3	Lack of or inadequate qualification, training or experience

Group	Code	Description
Airline (Continued)	10.4	Incorrect or inadequate procedures
	10.5	Company management failure
	10.6	Low fuel state
	10.7.1	Flight Crew Preparation - Loading incorrect (includes external door not secured, where flight crew have responsibility for this action)
	10.7.2	Flight Crew Preparation - Inadequate pre-flight planning or preparation
	10.8.1	Flight Crew Handling / Skill - Flight handling
	10.8.2	Flight Crew Handling / Skill - Fast and/or high on approach
	10.8.3	Flight Crew Handling / Skill - Slow and/or low on approach
	10.9.1	Flight Crew Human performance - Disorientation or visual illusion
	10.9.2	Flight Crew Human performance - Fatigue
	10.9.3	Flight Crew Human performance - State of mind
	10.9.4	Flight Crew Human performance - Incapacitation, medical or other factors reducing crew performance
	10.10.1	Flight Crew Perception and Decision-making - "Press-on-itis"
	10.10.2	Flight Crew Perception and Decision-making - Poor professional judgement or airmanship
	10.10.3	Flight Crew Perception and Decision-making - Deliberate non-adherence to procedures
	10.10.4	Flight Crew Perception and Decision-making - Slow or delayed action
	10.10.5	Flight Crew Perception and Decision-making - Omission of action or inappropriate action
	10.10.6	Flight Crew Perception and Decision-making - Unintended flight into IMC
	10.11.1	Flight Crew Situational Awareness - Lack of positional awareness - in air
	10.11.2	Flight Crew Situational Awareness - Lack of positional awareness - on ground
	10.11.3	Flight Crew Situational Awareness - Lack of awareness of circumstances in flight
	10.11.4	Flight Crew Situational Awareness - Failure in look-out
	10.12.1	Flight Crew Use of automation or tools - Incorrect selection on instrument or navaid
	10.12.2	Flight Crew Use of automation or tools - Action on wrong control or instrument
10.12.3	Flight Crew Use of automation or tools - Interaction with automation	
10.12.4	Flight Crew Use of automation or tools - Failure in CRM (cross-check/co-ordinate) / TRM	
Environment	11.1	Weather general
	11.1a	Wind shear, upset or turbulence
	11.1b	Cross-wind
	11.1c	Icing
	11.1d	Lightning
	11.1e	Poor visibility or lack of external visual reference
	11.1f	Volcanic ash, sand, precipitation, etc.
	11.2	Runway or taxiway condition (ice, slippery, standing water, debris, etc.)
	11.3	Wake turbulence - correct separation
11.4	Birds/Wildlife	
Regulation (safety or other)	12.1	Illegal, unauthorised or drug smuggling flight
	12.2	Inadequate regulation
	12.3	Incorrect regulation
	12.4	Inadequate regulatory oversight
	12.5	Non-safety related restrictions

Annex D Passenger Protection

1 Introduction

1.1 Overview

1.1.1 The safety of the UK citizen forms the core of the CAA's activities as a safety regulator. In view of the context of the Offshore Review, this Section is concerned with the protection of passengers in the event of an air accident. It does not consider Health and Safety at Work issues such as noise, heat, vibration, or trips and slips whether on board, boarding or disembarking the helicopter.

1.1.2 Although treating the cause is usually to be preferred to treating the symptoms, it is unrealistic to expect to be able to prevent all offshore helicopter accidents. As for all other modes of transport, it is therefore considered appropriate to employ all reasonable and practicable measures available to mitigate the consequences of accidents in terms of protecting passengers against injury or death.

1.1.3 The CAA believes that the accidents likely to present a hazard to offshore passengers comprise mid-air collisions and bird strikes, crashes onto land or an offshore installation, ditchings and water impacts.

1.2 Mid-Air Collision/Bird Strike

1.2.1 Mid-air collision with another aircraft is a real risk in the North Sea operating area and a number of near misses (airproxes) have occurred (see Section 3.9 of Annex G). Studies of airproxes have shown flight in uncontrolled airspace and mixing of civil and military traffic to be major factors, and both occur in the North Sea operating area. Since there is nothing that can sensibly be done to mitigate the consequences of such an event, the only realistic approach is prevention and this has been addressed by the implementation of flight following (the multi-lateralisation system) and Aircraft Collision Avoidance Systems (ACAS).

1.2.2 Bird strikes present a significant hazard to aviation in general and could, in principle, present a threat to helicopters operating offshore. However, no significant incidents have been known to have occurred and helicopters are designed to withstand strikes from birds up to a specified mass and density. It is not known how representative the bird strike certification standards are of the sea bird population, but experience suggests that this is not a problem area.

1.2.3 In view of the foregoing, mid-air collisions and bird strikes are not considered any further in respect of passenger protection and no recommendations are made.

1.3 Crash

1.3.1 For fixed-wing aircraft operations, the majority of accidents occur during the take-off, climb-out, approach and landing flight phases, i.e. close to the point of departure or the destination. For offshore helicopter operations, onshore crashes at airports and crashes at offshore installations might therefore both be expected and, indeed, have occurred.

1.3.2 Crashes are catered for in the EASA Certification Specifications which include measures such as structural strength requirements, crashworthy fuel tanks, seat belts and energy absorbing seats. These provisions are equally applicable to onshore and offshore crashes, are believed to be adequate and are not considered further in this review.

1.3.3 Crashes can result from technical failures; the helicopter's engines, rotors and transmission are highly loaded during take-off and landing, although exposure to these conditions is limited. Pilot performance is another potential cause, and the scope for error is exacerbated at offshore installations where the obstacle environment and other features such as topsides structure-induced turbulence, turbine exhaust gas plumes and flares present additional hazards not normally experienced onshore.

1.3.4 It is the offshore environment that is unique to offshore helicopter operations and clearly presents the greatest hazard in terms of both the likelihood of a crash and the challenges in addressing the consequences, especially at normally unattended installations. Onshore crashes are considered to be adequately addressed, and the remainder of this review is focused on crashes at offshore installations.

1.4 Ditching/Water Impact

1.4.1 For the vast majority of the time during offshore operations, the helicopter is flying over water. Any technical failure preventing continued safe flight or any contact with the surface due to pilot error or external factors will therefore very likely result in the helicopter arriving in the sea. In civil operations, such events are classified as either ditchings or water impacts.

1.4.2 Ditching has a specific meaning in civil aviation and is currently defined in the EASA Certification Specifications as follows:

“Ditching may be defined as an emergency landing on the water deliberately executed, with the intent of abandoning the rotorcraft as soon as practical. The rotorcraft is assumed to be intact prior to water entry with all controls and essential systems, except engines, functioning properly.”

1.4.3 Ditching certification is required for offshore operations and there is a set of requirements that must be complied with which include water entry and sea-keeping performance. Ditching is therefore a relatively well defined event that the helicopter manufacturer is able and required to design for.

1.4.4 Any contact with the water which lies outside of the ditching definition is classified as a water impact. For the purposes of safety analysis, these are normally classified further as either survivable where a significant proportion of the occupants survive, or non-survivable where none or only a very small proportion of the occupants survive the impact. Currently, there are no specific requirements relating to water impact and it would be difficult to cater for such events in the same way as for ditching due to the wide range of scenarios that are possible and the very large impact forces that could be involved. Furthermore, there is a limit to what measures can practicably be taken.

2 Crash

2.1 Introduction

2.1.1 As noted in Section 1.3, this review is constrained to crashes on offshore installations. Examples of such accidents are G-BEWL at the Brent Spar in 1990, G-AYOM at the Claymore Accommodation Platform in 1995, and G-BKZE on the West Navion drill ship in 2001.

2.2 The Hazards

2.2.1 The hazards associated with crashes onto offshore installations are largely the same as for crashes at onshore sites and include impact injuries, post-crash fire, and injury (mainly to persons outside of the aircraft) due to rotor strike or flying debris.

2.3 Impact Injuries

2.3.1 Currently, all occupants are required to be restrained by harnesses which include an Upper Torso Restraint (UTR) and load attenuating/stroking/crashworthy seats must be fitted. Although these measures are undoubtedly beneficial, care needs to be taken to ensure that seat belts can be quickly and easily released and that occupants do not become entangled with them. In addition, the brace position used with stroking seats must be modified so that the feet are not placed under the seat in order to avoid lower limb injuries that could impede escape and survival.

2.3.2 The addition of air bags to helicopters has been considered, but there are significant concerns regarding the hazards that they might present in terms of hindering escape from the cabin, especially if submerged, and in terms of the hazard that would undoubtedly be presented by inadvertent deployment in flight if installed in the cockpit.

2.3.3 Crash helmets have also been proposed, especially for the flight crew whose heads are especially close to the aircraft structure and other injury inducing objects. Helmets are already worn by flight crews of search and rescue helicopters, but there are valid arguments against wider use in terms of the potential for neck injury over prolonged periods of use due to the weight of the helmet (see "Assessment of Hazards Associated With Pilots Wearing Helmets While Flying in the C-NL Offshore Area" produced by The Hazard Assessment Team of the C-NLOPB Offshore Helicopter Safety Inquiry Implementation Team).

2.4 Post-Crash Fire

2.4.1 Post crash fire is a major hazard in all aviation accidents in general, and is exacerbated where access to the crash site is limited such as at offshore installations. An additional issue at offshore installations is the fact that they are regarded as unlicensed operating sites. Under Article 96 of the Air Navigation Order (ANO) 2009, offshore helicopter operators are required to satisfy themselves that each helideck they operate to is 'suitable for the purpose'. Helicopter operators discharge their duty of care through an inspection programme undertaken on their behalf by the Helideck Certification Agency (HCA), who assesses helidecks and related facilities against standards and best practice in UK Civil Aviation Publication CAP 437. In essence the HCA Certification process provides an assurance to the helicopter operators that they are fulfilling their duty of care under the ANO in only operating to helidecks that are suitable for the purpose.

2.4.2 Chapter 5 of CAP 437 contains detailed prescriptive requirements for Rescue and Fire-Fighting Services (RFFS) that are based on international standards and recommended practices in ICAO Annex 14 Volume II and the Heliport Manual (Doc. 9261). For manned installations and vessels and for new build Normally Unattended Installations (NUIs), best practice requirements specify the delivery of foam (e.g. AFFF) at a high application rate and for an extended duration dispensed from either a Fixed Monitor System (FMS) or from a Deck Integrated Fire-Fighting System (DIFFS). For a NUI, which is unmanned for at least the first

and last flight of the day, an automatically activated DIFFS ideally with a passive fire-retarding surface is preferred since this solution provides for automatic fire suppression and active intervention in the event of a major fire situation occurring during a take-off or landing where all trained fire crews are on board the helicopter.

2.4.3 Historically, for existing NUI facilities on the United Kingdom Continental Shelf (UKCS), CAP 437 'current best practice' has not been applied for RFFS and, until recently, platform operators selected an RFFS on the basis of United Kingdom Offshore Operators Association (UKOOA) 'Guidelines for the Management of Offshore Helideck Operations' (Issue 5 - Feb 2005). The 'UKOOA Guidelines', which have been superseded by Oil & Gas UK 'Guidance for the Management of Aviation Operations (Issue 6, April 2011 - containing no specific reference to NUI RFFS), stipulated only minimal fire-fighting media requirements which were broadly equivalent to scales specified for a low intensity H1 helicopter operation at a temporary onshore heliport (reference source: CAP 789, Annex 3 to Chapter 21). It was not intended that such a minimal provision of primary fire-fighting media should be deemed acceptable for a permanent heliport operation, operating in a remote location in a hostile environment onto minimum size elevated landing areas, routinely using helicopters that are not only larger than the H1 category, but also carry more passengers and fuel compared to helicopters typically utilizing the CAP 789 low intensity requirements. Using the risk assessment elements promulgated in Appendix D of CAP 437, selection of such a reduced level of fire cover when all these factors are considered together is unjustifiable.

2.4.4 It is evident that the current arrangements for RFFS on fixed NUI platforms on the UKCS are inadequate to address all likely and reasonably foreseeable fire situations that may be encountered during routine offshore helicopter operations. For this reason, taking account also of concerns raised by the offshore helicopter operators and the HCA, and with the support of the UK Health and Safety Executive, the CAA has undertaken to conduct a review of the minimum scales of fire-fighting media that would be appropriate for existing NUI assets operating on the UKCS. The results of the review, conducted with reference to other sources of UK best practice (including CAP 168 and CAP 789) and ICAO Annex 14 Volume II and the Heliport Manual (doc. 9261), are detailed in Appendix D of CAP 437.

2.5 Injury Due to Rotor Strike

2.5.1 Most passenger embarkation and disembarkation takes place with the rotors turning, and it is always necessary for ground crew to operate in the vicinity of helicopters with running rotors. The hazard presented is obvious and ground crew are trained and passengers are briefed on the correct procedures for approaching and departing from helicopters in order to minimise the risks (see Oil & Gas UK Guidelines for the Management of Aviation Operations, Issue 6, April 2011). Nevertheless, accidents can still happen (e.g. fatal rotor strike involving G-BLEZ on the Viking B platform in 1992), and 'near misses' have occurred when procedures have not been followed.

2.5.2 Operations to moving helidecks are more hazardous in this regard due to the risk of the helicopter sliding across the deck (e.g. G-BOND on the Mayo diving support vessel in 1992) or tipping and, *in extremis*, rolling over on the helideck (e.g. G-BKZE on the West Navion drill ship in 2001). There is little that can practically be done to mitigate the consequences of such eventualities and the best approach is considered to be prevention. Such occurrences have historically

been associated with weaknesses in the regulation of operations to moving helidecks and this is being addressed by the research described in Section 3.3 of Annex G.

2.6 Injury Due to Debris

2.6.1 Injury due to impact of debris from a crash is most likely to affect personnel outside of the aircraft such as ground crew or other installation crew. Such personnel may best be protected by ensuring that all non-essential persons remain inside the installation accommodation during helicopter operations, and that those required to be outside remain below helideck level until the helicopter has landed/departed.

2.6.2 Embarking/disembarking passengers or flight crew performing ground duties are also at risk during operations to moving helidecks in the event of the helicopter rolling over and the rotors disintegrating following contact with the helideck or surrounding superstructure. Personnel movements on the helideck during helicopter rotors running turn-arounds should be minimised and personnel should remain below the level of the helideck as much as possible. Current industry guidance (Oil & Gas UK Guidelines for the Management of Aviation Operations, Issue 6, April 2011) does not cover this hazard and could usefully be expanded.

3 Ditching/Water Impact

3.1 The Hazards

3.1.1 Setting aside non-survivable water impacts which are judged to be impractical to mitigate, the hazards associated with ditchings and survivable water impacts are similar, and are considered together here in the interests of simplicity and clarity. They are also considered in the order in which they would normally be expected to be encountered during a ditching or water impact event.

3.1.2 In the chain of events following water contact the first hazard that is encountered is the risk of injury due to the impact. This is unlikely to present a significant hazard in ditchings but is a major risk in water impacts. In survivable water impacts, however, analysis of the accidents clearly and consistently shows that, where the cause of death is known, most fatalities are due to drowning rather than impact injuries (see CAA Paper 2005/06). However, loss of consciousness or incapacitation due to injury can prevent or impede escape so all reasonable steps should be taken to minimise impact injuries. Unsurprisingly, post crash fire is not an issue in the case of ditching/water impact.

3.1.3 Note that loss of consciousness and/or injuries can also prejudice survival in the sea following successful escape from the helicopter. Here, the primary hazards are drowning and death from exposure.

3.2 Impact Injuries

3.2.1 Injuries due to water impact present essentially the same hazards as those associated with crashes and the same provisions are relevant to both scenarios (see Section 2.3). Due to differences in the loading mechanisms involved with water impact compared to impact with the ground, however, the peak loads are generally larger in water impacts (see CAA Paper 96005).

3.3 Drowning Inside the Helicopter

3.3.1 Introduction

3.3.1.1 As stated in 3.1 above, the majority of fatalities in ditchings and survivable water impacts are due to drowning. The main factors affecting the risk of drowning inside the helicopter are the likelihood of the helicopter capsizing and/or sinking and the ability of occupants to escape from the helicopter.

3.3.2 Capsize and/or Sinking

3.3.2.1 In ditchings, it would normally be expected that the helicopter will initially be upright and will float. However, capsize could occur due to imperfect alighting on the sea, non-deployment or incorrect deployment of the emergency floatation system (e.g. due to failure or partial failure), or the prevailing sea conditions exceeding the ditching performance of the helicopter in terms of water entry. Capsize could also occur after successful alighting on the water due to the sea conditions exceeding the ditching performance of the helicopter in terms of stability, i.e. sea-keeping performance.

3.3.2.2 In survivable water impacts, the helicopter almost always capsizes immediately and often rapidly sinks. In many cases the emergency floatation system is either not armed or not activated, and in others the floatation system is damaged and fails to deploy or only partially deploys. Since the requirements do not drive the helicopter manufacturers to produce crashworthy emergency floatation systems, other than by addressing the ditching water entry scenario, the outcome of a survivable water impact is largely a matter of luck. The UK industry has, however, voluntarily implemented the Automatic Float Deployment System (AFDS) which has proven very effective in at least one survivable water impact (G-REDU, 18 February 2009).

3.3.3 Escape from the Helicopter

3.3.3.1 In the case of a successful ditching where the helicopter remains upright, escape from the helicopter, ideally directly into the life rafts without needing to enter the sea, is usually relatively straightforward. Occupants will usually use the normal aircraft exits in these circumstances and it would be expected that no significant difficulties would be encountered.

3.3.3.2 In the event of capsize and/or sinking occupants will usually have to make an underwater escape, often in very difficult circumstances, e.g. disorientation due to the rotation of capsize, poor visibility (underwater and sometimes at night), shock, panic and possibly injuries too. Even when equipped with insulated immersion dry suits, breath hold times in typical sea water temperatures (and especially hostile areas such as the North Sea) are less than 20 seconds and can be as little as 6 seconds (see CAA Paper 2003/13), limited primarily by the effects of cold shock. The normal escape route in this situation is via the push-out windows which are aligned with the seat rows. Evidence from escape trials in Helicopter Underwater Escape Trainers (HUETs), however, indicates escape times ranging from 27 to 92 seconds (see CAA Paper 2003/13), the longer times corresponding to occupants in inboard seats who have to wait their turn to escape.

3.3.3.3 The mismatch between breath hold time and escape time, for at least the middle seat occupants, is widely known and accepted and has been addressed to some extent at least by the voluntary deployment of Emergency Breathing Systems (EBS) by the oil and gas industry. The oil and gas industry also mandates

helicopter safety training for its workforce which includes HUET simulator exercises conducted in a swimming pool environment.

3.3.3.4 Other issues relating to underwater escape are locating and operating an exit, buoyancy, snagging and exit size:

- Exit location: Exit location is hindered by disorientation due to the rotation of capsized, poor visibility due to being underwater without goggles or a face mask and sometimes darkness. The workforce are trained to maintain hand contact with their adjacent push-out window to assist orientation but, in the absence of anything to hold on to, this is difficult and no help to middle seat occupants. Also, occupants may need to use both of their hands in order to deploy their EBS. Exits are identified with illuminated markers (EXIS) in addition to the normal decals, but these may be of limited use due to the bubbles usually present in the water.
- Exit operation: Exit operation can also present difficulties. Normal exits are rarely used due to the difficulty in locating and operating the handles when disoriented and, possibly, upside down. Most survivors make their escape via the push-out windows. In water impacts, survivors often have no recollection of opening exits and it is suspected that push-out windows are usually forced out in the impact. However, some difficulties in opening push-out windows have been reported and it is necessary to operate the push-out window prior to releasing the seat belt; it might be difficult to apply sufficient force to the window if the occupant is floating free in the cabin.
- Buoyancy: Until out of the helicopter, buoyancy can be very unhelpful. Once the seat belt is released, the occupant will float up away from the exit unless a firm hand hold is maintained. This is one of the main reasons why the life jacket must not be inflated until outside of the helicopter. However, the human body is naturally buoyant and this buoyancy is significantly increased by the immersion dry suits that are worn (mandated by aviation regulations when the sea temperature is below 10°C, mandated by the oil and gas industry for their work force for all offshore flights). The buoyancy of these suits is minimised, but there is a trade-off to be made between the thermal insulation required to ensure survival while awaiting rescue and the buoyancy of the suit. Buoyancy may be further increased by the EBS, depending on which type of EBS is used.
- Snagging: Given the very limited time available for escape, anything that can slow progress must be avoided. Problems have been encountered in releasing seat belts or becoming entangled in seat belts, and this is more likely following the deployment of Upper Torso Restraint (UTR) and additional Personal Protective Equipment (PPE) such as EBS. In the past, the inability to release headset cables and/or becoming entangled with headset cables has caused at least one fatality, and wireless head sets are now used.
- Exit size: A significant concern that has relatively recently emerged is the adequacy of the minimum exit sizes specified and, in particular, the minimum size of push-out windows, these typically being the smallest exits. The reason for the concern is the increase in passenger size since the minimum exit size was set, due both to a general increase in average body size of the offshore work force and also an increase in the bulk of the PPE worn. A survey of the offshore work force is presently being conducted by Robert Gordon University which will inform any action that may need to be considered in terms of increasing exit sizes (where possible) and/or placing restrictions on the size of

passengers that may be seated next to small exits (e.g. push-out windows) or even not allowed to fly offshore.

3.4 Survival in the Sea

3.4.1 Introduction

3.4.1.1 Once safely out of the helicopter, the next challenge is to survive long enough to be rescued. Survivability will obviously depend upon the prevailing environmental conditions in terms of the weather and the sea state, and the option not to fly in especially adverse conditions always exists. That aside, survivability will depend on the condition of the survivors and the effectiveness of their survival equipment. This includes life rafts, life jackets, and immersion suits.

3.4.2 Life Rafts

3.4.2.1 Life rafts can significantly extend survival time and are therefore very important. For maximum benefit, survivors should avoid getting wet if at all possible, entering the life raft 'dry shod'. Of course this is not always an option and life rafts include boarding ramps to assist entry from the sea.

3.4.2.2 As a result of difficulties encountered with accessing and deploying life rafts stowed within the cabin, all offshore helicopters now carry externally mounted life rafts. These are effectively mandated by the requirement for 50% of the life rafts to be deployable by the crew from their normal station. Although provision is made for external deployment, the location of the operating handles on most helicopters is such that they are underwater after the aircraft has capsized and this needs to be addressed. There have also been some issues with deployment, involving tangling of mooring lines and survival pack lines, and the need for improved deployment testing and a formal technical standard for external life rafts has been identified. In addition, although life rafts are designed to cope with conditions up to sea state 6, they can be very difficult to deploy in wind speeds normally associated with sea state 6.

3.4.2.3 Reversible life rafts are *required (unless a non-reversible life raft is demonstrated to be self-righting in the fully inflated condition)* which do not need to be righted if they deploy upside down or flip over following deployment. However, non-reversible life rafts have a larger freeboard which makes them less likely to overturn and provide a better environment for the occupants. On the other hand, the larger freeboard may make them harder to board from the sea which can be quite difficult at the best of times.

3.4.2.4 Whatever the type, all life rafts include a deployable hood to protect occupants from the weather, and also include a survival pack containing, *inter alia*, an Emergency Locator Transmitter (ELT), signalling flares, sea sickness tablets and fresh water; sea sickness can be very debilitating, can impede rescue. Otherwise, typical rescue times are within an hour or two and, as such, survival for periods extending to days or even longer are very unlikely to be required in the UK offshore environment.

3.4.2.5 A significant issue with life rafts has been damage from contact with sharp objects in the water such as the helicopter structure or debris from the helicopter including doors that have been jettisoned. The helicopter structure is already required to be 'de-lethalised'. Whereas this may be effective in respect of an essentially intact helicopter, it would not be reasonable to expect that to extend to an aircraft that has been damaged in an impact. However, consideration might be given to minimising the use of carbon fibre in areas vulnerable to damage in a

water impact; carbon fibre debris is especially hazardous due to the sharp edges that result and because it normally doesn't sink. In addition, the puncture resistance of the life rafts could be increased although this may unhelpfully increase the weight and packed size.

3.4.3 Life Jackets

3.4.3.1 Permanent wear life jackets are worn by all occupants which include a whistle and a strobe light. They also include a spray hood to shield the survivor and assist breathing in high seas; although this is regarded as being very important, it is not currently mandated. Another feature included in current equipment but not mandated is a crotch strap to prevent the life jacket from riding up too high on the wearer's body.

3.4.3.2 Life jackets are designed to ensure that the survivor floats at the correct angle in the water (feet lower than the head) to facilitate turning and maintain the survivor's airway. Life jackets are also designed to keep the survivor floating face up to prevent drowning if they should lose consciousness, e.g. due to exposure. An issue exists in this respect as the additional buoyancy of the immersion suit can interfere with the self righting ability of the life jacket. The ability of the life jacket to self-right the survivor when worn with an immersion suit should therefore be considered, but it should be noted that this may result in an increase in the size of the life jacket and lead to greater difficulties in boarding the life raft.

3.4.4 Immersion Suits

3.4.4.1 As previously stated, these are mandated by aviation regulations for all occupants when the sea temperature is below 10°C, and mandated by the oil and gas industry for their work force for all offshore flights. Their purpose is to increase survival time by keeping the wearer dry and warm. They are not comfortable to wear due to the tight neck and wrist seals needed to keep the suit water tight, and the thermal insulation required to ensure survival in a cold sea makes them very hot to wear, especially during warmer weather.

3.4.4.2 The main problem experienced with immersion suits has been water leakage, but this is believed to have been mainly associated with older designs of suits that were not permanently worn fully sealed. In terms of thermal stress, there is no escaping the trade-off between discomfort during routine flights and survival time in an emergency. However, the advent of air conditioning in modern helicopters has doubtless eased the problem.

3.4.4.3 Associated with immersion suits is the issue of gloves. Without gloves, survivors' hands are rapidly rendered useless by cold so it is very important that these are donned as soon as possible and before getting wet. It is therefore essential that any equipment that survivors are expected to use can be operated with gloved hands.

3.5 Rescue

3.5.1 Introduction

3.5.1.1 Despite the safety and survival equipment provided, the marine environment can be very hostile especially if survivors are injured and/or exposed to adverse weather or sea conditions. Timely rescue is therefore essential if casualties are to be minimised, and the services provided are reviewed in Section 3.8.

3.5.1.2 Even where services are available, however, rescue either by sea or by air is not necessarily guaranteed. In particular, heavy seas can prevent successful rescue and helicopter operations are presently voluntarily suspended when the significant wave height exceeds seven metres (sea state 7).

3.5.1.3 In order to be rescued, survivors first have to be located. In terms of the helicopter and its occupants, this is addressed through the provision of both visual and radio aids.

3.5.2 Visual Aids to Location

3.5.2.1 High visibility/retro-reflective markings are applied to the upper and lower surfaces of helicopters to assist visual location of the aircraft whether floating upright or inverted. Passenger immersion suits, life jackets and life rafts are fabricated from high visibility material and carry retro-reflective markings in order to help locate survivors in the water. Life jackets and life rafts have survivor locator lights attached. In addition, flares are provided in the life raft survival pack to attract the attention of rescue services. Although not currently mandated, life jackets are also fitted with a strobe light.

3.5.3 Radio Aids to Location

3.5.3.1 Offshore helicopters are fitted with an Automatically Deployable Emergency Locator Transmitter (ADELT), and the life raft survival packs contain a manually deployed Emergency Locator Transmitter (ELT). In addition to this equipment that the helicopters are required to carry, the oil and gas companies issue each passenger with a Personal Locator Beacon (PLB). All of these devices operate on the same frequencies (121.5 and 406 MHz, 243 MHz optional) and care is required to ensure that the operation of one device does not compromise that of another. In particular, PLBs should be switched off once the survivor is safely in the life raft and the ELT has been deployed as multiple transmissions can adversely affect the performance of some locator systems.

3.6 Existing Ditching/Water Impact Provisions

3.6.1 Review of Existing Equipment

3.6.1.1 Introduction

3.6.1.1.1 A review of the relevant standards for PPE has been conducted comprising a review of the PPE currently in use, and a comparison of the current and previous PPE standards used for UK offshore operations.

3.6.1.2 Equipment Standards

3.6.1.2.1 JAR-OPS 3.827 requires flight crew to wear survival suits when the water temperature may fall below +10°C and/or when the estimated rescue time is less than the estimated survival time. This requirement is extended to passengers under JAR-OPS 3.837, although passengers on offshore oil and gas support flights are required to wear immersion suits at all times by the oil and gas companies.

3.6.1.2.2 It should be noted that the PPE standards are being reviewed under the EASA Helicopter Ditching and Survivability Rule Making Task RMT.0120 (27 & 29.008).

3.6.1.2.3 The utilization of the various immersion suits available for use in the North Sea is as follows:

- 60% of passengers use the Survitec 1000-series suit/Shark LAP jacket combination.
- 35% of passengers use the Survitec 500-series suit/Shark LAP jacket combination.
- 5% of passengers use the Shark Immersion Suit Style 93204/Shark LAP jacket combination.
- 95% of crew use the Survitec 400-series suit/RFD Beaufort Mk 15 and 44 jackets combination.
- 5% of crew use the Survitec 1000-series suit/RFD Beaufort Mk 15 and 44 jackets combination. The 1000 series are new to the market and are gradually being introduced.

3.6.1.2.4 The Survitec 1000 series is to the latest European Technical Standard Order (ETSO) standard and consequently has to meet a specific thermal protection requirement, whereas the other suits meet CAA Specification No. 19 and have no specific thermal standard to meet, although they are required to provide “...an acceptable standard of body insulation...”.

3.6.1.3 Differences between the Standards

3.6.1.3.1 The two immersion suit standards differ primarily in that ETSO-2C503 Appendix 1 paragraph 9.1 requires:

“The suit shall provide the user with thermal protection in the water that it at least satisfies the test requirements of paragraph 3.8 of EN ISO 15027-3:2002 as a class B suit system.”

3.6.1.3.2 Whereas the CAA Specification No. 19 Appendix A1.3 requires:

“The achievement of an acceptable standard of body insulation depends on the wearing of recommended clothing in conjunction with the immersion suit. Operators must provide means for underclothing of the correct insulation value to be worn with the immersion suit taking account of the body characteristics of the crew member and the expected sea temperature. Operators must advise crew members of the necessity for correct underclothing to be worn by means of a statement in their Operations Manuals.”

3.6.1.3.3 In addition, paragraph A1.6 also requires:

“Operators should note that since the function of an immersion suit is to preserve the insulation of the crew member in severe conditions, there is a consequent possibility of over-insulation in exceptionally warm conditions. This can lead to extreme discomfort and heavy perspiration with an attendant risk of dehydration or cramp in exceptional cases. The human factors consequences of operation for long periods in such conditions, while difficult to quantify, should not be disregarded. In such circumstances, when the wearing of an immersion suit is not required by the ANO, it is possible that the flight safety disadvantages of the wearing of such a garment could outweigh the benefit of its survival value in the water. If operators choose to require crews to wear survival suits in conditions when they are not required by the ANO, account must be taken of the above and the operator must take all reasonable precautions to ensure that flight safety is not unnecessarily compromised.”

3.6.1.3.4 Based on feedback from suppliers and end-users, a consequence of the ETSO thermal requirement is that flight crews are unlikely to wear immersion suits when not required due to the added weight and stress of wearing the suits. This is not such an issue for suits designed to meet CAA Specification No. 19, however, which do not have to meet any specific thermal standard. The same factors also apply to passengers, but it is essentially a matter of discomfort for a relatively short period of time in an 'inactive' state and does not present a safety risk.

3.6.1.3.5 CAA Specification No. 19 paragraph 7.1 also requires:

“Passive self-righting from any other attitude to the face-up position shall occur within 5 seconds, remaining stable in that position with the mouth at least 120 mm above the waterline”.

This requirement is not in the ETSO because there was concern that it would lead to a bulky design of life jacket that might conflict with the requirement for the wearer to be able to board a life raft. It is understood, however, that helicopter winch men do prefer a more buoyant equipment combination to aid rescue.

3.6.1.3.6 Other points to note include how the performance of the survival suit can be degraded by the following factors:

- Incorrect Garment Fit:
 - Too tight: movement restricted, seals compromised.
 - Too big: too much trapped air, loose fabric snag hazard.
- Incorrect Seal Size:
 - Too big: water Ingress > 200 g maximum allowance.
 - Too tight: breathing, blood and fluid flow restricted.
- Worn Incorrectly
 - Waterproof Entry and Urinal Zippers not fully closed;
- Clothing Ensemble Underneath:
 - Too much: restricts movement, overheating.
 - Not enough: insufficient in-water thermal protection.

3.6.1.4 Summary

3.6.1.4.1 The immersion suits in use are transitioning to the latest standard. The main differences between the earlier and current standards are:

- the requirement to meet a specific level of thermal insulation in the current standard, and
- the absence of a self-righting requirement in the current standard.

3.6.1.4.2 The life jackets in use remain the same as those originally certified by the CAA prior to the introduction of the EASA ETSO which is comparable to the CAA specification.

3.6.2 Review of Compliance with Existing Ditching/Water Impact Safety and Survival Equipment Requirements

3.6.2.1 Review of Rotorcraft Flight Manuals and JAR-OPS 3 Subpart K Equipment Lists

3.6.2.1.1 A review of Rotorcraft Flight Manuals (RFMs) and the Helicopter Operators' JAR-OPS 3 Subpart K Equipment Lists was performed to establish compliance with the airworthiness and operational requirements relating to passenger and flight crew safety and survival equipment. The detail of the review is presented in Appendix 1 to Annex D. Note that the review only covered equipment required under aviation regulations and not any additional equipment, such as Emergency Breathing Systems (EBS) or Personal Locator Beacons (PLBs), issued to passengers by oil and gas companies.

3.6.2.1.2 With regard to the review of RFMs, some room for improvement in the procedural information and guidance on the locations, markings and operation of emergency exits, and the emergency evacuation procedures for post-ditching egress was identified. It is recommended that this be addressed by the corresponding type certificate holders.

3.6.2.1.3 In respect of the review of JAR-OPS 3 Subpart K equipment compliance checklists of the three approved helicopter operators, part numbers were not listed for a significant number of equipment items so it was not possible to establish whether the actual equipment in use is approved as required in JAR-OPS 3. It is recommended that this be addressed by the helicopter operators.

3.6.2.2 Review of Operations Manuals Part A and Part B

3.6.2.2.1 The contents of Operations Manuals Part A and Part B for Bond Offshore Helicopters, Bristow Helicopters and CHC Scotia Helicopters were reviewed with respect to emergency equipment and passenger evacuation procedures.

3.6.2.2.2 It was noted that, with the exception of one helicopter type with one helicopter operator, Operations Manual Part B contained insufficient information regarding the operation of helicopter doors and exits for both normal and emergency operations. There was insufficient information identifying primary and secondary exits and when each should be used. Although it was suggested by the evacuation procedures that the main cabin doors are the primary exits, window exits are likely to become the primary means of escape in the event of the helicopter capsizing.

3.6.2.2.3 The clarity of information contained on passenger safety cards varied. The majority of cards reviewed relied on the use of words to supplement incomplete pictorial information and presented a very cluttered appearance, which did not facilitate the assimilation of instructions. In most cases, the method of jettisoning the main cabin door was not fully shown. A number of cards did not show the full deployment of life rafts or the method of detachment from the helicopter.

3.6.2.2.4 The use of emergency equipment contained in the Operations Manuals was insufficient and this was reflected in the information contained in the passenger safety cards. None of the safety cards reviewed contained instructions on the use of fire extinguishers yet, if a fire occurred in the cabin, a passenger may be the best placed person to respond.

3.6.2.2.5 The design of the AW139 main cabin door does not permit jettisoning, egress being via the window exits. These are more difficult to evacuate from owing to the

size of aperture, and the rate of egress is therefore likely to be reduced compared to egress from a main cabin door. Furthermore, in the event of an evacuation on land or an offshore installation, use of window exits may result in injury as passengers will fall from the exit to the surface below.

- 3.6.2.2.6 It would be appropriate for helicopter operators to review the contents of their Operations Manuals and passenger safety cards in order to ensure the contents provide sufficient information and instructions to facilitate personnel in effecting evacuation or responding effectively to an in-flight emergency.

3.6.3 Control of Cabin Interiors and Carry-On Equipment

- 3.6.3.1 A trend for equipment to be carried that has not been approved for installation or not agreed as 'carry-on' equipment directly with the CAA emerged from several surveillance visits and inspections of SAR helicopters. This was corrected, but operators must ensure that all interior configurations and post-delivery modifications are approved by an appropriate Design Organisation and that equipment designated as 'carry-on' is fully declared and agreed as to its approved status and carriage with the CAA.

3.7 Safety Improvement Initiatives

3.7.1 Introduction

- 3.7.1.1 During the period from 1976 to end 2012 there were a total of 12 ditchings and 16 water impacts in UK offshore operations. Although none of the ditching resulted in any fatalities, a safety assessment performed using established aviation criteria (EASA CS-27 and 29.1309) indicates that loss of life as a result of post-ditching capsize in hostile sea areas such as the North Sea is to be expected. The safety assessment is reproduced in Appendix 2.

- 3.7.1.2 As regards the water impacts, seven of the 16 were considered to be non-survivable, i.e. there were no survivors or only a very small number of the occupants survived. Of the 38 fatalities that resulted from the nine survivable water impacts, 31 failed to escape from the helicopter. Of these 31, the main cause of death was drowning, with only three of the deaths due to incapacitation. This echoes the results of larger studies (see CAA Paper 2005/06), which also found that the main cause of death is drowning. Six of the seven that managed to escape from the helicopter then perished in adverse sea conditions (sea state 7) before they could be rescued.

- 3.7.1.3 As a result of the accident experience, a number of opportunities for improvement have been identified and a series of joint industry reviews have taken place, culminating in the current EASA Ditching and Survivability Rule Making Task (RMT). The RMT is effectively drawing together all of the output from the earlier initiatives and research studies and reviewing the certification requirements and advisory material. The terms of reference of the RMT are presented in Appendix 3 to this Annex (Annex D). The history of the various initiatives and research studies is summarised in Annex G.

3.7.2 Improvements Incorporated in the Certification Requirements and Advisory Material

- 3.7.2.1 The following changes fall into this category:
- Seat belts with upper torso restraint.
 - Load attenuating/stroking/crashworthy seats.

- EXIS emergency exit lighting.
- Immersion suits.
- Externally mounted life rafts
- ADELTA.
- De-lethalisation of aircraft fuselage/structure (regarding damage/puncturing of life rafts).
- Improvements/upgrades to specifications for immersion suits, life jackets and life rafts.

3.7.3 Improvements Voluntarily Introduced by the Industry but not Incorporated in the Certification Requirements and Advisory Material

3.7.3.1 The following changes fall into this category:

- Safety and survival training (see Section 3.9).
- Seat rows aligned with push-out windows.
- Emergency Breathing Systems (EBS).
- Automatic deployment of Emergency Floatation System (EFS) – known as Automatic Float Deployment System (AFDS).
- Suspension of operations when the significant wave height exceeds 7 metres.

3.7.4 Improvements Under Consideration by the EASA Helicopter Ditching and Survivability Rule Making Task RMT.0120

3.7.4.1 The following changes fall into this category:

- All changes listed in Section 3.7.3.
- Sea-keeping performance matched to wave climate in intended area of operation/sea-keeping performance included in Rotorcraft Flight Manual (RFM).
- Prohibit operations over sea areas where the wave climate exceeds the certified ditching capability.
- Prohibit operations over sea areas where the wave climate precludes a reasonable prospect of safe rescue.
- Demonstration of compliance based on (significantly more realistic) irregular wave testing.
- Automatic arming of EFS.
- Improved crashworthiness of EFS (prevention of single point failures, autonomous floatation units).
- Addition of redundant floatation unit to EFS.
- Side-floating EFS configuration.
- Hand holds adjacent to push-out window exits.
- Standardisation of emergency exit operation.

- Consideration of impact damage in respect of de-lethalisation of aircraft fuselage/structure.
- Raise sea temperature limit for mandatory wearing of immersion suits.
- Review and upgrade (as required) of specification for immersion suits regarding conspicuity, insulation, buoyancy, sizing, snagging hazards and separate specifications for crew members.
- Review and upgrade (as required) of specification for life jackets regarding conspicuity, self-righting capability (in combination with an immersion suit), crotch strap/other means of preventing life jacket from riding up, snagging hazards.
- Review and upgrade (as required) of specifications for life rafts regarding release from any floating attitude, durability, length of painter line(s), standard occupant weight, stability and drift.
- Production of a formal specification for externally mounted life rafts.
- Production of a formal specification for EBS.

3.7.5 Progression of Safety Improvement Initiatives

3.7.5.1 Under the current EASA RMT, a Notice of Proposed Amendment (NPA) to the rules is scheduled to be published in mid-2014. In its published rulemaking programme 2014-2017, EASA has indicated that the task will be completed in 2016 with publication of new design standards. Whereas there is presently good agreement on a range of improvements to the rules and advisory material within the RMT working group in respect of new applications for certification (i.e. new helicopter designs), the proposals may be moderated in terms of safety improvement impact by the Regulatory Impact Assessment (RIA) and industry consultation phases. There is further uncertainty regarding how many of the improvements will be mandated for retrospective application to the existing fleet and the timescale of the RMT is, itself, a matter of concern in as much as anything that it does deliver will be in the medium to long term.

3.7.5.2 Rather than await the uncertain outcome of the EASA RMT, the oil and gas industry could extend its voluntary measures along the lines presently proposed by the RMT. This would have a double benefit: first, it would result in the earlier introduction of life-saving measures; second, it would facilitate the passage of the RIA by effectively reducing the cost to industry of regulating for the measures progressed (because they would have already been paid for), making inclusion in the requirements and a level playing field for all European helicopter operators more likely. The key measures that the oil and gas industry should consider are:

- Retrofit of the side-floating helicopter scheme which mitigates the consequences of capsize by ensuring that an air pocket is retained within the cabin, reducing the time pressure to escape, and that some of the escape routes remain above the water level facilitating egress. This scheme also significantly enhances the crashworthiness of the EFS by increasing the floatation unit redundancy.
- Replace or enhance the EBS presently deployed with equipment meeting the requirements of Category 'A' in the specification published by CAA in CAP 1034. Category 'A' EBS is designed to be deployable underwater in a time period commensurate with likely breath hold time.

- Automatic arming/disarming of EFS; together with AFDS this should ensure that the EFS is deployed in all ditchings and water impacts.
- Hand holds next to windows to improve exit location, assist operation of push-out windows and to help overcome the effects of buoyancy.
- Standardisation of exit operation/marketing/lighting, focusing particularly on push-out windows.
- Self righting life jacket/immersion suit combination to improve survivability while awaiting rescue, especially where a survivor loses consciousness, e.g. due to exposure.
- External life raft release by survivors in the sea in all foreseeable floating attitudes.

3.7.5.3 Even with the full support of the industry, most of the above measures will take a significant amount of time to implement. However, there are operational mitigations that could be introduced relatively quickly that would provide a safety benefit in the short term, and provide an incentive to expedite improvements to the aircraft and equipment. The following operational measures could be considered:

- Constraining the number of passengers on each flight such that every passenger is seated next to an push-out emergency exit, improving the prospect of safe egress from a capsized helicopter.
- Ceasing operations when the sea conditions exceed the certificated ditching performance of the helicopter.
- Ceasing operations when reasonable prospect of safe rescue cannot be assured in order to mitigate the consequences of a ditching or survivable water impact. (Note that the certificated ditching performance of any helicopter is very likely to be more limiting than this restriction.)
- Restrict passengers to a body size (including all required safety and survival equipment) commensurate with push-out window exit size on all offshore helicopter flights.

3.7.5.4 As regards the first point in paragraph 3.7.5.3, one oil company has already introduced this measure for the Super Puma/EC225, reducing the seating capacity from 19 to 14.

3.7.5.5 Regarding the second point in paragraph 3.7.5.3, in view of the currently accepted means of demonstration of compliance the claimed sea-keeping performance of any helicopter should be treated with caution. During earlier research (see CAA Paper 2005/06) helicopters tested in realistic sea conditions were found to capsize in sea state 4 to 5. A conservative approach would therefore be to downgrade the claimed sea-keeping performance of existing helicopters by one sea state unless or until evidence of testing equivalent to the new guidance proposed by the EASA RMT is presented and accepted. With reference to Appendix E1 of CAA Paper 2005/06, Table D1 below illustrates the likely impact of this restriction on North Sea operations in terms of all year average figures.

Table D1 Impact of Restricting Operations to Certificated Helicopter Ditching Performance

Operating Area	Helicopter Ditching Performance (Sea State)			
	3	4	5	6
	% Operations Lost			
Average all areas	61.8	27.7	8.55	1.4
Northern North Sea / West of Shetlands (avg. routes A & B*)	66.4	33.8	12.2	2.4
Mid North Sea (avg. routes C & D*)	55.0	19.8	4.3	0.4
Southern North Sea (avg. routes E & F*)	64.0	29.7	9.2	1.4

* See CAA Paper 2005/06, Appendix E1, Table 2.

3.7.5.6 On the third point in paragraph 3.7.5.3, there is no consistent or recognised standard across all helicopter operators. One operator allows the flight crew to make their own decision regarding whether to launch, but most rely on the declaration by the safety boat that there is a “good prospect of recovery” from the sea in the event of a ditching. This generally implies a significant wave height of less than 7 metres which equates to sea state 7. For sea states at the higher end of this range recovery would be reliant on use of the Dacon Scoop, a mechanical device that utilizes a net to ‘fish’ the survivor out of the water, which is not favoured by the flight crews.

3.7.5.7 On the fourth point in paragraph 3.7.5.3, Oil and Gas UK has commissioned a survey of offshore workforce body sizes at Robert Gordon University. The information that this exercise generates will be taken into account by the EASA RMT in reviewing the minimum dimensions of emergency exits.

3.7.6 Strategy for Improving Passenger Protection

3.7.6.1 The key measures that could be deployed in order to improve passenger safety and survival together with the scope of their effect and estimates of their relative cost and lead times are summarised in Table D2 below.

Table D2 Summary of Key Measures to Improve Passenger Protection

Measure		Scenario					Lead Time	Cost Impact
		Ditching		Water Impact		Rescue		
Ser.	Description	Prevent Capsize	Mitigate Capsize	Prevent Sinking	Mitigate Capsize			
(1)	Prohibit operations when sea conditions exceed certificated ditching performance	✓	x	x	x	✓	6 months	Med
(2)	Arming of EFS - procedural	x	x	(✓)	x	x	Now	Low
(3)	Arming of EFS - automatic	x	x	(✓)	x	x	1 – 2 years	Low/Med
(4)	Fit side-floating EFS	x	✓	(✓)	✓	x	3 – 5 years	Med/High
(5)	Allow only passenger seats adjacent to push-out window emergency exits to be occupied	x	✓	x	✓	x	Now	High
(6)	Require CAP 1034 Category 'A' (water impact) EBS	x	✓	x	✓	x	1 – 2 years	Med
(7)	Require CAP 1034 Category 'B' (ditching) EBS	x	✓	x	x	x	6 months	Low
(8)	Reduce escape time – exit location & operation	x	(✓)	x	(✓)	x	1 – 2 years	Low/Med
(9)	Reduce escape time – restrict passenger size	x	(✓)	x	(✓)	x	6 – 12 months	Low
(10)	Prohibit operations when sea conditions exceed sea state 6	x	x	x	x	✓	Now	Low
(11)	Improve post egress survival – life raft release and self righting life jacket/ immersion suit	x	x	x	x	✓	1 – 2 years	Low/Med

* Key: ✓ = effective, (✓) = partially effective, x = not effective.

3.7.6.2 The following features in Table 2 are highlighted:

- Only (1) will prevent capsizes and also addresses rescue and can be implemented in the short term at medium cost (due to loss of operations).
- (2) can be implemented immediately at low cost but is prone to human error and also only covers the arrival and departure.
- (3) will take longer and cost more than (2) but is more effective than (2) as it does not require any action from the flight crew and covers the whole of the flight.

- Together with (2) or (3), (4) will prevent sinking and, in addition, mitigates capsizing in both ditching and water impact scenarios. However, it is a medium to long term solution and medium/high cost.
- (5) mitigates capsizing in both ditching and water impact scenarios and can be implemented immediately but at higher cost than (4) or (6) due to loss of seating capacity.
- (6) mitigates capsizing in both ditching and water impact scenarios at lower cost than (5) or (4) but will take longer to implement.
- Although low cost and short term, (7) has limited effect; the EBS already deployed should meet CAP 1034 Category 'B', but it would need to be demonstrated and confirmed.
- Reducing escape time by (7) is highly desirable but the benefits are second order in comparison to (4), (5) and (6).
- (9) addresses a specific issue. The results of the Robert Gordon University study (see paragraph 3.7.5.7) will inform the extent of the problem and, hence, the benefit and impact of this measure.
- Although low cost and can be implemented immediately, (10) only addresses the rescue scenario.
- (11) improves the prospect of safe rescue by improving survivability while awaiting rescue.

3.7.6.3 Taking account of the foregoing and in view of the objective of both supporting the ongoing work of EASA RMT.0120 and providing interim solutions pending the EASA final decision in 2016, the following strategy has been determined:

- a) With effect from 01 June 2014, all offshore helicopter operations are to be prohibited when the sea conditions at the intended offshore location which the helicopter is operating to/from exceed sea state 6.
- b) With effect from 01 September 2014, operations are to be prohibited when the sea conditions at the intended offshore location which the helicopter is operating to/from exceed the certificated ditching performance of the helicopter. This measure will effectively supersede (a) above and will entail the helicopter operators establishing the realistic sea keeping performance of their aircraft types.
- c) With effect from 01 June 2014, helicopter operators' operating procedures will require the EFS to be armed for all overwater departures and arrivals.
- d) With effect from 01 June 2014, helicopter operators are to ensure that for all offshore helicopter operations only passenger seats adjacent to push-out window emergency exits are to be occupied. This restriction will not apply when either:
 - i. EBS meeting CAP 1034 Category 'A' performance specification is worn by all passengers; or
 - ii. side-floating EFS is fitted.
- e) With effect from 01 April 2016, helicopter operators are to ensure that for all offshore helicopter operations all occupants (passengers and crew) wear EBS that meets the CAP 1034 Category 'A' performance specification. This restriction will not apply when the helicopter is equipped with side-floating EFS.

- f) With effect from 01 April 2015, helicopter operators are to ensure that only passengers with a body size (including all required safety and survival equipment) commensurate with push-out window exit size are carried on offshore helicopter flights.
- 3.7.6.4 None of the restrictions in 3.7.6.3 above should apply to offshore helicopter flights conducted in direct response to an offshore emergency.
- 3.7.6.5 The timescales and associated rationale for the measures listed in 3.7.6.3 above are as follows:
- a) Prohibit offshore operations when sea conditions exceed sea state 6 (3.7.6.3 (a)) - this restriction can be implemented with a very short lead time; a modest period of notice is considered appropriate, however, in order to allow for any training and/or promulgation of procedures leading to an implementation date of 01 June 2014. The initial impact will be ameliorated to some extent by the calmer sea conditions during the summer months.
 - b) Prohibit offshore operations when sea conditions exceed the certificated sea keeping performance of the helicopter (3.7.6.3 (b)) – due time needs to be allowed for the helicopter operators to establish the realistic ditching performance of their helicopter types. That means either obtaining evidence of testing equivalent to the new guidance proposed by independent experts to the EASA RMT to support the claimed sea keeping performance, or downgrading the claimed sea keeping performance by one sea state. The implementation date of 01 September 2014 coincides with the onset of heavier sea conditions hence exposure during the interim period is limited.
 - c) Revise operating procedures to require the EFS to be armed for all overwater departures and arrivals (3.7.6.3 (c)) – this measure can be implemented with a very short lead time; a modest period of notice is considered appropriate, however, in order to allow for operations manuals to be updated and any required flight crew notices to be produced and issued, hence the implementation date of 01 June 2014.
 - d) Only passenger seats adjacent to push-out window emergency exits are to be occupied on all offshore helicopter operations (3.7.6.3 (d)) – this restriction can be implemented with a very short lead time; a modest period of notice is considered appropriate, however, in order to allow for schedules to be adjusted and any other provision/planning required to be instigated in order to mitigate the consequences. Since the side-floating helicopter scheme represents a medium to long lead time measure, this restriction can most expeditiously be removed by the deployment of CAP 1034 Category ‘A’ EBS. It is expected that Category ‘A’ EBS could be introduced within a period of one to two years.
 - e) Requiring the deployment of CAP 1034 Category ‘A’ EBS (3.7.6.3 (e)) – this will alleviate seating restrictions and provide all occupants with similar protection for underwater escape. Introducing the requirement from 01 April 2016, allows reasonable time for procurement, training and introduction. It is anticipated that those helicopter types most affected by the seating restrictions would introduce the requirement first in order to recover load capacity. The requirement may be relieved by the introduction of the side-floating scheme.
 - f) Restricting passengers to a body size (including all required safety and survival equipment) commensurate with push-out window exit size on all offshore helicopter flights (3.7.6.3 (f)) – this is considered to be a short lead

time measure although some notice will reasonably be required in order to establish an appropriate metric and associated limit, and to implement a scheme to measure the offshore workforce. It is anticipated that body size will form an additional requirement for qualification for working offshore. An implementation date of 01 April 2015 is therefore considered appropriate.

3.7.6.6 In addition to the measures listed in paragraph 3.7.6.3 above, the CAA will encourage Oil & Gas UK to require their contracting helicopter operators to implement the following key items from the EASA RMT.0120 (27 & 29.008) draft NPA:

- a) Fitment of the side-floating helicopter scheme.
- b) Implement automatic arming/disarming of Emergency Floatation Equipment.
- c) Install hand holds next to all push-out window emergency exits.
- d) Standardise push-out window emergency exit operation/marketing/lighting across all offshore helicopter types.
- e) Ensure that external life rafts can be released by survivors in the sea in all foreseeable helicopter floating attitudes.
- f) Ensure that all life jacket/immersion suit combinations are capable of self-righting.

3.8 Offshore Search and Rescue

3.8.1 UK Search and Rescue

3.8.1.1 The UK organisation for civil maritime and civil aviation search and rescue is derived from the UK Government's adherence to the Convention on the Law of the Sea (UNCLOS), the Convention on Safety of Life at Sea (SOLAS) (1974), the Maritime Search and Rescue Convention (1979) and the Convention on International Civil Aviation (Chicago 1944) (Annex 12).

3.8.1.2 The UK Government assumes responsibility for civilian maritime search and rescue, and delegates this responsibility to Her Majesty's Coastguard (HMCG) – part of the Maritime and Coastguard Agency (MCA). The MCA is an executive agency of the Department for Transport.

3.8.1.3 The MCA is responsible for developing, promoting and enforcing high standards of marine safety; minimising loss of life amongst seafarers and coastal users; responding to maritime emergencies 24 hours a day; and minimising the risk of pollution of the marine environment from ships and, where pollution occurs, minimising the impact on UK interests.

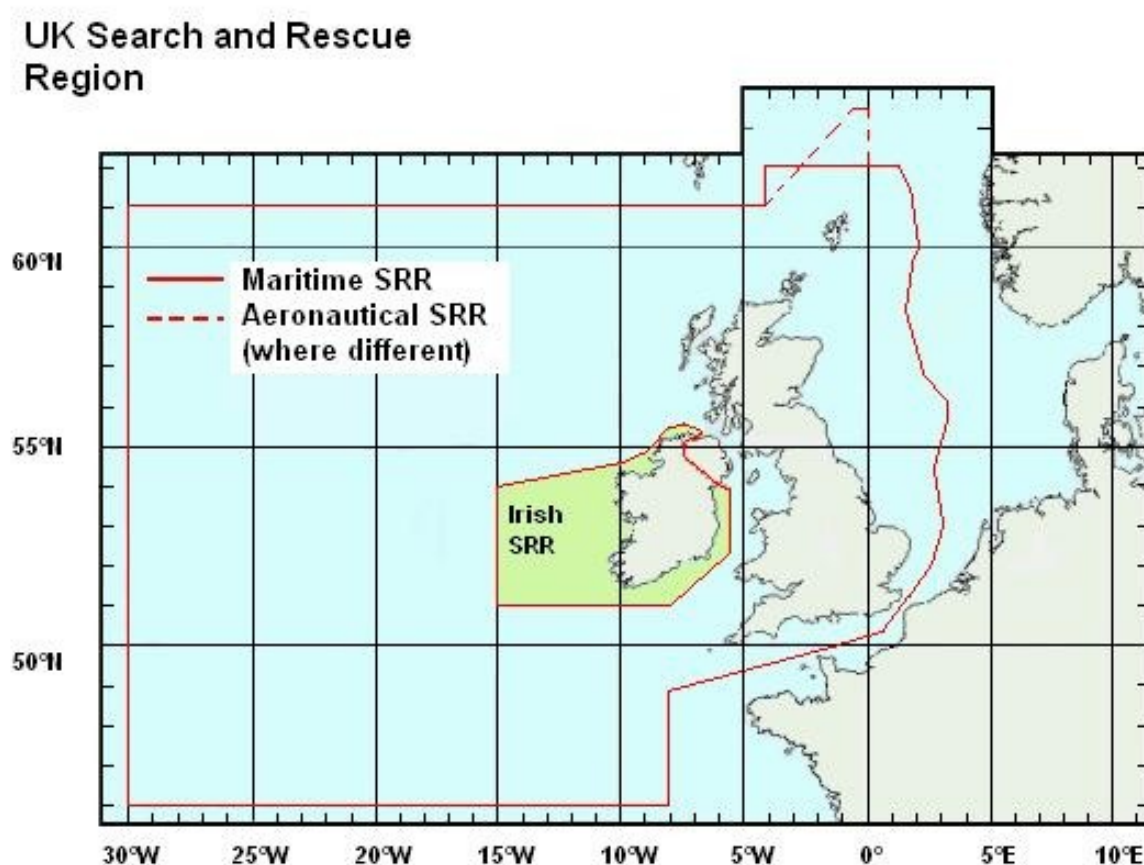
3.8.1.4 The MCA's response to emergencies is undertaken by HMCG which is the authority responsible for the initiation and co-ordination of civil maritime search and rescue within the United Kingdom Search and Rescue Region (UKSRR). This includes the mobilisation, organisation and tasking of adequate resources to respond to persons either in distress at sea, or those in inland waters, or to persons at risk of injury or death on the cliffs or shoreline of the United Kingdom.

3.8.1.5 The UK Search and Rescue region covers 1.25 million square nautical miles of sea and over 10.5 thousand nautical miles of coastline.

3.8.1.6 HMCG can call upon a wide variety of resources, known as declared assets, when coordinating Search and Rescue including:

- 362 HMCG Rescue Teams comprising 3,500 voluntary members.
- 12 SAR helicopters bases – six Royal Air Force (RAF) bases at RAF Valley, Royal Marines Base Chivenor, Wattisham Airfield, Normandy Barracks (Leconfield), RAF Boulmer, RAF Lossiemouth; four MCA bases at Lee on Solent, Portland, Stornoway and Sumburgh; and two Royal Navy (RN) bases at Royal Naval Air Station (RNAS) Culdrose and Gannet SAR Flight, Prestwick.
- 236 Royal National Lifeboat Institution (RNLI) bases operating over 340 lifeboats.
- Beach lifeguard units, police, ambulance and fire services, mountain and cave rescue teams and chemical incident response for vessels at sea.

Figure D1 UK Search and Rescue Region



3.8.1.7 Under the new UK SAR-Helicopter contract awarded by the DfT to Bristow Helicopters Ltd in March 2013 to commence in 2015, 22 helicopters will operate from ten bases.

- Ten Sikorsky S-92s will be based, two per site, at Stornoway and Sumburgh, and at new bases at Newquay, Caernarfon and Humberside airports.
- Ten AgustaWestland AW189s will operate, two per site, from Lee on Solent and a new hangar at Prestwick airport, and new bases which will be established at St Athan, Inverness and Manston airports.

- Plus one training AW189 at Inverness and one training S-92 at Stornoway.

3.8.1.8 Presently, approximately 70% of high and very high risk areas within the UKSRR are reachable by helicopter within 30 minutes. Under the new contract, approximately 85% of the same area would be reached within this timeframe.

3.8.1.9 To demonstrate the ability of the UK SAR system to respond to an offshore accident Appendix 3 to this Annex (Annex D) shows the declared SAR assets and non declared resources that attended the helicopter accidents during the period 27 December 2007 to 23 August 2013.

3.8.2 Health and Safety Executive

3.8.2.1 The Health and Safety Executive (HSE) is the national independent watchdog for work-related health, safety and illness. They are an independent regulator and act in the public interest to reduce work-related death and serious injury across Great Britain's workplaces.

3.8.2.2 The HSE's Energy Division (ED) is responsible for regulating the risks to health and safety arising from work activity in the offshore oil and gas industry on the UKCS.

3.8.2.3 The Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) Regulations 1995 sets out requirements for rescue and recovery under Regulation 17:

"The duty holder shall ensure that effective arrangements are made, which include such arrangements with suitable persons beyond the installation, for:

- a) recovery of persons following their evacuation or escape from the installation; and*
- b) rescue of persons near the installation; and*
- c) taking such persons to a place of safety,*

and for the purposes of this regulation arrangements shall be regarded as being effective if they secure a good prospect of those persons being recovered, rescued, and taken to a place of safety."

3.8.2.4 The Approved Code of Practice for the above regulation states that:

"Effective arrangements should be capable of securing a good prospect that persons evacuating or escaping from installations, or who fall overboard, or who are in a helicopter which ditches near the installation on landing or take-off are recovered and rescued and taken to a place of safety. Performance standards should be set to achieve this for weather and sea conditions likely to be encountered."

3.8.2.5 The Guidance to the above regulation states that:

"...a place of safety means an onshore or safe offshore location or vessel where medical treatment and other facilities for the care of survivors are available."

and:

“Effective arrangements must be made for recovery, rescue, etc., including arrangements with suitable persons beyond the installation. If the search and rescue facilities provided by the coastguard are liable to be stretched, for example at remote locations, the duty holder may need to provide in-field facilities. The consultations for the emergency response plan under regulation 8 should include this point. This regulation does not require a standby vessel at every attended installation. However a standby vessel may be the only effective means of compliance. The duty holder must provide effective arrangements for recovery, rescue and taking to a place of safety which secures a good prospect of achieving these objectives. The duty holder may not aggregate all risks as a basis for arguing for arrangements which do not provide a good prospect of survival.”

3.8.2.6 These arrangements are described in offshore installation’s Safety Cases and other supporting documentation and will cover things like the use of offshore helicopters (BP Jigsaw project), lifeboats, life rafts, standby vessels, emergency response and rescue vessels, fast rescue craft, daughter craft and Dacon Rescue Scoop.

3.8.2.7 Of the 30,000 offshore workers in the UK sector, roughly 12-14,000 are offshore at any one time during the summer and 10-12,000 during the winter.

NB: The Dacon Rescue Scoop is a controversial piece of equipment and it is recommended that this be investigated further outside of this review.

[Link to Statutory Instruments 1995 No. 743 The Offshore Installations \(Prevention of Fire and Explosion, and Emergency Response\) Regulations 1995](#)

[Link to the PFEER Regulations 1995 Approved Code of Practice and guidance](#)

3.8.3 Norwegian Search and Rescue

3.8.3.1 The Ministry of Justice and Police is responsible for the administrative coordination of Norway’s search and rescue services. Operational coordination of the rescue sub-centres is handled by the police districts. Ministerial responsibility for SAR is handled by the Rescue Service Unit in the Ministry’s Department of Civil Emergency and Rescue Planning.

3.8.3.2 Norway has a coastline of 28,953 km and its SAR Region covers Bodø Oceanic and Norway FIRs. SAR resources include:

- Air Force – 6 onshore bases with 12 twelve Sea Kings plus an AS332 L based at Svalbard, to be replaced by 16 AW101s by 2020.
- Oil Industry – one onshore and four offshore bases each with one EC225/AS332.
- Police.
- Medical institutions and ambulance service.
- National Air Ambulance Service.
- Municipal Fire Departments.
- Navy/Coast Guard.
- Army/Home Guard.

- Civil Defence.
- Airport Fire and Crash Rescue Service.
- Industrial Civil Defence.
- Offshore oil operators.
- The Norwegian Society for Sea Rescue.
- Civilian helicopter companies.
- Alpine Rescue Groups.
- The Norwegian Speleological Society.
- The Norwegian Aero Club.
- The Norwegian Red Cross.
- The Norwegian People's Aid.
- Norwegian Rescue Dogs.
- The Norwegian Radio Relay League.

3.8.3.3 In 2003 the UK HSE funded a [review](#) of the approach adopted in the Norwegian Sector for operating offshore based SAR helicopters and assessed significant differences between the Norwegian Continental Shelf Operations and the recommendations made for using onshore and Offshore Based Rescue and Recovery (OBRR) helicopters on the UKCS published by the HSE in 2001.

3.8.4 The Netherlands Search and Rescue

3.8.4.1 The Nederlandse Kustwacht (Netherlands Coastguard) is supported by assets provided by the Royal Netherlands Air Force, Defence Helicopter Command, Netherlands Oil and Gas Exploration and Production Association (NOGEP) and the Royal Netherlands Sea Rescue Organization (KNRM).

3.9 Safety and Survival Training

3.9.1 Currently, no passenger training other than the pre-flight video briefing is required under aviation requirements. The oil and gas industry, however, require personnel travelling on offshore helicopters to undertake and pass a course on offshore safety and survival which includes significant helicopter content. The form and format of the training is standardised across the UK oil and gas industry and is defined by the Offshore Petroleum Industry Training Organisation (OPITO).

3.9.2 Survivex is a major provider of this training and a meeting was held between CAA representatives and key Survivex staff members at their Aberdeen facilities. Taking due account of the Norwegian approach to safety and survival training, the main opportunities for improvement discussed were:

- Improving the fidelity of the training in respect of environmental factors such as wind, waves, precipitation, and lighting level.
- Improving the fidelity of the training in respect of including escapes through 'worst case' exits and cross-cabin escapes.
- Increasing the frequency of refresher training; this is presently every four years which is widely regarded as being inadequate.

- Including exposure of trainees to representative examples, in role and type, of real helicopters.

3.9.3 The report on the meeting is presented in Appendix 4 to Annex D.

4 Comparison with Norwegian Operations

For a comparison to be made, the Norwegian CAA was asked three questions relating to passenger protection.

4.1 Sea Survival Training

4.1.1. Do Norwegian passengers undergo realistic sea survival training, in the sea rather than in the dunker?

- The dunker training, which is not mandatory, is performed in controlled conditions in the pool. In addition use of the survival suit, boarding life rafts and preparing for survival is mandatory for all. This is normally performed outdoors, in the sea with the conditions that exist at the time. However, this is usually done inshore in sheltered conditions.
- The training requirement is: initial training and then every four years, based on a curriculum given in the OLG guidelines. Mutual recognition is practiced around the North Sea, provided it is done at an “OPITO” approved training centre.
- The Norwegian approach is similar to the UK except for the section of training performed outdoors. Although in relatively benign sea conditions, this is significantly better than using a pool environment and goes some way towards the improvement in the fidelity of training in the UK recommended (see Appendix 4 to Annex D).

4.2 Emergency Breathing Systems

4.2.1. What type EBS is used?

- Re-breather type EBS, training is performed initially and every four years.
- ‘Pure’ re-breather EBS is considered to be inferior to the ‘hybrid’ EBS deployed in the UK sector - see CAP 1034, Development of a Technical Standard for Emergency Breathing Systems.

4.3 Limiting Sea Conditions

4.3.1. Do operators apply any particular limits for wave height (or the oil companies)?

- There are wave height limitations if the SAR helicopter is not on readiness. 4.5 meters – maximum 7 meters is stated in OLF Recommended Guideline 064, depending on the capability of the standby vessel.
- But as far as it is understood, this not strictly adhered to as it may be evaluated from flight to flight.
- The limits applied in UK operations are equivalent to sea conditions of seven metres significant wave height and the decision is usually taken by the master of the safety boat at the destination. It is not known how many flights are cancelled due to excessive sea conditions in the UK.

5 Recommendations

5.1 Crash

- 5.1.1 It is recommended that the helicopter operators, acting together with or via the Helideck Certification Agency, should limit the frequency of flights to NUIs according to the fire-fighting facilities provided in line with Appendix D of CAP 437 – Standards for Offshore Helicopter Landing Areas.

5.2 Ditching/Water Impact

- 5.2.1 The CAA should apply an operational restriction prohibiting non-emergency offshore operations when the sea conditions exceed sea state 6, effective from 01 June 2014.
- 5.2.1 The CAA should apply an operational restriction prohibiting non-emergency offshore operations when the sea conditions exceed the certificated ditching performance of the helicopter, effective from 01 September 2014. Note that such a restriction will effectively also prevent operations when reasonable prospect of safe rescue cannot be assured.
- 5.2.3 Offshore helicopter operators should establish the ditching performance of their helicopter types in realistic sea conditions (i.e. irregular wave testing) and revise their operational limits accordingly.
- 5.2.4 The CAA should require helicopter operators' operating procedures to require the EFS to be armed for all overwater departures and arrivals, effective from 01 June 2014.
- 5.2.5 The CAA should mandate the provision of permanent wear Emergency Breathing Systems that meet the Category A specification detailed in CAP 1034 for all occupants (i.e. passengers and flight crew), within a commensurate time period (e.g. 2 years). This restriction will not apply when the helicopter is equipped with side-floating EFS.
- 5.2.6 The CAA should require that, effective from 01 June 2014, only passenger seats adjacent to push-out window emergency exits are to be occupied for all non-emergency offshore helicopter operations. This restriction will not apply when either:
- i. EBS meeting CAP 1034 Category 'A' performance specification is worn by all passengers; or
 - ii. side-floating EFS is fitted.
- 5.2.7 The CAA should prohibit the carriage of passengers with a body size (including all required safety and survival equipment) not commensurate with push-out window exit size for all non-emergency offshore helicopter operations, effective from 01 April 2015.
- 5.2.8 It is recommended that Oil & Gas UK require their contracting helicopter operators to implement the following key items from the EASA RMT.0120 (27 & 29.008) draft NPA:
- Retrofit of the side-floating helicopter scheme.
 - Implement automatic arming/disarming of EFS.
 - Install hand holds next to all push-out window emergency exits.

- Standardise push-out window emergency exit operation/marketing/lighting across all offshore helicopter types.
- Ensure that external life rafts can be released by survivors in the sea in all foreseeable helicopter floating attitudes.
- Ensure that all life jacket / immersion suit combinations are capable of self-righting.

5.2.9 The EASA Helicopter Ditching Occupant Survivability RMT should consider mandating safety and survival training for passengers.

5.2.10 OPITO should review and enhance its safety and survival training standards with regard to the fidelity and frequency of training provided.

5.3 Existing Ditching/Water Impact Provisions

5.3.1 Rotorcraft Flight Manuals (RFMs)

5.3.1.1 It is recommended that the three Type Certificate Holders (AgustaWestland, Eurocopter and Sikorsky) review and enhance the procedural information and guidance in their RFMs with regard to:

- The locations, markings and operation of emergency exits.
- Emergency evacuation procedures with special regard to post-ditching egress.

5.3.2 JAR-OPS 3 Subpart K Equipment Lists

5.3.2.1 It is recommended that the three approved helicopter operators conduct a review of their JAR-OPS 3 Subpart K equipment compliance checklists with a view to providing detailed information on the survival equipment installed and issued to passengers, including part numbers, to assist in determining that the actual equipment fitted and supplied to each type operated is approved as required by JAR-OPS 3.

5.3.3 Operations Manuals Part A and Part B

5.3.3.1 It is recommended that helicopter operators review the contents of their Operations Manuals and passenger safety cards in order to ensure the contents provide sufficient information and instructions to facilitate personnel in effecting evacuation or responding effectively to an in-flight emergency.

5.4 Offshore Search and Rescue

5.4.1 The search and rescue organisations and resources that cover offshore helicopter operations in and around the North Sea are dedicated, highly-capable people/entities who are world leaders in their field. No recommendations are made.

Appendix 1 to Annex D: Review of Compliance with Existing Ditching / Water Impact Requirements

This Appendix contains the results of a desktop review of airworthiness and operational compliance by the Rotorcraft Type Certificate Holders and Helicopter Operators. The review covered Rotorcraft Flight Manuals and AOC Holders' JAR-OPS 3 Subpart K Equipment Lists.

1 Rotorcraft Flight Manuals (RFMs)

1.1 Introduction

1.1.1 The RFMs for the AgustaWestland AW139, Eurocopter EC225 and Sikorsky S-92 were reviewed with specific regard to ditching procedures, and emergency exit configuration and information regarding location and operation.

1.2 AW139-RM-4D doc no. 139G0290X002

- Basic information is provided in Section 3 regarding the locations, markings and operation of the emergency exits.
- Little information could be ascertained regarding ditching evacuation procedures.

1.3 EC225 LP RFM dated 19/08/2013

- Basic information is provided in Section 3.1 regarding the location of the emergency exits and the emergency evacuation procedure.
- Little information is provided regarding ditching evacuation procedures.

1.4 S-92 RFM doc S92A-RFM-006 Rev. 13 dated 26/07/2012

- Part 1, Section III of the RFM provides information on the location and operation of the emergency exits. This Section also provides procedural information regarding ditching and post ditching evacuation.

2 AOC Holders' JAR-OPS 3 Subpart K Equipment Lists

2.1 A Cabin Safety equipment review was undertaken utilizing information supplied by CHC Scotia Helicopters, Bond Offshore Helicopters and Bristow Helicopters. The review was limited to a desktop assessment of declarations within the operator JAR-OPS 3 Subpart K and L compliance statements. The following paragraphs of JAR-OPS 3 Subpart K were reviewed:

- JAR-OPS 3.730 – Seats, Safety belts, harnesses and child restraint devices
- JAR-OPS 3.731 – Fasten seat belt and No Smoking signs
- JAR-OPS 3.745 – First Aid Kits
- JAR-OPS 3.775 – Supplemental Oxygen – non-pressurised helicopters
- JAR-OPS 3.790 – Hand fire extinguishers
- JAR-OPS 3.800 – Marking of Break-in points
- JAR-OPS 3.810 – Megaphones
- JAR-OPS 3.815 – Emergency Lightning
- JAR-OPS 3.825 – Lifejackets

- JAR-OPS 3.827 – Crew Survival Suits
- JAR-OPS 3.830 – Life Rafts and survival ELTs or extended overwater flights
- JAR-OPS 3.835 – Survival Equipment

2.2 The comments and results of the review are detailed below:

- i) Bond AS365 N3 Form TECH R063(a) Iss. 1, Rev. 5 dated 9/09
No Comment.
- ii) Bond AW139 Form TECH R063(b) Iss.1, Rev.6 dated Dec2010
No Comment.
- iii) Bond EC225 LP Form TECH R063 Iss 1, Rev 2 dated Jan 2008
No Comment.
- iv) Bond AS332 L2 Form TECH R027 Iss.1, Rev1 dated Aug 2005
No Comment.
- v) Bristow AS332 L Rev2
Survival equipment is declared but no specific part numbers are listed.
- vi) Bristow AW139 Initial Issue
Survival equipment is declared, apart from 3.827 which incorrectly states Crew survival suits are N/A, but no specific part numbers are listed.
- vii) Bristow EC155 B1 Revision 1
Survival equipment is declared but no specific part numbers are listed.
- viii) Bristow EC225 LP Initial Issue
Survival equipment is declared but no specific part numbers are listed.
- ix) Bristow S-76C++ Revision 4
Survival equipment is declared but no specific part numbers are listed.
- x) Bristow S-92 Revision 2
Survival equipment is declared, apart from 3.827 which incorrectly states Crew survival suits are N/A, but no specific part numbers are listed.
- xi) CHC Scotia AW139 dated 19/6/13
Survival equipment is declared but no specific part numbers are listed.
- xii) CHC Scotia S-92 Iss 1, Rev 0 dated 28 May 2013
Survival equipment is declared but no specific part numbers are listed.
- xiii) CHC Scotia EC225 LP Iss 1 Rev 0 dated 30 April 2010
Survival equipment is declared but no specific part numbers are listed.
- xiv) CHC Scotia AS332 L2 dated 14 Feb 2011
Survival suit part numbers not listed, otherwise no comment.
- xv) CHC Scotia AS332 L dated 29 May 2013
Survival suit part numbers not listed, otherwise no comment.

Appendix 2 to Annex D: EASA Helicopter Ditching and Survivability Rule Making Task RMT.0120 – Target Probability of Capsize

1 General

- 1.1 A rational approach to regulating helicopter ditching performance would be to set a target level of safety and use a risk assessment to determine the performance required. In the absence of anything better, it is proposed that the CS 27/29.1309 methodology be used for this exercise.

Note: This section addresses ditching/emergency floatation stability only and not the water entry case (ditching only). However, the appropriate sea conditions must be applied to water entry through consideration of the range of water surface angles that could be presented to a ditching helicopter on contact with the water.

2 Severity of Capsize¹

- 2.1 The severity of a capsiz e is established using the severity classifications of CS 27/29.1309 reproduced in Table 1 below.

Table 1 CS 27/29.1309 Severity Classification

Severity	Description
Catastrophic	Failure conditions which would result in multiple fatalities, usually with the loss of the aircraft.
Hazardous	Failure conditions which would reduce the capability of the aircraft or the ability of the crew to cope with adverse operating conditions to the extent that there would be: <ul style="list-style-type: none"> • a large reduction in safety margins or functional capabilities, • physical distress or excessive workload such that the flight crew cannot be relied upon to perform their task accurately or completely, or • serious or fatal injury to a relatively small number of the occupants other than the flight crew.
Major	Failure conditions which would reduce the capability of the aircraft or the ability of the crew to cope with adverse operating conditions to the extent that there would be, for example: <ul style="list-style-type: none"> • a significant reduction in safety margins or functional capabilities, • a significant increase in crew workload or in conditions impairing crew efficiency, or • discomfort to the flight crew, or • physical distress to passengers or cabin crew, possibly including injuries.

¹ Sea keeping performance corresponds to the ability to remain upright for a period of 5 minutes in the given wave climate, this being judged to be sufficient time to evacuate the helicopter.

Severity	Description
Minor	Failure conditions which would not significantly reduce aircraft safety, and which involve crew actions that are well within their capabilities. Minor failure conditions may include, for example: <ul style="list-style-type: none"> • slight reduction of safety margins or functional capabilities, • slight increase in crew workload, such as routine flight plan changes, or • some physical discomfort to passengers or cabin crew.
No Safety Effect	Failure conditions that would have no effect on safety; for example, Failure conditions would not affect the operational capability of the aircraft or increase crew workload.

- 2.2 The primary hazard in the event of capsizing is drowning. The cabin rapidly fills with water and the occupants must usually make an underwater escape, often in very difficult circumstances, e.g. disorientation due to the rotation of capsizing, poor visibility (underwater and sometimes at night), shock and panic. Even when equipped with immersion dry suits, breath hold times in typical sea water temperatures (and especially hostile areas such as the North Sea), are less than 20 seconds and can be as little as 6 seconds [1], limited primarily by the effects of cold shock. Evidence from escape trials in helicopter underwater escape trainers (HUETs) indicate escape times ranging from 27 to 92 seconds [1], the longer times corresponding to occupants in inboard seats who have to wait their turn to escape.
- 2.3 There is therefore a demonstrated and widely known and accepted mismatch between breath hold time and escape time for at least the middle seat occupants. Drowning can therefore reasonably be expected for at least a proportion of the occupants. This equates to a CS-27/29.1309 severity of HAZARDOUS, i.e. “serious or fatal injury to a relatively small number of the occupants other than the flight crew”.
- 2.4 The mismatch between breath hold time and escape time can be addressed by measures such as:
- a) the provision of Emergency Breathing Systems (EBS) which reduce the effects of cold shock and also provide an air supply to extend underwater survival time, or
 - b) side-floating Emergency Flotation Systems (EFS), which ensure that an air pocket is retained in the cabin, removing the time pressure to escape and also providing an above water escape path.
- 2.5 With the application of either or both of these measures, it is considered reasonable to assume that drowning can be largely avoided. It is acknowledged that a residual risk of drowning would remain, but this is considered to be small enough to ignore for the purposes of this exercise (a simplifying assumption). Capsizing with appropriate provisions would therefore equate to a CS-27/29 severity of MAJOR, i.e. “physical distress to passengers or cabin crew, possibly including injuries”.

2.6 In summary:

- A capsized **without** EBS or side-floating EFS = **HAZARDOUS**
- A capsized **with** EBS or side-floating EFS = **MAJOR**

3 Frequency of Capsize

3.1 If the target level of safety of CS-27/29.1309 is adopted, the maximum frequency of capsized allowed is obtained from the CS-27/29.1309 risk matrix presented in Table 2 below, using the corresponding event severity. Note that the trivial case of 'No Safety Effect' has been omitted for simplicity.

Table 2 CS-27/29.1309 Matrix

		Severity			
		Catastrophic	Hazardous	Major	Minor
Frequency	Probable	UNACCEPTABLE	UNACCEPTABLE	UNACCEPTABLE	UNACCEPTABLE
	Remote	UNACCEPTABLE	UNACCEPTABLE	ACCEPTABLE	ACCEPTABLE
	Extremely Remote	UNACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE
	Extremely Improbable	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE

3.2 For the case of capsized **under current standards** (i.e. HAZARDOUS), the maximum frequency should be no worse than Extremely Remote.

3.3 For the case of capsized **with enhanced standards** (i.e. MAJOR), the maximum frequency should be no worse than Remote.

3.4 Frequencies are quantified in CS-27/29.1309 as shown in Table 3 below.

Table 3 CS 27/29.1309 Probability Classification

Frequency Category	Qualitative Description	Quantitative Description
PROBABLE	Anticipated to occur one or more times during the entire operational life of each rotorcraft.	Failure condition frequency is more than 10^{-5} per aircraft flight hour.
REMOTE	Unlikely to occur to each rotorcraft during its total operational life but which may occur several times when considering the total operational life of a number of rotorcraft of the type.	Failure condition frequency is between 10^{-7} and 10^{-5} per aircraft flight hour.

Frequency Category	Qualitative Description	Quantitative Description
EXTREMELY REMOTE	Not anticipated to occur to each rotorcraft during its total life but which may occur several times when considering the total operational life of all rotorcraft of the type.	Failure condition frequency is between 10^{-9} and 10^{-7} per aircraft flight hour.
EXTREMELY IMPROBABLE	So unlikely that they are not anticipated to occur during the entire operational life of all rotorcraft of one type.	Failure condition frequency is less than 10^{-9} per aircraft flight hour.

3.5 Thus, the target frequencies are:

- For capsizes **without** EBS or side-floating EFS = **between 10^{-9} and 10^{-7}** per flight hour.
- For capsizes **with** EBS or side-floating EFS = **between 10^{-7} and 10^{-5}** per flight hour.

4 Sea Keeping Performance

4.1 The frequency of capsizing (F_C) is the product of the frequency of ditching (F_D) and the probability of encountering sea conditions severe enough to capsize the helicopter (P_{SS}), i.e. $F_C = F_D \times P_{SS}$. The latter term is a function of the sea keeping performance of the helicopter and the wave climate over which it is operating.

4.2 The frequency of ditching may be estimated from historical data. In the period 1976 to 2012 there have been 12 ditchings during the 3.5 million (approximately) flight hours flown (see Table 5 at end). This gives:

Frequency of ditching = 3.4×10^{-6} per flight hour.

4.3 The maximum probability of ditching in sea conditions severe enough to capsize the helicopter may then be obtained by dividing the frequency of capsizing by the frequency of ditching, i.e. $P_{SS} = F_C / F_D$. This means that the probabilities of encountering sea conditions severe enough to capsize the helicopter should be:

- **Without** EBS or side-floating EFS = between **0.029%** and **2.9%**.
- A capsizes **with** EBS or side-floating EFS = between **2.9%** and **29%**.

4.4 Making the simplifying assumption that a helicopter will capsize (probability = 1) if ditched in sea conditions exceeding its certified limit, and will not capsize (probability = 0) if ditched in sea conditions within its certified limit, and that the certified limit of a helicopter may be defined in terms of a single sea state², the

² Note that "sea state" represents a rather imprecise definition of sea conditions and is used here for illustrative purposes only. In practice, it will be necessary to define appropriate spectra for 'hostile' and 'non-hostile' operating areas and then use the corresponding wave climate scatter tables to select appropriate significant wave height and zero crossing periods that, added together, have a probability of exceedance of 0.029%, 2.9% or 29% as appropriate. It is suggested that the JONSWAP spectrum would be an appropriate choice for 'hostile' sea areas; a suitable candidate for 'non-hostile' sea areas will need to be identified.

probability of encountering sea conditions severe enough to capsize the helicopter is then simply the probability of the sea conditions in the intended area of operation exceeding the certified limit.

4.5 It has been agreed that, for the purposes of ditching certification, two definitions of 'probable sea conditions' be adopted:

- **Hostile** sea areas already defined by [2] as north of 45°N and south of 45°S.
- **Non-hostile** sea areas already defined by [2], as between 45°N and 45°S.

4.6 Given that the overwhelming majority of European offshore helicopter operations take place in the North Sea, it is considered appropriate to adopt the North Sea wave climate for the **hostile** environment. Based on the data presented in [3] (Table 2 in Appendix E1), the probabilities of exceeding the range of sea states is presented in Table 4 below.

Table 4 Probabilities of Exceeding Sea States in the North Sea

Probability of exceeding sea state (%)	Sea State Code and Upper Significant Wave Height Limit				
	3	4	5	6	7
	1.25 m	2.5 m	4 m	6 m	9 m
Average all year and all six routes	61.8	27.7	8.55	1.4	0.07
Maximum all year and all six routes	90.6	65.3	30.9	6.9	0.6

4.7 Using the average values, the ditching limits needed to achieve the CS 27/29.1309 target level of safety in **hostile** sea areas are:

- Without EBS or side-floating EFS = ideally > sea state 7 (0.029%), but no lower than sea state 6 (2.9%).
- A capsize **with** EBS or side-floating EFS = **ideally sea state 6** (2.9%), but **no lower than sea state 4** (29%).

4.8 If it is accepted that a sea state 6/7 ditching capability will be impractical to achieve, it follows that Category B EBS or side-floating EFS will be required to achieve an acceptable level of safety for the ditching case. Category A EBS or side-floating EFS will, in any event, be required if the survivable water impact case is to be addressed, hence it appears that the way forward should be to mandate Category A EBS or side-floating EFS.

4.9 When considering the upper and lower limits for the case with EBS or side-floating EFS, it should be borne in mind that the sea states quoted are based on all year all North Sea area averages. The upper limit of sea state 6 (at least) would be required to be met to cover worst case conditions (i.e. northern North Sea during the winter months), or else operations would need to be prohibited when the sea conditions exceeded the certificated ditching performance.

4.10 A similar exercise will need to be performed for non-hostile sea areas; it is suggested that the Gulf of Mexico wave climate be used as the definition for the **non-hostile** environment.

5 Discussion

- 5.1 Wave tank testing experience suggests that most helicopters are capable of achieving sea state 4 to 5 with present EFS, and that sea state 5 to 6 is feasible with the addition of float scoops. Sea state 7 is considered to be impractical. It is therefore suggested that, in order to meet the CS27/29.1309 target level of safety, it will be necessary to address the consequences of capsize in some way or to restrict the operation through a FM limitation.
- 5.2 EBS is currently deployed voluntarily for the majority of European offshore operations. With reference to [4], this equipment is likely to meet Category B of the proposed technical standard and therefore be suitable for mitigating the ditching scenario. Retrospective application of this element is therefore likely to be practical and cost effective, although EBS would need to be mandated and the proposed technical standard of [4] developed into a formal standard, i.e. a European Technical Standard Order (ETSO).
- 5.3 Note that consideration is also being given to addressing survivable water impacts. Immediate capsize and/or sinking occurs in almost all water impacts, and accounts for all of the drownings in North Sea operations. The measures currently available to mitigate survivable water impacts include side-floating EFS (for floatation system redundancy and to mitigate capsize) and EBS (only to mitigate capsize). For EBS, a Category A system would be required (capable of rapid underwater deployment); currently deployed EBS are unlikely to be suitable. Mitigation of survivable water impacts will therefore also address the post ditching capsize scenario.

6 Conclusions

- 6.1 CS 27/29.1309 has been used together with UK offshore ditching statistics to form a rational basis for setting target probabilities of capsize for the North Sea wave climate, i.e. the proposed definition for **hostile** sea areas. A similar exercise needs to be conducted for a representative **non-hostile** sea area, e.g. the Gulf of Mexico.
- 6.2 The analysis has demonstrated the need to address the consequences of capsize to meet the CS 27/29.1309 target level of safety. With effective measures in place, helicopters operating over hostile sea areas should ideally be capable of withstanding **sea state 6**. As a minimum, this should apply to all new helicopter certifications. Operation of helicopters should be limited to sea conditions within their certificated ditching performance. Note that to take credit, the currently deployed EBS (expected to meet the requirements for Category B) would need to be mandated, i.e. assessed against a formal specification and approved. Note, however, that Category A EBS is required to mitigate the consequences of survivable water impacts.

7 References

- [1] CAA Paper 2003/13 – Preliminary Study of the Implementation and Use of Emergency Breathing Systems, UK CAA, London, 24 October 2003.
- [2] EASA Ops: Annex I 'Definitions for terms used in Annexes II-VIII'.
- [3] CAA Paper 2005/06 – Summary Report on Helicopter Ditching and Crashworthiness Research, UK CAA, London, December 2005.

- [4] CAP 1034 – Development of a Technical Standard for Helicopter Emergency Breathing Systems, UK CAA, London, May 2013.

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21 January 2014

Table 5 Ditchings

The following ditchings have occurred in UK offshore operations during the period 1976 to end 2012 when the UK CAA Mandatory Occurrence Reporting scheme has been in operation.

Aircraft Reg. No.	Date	UK AAIB Report/Bulletin Ref.
G-ATSC	08/03/1976	11/76
G-BBHN	01/10/1977	8/78
G-BEID	31/07/1980	14/80
G-ASNL	11/03/1983	4/85
G-BISO	02/05/1984	5/87
G-BKFN	15/05/1986	9/87
G-BEID	13/07/1988	3/90
G-BDES	10/11/1988	1/90
G-TIGK	19/01/1995	2/97
G-JSAR	21/11/2006	Dutch AIB investigation
G-REDW	10/05/2012	S2/2012
G-CHCN	22/10/2012	S6/2012

Appendix 3 to Annex D: EASA Helicopter Ditching and Survivability Rule Making Task RMT.0120 – Terms of Reference



European Aviation Safety Agency

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TERMS OF REFERENCE

Task Nr:	RMT.0120 (27&29.008)
Issue:	1
Date:	xx Month 2012
Regulatory reference:	CS 27.801, CS 27.1411, CS 27.1415, AC 27-1B Change 3 CS 29.801, CS 29.1411, CS 29.1415, AC 29-2C Change 3
Reference documents:	(1) JAA Water Impact, Ditching Design and Crashworthiness Working Group (WIDDCWG) report (2) JAA Helicopter Off-shore Safety & Survivability (HOSS) report (HOSS/WP-99/8.5) (3) UK-CAA Review of Helicopter Offshore Safety & Survivability (CAP641)

1. Subject: Ditching Occupant Survivability

2. Problem/statement of the issue and justification; reason for regulatory evolution (regulatory tasks):

Experience has shown that water impact events can lead to loss of life. Even a successful ditching or emergency landing on water by a helicopter can still lead to catastrophic consequences due to the propensity for a helicopter to capsize. Enhanced design standards are therefore proposed to both reduce the likelihood of capsize and to further enhance the ability of occupants to escape and survive.

3. Objective:

This task is aimed at enhancing post ditching and water impact standards that could significantly enhance occupant escape and survivability. It will consider the recommendations made by the JAA Water Impact, Ditching Design and Crashworthiness Working Group (WIDDCWG) and the Helicopter Offshore Safety and Survival (HOSS) working group.

4. Specific tasks and interface issues (Deliverables):

1. Review accepted definitions of 'Ditching', 'Emergency landing on water' and 'Water impact' and determine, based on experience from previous accidents and incidents, whether there is an identified safety need to amend or expand the regulatory scope.
2. Review JAA WIDDCWG and HOSS Working Group Report recommendations and other relevant papers relating to water impact, ditching design and survivability.
3. Assess whether the current interpretation of CS 27/29.801(d) to demonstrate floatation stability in reasonably probable water conditions as being SS4 should be amended to address a broader consideration of regional climatic sea conditions. Consideration should be given to different operating environments, the need to align with operational rules, different categories of rotorcraft and the possibility of multiple standards. Consider the definition of reasonably probable water conditions in terms of

RMT.0120 (27&29.008)

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significant wave height, zero crossing period and wave spectrum (WIDDCWG Recommendations 2.1 & 2.2/HOSS Proposal 2.2.1).

4. Review the acceptable means of demonstration of compliance in terms of regular vs. irregular wave testing (WIDDCWG Recommendation 2.4/HOSS Proposal 2.2.2).
5. Identify regulatory changes that could enhance crashworthiness of emergency flotation systems, both in ditching and water impact events. For example, by minimising/avoiding float damage, by providing float redundancy, and by improved design of activation and gas distribution systems.
6. Review novel solutions, including the side-floating helicopter emergency flotation scheme, as a means of mitigating the risk of post ditching capsize, and as a means of improving emergency flotation system crashworthiness in respect of water impacts (WIDDCWG Recommendation 3.1/HOSS Proposal 2.5.2).
7. Develop appropriate rule change proposals for the following:
 - Automatic activation of flotation system (WIDDCWG Recommendation 1.2/HOSS Proposal 2.5.1). The flotation system should be automatically activated (either primary or secondary means) upon sensing water immersion.
 - Flotation System Arming/Disarming (WIDDCWG Recommendation 1.3/HOSS Proposal 2.5.1). During any flight over water, the possibility of the automatic float activation feature being disabled, e.g. deactivation of the system, should be minimised.
 - Use of fuel jettison (WIDDCWG Recommendation 2.5). Fuel jettison aspects should be removed from regulations.
8. Consider the economic and technical viability of external life raft deployment with the rotorcraft in any probable attitude (WIDDCWG Recommendation 3.3/HOSS Proposal 2.3).
9. Review existing ETSO standards for life raft (ETSO-2C70a and ETSO-2C505) and how to mandate their fitment and protection from damage when installed (HOSS Proposal 2.3).
10. Review emergency exit design, ease of operation and the possible standardisation of opening procedures.
11. Develop appropriate rule change proposals regarding push-out windows, having regard for the need to clarify:
 - minimum practical dimensions for suitable escape openings (considering passengers wearing survival suits);
 - the provision of handles or other aids to facilitate the pushing out of windows;
 - the non-acceptability of seating restrictions imposed either because of passenger size, physical abilities or the prescribed need to align seat rows with windows;
 - an appropriate standard of marking and lighting having regard to the status of the opening being only for underwater escape;
 - the justification for requiring push-out windows in small cabins if crew and passenger doors are jettisonable.(WIDDCWG Recommendation 3.2/HOSS Proposal 2.4.1)
12. Review CAA Paper 2003/13 and draft specification for an EBS, and determine if its content and maturity is suitable for development of an ETSO standard. Consider requiring EBS to enhance occupant escape and survivability (HOSS Proposal 2.4.2.2).
13. Based on accident and incident data, identify issues related to ELT/PLB installation and functioning that have resulted in poor in-service experience. (This task is linked

RMT.0120 (27&29.008)

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to Rulemaking Task RMT.0274, which will consider broader issues relating to ELT installation and functioning and aims to provide consistent regulation across all CSs.)

14. Draft rulemaking text applicable to CS-27, CS-29 and CS-ETSO together with revised AC 27-1 and AC 29-2 Guidance Material based on the reviews accomplished. Where applicable, recommend changes to other regulatory documents.
15. Consider the need for retroactive application in CS-26 of any of the rule changes being proposed.
16. Draft an NPA to propose the rulemaking changes, including a RIA.

5. Working methods (in addition to the applicable Agency procedures):

Group

6. Time scale, milestones:

NPA: March 2014
Decision: March 2015
CRD: March 2015

Appendix 4 to Annex D: SAR Assets Utilized During Offshore Helicopter Accidents (2006 – 2013)

1 Nomenclature

FRC	=	Fast Rescue Craft
DC	=	Daughter Craft
ARRC	=	Autonomous Rescue and Recovery Craft
FV	=	Fishing Vessel
OSV	=	Offshore Support Vessel (oil and gas industry)
RNLI	=	Royal National Lifeboat Institution

2 AS355N, G-BLUN, 27 December 2006, Morecambe Bay

Incident 29932.

ARCC informed at 1836z by Liverpool Coastguard.

Search Coordinated by Liverpool Coastguard.

Assets Tasked:

Aircraft:

- Rescue 122 (RAF Sea King, RAF Valley) – two sorties
- Rescue 128 (RAF Sea King, Leconfield) – one sortie
- Rescue 177 (RN Sea King, HMS Gannet, Prestwick Airport) – one sortie

Surface Vessels:

- RNLI Lifeboat Barrow
- RNLI Lifeboat Fleetwood
- RNLI Lifeboat Lytham St Annes
- Highland Sprite (OSV)
- Grampian Supporter (OSV)
- Clywd Supporter (OSV)

3 EC225, G-REDU, 18 February 2009, ETAP

Incident 40310.

ARCC informed at 1824z by Aberdeen Coastguard.

Search Coordinated by Aberdeen Coastguard.

Assets Tasked:

Aircraft:

- Rescue 137 (RAF Sea King, RAF Lossiemouth) – one sortie
- Rescue Bond 1 (Bond Super Puma operated by BP JIGSAW, Millar Platform, N Sea) – one sortie

- Rescue 51 (RAF Nimrod MR2, RAF Kinloss) – one sortie

Surface Vessels:

- Caledonian Victory (OSV)
- ARRC 01 – launched from Caledonian Victory
- ARRC 02 – launched from Caledonian Victory
- Grampian Cavalier (OSV)
- Grampian Pride (OSV)
- Grampian Prince (OSV)
- Maersk Fighter (OSV)
- Highland Pride (OSV)

4 AS332 L2, G-REDL, 01 April 2009, off Peterhead

Incident 40803.

ARCC informed at 1257z by Aberdeen ATC.

Search Coordinated by Aberdeen Coastguard.

Assets Tasked:

Aircraft:

- Rescue 137 (RAF Sea King, RAF Lossiemouth) – one sortie
- Rescue Bond 1 (Bond Super Puma operated by BP JIGSAW, Millar Platform, N Sea) – two sorties
- Rescue 131 (RAF Sea King, RAF Boulmer) – one sortie

Surface Vessels:

- RNLI Lifeboat Peterhead
- RNLI Lifeboat Fraserburgh
- Normand Aurora + FRC (OSV)
- Caledonian Victory + ARRC (OSV)
- Maersk Chaser (OSV)
- North Fortune (OSV)
- Ocean Swan + DC (OSV)
- VOS Lismore (OSV)
- Maersk Finder (OSV)
- FV Vertrauen
- FV Maggie Ann
- + 6 other vessels involved in subsequent search.

5 EC225, G-REDW, 10 May 2012, off Aberdeen

Incident 56694.

ARCC informed at 1110z by Scottish Distress and Diversion Cell.

Search Coordinated by Aberdeen Coastguard.

Assets Tasked:**Aircraft:**

- Rescue 131 (RAF Sea King, RAF Boulmer) – one sortie
- Rescue Bond 1 (Bond Super Puma operated by BP JIGSAW, Millar Platform, N Sea) – two sorties
- Rescue 102 (HMCG S-92, Sumburgh) – two sorties

Surface Vessels:

- RNLI Lifeboat Aberdeen
- RNLI Lifeboat Peterhead
- Fugro Searcher (OSV)
- Siem Garnet (OSV)
- Safmarine Andisa (OSV)
- Siem Amethyst (OSV)
- Seven Pelican (OSV)
- REM Supporter (OSV)
- Seabed Worker (OSV)

6 EC225, G-CHCN, 22 October 2012, Fair Isle Channel

Incident 59543.

ARCC informed at 1419z by Scottish Distress and Diversion Cell.

Search Coordinated by Shetland Coastguard.

Assets Tasked:**Aircraft:**

- Rescue 137 (RAF Sea King, RAF Lossiemouth) – one sortie
- Rescue 100 (HMCG S-92, Stornoway) – one sortie
- Rescue Bond 2 (Bond Super Puma operated by BP JIGSAW, Sumburgh) – one sortie

Surface Vessels:

- Nord Nightingale (Tanker) + FRC
- RNLI Lifeboat Kirkwall
- RNLI Lifeboat Lerwick
- RNLI Lifeboat Aith
- HM Coastguard ETV Herakles

7 AS332 L2, G-WNSB, 23 August 2013, off Sumburgh

Incident 64097.

ARCC informed at 1727z by Police Scotland, Inverness.

Search Coordinated by Shetland Coastguard.

Assets Tasked:**Aircraft:**

- Rescue 102 (HMCG S-92, Sumburgh) – one sortie
- Rescue Bond 2 (Bond Super Puma operated by BP JIGSAW, Sumburgh) – one sortie
- Rescue Bond 1 (Bond Super Puma operated by BP JIGSAW, Millar Platform, N Sea) – one sortie
- Rescue 137 (RAF Sea King, RAF Lossiemouth) – one sortie

Surface Vessels:

- RNLI Lifeboat Aith
- RNLI Lifeboat Lerwick
- Sumburgh Airport Fire & Rescue Boat, HIAL.
- Hirta (Marine Scotland)
- Hjaltland (Northlink Ferries)
- Helliar (Northlink Ferries)
- Gerda Seale (live fish carrier)
- MHM Coastguard ETV Herakles
- Bibby Polaris (OSV)

Appendix 5 to Annex D: Role of Survivex – Summary of Interview with Training Staff

1 Background to Survivex Offshore Training courses

- 1.1 Survivex deliver a wide range of courses from their own training facilities in Aberdeen, at client premises, national and international and from an offshore installation. Where possible training courses carry industry recognised accreditations. Training conducted at Survivex premises in Aberdeen includes OPITO approved Offshore Survival Training, including Basic Offshore Survival Induction and Emergency Training (BOSIET), Further Offshore Emergency Training (FOET) and both stand-alone and integrated Helicopter Underwater Escape Training (HUET) with Emergency Breathing Systems (EBS). In addition the company offers Fire Training, Helicopter Operations Training including Helicopter Refuelling, OPITO approved Helideck Landing Officer initial training and Helideck Assistant training. Radio courses address CAA Aeronautical VHF Radio Operator training and Short Range Radio Certificate.
- 1.2 Survivex is one of two specialist training providers based at Aberdeen which includes Falck Nutech. Petans are based at Norwich airport and provides a range of similar courses at a convenient location for personnel based in the southern North Sea.

2 Interview with Training Staff – Katrina Smith, Survival Team Leader, Mike Gowans, Skills Training Team Leader and Andrew Green, Director

2.1 Introduction

- 2.1.1 An interview was arranged between CAA inspector Captain Mike McDougall and the Survivex MD, George Green. Kevin Payne and Mike McDougall visited Survivex premises at Aberdeen airport on the morning of Wednesday 23 October 2013. During a 90-minute interview the following salient points were discussed:

2.2 Fidelity of Training

- 2.2.1 Survivex is keen for offshore survival / underwater escape training given to be more representative of the operating environment. Some suggestions to improve realism of training included the use of an environmental tank with simulated waves, precipitation, dimmed lighting and realistic training that enables occupants of a ditched helicopter to negotiate a life raft in higher sea state conditions. Note that the minimum pool temperature for UK training details is 22°Celsius.
- 2.2.2 OPITO approved Underwater Escape Training requires negotiating (exiting) a standard size hatch window set up in a generic helicopter. Candidates are not trained in the worse case small window found in the most limiting type. Note that training is not helicopter type specific.
- 2.2.3 It is evident that in Norway part of the sea survival training is still performed in the open sea (in a Fjord), and part of the training is completed in a swimming pool environment. Norwegians have to re-right a marine life raft rather than an aviation life raft. Norwegian HUET is completed in the swimming pool environment.

2.2.4 The current HUET provides no element of surprise. A maximum of 4 delegates are seated in a helicopter mock-up where everyone has immediate access to a window exit. This is unrepresentative of the real life situation where the issues of cross cabin escape and occupation of seats not adjacent to an exit can significantly affect speed and ease of underwater escape.

2.2.5 Helicopter Underwater Escape Training is not related to a particular helicopter type but uses an unrepresentative (generic) helicopter with push-out windows that are unrepresentatively easy to operate (e.g. there is no rip strip used in any of the windows used for training). Survivex opinion is that type specific helicopter training would be very difficult to achieve. Realistic training is best satisfied by paying attention to type specific safety briefing (DVD) material.

2.3 Duration, Content and Frequency of Training

2.3.1 BOSIET in Norway is a 5-day course. In the UK it is only 2.5 days. Norwegians spend one whole day on H&S culture and spend further additional time on fire-fighting and first aid. They also practise drills on a rescue slide as part of the Norwegian course which the UK version of the course does not include.

2.3.2 OPITO approved standards are generally developed with little or no input from the training providers. It is noted that "OPITO is an industry owned not-for-profit organisation that exists solely to service the needs of the oil and gas industry. OPITO is employer led in all aspects of what it does..."

2.3.3 The 4-year periodicity of basic offshore survival training (BOSIET/FOET) was questioned by Survivex training staff. The general consensus is that FOET should occur every 2 years rather than every 4 years.

2.4 Other Issues

2.4.1 Survivex reports evidence that helicopter operators are being proactive in passing on good practice to the training providers, e.g. Bond Offshore Helicopters recently forwarded the new brace position to them.

2.4.2 Survivex representatives could see the benefit of trainees viewing an actual helicopter (role and type) as part of their initial induction and recurrent training.

2.4.3 Survivex opinion was that UK should not be using Short Term Air Supply System (STASS) on helicopters. It was pointed out that STASS comes under the diving at work regulations and there are minimum periods prescribed after use in training before a user is permitted to fly. No-fly periods are dependent on the medical condition of the individual, e.g. an asthma sufferer would have to avoid flying for a protracted period.

2.4.4 Survivex was unable to confirm how many candidates fail the training but the number was understood to be not insignificant. The greatest proportion of failures is attributed to those who, for one reason or another, refused to complete the training.

3 Recommendation for improvements in offshore survival training (BOSIET/FOET/HUET and EBS)

3.1 It is recommended that:

- Offshore survival / underwater escape training should be made more realistic e.g. wind, waves, water temperature, dimmed lighting.

- During training sorties escape should be required through representative 'worst case' exits/ window.
- HUET training should consider aspects of cross-cabin evacuation and simulate escape from centre aisle seating.
- During training candidates should be exposed to real life (representative) helicopters – in role and type.
- The periodicity of survival training should be reviewed such that Further Offshore Survival Training becomes more frequent than every four years.
- If the CAA undertakes the certification of all helidecks, a review of the OPITO standards should be undertaken for the elements of survival training, fire training, radio courses and helideck operations.

Annex E Operations

1 Helidecks

1.1 Role of the UK Health and Safety Executive

1.1.1 Background to the UK Health and Safety Executive Involvement in Offshore Safety

1.1.1.1 In April 1991 the Health and Safety Commission (HSC) and the Health and Safety Executive (HSE) took over from the Department of Energy the responsibility for offshore safety regulation. The Offshore Safety Act 1992, implementing the Cullen recommendations following the Piper Alpha disaster in 1988, transferred power to the HSE on a statutory footing. Since April 1991 the HSE has introduced four sets of modern major accident hazard goal-setting regulations which contain provisions relating to helideck safety on offshore installations. These update and replace the old prescriptive legislation with the provisions as follows:

- The Offshore Installation (Safety Case) Regulations 2005 (SCR) SI 2005/3117
- The Offshore Installation (Prevention of Fire and Explosion and Emergency Response) Regulations 1995 (PFEER) SI 1995/743
- The Offshore Installations and Pipeline Works (Management and Administration) Regulations 1995 (MAR) SI 1995/738
- The Offshore Installation and Wells (Design and Construction, etc) Regulations 1996 (DCR) SI 1996/913

1.1.1.2 The scope of HSE goal setting regulations and their interface with CAA Standards for Offshore Helicopter Landing Areas on installations* is described in more detail in CAP 437, Chapter 1.

*Note: the HSE has no regulatory oversight of helicopter landing areas located on non-installations, i.e. vessels.

1.1.1.3 A Memorandum of Understanding between the Civil Aviation Authority Safety Regulation Group (CAA/SRG) and the HSE establishes a framework of liaison between the two regulators to ensure effective co-ordination of policy issues, enforcement activity and investigation in terms of the interfaces of CAA/SRG and HSE responsibilities for safety in relation to aircraft and systems. Annex 4 addressing Offshore Installations covers the interface between the HSE and the CAA in relation to helicopter operations on and in the vicinity of offshore installations, now including energy structures such as offshore wind turbines. Annex 4 states that the HSE and the CAA will co-operate on any matters of relevance to the responsibilities of the organisations including regular liaison between contacts to ensure matters of mutual interest are discussed in a timely fashion and to participate in the Helicopter Liaison Group (HLG) of the Health and Safety Executive's Offshore Industry Advisory Committee (OIAC).

1.1.1.4 The OIAC – Helicopter Liaison Group is a sub-committee of OIAC. Its role is to act as a liaison forum to advise the OIAC on safety policy matters associated with those aspects of the provision and operation of helicopter facilities at offshore installations, which are subject to the Health and Safety at Work etc 1974 Act and PFEER by monitoring progress to improve safety and, by encouraging the joint

participation of representative organisations, to take actions to improve safety. Chaired by the HSE, the group also includes members from the CAA, the Helideck Certification Agency (HCA), the British Rig Owners Association (BROA)/ International Association of Drilling Contractors (IADC), British Airline Pilots Association (BALPA), the offshore unions, Oil & Gas UK, the British Helicopter Association (BHA) and International Marine Contractors Association. A decision is currently pending with the HSE as to the future of the group; whether or not it continues to perform a unique and specific role among the other offshore aviation forums (HSSG, ASTG, and HSRMC etc.) and therefore should be maintained as a stand-alone forum in its own right. The other option on the table is for the sub-committee to be disbanded and subject matter relegated to a standing item at the main OIAC.

Post-interview note: It has been decided by the HSE that the HLG will continue for at least two further meetings but now renamed the Helideck Liaison Group. Revised terms of reference are currently under discussion with the members.

1.1.2 Interview with James Munro, Operations Manager, HID – Energy Division Offshore at Lord Cullen House, Aberdeen

1.1.2.1 An interview was arranged with Mr James Munro with the assistance of Mr Tim Williams, SARG's Health, Safety and Environmental Advisor. Captain Mike McDougall and Mr Kevin Payne attended Lord Cullen House HSE's Aberdeen HQ on Tuesday 22 October 2013 and spent about 75 minutes with HID Operations Manager. Prior to the meeting a series of questions had been forwarded to James Munro. The CAA inspectors used the interview questions as an aide-memoire to deliver an effective interview within the limited timeframe available.

1.1.2.2 The points raised by Captain McDougall and Mr Payne included, but were not limited to, the following issues:

- g) What would the HSE's view be were the CAA to propose certificating/licensing helidecks in the North Sea?
- h) How would this impact on personnel assigned to the helideck operation (e.g. Helideck Landing Officers (HLO), Helideck Assistants (HDA), helideck fire crews etc)?
- i) How does the HSE view the current definition/concept for a Normally Unattended Installation (NUI)? Does it need to be refined/improved?
- j) How does the HSE view the current Memorandum of Understanding, Annex 4 Offshore Operations between the HSE and CAA/SRG?
- k) Does the HSE hold a position on the appropriateness, or otherwise, of offshore helicopter survival training being given to the offshore workforce?
- l) How does the HSE view its own role in the regulation of the helicopter transportation functions? Does the HSE still hold a helicopter specialisation and is it comfortable with its role?
- m) How does the HSE regard the CAA's "CAP 437: Standards for Offshore Helicopter Landing Areas" particularly in the context of the HSE's suite of goal-setting legislation?

- n) How robust are Platform Safety Cases in their treatment of aviation risks and in particular in assessing the impact of the installation and its processes on the safety of helicopter operations?

1.1.2.3 The following represents a summary of responses from the HSE:

- a) The HSE would have no objections in principle to the CAA seeking to certificate/license helidecks on offshore installations – it's logical for one regulator (the CAA) to have control of the whole journey: for the entire flight from airside at a (licensed) onshore heliport all the way through to disembarkation at the offshore helideck. The HSE would not wish to deploy any of its resources to achieve this goal.
- b) If helidecks are to be certificated (or licensed) it follows this will include oversight of the personnel who run the helideck operation 'airside', i.e. HLO, HDAs and radio operator. Currently, HLO's procedures and plant for helideck operations including take-off and landing are required by offshore safety law in the Management and Administration Regulations (MAR) 1995 Regulation 13.
- c) In offshore safety law, there is no legal difference between an NUI or an installation that has people on it permanently. There is no legal definition of an NUI; the HSE recognises that developing manning practices dictate NUIs are no longer being operated 'normally unattended'. The HSE agrees the modus operandi including frequency of visits to NUIs and the length of time they are being 'manned up' has increased significantly over the last 20 years plus.
- d) The HSE is keen to revisit the Offshore SRG/HSE MoU. The HSE does not necessarily agree for example that it is the place of the HSE to regulate the occupational health and safety of workers in transit.
- e) Survival training – the HSE has no expertise on which to offer an official opinion on the quality and appropriateness of offshore survival training. The HSE does not consider itself as having expertise in helicopter/aviation matters. These areas are viewed to be out-with the HSE's jurisdiction.
- f) By referencing CAP 437 in HSE goal setting requirements (e.g. PFEERs) and in Annex 4 to the MoU, CAP 437 is regarded by the HSE as the accepted helideck standard for installation duty holders. It was emphasised that the HSE considers "Goal setting regulations are prescriptive in process but not prescriptive in outcome". However, compliance with goal setting legislation is often demonstrated by showing that arrangements meet a relevant industry code or standard where it is appropriate for the hazard. So as an example of how goal setting regulations blend with prescriptive requirements: Fire events on the helideck are regarded in HSE legislation as reasonably foreseeable events which need to be addressed, in risk terms by taking appropriate measures with a view to protecting persons on the installation from fire and explosion and securing effective emergency response. CAP 437 (Chapter 5) is regarded as the means of compliance. This may require further demonstration to comply with PFEER Regulations 4 and 5.
- g) Safety cases tend to have very little content about aviation risks except where these impinge on the safety of the platform. Safety cases are assessed by the HSE without redress to the CAA.

1.1.3 Expert Judgement on Regulatory Interfaces

1.1.3.1 Mr Payne has been the FOI(H) section gateway for liaison with the HSE in matters pertaining to Annex 4 since 2001, and before this assisted in the process back to the early-mid 1990s. Based on historical interfaces it is evident that regular liaison between the HSE and the CAA has become less frequent in recent years to a point that the primary vehicle for liaison is now the twice-yearly OIAC - HLG. However, the HSE is currently considering the future of the HLG – whether it will continue as a stand-alone group or be absorbed into the main OIAC forum with helicopter issues relegated to a standing ‘item’ on the main OIAC agenda.

Post-drafting note: It has been decided by the HSE that the HLG will continue for at least two further meetings but now renamed the Helideck Liaison Group. Revised terms of reference are currently under discussion with the members.

1.1.3.2 Notwithstanding the decision on the ultimate future direction of the HLG, it is evident that the HSE sees its role primarily in terms of regulating the provision of suitable arrangements to establish a safe operating environment for helicopters on installations. This is achieved through demonstration in an installation’s safety case that arrangements are in place to comply with specific PFEER and MAR regulations along with CAP 437. The HSE has no jurisdiction over the occupational health and safety of workers in transit (currently included under the HSE’s role in the MoU Annex 4).

1.1.3.3 The environment would appear to be ripe for the CAA to consider further regulatory authority in areas which either have belonged within the bailiwick of the HSE and/or have been within the domain of both regulators. In particular the interface at the helideck where both regulators have held assumed authority; so in future, the helideck, were it to be licensed (or certificated) would fall solely within the regulatory domain of the CAA. At present the Air Navigation Order (ANO) 2009 Article 208 (3) requires an aerodrome licence to be issued for helicopter operations only for a flight which is a scheduled journey for the purpose of the public transport of passengers. Historically flights in support of offshore oil and gas exploration have been classed as non-scheduled and so have fallen outside the requirement to use a licensed aerodrome. However, there is scope to interpret the ANO more literally or to re-word relevant articles so that helidecks (and onshore heliports that service oil and gas scheduled journeys) are captured within the licensing/certification scope. If the CAA were to propose this, it is likely that the HSE would have no objections in principle. The mechanics of a licensing/certificating regime are discussed in more detail in the narrative relating to the Helideck Certification Agency (HCA).

1.1.3.4 Any licensing/certificating arrangement would need to consider also the training and competency of helideck personnel who include the Helideck Landing Officer (the HLO), the Helideck Assistants (the HDAs/fire guards) and the Radio Operator (RO). At present the (separated) training requirements of HLOs and HDAs come under the auspices of the Offshore Petroleum Industry Training Organisation (OPITO). OPITO is an industry owned not-for-profit organisation that exists solely to service the needs of the oil and gas industry and its employer led in all aspects of what it does; therefore all standards development activities are at the behest of industry employers. This arrangement should be reviewed.

1.1.3.5 The issue of what constitutes a Normally Unattended Installation (NUI) has become a bit of a hot potato in recent years, with a shift in manning policies which has led in many cases to NUIs being manned up more frequently, and for

longer periods, particularly compared with 20 years ago, when the definition for an NUI was last substantially amended. The situation came to a head over the issue of whether or not, given current manning practices, an NUI should be permitted to accept safety systems that are less stringent than they would be if the platform was classified as “permanently manned”. The detail as to whether a particular platform is classed as “manned” or as “normally unattended” is described in the platform safety case. The CAA has no input into the safety case assessment for a platform which is assessed by the HSE (although during one revision of Annex 4 of the MoU between the HSE and SRG an option for the CAA to review aviation aspects of a platform safety case was added; however, the ‘privilege’ was never invoked and has since been rescinded in the latest version of Annex 4 to the MoU - February 2013). In offshore safety law, there is no legal difference between an NUI and an installation that has people on it permanently; so there is no legal definition of an NUI. The HSE has insisted the design notifications for new installations that may fall in to the category of an NUI meet CAP 437 Chapter 5. That is that new NUIs will have semi-automated or automatic fire-fighting systems for their helidecks. This approach has been taken since the publication of the 6th edition of CAP 437 (December 2008).

- 1.1.3.6 In regard to the number of helicopter movements to a platform, this has led to situations where the number of annual movements to a “normally unattended” installation has exceeded (sometimes significantly) the number of movements annually to a “permanently manned” installation. Simply on the basis of exposure to risk due to the number of movements to a helideck, it is counter-intuitive (and not defensible) that a platform classed as a (high intensity) NUI should be permitted to provide safety systems which are less effective than, and inferior to, those that are routinely provided for a manned platform. An example is cited in the automated or semi-automated fire-fighting systems prescribed by CAP 437, Chapter 5. Historically these have always been implemented on fixed manned platforms, on Mobile Offshore Drilling Units (MODU) and on vessels, but not on NUIs; where a ‘dispensation’ from the early 1990s has allowed NUIs to provide only limited fire-fighting equipment (e.g. a set of extinguishers) to mitigate risks whose outcome is similar in likelihood and severity. So for a reasonably foreseeable event such as a worst case helicopter “crash and burn”, a situation has arisen where the barrier employed as an effective recovery measure for a foreseeable incident or accident is weaker and less effective for an NUI than it is for a manned installation, MODU or vessel.
- 1.1.3.7 In consequence, a comparison of helideck fire-fighting safety systems implemented on NUI versus those prescribed for fixed manned platforms (PMI) and for manned MODUs and vessels has concluded that the limited static equipment provided for NUIs is inadequate to address a reasonably foreseeable worst case ‘crash and burn’ scenario on an NUI helideck.
- 1.1.3.8 Following a series of meetings and communications between the CAA, the HCA, the HSE, the offshore helicopter operators and representatives from the Oil and Gas industry, the CAA issued a letter to industry dated 1 July 2011 that required 116 named NUIs to upgrade their existing fire-fighting arrangements to implement systems for the automatic and efficient delivery of foam capable of discharging at high rates of application and for durations that are effective in addressing a fire situation arising from a worst case ‘crash and burn’ incident. Depending on whether an NUI is categorised as “higher intensity” or as “standard intensity” (terms defined within the letter itself), offshore duty holders are given 3 years or 6 years in which to implement safety improvements. To date the industry has resisted taking any positive compliance action against the CAA letter

(reproduced in CAP 437 at Appendix D) and with only a few months to run until the first cut-off for compliance, for those NUIs classed in the higher intensity bracket, it seems unlikely industry will be able to implement required upgrades within the timeframe (even if there is a desire to do so). This is an example of where a CAA safety edict has apparently fallen on deaf ears with the oil industry and, in the absence of compliance, and without the leverage afforded by a certificating regime, the options to impose sanctions on helidecks that are non-compliant after 1 July 2014 are limited; one option would be to restrict helicopter operations by means of the operators Offshore Approval granted to each by CAA FOI(H). If helidecks are certificated it will be easier to exact compliance with CAP 437, since a condition of the licence/certificate would be to fit fire-fighting systems that comply with CAP 437, Appendix D or face invalidating the certificate. It would also by-pass the commercial pressures that can come into play under the current inspection and certification regime.

- 1.1.3.9 It is evident for this issue that, supported by the goal-setting requirements of the HSE PFEERs, with their endorsement of the prescriptive requirements of CAP 437, and if helidecks are to be certificated, there is good support from the HSE's suite of goal setting regulations to enable the application of CAP 437 minimum standards for the certification of offshore helidecks.
- 1.1.3.10 A post-crash fire is a major hazard for offshore helideck operations and as a reasonably foreseeable event needs to be appropriately mitigated. Major fires with the consequential loss of the helicopter have occurred on offshore helidecks outside the UKCS. Figure E1 below shows a crash and burn incident on the Temena E platform in the South China Sea which occurred in 1985. The helicopter pictured is the remains of a Puma 330J.

Figure E1 Remains of Puma 330J on Temena E Platform



1.1.4 Considerations Resulting from the Interview with the HSE

- a) HSE endorsement should be sought for an initiative to certificate all offshore helidecks in the UK sector ('installations' which come under the HSE's jurisdiction, as well as non-installations which do not).
- b) In connection with (a), the CAA should engage with OPITO to encourage a review to enhance the training standards for helideck personnel, e.g. HLOs, HDAs and ROs.
- c) Offshore survival training for passengers should be reviewed with the objective of making training programmes more realistic to the offshore environment. The review should include input from the offshore workforce and the offshore unions to ensure the realism of training programmes are balanced against the health and safety needs of the offshore workforce and their perceptions of the helicopter transportation risks.
- d) The CAA should engage with the HSE and the Oil industry to ensure that the acronyms, definitions and terminology used (e.g. NUI, PMI) for platform manning policies and procedures are commensurate with the risks posed to the helicopter operation.

The helideck and associated considerations will be addressed within the actions and recommendations of Sections D and E of the main report. The survivability recommendations are covered within Annex D, Passenger Protection.

1.2 The Helideck Certification Agency (HCA)

1.2.1 Background to Helideck Certification Agency involvement in offshore helideck inspections

- 1.2.1.1 The function of the Helideck Certification Agency (HCA) is to carry out periodic inspections of offshore helidecks on behalf of the UK offshore helicopter operators. As helidecks are unlicensed in the UK (they are not regarded as supporting scheduled journeys for the purpose of public transport of passengers – see Air Navigation Order 2009 Article 208 (3)), the Procedure for Authorising Offshore Helicopter Landing Areas on the UKCS relies solely on Article 96 of the Air Navigation Order 2009 which requires a public transport helicopter operator to reasonably satisfy himself that every place he intends to take-off or land is suitable for purpose. The HCA procedure is established through a memorandum of understanding between the UK offshore helicopter operators, that each will accept inspection reports and certification completed on their behalf by the HCA (the HCA procedure is described in more detail in CAP 437, Appendix F).
- 1.2.1.2 The Helideck Certification Agency started out life as the British Helicopter Advisory Board (BHAB) Helideck Sub-Committee in the early-mid 1990s (formed as an offshoot of the BHAB Offshore Sub-committee). In 2001 the name was changed to BHAB Helidecks with offices in Aberdeen and Norwich. In August 2005 a limited company was formed called the Helideck Certification Agency with offices retained in Norwich and Aberdeen. However, HCA was able to offer an expanded portfolio of services including inspection and certification of helidecks on installations and vessels not located in the North Sea, a helideck friction testing service, elements of dangerous goods and refuelling (included on an expanded Helideck Inspection Report – HIR) and on-site helideck crew training. For the assessment of non-routine matters including the formation and promulgation of non-compliances, the HCA relies on the technical input from senior pilots representing the offshore helicopter operators. Meetings of the HCA Helideck Steering Committee (HCA HSC) are held every three months rotating

between northern and southern North Sea bases. CAA inspectors attend all the meetings.

1.2.1.3 The Helideck Certification Agency is wholly-owned by two of the helicopter operators, Bristow and CHC, but functions to provide a helideck inspection and certification service, and to promote a level playing field, for the benefit of all the UK based helicopter operators (this includes several foreign registered operators who operate in the UK sector with the approval of Department for Transport DfT e.g. Dancopter and NHV). HCA performs, in effect, as a third-party contractor to the offshore helicopter operators and is audited on a rolling audit programme by the QA functions within the offshore helicopter operators. The CAA also assumes a role to periodically audit the processes and procedures of HCA. Though not a legal requirement to do so, the HCA publishes an Operations Manual which sets out their structures, responsibilities, qualifications, Notices of Agreed Procedures (NAPs) and documents their Quality System. It is noted that, from 2009, the HCA has had an operational presence in Norway with an office in Stavanger accommodating several Norwegian HCA helideck inspectors. The HCA chairs Helideck Steering Group meetings at 3-monthly intervals also in Norway.

1.2.1.4 All HCA certificated helidecks are promulgated in a document called the Helideck Limitations List (HLL) – which is available to everyone who wishes to access the information at www.helidecks.org. Part D of the HLL lists each individual helideck, by region, and records any non-compliance against CAP 437 (the baseline document used by HCA for all helideck inspections serviced by UK G-registration helicopters). As a consequence of any non-compliance, the limitations for each helideck are promulgated in the HLL (note: routine limitations are set by the HCA, while more complex limitations are afforded due process with the HCA HSC which meets quarterly). The following numbers of approved helidecks are listed in the HLL, by region, as follows:

<u>UK Northern North Sea:</u>	90 helidecks (8 normally unattended)
<u>UK West:</u>	19 helidecks (12 NUI, 3 renewable energy support helidecks)
<u>UK Southern North Sea:</u>	119 helidecks (98 NUI, 5 renewable energy support helidecks)
<u>Total number of helidecks (excluding all mobiles):</u>	<u>228 helidecks</u>

1.2.1.5 The above helidecks are located almost exclusively on fixed manned platforms and on NUIs. However, the HCA also certificates helicopter landing areas on mobile offshore installations (e.g. MODUs such as semi-submersibles and jack-up units) and vessels (e.g. diving support vessels, seismic research vessels etc). A section of the HLL (Part D) lists “Mobiles” recording more than 400 helicopter specific landing areas. It is understood, however, that the majority of the listed mobiles are not, and have not been, operated in the UKCS. The General Manager of the HCA estimates that between 50 and 100 mobiles can be operating in the North Sea at any one time.

1.2.1.6 Other sections of the HLL (Part D) address Norway, Australia, Brazil, Angola, Azerbaijan, Ghana and the Rest of the World. The General Manager acknowledges that the HLL needs to be reviewed with a view to re-apportioning some mobiles which do not necessarily appear in the area in which they primarily operate.

1.1.1 Interview with Alex Knight, General Manager HCA, Pete Garland (Senior Inspector NNS) and Graham Wildman (Senior Inspector SNS)

1.2.2.1 Captain Mike McDougall and Mr Kevin Payne attended HCA offices in Aberdeen on Monday 21 October 2013. Prior to the visit Mr Payne had issued a set of questions and discussion starters to Mr Alex Knight. The purpose of this Section is to draw out just the salient points from a whole day interview. The points raised with summary of responses from the HCA are:

- a) What does the HCA perceive as the top 5 risks related to helideck operations?
 - 1) Pilot training needs to be improved on the interpretation of helideck criteria including obstacle protected surfaces and helideck markings. The HCA has conducted training in the past for line trainers and senior pilots etc. but the average line pilot is not well educated in these matters and often does not understand how to interpret standard markings or to ensure the helideck is being maintained 'fit for purpose', e.g. obstacle protected surfaces are being kept clear at all times.
 - 2) Offshore refuelling. Quarterly reports are being issued by the three refuelling operators (Swire, Harran and Gordon Engineering) to the helicopter operators but there is no recognised OPITO approved refuelling course – only one person has to be 'qualified'. Basic housekeeping rules are not always being followed, e.g. refuelling hose is left out on the helideck creating an obstruction.
 - 3) Proximity of wind turbine platforms to oil and gas installation helidecks. In some instances Wind Turbine Generators (WTGs) are being sited to within half a mile of helidecks and this is a safety issue with unauthorised obstacles being within 1,000 m of a platform helideck etc. There appear to be no strong controls in place to prevent such occurrences.
 - 4) Introduction of new helicopter types. Acceptance of larger/heavier helicopters onto helidecks designed for smaller and lighter aircraft is a concern.
 - 5) Helideck Crew training – HLO trained every two years but no longer in the operational environment (now in a Ford Transit van in a field). HLOs and HDAs are required to multi-task these days. Why do HDAs have a separate course to HLOs in the UK? In Norway everyone does the HLO course regardless of their rank/role.
- b) How does the HCA assess its own safety performance (i.e. can it be satisfied that standards are improving in the North Sea)?
 - The HCA believes it is an improving situation but purely quantitative analysis (a graph of recorded non-compliances against an inspection time-line, if it were available) may not present a true reflection of the improving situation since with each new edition of CAP 437 new issues of non-compliance are generated against the latest 'current' best practice, which the HCA is then required to assess against (the scope of the HIR is periodically amended).
- c) In the HCA's opinion what advantages, if any, would licensing helidecks bring?
 - The HCA is positive in support of any initiative that might be taken to license helidecks in the UKCS (the HCA sees itself as being in a strong

position to deliver a helideck inspection and certification service on the UK sector).

- d) To strength the enforcement role of the HCA, would it consider being established as an accredited entity by EASA or working under the authority of the regulator, e.g. approval/accreditation 'on behalf of' CAA International or the UK CAA?
- The HCA is open to an accreditation process by EASA. The HCA would also be comfortable to return to negotiations with CAA International (which might have a wider connotation than merely certification of UKCS helidecks).
- e) Since taking on the inspection and certification process more than 15 years ago what initiatives has the HCA taken to improve operational safety and/or to extend the scope of its primary functions?
- The introduction of the six-monthly helideck checklist has improved compliance and focused offshore duty-holders on their responsibilities to maintain their landing areas 'fit for purpose'. The enforcement of three temporary certificates (and no more) has sharpened the focus for offshore duty holders who are now much more appreciative of the importance of a rectification programme to ensure a continuation of helicopter operators.
- f) How much effort is being expended by the HCA on helidecks which are not located in (and not initially bound for) the UK sector of the North Sea?
- The UK sector is still the 'bread and butter' for the HCA but the overseas inspection effort is not insignificant particularly in the Far East. Inspections are always conducted against CAP 437 even though most new-build helidecks are not bound (initially at least) for the North Sea.

Note: Subsequent to the interview it is understood that the owners of HCA have entered into negotiations for the company to be sold on.

1.1.2 Expert Judgement on HCA Interfaces

The following is a commentary on the HCA's top five safety concerns:

- 1.1.2.1 Pilot Training Deficient for Interpretation of Markings and Helideck Obstruction Criteria (Obstacle Limitation Surfaces)
- 1.2.3.1.1 This safety concern does not come as an entirely new revelation in that it supports the findings of an informal PPrune 'markings quiz' conducted several years previously for the pilot workforce. In regard to markings, and in particular the interpretation and use of the touchdown markings (i.e. the yellow circle), both CAP 437 and Annex 14 of the Convention on International Civil Aviation (Volume II) have been amplified in recent years to emphasise that only when the pilot lands correctly with his seat over the marking is the whole of the undercarriage within the landing area and all parts of the helicopter clear of any obstacles by a safe margin. By the same token a landing that is made without proper redress to the touchdown/positioning marking circle will quickly erode the safe margin between the helicopter and the obstacle environment and could potentially lead to an obstacle strike; especially where obstacles are at a minimum permitted safe distance from the touchdown location.
- 1.2.3.1.2 The issue of obstacles sited on the edge of the obstacle free sector (OFS) was highlighted by a recent serious incident involving an S-92 G-IACE - whilst landing on the oil rig Northern Producer in the northern North Sea on 10 September 2012

the helicopter struck a whip aerial sited on the edge of the 210° obstacle free sector.

- 1.2.3.1.3 The issue of helideck markings is also of concern for operations to Normally Unattended Installations (NUIs) predominantly located in the southern North Sea where the presence of bird activity at platforms which are often unattended for long periods has led to many cases of essential helideck markings being obscured by bird guano. In the past the industry has experimented with various bird control measures, but with, at best, only limited success. The CAA has repeatedly asked oil and gas companies to refresh the study commissioned more than 20 years ago by the HSE looking at the issue of effective bird control measures and the problems of birds habituating to the systems employed; but to date the oil and gas industry has been reticent to invest further expense in time and effort for a problem that has so far been unsolvable. To date the issue has been managed by the helicopter operators who, on a per visit basis, operate a system of visual assessment of markings and grade any deterioration on a scale of 1-10. If a certain level of deterioration is reached, daylight only operations are permitted. When markings become substantially obscured, helicopter operations to that helideck are prohibited except to permit a non-revenue flight for the purpose of cleaning the helideck. Such is the population of birds along offshore migratory routes that it is not uncommon for markings to become obscured within a very short period of time (perhaps 24-48 hours) and deck cleaning operations have to be immediately instigated. Contamination by bird guano not only obscures markings but significantly reduces the friction properties of the surface (a minimum coefficient of friction is prescribed by CAP 437 to ensure a helicopter does not tip or slide when landed on a helideck), and poses a risk to the occupational health of personnel working on, or locating to or from, a guano infested helideck (e.g. guano 'dust' is inhaled into the lungs and/or is trodden into the helicopter). Guano is also highly corrosive and so there is the threat of corrosion to safety critical equipment such as static fire-fighting extinguishers, where these are not robustly protected from the elements.
- 1.2.3.1.4 It is worth noting for the future, if the industry is unable to find practical, long lasting solutions to the problems of bird guano on helidecks, as well as markings being obscured, there is the possibility that the performance of new helideck "H" and "circle" lighting systems will be diminished, or in extreme cases rendered ineffective due to the presence of bird guano on the helideck surface marking and lighting.
- 1.2.3.1.5 To the author's knowledge there are no known incidents of birds striking a helicopter whilst landing at a helideck. However, this remains a reasonably foreseeable event for landing and take-off as well as the en-route flight phase.
- 1.1.2.2 Helicopter Refuelling – Training and General Housekeeping
- 1.2.3.2.1 Although CAP 437 addresses the subject in a high level of detail – in Chapter 7 "Helicopter Fuelling Facilities – Systems Design and Construction" and in Chapter 8 "Helicopter Fuelling Facilities – Maintenance and Fuelling Procedures" these sections are not within the sole editorial control of the CAA but are prepared for the CAA by Oil & Gas UK in consultation with the UK offshore oil and gas industry and with specialist fuelling companies (the CAA's technical expertise on the subject is limited to technical specialists in Aerodrome Standards Department). However, the HCA's concerns have more to do with the training and practical housekeeping elements of the refuelling operation rather than with there being any perceived deficiencies in the best practice guidance material. As has already been highlighted in the background to the HCA section, the HCA has

taken more interest in the refuelling operation in recent years and in training *in situ* of the helideck operational teams. They are therefore well placed to comment on a process that involves helideck crews, refuelling service providers (Harran, Swires and Gordon Engineering) as well as offshore helicopter operators – refuelling operations are covered as part of the Helideck Inspection Report (HIR). The comment on training is noted with interest – a review of Survivex training modules has confirmed that an offshore refuelling course is offered to the industry; however, it would appear that this is not an ‘OPITO approved’ course. The safety implications of a helicopter receiving contaminated fuel are obvious and it could be an aspiration of the CAA to review the procedures and processes for the offshore refuelling operation. This would naturally form part of a certification programme for helidecks.

1.1.2.3 Proximity of Offshore Renewable Wind Turbine to Oil and Gas Installations

1.2.3.3.1 The issue is addressed at a policy level in CAP 764 CAA Policy and Guidelines on Wind Turbines (5th Edition, June 2013). Chapter 3 Safeguarding Considerations, Section 3.24 addresses consultation zones around offshore helidecks and emphasises the importance of operators and developers taking into consideration all existing and planned obstacles around offshore helicopter destinations that might impact on the safe operation of associated low visibility approaches in poor weather conditions. To help achieve a safe operating environment a 9 NM radius consultation zone is established around an offshore development which is designed to act as a trigger for consultation with offshore helicopter operators, the operators of existing installations and exploration and development locations to determine a solution that maintains safe offshore helicopter operations alongside the proposed development.

1.2.3.3.2 Whilst the safeguarding guidance in Chapter 3 of CAP 764 is laudable and robust, it is not understood how it can be legally enforced when the installations and proposed developments in question are very often located outside UK territorial waters, in international open sea areas. Based on the interview with the HCA it would appear that renewable energy companies who have been granted a licence by government to develop a wind farm in an open sea area are often failing to consult adequately with the oil and gas energy sector with the consequence that wind farms are being proposed and sited well within the 9 NM radius consultation zone. The only legal protection an oil and gas installation has is the establishment of the 500 m exclusion zone (the HSE’s remit) around a platform which must not be infringed. This offers no firm assurances for the helicopter operator who needs a volume of obstacle-free airspace around the installation helideck within which a low visibility approach and missed-approach can be flown safely. Such approaches have to allow for an acceptable pilot workload, a controlled rate of descent, one engine inoperative performance and obstacle clearance. If fixed obstacles, such as wind turbine generators in an offshore wind farm, are located within the 9 NM consultation zone the regularity of helicopters being able to complete a low visibility approach profile may be impinged upon.

1.2.3.3.3 From the perspective of helicopter operations lifting from the helideck (the object of main focus for the HCA) the obstacle free sector is required to extend through 210 degrees out to a distance from the periphery of the landing area that will allow for an unobstructed departure path appropriate to the helicopter the helideck is intended to serve (CAP 437, Chapter 3, Section 6.2). This can present an operational problem if another fixed structure is located within 1,000 m of an installation helideck; in some cases it might present difficulties for a helicopter lifting and taking off from the helideck when the wind is in a certain sector.

1.2.3.3.4 With an expected proliferation in the development of renewable energy wind turbine farms, particularly from the present up to 2020, it is recommended to revisit this issue and ensure at least that there are robust and enforceable consultation processes in place between major stakeholders including offshore helicopter operators.

1.1.2.4 Introduction of New Helicopter Types- Acceptance of Larger/Heavier Helicopters onto Helidecks Designed for Smaller and Lighter Aircraft

1.2.3.4.1 Within the last 10 years a number of new helicopter types have been introduced to the UK sector of the North Sea which have replaced the 'workhorses' of the 1980s and 1990s. Consequently the Sikorsky S-61, the Bell 212/412/214ST and the Bo 105 have all retired from operations in the UK sector and have been replaced by a range of modern helicopters including the Sikorsky S-92, the EC225 and the AS332 L2, the AgustaWestland AW139, the EC 155 and, in future, the AW189 and possibly the EC 175.

1.2.3.4.2 When the S-92 and the EC225 were introduced to effectively replace the S-61N, in consideration of the higher MTOM of both the S-92 and the EC225 (when compared to the S-61), both manufacturers, Sikorsky and Eurocopter, each submitted 'cases for safety' through Consultavia (Mr Mike Ginn) to seek allowance for their new types to operate to helidecks that were designed for the S-61N (and therefore designed only for a 9.3 ton helicopter). On the basis of separate Consultavia analyses, which presented data for both the S-92 and the EC225 that demonstrated in the event of an engine failure from 30 ft at ISA + 15, the superior one-engine-inoperative capability and undercarriage damping efficiency of both helicopters produced emergency landing loads which were well within the design limits for an S-61 rated helideck. In consequence a number of CAA approval letters were issued to address the following:

28 Feb 2005 EC225 operations @ 11,000 kg to S-61N rated helidecks (t=9.3)

16 Jun 2006 S-92 @ 11,861 kg to S-61N rated helidecks (t=9.3)

19 Jun 2006 EC225 @ 11,000 kg to AS332 L2 rated helidecks (t=9.3)

14 Feb 2007 S-92 @ 12,020 kg to S-61N rated helidecks (t=9.3)

1.2.3.4.3 For each of the above cases the helicopter being introduced had an overall length D-value that either did not exceed the design D of the helideck or, in the case of the S-92 at 20.88 m, was lower than the design D for an S-61 capable helideck - which is 22.2 m. However, in 2007 Consultavia presented a 'case for safety' on behalf of Agusta/Bell which sought to justify the use of the AB139 on helidecks designed (t-rated) for the S-76. As the overall length (D-value) of the AW139 at 16.66 m was greater than that of the S-76, at 16.00 m, this introduced an additional element to the analysis – how to safely accommodate a helicopter with a D-value above (larger than) the certified D of the helideck. The following letters were issued to Agusta/Bell and AgustaWestland:

31 March 2005 AB139 @ 6,400 kg to 17 undersized and 28 >1D helidecks

10 June 2005 AB139 @ 6,400 kg to 21 undersized helidecks

2 March 2006 AW139 @ 6,400 kg to 6 undersized helidecks

20 May 2011 AW139 @ 6,800 kg to 52 mainly undersizes helidecks (this letter was on CAAi headed paper and signed by a CAAi business manager)

1.2.3.4.4 The principle for operations to undersized helidecks, with the proposed introduction of a new helicopter type, was first established during the initial AB139 analysis (signed off in March 2005) and acceptance has now been formalised by the production of a safety case “Risk Assessment for helicopter operations to helidecks in the UKCS which are sub-1D” (Final version dated 13/09/13). The risk assessment may be applied in the analysis of up to 56 helidecks where the approval for the largest helicopter authorised to use the helideck exceeds the design D of the helideck structure. This number includes 42 x 16.00 m helidecks authorised in principle to operate the AW139, three helidecks at 15.00 m which can operate restricted S-76 operations at 16.00 m and 6 x 13.68 m helidecks designed for the AS365 N2 but which are now operated by the AS365 N3 (D=13.73 m).

1.1.2.5 Helideck Crew training

1.2.3.5.1 This is an area where the HCA has some commercial interest but where the CAA has not had any direct oversight – other than in the CAA Aeronautical Radio Operator competency (through ANO article 204). The issue of OPITO approved training is further discussed in the Passengers Safety and Survivability Annex. It should be noted that if the outcome is to pursue a route towards certificating helidecks (see further discussion below) this would need to consider the personnel assigned to helideck duties, and any training programmes that they undertake to achieve and maintain competency.

1.2 Analysis of Helideck Non-Compliances from Helideck Limitations List

1.3.1 Having conducted a review of the HLL (dated 10 October 2013) it is evident that almost every helideck listed has notified some level of non-compliance. This is partly understandable in the context that many of the helidecks listed were designed in the 1970s and 1980s and so, in some cases, pre-date CAP 437 best practice standards and the standards and recommended practices of ICAO Annex 14 Volume II. Added to this CAP 437, now at 7th Edition Amendment 1, has evolved in many areas – especially since 1993 - and now provides much more detailed guidance even than the international standards and recommended practices in ICAO Annex 14 Volume II and the Heliport Manual (Doc 9261) – so is correctly described as an amplification of ICAO Annex 14 Volume II and the Heliport Manual. There has been a persistent evolution of standards in CAP 437 where, for certain aspects of design, existing helidecks have been required to implement the new requirements retrospectively, but for others they have been exempted (guidance on issues of implementation is now offered with each new edition of CAP 437). A good example of the latter is the case of helideck netting, where for helidecks completed up until 1 January 2012, netting is permitted to exceed the level of the landing area by no more than 25 cm, but for helidecks completed after this date has to be designed so its outboard edge is level with the elevation of the landing area.

1.3.2 A decision was taken within the ICAO Heliport Design Working Group (HDWG) around 2007 that this standard would only apply to new builds constructed after a certain date since to retrospectively apply the standard would be very costly for the industry to implement and could be difficult to justify through a Cost/Benefit Analysis. (CAP 437 policy has followed the standards and recommended practices of ICAO Annex 14 for this issue.) In consideration of the threats posed to helicopters by objects around the helideck, there has been a drive by the CAA and the HCA for industry to review, and where practical, modify, the obstruction environment around the helideck; there has also been a strengthening of the criteria for obstacles in the first segment of the Limited Obstacle Sector (LOS).

These more demanding criteria have sometime led to the creation of new non-compliances.

- 1.3.3 Recognising the potential for obstacle strikes on a helideck (there have been a significant number of incidents recorded in the Gulf of Mexico for example) the issue of obstacle height restriction for essential objects around a helideck has been the subject of successive reviews by the ICAO HDWG and further limitations have been imposed on obstacle heights in CAP 437. However, the UK has had to take a more pragmatic and measured view of obstacle height limitation/restriction (than was adopted during the ICAO discussion process leading to new and revised SARPs for these aspects); the UK objective has been to balance an absolute height limitation/restriction against the operational requirement for an essential object, to ensure it performs effectively in the function for which it is intended. So, for example, a perimeter light must be mounted sufficiently 'proud' of the helideck surface to enable it to perform the task for which it is intended (i.e. to provide effective visual cues for a helicopter that might be approaching an installation at a typically shallow angle – down to 0°). Or a fixed ring-main (or fixed monitor) fire-fighting system must be sufficiently 'elevated' to enable the nozzles/monitors to deliver foam solution at high rates of discharge to the whole of the landing area. Where automatic detection and activation is a requirement (e.g. on a NUI), a system of flame detectors would need to be provided and arranged with unimpeded 'line-of-sight' to all parts of the landing area.
- 1.3.4 In consequence of these issues there are a proportion of helidecks which carry notification of non-compliance of the obstacle protected surfaces – whether it is the 210° OFS, the 150° LOS or the falling 5:1 gradient – often because of these competing issues. The CAA's response through the HCA has been to request that offshore duty holders review the obstacle environment at the helideck and limit any infringements to as low as reasonably practicable; wherever practicable to meet the revised standards of CAP 437 and ICAO Annex 14 Volume II (note: new standards were published in 2013 for helidecks ≤16.00 m).

1.3 Proposal to License/Certificate All Offshore Helidecks

1.3.1 Background and Discussion

- 1.4.1.1 Aside from the way that the law is being interpreted at present (in that helidecks are deemed to fall under Article 96 of the ANO 2009 rather than under Article 208(3) and so do not require to be licensed by the CAA, but rather are approved 'fit for purpose' by the helicopter operators using an HCA inspection and certification process), the HCA was asked its opinion on a proposal to consider the licensing/certification of helidecks. The HCA was supportive of the initiative, perhaps on the grounds that it regarded itself well positioned to take on a business opportunity that it is already undertaking on behalf of the offshore helicopter operators.
- 1.4.1.2 From a UK CAA perspective this subject has been raised internally on several occasions in recent years, from both the legal and logistical perspectives – how (or if) the CAA could be resourced to complete a task of this nature and scope – to license/certificate helidecks on 228 fixed platforms in addition to as many as 100 floating installations and vessels operating in the UKCS.
- 1.4.1.3 The logical internal 'port of call' to undertake any licensing function is Aerodrome Standards Department (ASD). Indeed it was ASD Inspectors who undertook a representative inspection programme of helidecks on behalf of the Health and

Safety Executive between 1992 and 1995. However, all the inspectors involved in that programme have since retired and there is no current expertise within ASD to undertake a task to license/certificate helidecks. Under a Memorandum of Understanding which is in operation between Aerodrome Standards Department and Flight Operations (Helicopters), all matters relating to “unlicensed” helidecks, including the amendment of CAP 437, are assumed by Flight Operations (Helicopters) with specialist input from ASD, such as for Rescue and Fire-Fighting issues. Within FOI(H) resides one helideck specialist, supported by various technical specialist roles (e.g. Offshore Flight Operations Inspectors (FOIs), the ASD Fire Policy specialist and Flight Operations Research Manager). Whilst the helideck specialist has a thorough working knowledge of the requirements, he holds no recency in a helideck inspection and certification function; neither do any members of the specialist team. Therefore for the CAA to undertake effectively the helideck inspection and licensing/certification task ‘in-house’ will require a significant commitment to the recruitment, training and equipping of inspectors, both in time as well as in investment. Added to this under EASA aerodrome rules there will be no requirement for NAAs to license or certificate offshore helicopter landing areas, which are not open to public use and so fall outside the scope of the EASA Basic Regulation. Therefore it is not certain whether the CAA would have any appetite for such a major programme of work, given that it is not mandated by EASA, nor currently by ICAO (although the certification of heliports including offshore helidecks is a work item on the current programme of the HDWG).

- 1.4.1.4 If the task of licensing/certificating helidecks is to be undertaken effectively, one model to follow up is to enlist the services of the organisation that is already performing the function “on behalf of the helicopter operators”, to pursue a mechanism to enable *them* to complete the role and function. The Helideck Certification Agency fulfils this role already on behalf of the helicopter operators for all helidecks operated in the UK sector (see also Note below paragraph 1.2.2.1).

1.3.2 Considerations Arising from Interviews Conducted with the HCA

- a) The Oil industry should refresh the study undertaken more than 20 years ago, and funded by the HSE, for effective bird control measures on and around an offshore installation.
- b) Industry training standards need to be reviewed particularly those which relate to the Helicopter Refuelling Course. Refuelling procedures on deck should be reviewed.
- c) A review of the safeguarding arrangements around oil and gas installations and the possible conflict with the siting of installations engaged in offshore renewable should be conducted.
- d) The scope and mechanism for licensing/certificating all helidecks in the UKCS should be investigated. Current onshore helicopter bases which are not licensed would need to be included in the review.

The helideck and associated considerations will be reviewed and actioned as necessary by the CAA in concert with Action 10 of the main report.

2 Meteorological (Met) Information for Offshore Helicopter Operations

2.1 Introduction

2.1.1 This section of Annex E describes the current arrangements for the provision of meteorological information in support of offshore helicopter operations. It also highlights developments being undertaken to improve situational awareness offshore for operators and flight crew with regards to current weather conditions. In addition it reviews the provision of Met information provided by other North Sea States.

2.2 International and National Regulatory Arrangements

2.2.1 International Civil Aviation Organization Standards and Recommended Practices in Annex 3, require States to “*establish, or arrange for the establishment of, aeronautical meteorological stations on off-shore structures or at other points of significance in support of helicopter operations to off-shore structures*” and to provide “*meteorological information for pre-flight planning and in-flight re-planning by operators of helicopters flying to offshore structures*”.

2.2.2 The Civil Aviation Authority (CAA) has published guidance in CAP 437 Standards for Offshore Helicopter Landing Areas on the meteorological information to be provided from an offshore installation. Additionally it ensures that the content of offshore Met observer training courses cover all relevant aspects of offshore observing.

2.2.3 Following consultation with users the CAA has agreed with the Met Office and NATS the elements of Met provision that can be provided and cost recovered from the North Sea Round Trip Charge. Part of this provision includes the offshore helicopter Met briefing system (OHWeb), this is provided to the helicopter operators flying offshore by the Met Office, this gives a wide range of actual and forecast Met information for pre-flight planning.

2.3 Recent Incidents

2.3.1 In 2006, a helicopter taking workers to gas platforms in the Morecambe Bay crashed in poor visibility killing all the occupants. The subsequent Air Accidents Investigation Branch (AAIB) report contained a number of recommendations, including that “The Civil Aviation Authority should ensure that personnel who are required to conduct weather observations from offshore installations are suitably trained, qualified and provided with equipment that can accurately measure the cloud base and visibility.”

2.3.2 Following the accident the CAA reviewed the appropriate policy document, CAP 437. The Section on Meteorological Information was significantly revised and, following consultation with industry, was published in December 2008.

2.3.3 In 2009 a helicopter operating in the North Sea en route to the ETAP platform ditched in the sea in low visibility conditions. On this occasion a fog bank had enveloped the ETAP platform. This, once again, highlighted the need for operators to provide accurate and timely weather reports for offshore helicopter operations; the AAIB report on this recommended the CAA “to re-emphasise to Oil & Gas UK that they adopt the guidance in Civil Aviation Publication (CAP) 437, insofar as personnel who are required to conduct weather observations from vessels and platforms equipped for helicopter offshore operations are suitably trained, qualified and provided with equipment that can

accurately measure the cloud base and visibility, in order to provide more accurate weather reports to helicopter operators.”

2.4 Civil Aviation Publication (CAP) 437 Standards for Offshore Helicopter Landing Areas

2.4.1 Chapter 6 which provides guidance on meteorological information was significantly revised and updated in December 2008. CAP 437 now details the meteorological instrumentation that should be installed and the information needed for the pre-flight weather report as well as the radio message for transmission to helicopters en route. Meteorological Observer Training is also detailed and it is recommended that all personnel that provide weather information in support of offshore helicopter operations should be certificated.

2.4.2 During the 2008 consultation on the proposed changes to CAP 437, industry suggested that in order to reduce the cost of installing automated Met observing systems on every platform, those installations within a 10 mile radius of another installation with fully-equipped automated Met observing systems should not have to install visimeter, present weather sensors and ceilometer, provided that they have access to the information from an installation that does. In order to facilitate this, CAP 437 describes how a real-time web-based system could be established, that enables greater sharing of the weather information generated by the automated sensors. It should be noted that the operators in the Morecambe Bay have already installed such a weather network.

2.4.3 In April 2010 additional guidance relating to the provision of Meteorological Information from Offshore Installations was published in CAP 437, which gives more details of the instrument specifications and the format for the pre-flight weather report.

2.4.4 Since this time over 1,000 Met Observers have been trained and certificated in order to provide observations to helicopter operators. However, it has been noted by the helicopter operators that whilst there has been an improvement at some installations in the quality of the meteorological information over the last 12 months, overall the quality of the weather information being provided needs to improve further. In order for this to occur there still needs to be:

- Installation of the required automated sensors especially those for the reporting of cloud height and visibility.
- Greater sharing of weather information using a real time web based system.
- Ongoing *ab initio* and refresher training of Met Observers.

2.4.5 In view of consultation response in 2008 by both Oil & Gas UK and Oil and Gas Producers groups wishing to minimise Met Observer training, there was little prospect of installations agreeing to a requirement for certificated Met Observers capable of providing routine half hourly METAR reports on a 24 hour basis, consequently this was not considered as an option. However, it was agreed that about 14 installations would provide AUTO METARs every 30 minutes and be distributed on the AFTN, it should be noted that these sites were selected as they have all the required sensors. These AUTO METARs allow wider weather situational awareness across the North Sea domain, with half-hourly reports now being exchanged with the other North Sea States, i.e. Norway, Denmark and the Netherlands (see paragraph 2.5).

2.4.6 NATS currently receives near real-time, quality controlled, surface pressure information (QNH) from the Fulmar and Cormorant installations to assist with the provision of Air Traffic Services.

2.5 Observational Meteorological Data provided in the North Sea

2.5.1 As noted above CAP 437 requires that offshore installations provide weather reports for helicopter crew pre-flight briefing 2 hours before take-off.

2.5.2 Staff are required to be trained to provide these reports which are provided in a plain language form, it was a desire from industry to ensure this course was as short as practically possible consequently a weather observing course of 2 days was devised (against the current 10-day course for aerodrome METAR observing). This has resulted in an increase in the standards of weather reports being provided.

2.5.3 In March 2010, Oil & Gas UK formed the Weather Data Network Working Group, in order to establish a system that enabled greater sharing of weather observations around the North Sea. Following a number of meetings the Helimet system became operational in 2012 allowing access to all Oil & Gas UK members. Agreement on the funding of the system was reached with Oil & Gas UK who arrange the funding with their members.

2.5.4 The Helimet system is operated by Rignet under contract from Oil & Gas UK, it provides a number of facilities including:

- access to live weather information from over 105 installations mainly in the North Sea and shown in graphical and tabular forms;
- map based information highlighting where weather may be below (or above) certain limits;
- a facility for the weather observer to complete and issue the weather report form; and
- an archive of weather report forms.

Figure E2 Screen shot from Helimet showing installations providing real time information

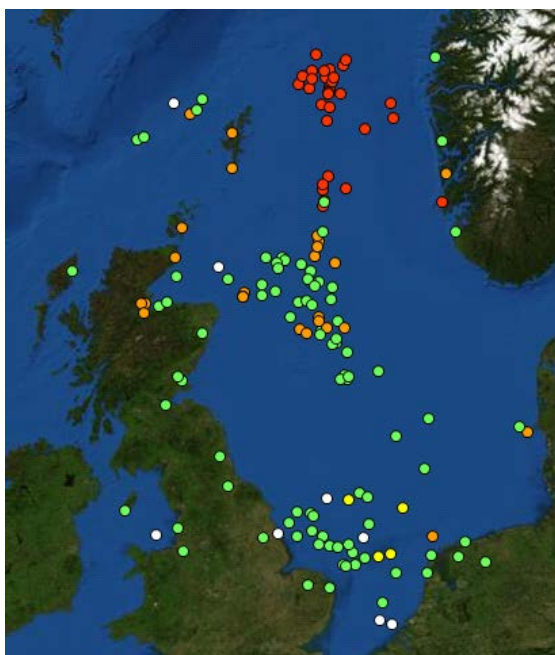
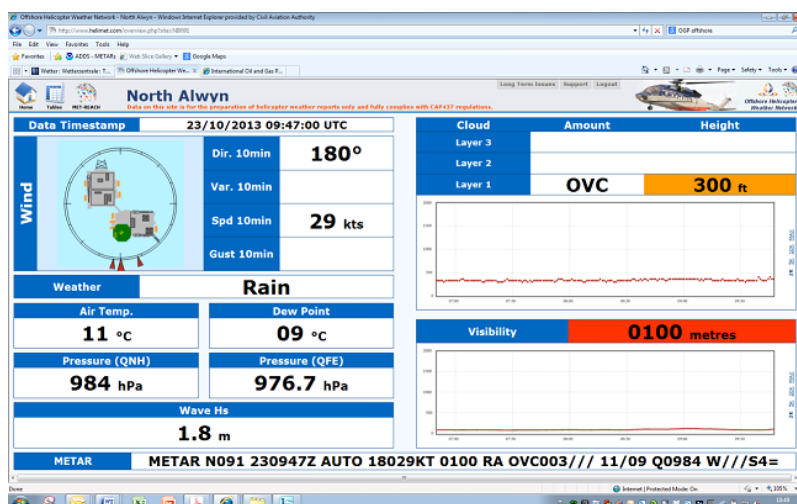


Figure E3 Screen shot from Helimet showing live weather information for the N Alwyn



2.5.5 The Helimet system has been designed for two main users, firstly those who wish to see the output from cloud and visibility sensors from a neighbouring installation to assist in the assessment of the weather conditions and secondly to enable an efficient method of submitting the weather report to the helicopter operators. Additionally it provides situational awareness of weather conditions across the North Sea for helicopter operations staff.

2.6 Current Meteorological Information Included Within the Round Trip Charge

2.6.1 An offshore Met briefing system is provided to the helicopter companies flying offshore, giving a wide range of actual and forecast Met information for pre-flight planning. The system, OHWeb, is provided by the Met Office. This includes a range of briefing information as well as the facility to generate printouts in the form of tailored print packs.

2.6.2 It includes the following information:

- Forecasts provided and funded specifically for offshore helicopter operations:
 - Low level significant weather and area forecasts
 - Low level wind and temperature forecasts
 - Liquid water content and icing forecasts
- Forecasts provided by the Met Office and made available on OHWeb:
 - Sea temperature analysis
 - Surface pressure analysis
 - Forecast lightning
 - Forecast visibility
 - Forecast wave height
- Forecasts and warnings provided by the Met Office and made available on OHWeb:
 - TAFs
 - SIGMETs
 - Aerodrome warnings

- Observational information provided by the Met Office and made available on OHWeb:
 - METARs
 - Colour coded observations
 - Radar
 - Satellite
 - Observed Lightning

2.7 Current Meteorological Information Not Included Within the Round Trip Charge

- 2.7.1 It should be noted that the provision of onshore TAF information, aerodrome weather warnings and SIGMET provision is cost recovered from the UK en-route air navigation service charge. It should be noted that the TAF is a site specific forecast, under ICAO requirements it provides forecasts for wind, cloud (height and amount), visibility and weather.
- 2.7.2 ICAO specifies that TAFs shall be prepared for the aerodromes that are listed in the relevant ICAO Regional Facilities and Services Implementation Document (FASID). This list is driven by user (operator) requirements, and typically reviewed annually at ICAO Regional Meteorological meetings. A TAF is a site specific forecast that provides forecasts for wind, cloud (height and amount), visibility and weather as well as expected significant changes in these elements during the period of validity. TAF are required to be kept under continuous review by the forecaster with amendments issued if the forecast exceeds certain thresholds.
- 2.7.3 Appendix B to ICAO Annex 3, Meteorological Service for International Air Navigation, lists the operationally desirable accuracy of forecasts. For each element (wind direction, wind speed, visibility etc.) a desirable accuracy, specified by operators, is listed alongside a recommended minimum percentage of cases that should fall within this range. For TAF this is typically 80%, but 70% for forecasts of cloud amount and cloud height. It should be noted that there are inherent difficulties in verifying TAF against these desired accuracy values, as the change criteria for TAF do not provide for an easy comparison. As a result most Met service providers around the world have developed separate TAF verification mechanisms.
- 2.7.4 During the development of Joint Aviation Authorities Requirements for Operations 3 (JAR-OPS 3) relating to commercial air transportation (helicopters), there was significant discussion about the use of TAF and its desired accuracy as part of the decision-making process for the alleviation of the requirement to select an alternate heliport for a flight to a coastal heliport under IFR for helicopters routing from offshore. It was recognised that such procedures are weather critical. As a result, it was concluded that a TAF does not offer consistently high enough accuracy for such planning and instead a landing forecast, known as a TREND, conforming to the standards contained in the Regional Air Navigation Plan and ICAO Annex 3, was specified as a requirement in JAR-OPS. The TREND consists of a concise statement of the mean or average meteorological conditions expected at an aerodrome or heliport during the two-hour period immediately following the time of issue. It contains surface wind, visibility, significant weather and cloud elements. ICAO Annex 3 also specifies operationally desirable accuracy for TREND forecasts. In particular, the value of the observed cloud height and visibility elements is expected to remain within $\pm 30\%$ of the forecast values in 90% of the cases. The JAA felt that this was a

much more appropriate accuracy on which fuelling decisions should be based, whilst recognising the short-period of the forecast. This position has been adopted by EASA, in its new Regulation on Air Operations (EC Regulation No. 965/2012).

2.7.5 Also funded from UK en-route charge is the provision of TREND forecasts, these are two-hour forecasts, appended to the 'METAR' weather observation from the aerodrome and are updated every 30 minutes. Consequently this is a resource intensive service. The majority of aerodromes in the UK requiring a TREND forecast are those that have 'Coastal Heliport' status under JAR-OPS. Currently the following 5 aerodromes relevant to offshore helicopter operations receive a TREND forecast:

- Sumburgh
- Scatsta
- North Denes
- Norwich
- Aberdeen

2.8 Flight Briefing Information Provided by Other States in the North Sea

2.8.1 In 2012, the Met Office on behalf of the CAA conducted a review of North Sea MET briefing web sites for the UK, Norway, Denmark and the Netherlands and produced a report "Review of North Sea MET briefing web sites." This details the type of information available on the websites that are used by pilots for pre-flight briefing.

2.9 METAR and TAF Information Provided by States in the North Sea

2.9.1 Norway

2.9.1.1 Norway provides 12 offshore installations that provide METAR using certificated observers, and a further 3 that provide AUTO METAR. Of the 12 that provide manual METARs, i.e. have a certificated MET observer who is authorised to provide METARs, 7 have been nominated to receive a TAF. The provision of Met information is covered by Norwegian regulation BSL G 7-1.

2.9.1.2 These 7 have been selected to provide reasonable coverage in key locations where there are a number of installations close by. All the TAFs are provided by forecasters based onshore.

Table E1 Norwegian Offshore Installations

Installation Name	ICAO Location Indicator	Lat.	Long.	Sea Surface Temperature	State of the Sea	TAF
Ekofisk	ENEK	5632N	00312E	Y	Y	Y
Gullfaks C	ENGC	6112N	00216E	Y	Y	Y
Heidrun	ENHE	6519N	00718E	Y	Y	Y
Heimdal	ENHM	5934N	00213E	Y	Y	Y
Norne	ENNE	6601N	00805E	Y	Y	Y
Oseberg A	ENOA	6029N	00249E	N	Y	Y

Sleipner A	ENSL	5822N	00154E	Y	Y	Y
Snorre A	ENSE	6127N	00208E	N	Y	N
Snorre B	ENQR	6132N	00212E	N	Y	N
Statfjord A	ENSF	6115N	00151E	N	Y	N
Statfjord B	ENFB	6112N	00149E	N	Y	N
Troll A	ENQA	6038N	00343E	Y	Y	N
Troll C	ENQC	6053N	00336E	N	Y	N
Ula	ENLA	5706N	00250E	Y	Y	N
Valhall	ENVH	5616N	00323E	Y	Y	N

2.9.2 Netherlands

2.9.2.1. The Netherlands has 12 offshore installations all of which provide AUTO METAR. From these 9 stations are used to provide an area forecast in the TAF code form. These forecasts are known as NAFs, a form of TAF which is not recognised by ICAO.

Table E2 Dutch Offshore Installations

Installation Name	ICAO Location Indicator	Lat.	Long.	Sea Surface Temperature	State of the Sea
F3-FB-1	EHFD	5451N	00442E	N	N
K13-A	EHJR	5313N	00313E	Y	Y
Lichteiland Goeree	EHSC	5156N	00340E	Y	Y
EuroPlatform	EHSA	5200N	00317E	Y	Y
K14-FA-1C	EHKV	5316N	00338E	N	N
F16-A	EHFZ	5407N	00401E	N	N
L9-FF-1	EHMG	5337N	00458E	N	N
AWG-1	EHMA	5330N	00557E	N	N
D15-FA-1	EHDV	5419N	00256E	N	N
Hoorn-A	EHQE	5255N	00409E	N	N
A12-CPP	EHAK	5525N	00349E	N	N
P11-B	EHPG	5221N	00320E	N	N

2.9.2.2 North Sea Area Forecast (NAF)

2.9.2.2.1 The Netherlands makes available an area forecast, in the TAF code form

2.9.2.2.2 The following locations are used as the basis for the area forecast (NAF).

- EHAK A12-CPP

- EHDV D15-FA-1
- EHFD F3-FB-1
- EHFZ F16-A
- EHKV K14-FA-1C
- EHMA AWG-1
- EHMG L9-FF-1
- EHPG P11-B
- EHQE Hoorn-A

2.9.3 Denmark

2.9.3.1 Denmark has 3 offshore installations that provide METAR provided by certificated observers. From these 1 station receives a TAF.

Table E3 Danish Offshore Installations

Installation Name	ICAO Location Indicator	Lat.	Long.	Sea Surface Temperature	State of the Sea	TAF
Tyra Øst	EKGF	5543N	0448E	N	N	Y
Horns Rev A	EKHR	5531N	0752E	N	N	N
Horns Rev B	EKHN	5536N	0737E	N	N	N

2.9.4 UK

2.9.4.1 The following 14 installations provide AUTO METARs. No TAF information is provided.

Table E4 UK Offshore Installations

Installation Name	ICAO Location Indicator	Lat.	Long.	Sea Surface Temperature	State of the Sea	TAF
Schiehallion FPSO	EGRI	6021N	00403W	N	N	N
Clair	EGRF	6041N	00232W	N	Y	N
Magnus	EGRE	6137N	00118E	N	Y	N
Bruce	EGRK	5944N	00140E	N	Y	N
Harding	EGRL	5916N	00130E	N	Y	N
Miller	EGRM	5843N	00124E	N	Y	N
Andrew	EGRO	5802N	00124E	N	Y	N
ETAP CPF (Marnock)	EGRS	5717N	00139E	N	Y	N
Mungo	EGRP	5722N	00159E	N	Y	N
Ravenspurn	EGRV	5401N	00106E	N	Y	N

N						
Cleeton	EGRT	5402N	00043E	N	N	N
West Sole	EGRW	5342N	00108E	N	Y	N
Cormorant Alpha	EGRG	6106N	00104E	N	N	N
Fulmar Alpha	EGRN	5629N	00209E	N	Y	N

2.10 Sea State Information

2.10.1 ICAO Annex 3 has a recommended practice in relation to the provision of information for helicopter operations. It is stated in Appendix 3.

4.8.1.5 Recommendation.— *In METAR and SPECI, the following information should be included in the supplementary information, in accordance with regional air navigation agreement:*

- a) *information on sea-surface temperature, and the state of the sea or the significant wave height from aeronautical meteorological stations established on offshore structures in support of helicopter operations;*

2.10.2 The UK has arranged that state of the sea information is provided from a number of offshore installations and is included in the AUTO METARs. Arrangements are being made to change the reporting from state of the sea to significant wave height which has been made possible following an amendment to ICAO Annex 3.

2.10.3 In addition forecast significant wave height information is provided on OHWeb.

Figure E4 Forecast Significant Wave Height – Screen Shot from OHWeb



2.11 Triggered Lightning Research and Development

- 2.11.1 Helicopter triggered lightning is a phenomenon which affects operations over the North Sea during the winter season, between November and April. It is thought that the presence of the helicopter triggers the majority of lightning strikes, since there is generally little or no natural lightning activity in the area in question prior to or following the strike and strike rates are much higher than would be expected if due purely to chance. From 1992-2010 there were typically 1-2 strikes per winter season. In addition, no strikes to helicopters have ever been known to occur during the summer months when the natural lightning activity is significantly greater than during the winter months. Previous attempts to forecast strike risk have resulted in forecasts which are insufficiently discriminating (i.e. high false alarm rate) to be of practical use to the helicopter operators.
- 2.11.2 Helicopters acquire a strong negative charge as they fly through air (due to static charging). This is normally discharged safely on landing on the Earth's surface, but if the aircraft comes close to a positively-charged region of a thunderstorm cell then there is potential for a lightning bolt to discharge through the helicopter, causing a triggered lightning strike. It is thought that triggered lightning strikes may occur due to:
- Flight of a helicopter into a positively charged base of a cumulonimbus cloud.
 - Flight of a helicopter under the positively charged anvil of a cumulonimbus cloud.
 - Flight of a helicopter from a positively charged to a negatively charged region of cloud.
- 2.11.3 Most strikes are positively charged (positive to negative), with a few being negatively charged (negative to positive). Most positively charged regions of a cumulonimbus cloud are found close to the 0°C isotherm where ice and snow melts, which results in charge separation.
- 2.11.4 Triggered lightning has been a particular issue in the North Sea and the Sea of Japan, although lightning strikes have been reported elsewhere (e.g. An NH Industries NH90 Helicopter (TTH), operated by the Royal New Zealand Air Force (RNZAF) was struck by lightning near Wellington on 22 August 2013, resulting in NZD10 million (USD8.2 million) of repairs). Considerable research has been conducted into winter thunderstorms in the Sea of Japan. Such storms are characterised by a small vertical extent, short duration and low flash rates with most storms only exhibiting a few lightning flashes over their whole duration. The area is similar geographically to the North Sea since, in both cases, advection of dry polar air masses over a warmer sea surface leads to potential instability. In the majority of cases, it appears that strikes have occurred in cold air convective outbreaks or in cold air situations. These occur when a cold airflow flows over a relatively warm sea; the temperature difference between the sea and the air above is often 6 °C or more. This strong temperature gradient leads to strong heating of the air above and often deep convection extending to 4 km or more in height.
- 2.11.5 In a typical winter season, there are probably around 10 cold air outbreaks in the North Sea operating area, each lasting around 3 days. This would mean that there are typically 30 strike-risk days per season. However, pilots are generally skilful in avoiding the areas of high risk, notably cumulonimbus clouds; most of the strikes have occurred when the pilots have not expected a strike (e.g.

cumulonimbus embedded in stratocumulus). Additionally, high charge regions in clouds are rare and there is a low potential for a helicopter to be caught either in the positive area of the cloud near the base, or underneath the anvil, or between two different charged areas.

- 2.11.6 Following work by the Met Office funded by the helicopter operators and Norwegian CAA, an algorithm for triggered lightning risk was produced based on outside air temperature and precipitation rate. Evaluation against past strike cases has demonstrated that the new algorithm successfully forecasts lightning risk on 80% of occasions when triggered lightning occurred.
- 2.11.7 Three risk levels are generated from the product (low, medium, high), with corresponding actions agreed among the operators:

Table E5 Actions in Response to Risk Levels

Risk Level	Colour Code	Action
High	Red	Avoid flight in these areas.
Medium	Amber	Enter these areas subject to the following conditions: a) Do not enter in IMC or at night; b) Maintain 10 NM from CB cells; and c) Avoid heavy precipitation.
Low	White	No restrictions on flight in these areas, but note potential to develop into higher risk areas.

- 2.11.8 During the trial, the performance of the algorithm was noted by each helicopter operator with a final review being held towards the end of April 2013. One helicopter operator noted that there were 42 flights cancelled plus 170 hours of delays over the previous winter whilst another reported 43 cancelled flights resulting from triggered lightning forecasts over 7 days. The total number of flights cancelled (1.2%) and flying hours lost (1.9%) are small compared to the totals for the entire season. However, on the days where there is disruption it is quite significant, possibly leading to 75% or more of the flights being cancelled.

3 Air traffic Management (ATM) & Offshore Communications

3.1 ATM

3.1.1 Overview

- 3.1.1.1 ATS services for the whole of the North Sea Sector are provided by NATS Aberdeen. Complex local and cross charging arrangements exist between the North Sea operators and Oil and Gas (O&G) UK.
- 3.1.1.2 NATS is a limited company, split into two main service provision companies (NATS En-Route PLC (NERL) and NATS Services Ltd (NSL)) and which is contracted to provide services by UK plc:
- NERL holds the monopoly of civilian en-route air traffic control over the UK and is regulated by the CAA who, for example, determine the charges NERL can make. NERL is funded by charging airlines for the provision of air traffic services.

- NSL competes for contracts in the free market to provide air traffic control at airports in the UK and overseas, as well as providing engineering, technical and education services in fields related to air traffic control.

3.1.1.3 Aberdeen NATS's top five risks / hazards do not include any issues relating specifically to helicopter operations.

3.1.2 Service Provision – North Sea

3.1.2.1 In generic terms, available radar/RT coverage over the Northern North Sea (NNS) means that NATS Aberdeen can provide a land-based radar service to traffic at 2,000 ft out to 80/90 NM, although there is good radar and RT cover at progressively lower levels nearer the coast.

3.1.2.2 Whilst offshore destinations west of the Shetlands are at the extreme range of the Sumburgh radar, multilateration coverage beyond 80 NM generally allows Aberdeen-based ATC to see aircraft out to the offshore platforms down to at least 1,500 ft with coverage down to heli-deck level in some areas. Indeed, multilateration and REBROS initiatives are considered to have provided a step change in safety in terms of surveillance³ and operational redundancy⁴. NATS has no remit to provide any services below 1,500 ft AMSL over the sea.

3.1.2.3 The current RT infrastructure is unlikely to support the establishment of Class D throughout the NNS helicopter operating area⁵, principally owing to the lack of available sites for Tx/Rx installations. NATS Aberdeen has also indicated a view that the adoption of BRNAV airspace in the North Sea would be inconsequential to their operation.

3.1.2.4 Over the Southern North Sea (SNS) the Claxby and Cromer radars (both land based) provide good coverage throughout most of the Anglia Radar Area of Responsibility; base of cover approximately 2,000 ft at 80 NM with cover at progressively lower levels nearer the coast. RT coverage is good throughout. There has been no NATS perceived need for multilateration coverage in the SNS Sea airspace due to the available radar coverage.

3.1.2.5 An offshore deconfliction service, applied under the terms of Memorandum of Understanding between NATS Limited and the off-shore helicopter companies, is a locally agreed service which permits a reduction in normal deconfliction separation standards between participating traffic (500 feet in VMC).

3.1.2.6 In the NNS sector NATS Aberdeen provides the Approach Surveillance Radar Service for both Aberdeen Airport and Sumburgh. No such arrangement exists with Scatsta which is becoming increasingly busy with fixed and rotary wing movements. Whilst potentially a relatively complex ATC environment, the Scatsta operation has not surveillance radar service; Scatsta ATCO, employed by SERCO, provide an Approach procedural service to a range of 25 miles.

3.1.2.7 Helicopter traffic involved in servicing O&G sites in the SNS operates out of Norwich and Humberside (both of which provide an Approach Surveillance Radar Service) and North Denes (Approach Procedural Service only).

³ In some areas aircraft can be seen to deck level.

⁴ There are 4 sectors each with 4 receivers: the service can function with three receivers serviceable in each sector.

⁵ Whilst technically Class D airspace does not need surveillance support, it is essential for such airspace to have RT coverage throughout the entire area.

3.1.3 Other related Issues – North Sea

- 3.1.3.1 Aircrew Experience. NATS Aberdeen has suggested the recent problems associated with the Puma fleet have resulted in an influx of crews who are not familiar with Aberdeen procedures. A callsign revision has been introduced (a doubling of the final letter (i.e. Helibus 23AA) is now used to identified crews who are new to the area). Associated with this period has been an increase in the number of level busts (7 in previous 2 months).
- 3.1.3.2 Flight Notification. For ATC planning purposes, NATS/NNS operators issue a daily 'Mayfly'; the notification of the schedule of flying for the day giving approximate departure times and the destination. Flight plans are not entered into the Integrated Initial Flight Plan Processing System (known as IFPS). Flight strips are generated locally in the Aberdeen EFPS (Electronic Flight Planning System). In the SNS, since NATS is not based at any of the participating airfields (Norwich, North Denes and Humberside), no initial 'Mayfly' is generated. Movement are notified to NATS in line with routine ATC handover procedures involving the departure airfield.
- 3.1.3.3 Helicopter Flow Trial. A Helicopter Flow Trial, whereby slot times were to be issued in an attempt to ease the 0700hrs congestion by facilitating two departures per 5 minutes, is in abeyance pending the return to normality post the recent Puma-related issues. Whilst it is evident that the O&G customers wish to move personnel at specific times, thus leading to peaks in helicopter activity, more flexibility from the O&G customers would be of benefit to the ANSP and helicopter operator. Aberdeen is quiet at weekends: movements half that associated with week days (approximately 200 movements/day as opposed to 400).
- 3.1.3.4 Offshore Wind Turbine Development. The increasing prevalence of wind turbines in the North Sea (and Irish Sea) has the potential to impact upon helicopter operations and the provision of associated radar services. As physical obstacles, turbines can dictate and restrict the direction from which helicopters can approach and depart offshore platforms and potentially limit operations at platforms during certain meteorological conditions. The issues associated with turbines generating Primary Surveillance Radar clutter and consequential limitations on the provision of radar services are well known. Objections to any proposed developments may be lodged during the planning process where there is likely to be an impact on the service provided by an ATS provider and suitable mitigations cannot be found. It is not known whether the same consideration and right of appeal is available to helicopter operators where the effects of the turbines can mask the presence of Rigs the airborne radars.

3.1.4 Irish Sea

- 3.1.4.1 A similar operation of helicopters serving O&G UK facilities takes place in the Irish Sea (principally the Liverpool and Morecambe Bay Fields). Such operations involve a single helicopter operator, currently Bond Helicopters, based at Blackpool Airport, whose standard fleet is comprised of two AS365 Dauphin Helicopters. ATS services are provided by Blackpool, BAe Warton, and Barrow (the latter AFIS only). In comparison to the North Sea operations the distances from the airport to the rigs are relatively short, there is no off shore communication relay, however the reported RT coverage is good almost to deck levels. All surveillance radar data is received from land based sensors; both Warton and Blackpool have site-located primary radars, close to the coast, providing coverage down to levels of approximately 500 feet or less in the vicinity of the rigs.

3.2 Airspace

3.2.1 Airspace Structure Headline Features⁶

3.2.1.1 The main features of the airspace of the offshore area of the London and Scottish FIRs from Great Yarmouth in the south to the East Shetlands Basin in the north are summarised as follows:

- Notwithstanding small portions of Class D associated with Durham Tees Valley, Newcastle, Aberdeen and Sumburgh Airports, the airspace from the surface to at least FL100 is principally Class G.
- Numerous military operated airspace constructs; Danger Areas, Managed Danger Areas, Aerial Tactic Areas.
- The Aberdeen and Anglia Offshore Safety Areas (OSA) are established to provide quasi known traffic areas. OSA dimensions are detailed and depicted within the AIP at ENR 1.6 and ENR 6-1-15-3/6-1-15-5 respectively:
 - The Anglia OSA consists of the Airspace from surface to 3500 ft ALT, whereas the Aberdeen OSA consists of the Airspace from surface to FL 100; they are depicted at Attachments 1 and 2. Helicopters operating within the Anglia OSA should not normally be flown below 1500 ft amsl unless forced to fly beneath by weather or for essential operating reasons.
 - Pilots of helicopters entering either OSA must establish 2-way RTF communication with the appropriate ATSU.
 - Notwithstanding minor differences in operation requirements associated with each OSA, pilots of fixed-wing aircraft are generally recommended to avoid the associated airspace. However, where utilisation of OSA airspace is essential, pilots of fixed wing aircraft should establish contact with the ATSU (Aberdeen) no later than 10 NM before entering the area giving their position, altitude, squawk, heading and intentions. Associated R/T and SSR requirements are published within the AIP.
- Helicopter Main Routes (HMRs) are routes typically and routinely flown by helicopters operating to and from off-shore destinations and are promulgated for the purpose of signposting concentrations of helicopter traffic to other airspace users. HMR promulgation does not predicate the flow of helicopter traffic; HMRs have no airspace status and assume the background airspace classification. Utilised by the ANSPs and helicopter operators for flight planning and management purposes, HMRs have no lateral dimensions but generally extend vertically from 1500 ft amsl to FL 60 over the Southern North Sea and from 1500 ft amsl to FL 85 over the Northern North Sea.
 - Whilst compliance with the HMR structure is not compulsory, in the general interests of flight safety, however, civil helicopter pilots are strongly encouraged to plan their flights using HMRs wherever possible. Other traffic operating in proximity of these routes is advised to maintain an alert look out, especially in the OSAs.
 - NATS Aberdeen view the retention of the HMR route structure as worthwhile, not only as a planning tool but to provide operational safety redundancy in the in the event of a failure of the Multilateration coverage.

⁶ Chart extracts from the UK AIP depicting helicopter routes and airspace infrastructure over the southern and northern North Sea are at Attachments 1 and 2.

- Helicopter Traffic Zones (HTZ) are established in the Southern North Sea as notification of helicopters engaged in platform approaches, departures and extensive uncoordinated inter-platform transit flying. Inter-platform flying by civil helicopters within HTZs contained within the OSA will be conducted on the company or field discrete frequency. HTZs consist of the airspace from sea level to 2,000 ft ALT contained within tangential lines, not exceeding 5 NM in length, joining the neighbouring circumferences of circles 1.5 NM radius around each individual platform helideck.

Figure E5 ATM Map of Southern North Sea

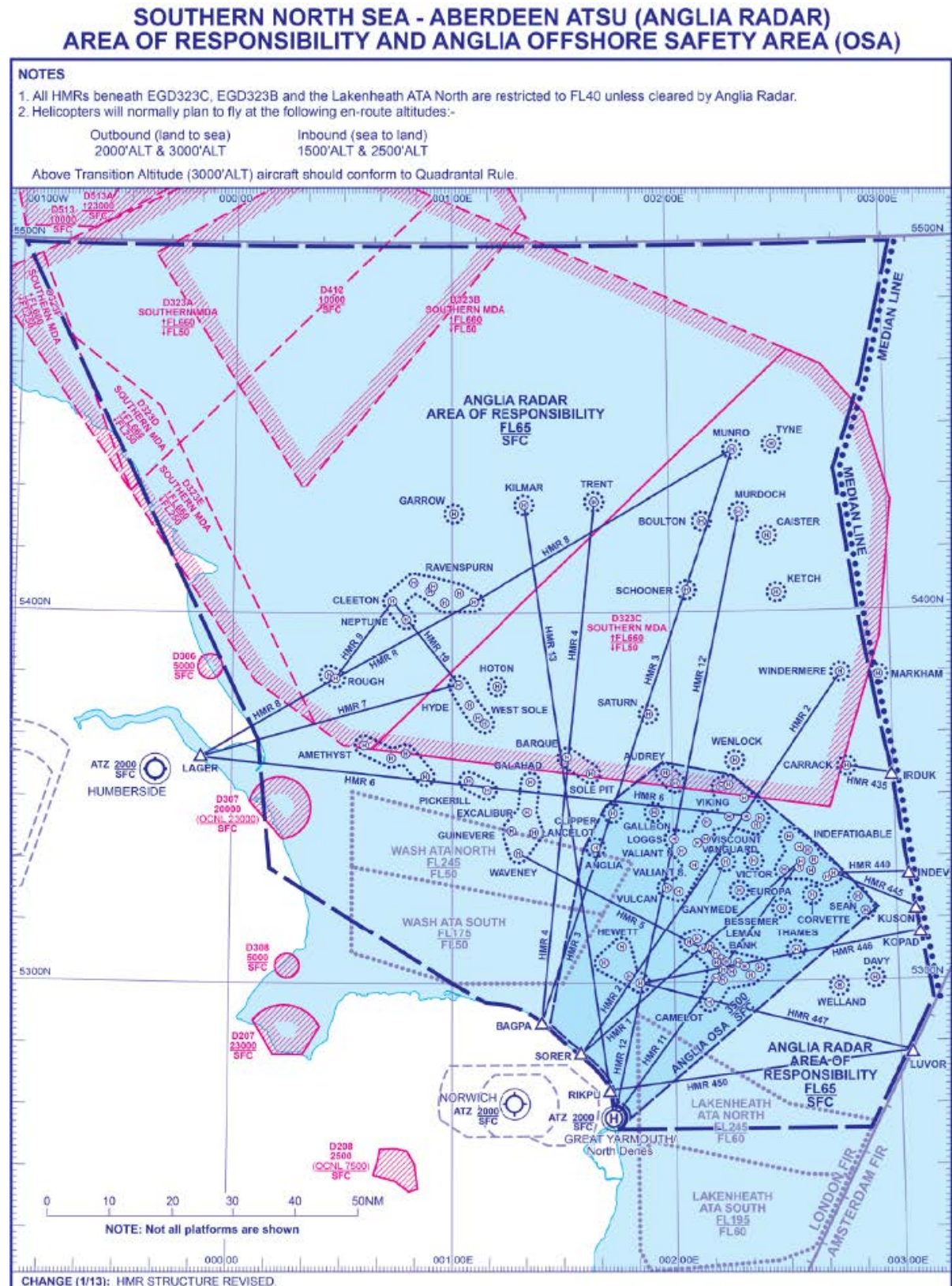
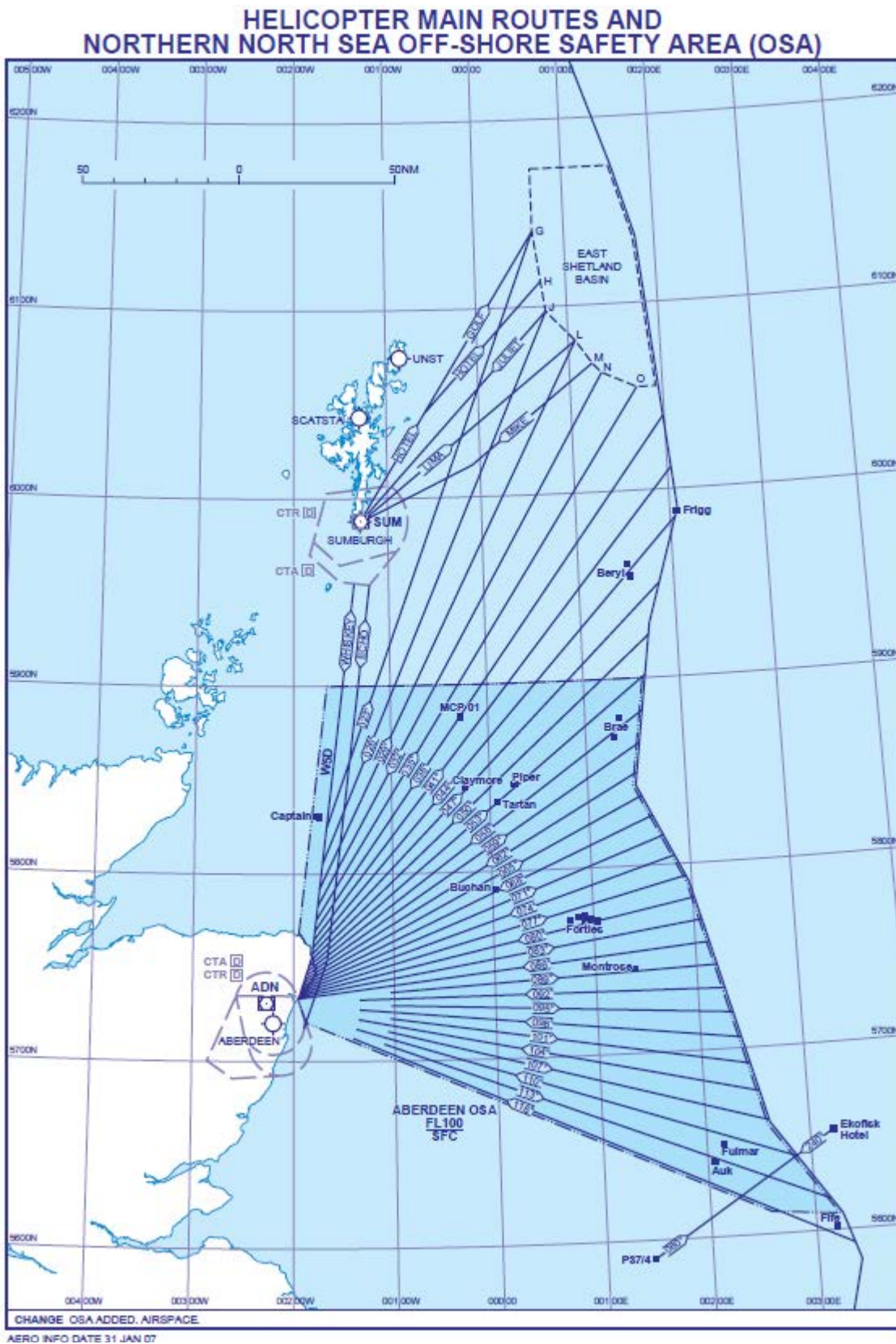


Figure E6 Helicopter Main Routes



3.2.2 Transponder Mandatory Zones (TMZ)

3.2.2.1 NATS Aberdeen has informally suggested that the introduction of TMZ airspace over the North Sea would be “beneficial”.

3.2.2.2 CAA TMZ Policy:

- TMZ policy is detailed within an associated Police Statement (available at http://www.caa.co.uk/docs/33/DAP_TMZPolicyStatement.pdf). This document indicates that:
 - A TMZ may be established for overriding safety reasons, where the airspace classification would not ordinarily require aircraft to carry a transponder.
 - A TMZ is defined, as a volume of airspace where aircraft wishing to enter or fly within the defined area, will be required to have and operate secondary surveillance radar equipment.
 - The dimensions of the TMZ should be of the minimum size to meet the sponsor's specific requirements.
 - Suitable allowance for non-compliant airspace users to gain access to relevant parts of the TMZ where a legitimate requirement exists should be considered.
- The Policy Statement additionally indicates that the establishment of any TMZ shall be in accordance with the Airspace Change Process (ACP) contained within CAP 724, the *Airspace Charter*, and the associated guidance published in CAP 725, the *Guidance on the Application of the Airspace Change Process*.
- The legal status of a TMZ outside UK Territorial Waters (and therefore outside the strict applicability of the UK ANO) has been discussed within an earlier ACP (Thanet/London Array TMZ). Whilst most of the UK FIR lies outside of the 12 NM limit and the CAA routinely faces this ANO-applicability problem, this has not typically inhibited SARG AAA (Airspace) from imposing similar restrictions. In concluding that there is no legal impediment to notification of TMZs beyond the 12 NM limit, AAA (Airspace), Hd S&SM additionally highlighted that the concept of TMZs has already been consulted upon and the introduction of such constructs within the airspace arrangements has already been addressed.
- The TMZ concept is not new and is legally catered for through ANO Schedule 5 coupled with associated notification. The establishment of a TMZ has no related CAS requirement or any proposed change in airspace classification. However, in line with the principles of ESP, fundamental to any proposal for the establishment of a TMZ (or indeed any new airspace construct) is a clear understanding of the current problem, the level of risk, the required outcome and the impact of implementation upon other airspace stakeholders. As has always been the case, AAA (Airspace) must balance the requirements all airspace users.
- In this case, the input received to date provides little more than the headline suggestion that the establishment of a TMZ of unspecified dimensions might provide some mitigation to an unspecified problem associated with helicopter operations over the North Sea. In the absence of the CAA perceiving an over-riding risk to safety that required an immediate change to the airspace structure over the North Sea, the NATS' TMZ suggestion would need to be subject to the ACP as set out in CAP 724/725.

3.2.2.3 Existing North Sea TMZ Work Stream:

- The approved establishment of 2 TMZs (in combination, the 'Greater Wash TMZs') has been subject to full ACP consideration. Approved during 2012, these TMZs will be established to mitigate the impact upon PSR caused by a

complex of wind farms off the Yorkshire, Lincolnshire and Norfolk coasts. A slippage in wind turbine construction time-frames resulted in a delayed requirement for the formal introduction of the TMZ (now expected Q1/2 2014).

3.3 Norwegian North Sea ATM and Airspace Arrangements

3.3.1 Airspace Classification

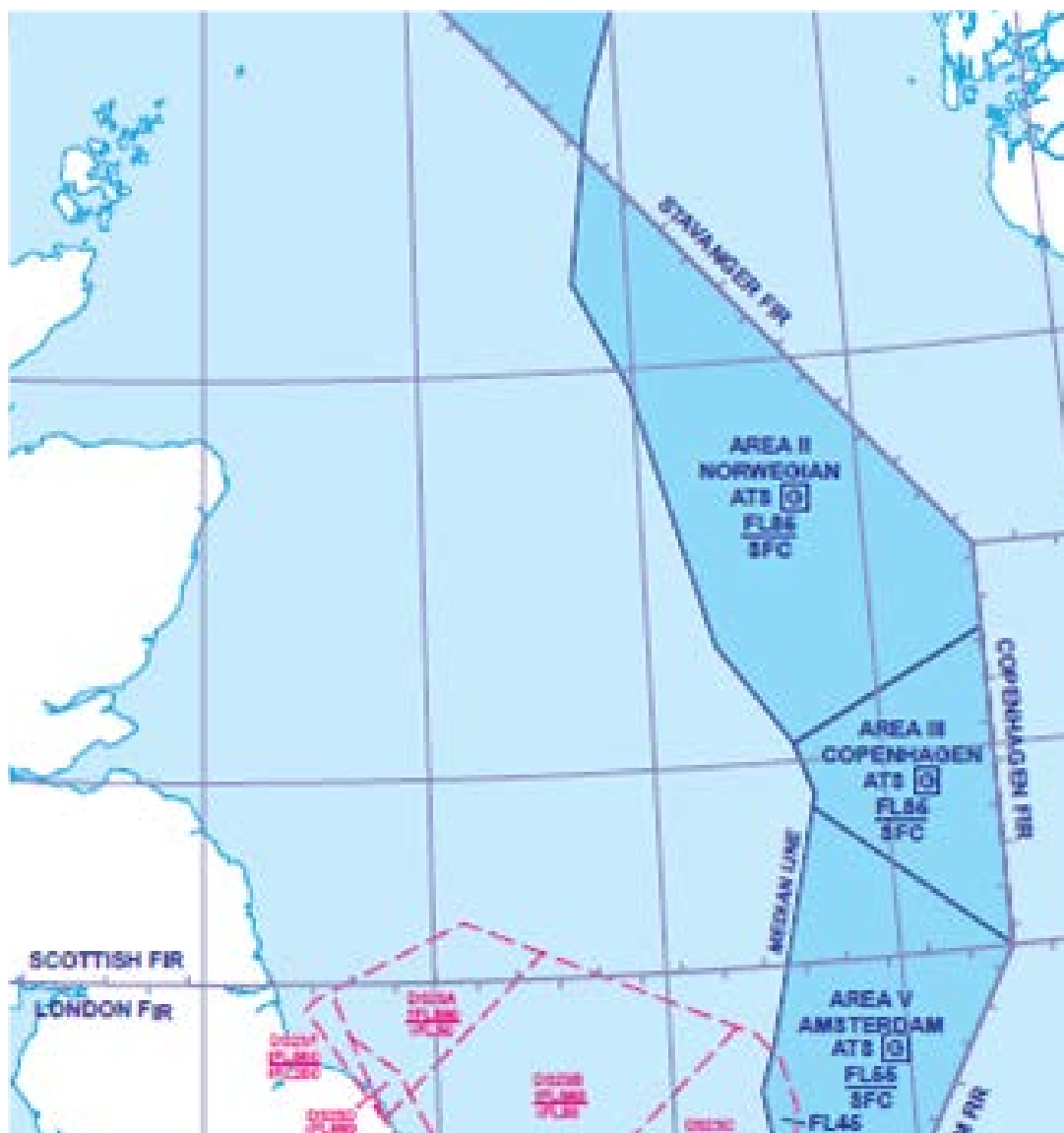
3.3.1.1 It is understood that any Class D airspace established in the vicinity of offshore platforms in the Norwegian Section of the North Sea is supported by a surveillance infrastructure (currently based upon radar stations based offshore) and an RT coverage that allows for 'radio contact with ATS till the helicopter is on deck at all fixed installations'. The progressive roll-out of an ADS-B infrastructure is due to replace the radar based surveillance. The Norwegian CAA report that this combination of surveillance and RT coverage means that, 'ATS has flight information/air traffic control service and alerting service responsibility for the whole flight.' Note that, the establishment of class D airspace within the Norwegian Sectors of the North Sea is apparently supported by a level of surveillance and radio coverage that the UK does not enjoy.

3.3.1.2 The Norwegian en-route ANSP (Avinor) sponsored ACP related to the establishment of Class D Airspace from 1,500 ft up to FL85 around the Ekofisk and Balder fields in the North Sea, is at an early stage of development. Currently, delegated ATSS are provided by Avinor west of the UK FIR and east of the median in the area annotated 'Area II Norwegian ATS in the chart below.

3.3.1.3 The relevant airspaces are:

- Statfjord CTA (based on radar) which was established in 1995, after the Gullfaks offshore (MSSR) radar was installed in 1994. Class E airspace established as this was the highest class it was realistically possible to achieve in international waters. Upgraded to class D in 2011 when Heidrun CTA was established. Statfjord CTA planned to be based on ADS-B from 2015/16.
- Heidrun CTA (based on radar) established in 2012, after installation of Heidrun offshore radar. Class D airspace established.
- Ekofisk CTA (based on ADS-B) will be established November 2014. Class D.
- Balder CTA (based on ADS-B) will be established November 2014. Class D.

Figure E7 North Sea ATM Meridian



- 3.3.1.3 The proposed airspace falls within the jurisdiction of the UK CAA and it has been agreed that an ACP, including associated consultation, will be carried out by Avinor and with assistance from NATS. The project has stalled in its progress due to the grounding of the Super Puma helicopters and the requirement to confirm appropriate RT coverage. Primary radar sources are located on the Norwegian coast and it is also proposed to augment the surveillance capability with ADS-B. Resource issues within Avinor during the summer 2013 had prevented further related progress.
- 3.3.1.4 The UK MoD awaits the receipt of a draft MoU/LoA from Avinor to identify a workable method of operations. The UK MoD has concerns regarding access to the airspace as UK military aircraft are not equipped with ADS-B. Ordinarily, aircraft over 'High Seas' would apply 'Due Regard', however, a state armed force is expected to apply Rules of the Air when within its national airspace. Consultation has yet to be initiated, however, the much awaited MoU/LoA is fundamental to the engagement of the UK MoD. The MoD would not wish to experience any restrictions upon tactical helicopter operations lifting from a ship.

It is also anticipated that seaborne operations will intensify in coming years with the delivery of a new aircraft carrier and the joint strike aircraft fleet.

3.4 Flight Planning

3.4.1 There is colloquial evidence that suggests in the Norwegian Sector all flights are subject to the IFPS, which is a part of the Eurocontrol centralised Air Traffic Flow Management (ATFM) system) an element of the Haren, Brussels-located Network Management Operations Centre (NMOC). Furthermore platforms in the Norwegian sector have ICAO designators, allowing their locations to be entered into the IFPS.

3.5 Summary

3.5.1 The Air Traffic Control (ATC) operations and environment within the North Sea and Irish Sea sectors were reviewed in conjunction with the main ATC service providers and helicopter operators. The review additionally considered the areas where the UK operation varied from that provided in Norway.

3.5.2 Over recent years the improvements in surveillance radar and radio coverage within the North Sea environment have had a significant effect, enhancing the service ATC providers are able to deliver during the en-route phase of flight, to and from the oil and gas platforms.

3.5.3 The airspace in the offshore areas of the London and Scottish Flight Information Regions (FIRs) from East Anglia in the south to the East Shetlands Basin in the north extend from the surface to at least Flight Level 100 and are principally Class G, within which are established numerous military operated airspace constructs (Danger Areas, Managed Danger Areas, Aerial Tactic Areas), the Aberdeen and Anglia Offshore Safety Areas (OSA) and 2 networks (North and South) of Helicopter Main Routes (HMRs) each of which have implications for helicopter operations in the en-route phase of flight. In association with the transition phase of flight at off shore destinations Helicopter Traffic Zones (HTZ) are established in the Southern North Sea as notification of helicopter activity engaged in platform approaches, departures and extensive uncoordinated inter-platform transit flying. Inter-platform flying by civil helicopters within HTZs contained within the Anglia OSA will be conducted on the company or field discrete frequency.

3.5.4 The Norwegian airspace arrangements vary from the UK in respect of the offshore operation, by utilising a higher classification of airspace but which requires the provision of an ATC surveillance capability in order to be managed. This variance was given full consideration, however given the significant reduction in military operations within the North Sea sectors, combined with the current civil / military operator understandings and the absence of evidence to suggest otherwise, it was deemed that the current airspace arrangements for the en-route phase of flight are satisfactory.

3.5.5 During the final phase of flight as the helicopter approaches the rig for landing, communication is transferred from ATC to the heli-deck radio operators, based on board the rig. The UK infrastructure does not support the provision of an ATC service to deck level, or the provision of such a service when helicopters make short shuttle flights between platforms within the oil / gas fields. There is no direct evidence to suggest the current arrangements are unsafe, or unsatisfactory, however in order to better understand operations during this phase of flight, the CAA intends to commission a further report to review offshore communication, handling and flight monitoring procedures.

Annex F Airworthiness

1 Introduction

1.1 Overview

1.1.1 The scope of the airworthiness review encompassed the following areas:

- 1) Background;
- 2) A review of the Aircraft Certification development history and the certification basis of the various helicopter types that make up the UK fleet in offshore;
- 3) For a targeted group of helicopters, a review of:
 - a) Flight Manual entries that prompted a 'Land Immediately' command;
 - b) the MOR database for targeted subject areas that were linked to the 'Land Immediately' command;
- 4) A review of a 5 year (October 2008 to October 2013) pool of technical MOR data to identify any other significant safety issues;
- 5) A review of worldwide accident reports covering the period from 1992-2013 for types operated offshore;
- 6) A review of the process for determining critical parts on helicopters and their maintenance;
- 7) A review of VHM effectiveness and Controlled Service Introduction;
- 8) A review of continuing airworthiness across the operators for the Offshore fleet.

1.1.2 The intention of the review was to assess the status and effectiveness of the current process that are designed to maintain airworthiness standards in Offshore helicopter operations. From the review, several recommendations have been made to improve process and or introduce new processes that will lead to an enhanced level of airworthiness.

1.2 Helicopter Types Reviewed

1.2.1 To order the various work streams and create a structured approach, helicopter types have been allocated a ranking.

- 1 Helicopter Types which are currently in service and which potentially have a long life, large or growing fleets, providing support for offshore operations.
- 2 Helicopter Types which are in service which have potentially reducing fleets providing support for offshore operations.
- 3 Helicopter Types which have or may be phased out or have smaller fleet numbers providing support for offshore operations.
- 4 Helicopter Types which only currently operate in the SAR role or have been phased out.

1.2.2 The rank is not intended to limit the review of any type but depending on the subject reviewed, engineering judgement has been used to determine which

priorities are included. The review in sections 2 and 3 was initially carried out on the rank 1 helicopters. After discussions with the operators this has been extended to the rank 2 helicopters and the results will be published at a later date. There will be further discussion if there is any benefit in extending the review to any of the other types.

Table F1 Helicopter Types Used by UK (including Search and Rescue)

	Helicopter Type	Rank	Year of Entry into Operational Service	UK Fleet size inc SAR
a	AgustaWestland AW139	1	2005	16
b	Eurocopter EC255 LP	1	2005	22
c	Sikorsky S-92	1	2005	26
d	Eurocopter AS332 L2	2	1998	6
e	Eurocopter SA365 C (AS365 N3)	2	1979 (2009)	0 (3)
f	Sikorsky S-76C	2	2006	6
g	Eurocopter AS332 L & L1	3	1982	13
h	Sikorsky S-76A ++	3	1980	0
i	Eurocopter EC155	3	2007	1
j	Sikorsky S-61	4	Pre-1975	2

1.3 Definitions

- **Part-145** is the requirement for approval for organisations that carry out maintenance of aircraft and components used for commercial air transport.
- **Part-M** is the requirements for approval of organisations that manage the continuing airworthiness of aircraft. This includes establishing the maintenance tasks to be carried out based on the manufacturer's instructions.
- **UK BCAR** is the British Civil Airworthiness Requirements. These were the UK requirements used prior to the introduction of Joint Airworthiness and subsequently the EASA requirements.
- **JAR-29** is the Joint Aviation Requirements for certification of the design for large helicopters.
- **Certification Specification 29 (CS-29)** is the EASA Requirements for certification of the design for large helicopters.
- **Certification** is the process of ensuring that the helicopter meets all of the applicable airworthiness standards.
- **Validation** or **Validating** is the process of certifying an aircraft type which is a non-European aircraft type and there is a bilateral agreement or working arrangement in place with that state.

- **The Certification Basis** for an aircraft is the requirements at the time of application and varied in line with the aircraft design as deemed appropriate by the type certificating authority.
- **AMC** – Acceptable Means of Compliance.
- **GM** – Guidance Material.
- **Notice of Proposed Amendments** is the method of circulating draft amendments for comment.
- **TCDS** – Type Certification Data Sheet; the document that records the set of requirements that the aircraft type has been certificated against.
- **Certificate of Airworthiness** is issued by the State of Registry to confirm that the aircraft meets the applicable type certification standards.

2 Certification Requirement Development

2.1 Introduction

- 2.1.1 This Section provides a baseline for the Certification Specifications achieved by the aircraft types that operate in the North Sea. A brief history of these standards is provided along with a brief description of what has changed as these standards have developed through the 1990s to the present day.
- 2.1.2 In order to be used operationally, an aircraft design has first to be approved (certificated) to these standards. An aircraft can be considered 'certificated' when it has been demonstrated to the satisfaction of the regulatory authorities that all the requirements have been met through testing, assessment and analysis. This is normally first completed with the National Authority of the state of design, and where necessary, later 'validated' by other foreign National Authorities. Since 2003 EASA has been responsible for aircraft certification on behalf of European Union member states. The Certification Basis for an aircraft is then considered to be the specific set of certification specifications (standards) that it met during its certification/validation process.
- 2.1.3 The requirements that form the certification standards are formed within the rulemaking body of a National Authority / EASA. In order for the public to comment on a draft rulemaking proposal, EASA publish Notices of Proposed Amendment (NPA) and the FAA publish Notices of Proposed Rulemaking (NPRM).
- 2.1.4 Over the period from the early 1990s up to the present day there has been both a change in ownership of the relevant airworthiness requirements as well as a development in the requirements themselves. From the original UK BCAR G helicopter certification requirements that were current for many years during the early development of helicopters, the requirements have transitioned through the Joint Aviation Authorities in the late 1990s to the current Certification Specifications now overseen by EASA, along with other codes that underpin the certification process such as the organisation design approval (Part-21) which also describes the certification process for new and changed products.
- 2.1.5 Also during this period the continuing airworthiness requirements covering maintenance and maintenance management transferred from UK BCARs through the JAA to EASA Part-M and Part-145.

2.1.6 This section is split into two parts for clarity:

- i) a review of the regulatory developments to the certification requirements for 'Part-29' [which is generic term including the FAA's FAR Part-29 'Transport Category Rotorcraft', and the European JAR-29 and CS-29 'Large Rotorcraft'] since the advent of JAR-29 in 1990, highlighting those changes that may have particular relevance to offshore operations (see paragraph 2.2); and
- ii) a summary of the certification bases of the ten rotorcraft types identified, obtained from the most relevant Type Certificate Data Sheets (TCDSs) in particular showing which if any of the more significant developments from (i) above were incorporated into the product's 'type design'(see paragraph 2.3).

2.2 A Review of Regulatory (Certification) Developments in the Period 1990 to the Present Day

2.2.1 A simple tabular listing of JAR/CS and the equivalent FAR Part-29 rulemaking since 1990, including all affected requirements, was provided by EASA and is presented in Figure F1. This table only lists the base requirements affected (i.e. it does not provide subparagraph information or whether or not the Acceptable Means of Compliance (AMC) and Guidance Material (GM) was also changed. The NPAs themselves can be consulted if this level of information is required). A summary 'timeline' is given below, with the information from Appendix 1 to Annex F reduced to just the titles of the NPAs and with those changes of particular relevance to offshore operation highlighted by underlining. In date order, these are:

- Crash resistant fuel systems (JAA NPA 29-10);
- Occupant protection (NPA 29-6);
- Rotorcraft critical parts (NPA 29-16);
- Vibration health monitoring (EASA NPA 2010-12);
- Damage tolerance and fatigue evaluation of composite rotorcraft structures (NPA 2010-04);
- Fatigue tolerance evaluation of metallic structure (NPA 2010-06).

2.2.2 It should be noted that these developments do not necessarily indicate the introduction of new requirements, but may simply have been wording changes, or changes to the AMC and/or GM. For instance, the 'Critical Parts' regulatory development of NPA 29-16 introduced by JAR-29 Amendment 3, highlighted in Table F2, relates to detailed but potentially significant interpretive changes, whereas the formal base requirement (29.602) was first introduced in the initial issue of JAR-29. The timeline simply indicates that changes were made.

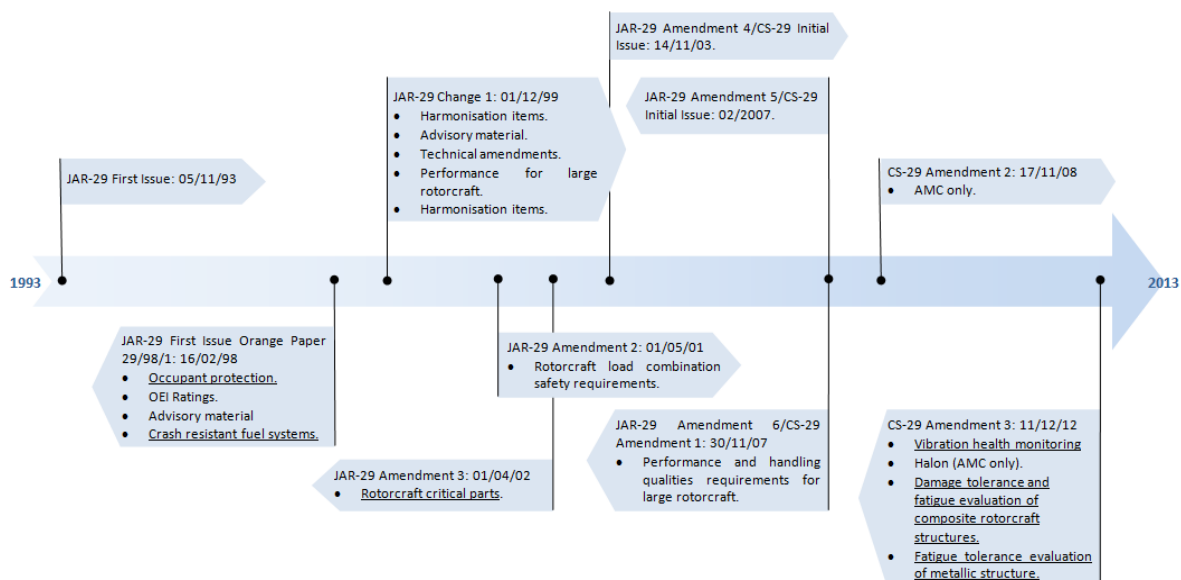
2.2.3 Other key requirements (such as the 29.927(c)(1) the 30 minute gearbox run dry capability test unless "extremely remote") were, by implication, introduced prior to 1990 (1988 in the case of this requirement, through FAR amendment 29-26).

2.2.4 Also, possible future rulemaking, such as that covering the recommendations of the Transport Canada/FAA/EASA 'Joint Cooperation Team' set up following the 12 March 2009 Cougar Helicopters accident and relating to rotor drive system lubrication system reliability, is ongoing.

2.2.5 It should also be borne in mind that the certification requirements from the US and EASA are the requirements the TCHs are expected to meet. In addition to these there are Operational Requirements that the operator (AOC Holder) must comply with, and in the particular case of offshore helicopters, the oil and gas industry impose some additional criteria such as more severe sea states, these are detailed in the Oil and Gas Producers (OPG), Aircraft management guidelines. These additional requirements are placed on the AOC operators in their contacts with the Oil and Gas producers

2.2.6 As demonstrated in Figure F1, significant rulemaking and changes have taken place but the benefits of these new certification requirements will take a while to show tangible benefits as they are mainly applicable to new designs (not derivatives, unless the applicant for a derivative elects to comply with a later requirement or the change itself is deemed significant). These requirement developments are not applied retrospectively to already certificated aircraft.

Figure F1 Summary Timeline of Helicopter Certification Regulatory Developments



2.3 Summaries of the Affected Types' Certification Bases

2.3.1 Table F2 below simply provides the so-called 'reference date' for establishing the Certification (or Validation, if a non-European type) activity and the consequent amendment state of the requirements in place at this time (and thus forms the basis of the responsible Authorities' investigations). Also, the so-called 'twin-brother' concept is employed when establishing the reference date for a Validation exercise. This concept adopts the date of application to the Primary Certifying Authority (PCA) as the reference date for the Validation, with the result that the certification bases for both programmes are of equivalent age. There can be times when the reference date is later than the date of application. This is because, with Part-29 Rotorcraft, the applicant has a five-year period in which the originally agreed certification basis remains valid. If the programme exceeds this, the reference date is reset to a later date in line with Commission Regulation (EU) No. 748/2012 Annex I (Part 21) 21.A.17(b), which is addressed by Action A2 in the main report.

2.3.2 The requirements imposed on the basis of the reference date do not tell the whole story, as it is not unusual for the designers to 'Elect to Comply' with more up-to-date regulations. These are generally, but not always, listed in the TCDSs.

- 2.3.3 Some such elect-to-comply instances are to formally published material, but others are to developments that are the subject of rulemaking or even just potential rulemaking.

Table F2 Reference Dates for Certification for Relevant Helicopter Types

Type	Reference Date	Latest applicable (Part-29) Requirements	Derivative (D) or New (N) Aircraft
AW139	12 March 1999	JAR 29 Amdt.3	N
EC225 LP	7 November 2000	JAR 29 Change 1	D
S-92A	11 April 2000	JAR 29 Change 1	N
AS332 L2	3 March 1986	FAR 29 to Amdt 29-24 [BCAR 29 + Blue Papers]	D
SA365 N3	6 October 1997	FAR Part 29 to Amdt. 29-16	D
S-76C++	16 September 2005	FAR Part 29 to Amdt. 29-35	D
AS332 L & L1	16 July 1980 (L) 18 June 1984 (L1)	FAR Part 29 to Amdt. 29-16 [+ BCAR Section G Issue 8 for L]	D
S-76A++	n/a; none currently operating offshore		D
EC155 B1	16 July 2002	FAR Part 29 to Amdt. 29-40	D
S-61N	9 September 1963	CAR 7, 1 August 1956, Amdt. Including 7-1 through 7-4	D

2.4 Discussion

- 2.4.1 A review of published information on in-service types does not provide a clear picture of the certification requirements with which they were obliged to comply.
- 2.4.2 The level of the detail for the certification bases of the various types provided in the US or European TCDSs is such that only the top level published requirement material is mentioned. The TDCS does not (and is not intended to) provide the precise means by which it was achieved or what assumptions were made in the compliance finding process. Whilst the requirement material often has acceptable means of compliance or guidance material supplied (AMC/GM) the nature of this material (as the name suggests) is optional and there can be differences in the way that manufacturers comply with the Part-29 requirements, based for instance on the configuration or particular design features of an aircraft.
- 2.4.3 Detailed compliance information, not least the assumptions made and the interpretation of the requirement material, is therefore not in the public domain due to it often being of 'commercial in confidence' nature. It should be noted that the TDCS is currently not intended to provide this level of detail – only the certification basis and associated limitations and conditions for the type approval.
- 2.4.4 Although two of the three helicopter types that are likely to see offshore operation in the near future (i.e. the Agusta Westland AW189, the Eurocopter EC175 and the Sikorsky S-76D) are of new design, the proportion of the aircraft in service today (both fixed and rotary wing) that are 'derivative' (i.e. are developed from prior models, rather than of completely new design) is large, as can be seen from

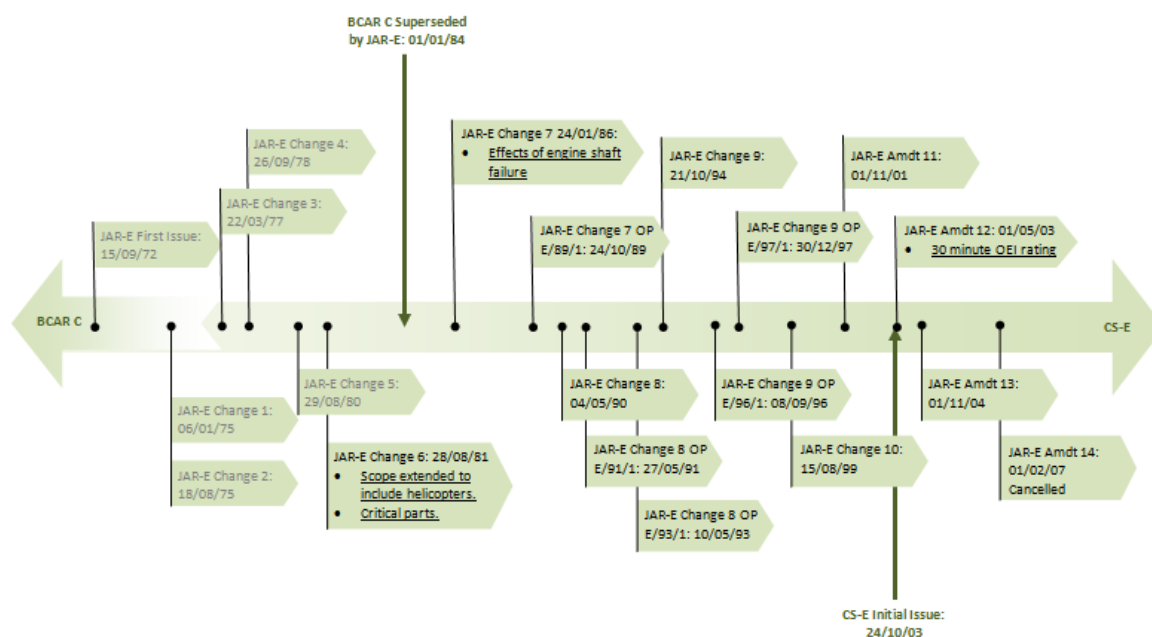
the above Table F2. The applicable type certification protocols for such derivative products are managed in the USA and Europe by the so-called 'Changed Product Rule' [FAR Part-21.101 & JAR-21, then EASA Part-21.101] from the early 2000s, in that areas of an aircraft that are changed, or are directly affected by the change, need to be addressed using the latest published certification requirements unless there is no clear safety benefit in doing so, or it is commercially impractical to do so. Whilst there are some clues in the requirements specifically mentioned, information on the areas of change for a derivative are not directly supplied in the TCDS. It is thus difficult to assess the degree to which compliance with the derivative's declared certification basis has been required or achieved. It would therefore be valuable if EASA was to make sufficient information available in the TCDS to define the complete type certification basis, and for this to include details of the areas of change for a derivative product (i.e. the areas of the aircraft to which the latest requirements apply, and by implication the areas where they do not), to provide a fuller picture of the aircraft's design standard.

- 2.4.5 When undertaking various regulatory tasks required of the CAA, such as Certificate of Airworthiness issue, continuing airworthiness review for the purpose of supporting flight operations, MOR analysis, etc the efficiency of that activity would be greatly enhanced if relevant data was available to the CAA, such as the areas of change for a derivative product (i.e. the areas of the aircraft to which the latest requirements apply, and by implication the areas where they do not), to provide a fuller picture of the aircraft's design standard, when the CAA is undertaking such legitimate regulatory work.

2.5 Engines

- 2.5.1 For completeness, engine types fitted to the current offshore fleet are listed below with their reference dates and nominal applied certification code.
- 2.5.2 Helicopter engines were not specifically addressed by JAR-E before amendment 6 in August 1981. Thus, in the period between JAR-E's initial issue in September 1972 and amendment 6, use was made of existing national codes such as the UK's BCAR Section C. A regulatory change of particular relevance to the offshore helicopter fleet (the 30-minute OEI rating/NPA E-19) was introduced at JAR-E Amendment 12, just before the code transitioned into CS-E (which was equivalent to JAR-E Amendment 13).
- 2.5.3 Due to the low number of purely engine-related occurrences offshore in the period when compared to those for the aircraft as a whole, details of developments to the European Engine code CS-E (formerly JAR-E) are not included.

Figure F2 Summary Timeline of Engine Certification Regulatory Developments



2.6 Discussion

2.6.1 In some instances, similar to the aircraft TCDS, the level of the detail of the certification basis is such that only the top level material is described and little or no information is therefore publically available regarding the precise means by which it was achieved or what assumptions were made in the compliance finding process, and for example, if alternate means of compliance were used. It would therefore also be useful if relevant data was available to the CAA, such as the areas of change for a derivative product, i.e. the areas to which the latest requirements apply.

2.7 Areas for Improvement

2.7.1 In the past, CAA and other NAA staff were fully involved in the certification process (Nationally or through the JAA process) and as such could maintain a closed loop information exchange between; design, certification, continued and continuing airworthiness subjects. The CAA like many other NAA's is no longer included in new product certifications and access to key continued airworthiness information is largely limited to the corrective action information that is made publically available.

2.7.2 The CAA, like other National Authorities, is responsible to undertake various regulatory tasks such as Certificate of Airworthiness issue, continuing airworthiness review for the purpose of supporting flight operations, MOR analysis etc as State of Registry.

2.7.3 In support of the CAA introducing new aircraft types onto its Register and managing in-service issues, improved access to continued airworthiness matters / hot topics would greatly enhance these processes and promote wider awareness of continued and continuing airworthiness subjects. This could be best achieved by enhancing the ongoing dialogue with EASA..

Action 1

The CAA will continue to work to develop the working relationship with EASA, in particular in the areas of sharing airworthiness information and the management of operator in-service issues. This will be achieved by periodic meetings and reviews with the appropriate EASA and CAA technical staff.

3 A Review of Worldwide Accident Reports on Types Operated Offshore Covering the Period from 1992-2013

3.1 Introduction

- 3.1.1 One of the Airworthiness review items was to collate and review helicopter accidents reports arising from investigations undertaken by the AAIB and other foreign agencies, to look at causal factors and assess the closure statements for relevance to this review and completeness. There was also the desire to follow up on any actions identified for the CAA in those closure statements to assess their effectiveness in addressing the causal factors identified in the original accident report.
- 3.1.2 Since 1992, we have identified over 100 accidents to helicopter types that have operated or continue to operate in the offshore. When reviewing that number of reports it is important to assess each for its value and continued relevance for the current/future offshore fleet. The introduction paragraph at the beginning of this Section on Airworthiness identifies which helicopters have been chosen for the review, their ranking and the explanation for the rank.
- 3.1.3 We have differentiated between those accidents where the causal factors were specific to the helicopter type and those that could be considered generic, and not type related. We have also included all fatal accidents, irrespective of their cause or the type of helicopter.
- 3.1.4 Having established this target set of reports related to aircraft types, each report has been assessed for the relevance of the causal factors for accidents offshore. To do this, we have considered that the one key issue that draws an accident into our review is whether the causal factors would increase the risk of ditching. This is the one major discriminant between simply having a review of all helicopter accidents and having a review of helicopter accidents relevant to operations offshore. The reader should bear in mind that although ditching may present a hazardous or catastrophic situation, the regulations provide for survivability, floatation, egress, etc. to minimise the effects. This aspect is also being reviewed under EASA rulemaking task (RMT.120). This is addressed in Annex D Passenger protection.
- 3.1.5 This means we did not consider as part of this review those accidents whose cause would not have increased the risk of a ditching. Examples of such might include a report of a ground run of the engines where the rotor brake had been inadvertently left on, so causing a fire, or where the left front passenger door fell off because the door jettison lever had been operated in error. There were a number of such examples that were not assessed from the accidents that to studied, so reducing the target population.
- 3.1.6 There were examples of course of accidents that have been caused by what we have termed 'generic' factors. These have been included in the study although they may not at first sight be considered as being associated with operations in the North Sea. These include tail rotor failures that resulted in a loss of control

and required an immediate autorotation descent or the failure of a maintenance crew to properly secure an engine cowling that subsequently departed in flight, striking the tail rotor. This could have led to a structural failure of the tail rotor blade and subsequent loss of control. Both these examples highlight the principal we have used of considering all causes that lead to an increased risk of ditching.

3.2 Review of Recommendations

3.2.1 The review has considered the following:

- A compilation of all helicopter accident reports both UK and worldwide from 1992 to 2012;
- A determination of the target population of those reports, as noted in the paragraph above
- A review of those reports in the target population, identifying type specific and generic causal factors, whether the cause was design, operational, etc., reviewing any Recommendations made to the CAA and any responses made to those recommendations.

3.2.2 This has been completed but further work is planned to ensure that we have captured all of the important information as the retrieval of the records is not a trivial task. Please also refer to Annex C, Review of Accidents. However, over the last eight years, the AAIB have been assessing the accidents they have investigated and identifying causal factors, contributory factors and consequences, and additionally have attributed a confidence rating to the data. Based upon this accident assessment, the AAIB have begun safety studies where the data merits it, and indicates common themes where a different approach may be required. This is a recent development and to date only one such review has taken place. The AAIB have been providing the CAA with the data.

3.2.3 We have identified a need for a CAA management system that provides a structured review of all accident reports and recommendations, both UK and foreign – as they apply to the UK fleet – to ensure a cohesive, fully joined up assessment of accident causes, components, themes and remedial actions. This will prevent the potential segregated nature of accident reviews and ensure there is a continuous assessment of safety critical issues that continues year on year, providing an historical timeline of cause, effect and remedy. Such a system will also ensure the remedial actions are effective - and if not, to ensure other actions are put in place that are monitored for effectiveness. This process should include all NAAs operating in the North Sea and EASA.

3.2.4 We have also concluded there is also the need for further review of the responses and closure statements made to other organisations that have been made in connection with the accident report Recommendations to ensure that:

- the closure statement was / remains appropriate;
- any promised actions actually did happen; and
- the actions taken are addressing the causal factors of the accident i.e. that they are effective.

3.2.5 Traditionally the CAA respond to AAIB Recommendations made to the CAA, with technical management oversight of the quality of the response and any activity on actions that may have been promised. Since 2011, the CAA has formalised this

activity, with two processes for dealing with AAIB Safety Recommendations, one for recommendations directed to the CAA, the other for recommendations directed to organisations which the CAA has regulatory oversight of. Both require active follow up either internally within CAA or externally with the affected organisation, to ensure that effective closure actions have been accomplished. (Ref. CAA AAIB Safety Recommendation Process 04-01-2011)

- 3.2.6 The SARG Leadership Team has also introduced a 'Dashboard' for tracking various performance indicators, one of which is the closure status of AAIB safety recommendations directed to the CAA. This process ensures high level awareness of whether we are meeting the timescales given to the AAIB in relation to the actions we have agreed to take in response to a Safety Recommendation. The closure of such a recommendation is not agreed by the Safety Data Department until the actions have all been completed and related documentation published. This ensures actions are not 'lost' within the business when people move from department to department or protracted timescales are involved due to the need for research and or the assistance from third parties.
- 3.2.7 It is believed that the control of the closure of AAIB Safety Recommendations directed to the CAA and those we regulate is now robustly managed. However, the documented evaluation of whether the actions implemented in response to these recommendations have been effective is not currently undertaken or coordinated by the Safety Data Department.
- 3.2.8 To that end, the earlier suggestion of a management system that reviews accident causal factor trends in North Sea could be expanded to include a review of closure statements and the effectiveness of any closure actions.
- 3.2.9 The total number of Recommendations made in the accident reports we have reviewed is approximately 250 and, of those, 34 have been made to the CAA, which are associated with airworthiness issues. Although all are now closed, many have been closed on the basis of some ongoing action - such as issue of an Airworthiness Directive etc., which are simple to validate as having been completed. Investigations are continuing, however, to ensure that all actions that have been identified as part of the closure statement have indeed been completed. The CAA has raised Action A1 to address this issue.
- 3.2.10 Recommendations:

Recommendation 1

It is recommended that EASA leads the development of a closed loop management system that provides a structured review of all accident reports and recommendations of helicopters operating offshore including those that could lead to a ditching. This should be done in collaboration with other North Sea NAAs and the CAA to ensure a cohesive assessment of both accident causes (looking for trends) and remedies (looking for suitability and effectiveness) in order to potentially prevent the segregated nature of accident reviews and ensure there is continuity to the safety reviews.

Recommendation 2

It is recommended that EASA involve NAA's annually with a forum to agree and exchange information on the performance of safety actions taken in line with accident investigation recommendations and potential other improvements that could be adopted, where appropriate.

3.3 Accident Causes

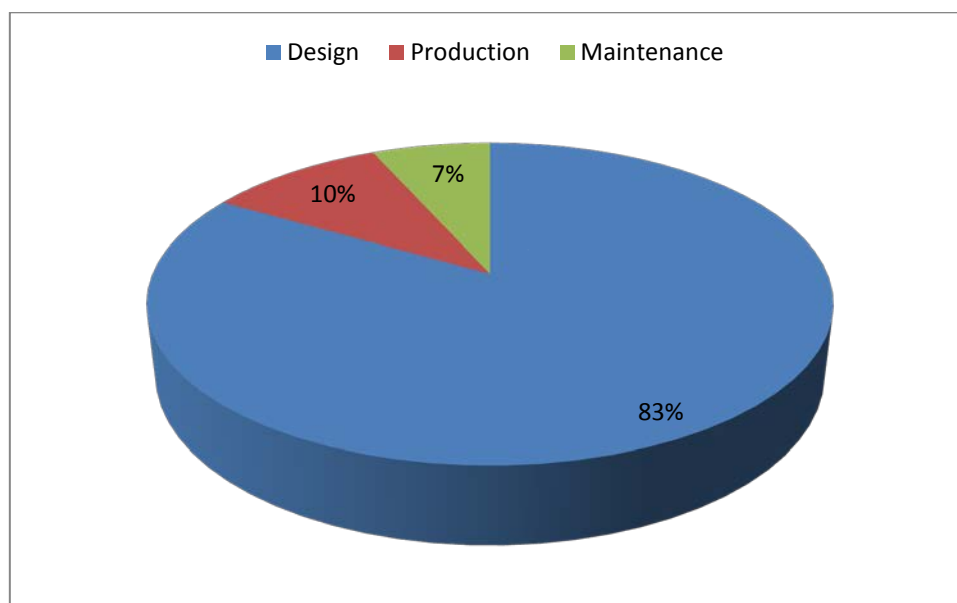
3.3.1 As noted above, the review assigned very generic causal factors to those accidents that were determined to be of particular relevance to safety in the North Sea, especially if they could possibly result in ditching of the helicopter. Many accidents were caused through a combination of issues, and although we have not attempted to rank the individual factors, we have broken down the design causes into the top five issues.

3.3.2 Over 100 accidents worldwide have been identified and of these 50 have been prioritised as either having occurred in the North Sea or having a cause that could have required a ditching if it had occurred offshore. Of these 50 reports 30 of them have been categorised as being of technical primary cause, rather than due to operational or environmental issues. The chart below at figure F3 gives a schematic picture of the how the technical causes of these accidents can be partitioned into their general subject areas. It should be noted that this data differs from that discussed in Annex C because the range of accident reports considered in this review included reports worldwide, as opposed to Annex C that only looked at reports associated directly with the North Sea operation. However from the data in Annex C, there is a clear step change in the accident rate that coincided with the introduction of Health and Usage Monitoring Systems (HUMS) in offshore operations.

3.3.3 The technical general descriptions are:

- Design - the cause was related to a failure in some aspect of the design, which when changed, for example by modification or amendment to instructional information, should prevent a recurrence of the incident
- Maintenance - related to some failure in the maintenance of the aircraft, such as bolts not being replaced in a fairing, this therefore includes Engineer Performance
- Production - Components / parts / fabrications not conforming to the design drawing or other deviations in the process.

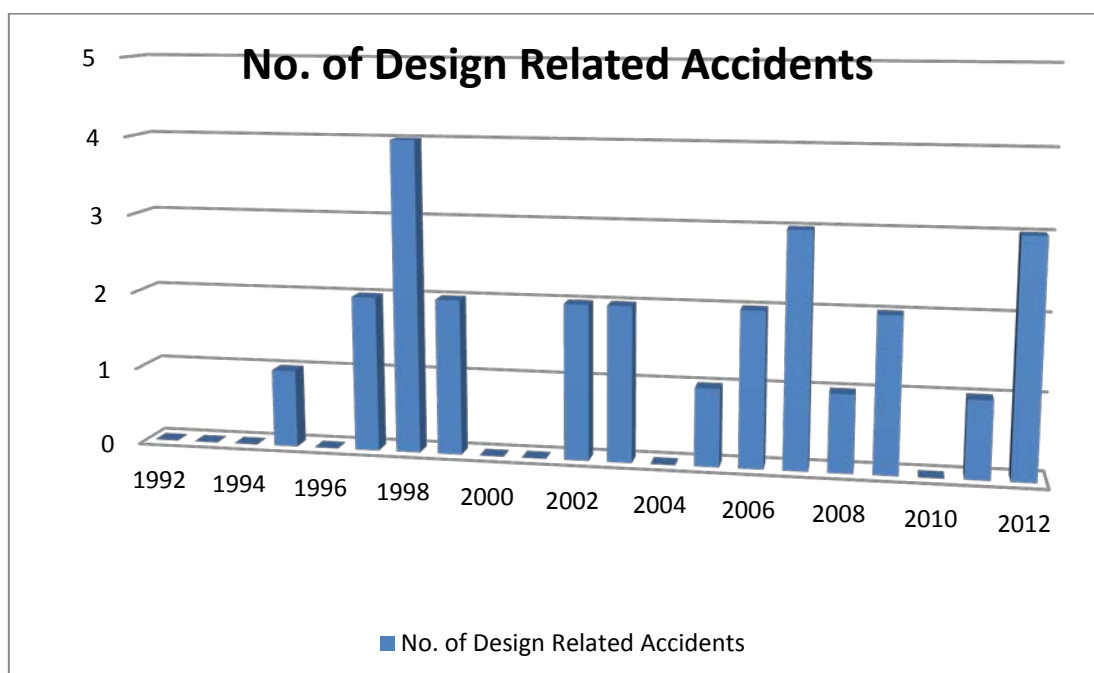
Figure F3 Causal factors



3.3.4 This group has not been ranked according to their severity, and they range from minor incidents to catastrophic accidents..From this high level review, although it is clear that causes arising from design aspects account for the major share of the target group of accidents, it is not possible at this time, therefore, in lieu of a more detailed analysis, to draw specific conclusions as to the real contribution made by design causes to offshore safety. Of the events attributed to design causes, the top five areas that have contributed are:

- Main Gear Box and transmission system - 20%
- Electrical - 20%
- Engines - 15%
- Horizontal Stabiliser - 11%
- Main Rotor Blade - 11%

Figure F4 Number of Design-Related Helicopter Accidents Per Year



3.3.5 Figure F4 is a simple chart of number of design related accidents which does not take into account parameters such as operating hours / cycles etc, hence does not indicate normalised rates. This simple view therefore does not indicate any specific trending.

3.3.6 Caution needs to be applied when drawing conclusions from this raw data. For detailed and meaningful conclusions to be drawn from this data, e.g. breaking the data into causal versus contributory factors and then ranking that data, greater analysis would be required. This is covered in Recommendation 3 above.

3.4 Broader Ramifications of Causal Factors

3.4.1 Recent offshore rotorcraft accidents have highlighted component features that have contributed to the failure of the component. These features have arisen either by design and or production practices. Once highlighted by the Accident Investigation the rotorcraft manufacturer has taken steps to eliminate these features from the specific item that failed, often referred to as “corrective action”. In line with good quality assurance practice, similar action should also be taken where similar features have arisen in the manufacturer’s total product line and eliminate them where necessary. The Type Certificate Holder is responsible for

design as part of his EASA Design approval and EASA is responsible for overseeing compliance with the design requirements. The continued acceptability of the design and associated changes are also part of the EASA's remit as well as the interface between production and design.

3.4.2 In one accident, there was only one maintenance intervention (chip detection) that could have prevented the accident, but due to human factors, the gear box degradation was missed. In large transport aeroplanes it would be expected that there would have been at least two or three maintenance interventions that would have detected component degradation prior to failure and as such a similar level of margin should be the common goal.

3.5 Recommendations:

Recommendation 3

It is recommended that EASA introduces procedures to monitor and track the efficiency and reliability of maintenance interventions when these are used during the certification activity to assure the safety target of the rotorcraft.

Recommendation 4

It is recommended that EASA ensures that the Type Certificate Holder completes a design review following a failure or malfunction of a component or system on any other similar feature on that aircraft type or any other type in their product line and defines appropriate corrective actions as deemed necessary.

4 Failures Advising 'Land Immediately'

4.1 Overview

4.1.1 The purpose of this review was to identify potential failure conditions (system components) which could result in "Land Immediately" (L.I.) Rotorcraft Flight Manual (RFM) required action and review system reliability associated with such failures. The relevance of this exercise is to identify where a command to land immediately would probably result in a ditching, when undertaking offshore operations.

4.1.2 In the preliminary stages of the activity, three specific helicopters types were identified as priorities for review, (the Eurocopter EC225, the Sikorsky S-92 and the AgustaWestland 139). From this we reviewed the current Type Certificate Holders' (TCH) Rotorcraft Flight Manuals (RFMs) available to us as detailed; where available we also reviewed RFM Supplements in order to determine additional conditions.

Table F3 Flight Manual Details for Relevant Helicopter Types

	AW139	S-92	EC225
RFM Reference	AW 139-4D	S-92 - Basic RFM SA S92A-ETM-RFM-003 Version 25.2 - including TREVS - Excluding supplements at the moment	EC225 – RFM RN 17 (dated 13-15 for main RFM). Accessed on Keycopter; main RFM, plus Supplements
Dated	5/9/2013	June 2013	August 19 2013

4.2 Summary of Information / Picture Formed

- 4.2.1 In our review we noted that in addition to the explicit “LI” RFM required action, there are also a number of events which result in a “Land Immediately” condition, but are not specified directly in the RFM, as they are implicit in the action required to be taken. Such examples include tail rotor drive failure and double engine failure.
- 4.2.2 Table F4 below provides an overview of those conditions which may result in an L.I. event, which is very much dependent on the individual circumstances associated with each event.
- 4.2.3 Broadly the types of event identified were similar between different helicopter types; although there were some differences, such as rotor brake failure. All three helicopter types have rotor brakes fitted; however, only the S-92 has a rotor brake fire procedure which specifically requires a “LI” condition; for the EC225 and AW139 similar procedures (for fire) do not exist.

Table F4 Overview of Conditions Which May Result in a 'Land Immediately' Event

RFM Procedure Title	S-92	AW139	EC225	Comment
GEAR BOX / TRANSMISSION SYSTEM MALFUNCTIONS	L.I.	L.I.	L.I.	AW139 has 30 minute run dry capability.
MAIN GEARBOX OIL PRESSURE/ TEMPERATURE CAUTION	L.I.	L.I.	L.I.	None
MAIN GEARBOX COMPARTMENT FIRE	N/A	N/A	L.I.	Only EC225 equipped with detectors.
TAIL/INTERMEDIATE OIL HOT/CHIP	L.I.	LASAPr	LASAPo	S-92 L.I. is conditional.
SWASHPLATE TEMPERATURE	L.I.	N/A	N/A	Only Sikorsky equipped with this system
ENGINE FIRES	L.I.	L.I.	L.I.	For S-92 land immediately only if signs of fire persist / whereas for the AW139 and EC225 it is land immediately if warning persists.
APU FIRE	L.I.	N/A	N/A	APU standard on S-92 optional on EC225 (ground use only)
CABIN OR COCKPIT FIRE (Baggage Bay)	L.I./ LASAPo	L.I.	L.I./ LASAPo	Dependant on severity
LOSS OF TAIL ROTOR THRUST IN FORWARD FLIGHT		N/A		AW139 has sufficient fin area to sustain forward flight; S-92 and EC225 require immediate entry to autorotation.
LOSS OF TAIL ROTOR THRUST IN A HOVER		L.I.		None
TAIL ROTOR CONTROL SYSTEM FAILURE Forward Flight	LASAPr		LASAPr	AW139 has extensive procedures.
TAIL ROTOR CONTROL SYSTEM FAILURE Hover	N/A	L.I.	L.I.	None
ROTOR BRAKE	L.I.	LASAPr	LASAPo	Only S-92 specifically addresses rotor brake fire

RFM Procedure Title	S-92	AW139	EC225	Comment
Single Engine Failure				Single engine failure could result in an immediate landing in some circumstances. When operating Performance Class 1 (Category A) over suitable terrain (e.g. an airfield) this would not be critical. For landing and take-off offshore there will be occasions when an immediate landing is required

Key	
L.I.	Land Immediately
	No explicit procedure to "land immediately, but implied by the failure condition and/or procedures.
LASAPo	Land as Soon As Possible
LASAPr	Land as Soon As Practicable

- 4.2.4 The actions required following the instruction in the RFM to LASAPo and LASAPr do vary between manufacturers. However, in general, one can say that LASAPo requires the helicopter to land at the nearest site at which a safe landing can be made whereas LASAPr does not recommend extended flight and the landing site and duration of the flight are at the discretion of the pilot.
- 4.2.5 In order to assess the occasions on which these component and system failures may have occurred, all 550 reported MORs for these three helicopter types have been reviewed over the five-year period from 2008 - 2013, in order to identify, where possible, those MORs which could have resulted in an L.I. Where relevant these MORs have been referenced in the paragraphs below.
- 4.2.6 The main driver for undertaking this piece of work was firstly to identify the system components that could cause such a failure and possible ditching and secondly to review the system reliability for such components.
- 4.2.7 The second part of this work, the system reliability assessment, requires input from TCHs, FAA and EASA. Due to the size of this exercise and the number of participants, this work is not included in this report. This will require a more detailed analysis be undertaken of all components which contribute to an L.I. event, and assess the in-service reliability data against reliability predictions established during certification. Such data should be available from the helicopter certification documentation (SSA, FMEA etc.) for a more detailed analysis. A Recommendation that such an exercise be carried out is included in the list at the end of this report.

4.2.8 Although outside the scope of this review, engine and MGB failure conditions that contribute to an L.I. event should have in-service reliability data compared with similar data from the Norwegian operators, in order to identify any significant differences.

4.3 Areas of Note

4.3.1 Review of 'Land Immediately'

4.3.1.1 The review of the component and systems failures that prompt a "LI" RFM action did not raise any significant issues. Not surprisingly there are many failures on helicopters which result, or can result, in "L.I." depending on circumstances. However, there were a number of items listed below that highlight apparent differences between different helicopters as well as specific L.I. actions:

4.3.2 MGB

4.3.2.1 MGB failure has resulted in 3 of the recent North Sea ditchings/crashes and a series of issues on the S-92 in non-EU operations. It should be noted that the S-92 fatal accident (Cougar Flight 91 TSB Report A09A0016 12 March 2009) was partially due to different perceptions by the flight crew of the capabilities of the gearbox following loss of all oil. This highlighted the need for clearer actions in the RFM that must be adhered to (see also Engine Bay Fire below). Note that following the S-92 and EC225 MGB issues, the systems and RFM procedures have been under review and improvements made by the TCHs and regulations.

4.3.3 Engine Bay Fire

4.3.3.1 The EC225 and AW139 RFMs require L.I. if a FIRE warning persists despite activation of the extinguisher bottles. The S-92 requires L.I. if fire is not extinguished. The exact intent would need to be confirmed with Sikorsky but it would appear that L.I. would only be required if there were positive signs of the fire persisting not just the warning. The AW 139 had no false (or real) warnings reported. For the EC225 over the past 5 years (review period of MORs for the OHSR) there were 9 MORs submitted in relation to fire warnings in flight (and 3 on the ground). There were no actual fires and therefore they were false warnings. If the RFM procedure had been followed, e.g. the fire extinguisher had been discharged, then there could have been several ditchings/forced landings. The S-92 had 9 warnings reported in the same period but there were no actual fires and therefore they were also false warnings. But as there were no actual signs of fire this would not have led to ditchings/forced landings. Note, the Flight Operation requirements include a requirement for operators to produce a flight operations manual and associated checklists to reflect the content or the intent of the RFM. In all cases (as far as can be determined from the MORs), the fire extinguisher bottles were not discharged as required by the emergency procedure in all cases (as far as can be determined from the MORs). This gives rise to a number of concerns:

- a) The potential for unnecessary ditchings.
- b) The potential for frequent false warnings could lead flight crew into not believing the warning is an issue as this could result in a genuine fire not being addressed as quickly as one would expect, this is a human factor consideration
- c) The crew is expected to follow the RFM and could be culpable if a L.I. instruction is not respected (in the case of a genuine fire) or equally

criticised if L.I. action is taken for what transpires to be a false warning especially if there was subsequent loss of life in the ditching.

4.3.3.2 The number of false engine fire warnings has been a known problem to offshore operators and this review has highlighted the extent and potential significance of these issues. The flight crew interpretation of the RFM has therefore been to look for positive confirmatory signs of fire before committing to any other actions. At least one operator has felt it necessary to take further steps by fitting rear view mirrors to assist in diagnosis, i.e. add a further mitigation / barrier.

4.3.3.3 In comparison the EC225 MGB compartment fire emergency procedure only requires L.I. if *both* warning captions illuminate (single warning caption only for engine bay fire) greatly reducing the probability of an incorrect action being taken as the MGB has a twin detection system. So, as long as the cumulative detection systems are serviceable and functioning this offers a further barrier to minimising a potential unnecessary ditching.

4.3.4 Rotor Brake Fire

4.3.4.1 The S-92, EC225 and AW139 have rotor brakes fitted (optional on AW139 but likely to be fitted for offshore operations); however, only the S-92 has a rotor brake fire procedure which specifically requires a “Land Immediately” condition. For the EC225 and AW139 similar procedure do not exist (for fire) but if the condition occurs may result in the pilots deciding to land immediately, dependent on conditions / decision-making under the circumstances. Some differences may be as a result of specific design differences which require further investigation.

4.3.5 Engine Failure

4.3.5.1 Single engine failure could result in an immediate landing in some circumstances. When operating Performance Class 1 (Category A) over suitable terrain (e.g. an airfield) this should not be critical. For landing and take-off offshore there may be occasions when an immediate landing is required. When hovering over the helideck this should not result in an accident, because the helicopter can land back onto the helideck. During transition to/from forward flight at the helideck, failure could result in a reject into the sea or, for a very brief exposure period, contact with the edge of the helideck and subsequent serious incident /crash. Note that this is addressed in JAR-OPS 3.517 “Operations Without an Assured Safe Forced Landing Capability” (also known by the previous title of “exposure”). This quantifies the risk and requires mitigations such as a Usage Monitoring System (UMS). Such a system is normally embedded within the HUMS/VHM system. This applies to all offshore helicopter types but some will be less susceptible due to a higher power/weight ratio. Risk will also be a function of atmospheric conditions, reducing with higher winds and lower temperatures.

4.3.5.2 As all current offshore helicopter types have two engines, failure of both engines would of course result in an immediate landing. Helicopter gliding distance is very poor compared to fixed-wing combined with generally relatively low cruising altitudes means that the most likely outcome is to ditch.

4.3.6 Swashplate Temperature

4.3.6.1 The swashplate is the component that translates the flight control inputs from the pilot into blade lift and the direction of that lift. Only the S-92 has a warning for high swashplate temperature which is possibly due to particular aspects of the design and the criticality of the potential failure modes. The S-92 procedure is multi-stage and unlikely to result in a ditching due to a false warning.

4.3.7 Loss of Tail Rotor Thrust

4.3.7.1 Loss of tail rotor thrust in the hover or transition to/from hover will most likely require an immediate landing and could have serious consequences if the failure occurred on a helideck. All helicopters operating in the North Sea will have similar failure characteristics.

4.3.7.2 The consequences of loss of tail rotor thrust in forward flight vary between helicopter types. As we understand it, the EC225 and S-92 cannot maintain powered flight, in this failure mode and would therefore require immediate entry to autorotation. CAA Paper 2003/1 (Helicopter Tail Rotor Failures) discusses the research work undertaken and concluded that it is possible that the entry may not be successful in some conditions due to extreme sideslip. According to the RFM, the AW139 can maintain powered flight following loss of tail rotor thrust (with sideslip) and immediate landing is not required. An engine off landing at an airfield would be required which is not without its risks but preferable to an immediate ditching. It is therefore recommended that CAA Paper 2003/1 is reviewed to determine if the recommendations have been followed through.

4.3.8 Electrical Fire

4.3.8.1 The AW139 has a L.I. for the worst case electrical fire. The EC225 and S-92 only state LASAPo but further action would be taken if the crew felt it imperative.

4.3.9 Recommendations/Actions

Recommendation 5

It is recommended that the helicopter Type Certificate Holder identify all major components or systems that could lead to a L.I. condition to ensure themselves that the actual reliability data available from the operators is validating the assumptions made at the time of certification. It is recommended that this review is overseen by the regulator for the State of Design.

Recommendation 6

It is recommended that EASA/Type Certificate Holder confirm the number of false engine fire warnings, investigate the reasons for them and determine/take actions that may be necessary to address this important safety issue.

Action 2

The CAA will review CAA Paper 2003/1 (Helicopter Tail Rotor Failures) to determine how well the recommendations have been taken forward and to assess if further action is necessary. The conclusions of this review will be discussed with EASA.

Action 3

The CAA will review human performance aspects of flight crew responses to engine bay fire warnings, specifically under the scenarios for offshore operations.

4.3.9 Conclusion

- 4.3.9.1 From this review of the failure conditions that could lead to a L.I. action as required by the RFM, the MOR data of actual in-service reported incidents has shown there is one area of potential concern - this is for the EC225, Engine bay fire warnings that should require a L.I. action but prove to be spurious. It would appear these are being assumed by crews to be spurious. Clearly, the frequency of engine bay fire warnings is not an acceptable situation and requires review by EASA and Eurocopter. Similarly, the response by crews is worthy of further assessment by CAA flight operations.

5 A Review of MOR Data

Period chosen for review:	October 2008 – October 2013 This was to establish a reasonably stable number of MOR's for the types, due to the differing introduction dates into offshore service.	
Aircraft types covered by the initial cut:	Eurocopter EC225	191 MORs assessed
	AgustaWestland AW139	192 MORs assessed
	Sikorsky S-92	161 MORs assessed

5.1 MOR Types Assessed by Airworthiness

- 5.1.1 All airworthiness technical MORs for the above types were initially extracted then any MORs listed under Primary Error Factor as 'Maintenance' or 'Technical Malfunction' was selected for assessment. The analysis was carried out by Technical experts from a selection of relevant backgrounds. . Note, the number of MOR's per aircraft type is not a direct indication of safety performance, as the incidents vary in severity and the reporting in itself has some degree of variation.

5.2 Analysis

- 5.2.1 An analysis of MORs has been carried out and a prime system failure for each identified. The top 6 issues for each type have been identified and are detailed below:

(NB. In Table F5 below a 'Chip' should be understood to be a small particle of metal and the term MRGB relates to non-chip gearbox issues)

Table F5 Most Common Maintenance or Technical Malfunction Primary Error Factors Identified in Helicopter MORs

AW139	192	EC225	191	S-92	161
Autopilot	8%	Chip	15%	MRGB	12%
Hydraulics	4%	Fire	9%	Fire	7%
Chaffing	4%	Oil	6%	Autopilot	6%
Chip	3%	Hydraulics	4%	Hydraulics	6%
Control restrictions	3%	MRGB	4%	Oil	5%
Tail rotor	3%			Chip	4%

5.2.2 All other MOR reports cover a wide variety of causes, were low in numbers and no common themes were identified.

5.2.3 It should be noted that there is a difference between causes that are associated with MORs that identify Chips and MRGB, and so these should not be seen as one and the same. The 15% of “Chip” occurrences were related to an increase reports after an accident on a Super puma. The 12% of MRGB reports on the S92 were related to a specific issue on cracking of the gearbox. Both of these issues have been addressed by Airworthiness Directives and modification.

5.3 Observations

5.3.1 Although the percentages don't show any major trends, experience of accident analysis has shown that one or more of these could be part of the accident chain.

5.3.2 One significant issue that was of note was fire MORs. The majority of the 'Fire' categorised MORs relate to spurious warnings. This seems to be having an effect on the way that Fire warnings are being treated in service. One of the S-92A MORs relates to fire warnings on 3 consecutive sectors (1 in-flight return and 2 abandoned departures) with a hot gas leak only being discovered after the third attempt. Another S-92A MOR described a hot gas leak which was initially treated as a spurious fire warning. The reporter was prompted to voice concerns that the large number of spurious fire warnings had caused this event to be treated as such initially.

5.3.3 The CAA is aware that not all service difficulties experienced by operators are reportable MOR's, these service difficulties can however reveal underlying issues that may in themselves contribute to incidents and accidents. It would therefore be of benefit for CAA and the operators to regularly compare the risk picture painted by MOR's in conjunction with their service experience to identify issues that the MOR scheme may not highlight. It is also considered that this should be shared more widely / collectively with the offshore operators on an annual basis.

Action 4

CAA Airworthiness will meet with offshore operators periodically to compare the trends of MOR's with operator in service difficulty / reliability data to ensure that the complete risk picture is captured and addressed.

6 Critical Parts

6.1 Introduction

6.1.1 This Section provides an overview of critical parts on a helicopter, how they are currently defined, what the requirement basis and history is and a review of the design, production and maintenance aspects, with specific reference to a number of helicopter types operating in the Offshore environment.

6.1.2 A “critical part” is a part the failure of which could cause a catastrophic event and additionally, to meet the design criteria, it requires a high level of integrity. Parts are typically identified as critical by a Failure Mode and Effects Analysis (FMEA) during the design and certification of the helicopter. To assure a high level of integrity of the parts a Critical Parts Plan is established by the rotorcraft manufacturer that identifies and controls the part's critical characteristics. Additionally, the Instructions for Continued Airworthiness (ICAW) and Overhaul Manuals should clearly identify critical parts and include the necessary

maintenance and overhaul instructions. Specifically these documents should specify:

- Comprehensive instructions for the maintenance, inspection and overhaul of critical parts and emphasise the importance of these and other special procedures/practices.
- Indicate to operators and overhaulers that unauthorised repairs or modifications to critical parts may have hazardous consequences.
- Emphasise the need for careful handling and protection against damage or corrosion during maintenance, overhaul, storage, and transportation, and the need for accurate recording and control of service life.
- Require notification to the manufacturer of any unusual wear or deterioration of critical parts and the return of affected parts for investigation.

6.2 Requirements Review

6.2.1 The helicopter “critical parts” requirement concept can be traced back to BCAR Section G (November 1975) which applies the requirement to the rotor and transmission system only. The requirement is developed and refined in BCAR Section G Blue Paper G778 (October 1985) and BCAR 29 (December 1986). JAR-29 applies the requirement to any part/component that could cause a catastrophic effect to the rotorcraft, and this is continued although refined in all subsequent requirements. Prior to FAR Part-29 Amendment 45 (October 1999) the FAA rotorcraft requirements did not include the need to identify critical parts. From March 2002 the European and the US critical parts requirements 29.602 texts were harmonised and from November 2008 the guidance material associated with 29.602 was fully harmonised.

6.2.2 See Appendix 1 to Annex F for critical parts requirements history table.

6.3 Discussion Points

6.3.1 As a result of the above, there are considerable differences between European and US products in terms of the number of critical parts. With the above changes the differences should reduce but this will be a function of the design, interpretation and standardisation by all parties involved in the design assessment.

- 1) With respect to “critical parts” the latest rotorcraft certification requirements define a catastrophic event as an inability to conduct an auto-rotation to a safe landing assuming a suitable landing surface is available. For operation in the Offshore environment, this assumption at times may not be consistent with actual operation. For a safe landing at sea (i.e. a “ditching”) a sea state of 4 is assumed (FAA AC 29-2C, paragraph 29.801). Thus if the rule did not assume that a safe landing surface was available there may be considerably more parts and failure modes classified as critical.
- 2) CAA Paper 2005/06 “Summary Report on Helicopter Ditching and Crashworthiness Research” states that in the northern North Sea, sea state 4 is annually exceeded 36% of the time, in winter it is exceeded 65% of the time and in summer only 7%. However the southern North Sea differs in that sea state 4 is exceeded only 14% of the time. Thus under some operating conditions there may be an incompatibility between the actual sea state in the North Sea and the validity of the assumption used in the “critical parts” certification requirements, noted in

1 above. One solution would be to amend this assumption and certificate to a higher sea state. However, whilst this approach will raise the standard it is unlikely to fully address all potential sea states/conditions – and would only be applicable for future aircraft. Thus, another option would be to reduce the likelihood of the need to carry out a ditching. In order to minimise landing in conditions in excess of sea state 4, an assessment of items that could result in a need to make a ditching could mean more parts and failure modes may need to be classified as critical or existing parts may need to have greater reliability; for example by more robust controls and/or improved maintenance activities.

It is worth noting that the Transportation Safety Board of Canada accident investigation report A09A0016 into the loss of Cougar Helicopters Inc Sikorsky S-92A, C-GZCH, discusses sea states off Newfoundland, where sea state 4 is exceeded about 50% of the time over the course of a year, and 83% of the time between December and February. Additionally, the Transportation Safety Board recommended “Transport Canada prohibit commercial operation of Category A transport helicopters over water when the sea state will not permit safe ditching and successful evacuation.”

- 3) With regard to the specific hazards associated with offshore operations, it is suggested that consideration be given to rulemaking that could be applied to helicopters which carry out Offshore Hazardous Operations to drive safety improvements. This should include engine and helicopter operational reliability systems, similar to those used for Extended Twin Operations and All Weather Operations.
- 4) Since November 1993 the large rotorcraft certification requirements (CS-29) covering critical parts introduced the facility for classification of particular areas of a component/part as critical as opposed to the whole component and other areas as non-critical. As a consequence the critical parts plan may only focus on specific areas of the part and not the part in its entirety. A recent investigation of a helicopter critical part failure included a part that had been treated in this manner. It is recommended that the rationale for this requirement and practice is reviewed once more at the certification requirement level and that this is compared with the good practice of engine critical parts as captured in CS-E (see below). For future new rotorcraft certification, where CS-29 Amendment 3 is required, this will be addressed as it has been included in the EASA guidance which applies FAA circular Advisory Circular 29-2C.
- 5) Comparison with Engine Requirements

The EASA and FAA engine requirement for critical parts (CS-E 515 for EASA) is worded differently. CS-E specifically requires the establishment of an Engineering Plan, Manufacturing Plan and Service Management Plan for all engine critical parts. Engine critical parts are defined as those that could cause hazard, not catastrophe. It should be noted that an engine failure of whatever sort can only be classified up to hazardous at the aircraft level.

While aspects of these attributes are covered in the Advisory Circular (AC) material for helicopter critical parts, there is no formal separation into equivalent plans and there are aspects which are barely covered at all but which could form part of a more detailed assessment required for North Sea operation. Part of a life management plan for engine critical

parts as an example would involve pulling a number of fleet life leading samples at intervals, if necessary in advance of any due overhaul/inspection time, and subjecting these parts to laboratory investigation rather than routine overhaul inspection. This can identify the initiation of potential future issues (corrosion pitting, development of wear, frottage patterns etc.) before they develop to an airworthiness concern. While unusual wear or deterioration found at overhaul is to be reported, this may not show up soon enough under normal overhaul inspection procedures. As the operators may not have access to laboratory equipment necessary for such assessment, the support of the manufacturers would be required.

The plan also includes in service flight profile monitoring, to pick up changes (e.g. short transits as opposed to longer flight sectors), i.e. validates the predictions and assumptions at time of certification.

The advisory material for the engine requirements also gives much more detail of what should be considered in developing lives (e.g. residual stress assessments, vibratory stress measurements, laboratory examination of time expired parts). Recent experience has shown that inspection of time expired parts or those retired at a reduced life due to wear etc can reveal important information about how a critical part has performed and therefore contribute towards product safety. Serious consideration should be given to adopting the critical parts life monitoring and assessment requirements of CS-E, for large transport rotorcraft critical parts.

- 6) BCAR 29 ACB 29.571 recognised the limitations of fatigue endurance testing, knowing these tests would be undertaken in benign conditions that do not practically simulate service conditions. Thus it was required that the applicant declared and instituted methods that would ensure the fatigue properties of components are adequately maintained throughout the life of the rotorcraft. Such methods would be expected to include:
 - adequate inspection (including overhaul),
 - specimen fatigue testing of components or parts at periodic intervals, and
 - limiting lives of components or parts for reasons other than fatigue where these reasons are likely to affect the fatigue properties.

BCAR 29 was withdrawn in November 1993 (as part of integration with the JAA process), and the current certification requirements don't require the applicant to institute methodologies that would confirm the adequacy of the fatigue life limits established during certification testing via evaluation of in-service components and/or components withdrawn from service.

6.4 Identification of Critical Parts

6.4.1 Design

- 6.4.1.1 Rotorcraft certified by the UK CAA between November 1975 and November 1993 required the rotor and transmission system to have a safety assessment/failure analysis to identify the necessary critical parts within the design. Review of the SA365 N, AS332 C and L and AS332 L2 UK CAA evaluation reports indicated that an assessment had been undertaken and reviewed by the evaluation team, although a listing of critical parts was not included in any of the reports. Rotorcraft

certified to operate within the UK post November 1993 would require a failure analysis to identify all critical parts. It has been confirmed that an analysis was undertaken for the EC225 LP (review of EC225 LP DGAC Certification Final Report), AW139 and S-92 (review of maintenance documentation).

6.4.2 Production

6.4.2.1 A Critical Parts Plan was required to be established for the rotorcraft targeted for this review. The certification evaluation report for the AS332 C and L models states that the critical parts quality control system was audited during the certification visit.

Note: Recommendation 9 (R16) should address this as CS-E includes a manufacturing plan. It is noted that FAA AC29-2c Change 3 does not specifically address the need for a manufacturing plan.

6.4.3 Maintenance

6.4.3.1 The Maintenance Manuals for the three rank 1 rotorcraft AW139, EC225 LP, and S-92 show a significant differences in how critical parts are dealt with – as detailed below.

6.4.3.1 AW139

Contains a specific section on critical parts, specifying that special care is need in the handling and storage of these items. It also lists the identified critical parts, this list is extensive including pilot collective stick assembly, pilot pedal assembly, MLG assemblies, main rotor hub assembly, MGB, main rotor blade assembly.

6.4.3.2 EC225 LP

Maintenance manual does not appear to have a specific section on critical parts nor does it appear to identify critical parts. However, the Airworthiness Limitations Section does list parts that have a Service Life Limit (SLL) established during the fatigue substantiation of the rotorcraft. It is known that for some transmission components the SLL does not dictate the actual in-service life of the component. Recent experience has shown that some manufacturers have some critical part components that are removed from service after relatively small service exposure, for example are removed from service at second overhaul, in comparison to the declared life. It is suggested that where this is the case, EASA and TCH holder should re investigate the assumptions of certification of the part, and particularly the failure analysis as such deviations are potential opportunities for loss of safety margin.

6.4.3.3 S-92

S-92 maintenance manual introduction paragraph P is entitled “Identification of Critical Parts”, and defines what the critical parts warnings are in the manual. The Airworthiness Limitation Section (ALS) also identifies replacement intervals. This list does indicate that some of the components contain critical parts as identified under the S-92 Flight Safety Parts Program. However, the significance of this is not detailed.

6.5 Summary

6.5.1 The review has highlighted potential inconsistencies in the approaches that the Type Certificate Holders have used in classifying these parts (and thereby what the regulators for the State of Design have accepted) and how the handling

instructions are identified in the ICA. In some cases these classify parts that can be removed during Base Maintenance checks such as windscreens, control rod and yaw pedals. Whilst these will be handled in a careful manner they may not be treated to the standard required of a critical part.

Recommendation 7

It is recommended that EASA initiate a rulemaking task to adopt the critical parts life monitoring and assessment requirements of CS-E for large transport rotorcraft, currently subject to CS-29, including retrospective application. This should cover at least for the following areas:

- i) Residual stress assessments
- ii) Vibratory stress measurements
- iii) manufacturing plan
- iv) Laboratory examination of time expired part

Recommendation 8

It is recommended that EASA revise CS-29.602 for large transport rotorcraft intended to operate over hostile sea conditions for extended periods of time, to ensure the failure mode effects and criticality analysis used to identify critical parts recognises that a safe ditching may not always be possible.

Recommendation 9

It is recommended that EASA provide additional guidance material to improve standardisation in approach to the classification of critical parts to minimise inconsistencies in the instructions for continued airworthiness, and where appropriate to require revisions to existing ICAs.

Recommendation 10

It is recommended that EASA consider developing requirements that could be applied to helicopters which carry out Offshore Operations in hazardous environments in a similar fashion to those used for aeroplane Extended Operations and All Weather Operations.

7 An Assessment of VHM Effectiveness and Controlled Service Introduction

7.1 Background

- 7.1.1 The adoption of health monitoring, initially as a CAA Additional Airworthiness Directive in 1999, came about as a result of recommendations from the AAIB following several incidents and accidents primarily in the Offshore environment. When introduced, it was recognised that it could not be completely effective in detecting all failure modes as they developed as it was not design assessed, it essentially had learned thresholds and was considered as our first generation HUMS / VHM . It was also assumed that the detectable modes and associated thresholds would develop over a time period sufficient to allow trending of signatures by maintenance teams and investigation of the reasons for those trends without necessarily removing parts from the aircraft. It was therefore developed as a monitoring tool to aid in maintenance (No hazard/No credit). It was not intended to replace other health monitoring measures specified as part of routine maintenance, such as chip detection.

- 7.1.2 VHM can nevertheless now be considered as an established, mature method to aid in the monitoring of transmission health by assessing vibration indicators against a series of fixed and learned thresholds. The assessment of VHM alerts and associated trend data requires expertise and it is important that skill levels are maintained by the operators and the TCH/OEMs. The majority of systems are now developed with the support of the OEMs who over time have generally come to view VHM as a useful tool and the continuing support of the OEMs is important in the North Sea operation. Many OEM's however still do not rely upon VHM for certification and as such it is offered as an option with no safety credit.
- 7.1.3 A review carried out in the mid 1990s estimated that VHM could aid in the detection of about 70% of those failure modes which the system was designed to monitor (ref. CAP 753). For helicopter transmissions, these modes are generally associated with detection of bearing wear, shaft out of balance and gear meshing changes. The effectiveness can be limited by several factors, e.g. sensitivity constraints due to remote sensors, or the level of forcing or propagation rate associated with a particular failure mode. Also, the overall sensitivity to a failure mode must be a balance between detecting those events which genuinely indicate deterioration and having a rate of false alerts which would be unacceptable in operation. In order to assess system effectiveness, aircraft are therefore required to go through a Controlled Service Introduction (CSI) to assess overall system performance. There have been problems in obtaining feedback from OEMs on condition of parts rejected from service for VHM indication thereby aiding in assessment of overall effectiveness. This has been addressed by recent changes introduced into CAP 753 and it is too early to assess the effect. As EASA as opposed to the CAA oversee the OEM's the effectiveness of this closed loop can only really be achieved with the support of EASA. Due to these difficulties a number of CSIs remain open and a programme to review these and where possible close these is being developed in conjunction with EASA. It was also clear from a review of our oversight of the operators' VHM systems that a more focused approach needs to be taken by the CAA to ensure that the operators' VHM procedures are fully effective, and reflect recent changes to CAP 753. A recommendation to rectify this is made below.
- 7.1.4 CAP 753 should also be reviewed to clarify alert generation and management, to ensure it is consistent and a system of amber/red warning thresholds is established to allow maintenance staff to identify the severity of the alert. Instances have arisen where maintenance staff and VHM analysts have found inconsistencies in the way VHM alerting systems work between the different helicopter types. This could be confusing for staff that work across various types.
- 7.1.5 Recent events leading to North Sea ditchings have highlighted some of the constraints associated with VHM. In one case, the part which suffered failure from an internal diameter in an epicyclic gear train could only be remotely monitored. Subsequent investigation of VHM data did not indicate any detectable trend prior to the event, even following enhanced analysis of the trends. In two other cases, subsequent review of VHM information indicated that there was a short time period of a few hours when an increasing trend could be detected, but the period was insufficient to allow meaningful trending under normal monitoring. Again the sensing was remote on the gearbox housing and the unexpected mode of failure in this case was such that no significant change in component stiffness which could be detected by VHM would be anticipated until the mode was well developed.
- 7.1.6 The CAA carry out regular audit of the operator's procedures and activities as detailed in CAP 753. These should also include VHM download procedures,

system/component reliability, the handling of VHM management of alerts and defects, at all of the bases.

- 7.1.7 It is generally understood by experts that the current in service VHM systems have not been design assessed / certified and that VHM is more effective in certain areas. VHM is intended to detect wear, imbalance etc. and is not intended / relied upon to prevent failures that could be catastrophic albeit it has proven an ability to do so in the past.

7.2 EASA Developments

- 7.2.1 EASA certification specifications changes introduced in CS-29 amendment 3 now incorporate requirements for the use of VHM. The regulation does not make use of VHM mandatory, but in cases where VHM is required either as part of a national rule (as in the UK) or where a manufacturer elects to fit a system then the regulation and advisory material define the performance of the system. The material used by EASA is largely drawn from guidance material previously published by the CAA, and the requirements are also based on the use of the system as an aid to maintenance personnel for fault finding.
- 7.2.2 Also, as the Helicopter Health Monitoring Advisory Group (HHMAG) drafted the VHM specification which has been used to provide the changes to CS-29 noted above, we would suggest this group also be re-established to provide a forum for discussion for best practice and developments on VHM. Note, a request for this group to be reinstated was made to EASA by the CAA in July 2012. This forum should include NAAs, operators and VHM manufacturers.
- 7.2.3 The CAA maintains that VHM is an effective addition to enhance defect detection and has promoted research aimed at improving detection capabilities. We continue to seek improvements in the effectiveness of these systems through support of further research where practical.

Action 5

The CAA will focus on the effectiveness of Vibration Health Monitoring (VHM) download procedures, system/component reliability, and the handling of VHM management of alerts and defects during audits of UK offshore operators.

Action 6

The CAA will review CAP 753 to clarify alert generation and management, to ensure it is consistent and a system of amber/red warning thresholds is established to allow maintenance staff to identify the severity of the alert.

Recommendation 11

It is recommended that EASA establish a forum for discussion for best practice and developments on Vibration Health Monitoring (VHM). This forum should include NAAs, operators and VHM manufacturers.

Recommendation 12

It is recommended that EASA review AMC 29.1465 to clarify alert generation and management, to ensure it is consistent and a system of amber/red warning thresholds is established to allow maintenance staff to identify the severity of the alert.

8 Continuing Airworthiness Across the Operators for the North Sea Fleet

8.1 Continuing Airworthiness Management

8.1.1 A major transition over the last ten years has been the implementation of the Part-M requirements. It is a requirement that all Commercial Aircraft operators hold a Part-M subpart G approval in order to hold an Air Operators Certificate. While all the operators were operating in accordance with JAR-OPS 3, and were therefore compliant with JAR-OPS 3 Subpart M (roughly translating to Part-M subpart C), and had “Technical Services” or “Fleet Support” departments in play, there was some difficulty in making the internal division between what was Part-145 activity and what was Part-M subpart G activity. To some degree this still exists, particularly with respect to reporting of defects and requests for assistance from OEMs.

8.2 Maintenance Programmes

8.2.1 All of the UK operators are required by EASA Part-M to have maintenance programmes based on the manufacturer’s requirements and recommendations. These are published by the manufacturers in the helicopter maintenance manuals. The mandatory requirements are listed in Chapter 4, Airworthiness Limitations, and the recommended maintenance is typically listed in Chapter 5 of the maintenance manuals. These are transferred into the operator’s maintenance programmes which are initially approved by the UK CAA. With the move to the operators having global operations they try to ensure that the programmes are the same around the world, apart from any national requirements. This simplifies the transfer of aircraft between countries.

8.2.2 The types that are currently going through the Type Certification process (AW189, AW169 and EC 175) have maintenance requirements based on the Maintenance Steering Group 3 (MSG 3). This has been widely used for large transport aeroplanes and should produce more effective and efficient maintenance requirements. It also provides a feedback system from the operators to monitor the effectiveness of the tasks. This will result in a Maintenance Review Board Report which provides the requirements on which the operators’ programmes will be based.

8.3 Maintenance Contracting

8.3.1 All of the UK Offshore operators have associated PART-145 maintenance organisations. They are also able to have maintenance contracts with other organisations. As the UK North Sea operators are part of multinational organisations it is becoming more common to develop international maintenance facilities which deal with their fleets worldwide.

8.4 Power by the Hour

8.4.1 Power by the hour arrangements for engines/transmissions etc. has also become a “norm” across the operators, either with the OEM or third party approved maintenance providers. The VHM guidance document (CAP 753) was amended in August 2012, to address a UK AAIB recommendation which recommended that operators include a process to receive detailed component condition reports (strip reports) in a timely manner to allow effective feedback as to the operation of the Vibration Health Monitoring system. All of the UK Offshore operators advised the CAA of difficulties in obtaining strip reports for defective items into which they

felt more investigation was required. As this is a CAA requirement this needs to be addressed to ensure that potential important safety information is not lost.

Action 7

The CAA will work with operators and their contracted engine and component maintainers to review processes that define when strip reports are required and determine necessary improvements to assure these are provided and thus ensure that potential safety information is not lost.

8.5 Continuing Airworthiness Management Contracting

8.5.1 Some of the operators have approved arrangements with other parts of their group to provide continuing airworthiness service such as the management of their fleets or for VHM management. These arrangements still ensure that the operator retains the responsibility for their fleet and have in-house expertise.

8.6 Continuing Airworthiness - Maintenance Provisions

8.6.1 Each of the operators has a Part-145 maintenance approval, typically the full scope for all types operated, including base maintenance approvals, and component workshop approvals.

8.6.2 The last ten years has seen the maintenance staff transition to the EASA Part-66 licensing requirements. There is currently an adequate pool of licensed engineers available to the offshore sector; however, in the last 15 years it has been recognised by the organisations that the average engineer age has been ever increasing, with fewer younger people coming to the sector.

8.7 Training

8.7.1 For the issue of a type-rated Part-66 licence in the size of helicopter used for the oil and gas sector in Categories C, B1 and B2 all staff must have attended a training course at an approved Part-147 training organisation. Typically these are initially provided at the manufacturer's Part-147 approved training facility. CAE have recently acquired the training facilities from Heli-one, Part-147 approved training facility, in Stavanger.

8.8 MOR Human Factors Errors in the North Sea Organisations

8.8.1 The operators all provide human factors training that includes interactive sessions as well as using a variety of other means. Only one operator currently sub-contracts this to a third party organisation.

8.8.2 The CAA has been carrying out an evaluation of UK maintenance errors as part of an on-going periodic review. MOR data between 2005 and 2011 has been assessed by Confidential Human factors Incident Reporting Programme (CHIRP) personnel, to identify and extract maintenance error occurrences for the data. The review identified around 2,000 occurrences from the total pool of all MORs submitted during this period and shows the error types only for the UK North Sea organisations, and this constitutes only 4% of the total MORs submitted. As the organisations all have combined Part-145, maintenance and Part-M subpart G continuing airworthiness organisations, the errors cover both approvals.

8.8.3 It can be seen from the chart below that Part-M over-run has the largest amount of reported errors. These range from significant issues such as over-runs of ultimate service life of airworthiness items, to less significant items such as fire extinguishers that were found to be life expired prior to being fitted to the aircraft.

To put this in context, helicopters have a large number of life controlled items, in comparison to aeroplanes.

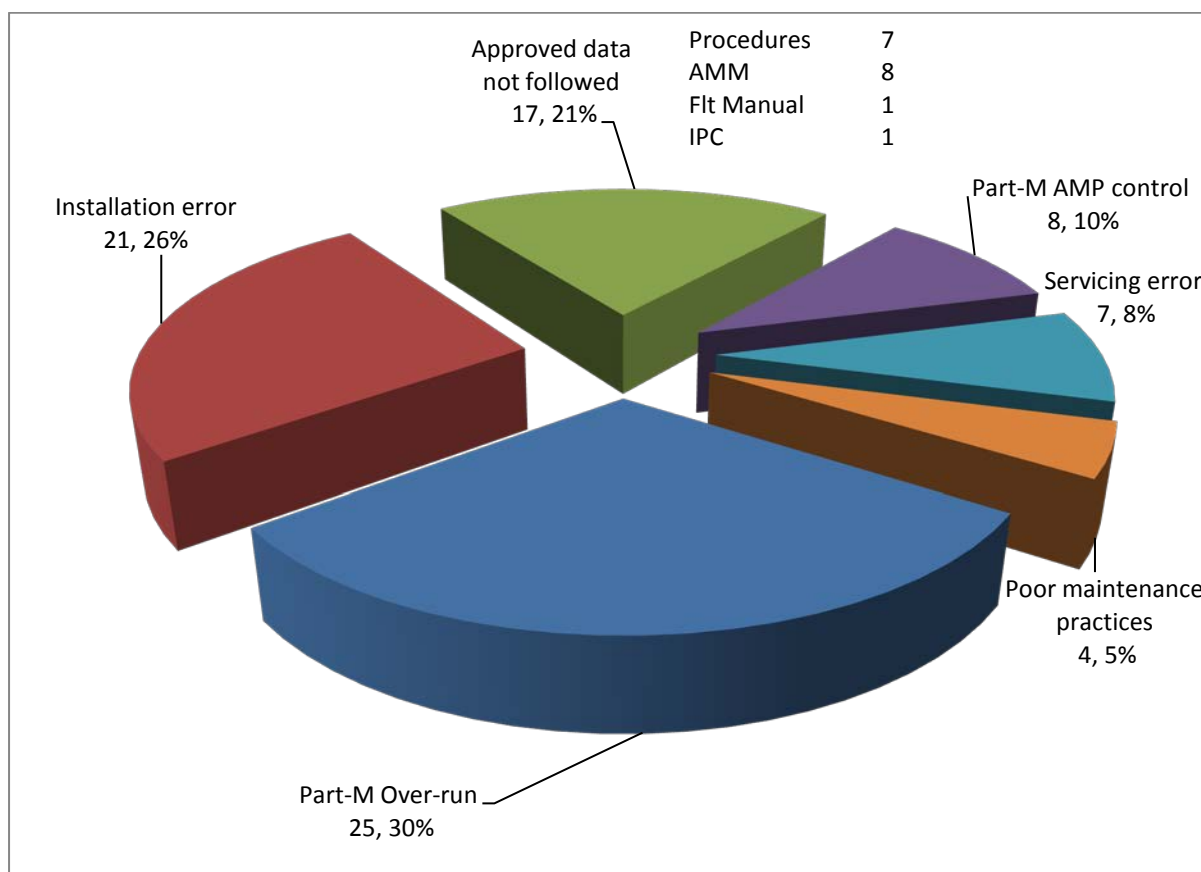
8.8.4 The next issue identified is Installation Error. Of this list over 50% of the reported incidents were related to systems that would have been subjected to a second inspection by an independent person, duplicate or independent inspection, prior to the task being released to service by a Part-145 authorised licensed engineer. Helicopter engineers are very aware of the requirements for these inspections, due to the consequences of a mechanical failure in a helicopter system. It should be noted that these events are a relatively small proportion (about 0.5% of the total) of the overall number of human factors occurrences reported. Incorrect installation is a widely used term to describe a variety of error types, such as incorrect part installed, not correctly installed, access panels not closed and incorrect-rigging. There are normally a number of contributory factors which lead to the error, such as not using maintenance data, incorrect recording of work, time pressures etc. A number of these human factor elements were embodied into maintenance regulations as a result of the AAIB report on, Boeing 737-400 G-OBMM. This highlighted a number of issues that are still relevant today and also apply to helicopters and should be considered. These include recommendations in the following areas (please refer to the UK AAIB for the full recommendations) :-

- 96-28 - Engineers are reminded that they are responsible for ensuring work is carried out using correct procedures and are not at liberty to deviate from the maintenance manual.
- 96-34 - The airlines maintenance organisation should review its instructions to maintenance supervisory staff with a view to redefine their responsibilities and to avoid them undertaking tasks which are inconsistent with their managerial role.
- 96-39 - Where aircraft maintenance or inspection tasks require elements of preparation for access and incorrect restoration of these preparatory actions might result in airworthiness hazards, these restoration actions are individually defined to be signed.
- 96-41 - Task cards are produced, any action which is required to be performed which has a particular airworthiness risk associated with it should be fully described fully together with the potential risks and not just referred to in another document.

Most of these and the other recommendations made are now in Part-145. This MOR review, and a number of AAIB reports, indicate that these issues are still relevant and are contributing to installation/maintenance errors being made.

Action 8

The CAA will carry out a further review of Human Factors Maintenance Error data referred to in this report and publish the results.

Figure F5 MOR Human Factors Errors reported in the North Sea organisations

8.9 Working Hours

8.9.1 A review of the shift patterns worked by the maintenance organisation was carried out. It showed, as expected, all of the organisations work a wide variety of shift patterns and times. These are focused around requirements of the various bases and vary to suit the local flying commitments.

8.9.2 The review showed that none of the shifts were longer than 12 hours and that there is a minimum of 11 hours off between shifts. The organisations all have voluntary arrangements to opt out of some of the provisions of the working time directive.

9 Summary

9.1 The North Sea provides a particular focus for airworthiness attention due to the potential hazards associated with ditching. The vagaries of the sea state, the prolonged flight times - sometimes up to four hours - and the risks once in the water all combine to make this an area of particular attention.

9.2 The review has therefore focused its attention on those issues and areas that relate to the possible causal factors that could bring about a landing on water.

9.3 From the review of Flight Manuals, critical parts and MORs it is evident that there are instances and reports of failures of critical systems and components where the consequences are to 'Land Immediately'. The review highlighted a particularly high number spurious engine bay fire warnings that could have led to a ditching, had not the pilots decided to take alternative actions.

- 9.4 The VHM system clearly plays a very significant role in operations in the North Sea, identifying trends of deterioration in any one of the systems being monitored. As technology in this area becomes more sophisticated (real time monitoring), advances in use and potential credit must always be balanced with demonstrated capability and reliability. The CAA maintains that VHM is an effective addition to enhance defect detection and has promoted research aimed at improving early detection capabilities.
- 9.5 The review of worldwide accidents on the types operated offshore, whose causes may have produced an unintended ditching had the situation occurred in the North Sea showed a high percentage were due to design causes. The sensitivity of the helicopter design to small flaws and errors is internationally recognised, especially when compared to the multi-load path designs of their fixed-wing counterparts. This fact, coupled with the pressure to maximise structural and component efficiency, should provide the industry with a note of caution. The entire framework in which the helicopters operate - design, certification, maintenance, operation - must have all the various links that tie that framework together, working robustly and reliably. The various recommendations that have arisen throughout this review have in one way or another attempted to ensure those links are reinforced, that best practice is used and that we are using all the tools available to us to maximise the safety of the flight crews, passengers and aircraft in this forbidding environment.

Appendix 1 to Annex F: Critical Parts Requirements History

Date	Certification Requirements for Critical Parts			Aircraft Type
	UK	Europe	USA	
November 1975	CAP 465 BCAR Section G Rotorcraft (only applicable to rotor and transmission system)			Eurocopter SA365 N Eurocopter AS332 L
October 1985	CAP 465 BCAR Section G Rotorcraft Blue Paper G778 (only applicable to rotor and transmission system)			
December 1986	CAP 524 BCAR 29 Rotorcraft (only applicable to rotor and transmission system)			Eurocopter AS332 L2
November 1993	Joint Aviation Requirements JAR-29 Large Rotorcraft, Amdt 0			Eurocopter EC225 LP Sikorsky S-92
October 1999			FAA Part-29 Amdt 45 FAA AC 29-2C	
March 2002	Joint Aviation Requirements JAR-29 Large Rotorcraft, Amdt 3			AgustaWestland AW139
November 2003	EASA Certification Specifications for Large Rotorcraft CS-29, Amdt 0			
April 2006			FAA Part-29 Amdt 45 FAA AC 29-2C Change 2	
November 2008	EASA Certification Specifications for Large Rotorcraft CS-29, Amdt 2			

Annex G Helicopter Safety Research Projects

1 Introduction

- 1.1 Since the late 1980s, the UK Civil Aviation Authority (CAA) has been leading a programme of research aimed at improving the safety of offshore helicopter operations. The motivation for this initiative came from a major joint CAA/Industry review of helicopter airworthiness, commissioned in 1982. This study led to a number of research projects and other reviews which, in turn, led to further research projects. A total of around 20 major safety issues have been investigated covering airworthiness and operational issues, and covering helicopters and helidecks. This programme of work has been jointly funded and monitored by the UK CAA-run Helicopter Safety Research Management Committee (HSRMC).

2 Background

2.1 Helicopter Airworthiness Review Panel (HARP)

- 2.1.1 In the 1970s and early 1980s the disappointing safety record of helicopters transporting people to work on oil rigs in the North Sea led to the formation of the Helicopter Airworthiness Review Panel (HARP). This group reported its findings in the HARP Report (CAP 491) in 1984, which contained recommendations for research into helicopter health and usage monitoring, crashworthiness and ditching. The HARP Report also called for an investigation of human factors-related accidents which led to the formation of the Helicopter Human Factors Working Group. This group reported its findings in CAA Paper 87007 in 1987, which included recommendations for research into a further seven, mainly operational areas.

2.2 Review of Helicopter Offshore Safety and Survival (RHOSS)

- 2.2.1 In addition to these two joint industry initiatives, a major review of offshore safety and survival was commissioned in 1993 in response to an AAIB Safety Recommendation (93-30) following the fatal accident at the Cormorant A platform in 1992. This study was conducted by the Review of Helicopter Offshore Safety and Survival (RHOSS) working group, which reported its findings in CAP 641 in 1995. The overall effect of this exercise on the helicopter safety research programme was to add impetus to the crashworthiness (water impact) and ditching projects.

2.3 Helicopter Safety Research Management Committee (HSRMC)

- 2.3.1 The resulting programme of helicopter safety research has been funded and monitored by the UK CAA-run HSRMC. The HSRMC was originally set up by the UK CAA in the late 1980s to manage a joint UK CAA/UK Government/UK oil industry (then UKOOA, now Oil & Gas UK) research fund that was created to progress the recommendations of the HARP report following the loss of 45 lives in the Chinook accident in 1984 (G-BWFC). The committee is still thriving and has evolved over time expanding its membership to include the UK MoD, the UK helicopter operators (BHA), the European Helicopter Association (EHA), the European Aviation Safety Agency (EASA), the Norwegian and other European NAAs with offshore helicopter interests, Norwegian Oil & Gas, the Canadian oil industry (C-NLOPB), and Danish Offshore Natural Gas (DONG) representing the offshore wind energy sector.

2.3.2 To date, the committee has overseen around £10M of research funding spread over a wide range of helicopter safety issues, the majority of which have their ultimate origins in the HARP Report. The current HSRMC research programme is reflected in the large public transport helicopter section of the UK CAA's 2009/11 Safety Plan (CAP 786, available at www.caa.co.uk). The following Section provides a top-level summary of current activities on the following 11 main projects overseen by the HSRMC:

- Health and Usage Monitoring Systems (HUMS)
- Ditching and Water Impact
- Operations to Moving Decks
- Helideck Lighting
- Helicopter Flight Data Monitoring (HFDM)
- Offshore Approaches
- Helideck Friction
- Helideck Environment
- Airborne Collision Avoidance Systems
- Terrain Awareness Warning Systems
- Lightning Strikes

3 Research Projects

3.1 Health and Usage Monitoring Systems (HUMS)

3.1.1 Background

3.1.1.1 Transmission HUMS

3.1.1.1.1 The main focus of the HARP Report (CAP 491), published in 1984, was the application of HUMS to helicopters. The recommendations of HARP led to the establishment of the joint industry Helicopter Health Monitoring Working Group which reported its findings in CAA Paper 85012, published in August 1985. This, in turn, led to in-service trials of transmission HUMS at Bristow Helicopters and British International Helicopters on Super Puma and Sikorsky S-61 helicopter types respectively. The trials were successful and the offshore oil and gas industry determined to voluntarily retrofit HUMS to the offshore fleet which was completed in the early 1990s.

3.1.1.1.2 Although the in-service trials had been judged successful, as is often the case with such exercises, no major faults had occurred during the trial period and the effectiveness of HUMS had therefore not been demonstrated. It was consequently decided to conduct two main rotor gear box (MRGB) seeded defect test programmes, one using a Super Puma MRGB at Eurocopter and a second using a Sea King MRGB (virtually identical to the S-61) at Westland Helicopters. Eight defects were selected for each test programme based on faults that had occurred either in-service or during fatigue testing. A range of defect types covering components located in the high speed, low torque through to the low speed high, torque sections of the MRGBs were selected. The defects were initiated mainly using spark eroded 'seeds', and then propagated at normal operating torques wherever practicable. Vibration data and data from other types of sensor such as microphones, stress wave sensors and oil debris detectors

were collected and analysed. Propagation was terminated prior to final rupture in order to preserve the fracture surfaces for sectioning and metallurgical analysis. This work was completed in the mid to late 1990s, but has not been reported as both programmes were subject to confidentiality clauses. Nevertheless, the results have been used to drive further research initiatives aimed at improving the effectiveness of HUMS.

3.1.1.1.3 Although it is believed that HUMS has contributed significantly to a reduction in the airworthiness-related accident rate, it is generally accepted that there is room for improvement in the diagnostic performance of HUMS. In particular, it has been estimated that the effectiveness of current HUMS is around 69%, and that evidence of propagating defects is present in the vibration data for at least a further 13% of cases. It appears that HUMS has been most effective in respect of defects occurring outside of the MRGB, and that detection of defects within the MRGB has been less successful. This view is supported by the evidence presented by the two MRGB seeded defect test programmes where defects were often not unambiguously detected until very close to or even after final rupture. Areas identified as in need of attention were:

- improvement of warning time (i.e. the time between warning and component failure) - when conducting retrospective analyses, the presence of defects is nearly always apparent to analysts in the data in advance of any indicator thresholds having been exceeded, and hence any warnings being generated;
- detection of build defects - many warning thresholds are tailored on installation of the component/assembly using a simple 'learning' process. This improves sensitivity without increasing the false alarm rate. However, in the event of a build anomaly or defect these thresholds are set too high, effectively de-sensitising the analysis to the subsequent propagation of defects;
- accommodation of unexpected gear indicator reactions - the identification of defects in a timely manner can be compromised by the rigid application of preconceived ideas on how defects will manifest themselves in the vibration data. Experience has demonstrated that a wide range of reactions is possible, both in terms of which indicators react and how they respond;
- accommodation of reducing gear indicator trends - certain types of defect can manifest themselves as reducing indicator trends. A technique is required that can detect these.

3.1.1.1.4 In response to the above opportunities for improvement, the application of advanced analysis techniques to the extraction of underlying characteristics of HUMS Vibration Health Monitoring (VHM) data to provide a more precise and simple indication of the health of monitored components was demonstrated in a study performed by MJA Dynamics Ltd (now part of GE Aviation). This work included the application of these techniques to vibration data from two of the CAA/Westland Helicopters MRGB seeded defect tests. These demonstrations were conducted without any prior knowledge of defect size, type or location and the results showed great promise. The final report on this work was published as CAA Paper 99006 in September 1999.

3.1.1.1.5 Following on from this work, a major programme of work was commissioned at Smiths Aerospace (now part of GE Aviation) to develop and demonstrate, through in-service trials, an Artificial Intelligence (AI) based anomaly detection and diagnostic system. This project was successfully completed and was reported in CAA Paper 2011/01 in May 2012. A total of around two years of in-service

experience on the Bristow Helicopters Super Puma fleet was accumulated during which a number of defects occurred. The diagnostic system employed by the project, known as Advanced Anomaly Detection (AAD), proved very effective in the timely detection of defects that were not detected by the existing HUMS, including 'instrumentation' defects, i.e. defects in HUMS itself. AAD also delivered a significant reduction in false alerts which was a welcome and, to some extent, unexpected benefit; increasing the sensitivity of a warning system often comes at the expense of an increase in the false alert rate.

3.1.1.1.6 Persuaded by the results of the in-service trials, the offshore oil and gas industry have committed to voluntary implementation of AAD. AgustaWestland (AW) has licensed the GE Aviation system developed during the research for the AW139; Eurocopter is developing its own version of AAD initially for implementation on the EC225 and EC175; Sikorsky is also developing an equivalent system for the S-92. It is expected that, once tuned, the GE Aviation system on the AW139 will deliver similar or even better performance to that of the Super Puma trials at Bristow Helicopters. The Eurocopter system is to be evaluated in-service alongside the existing HUMS permitting direct comparison of its performance. The Sikorsky system is to be fully integrated so it will not be possible to objectively measure any improvement in performance.

3.1.1.1.7 Related AAIB Safety Recommendation:

- Aircraft Accident Report 2/2011, G-REDL near Peterhead, Safety Recommendation 2011-041.

3.1.1.2 Rotor HUMS

3.1.1.2.1 It is generally acknowledged that rotor system failures account for a similar number of fatal helicopter accidents as transmission failures. The application of health monitoring to helicopters was, understandably, initially focused on transmissions due to the major loss of life in the Chinook fatal accident in 1986 (G-BWFC) which was caused by a transmission failure. In an attempt to redress the balance, a number of small studies on health monitoring for rotor systems were commissioned at MJA Dynamics during the period 1990-1991. This work formed the preparatory phase of a three-phase programme that was to include seeded defect rig tests (second phase) and culminate in a full-scale demonstration (third phase). For various reasons the second and third phases were not progressed, but not because of any failing of the first phase. In fact the CAA considered that these studies had successfully demonstrated the potential of VHM to detect rotor system Potentially Catastrophic Failures (PCFs) sufficiently in advance of failure to provide a meaningful safety benefit. No significant development is known to have taken place since the completion of this work, and the advent of the Sikorsky S-76 fatal accident in 2002 (G-BJVX) served to refocus attention on this area.

3.1.1.2.2 An initial study on extending HUMS to rotors was commissioned at GE Aviation to review of all relevant work (including the earlier studies at MJA Dynamics) in order to form a consolidated view of the state of the art of the application of VHM techniques to the detection of rotor system PCFs. The study also included a review of rotor-related occurrences which revealed a reduction in the rate of occurrences. Recent high profile incidents around the time of the study (e.g. G-PUMI in October 2006), however, demonstrated the significant safety benefit in main and tail rotor fault detection and further work was considered appropriate. The final report was published as CAA Paper 2008/05 in March 2009.

3.1.1.2.3 In response to the findings of the review of rotor health monitoring, research entailing the application of the AAD techniques developed on the transmission HUMS research to in-service tail rotor HUMS data was contracted to GE Aviation. Attention was focused on tail rotors as the earlier study had revealed evidence of developing defects in tail rotor VHM data; no such evidence had been found for main rotor defects. The results of this work were slightly mixed, however. Whereas it seemed possible to detect faults prior to the start of the last flight (provided that both axial and radial vibration data were available), on-board analysis would be required to provide timely warnings. The main problems were the 'noisy' nature of the data and, in the case of the Super Puma study, the lack of axial vibration data. The final report on this work was published as CAA Paper 2012/01 in March 2013.

3.1.1.2.4 As regards main rotor health monitoring and further work on tail rotors, the CAA and AgustaWestland agreed a Non-Disclosure Agreement (NDA) which has enabled the CAA to participate in the AgustaWestland Rotorcraft Technology Validation Programme (RTVP). This major private venture funded programme includes significant work on rotor HUMS. The initial meeting between the CAA and AgustaWestland was held in February 2012 at which GE Aviation presented the work on the application on AAD to tail rotor VHM data. A progress meeting with AgustaWestland was held in June 2012 and further meetings will be scheduled at appropriate points in the programme. AgustaWestland has provided the CAA with presentations to brief the industry. The programme is scheduled to conclude during first half of 2014.

3.1.1.2.5 Related AAIB Safety Recommendations:

- Aircraft Accident Report 1/2005, G-BJVX near the Leman F platform in the North Sea, Safety Recommendation 2004-040.
- Aircraft Accident Report 7/2010, G-PUMI at Aberdeen Airport, Safety Recommendation 2010-027.

3.1.2 Progress to Date

3.1.2.1 The following research has been completed and reported:

- Helicopter Health Monitoring – Operational Trials Review, CAA Paper 93002, CAA, London, February 1993.
- Helicopter Health Monitoring – Bristow Helicopters Ltd - Operational Trial of Helicopter Health Monitoring Techniques, CAA Paper 93003, CAA, London, February 1993.
- Helicopter Health Monitoring – British International Helicopters Ltd - Operational Trial of Sikorsky S-61N Health and Usage Monitoring System Demonstrator, CAA Paper 93004, CAA, London, February 1993.
- Intelligent Management of HUMS Data, CAA Paper 99006, CAA, London, September 1999.
- HUMS Extension to Rotor Health Monitoring, CAA paper 2008/05, CAA London, March 2009.
- Intelligent Management of Helicopter Vibration Health Monitoring Data, CAA Paper 2011/01, CAA, London, May 2012.
- The Application of Advanced Anomaly Detection to Tail Rotor HUMS Data, CAA Paper 2012/01, CAA, London, March 2013.

3.1.3 Next Step(s)

- 3.1.3.1 No further research or development on transmission HUMS is envisaged other than supporting, where appropriate, the implementation of AAD and also EASA's initiative to improve the health monitoring of epicyclic stages in response to the UK AAIB Safety Recommendation 2011-041.
- 3.1.3.2 As regards rotor health monitoring, the CAA will continue to participate in the AW RTVP and monitor developments. Since it is now responsible for rule making/development, and in view of AAIB Aircraft Accident Report 7/2010 Safety Recommendation 2010-027, it was hoped that EASA would also participate in the AW RTVP. Unfortunately that has not happened.

3.2 Ditching and Water Impact

3.2.1 Background

- 3.2.1.1 The subjects of helicopter ditching and water impact were first identified for attention in the HARP Report (CAP 491), published in 1984. The main focus was initially on ditching where review studies found ambiguities in the associated requirements, raised questions about how the sea states specified in the requirements should be interpreted, and whether model tests should be performed in regular or irregular waves. There was evidence that helicopters capsize in breaking waves only, and that the occurrence of breaking waves in regular wave tests depends mainly on the characteristics of the test tank. Tests in irregular waves are considered to be more realistic and meaningful, and are to be preferred.
- 3.2.1.2 These review studies also questioned whether more stringent ditching criteria might be appropriate in sea areas where conditions are more severe. There are substantial differences in capsize risk between helicopters designed to sea state 4 and sea state 6 ditching criteria, between helicopter operations in the Northern and Southern North Sea, and between summer and winter operations. In terms of improving the sea-keeping performance of existing helicopters to meet an enhanced standard, an early experimental study had shown the benefits of float scoops in improving stability and helping to prevent capsize after ditching. An improvement in sea-keeping performance of one sea state was consistently obtained for a very modest increase in cost and weight.
- 3.2.1.3 In recognition of the mismatch between the practical upper limit of helicopter sea-keeping performance and prevailing wave climates, additional Emergency Floatation Systems (EFS) were subsequently devised to prevent total inversion following capsize. Rather than prevent capsize, the aim of this scheme is to mitigate the consequences by ensuring that an air pocket is retained within the cabin, reducing the time pressure to escape, and that some of the escape routes remain above the water level facilitating egress. Three such systems were model-tested in a wave tank, two of which performed satisfactorily and were considered worthy of further development. Passenger egress trials using a helicopter underwater escape trainer confirmed the benefits of side-floatation for improving chances of escape and survival after capsize.
- 3.2.1.4 The RHOSS Report (CAP 641), published in 1995, highlighted the fact that water impacts have historically presented a greater hazard than ditchings and recommended that more research be performed in this area. Earlier studies had highlighted the main cause of fatalities in 'survivable' water impacts to be drowning rather than impact injuries, and that the most effective means of improving survivability would be to improve the post crash operability of the EFS.

- 3.2.1.5 Investigations were consequently undertaken into possible ways to improve the crashworthiness of EFS. Three survivable water impacts were studied using finite element modelling techniques to establish the nature of the loads experienced. A number of EFS modifications were recommended to improve performance following a water impact. These modifications were considered to be cost-effective, and some are already incorporated into modern EFS design. Automatic arming and activation of EFS were judged to be the most cost effective. An associated study considered variability in water impact loads on typical floatation components over a wide range of possible survivable crash scenarios and sea conditions. The most important outcome from this study was in highlighting the major benefits of floatation redundancy, particularly having additional floatation units installed at a location less vulnerable to water impact, high on the cabin walls similar to those proposed to prevent total helicopter inversion following capsizing.
- 3.2.1.6 An alternative means of mitigating the consequences of capsizing following either ditching or water impact was considered to be through the provision of Emergency Breathing Systems (EBS), which have been developed and deployed voluntarily by the offshore oil and gas industry. A study into the implementation and use of EBS identified that such systems could help to overcome cold shock and extend underwater survival times. At the end of this study, however, the CAA reviewed its policy on EBS and concluded that there was no compelling case to either mandate or ban the use of EBS. However, it was recognised that a specification should be produced for EBS in order to ensure that any equipment deployed would be compatible with other Personal Protective Equipment (PPE) and other safety and survival considerations. Further research was therefore performed, resulting in a technical standard which has been published in CAP 1034.
- 3.2.1.7 The CAA presented the findings from its ditching and water impact research to the JAA Helicopter Offshore Safety and Survivability (HOSS) working group and to the FAA/JAA/Industry Joint Harmonisation Working Group (JHWG) on Water Impact, Ditching Design and Crashworthiness (WIDDCWG). Both groups supported the findings and produced working papers recommending similar changes to the airworthiness requirements and guidance material. They also recommended further development of the side-floating helicopter concept for which the next step was a helicopter type-specific design study. Following the transfer of responsibility for airworthiness requirements to the European Aviation Safety Agency (EASA) in 2003, the side-floating helicopter type-specific design study was commissioned at Eurocopter by EASA. This work confirmed the effectiveness of the scheme, but also highlighted some issues that would require careful consideration such as inadvertent deployment in flight.
- 3.2.1.8 The JAA HOSS working group and the JAA/FAA WIDDCWG recommendations also led to a review of the ditching requirements and advisory material being commissioned by the JAA/FAA Rotorcraft Steering Group (RSG). This tasking was taken over by EASA who have subsequently established a Rule Making Task (RMT.0120). The scope of the RMT is based on the recommendations of the JAA HOSS and JAA/FAA WIDDCWG reports and held its first meeting in January 2013. A Notice of Proposed Amendment (NPA) detailing the changes proposed is scheduled to be published in mid-2014, with the EASA final decision being announced in 2016.

3.2.19. Related AAIB Safety Recommendations:

- Aircraft Accident Report 2/93, G-TIGH near the Cormorant 'A' platform, East Shetland Basin, Safety Recommendations 93-26, 30 and 31.
- Aircraft Accident Report 7/2008, G-BLUN at the North Morecambe gas platform, Safety Recommendation 2008-036.
- Aircraft Accident Report 1/2011, G-REDU at the ETAP Central Production Facility Platform, Safety Recommendation 2011-065.

3.2.2 Progress to Date

3.2.2.1 Although further detail work will doubtless be required in order to implement some of the changes on individual helicopter types, and some further relatively minor studies may be required in support of the EASA RMT, it is believed that all generic research required has been completed and reported as follows:

- Helicopter Float Scoops, CAA Paper 95010, CAA, London, December 1995.
- Devices to Prevent Helicopter Total Inversion Following a Ditching, CAA Paper 97010, CAA, London, December 1997.
- Helicopter Ditching Research – Egress from Side-Floating Helicopters, CAA Paper 2001/10, CAA, London, September 2001.
- CAA Paper 96005, Crashworthiness of Helicopter Emergency Flotation Systems, CAA, London, July 1996.
- *Crashworthiness of Helicopter Emergency Flotation Systems*, CAA Paper 2001/02, CAA, London, September 2001.
- *Summary Report on Helicopter Ditching and Crashworthiness Research*, CAA Paper 2005/06, CAA, London, December 2005.
- Preliminary Study of the Implementation and Use of Emergency Breathing Systems, CAA Paper 2003/13, London, October 2003.
- Development of a Technical Standard for Emergency Breathing Systems, CAP 1034, London, May 20013.

3.2.2.2 In terms of the EASA RMT, three meetings have been held and good progress is being made. The general scope of the changes to the requirements and advisory material have been identified and agreed. Work on drafting the NPA for discussion and agreement prior to publication is in progress. The next meeting of the RMT is scheduled for March 2014.

3.2.3 Next Step(s)

3.2.3.1 The RMT is scheduled to complete by 2016. In the meantime, the Canadian industry (Canadian-Newfoundland and Labrador Offshore Petroleum Board - C-NLOPB) have mandated the provision of EBS and are progressing a helicopter type specific study on the Sikorsky S-92 for the side-floating EFS scheme. The CAA is assisting C-NLOPB in the direction and monitoring of this project.

3.3 Operations to Moving Decks

3.3.1 Background

3.3.1.1 Helideck motion limits are presently specified in terms of a maximum pitch, roll and heave rate. Whereas these parameters may be appropriate for the landing

itself, in-service experience and analysis of the associated mechanics indicate that they are poor predictors of whether the helicopter will tip or slide once landed on the helideck. Furthermore, the present limits take no account of wind (speed, relative direction and gusting), which can significantly affect on-deck stability. In addition, review of related MORs highlights major issues with misreporting of vessel motion to flight crews and changes in wind speed and direction after landing that need to be addressed.

3.3.1.2 A programme of research is being carried out, the main element of which comprises the development and validation of a new Motion Severity Index (MSI) based on helideck accelerations, and an associated Wind Severity Index (WSI). Helicopter operating limits in terms of the MSI and WSI are being established in the form of a chart that will eventually be added to the helicopter Operations Manual or Flight Manual. An on-deck relative wind monitoring scheme has also been devised and a traffic light system that will indicate the helideck motion status directly to the flight crew is being developed. It is believed that most existing Helideck Monitoring Systems (HMS) will require essentially only a software modification in order to be capable of performing all the functionality needed for the proposed new scheme.

3.3.1.3 Related AAIB Safety Recommendation:

- Aircraft Accident Report 3/2004, G-BKZE at the West Navion drill ship, Safety Recommendations 2003-133 and 135.

3.3.2 Progress to Date

3.3.2.1 An extensive programme of research is in progress which has already included three instrumented aircraft trials and, most recently, an extended in-service trial on the Maersk Global Producer III FPSO in spring 2012. A full project report has been produced which is being maintained as progress is being made. The key elements of the project have been summarised in two papers presented at the September 2012 European Rotorcraft Forum.

3.3.2.2 Although further work is required before definitive helicopter type specific MSI/WSI limits can be produced, it has been agreed with the industry (Helideck Certification Agency – HCA) that sufficient progress has been made to warrant the introduction of an initial interim HMS that will address a significant proportion of the safety concerns while work continues on the remaining elements. The scope of the interim system was discussed with the HCA Helideck Steering Committee at their 27 February 2013 meeting. The following elements were reviewed and agreed:

- New heave rate measure – the current ‘Norwegian Method’ (NM) of calculating heave rate is to be replaced with Significant Heave Rate (SHR). The new measure removes the ambiguities associated with the definition of the NM and also avoids the problems of calculating heave rate at low heave amplitudes and long heave periods.
- Helideck traffic lights – this addresses misreporting of deck motion which accounts for about a third of the related MORs.
- Relative wind monitoring - this addresses the West Navion accident scenario (G-BKZE, November 2001, which involved loss of vessel heading control), and the passage of line squalls while on-deck (NB: Also applicable to fixed helidecks.)

- Initial MSI/WSI advisory only limits – initial advisory limits will be produced for the S.Puma and S-76; it is intended that limits for the AW139 and S-92 will follow.
- New HMS display – human factors design principles have been employed to develop an improved ‘standard’ display and to incorporate the additional information required for the new scheme.

3.3.3 Next Step(s)

3.3.3.1 A specification has been produced which will be used to tender for the production of an interim standard HMS for proving trials. A separate exercise to develop the lighting equipment needed to implement the helideck traffic light scheme will be progressed with the helideck lighting manufacturers. Following successful completion of the trials, the interim system will be rolled out by incorporation of the specification in the CAA’s CAP 437, Standards for Offshore Helicopter Landing Areas.

3.3.3.2 In parallel with the launch of the initial interim system, further work on the MSI/WSI limits will be progressed with a view to developing a methodology to enable helicopter manufacturers to produce helicopter type specific limits for their aircraft. It is envisaged that once a validated type-specific limit is available for a helicopter and incorporated in its Flight Manual, it will then be permissible to take credit for the MSI/WSI and consider relaxing the pitch/roll/inclination/heave rate limits for touchdown (provided that the MSI/WSI is within limits). In this case, the MSI/WSI will become a red ‘do not land’ limit.

3.4 Helideck Lighting

3.4.1 Background

3.4.1.1 Starting in 1995, the UK CAA has conducted a number of dedicated offshore and onshore trials aimed at identifying ways of improving the lighting of offshore helidecks. This initiative was born out of concerns within the industry that were highlighted further in an independent offshore helicopter pilot opinion survey reported in CAA Paper 97009.

3.4.1.2 Three main problems exist with current helideck lighting systems:

- the location of the helideck on the platform is often difficult to establish due to the lack of conspicuity of the perimeter lights;
- helideck floodlighting systems frequently present a source of glare and loss of pilots’ night vision on deck, and further reduce the conspicuity of helideck perimeter lights during the approach; and
- the performance of most helideck floodlighting systems in illuminating the central landing area is inadequate, leading to the so-called ‘black hole’ effect.

3.4.1.3 A series of three dedicated trials were conducted at the NAM K14B satellite in the southern North Sea during 1998/9 which established the basis of a new helideck lighting scheme. This scheme was tested and refined during two dedicated flight trials performed at an onshore site (Longside airfield) during 2002. A third series of trials were then conducted at Norwich Airport to establish the detail of the lighting scheme to support the production of a specification. These trials were completed in 2004, and a specification for a revised lighting system was drafted which comprised:

- green perimeter lighting located around the edge of the helideck, with the same layout as the existing scheme but with changes to the characteristics of the individual lights;
- a lit yellow Touchdown/Positioning Marking (TD/PM) circle superimposed on the current yellow painted marking;
- a lit green Heliport Identification marking superimposed on the white painted 'H'; and
- no floodlights.

3.4.1.4 The revised perimeter lighting was adopted by ICAO as a new international minimum standard in Annex 14 Volume II with a compliance date of 1 January 2009, and all helidecks in UK waters have been retrofitted. As regards the TD/PM circle and H lighting which was accepted by ICAO as an alternative to floodlights, prototype systems were manufactured by AGI Ltd to meet the specification and installed on the Perenco Thames A platform in the southern North Sea and the Centrica CPC-1 platform in Morecambe Bay. The lighting systems were subjected to in-service trials to evaluate their performance in a representative offshore environment, over a range of meteorological conditions, and to expose the system to a larger number of pilots.

3.4.1.5 Drawing on the experience gained from the trials of the prototype systems, the specification was refined and a production version of the system was designed and manufactured by Orga bv in The Netherlands. Following a successful CAA flight evaluation and in-service trials of the production standard equipment on the Centrica CPC-1 during winter 2012/13, the CAA has replaced floodlighting with the new TD/PM circle and H lighting in its standards material in CAP 437, 7th Edition, Amendment 01/2013.

3.4.1.6 Related AAIB Safety Recommendations:

- Aircraft Accident Report 5/88, G-BHYB near the Fulmar A oil platform, Safety Recommendation 4.4.
- Aircraft Accident Report 1/2011, G-REDU at the ETAP Central Production Facility platform, Safety Recommendation 2011-053.

3.4.2 Progress to Date

3.4.2.1 All research has been completed and reported as follows:

- Enhancing Offshore Helideck Lighting – NAM K14 Trials, CAA Paper 2004/01, CAA, London, January 2004.
- Enhancing Offshore Helideck Lighting – Onshore Trials at Longside Airfield, CAA Paper 2005/01, CAA, London, April 2005.
- Enhancing Offshore Helideck Lighting – Onshore Trials at Norwich Airport, CAA Paper 2006/03, CAA, London, November 2006.
- Specification for an Offshore Helideck Lighting System, CAP 1077, CAA, London, September 2013.

3.4.2.2 The resulting specification has been incorporated in CAP 437, Standards for Offshore Helicopter Landing Areas and the CAA has written to the industry effectively mandating the new standard with a compliance date of 31 March 2018.

3.4.3 Next Step(s)

- 3.4.3.1 The UK oil and gas industry has committed to retrofitting the new lighting via the Oil & Gas UK Aviation Safety Technical Committee (ASTG), and a joint industry working group has been formed in order to pool experience and expertise on installing the equipment. The CAA is actively supporting the working group and providing advice and encouragement to a further two manufacturers who are producing competing systems.

3.5 Helicopter Flight Data Monitoring (HFDM)

3.5.1 Background

- 3.5.1.1 Flight operations monitoring (FDM) is a mature and well-established practice among a number of UK commercial airlines (e.g. British Airways, Easyjet and Virgin Atlantic), with widely acknowledged safety benefits. In essence, it comprises the routine analysis of aircraft flight data to monitor compliance with defined operational criteria using a specialised computer programme. The operational criteria include the corresponding aircraft Flight Manual limitations, safe margins around the operational interpretation of the Flight Manual, and definitions of the good practice and airmanship that pilot training programmes seek to instill. Where comparison of the actual operation of the aircraft with the defined criteria reveals reduced margins or non-compliances, appropriate action is taken within the airline to improve unsatisfactory practices. As this process is continuous, the effectiveness of any corrective action taken is automatically monitored.
- 3.5.1.2 An in-service trial of the application of FDM to helicopters, known as the Helicopter Operations Monitoring Programme (HOMP), involving five Bristow Helicopters Super Puma aircraft was commissioned in 2000. The trial was concluded at the end of August 2001 and was very successful. As a result, the industry decided to proceed with full implementation of helicopter FDM on the North Sea fleet in advance of any regulatory action.
- 3.5.1.3 The CAA continued to promote helicopter FDM by funding its extension to a second helicopter type (Sikorsky S-76) and to a second offshore helicopter operator (CHC Scotia) in conjunction with the offshore oil and gas industry-led full-scale implementation plan. These trials demonstrated the successful transfer of the safety benefits of helicopter FDM, and usefully identified significant differences between operators and between helicopter types. The ICAO Helicopter Tiltrotor Study Group (HTSG) was also impressed by the research and, in 2004, unanimously agreed to propose to add helicopter FDM to ICAO Annex 6 Part III as a Recommended Practice for flight data recorder-equipped helicopters.
- 3.5.1.4 The remaining HOMP research is the provision of a measure of low airspeed for use in the ground-based analysis system. An aspect of flight operations monitoring unique to helicopters is the need for a measure of low airspeed in order to fully monitor the operation of the aircraft during the more demanding flight phases of take-off and landing. The pitot-static systems with which helicopters are equipped become increasingly inaccurate with reducing airspeed, primarily due to the influence of the main rotor wake, and effectively cease to function below a threshold airspeed of 20 to 50 knots (depending on helicopter type), and in sideways or rearwards flight.
- 3.5.1.5 Specialised mechanically based sensors do exist for providing enhanced low airspeed information, but these suffer from a number of disadvantages (e.g. cost,

maintenance and calibration overhead) which effectively render them inappropriate for a flight data monitoring programme. Alternative algorithmic-based solutions have been developed and trialled with varying degrees of success, but most require input parameters that are not currently available and are difficult/expensive to provide on helicopter flight data recording systems (e.g. all-up mass, centre of gravity location, servo positions).

- 3.5.1.6 A potential alternative non-mechanical approach to synthesising low airspeed utilizing only existing flight data parameters is to employ an Artificial Neural Network (ANN). Earlier work performed by Warwick University and Westland Helicopters Ltd (WHL) demonstrated the potential of ANNs to predict low airspeed (and direction).

3.5.2 Progress to Date

- 3.5.2.1 The HOMP trials and the extensions described above have been completed and reported as follows:

- Final Report on the Helicopter Operations Monitoring Programme (HOMP) Trial, CAA Paper 2002/02, CAA, London, September 2002.
- Final Report on the Follow-On Activities to the HOMP Trial, CAA Paper 2004/12, CAA, London, October 2004.

- 3.5.2.2 The only remaining HOMP research is the provision of a measure of low airspeed for use in the ground-based analysis system, which is attempting to utilize the ANN approach pioneered by Warwick University and WHL. The project has used a database of Bristow Helicopters Super Puma data, including low airspeed as measured by a Helicopter Air Data System (HADS), to 'train' the ANN. As a result of the work completed to date, it has now been established that this data is unreliable due to the HADS probe sticking. Although it is now clear that flight trials will need to be performed to generate a new database, the more recent analysis performed by GE Aviation has demonstrated significant potential of the concept. The final report on the GE work has been completed and accepted.

- 3.5.2.3 More recently, EASA tendered a research project to develop a low airspeed sensor for helicopters which, if successful, could negate the need for further work in this area, i.e. a measure of low airspeed would be generated directly rather than synthesized from other available parameters. Unfortunately no bids for the project were received.

3.5.3 Next Step(s)

- 3.5.3.1 On a more positive note, it has been agreed that a helicopter operator FDM user group be established. The first meeting is to be held in December 2013. It is expected that this initiative will enable significant improvements in the effectiveness of the operators' current HFDM programmes.

3.6 Offshore Approaches

3.6.1 Background

- 3.6.1.1 A need exists for an accurate and reliable instrument approach aid for conducting operations to offshore platforms. Currently, the only equipment available is the aircraft's weather radar which is neither designed nor certificated for the task and the operation is high workload and prone to error. In its report published as CAA Paper 87007 in July 1987, the Helicopter Human Factors Working Group recommended (Recommendations 4.1.1 and 4.2.1) that weather radars be tested

and approved for use in conducting low visibility offshore approaches, for their performance to be established and appropriate operational procedures to be developed.

- 3.6.1.2 This led to some modelling work being performed by the industry and an increase in the operating minima (minimum decision range increased from 0.5 NM to 0.75 NM), and a project to develop an approach radar which utilized the existing weather radar antenna and crew interfaces. Unfortunately the technology at that time was quite bulky and expensive, and did not perform very well during the very limited trials that were conducted. The emergence of satellite navigation in the form of the US DoD Global Positioning System (GPS) around that time led to a change in direction of the project. The concept of Differential GPS (DGPS) had been under study, test and refinement for a number of years and systems in operational use at that time were considered effective and reliable in their specific roles. DGPS was therefore considered to have the potential to fulfil the need for an offshore approach guidance system at relatively low cost, and represented a better way forward than attempting to improve weather radars.
- 3.6.1.3 Before the approval of DGPS-based offshore approaches can be contemplated, however, a number of issues will need to be addressed to ensure that appropriate levels of safety can be maintained. Apart from the more general considerations of integrity, availability, reliability, coverage, and accuracy, attention must also be directed towards the manner in which the technology is to be applied to this unique operation.
- 3.6.1.4 Related AAIB Safety Recommendations:
- Aircraft Accident Report 5/88, G-BHYB near the Fulmar A oil platform, Safety Recommendation 4.4.
 - Aircraft Accident Report 7/2008, G-BLUN at the North Morecambe gas platform, Safety Recommendation 2008-033.

3.6.2 Progress to Date

- 3.6.2.1 Work completed and reported to date comprises:
- Trials of Differential GPS (DGPS) guided offshore approaches – see DGPS Guidance for Helicopter Approaches to Offshore Platforms, CAA Paper 2000/05, CAA, London, November 2000.
 - Follow-on studies to DGPS trials - see DGPS Guidance for Helicopter Approaches to Offshore Platforms - Follow On Studies, CAA Paper 2003/02, CAA, London, June 2003.
 - Effect of helicopter rotors on GPS reception; data collection trials and analysis – see Effects of Helicopter Rotors on GPS Reception, CAA Paper 2003/07, CAA, London, December 2003.
 - Three-phase hazard analysis covering en-route navigation, WXR approaches and GPS enhanced WXR approaches - see Hazard Analysis of the Use of GPS in Offshore Helicopter Operations, CAA Paper 2009/06, CAA, London, February 2010.
 - The EU 6th Framework GIANT work including the design, hazard analysis and simulator trials of the SBAS Offshore Approach Procedure (SOAP), and EGNOS reception trials – see The SBAS Offshore Approach Procedure (SOAP), CAA Paper 2010/01, CAA, London, May 2010.

3.6.2.2 The current stage of the project called HEDGE (HELicopters Deploy GNSS in Europe) forms part of an EU 7th Framework project. The work essentially comprises the production and trials of a demonstrator SOAP system and the following additions to the project have been identified:

- integration of AIS (marine Automatic Identification System) into the navigation display,
- demonstration of the integration of SOAP with the enhanced helideck lighting,
- safety assessment of the visual segment, and
- addition of RNAV guidance to assist shuttling.

3.6.2.3 The first set of flight trials were performed over the weekend of 29/30 January 2011. Of particular note, the AIS was well received by the pilots and found to be very helpful in improving situational awareness. Some refinements to the trials system were identified and implemented for the second set of daylight trials which took place over the weekend of 12/13 November 2011. A report on the evaluation of AIS and an interim report covering the second set of daylight trials has been produced and accepted. The report on the first set of daylight trials has been produced for the EU and will be incorporated in the final report for this project.

3.6.3 Next Step(s)

3.6.3.1 The last part of HEDGE comprises night trials which are required primarily to investigate the interface between the instrument and visual segments of the approach. A representative visual environment is needed for these trials which effectively entails the provision of a helideck fitted with the new lighting system. It is presently expected that the target destination for the trials will be the BP Miller platform and the lighting equipment has been delivered. Preparation for installation is presently in progress.

3.6.3.2 In addition, Helios Technology have been awarded further EU Framework project called HEDGE NEXT. This will involve simulator trials to further develop the approach procedure focusing, in particular, on the visual segment and interfacing the procedure to low level RNAV routes. A workshop was held at Helios on 3 December 2012 to discuss this work and some operational concepts in need of investigation were identified for further consideration.

3.6.3.3 The final exercise required following completion of the simulator and demonstration trials will be the implementation of the system in a line aircraft for in-service trials. This is expected to entail modification of the aircraft's FMS and EFIS and will therefore require major involvement of a helicopter manufacturer.

3.7 Helideck Friction

3.7.1 Background

3.7.1.1 In the context of the practical difficulties associated with performing helideck friction surveys and the consequent desire of the industry to move to more portable, lightweight friction testing devices, clarification was requested from the CAA regarding the definition of the "...test method acceptable to the CAA..." stipulated in CAP 437, Standards for Offshore Helicopter Landing Areas. Past experience with lightweight testers has been mixed, particularly in relation to repeatability and coverage of the helideck surface. Furthermore, the effect of a

number of parameters on helideck friction survey results was called into question and required investigation.

- 3.7.1.2 In addition to the above issues, increasing use is being made in the industry of profiled aluminium helidecks. Friction surveys of these surfaces conducted using the Findlay-Irvine GripTester produce marginal results which are noticeably directional. The GripTester was not designed for use with this type of surface which relies on mechanical 'locking' of the helicopter wheels with ridges on the helideck surface rather than surface friction for resisting sliding. Spot testing devices are also unsuitable for this type of surface as the reading is very dependent on the exact positioning of the tester. There is therefore a need to identify an alternative means of establishing whether the degree of resistance to sliding provided by these surfaces is adequate.

3.7.2 Progress to Date

- 3.7.2.1 A programme of work comprising a review of a representative range of friction measuring devices has been completed by NLR. In essence, the work confirmed that braked wheel devices like the GripTester are the most appropriate type of device for measuring helideck friction. These devices are now available in a smaller, helicopter transportable form. Furthermore, the results demonstrated that the only parameter of significance was the condition of the helideck in terms of whether it was wet or dry; it is standard practice to test helidecks in the wet condition, this representing the 'worst case'. The final report was circulated with a CAA foreword for industry comment/consultation and all responses have been answered. The report will be published as a CAA paper together with the ongoing work on aluminium decks and helideck nets when this has been completed.
- 3.7.2.2 The contract with NLR was extended to add the work on establishing a new test criterion for profiled aluminium helideck surfaces. This involved full scale testing of five different types of aluminium deck surface using actual S-61 and S-76 wheels mounted on a test rig. All variables expected to be relevant were exercised. The work has been completed and the report delivered, accepted and circulated to the five aluminium deck manufacturers known to the CAA; no significant comments were received. The results indicate that none of the aluminium decks tested met the minimum μ value of 0.65 stipulated in CAP 437, despite evidence of acceptable GripTester results. The full scale test results were found to vary significantly with tyre contact pressure and it is suspected that this may explain the favourable GripTester results which may need to be scaled to be representative. The final report will be circulated for wider industry comment/consultation in due course.
- 3.7.2.3 Current practice in the event of a helideck not meeting the minimum CAP 437 μ value of 0.65 is to fit a helideck net. However, the effectiveness of helideck nets has never been confirmed experimentally and has been further called into question following the move from the 'standard' 20 mm sisal rope nets to the low profile FricTape nets following the introduction of the 25 mm obstacle height limit by ICAO. NLR was consequently tasked with conducting an initial, limited programme of full scale tests on helideck nets. The testing has been completed and the results show that the net produces peak μ values of around 0.65; the netted surface should ideally produce an average μ value of at least 0.65. The CAA and NLR are collaborating with FricTape, the net manufacturer, who have also conducted their own tests. The NLR and FricTape results are quite similar and, interestingly, FricTape obtained better results at lighter helicopter wheel loads. Lighter wheel loads are associated with higher winds which cause the helicopter main rotor to generate more lift, helpfully coinciding with the need for

friction to resist the sliding forces due to wind drag which also increase with wind speed.

3.7.3 Next Step(s)

3.7.3.1 NLR have been tasked with repeating the helideck net testing with a smaller wheel (S-76 wheel as opposed to the S-61 item used for the initial testing) in order to establish whether this has any effect, i.e. an increased 'chocking' effect might be expected with a smaller wheel. This work will also provide a baseline for testing at lighter wheel loads; the CAA has reliable lift data for the S-76 as a function of wind speed. This has been added to NLR's work programme which is expected to be completed in early 2014.

3.7.3.2 Following completion of the current test work at NLR, the CAA will produce a single report covering all of the work performed on helideck friction which will contain the associated NLR reports. The CAA will also produce a definitive friction survey methodology for 'normal' friction surface decks, and an equivalent means of assuring adequate resistance to sliding for profiled aluminium helidecks. This information will be included in the report and will be referenced/incorporated in CAP 437 as appropriate.

3.8 Helideck Environment

3.8.1 Background

3.8.1.1 In its report published as CAA Paper 87007 in July 1987, the Helicopter Human Factors Working Group recommended (Recommendation 4.2.4) that the magnitude and characteristics of helideck turbulence and its effect on performance and handling should be assessed to enable operational rules to be established.

3.8.1.2 A number of early studies were performed by various organisations but, in most cases, lack of definitive data and other information prevented any significant progress being made and attention was focused on other priorities. The heavy landing on the Claymore Accommodation Platform in August 1995 (G-AYOM) led to renewed interest and a new top-down review of helideck environmental issues was commissioned. The review was published as CAA Paper 99004, Research on Offshore Helideck Environmental Issues in August 2000, and contained the following principal recommendations:

- a) Review CAP 437 0.9 m/s vertical flow criterion.
- b) Specify CAP 437 2°C temperature rise criterion to be a three-second average and revise height range over which it is to be applied.
- c) Review CAP 437 recommendation for visualisation of turbine exhaust plumes.
- d) Link platform gas leak and blow-down systems to helideck status lights.
- e) Produce and publish joint industry helideck design guide.
- f) Establish limit on permitted level of turbulence.
- g) Exploit routine monitoring of FDR records for obtaining feedback on impact of environmental factors.
- h) Support moves to combine IVLL, operational envelopes and Aerad data into a single presentation.

3.8.1.3 Related AAIB Safety Recommendation:

- AAIB Bulletin 3/96, G-AYOM at the Claymore Accommodation Platform, Safety Recommendations 96-1 and 96-2.

3.8.2 Progress to Date

3.8.2.1 Progress in relation to the recommendations of CAA Paper 94004 is as follows (in order):

- a) Review CAP 437 0.9 m/s vertical flow criterion – the need for the criterion has been eliminated by the introduction of the new turbulence criterion. See Part 2 of CAA Paper 2008/02, Offshore Helideck Environmental Research, May 2009. CAP 437, Standards for Offshore Helicopter Landing Areas, has been updated accordingly. Completed.
- b) Specify CAP 437 2°C temperature rise criterion to be a three-second average and revise height range over which it is to be applied. CAP 437, Standards for Offshore Helicopter Landing Areas, updated. Completed.
- c) Review CAP 437 recommendation for visualisation of turbine exhaust plumes – research completed and published in CAA Paper 2007/02, Visualisation of Offshore Gas Turbine Plumes in October 2007. Recommendation to implement the scheme developed and tested added to CAP 437, Standards for Offshore Helicopter Landing Areas. Completed.
- d) Link platform gas leak and blow-down systems to helideck status lights – covered in CAA Paper 2008/01, Specification for an Offshore Helideck Status Light System, published in July 2008. Completed.
- e) Produce and publish joint industry helideck design guide. Design guide published in CAA Paper 2004/02 which was subsequently updated to take account of research in several areas and republished as CAA Paper 2008/03, Helideck Design Considerations – Environmental Effects. Completed.
- f) Establish limit on permitted level of turbulence. Extensive programme of research involving simulator trials performed and turbulence criterion developed (see CAA Paper 2004/03, Helicopter Turbulence Criteria for Operations to Offshore Platforms, September 2004), validated (see Part 1 of CAA Paper 2008/02, Offshore Helideck Environmental Research, May 2009), and added to CAP 437, Standards for Offshore Helicopter Landing Areas. Completed.
- g) Exploit routine monitoring of FDR records for obtaining feedback on impact of environmental factors. No progress.
- h) Support moves to combine IVLL, operational envelopes and Aerad data into a single presentation. No progress.

3.8.2.2 As can be seen, all recommendations have been addressed except for the last two which are effectively linked to the helicopter operators Flight Data Monitoring (FDM) programmes. A presentation to the Helideck Certification Agency (HCA) and the helicopter operators to promote this use of FDM data was given in Aberdeen in November 2006 and was well received. All information necessary to implement the algorithm in the operators' FDM programmes was provided to the helicopter operators and their FDM system suppliers. A further presentation was given to the helicopter operators in April 2008.

3.8.2.3 Disappointingly, virtually no progress in implementing this scheme has been made by the helicopter operators, despite its value and importance being

emphasised by the findings of an audit of the HCA by the CAA. It appears that few flow studies are being commissioned by the industry and no flow study results are being received by the HCA, and this situation is being exacerbated by poor reporting by flight crews; very few turbulence report forms are ever received. In addition, the importance of the hazard presented by encounters with offshore turbine plumes was highlighted by the issue of Sikorsky Safety Advisory SSA-S92-10-002 in April 2010. Action to re-route the turbine exhaust pipes on two platforms is understood to be in progress.

3.8.3 Next Step(s)

3.8.3.1 Advantage will be taken of the opportunity presented by the establishment of the helicopter operator FDM user group to promote, encourage and assist the use of FDM data to monitor the impact of environmental factors on helicopter operations. The first meeting was held in December 2013.

3.8.3.2 Some issues regarding the modelling of turbine exhaust plumes have been raised by the industry which, in essence, question the suitability of computational fluid dynamics for these exercises. This may need to be investigated.

3.9 Airborne Collision Avoidance Systems

3.9.1 Background

3.9.1.1 Helicopter operations occur mostly in uncontrolled (Class G) airspace under Visual Flight Rules (VFR). ATC provides either a Radar Advisory Service (RAS), Modified RAS (MRAS) or radar information service (RIS) to helicopters operating in surveillance radar coverage (up to about 80 miles from Aberdeen and most of the southern North Sea area). Outside of this, where VHF coverage exists, an Enhanced Flight Information Service (EFIS) is provided, which includes information on known conflicting traffic. As well as the main helicopter traffic, the airspace is also used by military and other civil aircraft. Special operations, such as trawler monitoring, also take place. Military users operate in restricted areas known as Managed Danger Areas (MDAs), but have been known to frequently leave these areas and interact with helicopter traffic.

3.9.1.2 In a study performed in 2005, it was found that, between 2000 and 2004, there were 21 Airprox occurrences involving helicopters flying to/from offshore platforms. Of these one third (7) were Cat B (safety not assured) and two thirds (14) Cat C (no risk of collision). Just over half (11) involved military aircraft, three involved other helicopters, three involved fixed-wing commercial air transport, three light aircraft and one a model aircraft. Three quarters (16) occurred in Class G airspace, four in Class D and one in Class F.

3.9.1.3 The volume of offshore helicopter traffic is relatively modest hence the associated Airprox statistics may not be fully representative of the underlying risk. Considering the significantly larger data set of fixed-wing passenger operations in UK airspace for the same period, however, a high level review of risk bearing (Cat A and Cat B) Airprox reports has identified the two most significant underlying factors to be flight in Class G airspace and military traffic. Both of these factors coincide for North Sea helicopter operations.

3.9.1.4 The risk of mid-air collision has been successfully addressed in fixed-wing aircraft operations through the provision of the Airborne Collision Avoidance System (ACAS). It was not entirely clear, however, whether ACAS could provide the desired level of safety benefit to North Sea helicopter operations. The ability of helicopters to achieve the required climb rate for the vertical avoidance

manoeuvres has been questioned, and the effectiveness of ACAS against fast moving military aircraft may be limited. It was therefore proposed that trials of ACAS on a North Sea helicopter be carried out to investigate these and any other technical and operational issues unique to helicopters and to the North Sea airspace environment.

- 3.9.1.5 A programme of work was proposed comprising in-service trials of TCAS II (a form of ACAS) equipment on a North Sea helicopter to establish the feasibility and likely benefits of fleet-wide implementation. A separate trial was, however, instigated by Bristow Helicopters removing the need for any action other than monitoring of the Bristow initiative.

3.9.2 Progress to Date

- 3.9.2.1 All work including dedicated (utilizing a BAE 146 'intruder' aircraft) and in-service trials has been completed outside of the HSRMC research programme by Bristow Helicopters. Bristow has EASA TCAS II STCs for the AS332 L, S-92 and S-76 and has applied for a FAA STC for the S-92. All UK Bristow S-92s have TCAS II and the S-76C++ fleet is being equipped. Eurocopter has a TCAS II system certified for the EC225 which will be an option on the EC175. AgustaWestland is to offer TCAS II on the AW189. Sikorsky has no TCAS II systems yet but has plans. Bristows are retrofitting their fleet; the other operators have been slower on the uptake.

3.9.3 Next Step(s)

- 3.9.3.1 No further action is required unless it is considered appropriate to mandate the carriage of ACAS.

3.10 Terrain Awareness Warning Systems

3.10.1 Background

- 3.10.1.1 Following the accident involving a Sikorsky S-61 helicopter approaching the Scilly Isles (G-BEON) in 1983, the UK CAA mandated the fitting of a low height aural warning system for overwater operations. The RACAL Automatic Voice Alerting Device (AVAD) became the standard system, and the requirement was later adopted into JAR-OPS 3.660. This equipment is designed to protect against the Scilly Isles accident scenario of a slow, inadvertent descent into the sea and is believed to be effective in such cases. However, it has proven ineffective for the other six offshore CFIT/loss of control accident scenarios that have occurred in the UKCS.
- 3.10.1.2 More recently the Honeywell Enhanced GPWS (EGPWS, a form of HTAWS), which incorporates the AVAD function, has become available and is fitted to the latest helicopter types, i.e. the Sikorsky S-92, AgustaWestland AW139 and Eurocopter EC225. This equipment potentially represents an enhancement to the basic AVAD function and has demonstrated the capability of significantly reducing CFIT accidents in fixed-wing operations. Unfortunately, the warnings have not been optimised for helicopter offshore operations resulting in a high false alert rate and insufficient warning time to provide any significant benefit over and above the basic AVAD function.
- 3.10.1.3 As a result of the high nuisance alert rate being experienced in service and the EGPWS issues arising from the accident near the ETAP in February 2009, a programme of work aimed at using Flight Data Monitoring (FDM) data to develop modified EGPWS warnings was launched in spring 2010.

3.10.1.4 Related AAIB Safety Recommendations:

- Aircraft Accident Report 2/93, G-TIGH near the Cormorant 'A' platform, East Shetland Basin, Safety Recommendation 93-24.
- Aircraft Accident Report 1/2011, G-REDU at the ETAP Central Production Facility platform, Safety Recommendations 2011-060, 061, 062 and 063.

3.10.2 Progress to Date

3.10.2.1 Eurocopter EC225 flight data from Bristow Helicopters' FDM programme has been used to establish the limits of normal operations. This has enabled the warnings and their associated input parameters to be developed and improved. The new warning configurations have been tested using the available data from four accidents and have demonstrated a worthwhile improvement in performance in terms of warning time with a 'nuisance' alert rate of no worse than 1:100 flights.

3.10.2.2 The project was extended to cover the Sikorsky S-76A+ to investigate whether a single set of HTAWS warnings could be produced to cover both helicopter types that maintained the low 'nuisance' alert rate already secured and still provided significantly enhanced warning times. This has been successfully achieved which is especially encouraging as it is believed that, as well as covering the spectrum of helicopter technological standards, a broad range of types of operation has also been addressed; the Bristow S-76A+ fleet used for this study are operated in the southern North Sea which involves a lot of manual flying and low level shuttling, which is quite distinct from the EC225 style of operation in the northern North Sea. An interim report covering all work completed to date was produced and circulated to relevant industry contacts in October 2012.

3.10.3 Next Step(s)

3.10.3.1 The next step in the project will be to examine the form and format of the associated flight deck warnings. The aim of this work will be to identify the most suitable and/or practical warning methods (auditory, visual and tactile) for pilots to ensure that they respond in a timely manner to HTAWS warnings. Current guidance on providing warnings in helicopters is considered to be deficient; fixed-wing guidance might form a suitable basis but may not be fully relevant, e.g. the ambient noise environment in a helicopter flight deck is significantly different to fixed-wing aircraft.

3.10.3.2 The project will comprise a review of existing guidance on fixed-wing warnings, relevant CFIT accidents (i.e. fixed and rotary wing accidents where TAWS warnings were considered inadequate), and a literature review to identify the optimum means of alerting helicopter pilots to TAWS warnings. The warning methodology(s) identified will be compared with representative helicopter cockpit environments to confirm their suitability.

3.10.3.3 When suitable methods for alerting pilots have been identified, a trial using flight simulators and/or other devices will be conducted to investigate the efficacy of the proposed warning methodology. Flight simulator trials are also envisaged both for full flight crew evaluation of the complete system and also to generate further 'accident' examples for testing the warning configurations.

3.10.3.4 Finally, when all work has been completed, the new HTAWS warning configurations will be promoted to HTAWS equipment manufacturers for incorporation in their products, and to standards organisations such as RTCA and

EUROCAE with a view to incorporating the results of the research into formal standards.

3.11 Lightning Strikes

3.11.1 Background

3.11.1.1 Lightning strikes present a significant safety risk to helicopters, particularly those operating in the North Sea region. Although the aircraft are protected against lightning strikes, it has been demonstrated that, in the UK offshore operating environment, the design and certification threat level will be exceeded five times more often than anticipated.

3.11.1.2 Although there were issues relating to the lightning protection on the aircraft concerned, the lightning strike to G-TIGK in 1995 served to demonstrate the potentially severe consequences of lightning strikes to helicopters. Furthermore, lightning strikes can cause damage that is difficult to detect and which may later present a safety risk; the fatal accident to G-BJ VX in 2002 illustrates how, *in extremis*, this can result in catastrophe. In addition to the safety risk which formed the primary motivation for this project, any lightning strike to a helicopter will normally entail significant and expensive maintenance action. It is therefore considered that the best way to address this issue is to prevent strikes from taking place by avoiding operation in areas of high risk.

3.11.1.3 Lightning strikes to helicopters have occurred at a relatively constant rate of around two per year since the start of offshore operations in the North Sea. Despite the fact that there is ten times as much lightning activity during the summer months, helicopters are only struck during the winter months. In addition, the strike rate is significantly greater than that which would be expected were it due to chance alone. Having considered all of the evidence, it has been concluded that helicopters are 'triggering' lightning strikes and the meteorological conditions when this is likely to occur have been established.

3.11.1.4 Related AAIB Safety Recommendation:

- Aircraft Accident Report 2/97, G-TIGK North Sea 6 NM south-west of the Brae A oil platform, Safety Recommendation 95-45.

3.11.2 Progress to Date

3.11.2.1 As a result of the lightning strike to G-TIGK in 1995, several studies were commissioned by the CAA in the late 1990s. These comprised the following:

- CAA Paper 99008 – Lightning Strikes to Helicopters Over the North Sea – study of 11 documented lightning strikes to North Sea helicopters that took place between October 1992 and November 1996 to attempt to establish common weather features prevailing at the time and location of the strikes. Work performed by AEA Technology, with participation from EA Technology and the UK Met. Office.
- CAA Paper 99007 – Assessment of Lightning Threat to North Sea Helicopters – review of lightning characteristics in the North Sea region and comparison with the certification criteria; study of conditions associated with helicopter lightning strikes (includes a summary of CAA Paper 99008). Work performed by AEA Technology, with participation from EA Technology and the UK Met. Office.

- CAA Paper 2000/2 – A Further Study of Lightning Strikes to Helicopters Over the North Sea – review of forecasting models for triggered (using Patton model from regression analysis reported in CAA Paper 99007) and naturally occurring (using the NIMROD model which is based on extrapolation of observational data) lightning strikes. Work performed by the UK Met. Office.

3.11.2.2 In addition to these studies, some initial research into using helicopter mounted E field sensors ('mills') to detect the build up of electric field around the aircraft (and hence risk of a strike) was performed. Two key issues identified, however, were the rapid build up of potential, possibly too rapid to provide a useful warning, and the inability to provide any guidance on an appropriate escape manoeuvre. For these reasons this avenue of research was not progressed.

3.11.2.3 None of this work led to any practical solutions and, as helicopters continued to suffer lightning strikes at a steady rate, a high level review of the earlier research was conducted by the CAA in 2007. This review proposed short, medium and long term initiatives that might reduce the risk of a lightning strike or mitigate their consequences:

- The short term suggestion to investigate whether helicopters could be operated at different heights (i.e. as far away as possible from the zero degree isotherm) in winter was suggested to the helicopter operators in October 2007. This was taken up but it was noted that there might be relatively little scope for varying the cruise heights.
- As regards the long term suggestion to look at enhancing the lightning protection on helicopters, it is understood that CAA Paper 99007 was presented to the standardisation bodies responsible for the threat definition used for certification, but no action was taken. This is, perhaps, unsurprising as there are only three known areas in the world (the North Sea, the Sea of Japan and the Great Lakes in Canada) where enhanced protection would be required, representing a very small fraction of aviation activity. Also, the possibility of undetected damage causing failures at a later date (e.g. G-BJVX in July 2002) would remain. Furthermore, any resulting lightning protection enhancement would likely involve the replacement of the main and tail rotors and, hence, be relatively expensive.
- This left the medium term suggestion of investigating the potential for providing improved forecasting systems to help minimise exposure to lightning environments, and this formed the objective of the next attempt to solve the problem.

3.11.2.4 The UK Met Office was commissioned to develop a forecasting tool for addition to its OHWeb meteorological service in the form of an additional overlay. Two operational trials have been conducted during winter 2011/12 and winter 2012/13 and the system has shown considerable promise. A final trial is being performed during winter 2013/14 to evaluate the modifications introduced at the end of the winter 2012/13 trial, and confirm that the system is ready for full and permanent implementation.

3.11.3 Next Step(s)

3.11.3.1 Subject to satisfactory performance during the winter 2013/14 trial, the system will be declared fully operational and remain on the Met Office OHWeb service. Otherwise, any deficiencies identified will be addressed and evaluated further as required.

3.12 Other Helicopter Safety Research Projects

3.12.1 Pilot Intervention Times in Time-Critical Emergencies

3.12.1.1 This subject was highlighted for investigation as a result of the following three AAIB Safety Recommendations:

- Aircraft Accident Report 4/83, Westland Wessex 60 G-ASWI, 12 miles ENE of Bacton, Norfolk on 13 August 1981, Safety Recommendation 4.4,
- Aircraft Accident Report 7/87, Twin Squirrel AS355G-BKIH at Swalcliffe, near Banbury, Oxfordshire on 08 April 1986, Safety Recommendation 4.3,
- Aircraft Accident Report EW/C92/2/4, Robinson R22M G-BPPC at Oldham in February 1992, Safety Recommendation 92-26.

3.12.1.2 Current civil requirements allow designers to assume a “corrective action time delay” or “normal pilot reaction time” of one second. Flight simulator experiments conducted under this project involving the measurement of pilot intervention times to a range of time critical emergencies demonstrated that one second is overly optimistic. The results of the work indicated that a time of three seconds would be more realistic. This was presented to the JAA but was rejected. The research was published in CAA Paper 99001 as follows:

- Pilot Intervention Times in Helicopter Emergencies, CAA Paper 99001, CAA, London, January 1999.

3.12.2 Rotor Speed Warning and Protection

3.12.2.1 The research in this area was instigated in response to recommendation 4.1.17 of the report of the Helicopter Human Factors Working Group (CAA Paper 87007, July 1987) and the following two AAIB Safety Recommendations:

- Aircraft Accident Report 4/83, Westland Wessex 60 G-ASWI, 12 miles ENE of Bacton, Norfolk on 13 August 1981, Safety Recommendation 4.4,
- Aircraft Accident Report 7/87, Twin Squirrel AS355G-BKIH at Swalcliffe, near Banbury, Oxfordshire on 08 April 1986, Safety Recommendation 4.2.

3.12.2.2 The results of the work were published in CAA Paper 98004 as follows:

- Enhanced Warning and Intervention Strategies for the Protection of Rotor Speed Following Power Failure, CAA Paper 95009, CAA, London, October 1995.

3.12.3 Tail Rotor Failures

3.12.3.1 This joint CAA/UK MoD project was instigated in response to recommendation 4.1.18 of the report of the Helicopter Human Factors Working Group (CAA Paper 87007, July 1987) and the UK MoD Tail Rotor Action Committee report to the UK MoD Helicopter Airworthiness Maintenance Group. The work included a review of the related UK civil and military accidents and found that tail rotor failure rates in both civil and military service were eight times worse than allowed under the airworthiness design requirements. Fortunately, many tail rotor failure accidents are not catastrophic as the design requirements assume, but it was clear that scope existed for both preventing and mitigating tail rotor failures. The work covered the aspects of airworthiness design requirements, prevention and mitigation of tail rotor failures using HUMS and non-HUMS technology,

emergency procedures and advice, and pilot training. The final report on the project was published in CAA Paper 2003/01 as follows:

- Helicopter Tail Rotor Failures, CAA Paper 2003/01, CAA, London, November 2003.

3.12.4 Helicopter Handling Qualities

3.12.4.1 The overall aim of this project was to improve the handling qualities criteria and evaluation procedures in the civil helicopter airworthiness requirements. The first phase of the work examined current and proposed military rotorcraft handling requirements to determine their relevance to civil operations. The main conclusions of this study was that existing civil requirements are essentially qualitative, and would be better defined if supported by advisory quantitative handling criteria and tested procedures similar to those that had been adopted in military requirements. The second phase comprised a simulator-based experiment to demonstrate the process of developing quantitative handling qualities requirements, and to illustrate the benefits of the end product. The results were considered to be successful, but it was noted that significant further work would be required to fully develop the concept. This was expected to be taken forward as and when fly-by-wire technology was introduced into helicopters. The results of the work were published in CAA Paper 98004 as follows:

- Civil Helicopter Handling Qualities Requirements: Review and Investigation of Applicability of the ADS-33 Criteria and Test Procedures, CAA Paper 98004, CAA, London, June 1998.

3.12.5 Helicopter Flight in Degraded Visual Conditions

3.12.5.1 This project was originally launched as a proactive initiative taking advantage of a complementary UK MoD Corporate Research study. The comprehensive reviews of helicopter accidents in both North America and Europe under the International Helicopter Safety Team initiatives, however, has highlighted this to be a factor in a significant number of helicopter accidents, including some high profile accidents (e.g. G-CFLT in October 1996). The work comprised a review of the UK accident data, simulator experiments and a review of the related requirements. The results firmly established a direct link between flight safety, visual cueing conditions and helicopter handling qualities. Operating minima need to be better matched to helicopter handling qualities and inadvertent entry into degraded visual environments needs to be mitigated, e.g. through the provision of a 'head-up' attitude reference system. The results of the work were published in CAA Paper 2007/03 as follows:

- Helicopter Flight in Degraded Visual Conditions, CAA Paper 2007/03, CAA, London, September 2007.

3.12.6 Offshore Helicopter Pilot Workload and Safety Hazards Associated with North Sea and Irish Sea Helicopter Operations

3.12.6.1 The research in this area was instigated in response to an AAIB Safety Recommendation following a fatal incident in 1992 (Aircraft Accident Report 2/93, G-TIGH near the Cormorant A oil platform, Safety Recommendation 4.1) and recommendation 4.2.5 of the report of the Helicopter Human Factors Working Group (CAA Paper 87007, July 1987). The research took the form of a confidential questionnaire-based opinion survey of North Sea helicopter pilots

aimed at determining whether, and under what circumstances, the workload imposed by administrative matters was excessive. A response rate to the survey of just under 75% was achieved with the questionnaire which was considered exceptionally good. The results confirmed in flight paperwork to be a frequent cause of high workload that could occasionally cause a safety hazard. The main problems were short, multi-sector flights and late changes to routes and/or payloads. Some suggestions for improvements were made including standardisation of forms, removal of duplication, the introduction of automation and education of customers. It should be noted that the data contained in the questionnaires provided very useful input to the projects on helideck lighting and helideck environment. The final report was published in CAA Paper 97009 as follows:

- A questionnaire survey of workload and safety hazards associated with North Sea and Irish Sea helicopter operations, CAA Paper 97009, CAA, London, June 1997.

3.12.7 Helideck Status Signaling System

3.12.7.1 Following reports of 'wrong rig' landings, improvements to platform identification signs were investigated. This proved to be impractical and the focus was moved from preventing landings on the wrong platform to preventing landings on platforms in an unsafe condition. This was addressed through the development and demonstration of a helideck status signalling system comprising a system of red flashing lights, or wave-off lights. A specification and associated test protocol was published in CAA Paper 2008/01 (below) and the application of the system was added to CAP 437, Standards for Offshore Helicopter Landing Areas.

- Specification for an Offshore Helideck Status Light System, CAA Paper 2008/01, CAA, London, July 2008.

3.12.8 Visual Aids for Offshore Approaches

3.12.8.1 In response to an AAIB Safety Recommendation following a serious incident in 1987 (Aircraft Accident Report 5/88, G-BHYB near the Fulmar A oil platform, Safety Recommendation 4.4), operational trials of an Omni-Directional Approach Path Indicator were conducted at the Shell Kittiwake platform. It was concluded that visual guidance was unsuitable for the application and no further work was performed in this area. It was concluded that the best means of addressing the issue was through the provision of instrument guidance and this was progressed via the offshore approach project which has utilized GPS technology. The work performed on ODAPI was, however, published in CAA Paper 95011 as follows:

- A Feasibility Study into the Provision of an Omni-Directional Visual Glideslope Indicator for Helicopter Offshore Approaches, CAA Paper 95011, CAA, London, December 1995.

4 Conclusions

4.1 It has been the purpose of this Section to provide a brief overview of the origins of the UK CAA-led helicopter safety research programme, and to summarise the main research projects undertaken. The research programme has already led directly to significant progress being made in addressing a number of key safety issues. In particular:

- With regard to airworthiness, all UK North Sea and Norwegian offshore helicopters are fitted with HUMS, and significant improvements in its effectiveness are anticipated with the ongoing roll-out of AAD.
- Concerning operational matters, helicopter FDM has been implemented by all UK and Norwegian offshore helicopter operators, and retrofit of the new helideck lighting scheme is underway.
- Regarding external hazards, the helicopter triggered lightning forecasting system is in place on the Met Office's OHWeb service undergoing final evaluation, and the research on helideck environment has directly led to a number of improvements to the standards material contained in CAP 437 that is regarded and applied as best practice within the industry.

4.2 In addition, work on a number of the other significant safety initiatives covered in this Section is nearing completion, and it is hoped that the results and lessons learned will be implemented in the near future. Areas of particular note are:

- All of the work on helicopter ditching and water impact is being taken forwards within the current EASA Rule Making Task (RMT.0120), and it is hoped that at least some of the improvements will be expedited voluntarily by the oil and gas industry.
- The initial version of the new Helideck Monitoring System is to be launched following final verification of the specification. Issue of the invitation to tender for the manufacture of production standard equipment for in-service evaluation is imminent.

4.3 Projects of note expected to deliver in the slightly longer term are:

- GPS-guidance for offshore approaches.
- Enhancements to helicopter terrain awareness warning systems.

5 Recommendations

5.1 Although the helicopter safety research programme is generally regarded as being appropriately targeted and well run, there are two aspects that could be improved. Firstly, funding of research projects has been an issue for a number of years and has led to delays in initiating and/or progressing the work. A less labour intensive, more regularised arrangement between participating organisations would be of significant benefit. Secondly, due to the extended timescales associated with the aviation regulatory process and other factors which could lead to improvements being 'watered down' or even rejected, a faster and more focused approach to implementation via Oil & Gas UK could significantly improve 'pull through' on successful research projects.

5.2 The following recommendations are therefore made:

- The helicopter safety research programme should continue to be supported by regulators, the offshore oil and gas industry, helicopter operators and helicopter manufacturers.
- A less labour intensive, more regularised arrangement between participating organisations for the funding of research projects should be established.

- A faster and more focused approach to implementation of successful research projects should be established via Oil & Gas UK. This should be in addition to the enhancement of the aviation rules and guidance material.

Annex H Glossary

ADELT	Automatically Deployable Emergency Locator Transmitter
AFDS	Automatic Float Deployment System
AM	Accountable Manager
AMC	Acceptable Means of Compliance
ANO	Air Navigation Order
AOC	Air Operator's Certificate
AP	Auto Pilot
APU	Auxiliary Power Unit
ARA	Airborne Radar Approach
ASL	Above Sea Level
ATC	Air Traffic Control
ATO	Air Training Organisations
ATQP	Alternative Training and Qualification Programme
BCAR	UK BCAR is the British Civil Airworthiness Requirements. These were the UK requirements used prior to the introduction of Joint Airworthiness and subsequently the EASA requirements.
BOSIET	Basic Offshore Safety Instruction Emergency Training
CAA	Civil Aviation Authority (UK)
CAP	Civil Aviation Publication (UK CAA)
CAP 437	Standards for Offshore Helicopter Landing Areas
Certification	Certification is the process of designing and ensuring the helicopter meets all of the applicable standards.
Certification Basis	The Certification Basis for an aircraft is the standards which are applied during Certification.
CFMU	Central Flow Management Unit
CICTT	CAST/ICAO Common Taxonomy Team
Class G	Class G airspace is uncontrolled in that any aircraft may use the airspace under the Rules of the Air and although an air traffic service may be available it is not mandated.
CS-29	Certification Specification 29 (CS-29) is the EASA Requirements for certification of the design for large helicopters.
DGPS	Differential GPS

EASA Ops	Commission Regulation (EU) 965/2012, Air Operations Regulation
EFIS	Electronic Flight Instrument System
EFPS	Electronic Flight Planning System
ELT	Emergency Transmitter Locator
FAA	The Federal Aviation Administration (FAA) is the national aviation authority of the United States of America.
FAR	FAA Regulations
FDM	Flight Data Monitoring
FFS	Full Flight Simulator
FIR	Flight Information Region
FMEA	Failure Mode and Effects Analysis
FMS	Fixed Monitor System
FMS	Flight Management System
FODCOM	Flight Operations Division Communications
FSTDs	Flight Simulator Training Devices
GM	Guidance Material
HCA	Helideck Certification Agency
HEMS	Helicopter Emergency Services
HLL	Helideck Limitations List
HOMP	Helicopter Operations Monitoring Programme
Hostile Environment	[Reference; EASA Ops Annex 1] <ul style="list-style-type: none">(a) an environment in which:<ul style="list-style-type: none">(i) a safe forced landing cannot be accomplished because the surface is inadequate;(ii) the helicopter occupants cannot be adequately protected from the elements;(iii) search and rescue response/capability is not provided consistent with anticipated exposure; or(iv) there is an unacceptable risk of endangering persons or property on the ground.(b) in any case, the following areas:<ul style="list-style-type: none">(i) for overwater operations, the open sea areas north of 45N and south of 45S designated by the authority of the State concerned;(ii) those parts of a congested area without adequate safe forced landing areas;

HSE	Health & Safety Executive (UK)
HUMS	Heath & Usage Monitoring System
IFPS	Initial Flight Plan processing System
IFR	Instrument Flight Rules
IRI	Instrument Rating Instructor
JAA	Joint Aviation Authorities
JAR	Joint Aviation Requirement
JAR-29	JAR-29 is the Joint Airworthiness Requirements for certification of the design for large helicopters.
JAR-OPS 3	JAR-OPS 3 is the Joint Aviation Requirement for the operation of commercial air transport helicopters.
LI	Land Immediately
MAP	Missed Approach Point
MAUW	Maximum All Up Weight
MGB	Main Gear Box
MOC	Minimum Obstacle Clearance
MOR	Mandatory Occurrence Report
MRGB	Main Rotor Gear Box
MSA	Minimum Safe Altitude
NAA	National Aviation Authority
NATS	National Air Traffic Services
NPA	Notice of Proposed Amendments: is the method of circulating draft amendments for comment.
NUI	Normally Unattended Installation
OEI	One Engine Inoperative
OEM	Original Equipment Manufacturer
OGP	International Oil & Gas Producers Association
OPITO	Offshore Petroleum Industry Training Organisation. This is the Oil & Gas industry's focal point for skills, training and workforce development.
OSD	Operational Suitability Data
Part-145	Part-145 is the requirement for approval for organisations that carryout maintenance of aircraft and components used for commercial air transport.

Part-M	Part-M is the requirements for approval of organisations that manage the continuing airworthiness of aircraft. This includes establishing the maintenance tasks to be carried out based on the manufacturer's instructions.
PCA	Primary Certifying Authority
PLB	Personal Locator Beacon
PPE	Personal Protective Equipment
RFM	Rotorcraft Flight Manual
SAR	Search and Rescue
Sea State	Sea State is the general condition of the free surface of a large body of water with respect to wind waves and swell.
SFI	Synthetic Flying Instructor
Significant 7	The CAA 'Significant Seven' safety issues were identified following analyses of global fatal accidents and high-risk occurrences involving large UK commercial air transport aeroplanes. For each of these issues, joint CAA/industry task forces were created to study the safety issue in-depth and make recommendations on how their risk could be mitigated.
SMS	Safety Management System
SNS	Southern North Sea
SOP	Standard Operating Procedure
SPI	Safety Performance Indicator
SPA.HOFO	Specific Approval for Helicopter Offshore Operations
TCDS	Type Certificate Data Sheet
TCH	Type Certificate Holder
TRE	Type Rating Examiner
TRI	Type Rating Instructor
UKAIP	UK Aeronautical Information Publication
UKCS	UK Continental Shelf (Geographical area)
UTR	Upper Torso Restraint
Validation	Validation or Validating is process of certifying a type which is non-European type and there is a bilateral agreement or working arrangement in place with that foreign State.
VHM	Vibration Health Monitoring
VMC	Visual Meteorological Conditions