

Safety Review of Offshore Public Transport Helicopter Operations in Support of the Exploitation of Oil and Gas

Progress Report – 2019

CAP 1877

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Contents

Contents	3
Foreword	4
Introduction	5
Passenger safety and survivability	7
Operations	13
Airworthiness	17
Improving knowledge and facilitating change	25
Progress at a glance	30
HeliOffshore Update Summary for UK Civil Aviation Authority's CAP1145 Progress Report	60
Glossary	71

Foreword

In 2016, we published a progress update on the actions and recommendations contained in the Offshore Review (CAP 1145). This review will close the CAP1145 specific activity, but other work streams remain in place to tackle ongoing issues in both the offshore and onshore environments. We are committed to continuously improving the safety of helicopters generally and the safety of those who fly offshore remains at the forefront of our minds. We have been working closely with our colleagues in the European Aviation Safety Agency, relying particularly on its authority and leadership in rulemaking and certification, to achieve many of the objectives outlined in the original Offshore Review. We have also actively collaborated with Industry through the Offshore Helicopter Safety Leadership Group to secure better safety outcomes for all those engaged in offshore flying across Europe.

The previous updates and this publication demonstrate the progress that has been achieved with the measures that were introduced to improve the survivability aspects for passengers and crew and to minimise the likelihood of an accident in the first place.

Mark Swan,

Director Safety and Airspace Regulation, United Kingdom Civil Aviation Authority

November 2019

Introduction

In February 2014, we published a safety review of offshore helicopter operations (The Offshore Review ([CAP1145](#))). The Offshore Review examined the risks to helicopter operations to support the oil and gas industry in and around the North Sea. It was conducted in conjunction with the European Aviation Safety Agency (EASA) and the Norwegian Civil Aviation Authority and was peer-reviewed by independent experts. It identified a wide range of opportunities to improve the safety of those operations and to increase the chances of passengers and crew surviving an accident.

In total, the Review listed 32 actions and 29 recommendations that would all contribute towards the end goal of improving the safety of offshore helicopter operations. Some of these would necessitate long term changes in areas such as helicopter design, and others could be implemented almost immediately and have an instant impact on survivability.

Offshore helicopter operations are extending into the support of renewable energy sources, such as wind farms. Although this activity was not specifically examined in the Offshore Review (CAP 1145), many of the actions and recommendations were considered relevant to these new areas and are being adopted for operations in this sector.

The work done within EASA rule-making task RMT.0409 to update Commission Regulation (EU) No. 965/2012 (the Air Operations Regulation) finally came to fruition when on 1 July 2018 the new requirement for a Specific Approval for Offshore Operations became applicable across Europe. This requires all commercial operators and those non-commercial operators flying large helicopters to comply with the new regulations and obtain an approval from their relevant Competent Authority. These new regulations were influenced significantly by CAP 1145 findings and present a level playing field for operations to all offshore locations including helidecks, ships and wind turbines.

About this report

We stated that we would report publicly on the progress of all actions and recommendations in the Offshore Review. Two progress reports were accordingly published:

[CAP 1243: Safety review of offshore public transport helicopter operations in support of the exploitation of oil and gas – Progress Report 2015 \(January 2015\)](#)

[CAP 1386: Safety review of offshore public transport helicopter operations in support of the exploitation of oil and gas –Progress Report 2016 \(September 2016\)](#)

The Progress Report 2016 (CAP 1386) was to be the final progress report but over the intervening period, the regulatory landscape has changed, there was a further fatal crash in Norway in April 2016 (LN-OJF) and there have been changes to the joint CAA and

Industry body, which is now called the Offshore Helicopter Safety Leadership Group. All of these factors have led us to conclude that a further progress report is warranted and so, in January 2019, we conducted a Post Implementation Review (the PIR) of the actions and recommendations detailed within The Offshore Review (CAP 1145). The review problem statement was:

“Have the Recommendations and Actions in The Offshore Review (CAP 1145) been adequately implemented and have these achieved the objective of improving the survivability of passengers and crew following an accident?”

Whilst there is further activity ongoing in both the offshore and Onshore Helicopter operating domains, this report provides a final statement regarding progress against each action and recommendation within the Offshore Review (CAP1145). Where the first-person pronoun (we/us) is used in this document, it refers to the body corporate of the Civil Aviation Authority.

Within this report we also include responses from HeliOffshore¹ and the European Aviation Safety Agency (EASA). The full response from HeliOffshore is included as an Annex to this report.

¹ HeliOffshore is the global, safety-focused association of the offshore helicopter industry. In October 2014, leading helicopter operators formed the organisation with the specific mission of enhancing safety for offshore helicopter flights.

CHAPTER 1

Passenger safety and survivability

All of the Actions relating to the safety and survivability of passengers and flight crew (A5 through A10 inclusive) have been fully implemented, improving protection in the event of an accident as follows:

- increasing the chances of a safe rescue from the sea by prohibiting operations over the sea in conditions where the significant wave height exceeds 6 metres (A5);
- reducing the risk of a capsized helicopter by prohibiting operations over the sea in conditions exceeding the certified ditching performance of the helicopter (A6);
- reducing the likelihood of the helicopter sinking by requiring helicopter operators to ensure that the Emergency Floatation System (EFS) is armed for all overwater departures and arrivals (A7);
- increasing passenger underwater survival time, to improve the chances of escape from a capsized helicopter, through the introduction of new improved 'Category A' Emergency Breathing Systems (EBS) for all passengers (A8/A10);
- increasing the prospect of an escape from a capsized helicopter by ensuring that all passengers are seated next to an exit that is compatible with their body size (A9).

Further details are presented in the table at Annex A.

Originally mandated for UK operations only via the issue of a CAA Safety Directive, all these measures have now been underpinned through incorporation in the European Air Operating Rules² published by the European Aviation Safety Agency.

We are confident that these measures will improve the prospects of survival and safe rescue of passengers and flight crew in the event of a helicopter ditching or water impact. There remains scope for further improvement through progression of the recommendations and other initiatives, as described in the remainder of this section of the report.

European Aviation Safety Agency rule-making activities

Starting in December 2012, the EASA rule-making task (RMT.0120), "Helicopter Ditching and Water Impact Survivability", has undertaken a major overhaul of the helicopter Certification Specifications (CS-27 & 29) and associated Acceptable Means of Compliance

²

<https://www.easa.europa.eu/document-library/general-publications/easy-access-rules-air-operations>

(AMC) material, related to offshore survivability. We have been directly involved in this rule-making task which has culminated in the publication of new specifications and means of compliance in Amendment 5 to Certification Specifications CS-27 and CS-29 on 25 June 2018³. The key elements of the amendment include:

- emergency floatation systems are required to be resistant to damage as a result of a water impact;
- emergency floatation systems are required to automatically deploy upon contact with the water;
- if emergency floatation systems are disarmed for certain phases of flight then they should automatically be re-armed upon exiting those flight phases;
- revised ditching sea-keeping stability requirements, incorporating irregular wave testing representative of the actual sea conditions that are likely to be encountered in the event of a ditching (Note: the certified significant wave height is required to be promulgated in the RFM);
- underwater escape exits are required to be a minimum size (Type IV, equivalent to extra-broad - XBR) and be operable in the event of ditching or capsized. Underwater escape exits are also required to be easily identifiable when capsized and automatically illuminated;
- a minimum of two exits are required to be provided for each group of four passengers;
- seat rows are required to be aligned with underwater escape exits;
- to assist the location and opening of underwater escape exits when capsized, hand holds are required to be provided next to underwater escape exits;
- egress shall be possible through any underwater emergency exit with any door in the open and locked position;
- externally mounted life rafts shall be provided;
- it must be possible to release and initiate the inflation of the life raft from the flight deck, cabin and externally for all foreseeable floating attitudes, including capsized;
- it must be possible to directly board the life rafts in the event of a ditching;
- operating handles of underwater escape exits are required to be marked with black and yellow stripes to improve underwater visibility.

It should be noted that the list above is not exhaustive and some of the provisions listed above may not apply to Certification Specification CS-27 and CS-27 Category A types due to the need to consider the lower complexity of these designs and proportionality. The new certification specifications and means of compliance are only applicable to new applications for the certification of a helicopter design that are received after their adoption; however, the work of the rule-making task (RMT.0120) continues in the form of a review to consider which of the new measures, should be applied retrospectively to existing helicopters or to

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<https://www.easa.europa.eu/regulations#regulations-initial-airworthiness>

newly manufactured helicopters. Any retrospective action would be put into effect via the EASA regulation on Part 26, (additional airworthiness specifications for a given type of operation) containing the regulation and including the entry into force date, applicability criteria and top-level requirement, and Certification Specification CS-26 (Additional airworthiness specifications for operations, containing the technical means of complying with the regulation). A Notice of Proposed Amendment (NPA) detailing the proposed changes is expected to be published by EASA in Q1 2020.

Some of the changes under consideration relate to items listed in Recommendation 5, for which only some action has so far been taken by the industry. Recommendation 5 stated:

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/marking/ 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*

The submission at Annex B to this report from HeliOffshore, provides some detail on the progress of industry against each element.

Survival equipment

In response to issues identified during the EASA rule-making task (RMT.0120), a suite of new survival equipment standards is being produced for publication. This work is being undertaken by ASD-STAN, an Associated Body to CEN (European Committee for Standardization) for Aerospace Standards. The new standards will be published by CEN as European Norms (EN) and then directly referenced by EASA in the form of European Technical Standard Orders (ETSOs). We are contributing to this initiative by providing the working group with its chairman and secretary, and also an independent expert to draft the new standards material for review and agreement by the working group.

Progress as at September 2019 is as follows:

- **Emergency Breathing Systems (EBS):** A new standard for EBS has been developed and published as European Norm (EN 4856:2018). EASA has committed to publishing a covering European Technical Standard Order (ETSO-2C519) by the end of 2019. The new standard is based on the draft standard (The Development of EBS Technical Standards CAP 1034⁴) used to approve the EBS deployed in service in connection with Actions A8 and A10. The main

⁴

www.caa.co.uk/cap1034

differences between the new standard and the CAP 1034 requirement are that system capacity is defined by volume as opposed to duration, demonstrated by test and flight deck compatibility testing has been incorporated into the standard. We do not expect retesting/recertification of EBS that is already approved to the CAP 1034 standard.

- **Lifejackets:** Work on a new lifejacket standard is nearing completion. A key requirement being addressed is ensuring a self-righting capability for all lifejacket and immersion suit combinations in use which is ambiguous in the current standards. Self-righting becomes increasingly difficult to achieve as the level of thermal protection of the immersion suit is increased. The pre-standard European Norm (prEN 4862) is expected to be ready for submission by end-2019.
- **Immersion suits:** The new standard for immersion suits is well advanced and its primary aim is to address the issue of thermal stress on wearers, particularly flight-crew. This will be achieved through the introduction of four levels of thermal insulation (currently, only one is provided), to be matched to the prevailing sea surface temperature. It is expected that manufacturers will produce a single suit 'shell' with an associated range of thermal liners. The pre-standard European Norm (prEN 4863) is expected to be ready for submission late 2019/early 2020.
- **Life rafts:** The most significant life raft issue identified by rule-making task (RMT.0120) was the lack of any standard for helicopter externally mounted life rafts. Work on a new standard is underway to address this and other issues such as resistance to puncture, boarding facilities, survival bag/equipment design, and the length of the retaining line. The pre-standard European Norm (prEN 4886) is expected to be ready for submission by mid-2020.

We anticipate that all the new standards will be published by the end of 2021 and thereafter EASA can issue the relevant European Technical Standard Orders. It is not yet known how and when EASA proposes to give effect to the new standards. It will always be possible for the industry to voluntarily introduce equipment meeting the new standards once they have been published and, indeed, products approved to these standards are available. From a passenger protection perspective however, mandating through regulation would be more effective.

Safety and survival training

The frequency and fidelity of safety and survival training was highlighted as a matter for attention in The Offshore Review (CAP 1145). In relation to the mandate of such training, EASA has declared this to be "outside of the Agency's competency" (see Recommendation R6 in Annex A). Were such training to be required under aviation regulation as recommended, then we and/or EASA would be in a legal position to address the issues of frequency and fidelity directly. In the absence of such authority, it remains for the industry (the Offshore Petroleum Industry Training Organisation - OPITO) to review the training as described in Recommendation R7.

As at April 2019, the OPITO has modified the safety and survival training to include in-water training on the new Category A Emergency Breathing Systems (EBS). The mandate to introduce EBS required the manufacturers' minimum recommended training to be undertaken which comprised class room training only, and the adoption of this improvement to the training regime is welcomed. The introduction of in-water training was delayed due to concerns raised by the UK Health & Safety Executive (HSE) regarding the possibility of injury resulting from the use of compressed air breathing apparatus during training. Consequently, the training is initially limited to shallow water exercises, but we are encouraging Oil and Gas UK/OPITO to work towards extending the use of the breathing system to all exercises, including those conducted in the Helicopter Underwater Escape Trainer (HUET). Underwater escape training with compressed air breathing systems for all exercises was introduced in Canada in June 2016 with no problems or injuries reported so far.

The OPITO is also planning to review the Basic Offshore Safety Induction and Emergency Training (BOSIET) standard and has invited representation from us on the industry work group tasked with the review.

Safety and survival research

The proposed amendments to Certification Specification (CS-29) in Notice of Proposed Amendment published by EASA in March 2016 under Phase 1 of the EASA rule-making task (RMT.0120) included an objective-based provision (CS 29.801(i)) for 'post-capsize survivability features' that consider occupant breath-hold time. The associated acceptable means of compliance (AMC 29.801) stated that a design that included an 'air pocket' (where a significant portion of the helicopter remains above the water line and provides air for survivors) would be one possible means to provide such features. The intention was that after capsizing (as a result of a ditching or water impact) the emergency flotation system (EFS) of the helicopter would be specifically designed to assure a capsized floating attitude with an appreciable portion of the fuselage above water. This would provide an 'air pocket' in the passenger cabin, which would allow passengers/crew who had not managed to rapidly escape the aircraft to readily find a source of breathable air while they orientate themselves and make their escape.

EASA received a number of negative comments during the consultation of the proposed amendment (NPA 2016-01) regarding the 'post-capsize survivability features'. After considerable deliberation, EASA decided that the proposed 'air pocket' design solution was insufficiently technically mature to be presented as a possible means to achieve the improvement in safety intended by the proposed Certification Specification. EASA concluded that further research should be conducted with regards to the 'air pocket' solution, focussing on the areas of concern that had been raised by the adverse comments. EASA

EASA committed to actively follow technological developments and related research into enhanced emergency flotation systems that could provide an 'air pocket' in the event of a helicopter capsizing. To this end, EASA undertook to commission research to address the

concerns raised by the helicopter manufacturers. Consequently, EASA has recently launched a call for tender for a significant research task which will be initiated in early 2020.

In parallel with EASA activities, an analogous floatation system was being developed in Australia for a military aircraft, and funding was reported to have been committed to 'civilianise' the scheme. Unfortunately, the military programme was cancelled earlier in 2019 due to an Australian Government decision not to invest in the helicopter fleet in question. Although the cancellation of the project does not represent any criticism of the floatation system itself, it is now unlikely that the civilian programme will proceed.

CHAPTER 2

Operations

Safety Management

Operator Safety Management Systems (SMS) aim to drive a proactive approach to risk identification. They continue to develop in organisations we oversee, and we look at the output from these systems, as a primary indicator of the operator's ability to manage a safe flight operation. One of the benefits of an active SMS is the ability to identify and thereby manage potential risks that have not yet crystallised. The introduction of the requirement for a SMS into the continuing airworthiness regulations via the section known as 'Part CAMO', will reinforce this ability to identify and manage risks. Operator data from individual organisations is shared with us as part of our ongoing oversight activity and this operator specific data is then aggregated, to define generic risks across an operating sector i.e. for operators of the same aircraft type. These risks once anonymised, are shared confidentially with offshore operators for appropriate mitigating action.

Since its initial introduction, the Offshore Helicopter Safety Action Group (OHSAG) has been renamed as the Offshore Helicopter Safety Leadership Group (OHSLG) reflecting a review of its terms of reference and work streams, to act in a safety leadership role through appropriate governance to industry. Activities undertaken by this leadership group, include proactive action to identify future industry threats and safety opportunities, and the development of a generic risk log. This log is populated from both the anonymised sector risk data mentioned above and also from data sourced by the leadership group itself. The change in name therefore reflects the high level aims of the group including its sub groups who may be charged with particular tasks.

Oversight of operations

Our regulatory oversight remains highly active within the offshore sector, given the complexity of flight operations and the often-challenging operating conditions. A team of experienced inspectors with operational backgrounds as pilots, engineers and air traffic controllers conduct inspections in all aspects of offshore commercial air transport. This activity enables both us and the operator to agree on next steps in mitigating risks and resolving regulatory non-compliances.

The new European regulation for Specific Approval for Helicopter Offshore Operations (SPA.HOFO) introduced a number of regulatory requirements that embodied much of the detail and objectives in our Offshore Safety Directive 2014/01, which was established as a consequence of The Offshore Review (CAP 1145). The remaining items relating directly to helidecks are reported in Chapter 4 of this document and now appear in [Safety Directive 2019/02](#). Within the Helicopter Offshore Operations regulation, the requirement for a Helideck Directory (HD) is met in the UK, by the use of the products of the Helideck

Certification Agency (HCA)⁵. These products, along with other helideck technical matters, are in turn governed by the Helideck Steering Committee (HSC) as advised by the Helideck Technical Committee (HTC). In the absence of a legal method for us to certify offshore oil and gas installations, we have established an inspection programme to help identify and mitigate helideck risks.

The offshore oversight team focusses on all helideck operations, including a safety compliance assessment in line with the Helideck Directory requirements, as applicable to the helicopter operator. Any findings that relate directly to the infrastructure or service provision offshore, including dangerous goods⁶, are now reflected in limitations to the individual platform's directory entry

We have also augmented the existing [offshore oversight team, by mirroring current aeroplane oversight methods to influence safety in the ground handling environment focussing on such issues as cargo and baggage handling which is known as the Ground Handling Operations Safety Team (GHOST). The establishment of this offshore sub-group should encourage the sharing of best practice across both land-based and offshore helicopter operations.

Pilot training

A review of pilot training material recommended that operators engage with Original Equipment Manufacturers (OEM) to help develop their Standard Operating Procedures (SOP). Manufacturers are now producing Flight Crew Operating Manuals (FCOM) for their more complex helicopter types, alongside the introduction of Operational Suitability Data (OSD)⁷. This will enable flight operations and training departments to address syllabi for initial and recurrent training and facilitate the checking of both pilots and those providing the training and validation.

EASA has also launched the rule-making task (RMT.0724) 'Rotorcraft FCOMs' to improve the operating information provided to rotorcraft flight crew in the relevant aircrew manuals. Safety could be improved by standardising the structure and approach used to present operational information in rotorcraft manuals, thereby improving the clarity of this information. This rule-making task will consider the current approach utilised in the acceptable means of compliance to Certification Specification (CS-25), and other initiatives such as the activity undertaken by HeliOffshore. A notice of proposed amendment should be available in Q3 2020.

Original equipment manufacturers have already developed operating manuals for the EC225 and S92 in cooperation with HeliOffshore.

⁵ <https://www.helidecks.org/index.php>

⁶ Dangerous goods are defined by the International Civil Aviation Organisation (ICAO) as articles or substances which are capable of posing a risk to health, safety, property or the environment and which are shown in the list of dangerous goods in the ICAO Technical Instructions or which are classified according to those Instructions

⁷ OSD covers pilot training, maintenance staff and simulator qualification; the master minimum equipment list (MMEL); and possibly other areas, depending on the aircraft's systems.

We introduced an Alternative Method of Compliance (Alt MOC) in 2015 to provide offshore operators with the required flexibility to meet the safety intent of the existing pilot training and checking requirements. This has allowed best use of flight simulator time available and ensures that crews are checked in those areas identified by the operator as critical to flight safety. It also establishes a foundation for the future development of training and checking regimes such as Alternative Training Qualification Programmes (ATQP) and evidence-based training for those operators who have comprehensive, well established and mature training organisations and established Flight Data Monitoring (FDM) programmes.

The helicopter industry believes that there may be benefits in adopting competency-based training, as detailed in the current aeroplane Alternative Training Qualification Programme (ATQP) requirements, already established within European regulations. This training alternative, allows the operator to focus upon the issues that affect its specific operation, derived from its own evidence-based data, rather than meeting the general regulatory requirements. The airline industry is also further developing these concepts into evidence-based Training. The International Civil Aviation Organisation (ICAO) Document 9995 Chapter 1 background at 1.3, gives current guidance and states that:

“evidence-based training addresses pure scenario-based training in prioritising the development and assessment of key competencies, leading to a better training outcome. The scenarios recommended in evidence-based training are simply a vehicle and a means to assess and develop competence. Mastering a finite number of competencies should allow a pilot to manage situations in flight that are unforeseen by the aviation industry and for which the pilot has not been specifically trained”.

The industry, through their collective association, HeliOffshore⁸, is working to develop a helicopter-specific evidence-based training system alongside the current EASA evidence-based training rulemaking task which published Notice of Proposed Amendment (NPA 2019-08) “Update of organisation requirements – flight crew” for public comment on 14 June 2019.

These generic competency-based methodologies should enable crews to deal with technically complex aircraft in today’s evolving aviation system, by honing non-technical communication skills and behavioural awareness, based on human factors principles. The focus is on how people should identify, interact and deal effectively with a complex event. Simply applying a checklist during an emergency drill is usually not enough to resolve a modern complex situation. Through competency-based training concepts, the aviation industry continues to explore and develop programmes that focus on how people interact with and best manage complex aircraft. We are working closely with the industry to assess and adopt the best available training models. Evidence-based training is an example of a modern training model; it seeks to use data from events and individuals’ performance to determine priorities for training. This type of training is however, data and manpower

⁸ <http://helioffshore.org/about/>

intensive and implementation will be a challenge for helicopter operators. While development of these training systems continues, offshore operators are making best use of human factors principles within their current training programmes.

The CAA examiner assessment form, TS10, has been developed to include a non-technical assessment alongside a performance indicator function, to assist with standardisation and personal development. The flight examiner role is critical in upholding the standards and practices established for pilot competence. This formal report identifies how the examiner applied the current requirements and standards and acts as both feedback and record of the three-yearly 'Assessment of Competence'.

The monitoring of the pilot flying the aircraft and the trajectory of the aircraft in flight is a primary obligation of both pilots. Training in how to monitor pilots is embedded within operators initial and recurrent training and checking programmes but global accident and incident data, continues to indicate that automation and flight path management are key areas for attention in both aeroplane and helicopter operations. With evermore complex types emerging, it is apparent that monitoring and aircraft management skills are fundamental in ensuring a continuing safe operation.

Flight simulators are now available for all offshore helicopter types both in the UK and within Europe. These simulators facilitate accurate pilot training in devices that replicate the aircraft as equipped for offshore operations. EASA simulator requirements demand that these devices remain fit for their operational purpose. The introduction of Performance Based Navigation (PBN) [more accurate track keeping and navigational capabilities] means that crews and aircraft must be trained and equipped to meet the new requirements which rely on Global Navigation Satellite Systems (GNSS) technology. Simulators must therefore keep pace with this demand and flight crew training/checking syllabi adapted to meet the airspace, instrument approach procedures and system changes.

CHAPTER 3

Airworthiness

When considering the airworthiness actions (8) and recommendations (12) from The Offshore Review (CAP 1145), all were assessed as complete as per the updates communicated within The Progress Report 2015 (CAP 1243) and The Progress Report 2016 (CAP 1386). Recognising that for many of these subjects there has been ongoing work, including externally by operators, the oil and gas industry and also within EASA, the following is a summary of the work that has been undertaken to enhance the safety of offshore operations.

Sharing of Safety Critical Information

We have continued our dialogue⁹ with the offshore operators and EASA, with a focus on ensuring that there is clarity and alignment of the understanding of the Certification Directorate EASA with the reality of offshore operations. Meetings continue to be held in Aberdeen with the helicopter operators on a six-monthly basis, where both the initiatives relating to Action 31¹⁰ and Action 26¹¹ are discussed. The sharing of information on trends in Mandatory Occurrence Reports (MOR) has benefitted from our own continuous improvement activity and development of our processes. These improvements include all airworthiness related occurrence reports which are reviewed in detail on a weekly basis, with rules set for those that require greater investigation either by the reporter and/or us. A review of helicopter related occurrence reports has focussed our attention on topics such as critical part rejections, events that may result in additional crew work load, and/or actions that might require a helicopter to land immediately. Recognising the criteria for reporting¹², it is possible that not all safety critical events are being reported. In response to this deficiency, through our dialogue with industry, we have continued to improve the better sharing of information relating to in-service difficulties, reliability issues and additional maintenance burdens placed on the operators. During 2018, EASA also attended the meetings with the offshore operators in Aberdeen and continue to receive invitations and minutes of meetings from operators. We are also working alongside HeliOffshore and are aware of their analysis on global Return to Base (RTB) events.

Through the development of our own system for identifying and monitoring industry risk, (the Regulatory Safety Management System), we have engaged with the EASA Certification Directorate twice yearly, sharing identified industry risks and occurrence reports relating to the design of rotorcraft, aircraft and engines. In 2018 a meeting specifically on rotorcraft

⁹ Action A23, CAP 1145 refers

¹⁰ 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.

¹¹ CAA Airworthiness will meet with offshore operators periodically to compare the trends of MORs with operator in-service difficulty / reliability data to ensure that the complete risk picture is captured, addressed and that the desired outcomes are being achieved.

¹² (EU) 376/2014 and (EU) 2015/1018 refers

risks was held with the EASA Head of Rotorcraft, Product Certification Managers and subject matter experts in attendance. These meetings have permitted the better sharing of safety critical, reliability and maintenance related information, thereby enhancing EASA's engagement with Type Certificate holders especially where there is a need to make informed safety related decisions.

Future Safety Critical Parts Developments

Recognising the benefits of distributing safety critical information, there is consideration for focussing on data collection that adds value, better analysis and improved sharing of intelligence. Discussions with EASA led us to develop a proposal with offshore operators to share information relating to the early rejection of both critical parts¹³ and components, the failure of which may result in increased workload or action to land immediately. We have now produced a list of those critical parts and a pilot scheme of components that would require an immediate landing for the current offshore fleet types. Operators, EASA and the Type Certificate holder should all benefit from this improved sharing of information and intelligence in Q4 2019.

Vibration Health Monitoring

The Offshore Review (CAP 1145), reviewed the use of Vibration Health Monitoring (VHM) systems and their introduction to operations. VHM systems continue to be a major source of identifying issues with critical rotor and rotor drive systems for all operators and with the introduction of Specific Approval for Helicopter Offshore Operations (SPA-HOFO), with effect from 1 January 2019, all operators are required to have systems to collect, analyse and respond to detected alerts. The specifications for VHM systems for large rotorcraft are set out in Certification Specification (CS29.1465) and there are now requirements for system performance, both during the initial system certification phase and through-life, with the requirement to monitoring in-service performance. These requirements are referred to as the Controlled Service Introduction (CSI). EASA has formally approved the VHM systems for the current offshore fleets of helicopters, including the Sikorsky S92, Leonardo AW 139, 169 and 189, and Airbus Helicopters AH 175. The process of the Controlled Service Introduction has required the support of the Type Certificate holder, EASA and the operators, with further independent resource being provided to the process from our own vibration health subject matter expert.

In 2017 we introduced a detailed checklist for the completion of vibration health audits to check compliance with operator procedure manuals. The VHM audit is now scheduled as part of our oversight and focuses on how operators manage the day to day operational aspects of vibration health. In addition, it examines how the Continuing Airworthiness¹⁴ aspect of the process, including the interaction with the Type Certificate Holder, is conducted.

¹³ CS-E and CS29.602

¹⁴ Continuing airworthiness' means all of the processes ensuring that, at any time in its operating life, the aircraft complies with the airworthiness requirements in force and is in a condition for safe operation

We have continued to develop our knowledge of vibration health with the development of our own staff training programme to cover both the methodology of such monitoring systems and their operational use. A total of 7 staff are now trained and competent to provide oversight of operators using VHM as part of their operational approval, further staff are progressing through our training programme.

In February 2018 we provided further updates to the document, Helicopter Vibration Health Monitoring (CAP 753)¹⁵ to reflect Safety Directives, EASA Certification Memorandums and the publication of HeliOffshore's HUMS¹⁶ Best Practice Guidance¹⁷. The latter of these is a further initiative adopted following the publication of The Offshore Review (CAP 1145).

Independent review of operators use of Vibration Health Monitoring - 2019

As stated previously in this report, continued effort is considered necessary to strengthen the measures currently in place to reduce the offshore helicopter accident rate.

Airworthiness related accidents still account for a major proportion of all fatal accidents and of these, rotor and rotor drive systems continue to present a significant risk, influenced by the large number of critical parts utilised in these designs. The tragic fatal accident to LN-OJF in April 2016 provides continued evidence of this risk.

Vibration health monitoring systems are a major source of prognostic capability and provide advance detection of issues with critical elements of rotor and rotor drive systems for all offshore operators. The performance of VHM and its contribution to safety was considered in The Offshore Review (CAP 1145) resulting in two actions and two recommendations being made. Though the specific topics of these actions and recommendations have been addressed, it is recognised that there are still significant advances which can be made to further improve the prognostic capability and usability of VHM. At the same time, the current level of maintenance effort required to operate some of the existing VHM systems (VHMS), presents not only a significant additional operating cost, but increases the effort needed to identify 'real' issues, relating to mechanical problems of the rotor and rotor drive system, from the many false alerts generated.

We have performed a review of VHMS performance and operator procedures. This review identified a number of significant areas for improvement which have taken place since the first issue of The Offshore Review (CAP 1145) in 2014 and also some aspects of VHM which warrant additional effort for improvement. A summary of findings from this review are detailed below;

- **SPA HOFO:** The requirement for "Specific Approval for Helicopter Offshore Operations" (SPA-HOFO) became effective on 1 July 2018 with HOFO.155 requiring VHM for the current UK offshore fleet by 1 January 2019. This requirement states that all operators are required to have VHM systems to

¹⁵ www.caa.co.uk/cap753

¹⁶ Health and Usage Monitoring System

¹⁷ CAP 1145 Recommendation R26 refers to the development of VHM best practice.

collect, analyse and respond to detected alerts. The specifications used to assess VHMS design for compliance with HOFO.155 is Certification Specification (CS29.1465). A significant feature of this requirement is that this places requirements for system performance on the helicopter type certificate holder (or VHMS STC holder), both for certification and continued airworthiness throughout the life of the helicopter. At the end of 2018, EASA formally approved the VHMS for the current offshore helicopter types, including the Sikorsky S92, Leonardo AW 139, 169 and 189, and Airbus Helicopters AH 175. Having achieved initial certification in accordance with Certification Specification (CS29.1465) the next step is to complete the Controlled Service Introduction (CSI) phase, during which the VHMS performance in service will be monitored and evaluated. Final acceptance of compliance with (CS29.1465) post service introduction, will involve the Type Certificate holder, EASA, operators and a local National Aviation Authority¹⁸.

- **Technology and Performance:** During the last 4 years a number of new ground station systems have been introduced to existing helicopter VHM platforms along with a number of new VHM systems launched associated with recently certificated (last 10 years) helicopter types. These newer systems can now acquire significantly more indicator readings per flight, which provides greater resolution for understanding the significance of individual outlying data points (i.e. normal scatter or a real indication) over a much shorter time period. Improved avionic capability also allows capture of more raw data which can be analysed as necessary on the ground. The proportion of successfully completed downloads and improved threshold setting are also valuable improvements. Another potential step change is the introduction of automated trend monitoring which can increase the duration of advance warning. Unfortunately, introduction of new technology can sometimes lead to an initial increase in the number of false alerts which has been evident with recently introduced systems. Improvements have already been introduced to recover the alert rate back to a normal level.

Looking to the future, improved avionic capability, data analysis tools, real-time HUMS and artificial intelligence should all provide the next generation of VHMS significant scope for improvement.

Remaining Challenges:

There are three main findings of our review of VHM. These findings were the need to increase VHM prognostic capability, i.e. the period of advance warning available, the reliability of VHMS with respect to the rate of false alerts, which has historically been poor, and the proportionality of cost and effort consumed by VHM in comparison to other viable means of health monitoring. Though these findings will appear obvious to anyone familiar with VHM, these continue to be critical such monitoring to realise its potential for avoiding

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National Aviation Authority is the term used by EASA to denote the competent authority for aviation in a particular state.

future accidents whilst in parallel developing into a 'normal', reliable means of condition monitoring. These issues are addressed individually below;

- **Prognostic Capability:** There are several rotor drive system and rotor pitch control failures that have resulted in accidents over the past 10 years. These failures fall into 3 categories which are addressed below;
 - Main Gear Box (MGB) epicyclic module degradation / planet gear failure. VHM gear and shaft indicators have traditionally been targeted at components that rotate around an axis which remains fixed in relation to the location of the vibration sensor and for which a method of signal averaging is used to reduce scatter. As there are multiple planet gears that are continually moving in relation to the sensor, this presents a far greater challenge for effective VHM. By employing more accelerometers, monitoring individual planet gears, directing signal averaging to individual planet gears, developing new indicator algorithms and refining methods of threshold setting there is the potential to significantly improve epicyclic module health monitoring.
 - MGB internal shaft failure. Though there are already the means to monitor this type of failure condition, the failures experienced reinforce the knowledge that the timescale for development of some MGB internal mechanical failure modes may only be a few tens of hours. Accordingly, it is necessary to drive improvement of the prognostic capability of VHM, maybe by better location of sensors, and routinely downloading VHM data at each available opportunity, in order to maximise the likelihood of indicators providing a timely warning.
 - Rotor pitch control. Rotors present a different set of challenges to VHM as different modes of degradation often result in similar changes in VHM signal, i.e. energy at blade passing or once per revolution frequencies. Pitch control mechanisms, which typically contain a number of critical parts, will have some non-rotating and some rotating elements. Where VHM can be used to monitor these critical components, consideration should be given to extending the scope of VHM to cover these parts. Of particular concern are tail rotor pitch control bearings, which have exhibited reliability issues across platforms of several helicopter manufacturers.
- **Reliability / False Alert Rates:** Typically, the rate of false alarms for traditional means of condition monitoring, such as oil debris monitoring, or information provided to the cockpit, should generally be better than 10% of the actual event rate being monitored. The rate experienced on the current North Sea fleet over recent years has varied around 0.01 to 2 per flight hour, depending on helicopter type. In practice around 95% of the current Health and Usage monitoring System (HUMS) alerts can be considered as spurious, resulting in checks to the helicopter with no mechanical fault found. Generally, most of these 'false' alerts

are either due to a lack of optimized threshold settings or are 'real' alerts but resulting from reliability problems with the HUMS itself.

When this alert rate is compared with the actual failure rate of the components being monitored (extremely remote), it is clear that much more needs to be done to reduce the false alert rate and align with the rates set out in the document Helicopter Vibration Health Monitoring (CAP 753). Factors which can influence the false alert rate, and which account for the vast difference alert rates experienced across existing types, include sensor and wiring reliability, methods of data point smoothing (e.g. only indicate if 3 points out of 5 exceed the threshold), methods chosen for threshold setting and very significantly the use of multiple Condition Indicators (CI) from different sensor locations to generate alerts based on Health Indicators.

Each of these factors can present a balance or compromise between the confidence of optimising the point of early warning and the risk of increasing the likelihood of false alerts. Improving detection capability helps to separate the failure and normal CI values and thus reduces the need for compromise when setting thresholds. Further effort should be made to evaluate the potential to reduce false alert rates by monitoring potential failure conditions from multiple sources. A decision to increase the number of sensors to achieve this objective, should only follow demonstration of acceptable sensor and associated wiring failure rates. We also consider that there is scope to develop Key Performance Indicators (KPI) in order to better evaluate and compare different types of VHM false alarm prior to benchmarking acceptable performance targets.

- **Proportionality of cost and effort consumed by VHM:** Provision of VHM equipment is expensive in comparison to other means of condition monitoring. In addition, the operating costs can be high, due to the extent of maintenance required following frequent alerts or analysis of atypical vibration data. Though experience has shown that the cost of VHM is considered to be generally worthwhile, the industry should endeavour to implement and optimise different means of health monitoring whichever is most appropriate for the failure condition being monitored. This situation is continually changing as new opportunities for health monitoring become available due to advances in technology. Of particular note is that many gearbox failure modes result in debris being released into the lubricating oil system. For failure conditions which can be detected earlier using oil debris monitoring (ODM) consideration should be given to improving ODM capability alongside improvements in VHM.

Future Vibration Health Monitoring Developments

As part of our long-term strategy for VHM, we are developing a Bowtie¹⁹ risk model, looking at the threats that may make a risk apparent and the effectiveness of any controls in place

¹⁹

<https://www.caa.co.uk/Safety-Initiatives-and-Resources/Working-with-industry/Bowtie/>

that reduce the likelihood or impact of a risk. Our intent is to share the finalised version of this work, along with several other Bowties, with offshore operators in order that this may aid their internal risk management programmes. This work is in line with many other industry bow tie models we have developed which can be found on our website and a simple generic explanatory diagram is included below.



Recognising the requirement to continuously improve and add resilience to our knowledge, oversight and staff training of vibration health, we will be developing our training programmes, audit programme and CAA Publications (CAP) to reflect this work.

EASA has also launched the rule-making task (RMT.0711) 'Vibration health monitoring Systems' with the objective to drive and enable improvements in the fidelity of VHM systems and also to foster the modernisation of these systems which would provide additional safety benefits when compared to the existing legacy systems. The use of VHM to detect imminent failures of critical rotor and rotor drive components has been shown to greatly improve the level of safety of rotorcraft particularly for offshore operations. There is however, a need to improve the current Certification Specifications to reflect the evolution of modern VHM systems in order to gain the associated benefits. We intend to share feedback from the 2019 independent review of operators VHM through active participation in rule-making task (RMT.0711).

A Notice of Proposed Amendment (NPA) is expected around Q2 2020.

Maintenance Standards Improvement Teams

Since the publication of The Offshore Review (CAP 1145), we have further expanded on action A31²⁰, relating to the improvement of maintenance standards. Extending the initiative beyond the offshore helicopter working group, we have now established eight further working groups with representation from over fifty UK organisations. These groups

²⁰ 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.