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Civil Aviation Authority

Onshore Helicopter Review Report

CAP 1864

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Civil Aviation Authority
Aviation House
Beehive Ring Road
Crawley
West Sussex
RH6 0YR

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Enquiries regarding the content of this publication should be addressed to:
FSTechnicalSupportTeam@caa.co.uk

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Contents

Section A: Executive summary

Chapter 1: Introduction & background

Introduction

1.1 In 2013, and following several helicopter accidents in the North Sea, the UK Civil Aviation Authority (CAA) instigated a review into offshore operations which culminated in a comprehensive report published as CAP 1145 (Safety review of UK offshore public transport helicopter operations in support of the exploitation of oil and gas). This report raised many actions and recommendations to improve the safety of offshore commercial helicopter operations. Subsequently, the CAA determined that a similar approach should be undertaken with regards to the onshore sector of helicopter operations.

1.2 This determination was further influenced by several high profile onshore fatal accidents occurring in a similar timescale covering commercial air transport, corporate and police helicopter operations. These accidents supported the need for an in-depth study into the onshore helicopter industry environment and operations which differ significantly from the offshore sector in terms of scale, scope and complexity.

1.3 As the UKs specialist aviation regulator and given the absolute primacy of the safety of the passengers and crew involved in such operations, the CAA announced that the review would be initiated in January 2018. The purpose of the review was to study current operations, previous incidents and accidents and onshore helicopter flying in other countries to make recommendations aimed at improving the overall safety of the sector. The focus was to be aimed at commercial air transport operations, including those conducted as emergency services, non-commercial operations by complex helicopters and specialised operations (aerial work).

1.4 In delivering this report, the CAA engaged with the British Helicopter Association (BHA) and Cranfield University to provide a small team of subject matter experts that reviewed the document and offered comment and challenge to the content.

Background

1.5 The onshore helicopter industry covers a diverse range of operations including commercial and public air transport, corporate/business flights, specialised operations (aerial work), emergency services, training and private flying. In the UK the helicopter sector is relatively large compared with some other European countries and provides a significant contribution to the economy. This important industry has been influenced by the recent regulatory changes brought about by the adoption of European aviation regulations and continues to adapt to this environment.

1.6 These regulations set the basic standards for the acceptable level of safety throughout Europe based on the principles enshrined in the International Standards and Recommended Practices of the International Civil Aviation Organisation (ICAO). The very nature and flexibility of helicopter operations can in themselves offer challenges and opportunities for operators and it is important that these are all properly managed, and risk assessed. The requirement for operators to now have a management system clearly directed towards safety has provided an opportunity for improvements in the overall safety standards of the industry.

1.7 When considering what level of safety should be achieved and is achievable within the context of the regulatory framework, it is important to establish what the underlying context and hazard environment is to start with, and then look at how much this can be reduced. Most aeroplane airline operations are conducted within a safety framework produced via a combination of high technical reliability and redundancy and a highly structured and controlled aviation infrastructure. Conversely, by virtue of operational need, helicopters tend to operate within a mostly unstructured environment that is not necessarily optimised for aviation, and the technology is largely restricted by design to limited levels of redundancy.

1.8 Despite these fundamental obstacles, high levels of safety are achieved within commercial helicopter operations; it is conceivable that these levels of safety could reach equivalence with the aeroplane airline industry. As will be highlighted within this report, the primary assets in helicopter aviation and the most effective safety tools are the human elements; their skills, knowledge, training and culture.

1.9 In 2013, EUROCONTROL produced a White Paper entitled “From Safety I to Safety II”, in which it articulates the concept of shifting from a safety management perspective of focusing on the small number of things that go wrong to concentrate on the many things that go right. The UK helicopter industry is incredibly diverse, and the individual sectors have become agile in reacting to industry events. The proactive principles within operator safety management systems are still maturing but this shift in focus to a performance-based approach benefits an industry which has experience in many different facets of aircraft operation.

Action:

A1 *The CAA will consider developing guidance material on the principles of Safety II in appropriate Civil Aviation Publications (CAP) for each sector of UK helicopter operations so that best practice can be shared by all in meeting regulatory requirements.*

Other helicopter safety initiatives

1.10 The CAA has been involved in a range of helicopter specific safety initiatives in recent years collaborating with industry and other regulators within the UK, Europe and worldwide. These activities are over and above the partnership the CAA holds with the BHA through various onshore and offshore sub-groups which provide an opportunity for its members to discuss issues directly with the CAA.

1.11 In 1999, concern about a consistently high accident rate in small and medium size helicopters prompted the Executive Committee of the Safety Regulation Group to set up, in collaboration with the helicopter industry, the Small Helicopter Action Group which later became the Small Helicopter Safety Group, in order to devise a strategy for reducing the number of helicopter accidents and fatalities occurring each year. Several initiatives were undertaken and, in particular, revised visibility minima for helicopter flight in VFR and IFR were added to the UK Rules of the Air Regulations.

1.12 The European Strategic Safety Initiative (ESSI) was an aviation safety partnership launched in 2006 between EASA, other regulators and the industry as a ten-year programme and had three pillars covering commercial air transport aeroplanes (ECAST), General Aviation (EGAST), and helicopters (EHEST). ESSI's objective was to enhance safety for citizens in Europe and worldwide through safety analysis, implementation of cost-effective action plans, and coordination with other safety initiatives.

1.13 The European Helicopter Safety Team (EHEST) brought together manufacturers, operators, research organisations, regulators, accident investigators and a few military operators from across Europe. Co-chaired by EASA, Airbus Helicopters and the European Helicopter Association (EHA), EHEST was also the European component of the International Helicopter Safety Team (IHST). EHEST was committed to the objective goal of reducing the helicopter accident rate by 80% by 2016 worldwide, with emphasis on improving European safety.

1.14 The CAA was strongly supportive of EHEST which analysed and produced two detailed reports on helicopter accidents in Europe covering the period 2000 to 2015. From this analysis, implementation strategies were formulated to improve safety. This was helped through the development and production of much significant safety promotion material including pre-flight risk evaluation procedures.

1.15 Following a reorganisation within EASA, the ESSI and its elements were discontinued in 2016 to be re-established under various bodies including the Stakeholder Advisory Body. As a sub-committee of this body, the Rotorcraft Committee (R.COM) continues the liaison and safety work and has set up the European Safety Promotion Network Rotorcraft (ESPN-R) to continue to develop, disseminate and evaluate safety promotion material.

1.16 In December 2018, EASA officially launched the Rotorcraft Roadmap with the vision to achieve a significant safety improvement within a growing and evolving aviation industry by:

- Improving overall rotorcraft safety by 50% within the next 10 years.
- Making positive and visible changes to rotorcraft safety trends within the next 5 years.
- Developing performance-based and proportionate solutions to help maintain competitiveness, leadership and the sustainability of European industry.

Wherever possible, the CAA will continue to take an active role in all these initiatives and encourage the UK industry to do likewise.

1.17 The Offshore Helicopter Safety Leadership Group (OHSLG) was established following the offshore review. The OHSLG is a regulator and industry high level governance team that identifies and prioritises offshore aviation risks and devises workplans for safety sub groups to ensure effective action is taken to minimise those risks. It shares, monitors and defines the top industry risks identified individually by each helicopter operator and the CAA, and maintains oversight of all work contributing to improvements in helicopter safety. This review has considered whether a similar body to address onshore matters should be established.

Aim

1.18 The aim of this review is to provide a status report to the CAA Board on the overall assessment of safety performance of UK onshore helicopter operations and to set actions or make recommendations to improve safety with the ultimate aim of minimising the likelihood of accidents and incidents.

1.19 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. It is anticipated that all participants share this desire and will actively embrace their role in improving the safety of the industry.

1.20 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.

The actions and recommendations are recorded within the associated chapters and appendices and also listed in chapter 31 of the report.

Chapter 2: The onshore industry

2.1 The helicopter industry is a well-established and vibrant element of the UK aviation sector. The versatility of the helicopter lends itself to all manner of operations and these are fully utilised by operators conducting the whole range of possibilities including commercial air transport, charter, private, specialised operations (aerial work) and emergency services. The use of helicopters to support the vast range of requirements is essential to ensure a thriving market and therefore the safety and resilience of these helicopter operations is key.

2.2 The use of helicopters onshore is not only a method of transportation but an essential tool with regards national infrastructure and emergency services. The sight of a police or Helicopter Emergency Medical Services (HEMS) helicopter is a regular occurrence throughout the UK. In an average year emergency service helicopters fly:

- Over 20,000 air ambulance and emergency medical services flights (source Air Ambulance Association (AAA)).
- Over 28,000 missions in support of police forces and services protecting police officers and supporting public safety (source National Police Air Service (NPAS)).
- Over 2,500 Search and Rescue missions, which is equivalent to seven taskings per day, saving life and providing assurance to people undertaking both work and leisure activities throughout the country and at sea (source Department of Transport DfT).

2.3 The national infrastructure and other essential resources rely on helicopters to enhance effectiveness, ensure safety and reduce costs. According to the National Grid, it takes three linesmen climbing the towers one day to inspect three pylons, while an airborne observer in a helicopter can inspect six pylons in one hour. Gas and fuel pipelines are regularly inspected by helicopter to ensure there are no ground works being conducted that could damage the network.

2.4 The helicopter fleet registered in the UK of all types and usage stands at around 1250.

2.5 There are approximately 45 helicopter operators that have been granted an Air Operator's Certificate (AOC) allowing them to transport passengers, cargo or mail for remuneration or other valuable consideration. These operators must adhere to stringent organisational and operational requirements and come under the direct oversight of the CAA as the competent authority for the UK.

2.6 In addition, and in the context of this review, there are approximately 31 helicopters conducting commercial specialised operations (previously aerial work) and a further 63 large helicopters (>3175kg) conducting non-commercial operations.

2.7 A breakdown of the types is shown below:

Table 1 Helicopter types utilised for UK onshore operations

Helicopter Type	CAT/SPO/NCC	HEMS	Police	SAR	Average Fleet Age	Total
A109	69	2			15	71
AS 355	55				29	55
AS 365	11	2			21	13
AS350/EC130	45				17	45
AW139	5				5	5
AW169	5	9			1	14
AW189				11	3	11
Agusta Bell 206	25				40	25
Bell 206	66				35	66
Bell 407	6				6	6
Bell 412	4				25	4
Bell 429	3	1			5	4
Bo 105	3				39	3
EC 120	20				14	20
EC 135	14	20	20		12	54
EC 145 (BK117)	3	11	6		6	20
EC 155	11				11	11
Enstrom F-28	4				35	4
Guimbal Cabri G2	27				3	27
MD 900	8	5			15	13
R22	90				25	90
R44	155				12	155
R66	15				4	15
Schweizer 269	13				26	13
Sikorsky S76	6				15	6
Sikorsky S92	1			13	14	14
Grand Total						**764**

Chapter 3: The regulatory framework

3.1 The transportation of passengers or cargo by helicopter for remuneration or other valuable consideration is considered as Commercial Air Transport (CAT). To conduct such flights legally the operator must hold an Air Operators Certificate (AOC) issued in accordance with Commission Regulation (EU) No. 965/2012 (the EASA Air Operations Regulation – EASA Ops). EASA Ops also provides for non-commercial and commercial operation of helicopters under distinct sections as appropriate (Part-ORO, Part-NCC, Part-NCO and Part-SPO). Currently in the UK, two types of operations are considered as State activities, Search and Rescue (SAR) and Police operations, and these are both operated as Public Transport and regulated in accordance with the UK Air Navigation Order (ANO).

3.2 In a similar way, personnel licensing, helicopter design, production, certification and continued airworthiness are all covered by their respective European regulations and affect the operation of all helicopters covered by this review. The interaction between all elements of the regulations can be complex but experience with the new system is improving and benefits are being seen.

3.3 Regulatory development is conducted at both national and European levels depending on the subject in hand. The UK, through the involvement of the CAA and industry, continues to support EASA in developing and updating the necessary European regulations.

3.4 The CAA, as the Competent Authority, is required under the EASA regulations to conduct oversight of flight operations, aircraft maintenance, aerodromes and air traffic control; this is particularly applicable to AOC operators. The CAA carries out planned oversight and applies Performance-Based Regulation at an organisational level and at an onshore helicopter sector level through the CAA's Regulatory Safety Management System (RSMS); this is further explained below.

3.5 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 onshore 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.

Planned oversight

3.6 To carry out regulatory oversight in a manner that is both consistent and meeting the compliance obligations set by the applicable rule set, the CAA apply a process in which organisations are assessed and rated for their complexity. The assessment is based upon a set of questions which provide an overall complexity rating. The questions relate to type and number of organisational approvals held, type of aircraft maintained or operated, number of sub-approvals held, type of operation, number of sites and the number of people employed.

3.7 Following the assessment of an organisation's complexity, a baseline in terms of oversight is applied which prescribes the type and number of audits, the number of visits undertaken, and the composition of the CAA team involved. The baseline model of oversight is considered as steady state and does not consider the organisations performance.

3.8 Within the oversight baseline are included the number of planned audits and the attendance at organisational meetings. Typically, these would include the organisations safety, reliability and technical meetings. Unannounced visits are also included within the baseline plan.

Performance based oversight – entity & sector level

3.9 At an entity level performance-based oversight (PBO) is the method for assessing the safety performance of CAA organisational entities in addition to capturing their safety risks. It considers safety data and intelligence whilst assessing the overall performance of the entity. The performance-based process includes engaging with the entity's Accountable Manager to discuss the safety risks related to the organisation, how these are being managed and how these compare with the wider sector.

3.10 At a sector level, PBO involves grouping safety risk information, from audit reports and records, mandatory occurrence reports, organisational entity risks and the intelligence from the CAA oversight team. An internal review is carried out by the CAA sector team to understand and capture the key concerns and safety risks. This is used to shape the CAA oversight of the sector and to support informed decisions about safety outcomes that the CAA and industry aim to deliver. This information is also shared with industry through the course of our oversight and through industry seminars.

3.11 Onshore entities include all AOC's and a small number of the complex helicopter maintenance organisations. An overview of the risks and key themes associated with the helicopter onshore review in this review.

Regulatory safety management system

3.12 The Regulatory Safety Management System is internal to the CAA and sits above the Performance Based Oversight system. Differing from industry's safety management systems, the RSMS is primarily in place to gather and aggregate industry risks observed within the system, creating a data source enabling the CAA to decide on the effectiveness of its interventions and priorities for future oversight activity. Risk intelligence data is fed to every level within the organisation to ensure effective governance. In addition, the intelligence gathered, shapes the CAA's future policies and collectively delivers better safety outcomes for the UK public.

Chapter 4: Review process & scope

4.1 The scope of the review was based on statistical analysis of reportable occurrences, the review of historical reports and research. This focused work was predominately based on Flight Operations and Airworthiness topics with additional sources of relevant data and intelligence considered.

The review was conducted as a systematic safety analysis of onshore commercial helicopter operations to include emergency services, non-commercial complex helicopter (NCC) and specialised operations (SPO) sectors.

Current risks will be assessed paying attention to:

- The documented causal factors that have contributed to previous accidents;
- A comprehensive review of all previous UK accident and incident documentation;
- The scope and development of current requirements, both State and EASA, and emerging advancements in technology; and;
- The lessons learnt from CAP 1145 and applying the outcomes as appropriate.

The principal discussion, conclusions and recommendations contained within the main body of the report, with further detail and analysis provided and referenced in related appendices.

4.2 The Flight Operations review focused on the following areas:

- Review of each specific sector operating environment including emergency services operations for police, HEMS and SAR;
- AAIB Accident Data;
- Previous research carried out in the onshore sector;
- Helicopter operations in the London and London City areas;
- Unmanned Aerial Systems;
- Training and performance – Pilots;
- Operational Control and Supervision;
- Safety performance of aircraft, passengers and crews;

4.3 The Airworthiness review focused on the following areas:

- A comprehensive detailed analysis of Mandatory Occurrence Report (MOR) data;
- AAIB Accident Data;
- Certification Specification and the Role of the Type Certification Holder;
- Future Regulatory Rules Changes;

- A review of safety intelligence sources including compliance oversight and those support performance-based oversight;
- Compliance data;
- VHM status on onshore aircraft.

4.4 The review carried out a detailed analysis of European data, including as established by EHEST.

4.5 The review includes an engagement section, where a survey and questionnaires were sent to industry, to understand from their point of view, their perceived risks and hazards.

4.6 The review process was led by CAA’s Captain Rick Newson Flight Operations Manager (Helicopters) and David Malins Rotorcraft Airworthiness Sector Manager.

Section B: Analysis

Chapter 5: Occurrence investigation

5.1 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. The AAIB adhere to the International Civil Aviation Organization (ICAO) Annex 13 principles together with UK and EU legislation. For good reason accident investigation by the investigation branch and aviation safety regulation by the CAA are kept distinct.

5.2 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 view 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.

5.3 Occurrence reporting in the UK is governed by European Regulation 376/2014. It requires the reporting, analysis and follow up of occurrences in civil aviation and delivers a European Just Culture Declaration. An occurrence means any safety related event which endangers or which, if not corrected or addressed, could endanger an aircraft, its occupants or any other person. The purpose of occurrence reporting is to improve aviation safety by ensuring relevant safety information relating to civil aviation is reported, collected, stored, protected, exchanged, disseminated and analysed. It is not to attribute blame or liability.

5.4 From the UK State Safety Programme (SSP) and the Safety Strategy Board, the CAA has established a series of safety performance indicators (SPI's) that are predominantly based on occurrence data. SPI's are based on the state safety objectives and focus on occurrences (quantitative) and contributing factors (qualitative). The SPIs are based on the available safety data including the sources detailed in the SSP inputs section. The SPIs are monitored and reviewed by the CAA safety analysis team to ensure they remain appropriate. Whilst the SPI's focus more on significant issues associated with large commercial air transport aircraft operations, the same principles can be extended to other aviation sectors including onshore helicopter operations.

5.5 The CAA, under its performance-based regulation programme, collects and analyses safety related information at an organisational level and at a sector level from which a record of organisation and sector safety performance is recorded. This includes safety risk information which is communicated to organisations and the sector. This feedback at an organisation level is provided to the senior nominated personnel for their subsequent action to manage risks identified. Feedback at onshore helicopter sector level is provided internally and externally through CAA industry seminars.

Chapter 6: MOR review – Flight Operations

The review of Mandatory Occurrence Reports (MOR) was undertaken by CAA data analysts and Flight Operations Subject Matter Experts with the aim of identifying trends or hotspots within the scope of the review. By far, most MORs submitted were airworthiness in origin and the meaningful data was derived from high severity Category A and B MORs in conjunction with AAIB accident reports as detailed in Chapter 8 and Appendix 5.

Fig 1 below indicates that the onshore sector rate of reporting compared with that of Offshore and General Aviation (GA), this showing a slow general increase over the review period.

Figure 1 MORs and MOR reporting rate per 1,000 flights

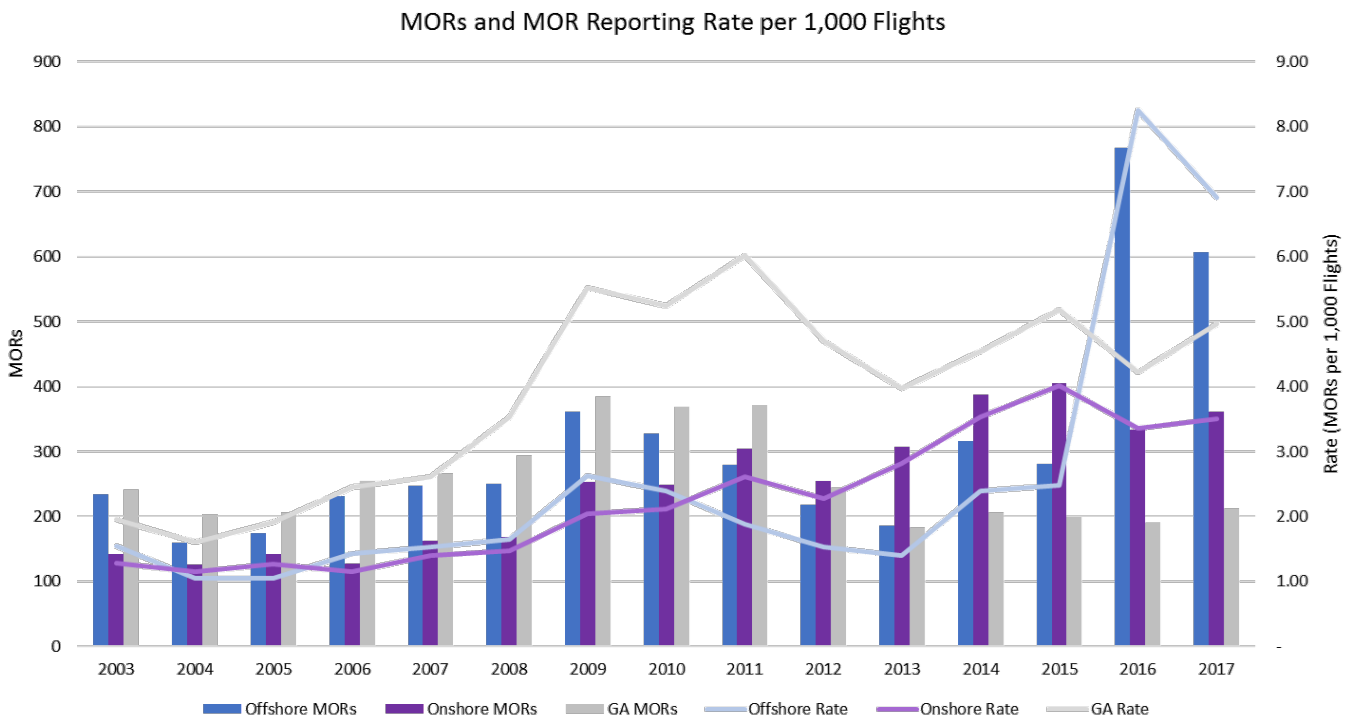
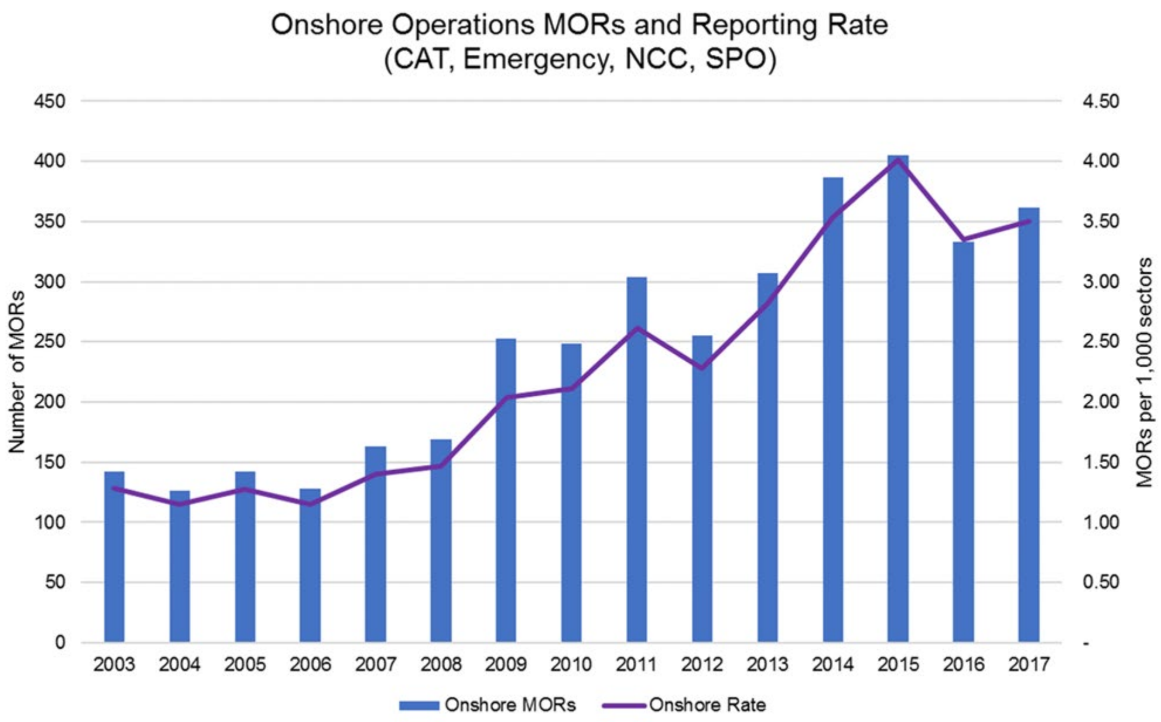


Figure 2 shows the expanded view of scope items and their reporting rates.

Figure 2 Onshore Operations MORs and reporting rate (CAT, Emergency, NCC, SPO)



The total number of submitted helicopter MORs throughout the period are shown in Fig 3 below and the scope items represent around 1/3 of all submitted. It should be noted that whilst a relatively small sector the emergency services appear to report more than the combined areas of CAT/NCC and SPO.

Figure 3 Helicopter MORs A-E by sector (2003 – 2017)

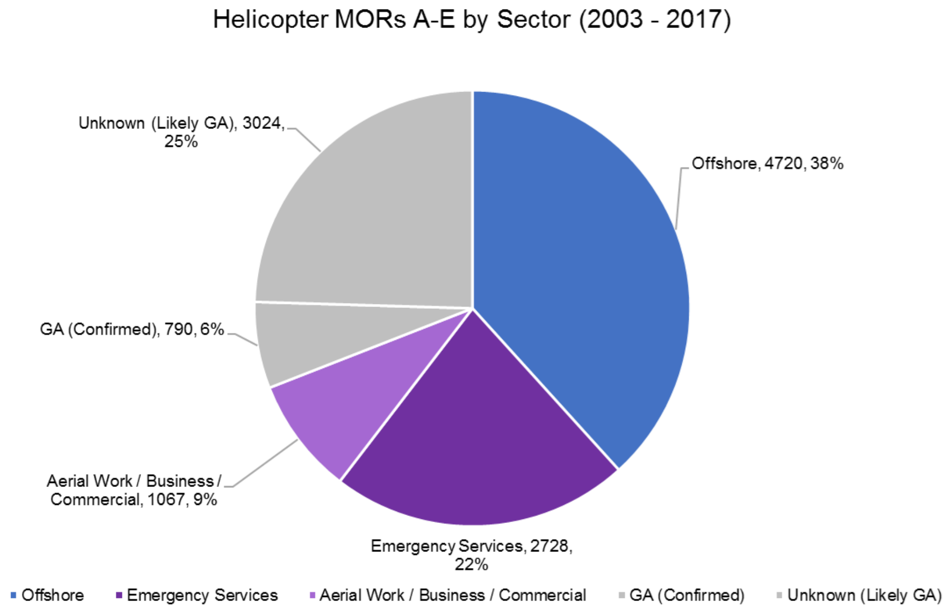
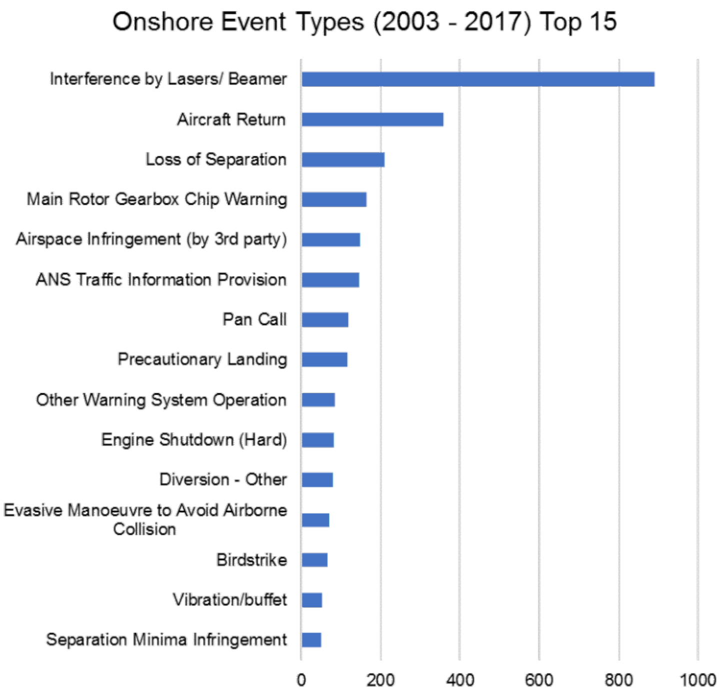


Fig 4 below identifies the top 15 operational event types in comparison with the top 10 of the highest severity. Of note is loss of separation and the subsequent evasive manoeuvre to avoid airborne conflict. This would correlate with continued concerns as documented in company risk logs for the need of electronic conspicuity for those operating in Class G airspace. Likewise, the perceived lack of air navigation service provision within the data set underlines the concerns threat of mid-air collision.

Figure 4 Onshore Event Types



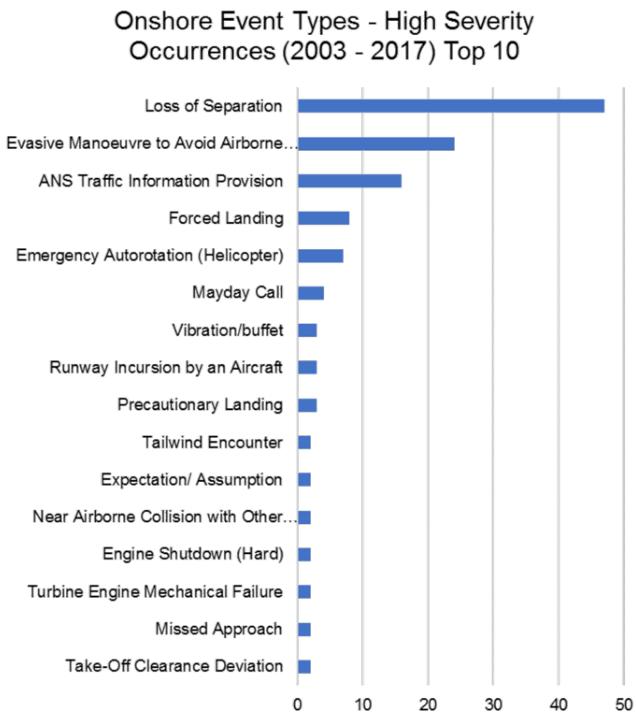
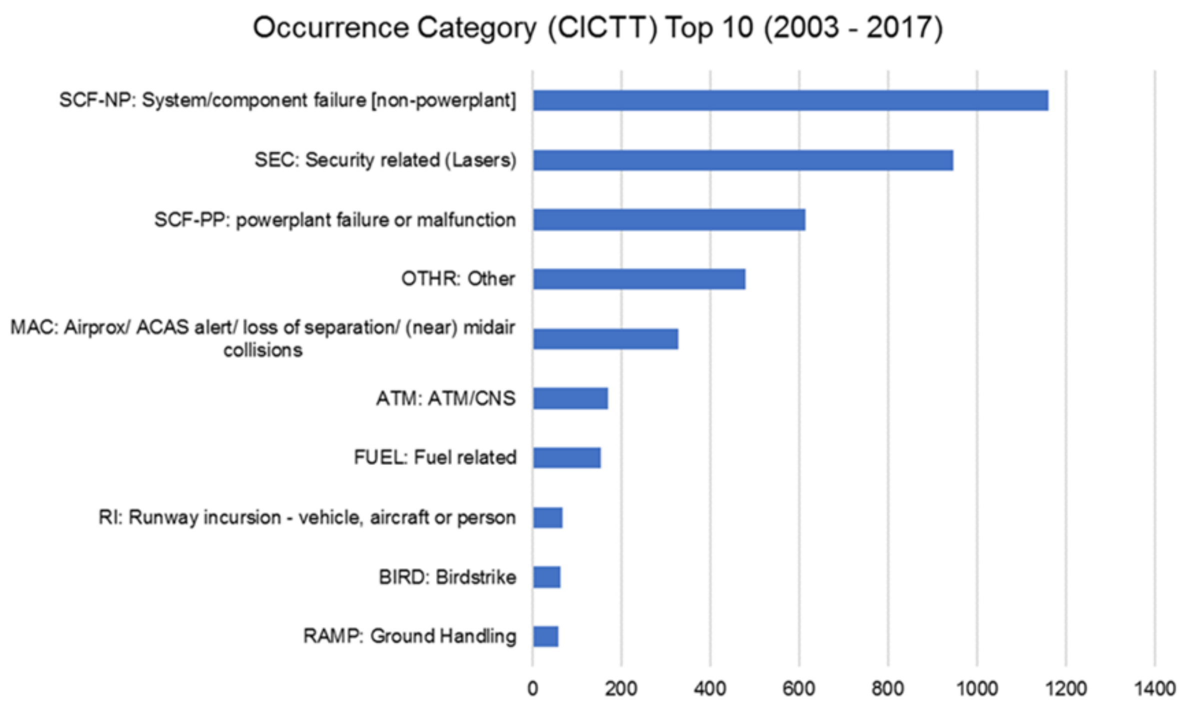


Fig 5 shows the Commercial Aviation Safety Team/ICAO Common Taxonomy Team (CICTT) taxonomy code data as derived from the MOR system. System component failure non power plant is a significant issue with nearly 1200 occurrences reported. As the name implies, this includes anything other than powerplant such as gearboxes, rotor systems, navigation systems, autopilot systems etc and is therefore a very broad category. Chapter 7 of the report offers some insight into technical occurrences but the current data set provides little granularity to derive conclusions from an operations perspective alone. Consequently, the AAIB accident reports and Cat A/B MORs provide a much richer picture of the issues at play. It was noted by the review team that detail for Human Factors elements within the current MOR system are difficult to report and therefore to derive conclusions.

Figure 5 Occurrence category (CICTT) Top 10 (2003 – 2017)



Chapter 7: MOR review - Airworthiness

Introduction

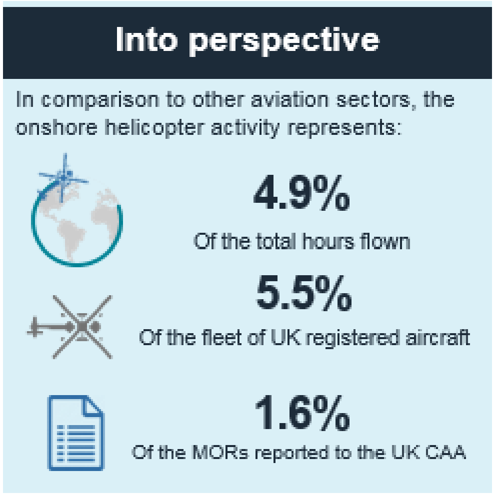
7.1 The review of the Mandatory Occurrence Reports (MOR) has been undertaken by both CAA data analysts and Subject Matter Experts within Airworthiness to understand if any specific issues or trends exist within the scope of the review. As discussed earlier in the review military, general aviation and offshore operations have been excluded in the wider MOR review.

Reporting breakdown

7.2 For the review period, the CAA looked the levels of MOR reporting across all areas of activity. This was broken down to identify reports which specifically related to airworthiness of onshore helicopters.

7.3 A total of 218,160 reports were received by the CAA across all capability areas. A total of 14,596 of these reports related to helicopter operations, both onshore and offshore. Of the 14,596 reports, 3461 (1.6%) of the reports related to onshore helicopters considered to be within the scope of the review and had Primary Error Factors related to airworthiness. To illustrate and provide perspective see Figure 1.

Figure 1

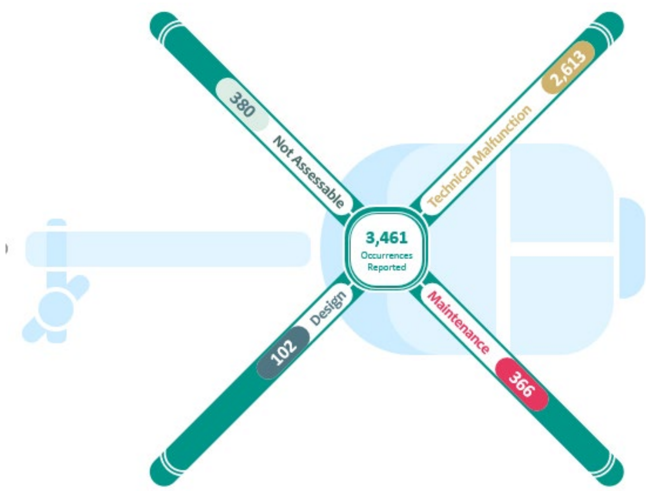


7.4 Of the 3461 MOR's within the scope of the review, these dated from 2003 – 2017 and were graded A – D. Grade E MOR's were excluded from the review as these were deemed to be outside of the requirements for reportable events - Regulation (EU) No 376/2014. The MOR's reviewed had been allocated the following Primary Error Factors (PEF) of;

(a) Design and Manufacture
(b) Maintenance
(c) Technical Malfunction

7.5 In some cases, reports received are classified as Not Assessable, or No Fault. However, some of these MOR's have been included in the overall data set but have not been subject to review.

Figure 2 Breakdown of Categories of MOR



MOR review root cause

7.6 Design & Manufacture and Maintenance reports have been the subject of detailed narrative review to allow a root cause to be allocated. The root causes have been grouped into the following four key areas:

(a) Relationships and Communications
(b) Type Certificate Holder and OEM Support
(c) Maintenance Standards and Human Performance
(d) Airworthiness Management

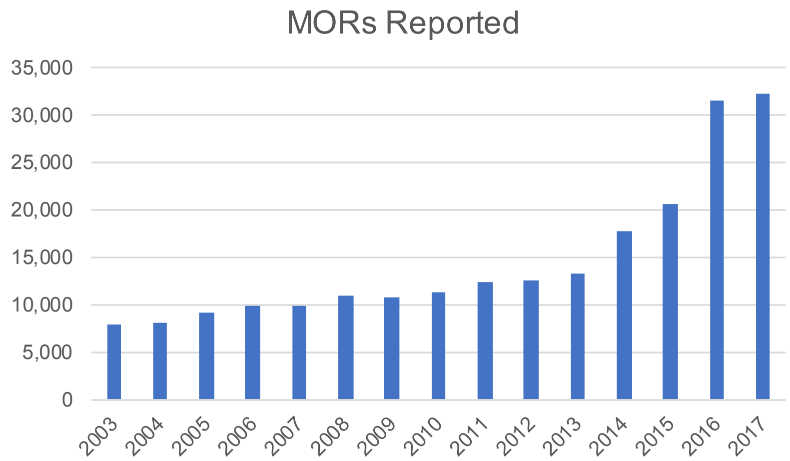
See Appendix 5 MOR Review for further information.

7.7 Technical Malfunction MOR's have not been the subject of a narrative review given their volume. A number of data driven methods have been trialled to extract actionable intelligence from these reports. However, the accuracy of searching narrative text provides variable and often inaccurate results. Based on this evaluation, the CAA has provided a high-level summary of Technical Malfunction reports with more detailed 'mini deep dives' of four helicopter types, whereby each report has been the subject of a detailed review and cleansing to extract actionable intelligence. See Appendix 5 MOR Review for further information.

Reporting levels

7.8 Reporting levels from 2003 – 2013 have ranged from 8,000 – 13,000 with a steady overall increase. The first step change in the number of reports was evident in 2014, with further steps changes in 2015 – 2017. These step changes relate to the introduction of the new reporting regulation (EU) 376/2014 and the requirement placed on operators to report safety related events. The rise in reporting levels from 2014 is evident and the proportionality of the reports being allocated to PEF's is typical of that observed across the wider industry. Reference Figure 2 MORS reported.

Figure 3



Onshore review deep dives

7.9 As part of the CAA's Performance Based Oversight programme each capability has developed its ability to perform focused analysis within a specific area of its operations. The Airworthiness capability has developed a process that allows it to perform the detailed analysis at an organisation, aircraft / engine type level. These types of analyses are referred to as 'Deep Dives'. Recent examples of the CAA's Deep Dives have allowed the findings identified to be actioned via the RSMS, with demonstrable mitigations of risks through its flexible oversight and influence of other competent authorities.

7.10 Following the publication of CAP 1145 the CAA initiated A31, Maintenance Standard Improvement Teams and working groups across the industry. Eight working groups were established however both the Onshore and Offshore Helicopter working groups also integrated the A26 action, review of MOR data, from CAP 1145 within their meetings. The Onshore Helicopter A31/A26 working group is represented by 5 organisations which through their respective operations, cover the diverse scope of the review.

7.11 The deep review of the A109 presented some interesting observations and some common themes from the other types reviewed. The reporting levels on the type are in line with the AS350 and AS355 which may suggest that the sectors, within which the types operate, report less than that of the EC 135 and MD 900. It is also evident that Maintenance Control and Servicing, events that can be attributed to the performance of the Part M, continue to be a common theme. The A109 series was the last of the deep dive reviews that was undertaken by the CAA. Unlike the previous types reviewed, due to the quorum of the A31 Onshore working group there was no representative with operational experience of the type to challenge the findings, specifically the technical aspects of the reports.

Action:

A2 *The CAA will carry out focussed oversight on, small and medium complex Part 145, Part M organisations relating to the reporting of safety events as per the requirements of EU 376/2014 to ensure there is a consistent level of reporting across all areas of the industry.*

Action:

A3 The CAA will invite a representative with experience of the Agusta/Leonardo product range to the Onshore A31 working group in order that events relating to the product range can be discussed.

7.12 During these meetings the group agreed that a 5-year MOR, 'Deep Dive' review should be initially conducted of the more prevalent types operated by the sector. The purpose of these reviews was to understand whether there were any adverse airworthiness issues or trends that had not previously been captured. Over the course of 2017 and 2018 a systematic review of the following types was conducted by the CAA and discussed with the Onshore A31/A26 working group members.

(a) EC 135 Series
(b) MD 900
(c) AS 350 & AS 355 series
(d) A109 series

7.13 Each ‘Deep Dive’ MOR review included all UK registered aircraft and included, where required, Military Registered Civil Operated Aircraft (MRCOA). Each review was conducted to a standardised methodology in order that a comparison could be achieved. The outline of each of the reviews was set out as follows:

(a) Review period; 2012 – 2016
(b) Fleet utilisation data based on fleet size
(c) MOR reporting levels and grades – based on number of reports versus utilisation
(d) Primary error factors comparison
(e) MOR’s relating to maintenance standards (A31)
(f) MOR’s relating to reliability and technical malfunctions (A26)

Summary of the 'Deep Dive' analysis can be found at MOR Review Appendix 5.

Development and improvement to the CAA's MOR process

Benefits of Reporting

7.14 The requirements to report events is regulated by Regulation (EU) 376/2014. The onshore helicopter industry and the wider industry audience should recognise that mandatory occurrence reporting forms a significant piece of actionable intelligence for the CAA. Without the intelligence the CAA's role in understanding and actioning safety critical events becomes more challenging. Via seminars and industry engagement the CAA continues to promote the use of the reporting system and feedback its intelligence from the information it receives.

Action:

A4 The CAA will communicate the importance of reporting occurrences in accordance with Regulation (EU) 376/2014 and in particularly to the non-commercial aviation community.

Receipt and classification

7.15 All MORs reported to the CAA under the occurrence reporting regulation 376/2014 are initially handled and processed by one centralised team. The MORs are triaged according to risk and prioritised accordingly for entry onto the ECCAIRS database.

7.16 Each MOR has its basic details recorded. In addition, using a taxonomy, event coding and descriptive factors are added. For example, primary error factor and a risk rating. Airworthiness MOR's are assigned to three primary error factors (PEF), these being design & manufacture, maintenance and technical malfunction. In some cases, reports received are classified as not assessable, or no fault.

7.17 Each MOR is then graded A1 – D3 on receipt based on the severity and probability. Voluntary reports are coded as grade E.

7.18 Follow up or final analysis information supplied from the reporting organisation will be appended to the MOR and any relevant details updated. This may lead to a change in the risk rating, the event coding or the root cause of the MOR.

Review and action

7.19 In 2018 Airworthiness introduced a new process for the review of all MORs, for those that have an airworthiness link. Each MOR is individually reviewed within CAA's Continued Airworthiness section, typically between 150 - 200 MORs per week. The review aims to highlight any MORs that require a CAA investigation or follow up action by CAA (notwithstanding the requirements for organisations within 376/2014). Types of action could include a variation in the level of oversight of an organisation, disseminating this information with similarly effected organisations in the event of a safety issue.

7.14 Those MORs opened for investigation vary on a case by case basis, however a critical component on a helicopter not reaching its design life, or a maintenance error resulting in a significant in-flight safety event will be discussed further with the reporting organisation.

7.15 MORs which have been opened are shared with the Airworthiness management team, for awareness for discussion in case of any additional action.

Distribution

7.16 Individual surveyors within Airworthiness receive MORs reported during the previous week by organisations for which they routinely oversee. This enables the Surveyor to have a clear picture of those MORs, enables them to consider whether they should be opened for further investigation or whether additional follow up action is needed.

Trending

7.17 As part of the CAA's Performance Based Oversight approach, Airworthiness are considering establishing a means to monitoring several Safety Performance Indicators (SPIs) and trending of events. SPIs will aid in the identification of airworthiness risks or an area linked with a reportable MOR. Examples include: In flight shut downs, chip detector warning events and maintenance overruns events.

Liaison with other National Authorities / EASA / FAA

7.18 For any MORs which involve a third-party organisation outside of the UK, or in an area for which the CAA is not the competent authority, the CAA may liaise with another national authority.

7.19 For example, if a UK registered or operated aircraft has an airworthiness issue linked with a component that has been overhauled by a non-UK Part 145 organisation. In this case the CAA may contact the national authority that oversees the Part 145 approved organisation. Alternatively, if the root cause of a reported MOR may be linked with component design the CAA will transfer this MOR to EASA to investigate, as the component authority for design.

MOR summary

7.20 Proportionally, onshore helicopters by size of fleet, number of hours flown and the number of MOR's raised is relatively small when compared to the wider industry using the same metrics. That said, key insights were gained from the in scope 3461 MOR's reviewed in the areas of design and manufacture, maintenance, including human factors related events and technical malfunction.

Design and manufacture;

a) 39 reports associated with production standards. There was no common theme within these reports.
b) 18 reports whereby the type certificate holder did not respond to in-service events.
c) 10 reports that relate to the failure of a critical component. These failures have the potential cause unsafe conditions that lead to a lower of safety standards.

Maintenance & Continued Airworthiness

a) Maintenance standards; 174 events were allocated to incomplete maintenance, maintenance error or break in task.
b) Continued airworthiness management; 82 reports were deemed to be caused by poor maintenance programme/continued airworthiness management, leading to maintenance being overflown. The data identified a rising trend in issues associated with the management of airworthiness and maintenance being overflown.
c) (19) were allocated to poor/lack of timely technical data, including work instructions. The reports were highly linked to maintenance being overflown, where the Continuing Airworthiness Management Organisation (CAMO) had failed, or incorrectly advised the Maintenance Organisation to carry out the required maintenance checks.

Technical Malfunction

a) Technical Malfunction is consistently the largest PEF across all sectors of the industry and therefore the review of these type of MOR's became an area where the CAA has recognised the benefit of improving its MOR process. The review considered 2613 Technical Malfunction events from 2003-2017 by focussing on the top 5 ATA chapters and a deep dive of 5 helicopter types.

7.21 It is difficult to extract actionable intelligence from technical malfunction MOR's without a line by line subject matter expert review. The introduction of the improved MOR processes, discussed within the report, provides assurance that report submissions are subject to this level of review going forward and where safety significant events or adverse trends are noted, tangible actions are taken to either gather further information, amend regulatory oversight or escalate matters to other competent authorities.

7.22 The maintenance related MOR's were heavily biased towards two primary areas, maintenance standards and airworthiness management. The CAA recognises that improving maintenance standards across the industry can prevent the lowering of safety standards and the contributing factors to events. It is also observed that the number of reported events relating to continued airworthiness management can lower safety standards. Whilst the more serious events of component service life's, being overrun, are rare, the severity of the periods can only be fully understood by the Type Certificate Holder, and the helicopters original certification basis.

7.23 The introduction of improvements to the MOR process ensures the CAA remains at the forefront of prioritising the most significant safety related MOR's. Its ability to triage, trend and combine the intelligence of the RSMS, results in effective industry risk management.

7.24 The review highlighted events relating to human factors and continuing airworthiness management functions. It was evident that human factors and engineering performance continues to be a factor in many reported events.

7.25 It should be noted that the ECCAIRS taxonomy focuses on the identification of the "root cause". The review noted that most of the events had contributing factors that led to the event occurring in the first instance.

7.26 The review noted that it remains difficult to assess the root cause from the reporter's narrative and the limited information this often contains. Unless the reporter identifies the root cause and the contributing factors using the ECCAIRS taxonomy it remains difficult to have a clear industry pictures of HF performance.

Recommendation:

R1 *The onshore review has shown important safety related data is not being captured as part of the ECCAIRS occurrence reporting system. It is recommended that EASA propose, to the ECCAIRS working group, amendments to the existing taxonomy for Human Factors and the ability to identify the HF additional contributory factors in events*.

Recommendation:

R2 *The onshore review has shown important safety related data related to component life limits is not being captured as part of the ECCAIRS occurrence reporting system.*

To extract actionable intelligence regarding component performance, it is recommended that EASA propose to the ECCAIRS working group that an additional requirement be placed on the reporter to identify when a component has been replaced and whether the component is subject to a life limit

7.27 Maintenance being overflown was evident and supports the wider MOR review. The evidence suggests maintenance is being incorrectly loaded and, or forecasted resulting in both maintenance checks, Airworthiness Directives and component life's being overflown. Both themes suggest that both the CAA and industry must continue to monitor and implement improvements that allow individual engineers and continued airworthiness staff the ability to be more vigilant and provide them with the knowledge and resources to prevent future errors.

Action:

A5 *The CAA will provide a review of industry reports and MOR's at each of its capability seminars. These reviews will be sector focussed highlighting significant safety events and adverse trends. Summary slides of these seminars will be shared via the CAA's website and highlighted via Skywise*.

Action:

A6 *The CAA will discuss and highlight its findings from the Design related MOR's with EASA and the competent authority for Design and Production to ensure there is awareness of the matters this review has raised.*

Note: See Appendix 5 for further information on the Airworthiness MOR review.

Chapter 8: Accident review – Flight Operations

8.1 A safety analysis of onshore commercial helicopter operations including emergency services, non-commercial complex (NCC) and specialised operations (SPO) was conducted for the period 2000 to 2017. Current risks were assessed with a focus on documented causal factors that have contributed to previous accidents and serious incidents. This included any CAT international operations affecting British aircraft.

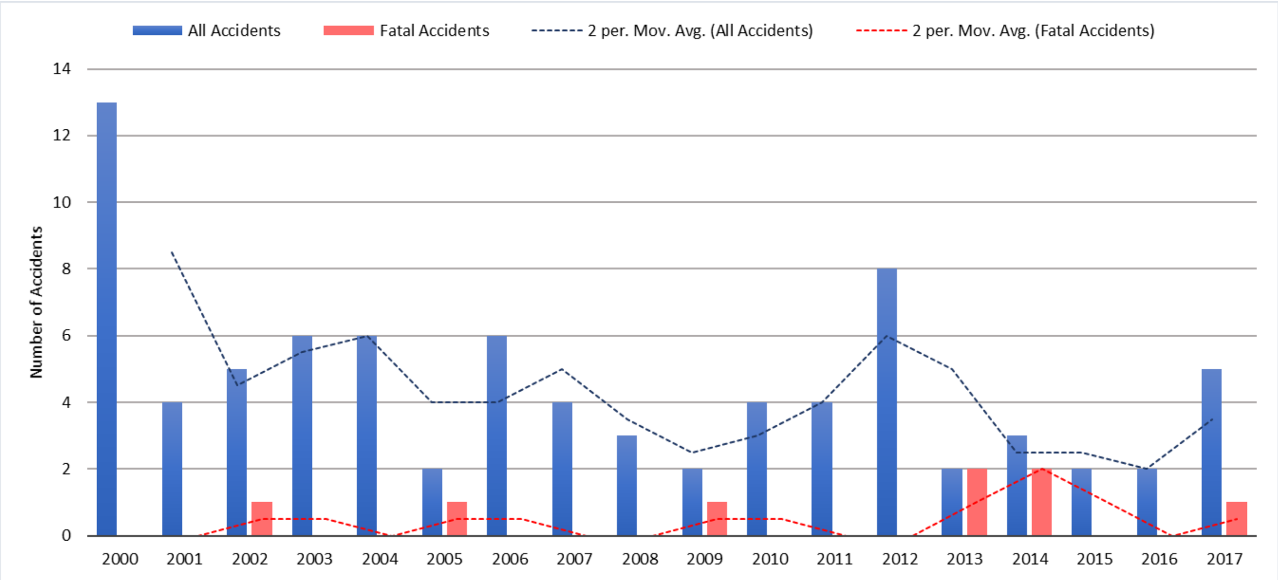
8.2 The review utilises accident investigation reports published by the UK AAIB as this data is comprehensive. To ensure all scope items were captured appropriately all UK registered helicopter accidents were initially reviewed to ensure they were categorized correctly e.g. private operations in some cases were placed under NCC. This process required the data analysis team to assess 377 accident reports to end up with a scope data set of 81.

Mandatory occurrence reports (MOR) were used to support the data with statistical validation. The accident report narratives were discussed by CAA helicopter inspectors to assist in understanding the operational picture of the overall event.

8.3 The full report is contained in Flight Operations Appendix 1 which includes a comparison of UK data with EHEST's European Helicopter Accidents conducted by the European Helicopter Safety Team. The purpose of this is to analyse any trends, similarities or differences so as to measure the effectiveness of any safety improvements already underway or support any recommendation for safety improvements or initiatives.

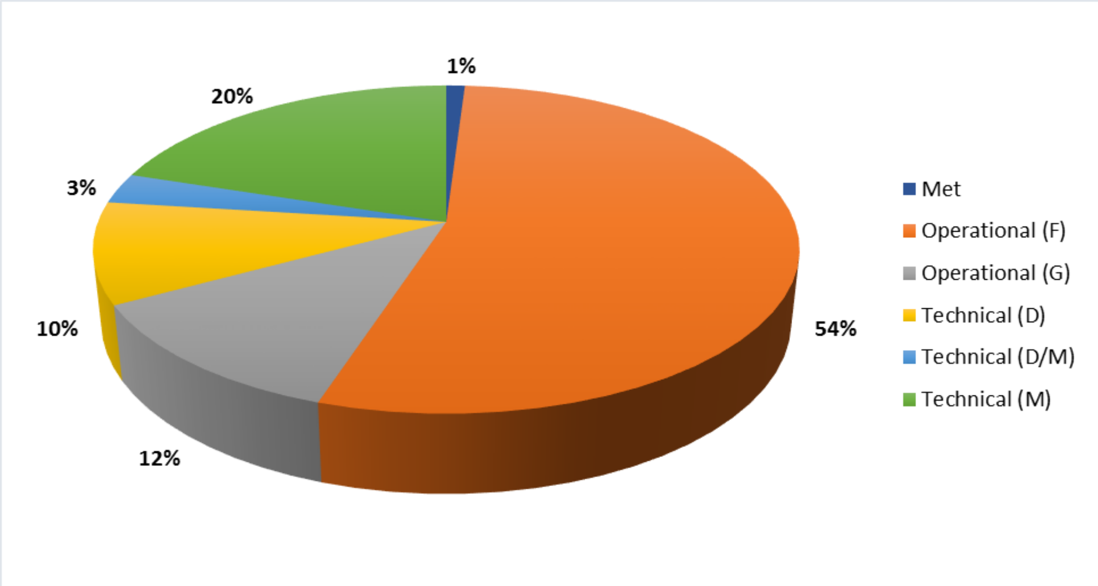
8.4 The complete results are shown in Figure 8.1. A two-year moving average was used to normalise and smooth the data to identify any trends. Accidents are plotted by calendar year as rotary aircraft have a versatile usability within various operation types.

Figure 8.1. Chronology of AAIB reported & investigated onshore commercial accidents



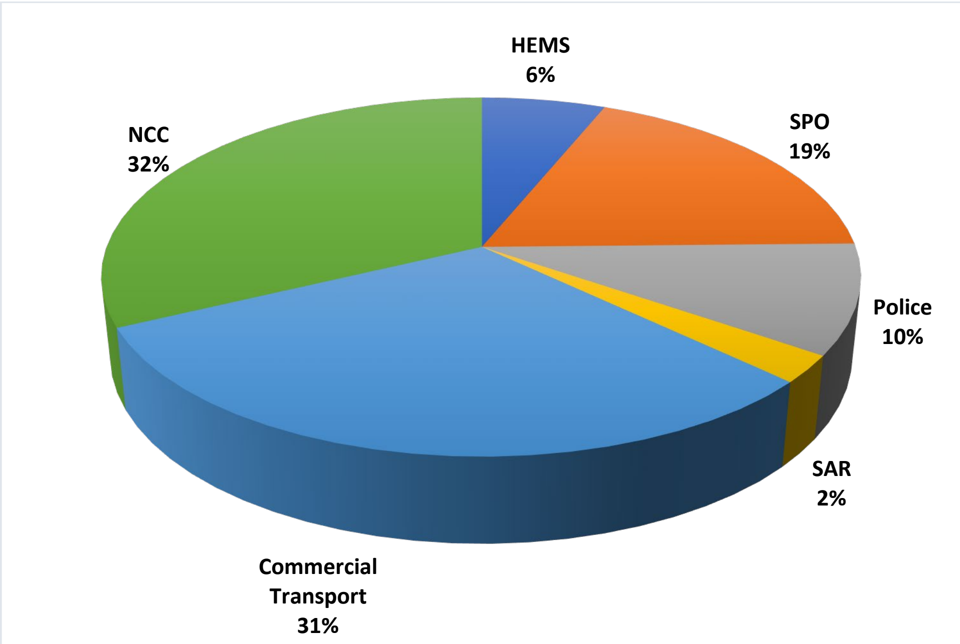
8.5 A total of 81 reportable UK onshore helicopter accidents were analysed between the period of 2000-2017. The breakdown of these accidents by a top-level grouping, as per CICTT Taxonomy, is shown in Figure 8.2 below.

Figure 8.2. Onshore helicopter accidents for the period 2000 to 2017 by CICTT grouping:



8.6 Figure 8.3 demonstrates a breakdown of the 81 reportable accidents, identifying that a significant proportion of those accidents involve passenger-carrying operations, however, a majority of the accidents relate to SPO and NCC operations.

Figure 8.3. Flight Type distribution of total 81 reportable accidents



Chapter 9: Accident review - Airworthiness

Introduction

9.1. The scope of review defined that accidents from 2003 – 2017, where the UK AAIB had conducted an investigation, should be considered. The data review concluded that 143 reportable accidents were within the scope of the review. These accident reports were allocated to the Flight Operations and Airworthiness teams within the CAA based on their allocated ICAO CICTT Taxonomy allocation. The team within Airworthiness considered 43 reports within the period to be within scope, based on the helicopter types and the event types. 100 reports were considered non-airworthiness related, these being either operational, unknown cause, or in some cases still under investigation.

9.2. The 43 reports were subjected to a detailed review by the airworthiness team, this focussed on ensuring the root cause was accurate and where there were actions and recommendations made; that the statuses of these were fully understood.

9.3. The ICAO CICTT taxonomy, despite its levels of breaking down reports, benefitted from further analysis of the narrative content with consideration for placing the root causes of these events into that more aligned with that utilised for the analysis of MOR's. Benefits from using this methodology allowed the review to focus more specifically on the area of causation, whether this be airworthiness management, design, maintenance or a production / manufacturing issue.

9.4. The objective of the accident review was to identify any trends, be these by helicopter type or cause. Consideration was given to the small size of the data set and the ability to draw trends or conclusive insights.

9.5. CAP 1145 recommended that the CAA's management systems be reviewed to ensure that all accident actions and recommendations have been addressed were embedded within business as usual processes currently applied. This review has captured the requirement set out in CAP 1145.

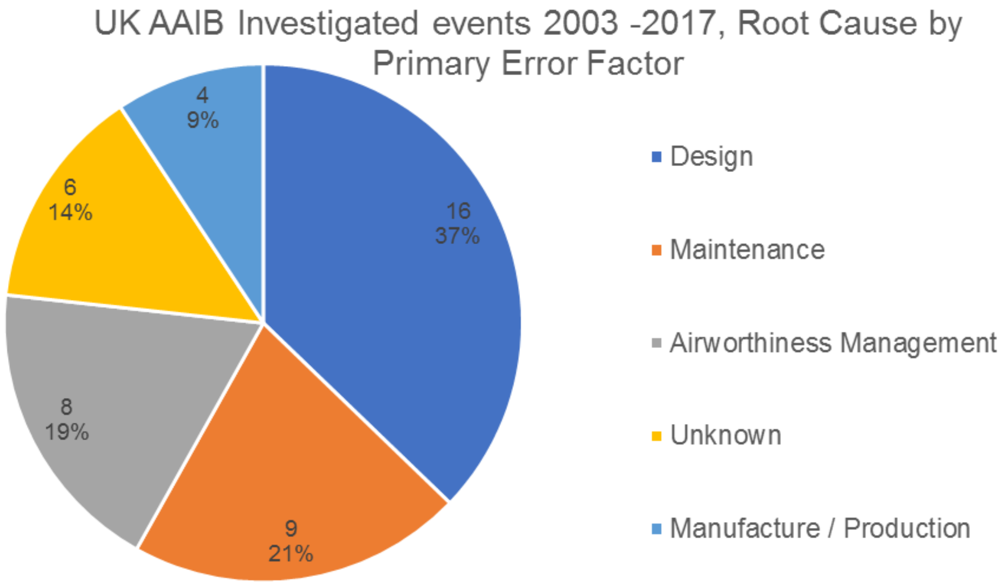
9.6. As a consequence of the airworthiness related accidents there were a total of 10 fatalities, 6 were crew and 4 were passengers.

Accident trends – Airworthiness by root cause

9.7. Given the size of the data set there was limited ability, and value in trying to establish whether any trend exists within the accident reports reviewed. The causation was allocated to one of the following areas to establish if there were any high-level trends:

1) Airworthiness Management – Continuing Airworthiness management including the provision of Maintenance Programme Management (M.A.708).
2) Design – Initial Design, including the responsibilities of the Design Organisation (Part 21).
3) Maintenance – The provision of maintenance support under Part 145 approvals, including the training.
4) Production – Manufacturing and production of components to support initial build or through life support of the helicopter and engines within scope of the review.
5) Unknown – Where the investigation could not readily identify the primary cause of the event.

Figure 1 2003 – 2017 AAIB Reportable Accidents – Root Cause by Primary Factor



Accident trends – Airworthiness by helicopter type

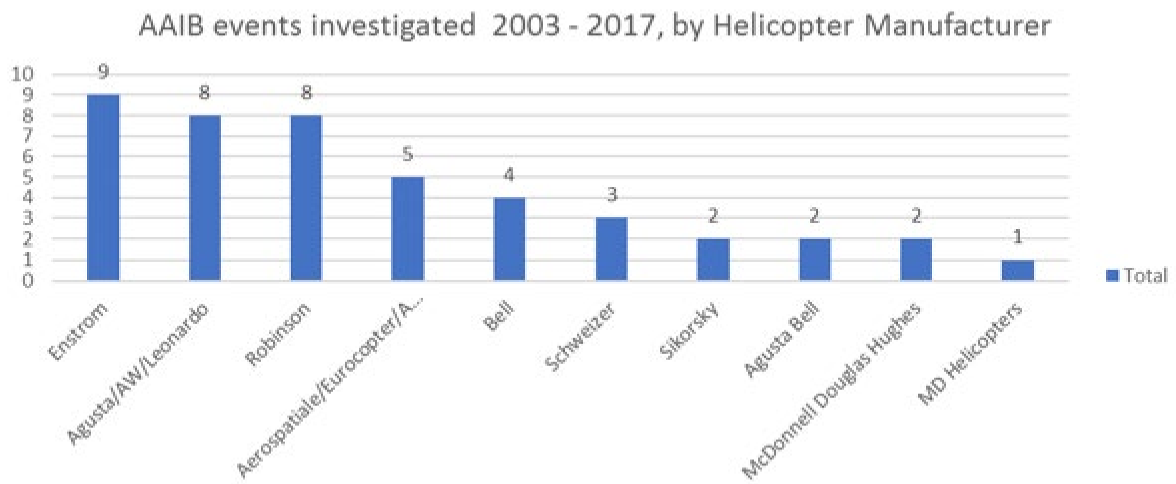
9.8. The airworthiness review of the accidents from 2003 – 2017 also focussed on whether there were any trends that could be associated with the types of helicopters included within the scope of the review.

To produce a consolidated prospective, given the size of the data set, each event was grouped against the respective Type Certificate Data Sheet, rather than against an individual type. i.e. A109A and A109SP were grouped against the A109. To provide a consolidated picture, given the diversity of the types involved in the review, a breakdown is provided by manufacturer, figure 2.

In terms of events investigated, figure 1, by manufacturer the top three comprised of non-complex and complex types;

1) Enstrom – 9 events
2) Agusta – 8 events
3) Robinson – 8 events

Figure 2 2003 – 2017 AAIB events investigated, by helicopter manufacturer



9.9. For complete results of the analysis of this data set; refer to Airworthiness Appendix 5.

Chapter 10: Flight Global accident data

Introduction

10.1 The review considered the advantages and disadvantages of reviewing global events relating to the agreed scope of the review. Following consideration, it was agreed that there would be no inclusion of global accident data and analysis based on the following assessment:

10.2 **Advantages of Inclusion of Global Event Data**; analysing more data could provide a better picture. For example, analysing worldwide data may uncover accident trends for a helicopter type that are not apparent when analysing UK data. However, any unsafe condition discovered because of a foreign accident would normally be addressed by an Airworthiness Directive issued by the respective competent regulatory authority for the helicopter type. The UK CAA would be made aware of Airworthiness Directives issued by other competent regulatory authorities.

10.3 **Disadvantages of including Global Event Data;** the completeness of the Flight Global dataset is not known. The focus tends to be on aircraft accidents which has a narrower focus than the CAA's MOR dataset. For example, the CAA dataset of relevant Airworthiness MORs, within scope of the review over the period 2003-2017 consists of 3,461 MORs. The Flight Global dataset of helicopter accidents where the operator nationality or the accident location is the United Kingdom is 226 accidents; eight of these are not equivalent to MORs (e.g. parked helicopters being blown over by wind or damaged by vandalism). Of the remaining 218 accidents, the CAA classified 10 as third-party (e.g. another aircraft was taxied into the helicopter) or unknown (no narrative description) and 141 as flight operations only. This only leaves 77 accidents relating to airworthiness. The totals of 77 airworthiness accidents 3,461 airworthiness MORs suggests that the global dataset is the equivalent of about 2% of the UK MOR dataset.

10.4 The Flight Global dataset does not include an equivalent to Primary Error. To classify each event, there would be a need to read all the Flight Global dataset narratives to be reasonably confident of having an accurate classification. The CAA anticipated the results from the insight would be limited.

10.5 The Flight Global dataset would be difficult to analyse from a flight operation perspective due to the way countries classify different types of operation which may vary, from the of the CAA, making it difficult to ensure that the review is comparing like with like.

10.6 Due to the results of any global analysis being limited by not having access to access to global utilisation data its accuracy would be questionable. Therefore, should the CAA present any data of global events this would be based on pure numbers and not a like for like comparison of UK operations. For example, if one helicopter type had most of the accidents, we could not be certain, whether it indicated a particular issue with the helicopter type or whether the helicopter type had more accidents due to a higher utilisation. In the case of CAP 1145 (the Offshore Helicopter Report) the CAA liaised with the Norwegian NAA to establish comparable data for the UK and Norway.

Note; further references to global events/accidents can be accessed via the following websites;

1. *EASA Annual Safety Reviews 2017 and 2018.*
2. *Flight Global*

Chapter 11: Oversight summary – Flight operations

Introduction

11.1 CAA Flight Operations conducts its oversight activity in accordance with EASA Ops Annex II Part-ARO and uses Performance Based principles consisting of two primary functions:

a) To consistently, proportionately, and efficiently allocate the use of CAA operational safety oversight teams or 'field force'.

b) To modify the volume, type and focus of CAA oversight according to risk and organisational performance.

11.2 The PBO process allows CAA Sector Managers to use the information gleaned from oversight and other safety intelligence sources to build a single risk picture, covering all operational aspects of each regulated entity.

11.3 A mature operator will be using its Safety Management System to identify and manage risk whilst remaining compliant with the safety requirements set by EASA and/or the CAA.

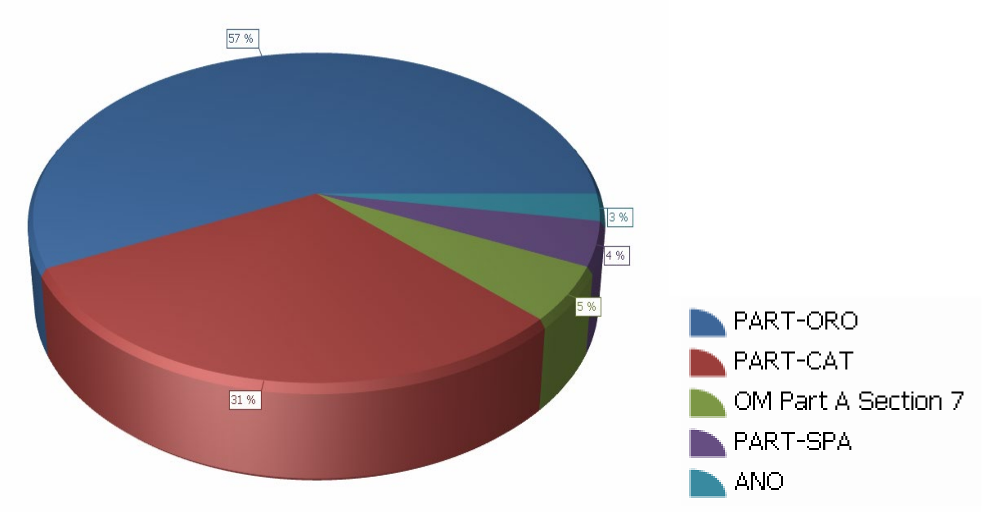
11.4 The Flight Operations Rotary department has one Sector manager and ten Flight Operations Inspectors, most of which are also Training Inspectors. They work closely with a number of Inspecting Officers some of which are specialists in Dangerous Goods and Cabin Safety matters. This team is further augmented by dedicated Flight Ops Training Inspectors who are primarily focused upon ATO activity. This team through a nominated Oversight Manager (assigned Inspector) for each regulated Entity will have an agreed oversight programme based upon the complexity of the Entity and its current risk profile. Mostly this is built up of ground and flight inspections and audits some of which may include unannounced visits.

11.5 Typically, audits may generate findings and observations which varying carry calendar dates for corrective action. In general, the lesser the timescale, the more significant the finding. In response to these the CAA looks for root cause analysis principles so that the finding is dealt with in a systemised manner and therefore shouldn't re-occur. All lessons learnt from this process now feeds the overall sector risk picture so that all parties can learn from the generic issues. To enable this the CAA has been holding both flight ops and airworthiness safety seminars twice per year to highlight the current issues and hot spots and will continue to do so on a regional basis around the UK.

Onshore helicopter findings

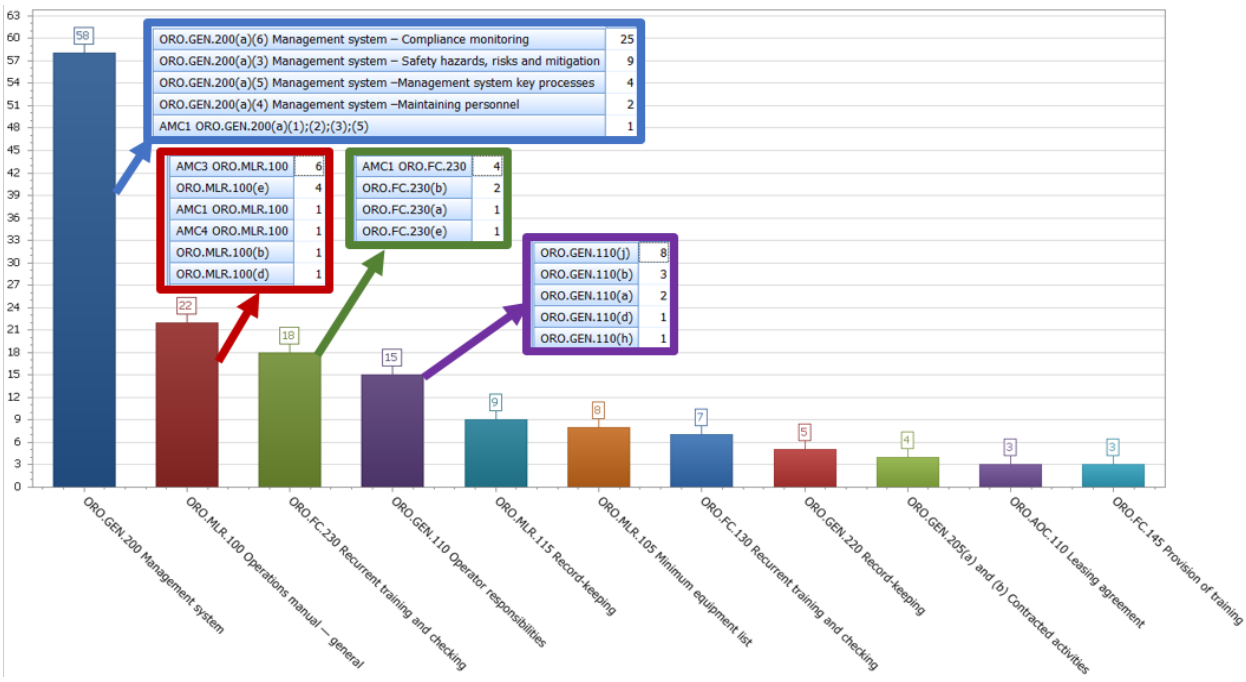
11.6 Flight Operations have raised 338 Findings against Onshore Helicopter AOC holders since October 2014 (introduction of Q-Pulse, CAA's auditing application). Q Pulse had been used for some years by the CAA airworthiness department and its introduction into Flight Operations has enabled a more systemised view of the reported data. The timing for its introduction coincided with the implementation of the new EASA Ops requirements and therefore the data collected since is relatively narrow compared to the wider ops scope of the review from year 2000 to 2017.

Figure 1. Survey response – As received



Part ORO Analysis

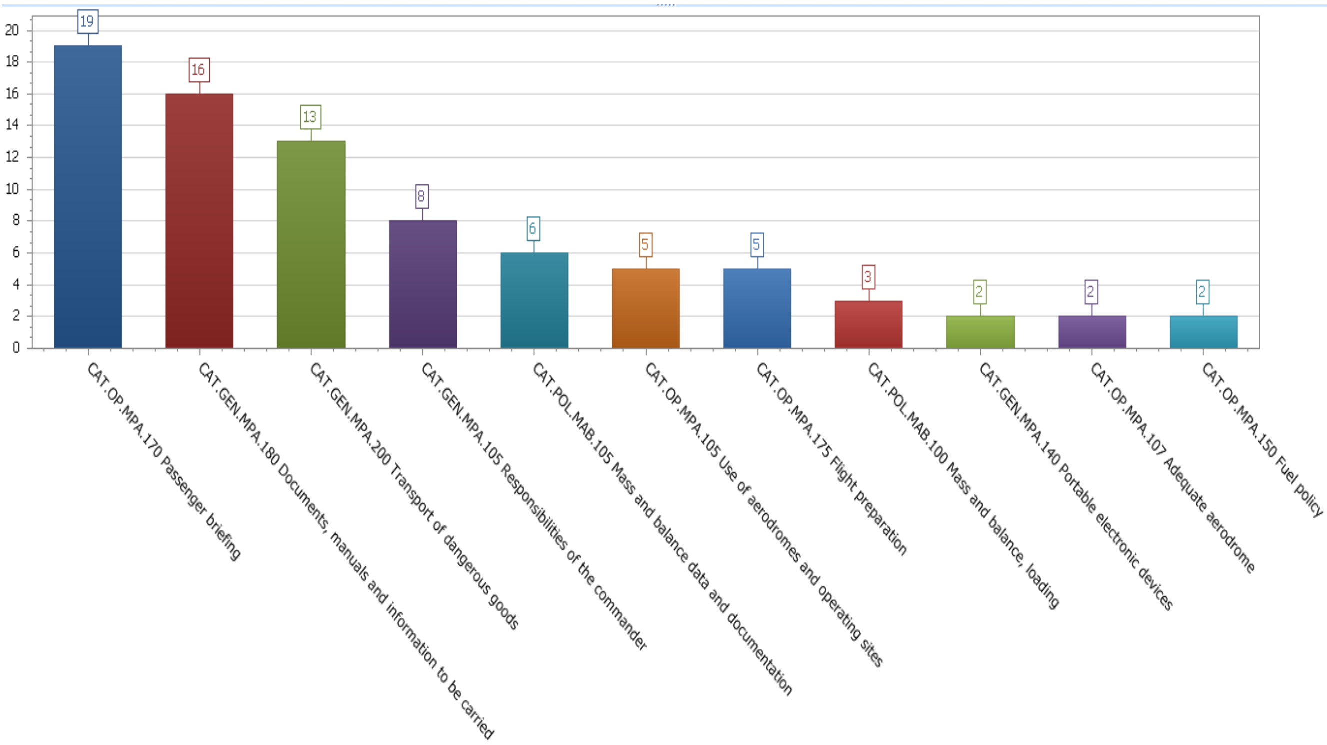
Figure 2. Survey response – As received



11.7 ORO.GEN.200(a)(6) (compliance monitoring) is the most common finding in terms of the area of the regulation, this is very similar to what is found in Aeroplane AOC holder oversight. Findings against ORO.MLR.100 (operations manual) are mostly related to the general contents of the Operations Manual and ensuring they are kept up to date. Findings raised against ORO.FC.230 (recurrent training and checking) are mostly related to the content of the published recurrent training syllabus. Findings raised against ORO.GEN.110 (operator responsibilities) are mostly related to the establishment and maintenance of dangerous goods training programmes for personnel as required by the technical instructions, this is a similar trend as seen in Aeroplane AOC operators.

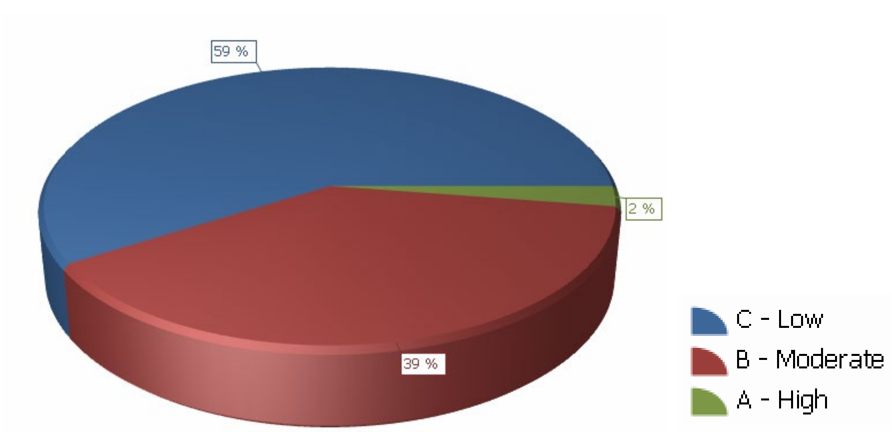
11.8 Part CAT Analysis

Figure 3. Cat Analysis



11.9 Safety Severity

Figure 4. Safety Severity



11.10 Only 2 level 1 findings have been raised against onshore helicopter AOC holders.

11.11 The Safety Severity of a finding allows us to understand which findings have an impact on safety. 59% of the findings raised are of a low safety Severity with no direct link to safety, 39% were a moderate Safety severity with a potential link to Safety and 2% were High with a direct link to Safety. This split in terms of safety severity are similar to Aeroplane AOC Operators.

Chapter 12: Oversight summary - Airworthiness

Introduction

12.1 The purpose of this chapter is to provide a summary of the analysis of Non-Compliance findings for the airworthiness organisations within the scope of this review. This included Part 145 maintenance organisations, Part M Continuing Airworthiness organisations and the CAA Aircraft Continued Airworthiness Monitoring (ACAM) programme (findings.

12.2 The review data set included approximately 65 approved organisations, 607 audit events and considered approximately 1700 individual findings from 2013 to July 2018. The findings review analysed the root causes identified, the compliance finding area of standard, as applicable to the regulation, (Part M, Part 145 and ACAM) and the non-compliance response performance by organisations.

12.3 In the analysis of the results from compliance findings review consideration should be given to certain factors affecting airworthiness oversight of approved organisations.

CAA oversight is carried out in accordance with the applicable regulation which sets out the requirements that organisations must demonstrate compliance. It also sets the compliance obligations for the regulator in terms of how oversight is applied. Additionally, CAA oversight is also guided by our PBO principles and prioritised at areas of safety concern or were the safety data and intelligence dictates.

Part 145 maintenance findings analysis

12.4 597 findings were raised against Part 145 rule and were generally across all areas from 145.A.10 to 145. A.85.

12.5 The trends by area of Part 145 over the reporting period were;

a) Part 145.A.65; findings related to the quality system, including not all parts of the rule verified for compliance, lack of internal quality oversight, inadequate process or procedures and lack of adequate feedback to senior personnel.

b) Part 145.A.30; findings related to personnel included competence assessment, lack of staff or capability and resource planning. Further analysis of personnel findings is carried out Para. 12.11.

c) Part 145.A.40; findings related to equipment tools and material included – calibration issues, lack of availability and poor standards of tooling being used.

Part M continuing airworthiness analysis

12.6 691 findings were raised with a breakdown against Part M and were generally across all areas from Part M Subpart B Accountability to Subpart I Airworthiness Review Certificate.

12.7 The trends in findings by area of Part M were;

a) M.A.708: Continuing Airworthiness Management; findings related to continued airworthiness management covers a wide range of continued airworthiness requirements. Common trends/issues included maintenance forecasting and planning, continued airworthiness records missing or inaccurate, missed task or task overruns.

b) M.A.302: Aircraft Maintenance Programme; findings related to aircraft maintenance programme included trends relating to lack of or inadequate maintenance programmes reviews, missed tasks including tasks related to repairs or equipment fitted, source data at the incorrect amendment status, lack of customisation from aircraft configuration and issues associated with maintenance programme variations.

c) M.A.706; Personnel Requirements; findings related to personnel requirements. Personnel issues are broken down further in para.12.11.

d) M.A.712: Quality System; quality system issues were broadly similar and in line with the Part 145 quality system issues highlighted in para.12.5.

Action:

A7 *The CAA will carry out focussed oversight of onshore helicopter Continued Airworthiness Management Organisations to verify their compliance with the management of continued airworthiness, to include a Critical and Life Limited Components, maintenance programmes, instructions for continuing airworthiness (i.e.'SB's and 'AD's), resources, knowledge and experience of staff.*

ACAM findings analysis

12.8 406 findings were raised with a breakdown against the CAA ACAM program. The CAA ACAM programme predominately focuses on the continued airworthiness aspects and the physical inspection of the helicopter. Findings related to physical defects were widespread across all areas of the helicopter with no trends.

12.9 The trends in findings raised across the ACAM programme were;

a) Airworthiness Directives (AD's); findings related AD compliance including AD compliance not recorded, AD overrun, missed repeat inspections and issues related to demonstration of compliance. The identified root cause being related to incorrect process / procedure issues followed and personnel competence or capability.

b) Aircraft Maintenance Programme;
   - Poor process applied to AMP variations / extension of frequency to task intervals.
   - Lack of customisation of AMP for helicopter configuration or equipment fitted.
   - AMP's out of date to source data from the Type Certificate of the helicopter and / or engine type.
   - AMP not subject to review by Operator / Part M organisation managing the AMP.
   - Missed tasks from the Type Certificate Holders Instructions for Continued Airworthiness (ICA).

12.10 The root causes for AMP compliance findings showed trends related to human error, competence / capability of personnel and organisation lack of regulatory awareness. Additionally, it is understood, there are contributory factors that go towards affecting the standards of maintenance programmes.

a) The complexity of some Type Certificate Holders Instructions for Continued Airworthiness; the source data and basis on which the AMP for the owner / operator is created. Predominately this originates from, newer technology helicopters certificated to CS29. This places a significant demand onto organisations in terms of resource, time and understanding.

b) The complexity of some Type Certificate Holders Instructions for Continued Airworthiness, whereby, penalty factors are applied to certain AMP tasks. This means, tasks have certain multiplication factors added which are based type of operation or weight of the helicopter. For example, weight factors for certain tasks or components.

c) The number of amendments required to keep the AMP current and up to date with the TC holders ICA.
d) The complexity of creating an AMP which includes all required elements – scheduled tasks, repeat inspections, AD requirements, and links to reliability data (MSG 3 derived AMP's).
e) A high number of maintenance programmes managed by Part M Continued Airworthiness organisations.

Action:

A8 *The CAA will engage and deliver, via the Onshore Helicopter Maintenance Standards Improvement team (A31), further development of the Continuing Airworthiness Management Organisation competencies to deliver guidance material for CAW functions.*

Personnel Findings Analysis

12.11 189 findings were related to personnel. This includes findings for Part M continued airworthiness and Part 145 maintenance. The trends by root cause over the reporting period;

a) Findings related to personnel whereby competency has not been demonstrated for specific roles, no procedures or process in place for competence assessment and poor quality of competence assessment carried out by approved organisations (Part M and Part 145).
b) Findings related to insufficient resources to support maintenance or the management of continued airworthiness.
c) Insufficient maintenance certifying staff for specific specialisations E.g. Airframe and Avionics staff.
d) Insufficient personnel resources to support the management of continued airworthiness.
e) Human factors training or continuation training; training overdue or not carried out, training not commensurate with role undertaken or poor training carried out E.g. not including all required elements of training. E.g. experience from incidents.
f) Insufficient experience and/or knowledge related to the role undertaken. E.g. Quality Manager and Continued Airworthiness staff.

Summary of Compliance Analysis

12.12 Airworthiness oversight of onshore helicopters and approved organisations is broadly focusing in the right areas, finding key areas of non-compliance against the applicable regulation. The analysis has highlighted a need for the CAA to focus and prioritise its oversight in the continued airworthiness area, in particular;

a) Aircraft Maintenance Programmes.
b) Resource levels within the CAMO.
c) Competency of Continuing Airworthiness Management staff.
d) Systems, Process and procedures in support of continued airworthiness.

Action:

A9 *The CAA will support industry in developing guidance material through the A31 working group structure to produce a framework to help CAMO staff gain the required knowledge and experience to progress through an organisation's structure and achieve specific roles within a CAMO.*

12.13 The analysis has highlighted trends where the helicopter industry should look to improve both general performance and compliance performance. These include;

a) The quality system for maintenance and continued airworthiness.
b) Oversight of resource planning for maintenance and continued airworthiness. The aim of which is to ensure the organisation has adequate resources.
c) Oversight of continued airworthiness functions identified in para.12.12.
d) Competence assessment for Part 145 and Part M organisations.
e) For continued airworthiness the review highlighted issues with aircraft maintenance programme compliance. This area can be exacerbated by the number of maintenance programs being manged by individual organisations and the growing complexity of creating and managing an AMP with all the required elements that need to be included.
f) Training and competency levels of staff working with CAMO's and Part 145's
g) Systems, Process and procedures in support of CAW.

12.14 The review of the compliance data set for the reporting period highlighted areas of repeat findings, whereby, organisations do not rectify findings with corrective actions which adequately support long term robust rectification. To prevent reoccurrence, it is key that effective root cause analysis is carried out by the organisation. Existing systems do not always properly identify root cause or causes which lead to ineffective corrective actions.

<u>Action:</u>

A10 *The CAA will work with the helicopter industry to help increase their awareness and understanding for the need of effective root cause analysis, via industry seminars and workshops.*

<u>Action</u>

A11 *The CAA will ensure that the results of this onshore helicopter review, compliance performance section, are fed back to all CAA Surveyors and at Industry Seminars.*

Section C: Flight Operations - General

Chapter 13: AOC management & operations

AOC Operators

13.1 A recurring theme in a number of onshore accidents and incidents has been that of poor decision making and lack of rule-based behaviours. It is recognised that onshore commercial helicopter operations differ significantly to those of an aerodrome to aerodrome fixed wing CAT operator where the latter is almost completely prescribed in terms of procedures and routes when conducted under IFR. Helicopter operations will require the flexibility of an off-aerodrome movement as part of the CAT task and nearly always a VFR sector to achieve it. To maintain this agility of operation in meeting the customers perceived needs the operator requires the bedrock of some fundamental supporting pillars and principals.

13.2 The company operations manual must fully reflect its operational needs and define not just what is required of the crew at every stage of flight but also define how it should be achieved in practice. This detail equally applies to all personnel concerned with managing the flight on the ground. In operating to the minimum regulatory requirements maximum flexibility is afforded to the operation, but this concept of minimum compliance exposes crews to uncontrolled task- focussed decision making.

13.3 The company safety culture should reflect its Safety Management System in action. If the underlying message, and expectation, is purely task orientated then management and workforce decisions will support that ethos. Risk-based decisions will then readily be made by side stepping operations manual procedures in order to fulfil both the customer's expectations and the company's commercial desire. Unfortunately, a sizeable number of the accidents within the dataset show poor decision making as a factor and violations were also present in a number of the fatal/serious accidents and incidents. Normalised deviation continues to be cited within the industry as indicated by the confidential survey and some of these accidents suggest that flight operations are being routinely conducted on the margins of safety and legality. Crews are keen to achieve the tasks they are given however if there is a perceived commercial pressure the task may be taken in haste and with inadequate planning, which of course will place more pressure and stress on the flight crew which could erode the safety of the flight.

13.4 A healthy safety culture is one supported by an active safety reporting system, both internal and external (e.g. MOR/whistle blowing), and one which is self-supporting so that lessons are learned. Since the tragic Vauxhall accident, the CAA has worked closely with the BHA in holding a number of safety culture seminars. External reporting has increased which does seem to indicate that the industry is becoming more aware in this area.

13.5 Rotorcraft flight manuals contain information that is necessary for safe aircraft operation taking into account design, operating or handling characteristics. Generally, the focus is what to do rather than how to do it, so it is therefore left to the operator to define this within its operations manual material. As discussed in CAP 1145, larger aeroplane and now helicopter manufacturers provide Flight Crew Operating Manuals (FCOM) and Flight Crew Training Manuals (FCTM) so that the end user can take the benefit of implementing the manufacturers operating philosophy including any automation protections.

13.6 Managing customer expectation is a significant issue for many in the onshore sector. This has been a common factor in recent accidents where real and perceived pressures on flight crew have adversely affected pre-flight planning and crew decision making. Applying mitigations and working practices that promote both the customers' well-being and flight safety throughout their interaction with the operator is key in their understanding of this 'safety partnership'. Similarly, interaction with the customer prior to the flight is best handled by the operations team so as to separate the flight crew who can focus on the flight planning process and decision-making without any perceived pressure.

13.7 Unlike pilots who serve an 'apprenticeship' early on in their career as a co-pilot within a multi pilot operation, such as within the offshore sector or military, onshore pilots tend to work within single pilot operations. This means that at the end of initial CPL training and operators conversion course (OCC) they then act as Commander on their own in between annual recurrent line checks. Therefore, there is little opportunity for formal consolidation by such pilots to ascertain what standard practices look like across the workforce. It is thus possible for poor practices and decision making or the use of' work-arounds' to become the norm. The 'osmosis' of learning from more experienced pilots is one of the benefits of multi-crew operations. Arguably, the single pilot IFR sector is the most challenging of all where the provision of checks and balances afforded by the presence of a second pilot are not required or available. Recent work by the CAA has enabled the opportunity for two Commercial pilots to utilise their CPLs within a multi-pilot operation under derogation from the licensing requirements and gain essential experience.

13.8 Industry is also working on a mentor scheme whereby junior industry pilots can discuss generic scenarios to better help with decision making.

Management

13.9 The management and associated 'culture' of an organisation are fundamental to its safe operation. A key part of the process is that company must have established an overall 'Management System' to control the organisation. At the heart of this is a requirement for procedures to identify and manage risk – a Safety Management System (SMS). Most small to medium sized AOCs have compliant but small teams to meet their safety responsibilities.

13.10 The use of the word ‘small’ to describe the size of operators is subjective but the majority of onshore AOCs come under the category of Non-Complex, i.e. less than 20 full time employees. As such the majority have one person holding more than one of the Nominated Person or Form 4 roles within the company.

13.11 All operators are required to have procedures to cover for periods of absence of key personnel, but this is particularly important in smaller companies where there may be limited additional personnel with appropriate experience.

13.12 This multi-tasking role within a small operation can lead to time management issues particularly where a nominated person may also have a flying or other operational responsibility.

13.13 All AOC holders (other than those operating A to A flights only) are required to hold an operating licence issued by the CAA. Onshore operators hold a Type B licence based on aircraft weight and passenger capacity and the ongoing financial stability of such licence holders is routinely reviewed. The regulations recognise the potential link between financial health and safety and is a prime consideration in CAA performance-based oversight.

13.14 The relationship between the management team and line personnel is crucial. The safety ethos and culture of an organisation is driven from the top and the communication of the company’s fundamental safety principles must be clear to all personnel. The element of trust in the management needs to be strong, with personnel understanding what is expected of them but also feeling certain that they will be supported in making difficult operational decisions in a competitive market. The presence of an SMS alone will not meet this aim; the understanding by everyone within an organisation of their importance in safety decision making is fundamental.

13.15 The balance to be struck is between keeping risks as low as reasonably practicable whilst remaining commercially viable and compliant. Nevertheless, how can the management team be certain that operations manual SOPs are being followed by flight crew particularly on single-pilot operations where decisions go unchallenged. There is no doubt that Flight Data Monitoring (FDM) as required by legislation for larger aeroplanes and offshore helicopters has had an impact in identifying operations outside the established limits. At present helicopter FDM is not mandated for onshore operations but should be considered.

13.16 Command and control procedures to manage the flight planning and dispatch process need to be robust, particularly where last-minute charters are concerned.

13.17 Many operators now use a form of ‘out brief’, of a type suggested by CAA Safety Notice SN-2019/007, using a challenge and response method.

The Operating Environment

13.18 Amongst VFR operators a significant level of activity is actually ‘A to A’ tasking in the form of sightseeing or city tours and off-airfield pleasure flying. On this subject, there is undoubtedly some resentment amongst operators of the ability of non-AOC companies to conduct similar ‘introductory flights’ or ‘cost-shared flights’.

13.19 There is anecdotal evidence that a significant amount of ad hoc charter is at relatively short notice and therefore the operational control procedures referred to earlier are particularly important.

13.20 Demand for flights to major sporting events such as the Cheltenham Festival, Royal Ascot and the British Grand Prix remains strong. It is important therefore that operators of the helipads at these events regularly review their procedures to ensure that they remain robust. Equally, helicopter operators must ensure that a level of complacency does not exist – the procedures can and do change.

13.21 Of concern to many continues to be the busy choke points between controlled airspace and areas of intense flying training. The CAA identifies ADS-B 'in/out' as is its preferred national system to improve electronic conspicuity for general aviation, but equally recognises that this also applies to CAT lower airspace users. Work continues in developing an integrated electronic surveillance solution to reduce airspace infringements, increase access into the busiest airspace but perhaps most important of all to enhance safety through improved situational awareness.

Off Aerodrome Landings

13.22 The helicopter’s key attribute of being able to operate from sites other than aerodromes is made easier in the UK than in some other European countries. Fundamentally the site must be safe in terms of aircraft performance and risk to third parties; additionally, the land owner’s permission is required. These requirements are the operator’s responsibility. However, in the UK there is a requirement that off-aerodrome landings within a congested area require permission from the CAA.

13.23 Most operators are well versed in the specific requirements for ensuring that a landing site is suitable but particular care and risk assessment is necessary for operations at night to remote locations.

(See Chapter 16: Heliports/Landing Sites).

IFR Operations

13.24 Balancing customer expectations for IFR flights against the requirement for fundamental safety decision-making can be a challenge. The expectation may be for a flight from an airport to an off aerodrome destination in all weathers i.e IFR capability does not mean all weather operations.

13.25 Advances in the technology of the latest IFR helicopters may have reinforced the expectation from customers that such aircraft can fly to any location in all weathers.

13.26 Ad hoc IFR let-downs and approaches have been a recurring subject of safety discussion for many years. The introduction of Performance Based Navigation (PBN) and Point in Space (PinS) approaches provide the opportunity to meet the needs in this area.

(See Chapter 14: PinS).

Environmental

13.27 The noise generated by helicopters has long been an issue and all operators need to be aware of the environmental effect of their activities. Any restrictions on helicopter activity could lead to a loss of revenue with an indirect impact on safety. Nevertheless, the industry should continue to make its best efforts to fly in a considerate manner and with due regard to the environment in which it operates.

Training

See elsewhere within this report, however:

13.28 Whilst perhaps stating the obvious, pilots need to be trained and checked for the variety of tasks they may be asked to undertake. The AOC operating area will cover the whole of the UK at the very least – are pilots equipped for all the airfield, airspace, role and terrain challenges they may encounter? A line check between two regularly operated locations doesn't necessarily provide a robust and challenging check of a pilot's knowledge and capabilities particularly with regards to operating in unfamiliar areas.

13.29 Decision making, and threat and error management principles are a key part of the process alongside established SOPs and should be embedded throughout the operator's conversion course and subsequent recurrent training and checking.

Safety Issues Identified by industry

13.30 Evidence collated for this report has been based upon the response to the online industry survey, CAA/BHA Onshore Helicopter Liaison Committee Meetings and Safety Seminars. Further validation is derived from the CAA Performance Based Regulation processes following meetings with Accountable Managers and associated safety risk assessments.

Repeat safety points from discussions and survey feedback forms include:

a) Landing sites – obstacle environment, survey methods, procedures and night operations.

b) Maintenance costs – product support/pricing policy from manufacturers

c) Airspace – Lower Airspace Radar Service (LARS)/choke points/non-transponder

d) IFR let downs – ILS currency. Expectation of IFR flight to their destination from customers
e) Weather – perceived accuracy of forecasting
f) Customer expectations – stress (e.g. London airspace/Battersea closures)
g) Regulatory knowledge – access and perception of continual change
h) Training – new pilots/simulators/robustness and relevance of training/complexity of new aircraft
i) Compliance with SOPs
j) Decision making and Human Factors
k) Reporting and the support culture
l) Competition from perceived umbrella operations.
m) Decline in the number of senior industry members/mentors
n) CFIT
o) Culture
p) CAA oversight

Subsequent considerations

13.31 Controlled Flight into Terrain (CFIT) appears as a regular reported/risk accident outcome globally and remains a real and present threat when operating within the low-level environment, especially when conducting approaches to and departing from landing sites. There can be a number of lead-in factors to CFIT, including deteriorating weather, pilot error due to loss of situational awareness, navigation errors or handling technical malfunctions. Possible mitigation to the threat of a CFIT is the inclusion of a Helicopter Terrain Awareness and Warning System (HTAWS)/Enhanced Ground Proximity Warning System (EGPWS). Operators should consider the fitment of these systems to their aircraft.

13.33 Oversight/Supervision whether AOC operations out of home and/or satellite bases or individual NCC operations, missing or inadequate oversight and supervision of flight operations are always the beginning of the ‘link in the chain’ prior to any incident/accident.

13.34 Risk Management and risk appetite differ across companies; therefore, the company must own its own risk profiles and manage them using the procedures adopted and include but not be limited to:

- Terrain and obstacle awareness;
- Inadvertent entry into IMC at low level;
- Pilot disorientation/loss of situational awareness;
- Accurate and timely operating base and en-route weather information;
- Ground risks to personnel at the operating site;
- NVIS-related limitations;
- Illumination of final approach and take-off area.

13.35 Training must continue to be of the highest-quality preparing pilots for the operating environment. EASA requirements identify this by stating that recurrent checks in the single-pilot role must be conducted in an environment representative of that operated. If crews enter the DVE unintentionally they must be equipped to recover to a safe flight condition. In variably this means Instrument Ratings with recency or the adoption of the previously adopted UK Instrument Night Qualifications (INQ), introduced following a number of LOC accidents.

13.36 Decision making, made realistic through training, should include meteorological training and testing post licensing. It is to note that the CAA Paper 2007/03 'Helicopter Flight in degraded Visual Conditions' – Pilot training issues; made the following conclusion: *"Pilots should be better trained to make informed decisions on whether 'to fly or not' in marginal conditions, or when IMC conditions are developing en-route. This might be achieved by developing a probability index based on factors that contribute to a high-risk accident scenario (e.g. meteorological conditions, visual conditions, visual range, acuity of the visual horizon, aircraft configuration, aircraft handling qualities)."*

It is also important to note that the AAIB Report on Agusta A109E G-CRST; includes the statement that *"…pilots will often be subject to pressures – real or perceived – to complete a task. These pressures might lead pilots to continue with flights in circumstances where otherwise they would not…"* The CAA is therefore considering re-writing the CAA Paper 2007/03 'Helicopter Flight in degraded Visual Conditions' – Pilot training issues.

13.37 Landing site selection training is paramount as the landing site choice is key to a successful outcome, this begins at the planning phase and should not be left to a single-pilot flying on the day that is presented with a sub-standard landing site.

13.38 Line training, ensuring the line training reflects the actual operation and continued relevance of the operator proficiency check to the tasks conducted.

13.39 Loss of control training, such as unusual attitudes (UA's) and vortex ring state (VRS), needs to be appropriately addressed in the aircraft and where possible using appropriately qualified FSTDs.

13.40 Wires/Obstructions. Wire strike detection technology is an ongoing issue; not always is the most expensive solution the correct one. An onshore operator recently has found one of the cheaper solutions gives greater protection. (ACANS -Aviation Command and Aircraft Navigation Systems). It is to be noted there has been an increase in the number of wind turbines construction onshore and these should heighten awareness throughout. The operator should consider the suitability of their onboard safety systems for the tasks they conduct in their Risk Assessments.

13.41 Type rating training, it is noted that until recently the type rating training syllabi have been limited to simply teaching the aircraft type and not the in-depth training on the ancillary and optional equipment's. Training offered is only focussing on the basics i.e. what is paid for, and essentials such as CAT A Profiles may well come at an extra cost, as opposed to coming as part of the type rating. Some operators influenced by cost and value are paying for only the basic level of training. With no mandate for specific training prior to operating, this manifests itself as a serious risk to the operation.

Recommendation:

R3 *It is recommended that operators ensure that their procedures and training material appropriately address the risks associated with off aerodrome landing sites and are monitored for effectiveness.*

Recommendation:

R4 *It is recommended that operators show clear evidence of operational control as defined in AMC1 ORO.GEN.110 (c), ensuring that there is a clear tasking process separating the customer and the flight crew.*

Action:

A12 *The CAA will review the previous UK Instrument Night Qualification (INQ) with a view to assessing its suitability for re-introduction.*

Recommendation:

R5 *It is recommended that operators create an Unusual Attitude training programme in line with the current Upset Prevention and Recovery Training (UPRT) as listed under Part ORO, ORO.FC. 220 & 230. The CAA will maintain oversight for the UPRT training within the current oversight program.*

Recommendation:

R6 *It is recommended that operators review their training manuals/Part D to ensure that:*

a) they are compliant with the Operational Suitability Data (OSD) including Training Areas of Specific Emphasis (TASE) for the types they operate; and

b) their current ground and flying training is relevant and suitable for the operational needs.

Chapter 14: NCC and SPO Operational Management

14.1 This aspect of the review focussed on the management arrangements and regulatory compliance of the Onshore Sector. Whilst it may be assumed that AOC holders by their very certification and oversight are considered to be competent to undertake CAT operations, the Non-Commercial Complex (NCC) and Commercial Specialised Operations SPO operators, on the other hand, need only make a Declaration that they are compliant with the requirements of Part ORO and NCC/SPO as appropriate.

14.2 (Safety) Management systems in compliance with the EASA Ops requirements have been in place since October 2014. AOC CAA oversight activity indicates that there are varying models mirroring the many type of operations and organisational complexity. The requirements recognise this, and operators are responding to the systemic processes inherent within their management systems. The nature of a well-constructed and managed safety management system should be agile in responding both proactively and reactively to events. By and large the industry is benefiting from this systemic approach and leaning those principles.

14.3 The CAA's oversight of declared NCC and SPO operations is in its infancy, since under the previous regulatory system these sectors could operate with little or no formal oversight. With the adoption of the NCC EU Regulations in 2016, and SPO EU regulations in 2017 both complex and non-complex aircraft were captured.EASA has an expectation that all such operations will be subject to an audit within 48 months of the initial Declaration. There are some 520-aircraft declared under NCC and SPO, across Fixed Wing and Rotary aircraft, with around 200 operators; this suggests that in the next 4 years some 50 audits per annum should be assumed.

14.4 The Declaration procedure requires the operator to make a statement as to the presence of an operations manual, although no verification as to the suitability or content of the operations manual is required.

14.5 The impact of the rule set on the industry is gradually being understood and now falling under scrutiny, particularly those SPO operators who need Permissions to conduct their activities. However, NCC operations appear to have continued unaffected by the introduction of regulation and oversight. Statistics might suggest that the SPO sector is relatively accident free, whereas the NCC sector has suffered from high profile accidents and near misses in the past few years. It should be remembered the NCO sector has not been addressed as part of this review.

NCC and SPO Management

14.6 Following the review of the management structures of NCC and SPO Operations it is evident that the management of these operations varies considerably. In general, those operations that have a close relationship with or are part of an AOC have structures that would on paper appear satisfactory and reasonable. However, it is also evident that smaller operators rely on a limited number of individuals to run the business and seek no third party or external assistance in the day to day running of the operation. Most of these organisations would be categorised as non-complex organisations (those with a workforce of fewer than 20 full time equivalents (FTEs) and are therefore bound by a less prescriptive set of management regulations.

Whilst larger NCC operators have both the willingness and resources to recruit competent managers, it is clear that small/medium size operators can find this challenging and possibly burdensome.

Understanding of EASA Regulations

14.7 CAA Oversight is beginning to indicate that those who hitherto have had little formal interaction with the EASA requirements have, in some cases, by necessity become the author and implementer of a set of operating standards that they might not yet fully understand. The Audits conducted to date on NCC operations have raised significant non-compliances. Early indications are that the CAA oversight programme of SPO operations will yield similar results, particularly with regard to Management / Safety Management Systems and maintenance requirements.

Management Systems

14.8 EASA and the CAA have placed the effectiveness of the company ‘Management System’ as one of the key components for operational safety. Many of the operators have not fully grasped or perhaps fully understand these concepts and hence compliance monitoring and safety management remains variable.

Compliance Monitoring

14.9 Many organisations would appear to nominate Compliance Managers, however this individual is frequently also the Accountable Manager. Although permitted, the requirement for a degree of independence of the compliance monitoring function is stated in the regulations:

> AMC1 ORO.GEN.200(a)(6) Management system
>
> (6) The independence of the compliance monitoring function should be established by ensuring that audits and inspections are carried out by personnel not responsible for the function, procedure or products being audited.

Operations Manuals

14.10 The variety and competence of the operations manuals reviewed was considerable and, with a few exceptions, the content of the manuals did not meet the requirements of EASA OPS. It was evident that some operators had not understood the actual requirements and were using a mixture of old manuals inherited from other operators or ones that were only compliant with older regulatory standards such as EU OPS, JAR OPS or CAP 360. In a handful of cases the requirement for any form of manual had not been appreciated.

14.11 There are specific differences between the requirements for NCC and SPO manuals which can be complex and therefore confusing to the newcomer. The particular requirements are set out in these parts of the regulation:

a. General

ORO.MLR.100 Operations manual;

AMC1 ORO.MLR.100 Operations manual — general;

b. NCC

AMC2 ORO.MLR.100 Operations manual — General

CONTENTS OF THE OPERATIONS MANUAL FOR CERTAIN TYPES OF OPERATION

For non-commercial operations with complex motor-powered aircraft, or CAT operations with either single-engined propeller-driven aeroplanes with a MOPSC of 5 or less, or single-engined non-complex helicopters with a MOPSC of 5 or less, taking off and landing at the same aerodrome or operating site, under VFR by day, the OM should contain at least the following information, where applicable: and,

c. SPO

AMC4 ORO.MLR.100 Operations manual — General

CONTENTS – NON-COMMERCIAL SPECIALISED OPERATIONS WITH COMPLEX MOTOR-POWERED AIRCRAFT AND COMMERCIAL SPECIALISED OPERATIONS

14.12 Essentially, the regulatory requirement only requires the operator to declare that it is operating in accordance with the them but falls short of requiring the National Aviation Authority (NAA) to ascertain that fact by reviewing operations manuals prior to the commencement of operations. The oversight process is deemed to be the acceptable method of that assurance. In terms of scale, there are roughly 200 active AOCs in the UK and evidently some 200 or so active NCC and SPO operations. The CAA will continue to review its national policy in meeting Part ARO in assuring compliance with the requirements of all operations manuals. The CAA recognises that while it has an inspecting and enforcement role in assuring aviation safety standards, as a performance based regulator it should also use direct its resources to best effect and in this context education clearly is required.

***Action*:**

A13 *The CAA will formalise its programme of education, advice and awareness to operators of EASA NCC and SPO requirements.*

Training

14.13 It is apparent that the NCC/ SPO sector is highly variable in its approach to meeting the new training requirements and pilot checks are almost exclusively conducted by external examiners. Evidence indicates that in some cases pilot competence would appear to be entirely reliant on the Proficiency Check (PC); whilst the regulatory need for an annual Operator's Proficiency Check (OPC) is often acknowledged, very few of the manuals reviewed provided evidence that training and checking was being undertaken that was relevant to the type of operational activity. The CAA will continue to review the contents of the operations manual Part D, particularly the operators' proficiency check and retains the right to sample the conduct of OPCs in these sectors. The content of the OPC should be published in the Operations Manual Part D including the name and qualifications of the Nominated Type Rating Examiner. Furthermore, many operators have overlooked the need to ensure CRM and Dangerous Goods Training Programmes.

14.14 However, whilst it has been observed that some flight crew have not been trained in accordance with the requirements of EASA OPS, it is also clear (and acknowledged by EASA) that some regulations currently lack the necessary detail in order to be fully understood. One such regulation is ORO.FC.130 'Recurrent training and checking'.

14.15 As part of their overall training procedures operators are encouraged to use flight simulators where available.

Minimum Equipment Lists (MEL)

14.16 It is a requirement that NCC and SPO operations have an MEL and that the MEL and any amendment thereto shall be approved by the competent authority (ORO.MLR.105(b) Minimum Equipment List). However, it is evident that not all operators hold a MEL approval, nor have they sought to obtain one. Most MELs were not evident during the review being generally held elsewhere or, in some cases operators indicated that their reference was the Flight Manual rather than MEL.

14.17 Some if not most MELS in this sector are undoubtedly out of date and frequently contain erroneous and/or irrelevant information. Many are based on JAR regulations and old Master MELS and make assumptions about their validity. Some operators declare the use of Rectification Interval Extensions programme but have no supporting Approval from the CAA. While Operators are encouraged to review the content and applicability of their MEL's, the CAA will continue to monitor and encourage progress of this area.

Operations

14.18 There is much discussion over the SERA regulation that allows descent under IFR for the purposes of landing. The legislation in this area effectively provides alleviation for take-off and landing in IFR (see (b) below) which would appear to permit a descent below Minimum Flight Altitude (MFA) provided the aircraft is intending to land. The industry reports that this practice is commonplace and causing considerable concern within the responsible elements of the sector.

SERA.5015 Instrument flight rules (IFR) — Rules applicable to all IFR flights

(b) Minimum levels

Except when necessary for take-off or landing, or except when specifically authorised by the competent authority, an IFR flight shall be flown at a level which is not below the minimum flight altitude established by the State whose territory is overflown, or, where no such minimum flight altitude has been established.

14.19 One NCC operator declared that “the regulation re descents below 1000 feet on a “GPS” approach needed to be changed since industry was routinely descending to 500 feet IMC on unapproved let downs”.

14.20 One responder voiced his concerns over NCO operations which appeared to be unregulated and that individuals routinely fly in poor weather (‘etc)’ whilst conducting private descents presumably under GPS guidance. The view was that the CAA should remind the industry that if they are not flying iaw SERA they are flying illegally.

Action:

A14 *The CAA will review SERA 5015 and consider implementing a national position so that all IFR take-offs and landings are conducted in accordance with either notified or approved procedures.*

NCC/SPO Approvals/Pilot Licences

There are indications that some Operators have continued to use Approvals issued by the state of registry (e.g. USA) and have failed to apply for relevant approvals issue by the Competent Authority (i.e. UK CAA). This would apply to MELs for example.

Similarly, some flight crew continue to operate under licences issued by third country states (e.g. USA) due to the aircraft state of registry. This is non-compliant with the regulatory requirement to operate under an EASA state issued flight crew licence or endorsement. [It should be noted that an endorsement is only valid for 12 months and cannot be extended]. Although the extent of this issue is yet to be fully identified, it has resulted in multiple aircraft ‘redeclaring’ in a third country state and thus falling outside of the EASA requirements and CAA oversight.

Issues for Non-Commercial Operations with Complex Motor-Powered aircraft (NCC)

a. Whilst there is a small team of CAA inspectors allocated to the task of oversight in accordance with the current requirements there is no-one dedicated to each company to whom they can contact directly.

b. There is no generic CAA e-mail address to which NCC enquires can be sent.

c. The CAA website contains little information relating to NCC operations.

d. Operators are unsure as to the process to be followed when an aircraft needs to be un-declared. This has resulted in the CAA holding inaccurate data relating to NCC operators.

Issues relating to Commercial Specialised Operations (SPO)

a. There is a requirement to hold an Approved MEL but it is common place for the same airframe to be Declared by multiple operators.

b. Non-standard and high risk operations (HR SPO) – for example: UK has a vibrant aerial filming sector, predominantly based in & around

London, working extensively with News organisations, documentary, tv drama and motion picture makers. Many of these flights require low-level sorties within congested areas – oversight & control is robust by means of low-level Permission process (Risk Assessments/Mission statements/SOPs/High Risk Authorisations) plus on-site inspections by CAA FO(H) technical experts.

c. Lack of Pilot experience/skill base and inadequate pilot training.

d. Provision of specialised training (specifically OPC and OCC) – recording & storing of results.

e. Commercial pressure & operator (customer) attitude to regulation (specifically ORO requirements, Flight Time Limitations (FTL), SERA).

f. Operator management (planning/pilot decision-making/flight following).

g. Helicopter External Sling Load Operations (HESLO) – content of CAP 426 remains relevant, Operators should ensure guidance is promulgated and followed.

h. Maintenance requirements – Part M/Part-145 and MEL Approvals.

Summary

14.21 The NCC/ SPO sector is responding to the new requirements as it apparently perceives them utilising material that is not subject to the same level of rigour as that applied to an AOC. Operators are now legally responsible to this new operating standard and subject to a quite different oversight methodology. These particular sectors are therefore potentially both legally and operationally exposed until such a time as compliance has been assured.

Industry discussions

Discussions were held with members of the NCC/SPO community: the following is a precis of the comments received, some may not be relevant to NCC/SPO but are of concern to operators.

g) The EASA derogations to the CAT requirements allowing cost sharing to take place is perceived by the commercial industry as undermining regulation, unfair and a threat to the small onshore operators.

Airborne Conflict:

The risk of airborne conflict is a very real threat and identified by many as a top risk.

Poor ATC radar coverage:

'Airborne conflict is made ever more likely by poor ATC service coverage e.g. the unreliable and 'sketchy' Lower Airspace Radar System (LARS) coverage. For such busy airspace such as Southern England it is incomprehensible to not be able to provide consistently good quality, reliable radar services'.

Lack of electronic conspicuity:

‘Without ATC service, it is vital that we are able to self-deconflict by a STANDARDISED and MANDATED form of electronic conspicuity across ALL platforms (Commercial, GA, Sport – especially gliders)’.

‘Presently, there are a number of systems in use, which aren’t compatible, nor does everyone fly with one. In the same way that use of seat-belts was mandated for vehicle users own safety, I think altitude transponders and electronic conspicuity should be mandated too’.

NOTAMs:

‘There are so many NOTAMS now for cranes, UAVs etc that there is a tendency to just skip them. Certainly, it would be impractical to plot them’.

‘Perhaps NOTAMs could have two categories; red for obviously hazardous factors (tall obstructions, live filming, air displays etc.) and amber for lower risks like low level cranes or NDBs not working’.

‘Only NOTAM cranes above 500ft AGL’?

Action:

A15 *CAA will liaise with NATS to review the NOTAM system with the aim of improving the presentation of information to end users.*

ATC Services Outside Controlled Airspace are limited in many areas.

This is understandable in remote and mountainous areas, however, there are areas within the southern UK where ATC units are perceived to be reluctant to offer radar services below safety altitude, or reluctant to offer a radar service full stop as they aren’t a LARS unit.

Those facilities that do offer a LARS are often too busy to do it effectively.

One reporter cites that the new electronic flight strips may be causing delays and added pressure on ATCs.

Weather reporting:

Should have better weather reporting – e.g. a cloud-base recorder at Banstead and somewhere on the Brent/BNN radial somewhere might be a useful way of ensuring conditions are suitable for entry to LHR airspace under VFR/SVFR?

Military Weather Reporting:

This is not being promulgated outside the military. Military Met/ATCs only update the weather hourly whereas the civilian operators manage every 30 mins.

The new actual met conditions being controlled by Military Met Offices as opposed to what the TWR controller can actually see is becoming a flight safety hazard.

Airfields should not decline an aircraft from making an approach to break cloud and continue VFR, with the option to go-around/land if conditions not suitable to continue.

An example would be Northolt approach, then heli-routes or direct to Brent/Battersea, which is currently only available to certain operators.

Perhaps define the minima where it would be permitted to continue?

Training:

Make CPL(H) training more relevant to the commercial world. It currently appears to be an 'advanced PPL' course with tighter flight tolerances.

Widen the scope of the training to include more CRM training, focus on decision-making in demanding situations. Include LOFT (in suitable simulator) as a requirement for the CPL course.

Ensure Line Training is carried out by Line Training Captains with significant relevant experience in the role.

Regulatory Oversight:

Part NCC - The CAA should adopt the FOI(H) CAT oversight model for Part NCC operators: i.e. specify a CAA FOI point of contact for questions and support.

Audit/Compliance:

Promulgate an audit/compliance programme for Part NCC operators.

PinS:

Progress the PinS procedure quickly to allow safe, risk assessed, recognised and approved procedures to prevent some still descending below Minimum Safety Altitude (MSA) IMC to land. Or allow operators to construct their own approaches (perhaps with CAA approval/or at least oversight?).

The night VFR limits (cloud base 1500ft requirement) must be taken into account in the 'Proceed VFR' PinS approaches.

Visibility requirements:

Review the visibility requirements for ground visual contact flying in reduced visibility:

IFR used to be 800m pre-SERA but now not stated/permitted; alternative is VFR which is 1500m.

Publications:

e.g. AIP – ensure it is updated in a timely manner – e.g. night VFR limits outside CAS.

Streamline the amount of publications.

Mapping – ensure that the CAA charts (e.g. ½ mil) are updated with more regularity.

Chapter 15: Flight Operations – pilot training

Introduction

15.1 As part of the Helicopter Onshore Safety Review, an appraisal of pilot training was carried out to identify and address where feasible, any associated safety-related issues. To achieve this the following activities associated with the onshore industry were carried out:

a. CAP 1581 – Pilot training review (Frazer Nash) was used to identify common key findings and recommendations from the offshore sector that would equally apply to the onshore industry;

b. Over 140 individuals holding senior training posts were asked to give feedback on any issues related to training. The feedback topics ranged from the basic Private Pilot's Licence (PPL) course training to theoretical knowledge exam contents to examiner standardisation;

c. All helicopter accidents dating from 2002 were reviewed to identify if any recommendations made were related to or could be attributed to training;

d. All MORs from 2014 were assessed for any training safety related content;

e. Instructor training and standards were reviewed to see if there were any safety-related lessons to be learned;

f. Examiner Assessment of Competence (AoC) reports (CAA Form TS10) from 2010 was reviewed to identify if there were any trends;

g. Industry's use of simulation was reviewed, including feedback from trainers as to the benefits associated with training in Flight Simulation Training Devices (FSTDs);

h. The availability of Flight Crew Operating Manuals (FCOMs) and Operational Suitability Data (OSD) was collated to see what the current availability was; and

i. Discussions with CAA examining and standardisation staff.

This activity provided a large amount of information which was very useful in helping assess the current state of pilot training, both initial and recurrent, and actions and recommendations have been made where appropriate.

CAP 1581 – Pilot training review

15.2 Whilst the helicopter content was mainly associated with the offshore industry, CAP 1581 was reviewed to see what findings or recommendations, could equally be applied to the onshore industry. The challenges identified within the CAP, as well as the key findings and recommendations have an almost direct read across to the onshore sector and therefore this report is recommended reading for training organisations, trainers and the like. In way of an example relating directly to automation issues elsewhere in this review:

"The pilot training community supported by the training regulations should ensure that comprehensive training needs analyses are conducted to inform the balanced design of training, throughout the training pipeline. Attention should be given to ensuring that fundamental topics around automation management, use of manual flying and core cognitive skills, e.g. decision making, are strongly represented across training."

Action:

A16 *The CAA, with the assistance of the industry, will review CAP 1581 and ensure that wherever possible the recommendations therein are adopted.*

Feedback

15.3 Pilot Supply Chain

A pilot who wishes to operate a helicopter must hold an appropriate license issued by the CAA. To gain the license he must complete the training and testing as laid out in the Aircrew Regulation (Licensing) at an Approved Training Organisation (ATO) or Declared Training Organisation (DTO). Helicopter training is intensive, demanding and comes with associated risks which are mitigated as far as possible by the training organisation following the regulations and by ensuring that the training is delivered by appropriately qualified and experienced instructors. Most aspiring pilots fall into two separate groups that can generally be identified by finances. The smaller group tends to be rather well off and look upon flying their own helicopter for pleasure or possibly mixed with business activities. The larger group is populated by mainly young, enthusiastic, highly motivated self-funding individuals who have to keep one eye on costs. They want to achieve the required standard in the minimum training time to ensure the lowest financial cost to themselves. This has an understandable impact on where they do their training and even who they do it with.

Training organisations, and to some extent instructors and examiners, are not immune to this economic landscape and to that end, they can be influenced by these scenarios as they may not have the strength of character or the experience to 'do the right thing'. There is evidence that standards within the pilot supply chain have declined since the introduction and adoption of European rules and standards. Areas of concern that have been identified include:

a. The reduction in flight time experience requirements to become a flight instructor.

b. The Theoretical Knowledge (TK) exams are less demanding with many candidates achieving passes by studying previous exam papers, rather than learning the subject.

c. Instructing is seen as a stepping stone or a temporary position and not a career choice, resulting in low motivation to achieve in the training environment.

d. A reluctance from experienced instructors and examiners to accept and adapt to change.

e. Poor standardisation across the training community.

f. No oversight of PPL(H) training.

Actions and recommendations where appropriate, have been addressed elsewhere in this Review.

CAP 1581 – Avoidance of minimum compliance

15.4 In order to maintain high standards across the training system, all organisations should strive to do more than just seek to meet the minimum level for compliance. Achieving this will rely on other barriers being implemented and pan-community culture of excellence.

Training Guidance Material

15.5 A review of CAA issued training/standards/guidance documents showed that there were some 86 current documents still available, some dating from 2000. Keeping these documents up to date and relevant is an obvious resource problem for the CAA in light of resourcing issues that are recognised by the industry. Feedback indicates that industry acknowledges this problem but would rather keep the documents available even if they are out of date because it recognises the value of such material in providing information and guidance on regulatory compliance as well as best practice.

Action:

A17 *The CAA will conduct a review of all of its training, standards and guidance material associated with the onshore helicopter industry to ensure that it is relevant and up to date.*

CAP 1581 – Maintaining instructor currency in training developments (aircraft systems, etc)

15.6 Given the rapid pace of change in modern aviation and with on-going developments in training, instructors need to be supported in staying up-to-date with the latest technologies and techniques that they are training both for and with.

CAP 1581 – CAA organisational structure based on industry need

15.7 Regulatory approaches need to develop as industries mature and to meet broader societal requirements, but regulators still need to be able to provide support to the full range of organisation types under their control; there is concern that the CAA is no longer able to provide the level of guidance and support needed by industry because of the streamlining of its services following the move to EASA.

Regulations

15.8 One area of feedback reporting was ‘regulatory lag’, ie the regulations not keeping pace with the capabilities of the modern types. This is evident in many areas of the training and checking requirements where the emphasis continues to focus on engine failures, yet the actual reliability of modern engines continues to suggest we should be devoting more of our valuable and expensive training and checking airborne time to the more human factors aspects of the aircraft such as the man-machine interface and systems management.

There is a small but growing Multi-Pilot (MP) market in the onshore industry, originally and continuing within the Corporate and Charter sectors but with a growing number of HEMS operations adopting MP cockpits. This is primarily due to of the introduction of new generation types that are more designed and suited to having a Pilot Flying (PF) ably assisted by a Pilot Monitoring (PM) who does all the routine ‘admin’ heads in activity. Moving from a Single Pilot (SP) to a MP operational environment has brought some difficulties for the onshore industry where there was a historical scenario of carrying a second pilot to improve the lookout and domestics of radio calls, map reading etc, but it effectively remained a SP cockpit from the operating, training and checking perspective. The MP legislation for an Airline Transport Pilot Licence (ATPL) and Multi-Crew Cooperation (MCC) have thrown up additional problems for industry, once again showing that the regulations can sometimes be ‘inflexible’ and frustratingly incompatible with achieving the safest practice.

CAP 1581 – CAA organisational structure based on industry need

15.9 Regulatory approaches need to develop as industries mature and to meet broader societal requirements, but regulators still need to be able to provide support to the full range of organisation types under their control; there is concern that the CAA is no longer able to provide the level of guidance and support needed by industry because of the streamlining of its services following the move to EASA.

Operator Conversion Course (OCC)

15.10 One area of training and checking that is poorly understood is the OCC training. This is required for all pilots joining the company and in effect covers all the administration and training and checking that the pilot needs to carry out before they operate aircraft for that company. It is not just a type rating course, it is not just wearing the flight suit with a company logo on it. It should be a comprehensive package of training that not only fully prepares the pilot to step into the cockpit on his own to do the company's business, but also should be used as a marker for the company management that the pilot is not only fully trained to carry out the flight in accordance with all of their rules/Standard Operating Procedures (SOPs) etc. but also in line with its culture.

Training Standards Meetings

15.11 Almost all respondents raised the lack of regular formal meetings with the CAA which provided the opportunity for industry trainers and the CAA to raise concerns or issues as well as to provide a forum for improving and developing a healthier understanding and relationship between all concerned.

***Action*:**

A18 *The CAA will instigate periodic Training Standards meetings with industry.*

CAP 1581 – Consistent application of standards and checks

15.12 This is a broader challenge than just within the UK but is important across individuals (pilots, instructors), organisations, types of operations and nations.

Crew Resource Management (CRM)

15.13 The concepts and training requirements for CRM and more recently Threat and Error Management (TEM) is generally understood within the aviation industry as a whole and should be an integral part of personnel recurrent training and checking programmes. However, some parts of the onshore industry still struggle to see such training and checking as anything other than another burden on their time and budgets. This is possibly due to the lack of appropriate 'CRM Trainers' and again not having any appropriate simulators where CRM scenarios can be introduced to a much more effective and constructive outcome. It is also recognised that the onshore industry is unable to capture CRM/TEM material due to the lack of installed recording devices such as Cockpit Voice Recorders, Flight Data Recorders and Airborne Imaging Recorders. This lack of available and focussed helicopter material could be the reason why more readily available but possibly inappropriate material from the aeroplane industry is used in training sessions.

It is accepted that the principles of CRM/TEM are similar for virtually all types of aviation however, is it appropriate and more importantly effective that an onshore SP, Single Engine (SE) operator is likely to contract in a CRM trainer with presentations focused in the fixed wing environment – which is substantially different from the rotary world, with scenarios specific to the fixed wing environment which have limited or inappropriate read across potential.

The evidence suggests there is a case for either the CAA or industry bodies to produce and run regular CRM training for industry that meets the required legislation but is also tailored to the different sectors.

***Action*:**

A19 *The CAA, in conjunction with the Flight Crew Human Factors Advisory Panel (FCHFAP), will produce and provide focused CRM courses for industry that will meet industry's needs in respect of initial and recurrent CRM training.*

CAA Sampling of Aviation Training Organisations (ATOs)

15.14 One aspect of CAA oversight that was highlighted was the lack of oversight of ATOs. This was not just in the case of UK Training Organisations but also ATOs located outside of the UK. There is some evidence that the pass/fail rates for some ATOs reflect some unrealistic data in that there have over recent years been no partial passes or failures being reported back to the UK CAA. In effect, the school has a 100% pass rate. Additionally, one recent enquiry identified that an ATO had regularly been able to complete a full initial Instrument Rating Skills Test in exactly 1:00 hour. Most UK Instrument Rating Examiners would advise that an equivalent test would require in the region of 1:40 to 2:00 hours to complete. When asked to clarify the Head of Training at the ATO remained adamant that all aspects of the required test items had been successfully completed including the required en-route items.

Accidents

15.15 Since 2004 there have been 53 accidents within the UK onshore helicopter sector. Of these 18 resulted in fatalities costing 55 lives. The greatest number occurred within the Private sector with 27 accidents, followed by 14 occurring during CAT operations, then 9 under SPO, 2 whilst operating for the Police, 1 under a HEMS and 2 occurring during actual training flights.

Of the 53 accidents investigated only 8 have a training connection and the data shows they involved mainly ATPL holders, operating a mix of types ranging from the S76 to the Westland Wasp. Not unexpectedly the critical phase of flight where the majority of these accidents occurred was during Hover Inside Ground Effect (HIGE) activity, take-off, manoeuvring or during landing. Only 1 of these occurred at night and the majority were attributed to pilot handling or incorrect procedures, with an isolated accident attributed to poor communications.

Further analysis shows that 3 resulted in hard landings during One Engine Inoperative (OEI) rejects (2 by day, 1 at night); 1 instance of dynamic rollover during take-off and 2 cases of loss of control during hydraulic failure practice; 1 incident was attributed to an auto-trim failure which was misdiagnosed, and the poor communications incident resulted in a mid-air collision between a landing fixed wing and a hovering helicopter.

Reviewing the experience levels (hours accumulated) of the commanders showed that the lowest had 2500 hours and the most experienced had some 14,159 hours. The on-type figures gave the lowest figure of 93 hours with the highest being over 2,632 hours.

What this all points to is that training on aircraft represents a significant risk to the aircraft and occupants with little sympathy being shown for the experience level of the instructor/examiner.

Actions and recommendations where appropriate, have been addressed elsewhere in this Review.

Mandatory Occurrence Reports (MORs)

15.16 82 reports were identified since 2014 as having some connection with training. The greatest number of these, not unexpectedly, involved Human Factors (HF) errors as the single cause or as a major contributing cause to the occurrence.

Instructors

15.17 There was considerable feedback from industry Flight Instructors (FIs). Comments made ranged from the entry requirements for attending an FI

Course, the course content, through to progressing as a new FI to having the restricted status removed and then continuing as an FI and moving into becoming an FI instructor/tutor.

The current requirements appear to be almost solely based on achieving a required number of hours with limited opportunity for standardisation, demonstration of competency or development for the FI throughout his initial instructional phase when such oversight can be crucial in giving appropriate feedback to assist with personal and professional development as an instructor.

Examiners

15.18 A review was conducted of the narrative section of the 'Examiner Assessment of Competency' reports from 2010 to ascertain any common findings in either the examiner being reported upon or their candidates under test/check. 86 reports were reviewed, and the most common issues were to do with examiners having weak or poor facilitation skills and a poor understanding or application of Threat and Error Management. There was also some evidence of poor understanding of the requirements in item repeats and retests. It was considered that issues such as those mentioned above could be better addressed with industry in an appropriate forum such as there used to be with the now defunct Training Standards Liaison Group.

Current regulations place a requirement on the CAA to provide examiner standardisation courses or to approve industry to do so on its behalf. There is some evidence that examiners can have difficulty accessing appropriate seminars and in order to meet its obligations it may be appropriate that the CAA either runs such courses or contributes to existing approved ones.

Another major feedback point was the difficulty in the onshore industry of gaining 50 hours as a Type Rating Instructor (TRI) as a pre-requisite before commencing training and checking to gain an Examiners Certificate. Whilst the ethos behind it makes sound sense to most, it is felt that the requirement is not competency based, unrealistic and onerous, and there is a case that the CAA should investigate ways of assisting industry with this issue by either seeking a change to the rules, or by other means to require a more appropriate and realistic means of compliance in this area.

Recommendation:

R7 *It is recommended that the industry propose a case for rule change for the suitability of the pre-requisite experience required for Type Rating Examiners with a view to ensure that it is proportionate and attainable.*

Simulation

15.19 The onshore industry remains a predominantly Single Pilot operating environment where includes a broad mix of aircraft complexities ranging from the basic helicopter types such as the R22/R44 through to the highly sophisticated modern generation types such as the H145 and AW169. These more modern types are being introduced into an operating environment which is historically devoid of simulation where all training and checking is carried out on the actual aircraft with the inherent risks and poor fidelity that this brings with it. Industry is faced with a dilemma, apply the tried and tested ways of doing training and checking in aircraft that have much greater levels of complexity along with ever greater restricted training envelopes where the manufactures philosophy is to do all such activities in simulators or bear the not insignificant costs of carrying out training and checking in simulators which, more often than not, are located outside the UK.

Out of over 140 operator/entities within the industry, only 14 reported making use of simulation. These 14 organisations made use of some 14 devices in total of which only 3 were based in the UK. The declared use included carrying out ad-hoc initial type rating training, all recurrent training and checking and ad-hoc emergency drills every three years. Rules require the use of simulation, when available, and to provide some standardisation/interpretation, the CAA published guidance to industry on what 'available' meant.

Action:

A20 *The CAA will review its policy and guidance to industry on the use of simulation for training and testing.*

Flight Crew Operating Manuals (FCOM)

15.20 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. Therefore, 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 have been able to liaise with the manufacturer. The consequence is that current knowledge is generally handed down in a third-party fashion rather than obtained directly from the source. Within the aeroplane industry the larger manufacturers define their recommended SOPs in documents such as the FCOM and the Flight Crew Training Manual (FCTM). These provide a standard for ATOs and AOC holders; a practice that should be adopted by the helicopter community.

Reviewing the status for onshore types shows that there are currently no FCOMs available.

***Recommendation*:**

R8 *It is recommended that EASA encourage the Original Equipment Manufacturers (OEM) to produce Flight Crew Operating Manuals (FCOM) and Flight Crew Training Manuals (FCTM) for all current and future helicopter types.*

Operational Suitability Data (OSD)

15.21 A review of the availability of OSDs identified that of the 36 types used by the onshore industry, some 20 had an OSD available.

The OSD details the OEMs 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 aspects of the type, mainly the 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 and with it.

OEMs have differing design concepts and autopilot operating philosophies such that each aircraft type must be flown in a manner that may be very different from a pilot’s previous experience. Current requirements do not adequately specify the necessity for a thorough understanding of the manufacturer’s philosophy for the operation of complex autopilot systems. Nor do they define the appropriate modes, establish optimum use of the autopilot or prepare crews well for conducting the MP role. ATOs and AOC holders should adopt the OEMs 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.

EASA is 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. A review of the current availability of OSDs for onshore types shows the majority of types have OSDs available.

Autorotations and Engine Off landings

15.22 All helicopter pilots are required to demonstrate competency in autorotative descents and for single-engined pilots to further demonstrate proficiency in actual autorotative landings to the ground. In all cases, the intent is for the pilot to be able to appropriately enter autorotation and manoeuvre the aircraft to achieve placing it over a suitable landing area for the expected or actual engine off landing. The skill or proficiency for pilots is to get the aircraft from the point of experiencing the (simulated) loss of power to the point where he would carry out the procedure for the final stages of the engine(s) off landing. As has been seen in the analysis of a number of real engine failures, the pilot action of 'flare-check-level/flare-level-check' is set within motor muscle memory.

A review of examiner assessments of competence through the CAA form TS10 indicates that some examiners and candidates find the exercise challenging in both managing the emergency flight profile and in striving for the expected outcome of a successful landing.

Within the single-engined community, there is evidence that some pilots are not being required to demonstrate actual engine off landings. Whether this is due to a lack of confidence on the part of the instructor/examiner or a desire not to expose the aircraft to possible damage etc. is unclear.

The use of simulators facilitates this exercise extremely well. Twin engine helicopters are not certified for actual engine off landings for training and some are also restricted in the intentional reduction of engine power to simulate the power loss. Whilst instructors and examiners will strive for high fidelity of autorotation exercise, safety is paramount in the real aircraft and therefore there is a level of falseness around both entry and recovery.

a. The AAIB investigation into the Police EC135 G-SPAO crash in Glasgow in November 2013 identified several factors, casual and contributory with regards to the crash.

   One causal factor was:

   "a successful autorotation and landing was not achieved, for unknown reasons".

b. A Hungarian Transportation Safety Bureau report into an EC135 accident on 31 July 2008 commented "that the pilot should have been able to perform a successful autorotation. The significant descent rate and the hard touchdown indicated that the autorotation was initiated with delay".

It also issued a safety recommendation:

BA 2008-226-45_4: Vb suggests to the operator that special attention be paid to the practical training of emergency procedures, particularly with regard autorotation, during training and periodic inspection

c. A Japanese Accident report into an Augusta A109K2 helicopter crash on 03 May 2005 concluded:

It is considered very likely that this accident was caused by the crash of the aircraft, preceded by both engines power loss, no autorotation manoeuvre, NR rpm decay, and uncontrollable conditions.

Autorotation training is usually conducted from an altitude with sufficient safe margin. In this accident, it is considered possible that low flying altitude at the moment of loss of engine power constituted a factor that prevented the aircraft from autorotation

Action:

A21 *The CAA will engage with Industry to review the training and testing of engine failures leading to autorotation to ensure that the appropriate skills and awareness are being addressed.*

Chapter 16: Flight Operations - heliports

16.1 It is an EASA requirement that all scheduled CAT Operations be licensed and there are three onshore licensed heliports' in the UK; London (Battersea), Cheltenham and Leeds Heliport. Licensed heliports are to be manned with fully trained personnel to operate the fire-fighting equipment, refuel the aircraft and provide passenger handling services for all aircraft movements. Prior to 2014 Penzance and Tresco Heliport's were also licenced, and with the reintroduction of the Penzance-Scillies operation, it is planned for them both to return to a full licensed state in 2020.

16.2 Heliports

On occasion, there may be a requirement for some unlicensed heliports such as Silverstone, Ascot, etc. to apply and hold a temporary licence for the larger organised events. The conditions of the licence will be similar to that of a permanently licenced heliport. All other landing sites are therefore unlicensed and have to meet the safety criteria under the current regulation.

It is the responsibility of both the helicopter operator and the pilot in command to ensure that all landing/operating sites to be used are not only fit for purpose but are adequate for the type of helicopter and the planned operation.

All operators must establish in their Operations Manuals procedures for the use of both licensed and unlicensed helicopter landing sites/operating sites, rescue and fire-fighting services, site selection, survey procedures and, where applicable, pleasure flying site requirements. Presently that guidance comes in the form of the outdated CAP 789 for all helicopter operations onshore.

CAP 789 is currently under review and will be re-published to ensure that previously established best practice is not lost.

16.3 Hospital helicopter landing site directories are the responsibility of the helicopter operator and they are to ensure the landing sites are suitable for their individual aircraft types. The site owner provides the facilities and infrastructure for that landing site and, in many cases, provide services such as security, and rescue and firefighting services Certification directly by the CAA or through an appropriately qualified entity would provide the framework for the standards of the infrastructure of landing sites. The current policy of individual organisations maintaining their own landing site directories is to continue.

16.4 Operations to Hospital Helicopter Landing Sites (HHLS) at UK hospitals are classed as ‘non-scheduled’ therefore those HHLSs remain unlicensed. CAP 1264; Standards for Hospital Helicopter Landing Areas, first published in February 2016 continues to be the best practice guidance material for all new builds and the template for compliance.

HEMS Helicopters form an essential part of the UK’s Pre-hospital response to patients suffering life-threatening injuries or illnesses. HHLS’s are routinely provided at hospitals for the transfer of critically ill patients by air ambulance helicopters and by helicopters operating in the HEMS and SAR roles, these HHLS’s require fire-fighting systems and integral aeronautical lighting if used at night. However, there are at times a requirement to use secondary landing sites on recreational and/or sports fields that are remotely located to the Hospital, equipped only with an “H” and a windsock present.

A landing site inspection or routine survey is a ‘snap-shot’ of the health of the landing site and its environment, the continuing ‘fit-for-purpose’ condition of the site and its ancillary equipment are therefore seen as a matter for the site management often in consultation with the helicopter operator.

16.5 In recent years, UK operators have benefitted in operating the latest certified and generally higher-performing helicopter types. In many cases the landing sites used have remained as they were designed for the earlier generation of and operators have underwritten such operations within their own accepted risk assessments.

However, the desired outcome is that, where practicable, such landing sites be upgraded to meet the appropriate standard for the conduct of flights in the modern era. It is noted that not all landing sites remain fit for purpose due to either environmental or significant infrastructure changes (e.g. new obstructions).

16.6 Elevated Helipads offer a number of advantages over surface-level arrangements including but not limited to control of obstructions, noise nuisance, downwash effects and security of the landing area. By their very nature they are normally situated in congested areas. The operator, therefore, will require a Permission from the CAA. Such sites, due to the perceived risk to third parties in a building itself or close by, require that only those helicopters capable of Class 1 Performance are permitted to land at, or take-off from roof-top sites. The helicopter type intended to be used must possess a helipad profile for the specific rooftop site within its flight manual; this technique, in the event of a failure to one of the power units occurring at any time during the take-off or landing, will enable the aircraft to reject safely on to the helipad available or to fly away avoiding all obstacles by a vertical margin of at least 35 feet.

In the absence of such a profile, alternative means of compliance can be met provided the helicopter is able to hover outside ground effect with one engine inoperative at the site and in the prevailing ambient conditions.

The minimum size of the helipad will also be described in the RFM or Flight Manual Supplement for the aircraft type under consideration. Elevated helipads not conforming to these dimensions should not be considered. Proposed use at night will attract the need for a CAA proving flight. Factors considered will include helipad size, obstacle environment, helipad and obstacle lighting provided, including use of approach path indicators (where provided) and visibility from the helicopter to be used.

In all cases, it is recommended that the owner of a roof-top facility proposed for use as a helipad should consult with the helicopter operator(s) and the local planning authority before committal to the project. It is also prudent to engage the services of an aviation consultant to assist the project from concept, through feasibility and design, to construction. Recent experience has shown that where planning permission goes to public enquiry, environmental considerations weigh heavily in the decision-making process. The general public is aware of environmental matters and due recognition should be given to these sensitivities.

Roof-top heliports should be notified to the CAA. To this end an architect's drawing/plan together with aerial photographs of the site and/if, the roof top facility already exists, photographs taken to cover the area all around the site, should be forwarded to Flight Operations Inspectorate (Helicopters) in the case of CAT flights and to the General Aviation Unit for private operations.

16.7 Approaches to helicopter landing sites at night are particularly challenging because of the ever-changing landscape and/or the infrastructure surrounding the landing sites. In some cases, with no additional aids to highlight the structures around.

The use of 'approved portable night approach-path aids' has proved effective in some of the larger companies on-shore, thereby offering a tool for safer approaches at varying landing sites. Offshore and roof top initiatives have introduced a minimum standard of deck lighting which aids visual acquisition of the helideck, facilitates a sight picture approach and provides for obstacle clearance.

Operators should consider a review of their night landing sites and their suitability for continued operations. The CAA will ensure their compliance utilising the current oversight programme.

16.8 Risk Assessments (RA)

a) When using any landing site, the last line of defence pre-landing is the airborne risk assessment; the recognised full 5 'S' Recce, analyses the Size, Shape, Surrounds, Surface & Slope of the landing site and should be used by the pilot/crew to access its suitability for landing.

b) However, when planning to use a Helicopter Landing Site, a Safety RA should be raised alongside any application for a Permission; this is a CAA requirement and is used to ensure all possible mitigations have been considered within the company's oversight of the operation in meeting an acceptable level of safety. Some points that should at least be considered; the use of engine reliability statistics for the types used, documentation such as the RA and Permission/Exemption, should be revalidated annually, SOP's for 'Power Loss' or 'One Engine inoperative' at critical points and provision of company or other Helicopter Landing Site Directory with details.

16.9 Permissions and Exemptions may be applied for and granted if the CAA is satisfied that a mitigated and acceptable level of safety has been assured. For those sites which are in congested areas and which require permissions from the CAA, unless the operator can show that there is no third-party risk in the event of a power unit failure, such permissions will be conditional upon the aircraft being operated to Performance Class 1. Thus, in most cases, Class 1 performance is the required norm.

16.10 Identification of risks, the key purpose of a comprehensive risk assessment, is intended to protect first and foremost the third parties and but also passengers and crew of the helicopter.

There are several unique hazards faced by all operators; such as environmental factors, where a proportion of operations take place often in poor weather and/or at night. The crew(s) continues to be under considerable commercial pressure (be they real or perceived) to carry out the task regardless of the environmental and geographic conditions.

Singularly or a combination of the following weather are contributory factors; deteriorating visibility, low cloud, fog, falling snow or heavy rain or operations at night could lead to a Degraded Visual Environment (DVE) event which in turn may become an inadvertent entry into Instrument Meteorological Conditions (IMC) incident.

Off Aerodrome Landing Sites present the operator with many variable risks The operator must therefore ensure that the landing site is suitable and needs to identify all potential risks such as obstructions, wires, hazards to members of the public etc including those associated with night operations. Recent incidents in the UK indicate that some specific focus is required by industry to ensure that operators have robust procedures and training material established in their operations manuals. The intent is to ensure crews are supported in making the most informed decision to depart for an off aerodrome landing thereby minimising airborne tactical decisions making.

The establishment of VFR ‘Stabilised Approach’ approach procedures or ‘Visual Gate Approaches (VGA)’ for night operations can be highly beneficial. A Night Visual Gate Approach, (Night VGA) is a fully stabilised approach designed to be used to control the entry to an airfield/landing site in the hours of darkness. It utilises the Upper Modes of the aircrafts flight control systems and ensures a standardised, controlled, approach for all pilots and crews. It’s designed, where possible, to reduce cockpit workload which in turn, enhances situational awareness and frees up spare capacity.

In considering the primary destination landing site have all other local options for suitable alternates been considered so that crews have a practical option rather than an impractical and logistically unwelcome diversion to an aerodrome some distance away.

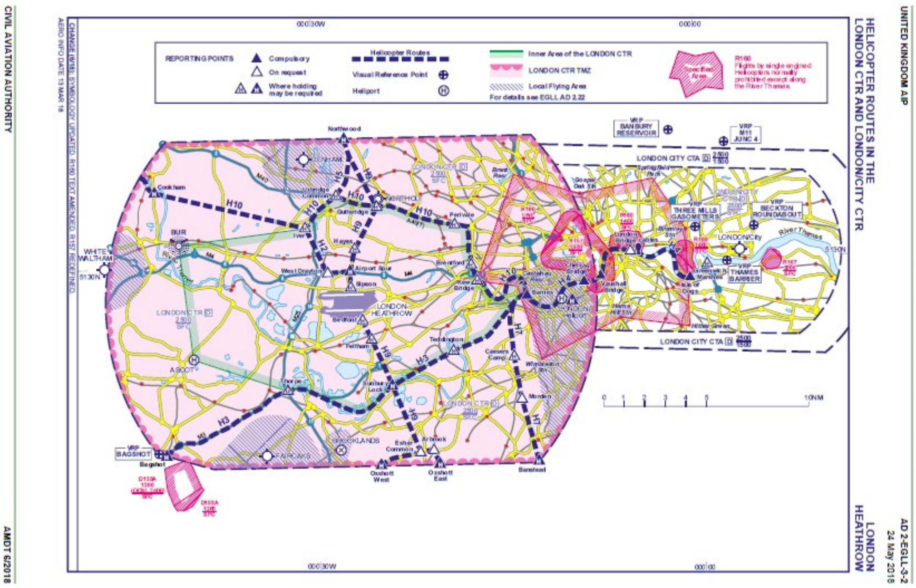
See Ch 13 AOC Management and Operations for decisional and procedural considerations

Chapter 17: Flight Operations – Helicopter operations in the London and London City CTRs

17.1 Introduction

The purpose of this section is to discuss Helicopter Operations within the London and London City Control Zones. It should be noted that since the implementation of this review a joint industry/CAA London CTR Working Group has been formed to conduct a wider study of the airspace.

Figure 1 London CTR



17.2 Operational procedures

17.2.1 UKAIP

Helicopter operations within the London and London City Control Zones are governed by the extracts from UKAIP AD2-EGLL textual data at Appendix 1. The Helicopter routes were set up to provide separation from aircraft departing and landing at Heathrow – note that H4 ends at the Isle of Dogs because the Control Zone (CTR) originally extended that far to the East. The routes give VFR and SVFR helicopters access to London Heliport at Battersea and access to other non-licensed helicopter landing sites. The routes are also used for zone transit, pleasure flying, aerial photography and routing of emergency services helicopters when Heathrow or City traffic precludes direct routing.

17.2.2 **London Helicopter Routes in the London Control Zone Chart Changes**

The most notable change between Edition 1 and Edition 18 of Helicopter Routes in the London Control Zone chart is that on edition 1, the highest buildings were power station chimneys, St Pauls Cathedral and Post Office Tower (650' AGL – 740' AMSL).

This coincided with the topping out of Nat West Tower at 750' AGL (800' AMSL) and this remained the tallest building in London until 2009 when the Heron Tower in the City of London topped out at 755' AGL. Currently, in 2018, the Shard at 1016' AGL is London's tallest building. The past twenty years have also seen a prolific growth of taller buildings being built along the River Thames which lies beneath H4.

In Aug 2016 concerns over this encroachment lead to the CAA Flight Operations Department (Helicopters) conducting an airborne survey of each helicopter route and video imagery was taken so as to establish a baseline. Routes were assessed from both single and twin-engine perspectives and with the vertical availability of operating airspace considered in meeting the rules of the air, air traffic considerations and practical visual navigation.

This assessment indicates that safeguarding of all helicopter routes needs to be considered (see 6.2 for Battersea specific safeguarding) and that CAA/NATS should publish minimum route heights/altitudes for the helicopter routes to augment the current maximum altitudes. This would assist pilots in ensuring compliance with SERA minimum height rules. Some of the current Helicopter Route Visual Reporting Points (VRP's), are hard to identify due to their flat geographical nature. Late identification and routing to them can lead to exceedances of ATC clearances and in the worst case, loss of separation with other aircraft.

The helicopter route VRP's should be easily recognisable and identifiable well before the possibility of unintentional ATC clearance exceedance i.e. Battersea Power station, the London Eye and Wembley Stadium etc. are good visual points on the London skyline and can be easily identified from a distance. The London Helicopter Route VRPs' should be reviewed to see if they can incorporate 3D objects that can be easily identified on the London Skyline coincident with maintaining ATC clearances and airspace requirements.

Consideration should be given to:

a. Reviewing the Helicopter Routes chart markings to include a minimum and maximum route altitude commensurate with SERA minima and Air Traffic Separation.

b. The London Helicopter Route VRPs' should also be reviewed to see If they can incorporate objects with a vertical extent that can be easily identified on the London Skyline whilst maintaining airspace separation requirements.

17.3 Weather minima for VFR/SVFR helicopter operations

Following the Vauxhall bridge accident with A109 G-CRST, AOC operators were asked to review their operations manual and advice to the flight crew for the weather minima they would apply for operations within the London CTR. Despite the published AIP minima being clear of cloud with the surface in sight (COCSIS) and 1 km visibility, the majority have since set 1000' cloud ceiling and 3km visibility as the minima for VFR and SVFR operations within the London CTR. The new London CTR area forecast 'traffic light' system facilitates effective crew decision making as the triggers for cloud base and visibility are based upon this criterion.

Recommendation:

R9 *It is recommended that the London CTR Working Group review the weather minima for SVFR helicopter operations within the London and London City CTRs with a view to establishing minima of 3km visibility and 1000ft cloud ceiling for all helicopter operations. However, operations under SPA.HEMS approval and State AOC's (Police and SAR) should be permitted to operate to current lower minima.*

Recommendation:

R10 *It is recommended that the London and London City CTR Air Navigation Service Provider (ANSP) provider investigate the possibility of formally closing the heli-routes according to the weather limits outlined above and formally opening them when weather is above the limits.*

17.4 Single engine helicopter forced landing areas

"Single Engine Helicopters – safe forced landing space without hazard to people or property. The term 'safe forced landing' is defined in ICAO documentation and Annex 1 of the EASA Air Operations Regulation as "an unavoidable landing or ditching with a reasonable expectancy of no injuries to persons in the aircraft or on the surface" and this is of particular relevance for commercial air transport operations "

It was notable during the airborne review, that the green spaces on the chart have remained relatively untouched since the inception the helicopter routes, thus providing areas for a safe forced landing in the event of an engine failure for single-engine helicopters flying along the routes. The River Thames is part of the 'congested area' of London, as defined, and the helicopter routes have been established presumably on the basis that the river is a relatively uncongested part of the congested area. However, it remains a consideration that closure of the relevant section(s) of the helicopter routes to single-engine helicopters should be enforced if a significant event is taking place on the River Thames. It is noted that the intent of the designated helicopter routes was only ever to define agreed transit routes. It was never intended for these routes to be used for aerial work that involved hovering over a specific site or location.

What has changed however, is the use of these green spaces and the River Thames, as more people use them for recreational activities than was perhaps the case in the 1970's. What must be considered is whether the risk to third parties from a helicopter carrying out a forced landing are greater today than was the case in the past. It should be acknowledged that engine reliability has dramatically increased, notably so for power turbine helicopters, particularly those with HUMS/UMS.

17.5 Societal risk appetite

Societal risk appetite has clearly changed over the past decades, leading to questioning:

a. Whether third-party risk remains adequately contained in event that the congested area green spaces along the helicopter routes are used for a helicopter forced landing?

b. Whether the River Thames is still acceptable as a safe forced landing area (given the safety of other river traffic at certain times/events, the ability of occupants to exit a helicopter in a fast-flowing river, proximity of moored barges and bridge structures? Note Draft (As at 1 August 2018) EASA Safety Information Bulletin "Use of Water Surfaces as Helicopter Safe Forced Landing Areas.";

c. Whether single-engine helicopters should still be permitted access to the London Helicopter Routes, and If so, should they be required to have engine reliability monitored through a requirement for UMS?

17.6 Report of the London CTR Review Group

The CAA Directorate of Airspace Policy conducted a review of the London CTR in 2005, the purpose was to determine what changes, if any, are required to the structure of the London (London/Heathrow) and London (City) CTRs, regarding the operation of the Special VFR procedures on the Helicopter Route Network and elsewhere.

The report's recommendations, copied at Appendix 2 were completed, many of them finally being concluded as part of the work relating to the reclassification of the London CTR from Class A to D.

17.7 Types of helicopter operations in the London CTR

17.7.1 Police

h) Require priority access (CAT A or CAT B) to all parts of the CTR but must obtain ATC permission to enter controlled airspace or move within it. Police helicopters generally operate off-route but also use routes when tasking priority permits.

a. Occasionally land at various sites for Police tasking.

b. Multiple CAT A or CAT B Operations, Police & Police and Police & HEMS.

17.7.2 HEMS

a. Require priority access to London Hospitals for patient delivery.

b. Require access for HEMS landings within the congested area.

c. CAT A for HEMS and CAT E for positioning.

17.7.3 CAT/NCC/NCO London Heliport Access

a. The Helicopter routes were primarily designed to permit VFR and SVFR access to London Heliport located on the river Thames at Battersea.

b. Off route access to Battersea via Brent Reservoir and the London Heliport local area

17.7.4 Photographic and News gathering

a. No specific permission is required unless operating within the restricted areas (in which case an Enhanced Flight Number is needed from ATC), or requiring operations below SERA minimum heights.

b. Filming flights are a Specialised Operation (SPO) requiring specific Permissions and/or Exemptions granted by the CAA as well as close liaison with the CAA, Police, Local and Port of London Authorities.

17.7.5 Pleasure flights

Mainly a mix of single and twin-engine turbine helicopters from various airfields around London but can include piston engine helicopters such as R44. On Company has its headquarters based at and operates from the London Heliport. Flights normally follow H4.

17.7.6 Private flights/NCO

Some multi-engine helicopters routing to/from the London Heliport and private landing sites, but mainly NCO single-engine helicopters transiting the helicopter routes, particularly at weekends.

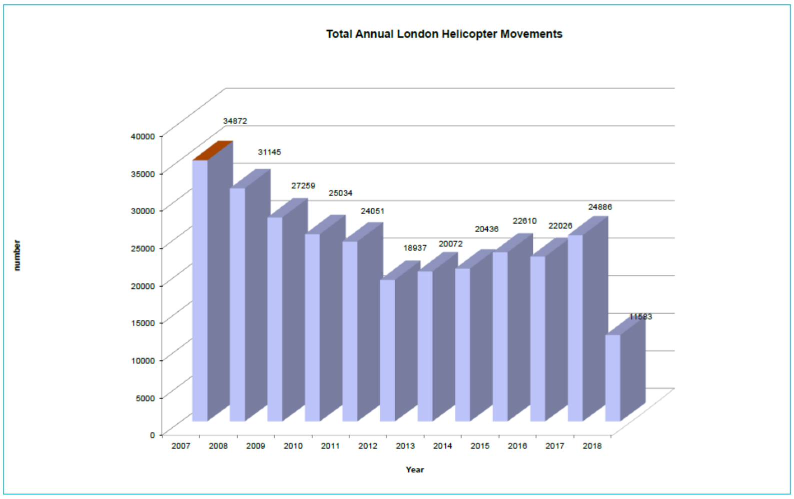
17.7.7 Training Flights both Military and Civil

Training flights are conducted by both military and civil operators.

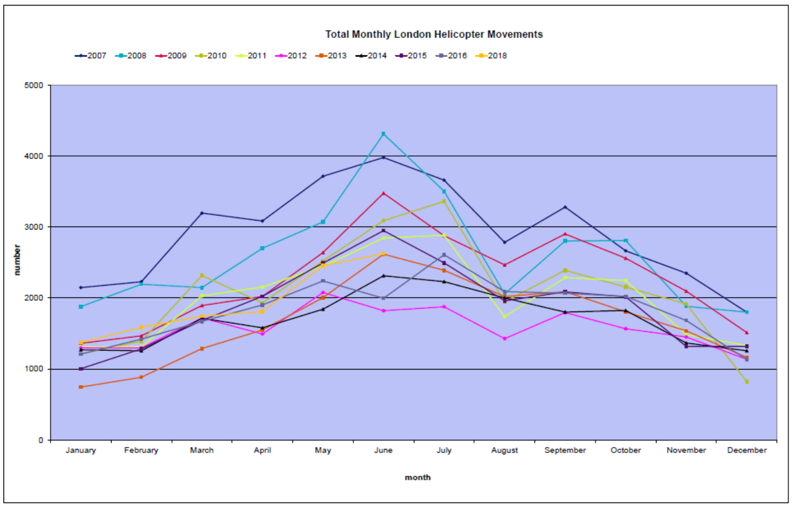
17.7.8 Total Helicopter Movements London Airspace (CAP 1456)

The following graphs show the total number of helicopter movements through London Airspace from 2001.

Figures 2, 3, 4 & 5. Helicopter Movements in London Airspace



Published 1 August 2018

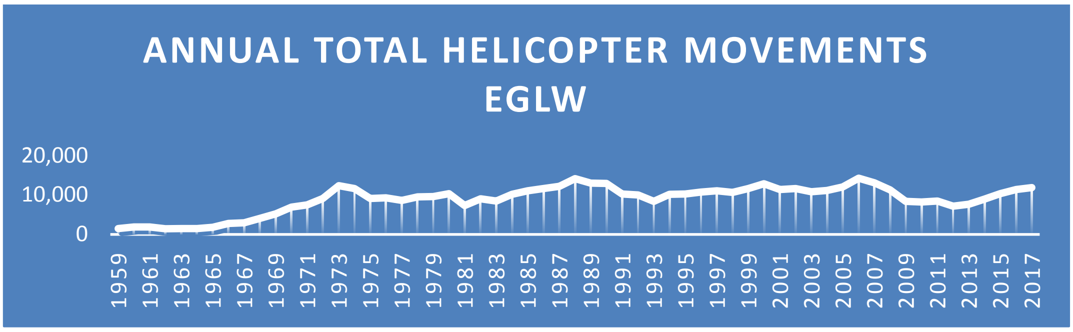


Published 1 August 2018

Total Monthly London Helicopter Movements

	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total
2007	2145	2227	3195	3083	3714	3978	3659	2783	3279	2663	2348	1798	**34872**
2008	1877	2192	2145	2699	3071	4310	3503	2057	2802	2809	1881	1799	**31145**
2009	1360	1465	1893	2020	2639	3475	2876	2464	2901	2559	2095	1512	**27259**
2010	1209	1390	2315	1930	2521	3088	3360	1946	2389	2152	1915	819	**25034**
2011	1312	1309	2030	2152	2446	2842	2883	1734	2286	2245	1483	1329	**24051**
2012	1297	1295	1717	1491	2076	1819	1875	1426	1793	1565	1449	1134	**18937**
2013	743	882	1286	1547	2003	2616	2389	2019	2087	1803	1536	1161	**20072**
2014	1269	1254	1713	1578	1840	2312	2229	1999	1800	1823	1364	1255	**20436**
2015	1002	1282	1681	2023	2490	2948	2493	1959	2084	2016	1316	1316	**22610**
2016	1208	1419	1669	1900	2239	1995	2608	2088	2066	2021	1681	1132	**22026**
2017	1119	1232	1904	2241	2472	2708	2980	2192	2387	2226	2106	1319	**24886**
2018	1373	1584	1741	1808	2455	2622							**11583**

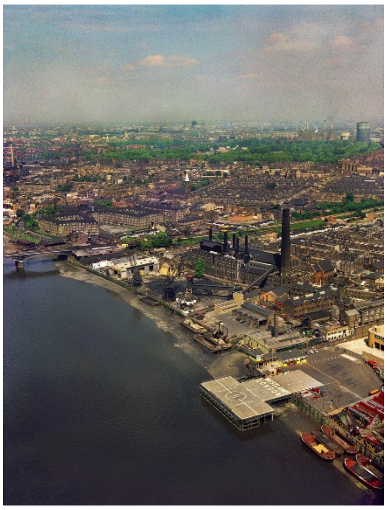
Published 1 August 2018



17.8 London Heliport

Figures6, 7 and 8. London Heliport

Then



Now

17.9.1 Background

The London Heliport (Formerly Westland Heliport) ICAO designator EGLW, has been in continuous operation since it began helicopter operations in April 1959. Since its inception, it has seen over half a million helicopter movements all of which have been accident-free. (524,581 by the end of 2017). The peak yearly movements occurred in 2006, with 14,258 movements. Currently, the Heliport is capped at 12,000 movements per annum. Notable incidents have been few and included a Bell 206 Jet Ranger engine failure on short finals to the helipad, an AS350 single engine Squirrel that experienced a heavy landing and an Agusta 109 which during taxy, rotors contacted the perimeter fence. In all of these incidents, there were no injuries to either aircraft occupants or third parties.

The Heliport Management System includes an active Safety Management System (SMS) which incorporates a healthy safety culture evidenced by Mandatory Occurrence Reporting, Internal Safety Reporting, Hazard Identification and Risk Management as well as safety training for all Heliport personnel.

The Heliport insists that all Pilots must receive formal familiarisation training prior to operating to or from the heliport, the need for and robustness of this requirement is borne out by the 19 Air Traffic Service incident reports in the period 2016-2018 (Formal SMS reporting began in 2016). These incidents are summarised below:

Figure 9 London Heliport Internal ATS Incident Reports

DATE	SUMMARY
01/02/2016	Runway Incursion
17/03/2016	Runway Incursion
28/04/2016	FATO Incursion
08/06/2016	Runway Incursion
10/08/2016	Departure from Incorrect Runway
03/11/2016	Departure without clearance
01/12/2016	Runway Incursion
21/03/2017	Unauthorised Taxi
22/03/2017	Unauthorised Taxi
26/05/017	Departure from Wrong Runway
17/06/2017	Runway Incursions - not recognised as runway was inactive
30/06/2017	Non-Standard Departure

02/07/2017	Non-Standard Departure
06/07/2017	Departure without clearance
24/07/2017	Unauthorised Taxi
24/09/2017	Take Off Without Clearance
06/09/2017	Take Off Without Clearance
22/10/2017	Take Off Without Clearance
02/02/2018	Departure from Wrong Runway

17.10 **Current Risks**

17.10.1 Building and Crane encroachment on River Thames

The London Heliport was accepted on the list of officially safeguarded aerodromes at the end of 2016. A bespoke safeguarding map covering a radius of 4.5km (based on the landing platform) has been accepted by 7 local planning authorities and secures effective consultation for any new tall structures taking place. The (planning) Safeguarding Circular 1/2003 has been updated to include the name of the London Heliport.

However, there appears to be no official safeguarding for the rest of the Heli route structure.

Recommendation:

R11 *It is recommended that the Heli routes within the London and City CTR's be safeguarded to ensure safe and legal separation can be maintained at the minimum and/or maximum route altitudes. These should be rigorously safeguarded at holding points and approach and departure directions from/to the London Heliport.*

17.10.2 Turbulence from high rise buildings surround the helipad

Although turbulence modelling is mandated for high rise building design and control, it has not been modelled for its effect on helicopter operations on the London Heliport FATO or Ramp.

Recommendation:

R12 *It is recommended that the London Heliport Operator establish a baseline turbulence model such that the effect of future building work around or adjacent to the FATO and Ramp can be determined.*

17.10.3 River Traffic for CAT A departures

River traffic is still an issue for ATC to be aware of particularly large ballast barges that load/offload approximately 0.5nm to the West of the Heliport. Local control and liaison with Port Authorities are adequately manging this risk. Pilots need to be aware of rotor downwash from larger helicopters on light watercraft during arrival and departure.

17.10.4 Northern Local Flying Area (LFA)

Currently, VFR/SVFR helicopters departing to the north depart the heliport eastbound along H4 to Waterloo Bridge to clear the London CTR and then turn Northwest between R157 and R158 arrival of helicopters. This puts them near high rise buildings and any slight errors in the tight track keeping required can lead to infringements of the Restricted Areas. The other alternative of course, is a southerly departure to exit the lane via the local flying area to the south of the heliport followed by a transit around the CTR remaining clear of controlled airspace – this of itself introduces further possibility of errors in navigation, fuel and of course, all the current safety issues of operating outside controlled airspace reported elsewhere in this review.

The Senior Air Traffic Control Officer (SATCO) at London Heliport has proposed a Northern LFA, from the edge of the Air Traffic Zone (ATZ) at Barnes due North to intercept the CTR where the M1 crosses its Northern Boundary. which could be activated in conjunction with Heathrow and Northolt ATC. This would permit helicopters departing the heliport to the North to route H4 to Barnes at 1000' within the ATZ and then turn North to track to the end of the M1 adjacent to the Brent Reservoir. As well as improving airspace management and efficient release of departing helicopters wishing to go North from the London Heliport, this proposal if enacted, would also improve the safety of helicopter departures by turning them northbound without having to close with the high buildings to the east and north of the heliport. The construction of the LFA north would also mitigate against closures of SVFR radar services, such that heliport traffic could still enter and leave the CTR to the North of the Heliport.

Recommendation:

R13 *It is recommended that the London Heliport investigate the possibility of implementing a Local Flying Area to the north of the heliport.*

17.11 Accident & Incidents Review

a. London CTR Helicopter Accidents

Agusta 109 G-CRST AAIB Accident report conclusions and recommendations

UK AAIB Aircraft Accident Report 3/20–4 - Agusta A109E, G-CRST, 16 January 2013

Summary:

At 0820 hrs on 16 January 2013, the Air Accidents Investigation Branch (AAIB) was notified that a helicopter flying over central London had collided with a crane and crashed into the street near Vauxhall Bridge. A team of AAIB inspectors and support staff arrived on the scene at 1130 hrs.

The helicopter was flying to the east of London Heliport when it struck the jib of a crane, attached to a building development at St George Wharf, at a height of approximately 700 ft. AMSL in conditions of reduced meteorological visibility. The pilot, who was the sole occupant of the helicopter, and a pedestrian were fatally injured when the helicopter impacted a building and adjacent roadway.

The investigation identified the following causal factors:

The pilot turned onto a collision course with the crane attached to the building and was probably unaware of the helicopter's proximity to the building at the beginning of the turn.

The pilot did not see the crane or saw it too late to take effective avoiding action.

The investigation identified the following contributory factor:

The pilot continued with his intention to land at the London Heliport despite being unable to remain clear of cloud.

b. London CTR Incidents within the review period

Bell 206L-4 Long Ranger IV, G-PTOO precautionary landing at London City Tail rotor vibration March 2011

c. London Heliport Helicopter Accidents

The London Heliport has an excellent safety record with no accidents involving injury or loss of life reported in its 58 years of operation and over half a million movements.

- A109 VR-CCK Rotor contact with parked S-76 1993.
- Bell 206 G-BXLI engine power loss on finals 2002.
- AS355 G-MOBI Heavy Landing 2016.

No conclusions can be drawn from these few unrelated accident reports.

London CTR MOR REVIEW

A review was undertaken of MOR's that could easily be identified in the ECCAIRS system as being reported by Heathrow, London City, London Heliport and Thames Radar and associated with helicopters operating within and around the London and London City CTR's during the period 2000 and 2017.

Of the 87 MOR's submitted by ATC during the period, 30 were infringements of the CTR's, 14 failures to follow or adhere to ATC instructions/clearances and 6 were associated with poor knowledge of and/or adherence to procedures for Heathrow crossings.

The most significant finding from these MOR's is that the failure to follow or exceedance of an ATC clearance often lead to aircraft departure delays at LHR and LCY and in some cases, loss of separation between aircraft. Consideration should be given to mechanisms whereby Helicopter Pilots who intend to enter the London or London City CTR's on VFR or SVFR clearances, are reminded of the absolute necessity to adhere to ATC clearances.

17.12 **Summary**

Helicopters have been operating through and into London CTR for over 50 years. Up until 2013, the safety record was impeccable. The Accident inquiry to G-CRST majored on pilot decision making and that is a subject covered in depth elsewhere in this Onshore Helicopter Review. The recommendations in this report, if enacted, would introduce additional controls that would enhance the safety of helicopter operations within London and London City CTR for the next 50 years.

Chapter 18: Flight operations point in space

18.1 The current IFR situation in the UK for rotorcraft is constrained to using procedures that have been designed for fixed-wing aircraft, and in general; heliports are not well equipped in terms of ground navigational aids.

All onshore operations, and in particular, HEMS and SAR, can theoretically take place under IFR, but there are a number of operating conditions in the Air Ops Regulation that do not make IFR a completely practical solution.

A number of the reported incidents and accidents in this report occurred in a DVE where the option of an Instrument Approach/Departure Procedure established at the off aerodrome operating site may have been of significant safety benefit. In recognition of the needs of onshore helicopter IFR operations the use of Point in Space (PinS) approaches and departures to an initial departure fix (IDF) is therefore required.

Many reporters cited that consideration should be given to the re-introduction of Quadrantal Rules in the UK, and if enacted will enable a more formalised vertical separation of lower-level IFR traffic including helicopters.

18.2 The recent changes under Performance Based Navigation (PBN) has plans that rotorcraft operating under 'Blue Light Operations' will no longer be limited to VFR/VMC conditions.

18.3 Operators are encouraged to design their own procedures and approaches, this must meet with the CAA's approval and its continued oversight. Enabling each entity to have complete ownership of their procedure/approach is essential.

Industry wishing to conduct PinS operations must have CAA approval for all PBN operations. Therefore, when applying for a PinS approval, consideration should be given to the following:

a. All PinS approach procedure applications may take time to be processed thus the content should encompass safe, risk assessed, recognised and approved procedures.

b. Prior to the approval procedure of all PinS operations, a review of the airspace within which the procedure sits in must be reviewed by Airspace, Air Traffic Management & Aerodromes.

c. All operators should refer to Regulation (EU) 965/2012 Air operations provisions, Annex V Part-SPA; Sub-part B: PBN for their application content.

d. Compliance Monitoring and management of change are to be included the process for the continued performance-based oversight program for the addition of all PinS operations.

e. As a part of the approval process, the entity needs to clearly list the ground, synthetic, flying training and procedures for any ‘Signal in space’ failures or performance issues.

f. All entities are to evidence to the authority that their crews are all correctly trained and qualified to recover post a DVE event.

18.4 The culmination of the PinS approach procedure will include either a “proceed visually” or a “proceed VFR” instruction from the Missed Approach Point (MAPt) to the heliport or landing location.

a. Proceed Visually

The PinS instrument approach segment delivers the helicopter to a MAPt. The visual segment connects the MAPt to the heliport or landing location, by a direct visual segment. If the heliport or landing location and visual references associated with it can be acquired visually prior to the MAPt, the pilot may decide to proceed visually to the heliport or landing location otherwise a missed approach shall be executed.

b. Proceed VFR

Under ‘Proceed VFR’ there is no obstacle protection in the visual segment.

Depending on the class of airspace and the time of day, the ‘proceed VFR’ minima can mean anything from visibilities of 800m’s to 5,000m’s. it is, therefore, possible that if the MAPt of the PinS approach and the IDF are very close together to the heliport or operating site, the VFR minima may be much higher than for the purpose of achieving the landing or go-around, especially at night.

The pilot shall comply with VFR to see and avoid obstacles when proceeding from the MAPt. to the heliport or landing location.

The visibility for these approaches is the visibility published on the chart, or VFR minima as per the requirement of the class of airspace, or State regulations.

Consideration should be given when entities are planning a procedure with ‘Proceed VFR’; the planning must capture both the VFR limits for both day and night.

18.5 Given that PinS approaches are likely to be established within uncontrolled Class G airspace, consideration must be given to airborne conflict. Recent work carried out by the CAA has seen the development of a minimum technical specification for low power, lightweight, portable Electronic Conspicuity Devices that operates using ADS-B. This work has been completed in collaboration with the Conspicuity Working Group (CWG), a multi-stakeholder group comprising NATS, AOPA and a cross-section of the GA/onshore community.

Please follow the links to:

Electronic Conspicuity devices

CAP 1837

Consideration to CAT.IDE. H.345 Communication and navigation equipment for operations under IFR or under VFR over routes navigated by reference to visual landmarks should be made.

18.6 In the UK at this time there is no real data to support any trends be they pro or con for the operation of helicopters within the PBN environment, thus stats cannot be provided.

Norway are currently using PBN systems for its helicopter operations, and of the 49 incidents/accidents identified in Norway's AAIB's database, there are no recorded events associated with either PBN or PinS approvals.

18.7 The risks to helicopters operating in the low-level environment with the new skill set that is PBN; are such as but not limited to:

a. Environmental Factors

i. Weather; Visibility/low cloud/fog/falling snow

To assist with planning and under the current onshore review, a study of whether the current available meteorological data is fit for purpose is ongoing.

Where weather reporting/gathering for the 'go/no-go' decision is not being provided in Norway as they use video links, to give them a semi-accurate weather picture along the route and at the destination.

ii. Night

iii. Geography

b. Loss of control read across to DVE, due to either the lack of night experience or non-instrument rated pilots. Whereas, the current recency requirement is viewed as not being sufficient in dealing with the loss of visual references during a flight.

c. CFIT / Airborne Conflict.

d. Decision-making training (human factors).

18.8 Conclusions

The introduction of PBN and PinS Approaches with the relevant laid down training requirements and strict adherence to the weather minima associated would alleviate some of the issues.

The current CAA documents will assist onshore operators to apply for and design their PinS approvals:

a. CAP 1616 Airspace Design, Guidance on the regulatory process for changing airspace design including community engagement requirements; the ACP process is contained within.

b. CAP 1122 Application for instrument Approach Procedures without an Instrument Runway and/or Approach Control.

The CAA is currently devising a Helicopter PinS CAP (Guidance Material) for all PinS operations, the CAP will include guidance on the following subjects for PinS procedure applications;

b. Operational and infrastructure requirements;

c. Aircraft;

d. Heliports;

e. Airspace;

f. Air Traffic Management;

g. Navigation Performance;

h. Concept of Operations; and

i. Ownership.

Chapter 19: Flight Operations – Unmanned aerial systems (UAS)

19.1 Unmanned Aerial System (UAS) consist of three components, an unmanned aerial vehicle (UAV) commonly known as a drone, a ground-based controller and a system of communication between the two.

The term Unmanned Aerial Vehicle covers a variety of different types and may be referred to as:

- Drones
- Remote Piloted Aircraft Systems (RPAS)
- Model Aircraft

Remote Controlled Aircraft

For the purpose of this section the term Drone will be used as it is the most recognisable term used.

Under the Air Navigation Order 2016 Articles 94 and 95 drones are classified as small unmanned aircraft and small unmanned surveillance aircraft, the latter having means to undertake any form of surveillance or data acquisition.

Due to the increasing popularity and in response to the aviation industry the government undertook a consultation in 2017 into the rules and regulation that applied to drones.

19.1.1 As a result of the consultation the following regulations were put in place:

a. A height limit of 400ft for all drone flights
b. A restriction from flying drones within 1km of protected aerodromes in the UK, unless you have the permission of the Air Traffic Control unit in question.

Following on from an incident at Gatwick airport in December 2018 where there were reports of drone activity within 1km of the airport boundary new regulations were put in place. On 13 March 2019 the drone flight restriction zone (FRZ) around airports and airfields came into place. This restriction uses the airfield existing aerodrome traffic zone which has a radius of either two or two and a half nautical miles and then 5km by 1km zones starting from the point known as the "threshold" at the end of each of the airfields runways. Both zones extend upwards to a height of 2000ft above the airfield. It is illegal to fly a drone at any time within these restricted zones unless you have permission from air traffic control at the airport or, if air traffic control is not operational, from the airport itself.

Figure 1 Heathrow flight restriction zone

From 30th November 2019 two more regulations will come into force

a. Operators of drones above 250g to be registered
b. Pilots flying these drones (known as 'remote pilots') to obtain an acknowledgement of competency from the CAA, having passed

requirements set by the CAA such as an online safety test to prove their knowledge of the restrictions

With regards to both the 400ft and airports restrictions, where drone operations are deemed to be as safe as reasonably practical, the CAA will have the power to exempt operators from adhering to these rules.

19.2 Operator Approval and CAA Permissions

UAS operators who want to operate commercially within the UK are required to apply to the CAA for permission. There are two levels of permissions applicable to UAS.

19.2.1 Standard Permission Holder

If an operator only intends to fly a drone within the limits of the regulations, (not above 400ft or/and in accordance with the minimum distances stated in the Air Navigation Order).

19.2.2 Operational Safety Case Holder

When an operator wants to operate to above 400ft and within the minimum distances, they are required to apply to the CAA with a safety case. If approved they are issued an Exemption which can be valid for 12 months.

Generally, when an operator intends to fly a drone they should have a procedure to follow, this could involve setting up a NOTAM and logging their intended operation onto a web-based platform. Once this procedure is completed it is then very much down to the see and avoid principle when trying to avoid a mid-air collision. This principle can be quite difficult for the helicopter pilot due to the size of the drone.

19.3 Flying High Challenge

As part of the government's modern Industrial Strategy the Nesta Flying High challenge has already identified 5 cities/areas with plans for how drone technology could operate in their complex city environments to address local needs. The cities/areas involved are:

- Bradford
- London
- Preston
- Southampton
- West Midlands (Birmingham, Coventry and Wolverhampton)

Figure 5.1. The future

19.4 **EASA and UAS**

EASA have issued an NPA (January 2018) which proposes new rules and regulation for Drone Operators (Part-UAS).

Under Part- UAS drone operators will be separated into different categories.

19.4.1 **Open Category:**

Mainly for the small drones and hobbyists, various options within that category.

Up to 25kg but generally no flights over congested areas or uninvolved people (unless the drone is extremely light (<250g)

19.4.2 **Specific Category:**

For operators who don`t want to comply with the limits of the open category. These operators could with approval operate over congested area`s and members of the public not involved in the operation.

Generally, the drones should be operating below 400ft, the main risk to helicopters is when landing and taking off. Until there is a method to geo-fence/transponder equip the drones the risk will always be there.

19.5 **U-Space**

The vision for the future which will enable complex drone operations with a high degree of automation to happen in all types of operational environments.

U-Space is the term adopted by the EU Commission for a set of services supporting low level drone operations (below 120m). A fully automated infrastructure will provide the drone pilots with all the information needed to conduct a safe operation, including air traffic management, and will ensure that drones do not enter any restricted zones.

In particular, U-Space will provide support to Beyond Visual Line of Sight (BVLOS) operations and will be the fundamental basis for dense operations in urban areas. The latest technology will be used to enforce the regulation and protect citizen’s rights.

U-Space will be gradually deployed, starting in 2019, when, thanks to the EASA Opinion, the foundation elements will be set up: drone registration, electronic identification and geo-awareness. Additional functionalities will be progressively deployed until U-Space is operational in 2025, allowing fully autonomous operations.

19.6 Drones and Helicopters

Drones are and will continue to operate in the same airspace as Helicopters. Although there has been a small number of Airprox`s involving helicopters and drones the risk will increase substantially with the increased number of drones operating.

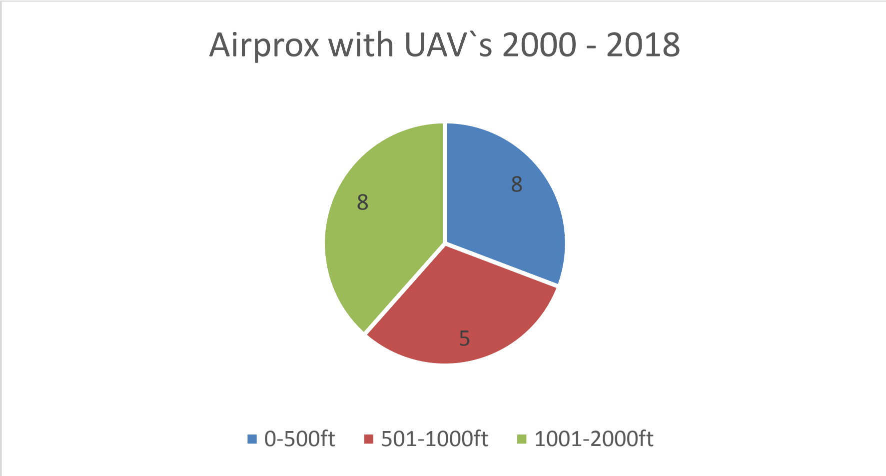
Drones are notoriously difficult to see which in part explains why there are so few Airprox`s reported. It may be that there have been more close calls but have gone unseen by the helicopter crews.

Table 1 Helicopter Airprox with Drones 2000-2018

DATE	TYPE	LOCATION	ALTITUDE
21-Sep-10	MD902	Headcorn	1200
30-Sep-14	AW139	Norwich	1000
11-Apr-15	EC135	Kenley	1600
17-Mar-16	*	Pennines	350
26-Apr-16	S92	Carlisle	600
26-Aug-16	EC145	Lippitts	1900
23-Oct-16	R44	Londonderry	1000
11-Dec-16	R44	Heathrow	900
21-Jan-17	S92	Mennia Straight	500
22-Jan-17	B206	Vauxhall Bridge	1300
10-Apr-17	AS355	Blackbushe	2000
10-Apr-17	AW189	Hampshire	500
30-May-17	AW139	Whitstable	500
31-May-18	AW189	Beaulieu	500
22-Feb-18	EC135	Milton Keynes	1500
05-Apr-18	S92	Newquay	70
02-June-18	MD902	London	200
04-June-18	AS355	Garforth	550
16-June-18	AW169	Gatwick	1200
30-June-18	MD902	London	350
21-Nov-18	AS350	Cornwall	1500

*Report made by Drone Operator

Figure 3



There was a total of 499 Airprox with UAV`s of which 21 were "civilian" helicopters.

The majority were with airliners or other similar fixed wing aircraft.

19.7 **Drone Sightings**

Drone Sighting have only really began being recorded from 2015.

Table 2 Drones Sightings

Year	Sightings & on ECCAIRS by helicopters
2015	6
2016	9
2017	8
2018	21

Each year from 2015 there have only been single figure sightings by helicopters recorded on ECCAIRS. There has been no requirement for operators to record drone sightings on ECCAIRS, they will usually document any sightings as a flight safety report / air safety report.

Requested data from the UK Police and HEMS operators for the period 2015 – 2018 detailed 26 drone sightings, at least half were sighted from the ground after the helicopter had landed.

19.8 **NOTAMS**

In the early days of UAS operations, especially around the London area NOTAMS were issued for all UAS activity. This initially worked well and increased situational awareness in and around the London. The increase of UAS activity has made the viewing of NOTAMS in London problematic due to the mass of circles.

Crane and UAS operators in the London issue NOTAMS when they are operating, unfortunately due to the numbers operating the airspace can look very congested when looking at a map view of NOTAMS for any particular day.

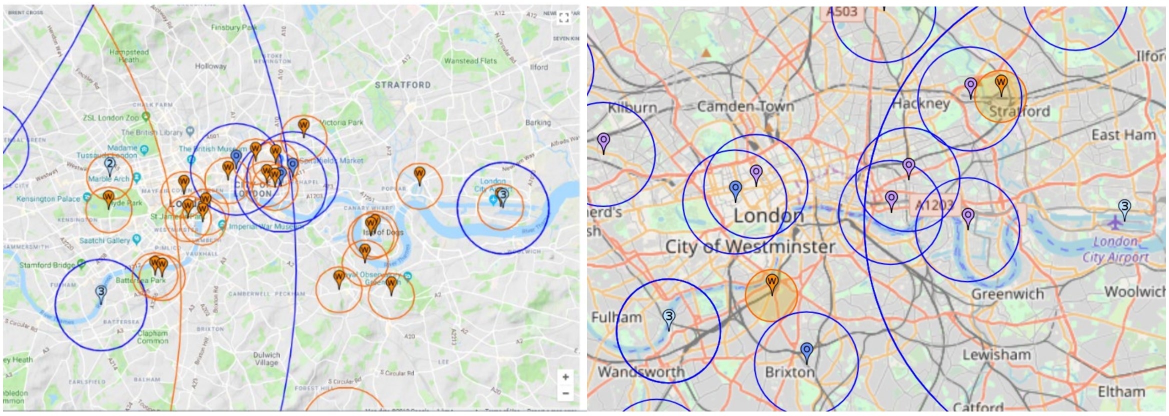
These NOTAMS are identifiable by a circle unless more information is requested.

There is a risk due to the number of NOTAMS that pilots are unable to retain the information as to where and what is operating.

Recent research work resulted in the removal of NOTAMS for UAS operations below 400ft within the London zone. Figure 19.2 gives an example of a NOTAM map before and after the removal.

Figure 4 An example of the NOTAM`s in London with the number of UAS sites (W`s in orange)

With Drones <400ft showing Drones <400ft removed



19.9 **Technology**

There are companies who are investing time and money into products which will allow drones to operate in the same airspace as manned aircraft. Below is a few of the current products available.

19.9.1 **Drone Detection**

The manufacturer DJI has a drone detection platform that identifies the electronic signal between UAV components which will identify if a drone is being flown in a specific area (Limited to DJI drones at the present time but the firmware will be available to other manufacturers)

It does not intercept, take control or land the drone but alerts the landowner (think hospital/police base) as to the presence of a drone.

This can be a portable system or permanent one and can work from 5 to 50km

19.9.2 **Drone control systems**

Companies have developed software that intercepts and inserts messages that “tell” the drone to exit an area, return home or land at a predetermined safe zone. Can control multiple drones.

19.9.3 Live Tracking

Companies are working on systems for tracking drone similar to Flightradar24 for aircraft. It uses ADSB-out technology. BCON is a drone specific ADSB chip that can be easily fitted to drones.

19.10 Radar detection

Already installed at several airports this radar-based system can track and classify small unmanned Air Systems up to a range of 5km.

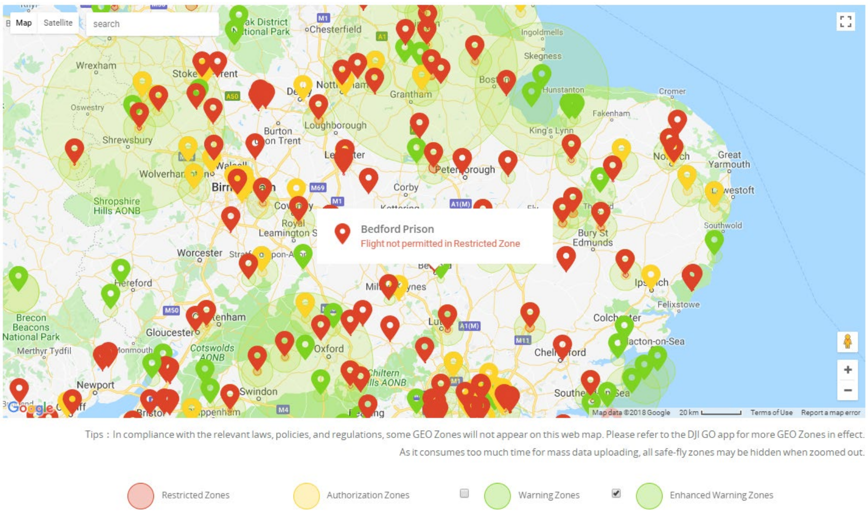
19.10.1 FLARM

FLARM offers products for drones which cater for electronic conspicuity, tracking and traffic awareness.

19.11 Geo Zones

Drone manufacturers have different ways of “advising” where it is safe to fly. Below is an example of DJI`s GEO system. This is advisory only and users are still responsible for checking what laws and regulations apply.

Figure 5 DJI’s GEO System



19.12 Conclusions

Commercial drone operations are still in its infancy, it is important that as it grows it is integrated into the airspace with minimum risk to existing users. Drone technology is constantly evolving, the products available to try and prevent mid-air collisions are an important part of this process.

As the popularity of drones increase so does the technology around them. There are many manufacturers investing in the industry with products to aid drone detection or prevent them operating in a specific area.

It will be difficult to find a one size fits all product or procedure.

The areas of helicopter operation where the most risk of a mid-air collision occurs is when operating below 500ft and during take-off and landing.

It would be impractical if not impossible to protect every possible landing area however consideration should be given to applying the same regulation that applies to aerodromes to hospital landing sites and permanent helicopter bases.

The use of NOTAM can aid to flight planning however due to the increasing number of NOTAMS it can lead to complacency when reviewing them.

It may be that the airspace below 500ft becomes an “area of intense drone activity” similar to the areas of intense aerial activity, until technology catches up and allows for the free integration of drones and helicopters.

There may be some benefit in introducing a “priority” NOTAM system where any drone operating above the 400ft standard permission is highlighted when viewing the NOTAMS.

Chapter 20: Previous research

In response to particular safety issues the CAA conducts safety research projects and publishes those results with recommendations. As such previous research in the onshore sector has been reviewed with the following outcomes:

20.1 Pilot Intervention Times in Helicopter Emergencies

This subject was highlighted for investigation as a result of the following three AAIB Safety Recommendations:

a. Aircraft Accident Report 4/83, Westland Wessex 60 G-ASWI, 12 miles ENE of Bacton, Norfolk on 13 August 1981, Safety Recommendation 4.4;

b. Aircraft Accident Report 7/87, Twin Squirrel AS355 G-BKIH at Swalcliffe, near Banbury, Oxfordshire on 08 April 1986, Safety Recommendation 4.3;

c. Aircraft Accident Report EW/C92/2/4, Robinson R22M G-BPPC at Oldham in February 1992, Safety Recommendation 92-26.

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.

The executive summary of CAA Paper 99001 is presented in Appendix 1 to chapter 14.

There is no obvious evidence of pilot intervention times being a significant factor in the 81 CAT occurrences during the period 2000 to 2017. However, this factor could be more prevalent in the GA occurrences due to the extensive use of aircraft with low inertia rotors.

20.2 Rotor Speed Warning and Protection

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:

a. Aircraft Accident Report 4/83, Westland Wessex 60 G-ASWI, 12 miles ENE of Bacton, Norfolk on 13 August 1981, Safety Recommendation 4.4;

b. Aircraft Accident Report 7/87, Twin Squirrel AS355G-BKIH at Swalcliffe, near Banbury, Oxfordshire on 08 April 1986, Safety Recommendation 4.2.

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.

The executive summary of CAA Paper 95009 is presented in Appendix 2 to Chapter 14.

There is no obvious evidence of loss of rotor speed being a significant factor in the 81 CAT occurrences during the period 2000 to 2017. However, this factor could be more prevalent in the GA occurrences due to the extensive use of aircraft with low inertia rotors.

20.3 Tail Rotor Failures (TRF)

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 TRF rates in both civil and military service were eight times worse than allowed under the airworthiness design requirements. Fortuitously, many TRF accidents are not catastrophic as the design requirements assume, but it was clear that scope existed for both preventing and mitigating TRF. The work covered the aspects of airworthiness design requirements, prevention and mitigation of TRF 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.

The executive summary of CAA Paper 2003/01 is presented in Appendix 1 to Chapter 14.

Of the 81 CAT occurrences during the period 2000 to 2017, 16 (20%) involved TRF, one of which formed one (17%) of the six fatal accidents. The relevant occurrences are as follows as follows:

a. G-SAEW, 21.04.2000, SCF-–P - Tail rotor pitch change unit failure due to inadequate maintenance.

b. G-BZBD, 23.08.2000, LOC–I - Main rotor struck tail boom during extreme maneuvering.

c. G-LGRM, 11.09.2000, UIMC, LOC–I - Suspected, but unconfirmed tail rotor failure during recovery from IIMC.

d. G-BYNZ, 24.09.2000, UIMC, LOC–I - Suspected loss of tail rotor effectiveness during recovery from IIMC.

e. G-DNLB, 24.05.2002, EXTL, LOC–I - External load strike on tail rotor. Fatal accident.

f. G-BVJE, 23.02.2003, LA–T - Tail rotor struck water surface during low altitude operations.

g. G-BAML, 30.05.2003, LOC–I - Loss of tail rotor effectiveness.

h. G-AYMW, 05.04.2004, LOC–I - Loss of tail rotor effectiveness.

i. G-WLLY, 21.12.2005, SCF-–P - Vertical fin detached causing loss of tail rotor and TRGB.

j. G-DNHI, 09.10.2006, SCF-–P - Exhaust duct separated and struck tail rotor causing loss of tail rotors and TRGB.

k. G-BPIJ, 21.05.2009, LOC–I - Loss of tail rotor effectiveness during training sortie.

l. G-GCMM, 19.07.2011, CT–L - Tail rotor struck fence during landing.

m. G-BXRR, 24.03.2012, A–C - Tail rotor struck ground during heavy landing.

n. G-STGR, 04.05.2012, CT–L - Tail rotor struck hedge during landing.

o. G-ORKY, 08.10.2012, EX–L - Lifting sling struck tail rotor due to excessive speed.

p. G-BXGA, 16.10.2012, EX–L - Lifting sling struck tail rotor due to excessive speed.

In terms of the above-mentioned research, these may be broadly classified as follows:

- Internal TRF (mechanical failure of TR system) **2** (a & c above)

Internal TRFs may be reduced through the application of vibration health monitoring techniques. Such solutions are likely to be viewed as unduly complicated and expensive for the class of helicopter and types of operation involved, however, especially as this cause accounts for only two of the 16 TRF-related occurrences.

- External TRF (failure of TR due to strike, e.g. FOD) **6** (b, e, i., j. o & p above)

There is no obvious solution to external TRFs apart from employing designs that are less vulnerable to damage such as the fenestron. Retrofitting a fenestron is not feasible.

- Tail rotor strike (e.g. TR struck ground, hedge, tree) **4** (f, l, m & n above)

In the case of tail rotor strikes, these could be avoided by the use of strike warning systems. Such systems have been evaluated to protect against main rotor strike in operations where a significant risk may exist, e.g. SAR. It is not known whether a system has been developed for tail rotors and, in any event, might only have been effective for two out of the four occurrences (i.e. two of the strikes resulted from loss of control).

- Loss of TR effectiveness **4** (d, g, h & k above)

Loss of tail rotor effectiveness can occur where the helicopter is operated outside of RFM limits, warnings, cautions and performance.

Overall, there appears to be no obvious single solution that might be deployed to reduce the frequency of tail rotor failures and, for each of the measures noted in the research taken individually, there is arguably not a strong enough cost/benefit case to warrant implementation.

However, one measure that could help mitigate most tail rotor failure scenarios would be the provision of improved emergency procedures and training. Few rotorcraft flight manuals contain any advice or procedures, and, in some cases, pilot training is based on the characteristics of the flight simulator which are usually not validated and can be very misleading. These aspects are considered in the above-mention research.

- EHEST (HE1) Loss of Tail Rotor Effectiveness.
- Helicopter Tail Rotor Failures, CAA Paper 2003/1 November 2003

Recommendation:

***R14**: It is recommended that aircraft manufacturers and training organisations review CAA Paper 2003/01 with a view to providing reliable emergency* *procedures/advice/training for pilots to apply in the event of a tail rotor failure or loss of tail rotor effectiveness.*

20.4 Helicopter Flight in Degraded Visual Conditions

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, where this is not practicable, 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.

The executive summary of CAA Paper 2007/03 is presented in Appendix 1 to Chapter 14.

Although not immediately obvious in every case from the CICTT code allocated, flight in poor weather/visibility was a major factor in eight (10%) of the 81 occurrences, and two (33%) of the six fatal accidents. The relevant occurrences are as follows:

a. D-HCKV, 02.01.2000, UIMC, CF–T - Flight into deteriorating weather; no pressure to continue mission and elected to discontinue flight. Accident occurred during recovery (turned).

b. G-LGRM, 11.09.2000, UIMC, LOC–I - Flight into deteriorating weather/visibility. Accident occurred during recovery (turned).

c. G-BYNZ, 24.09.2000, UIMC, LOC–I - Flight into deteriorating weather/visibility; elected to discontinue flight. Accident occurred during recovery (turned).

d. G-SPAU, 17.02.2002, LOC–I - Aircraft entered thick cloud and crashed after (suspected) inadvertent autopilot disconnection.

e. G-IANG, 30.04.2003, CF–T - Reduced height in DVE; tail rotor struck power cables.

f. G-WIWI, 03.05.2012, CT–L - Nearly hit trees during approach in poor visibility at night.

g. G-CRST, 16.01.13, CF–T - Collided with crane during approach in poor visibility. Fatal accident.

h. G-LBAL, 13.03.14, CF–T - Attempted take-off in poor visibility. Fatal accident.

The consequences of flying into poor weather/visibility are broadly:

f. Loss of control, usually due to disorientation/loss of spatial awareness (three of the eight cases);

g. Collision with an obstacle or terrain while in control (i.e. CFIT), usually due to loss of situational awareness/getting lost (five of the eight cases).

According to the above-mentioned research, loss of control may be expected where there is a mismatch between the visual cueing environment and the handling qualities of the helicopter. It follows, therefore, that loss of control could be avoided by improving the handling qualities by, for example, requiring that all helicopters are fitted with stabilisation systems. Alternatively, outside visual cues may be supplemented using a head up attitude display. Improvement of recovery training could also help, but care would be required to ensure that pilots do not become complacent about entering degraded visual cueing environments.

In the case of CFIT, the provision of additional equipment such as HTAWS and/or wire detectors might help, although such equipment does have its limitations, e.g. it would not have helped in the case of G-CRST as the crane that the helicopter struck would not have been in the HTAWS database.

For both scenarios, however, the cost of technical solutions would likely be high in relation to the size of the aircraft and type of operation involved. Furthermore, all aircraft involved in the eight occurrences were equipped with stabilisation systems and one of the CFIT cases (actually a near miss) was equipped with HTAWS. If the occurrence rate is considered to be unacceptable then, by itself, mitigation appears unlikely to provide a satisfactory solution.

However, in all cases, the accident could have been avoided by deciding not to fly which would represent a universal and relatively inexpensive solution. It is not certain to what extent either self-inflicted or external (e.g. customer/commercial) pressure contributed to the decision to undertake the flight in each of the occurrences, but all flights were within the legal limits at the point of departure. It is clear, however, that there was the potential for pressure to have influenced the pilot in all cases. In addition, it is always possible for the pilot to exercise poor judgement irrespective of any pressure to fly. In any event, had the weather been known to be below limits at the point of departure, en-route or at the destination it would arguably have been more likely that the pilot would have decided not to fly and avoided the occurrence.

Under the current rules, helicopters can legally fly VFR below 3000ft clear of cloud and with the surface in sight at a met vis of only 1500 m it is understood that the rules reflect the ability of these aircraft to slow down and land in the event that visibility deteriorates to a point where the flight cannot be continued safely. From the evidence of the eight occurrences, it appears that this either does not always happen or else is not always a safe option in practice. It should be noted that helicopters become less stable with reducing airspeed, increasing the need for outside visual cues.

In view of the foregoing, it would appear reasonable to consider introducing higher limits for helicopters. However, the CAA currently has only limited ability to deviate from the Standard European Rules of the Air (SERA), so any increase in minima would essentially need to be introduced on a voluntary basis, supported by operators' Safety Management Systems.

Recommendation:

R15 *It is recommended that operators review the VFR minima in their operating procedures in the context of their operations and the flight characteristics (e.g. handling qualities) of their aircraft and adopt and apply higher minima where appropriate.*

Section D: Flight Operations – Emergency services

Chapter 21: Police Air Operations

21.1 History

There is a long history of Police Air Support in the UK beginning in the 1920`s and 1930`s but it wasn`t until 1973 when the Metropolitan Police purchased three helicopters that there was a significant increase. By 1993 there were 16 full-time air support units in England and Wales mainly operated by independent police forces.

The following years a new police air support strategy was developed which allowed more forces to take advantage of air support. As a result, by 2009 police forces in England and Wales were operating 33 helicopters from 31 air support units.

In 2009/2010 a new review had been undertaken which recommended the formation of a National Police Air Service (NPAS).

NPAS was formally launched in October 2012 with a plan to have 23 (plus three spare) helicopters operating from 20 bases. However due to various reasons as of July 2019 this has been reduced to 19 helicopters operating from 14 bases with an order of four fixed wing to compliment the helicopters.

Northern Ireland air support is provided by the Police Service of Northern Ireland (PSNI) by three helicopters and two fixed-wing.

In Scotland, Police Scotland air support is provided by one helicopter supplied by a commercial operator.

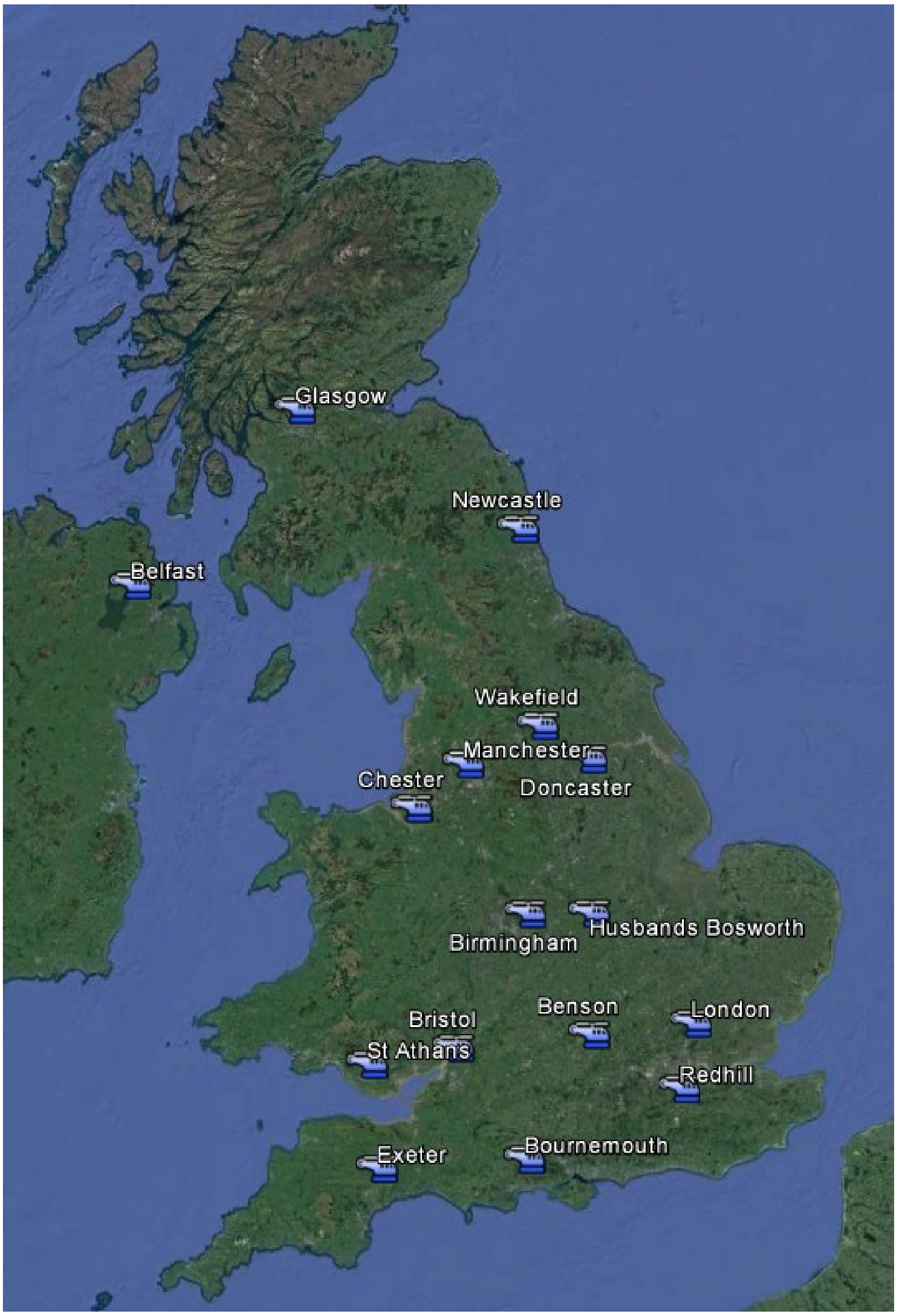
21.2 Operations

In the UK police aviation is deemed to be a “state operation” and as such operates in accordance with the ANO.

Article 134 of the ANO states that any flight by an aircraft registered in the UK in the service of a police authority is deemed to be a public transport flight.

Standardised European Rules of the Air (SERA) applies to all aircraft flying in the UK. The CAA has issued exemptions to aircraft operated in accordance with the terms of a police air operators certificate from certain requirements of SERA. These exemptions are in the form of Official Record Series 4 General Exemptions.

Figure 1 Map of police bases within the UK



21.3 **Fleet**

There are 17 EC135 and six EC145 helicopters currently in operation. throughout the UK. These are all IFR certified multi-engine helicopters flown by commercial pilots, the majority are employed directly by the Police Forces who operate the air support units (NPAS and PSNI). Police Scotland contract in their pilots from a commercial operator.

21.4 **Fixed wing**

At the time of this report there are only two fixed wing aircraft operational, they are Britten-Norman Islanders operated by the Police Service of Northern Ireland. NPAS have four Vulcanair P68 aircraft on order.

21.5 **Crew**

The helicopter crews generally consist of one Pilot and two Tactical Flight Officers (TFO).

21.6 **Operational Area**

Prior to the formation of NPAS in 2012 the air support units used to operate only in their force areas. There was the occasional mutual aid request or consortium agreement which would take them out of their area. Police crews became very familiar with the terrain and had a lot of “local” knowledge.

The units are now not restricted to area and can be requested to operate nationwide.

Up until 2013 Strathclyde Police were the force in Scotland who had their own air support unit. Following the Police and Fire (Scotland) Act 2012 and the creation of Police Scotland in 2013 the former Strathclyde Police air support unit became Police Scotland air support unit, as a result the police helicopter now covers the whole of Scotland from its Glasgow base.

21.7 **Unmanned Aerial Vehicles**

Most police forces have access to unmanned aerial systems of some kind, more commonly known as drones. It is still early days of police drone operations and the procedures are still being developed. In England and Wales, the operation tends to be either overseen and operated by individual forces or contracted in from the Fire and Rescue Service. There are occasions when the police helicopter is tasked to the same incident as the police drone, procedures in place should mean that the NPAS control room is informed each time a police drone is dispatched. Historically this has not always been the case and as a result NPAS have highlighted a “blue on blue mid-air collision as a specific risk.

In Scotland, all police aviation activity is overseen by one entity who receive the task information and allocate the appropriate resource (drone or helicopter). This has resulted in more appropriate use of resources and reduced the risk of a “blue on blue” mid-air collision.

To ensure safe operation the operational control and supervision of all police aviation activity should ideally be done by one entity.

Recommendation:

R16 *It is recommended that operational control and supervision of all Police Aviation activity should be undertaken by one entity to ensure that all airborne assets are under central control.*

21.8 Police Operations

There have been five accidents involving Police helicopters between 2000 and 2017, one of which involved fatalities.

As part of this review discussions took place with management and pilots at the NPAS. There was a review of Safety Reports, MOR`s and Accident Reports from the period 2000 to 2018. There are references made to AAIB`s reports pre-2000 and to Foreign helicopter accidents which support some of the recommendations.

21.9 Training and Experience

In the early stages of police air support the CAA issued “Exemptions” to police forces to enable police officers who held private pilots’ licences to fly aircraft in connection with their duties. Following the Hampshire Police Edgely Optica crash in May 1985 where the pilot and photographer died, the AAIB issued a safety recommendation that the pilots should be suitably licenced and qualified for the task.

Today the minimum qualification for a pilot is a Commercial Pilots Licence (Helicopter) or Commercial Pilots licence (Aeroplane) as appropriate, which includes a rating on the type to be flown. The individual operator can stipulate the minimum levels of experience they require of a line pilot.

Although all Police helicopters are single pilot IFR certified, not all pilots are Instrument Rated. There is an ambition within the industry to have all pilots Instrument Rated within the next few years although there is no regulatory requirement.

Non-Instrument Rated pilots are required to carry out an Instrument Night Qualification section during their Operators Proficiency Check (OPC) and a mutual Instrument Flight of one hour in-between OPC`s.

There is a requirement that police operations are conducted as a public transport flight, as a result police pilots are required to pass an OPC every 6 months and a line check every 12 months. The OPC form should reflect the type of operation being conducted and test the pilot in manoeuvres and emergencies in areas they will be operating.

For example, police helicopters spend a large amount of time in the hover at various heights or operating at low levels at night, it is therefore reasonable to test the pilot in dealing with emergencies when in in these scenarios.

Training for emergencies in these scenarios using the actual aircraft can be difficult. Simulators have proven their worth with regards pilot training and checking in situations which would be impossible or dangerous in the real aircraft. Both Part Ops and Part FCL reflect this by requiring simulation, when available. It is therefore recognised that the use of simulators should be implemented into Police pilots training and checking programmes.

21.10 **Operating in rural areas out of hours**

The nature of police aviation requires availability 24 hours a day, as a result there are times and locations when the availability of fuel, air traffic services and weather is limited or not available.

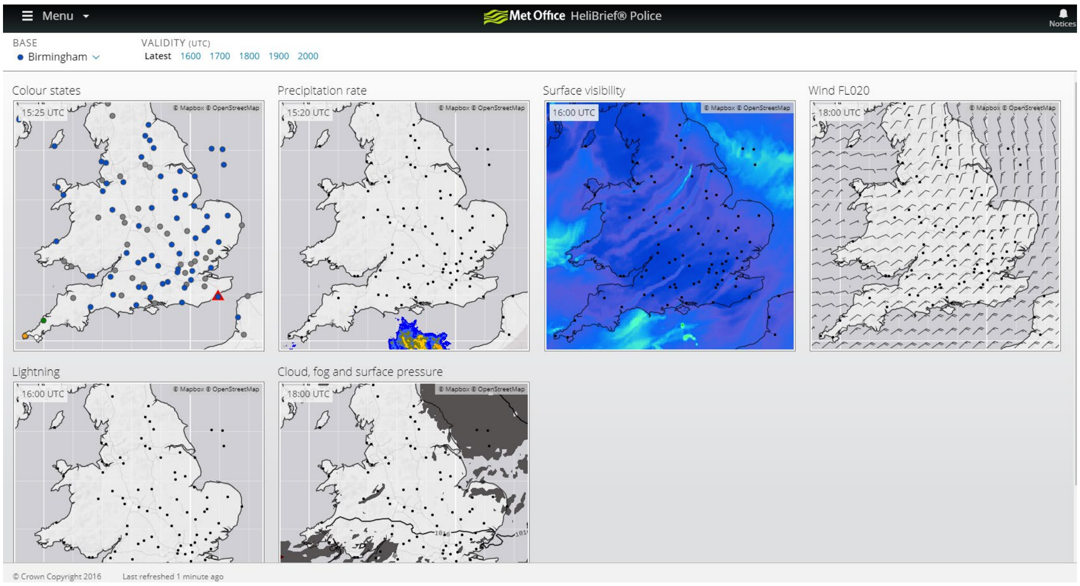
21.11 **Weather**

Police like other operations are subject to weather limitations, theses differ when operating day/night or congested/rural. Weather forecasting in parts of the country where there are not airfields operating 24 hours can be problematic.

TAFS and METARS are generally only available when the relevant Airports are open and have a qualified met observer.

The Met Office provide a tailored product for the Police called Helibrief®, this provides detailed information specific to the police operation.

Figure 2 Helibrief



Screenshot from Met Office HeliBrief ® Police (Crown copyright)

All 14 NPAS bases have weather stations, there is work ongoing with the emergency service providers (SAR, Police and HEMS) to enable each of the operators having remote access to weather stations at the individual bases. This information is unregulated and provided by a commercial company.

This will allow access to over 150 other weather stations based at various locations throughout the UK. This can be viewed over the internet using computers, phones or tablets. There is an ambition to have access to the weather station information through their EFB.

The information from these weather stations is unregulated but gives the pilot a good situational awareness of the possible weather in an area.

Recommendation:

R17 *It is recommended that the UK Meteorological Office, Industry and the CAA review the availability of weather forecasting and reports in remote areas of the country.*

21.12 **Controlled Flight into Terrain (CFIT)**

21.12.1 Terrain

Operating in the areas and heights that police helicopter operates there is ever present risk of CFIT. There can be many lead up factors to CFIT, bad weather, navigation errors, technical malfunction, pilot error due to loss of situational awareness is the most common factor.

Traditional TAWS cannot be retrofitted to helicopters because they operate at a much lower altitude than aeroplanes and sophisticated algorithms are needed to ensure the system knows when to give the pilot a warning or an alert.

Helicopter Terrain Awareness and Warning System (HTAWS) is the helicopter version. In the UK the requirements for HTAWS sits with SPA.HOFO.160:

“Helicopters used in CAT operations with a maximum take-off mass of more than 3175kg or a MOPSC of more than nine and first issued with an individual C of A after 31 December 2018 shall be equipped with an HTAWS”

Police operations are not captured by this requirement and therefore currently do not need to have HTAWS fitted.

The National Transportation Safety Board (NTSB) report into the Maryland State Police AS365 helicopter crash in September 2008 concluded that:

“if the helicopter had been equipped with a terrain awareness and warning system, aural terrain alerts of “Caution Terrain,” “Warning Terrain,” and “Pull -up” would have been provided. These would have been more salient than the alert provided by the radar altimeter and likely would have caused the pilot to attempt to arrest his descent” Police operators should ensure that their safety risk mitigations are effective and monitored to minimise the risk of CFIT.

21.13 **Wires and Obstacles**

Police operation can require pilots to fly at lower altitudes than would be considered normal aviation practice. This takes them into areas where obstacles and wires become a threat.

Wire detection technology has been improving over recent years however none are 100% reliable. Recent studies by an onshore operator found that current products available varied in effectiveness. The most reliable method used by emergency service pilots is the wire overlay function of a moving map system. This utilised a moving map function which highlighted the wires as you approached them.

Recommendation:

R18 *It is recommended that Police/SAR/HEMS operators should include in their safety risk mitigations, fitting their helicopters with systems for the detection and avoidance of obstacles and wires.*

Figure 3 Wire Awareness Software Product

21.14 **Mid Air Collision (MAC)**

Mid-air collisions remain a key risk to police helicopters who operate regularly in the band of busy and complex airspace alongside general aviation and military aircraft. This airspace is continuingly being subject to change due to future airspace policies and programmes that are planned.

With the ever-increasing demand for extra controlled airspace by Airports there will be the inevitable "choke" points. The risk of a mid-air collision in these areas will rise accordingly.

Emergency Services have seen an increase in Airprox reports in the last few years.

Table 1 Airprox Reports

Year	Number of Airprox Reports
2015	8
2016	10
2017	26
2018	24

The increase in popularity of Drones will have significant impact on police helicopters who operate in the same band of airspace, this issue is dealt with elsewhere in the review.

21.15 On Scene and Landing Sites

Police helicopter taskings range from a lone suspect search to being part of a large multi-agency response to a major incident. The response to any major incident can involve Police, SAR and HEMS aircraft. Additionally, there may be military and media helicopters operating in the same airspace.

Procedures and guidelines have been developed over the years to enable the coordination of aircraft at major incidents to be safely managed. These procedures evolve and change over time, the document Helicopter Emergency Liaison Plan (HELP) produced by the British Helicopter Association has been replaced by The Combined Tactical Air Cell (CTAC),

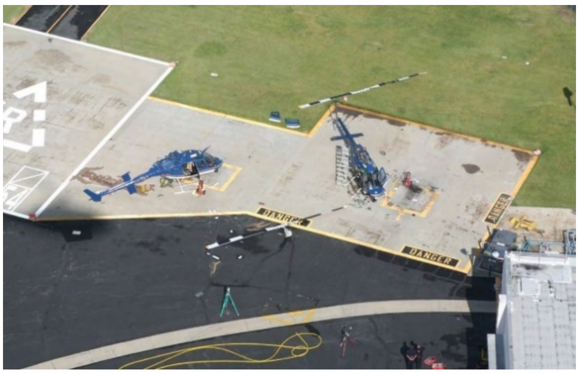
There have been examples of incidents in other countries where two or more helicopters have utilised the same landing site and collided.

In Germany, an AS332 and EC155 helicopter collided in white out conditions at a sports stadium when landing during a training mission.

Figure 7 German Federal Police landing at the Olympia Stadium Berlin 21 March 2013

In Pasadena USA, two Bell 206 helicopters collided at an operating base due to among other factors, incorrect positioning on the pad. One helicopter was conducting an engineering ground run while the other was landing back at base.

Figure 8 Pasadena Police Department B206 incident 2012



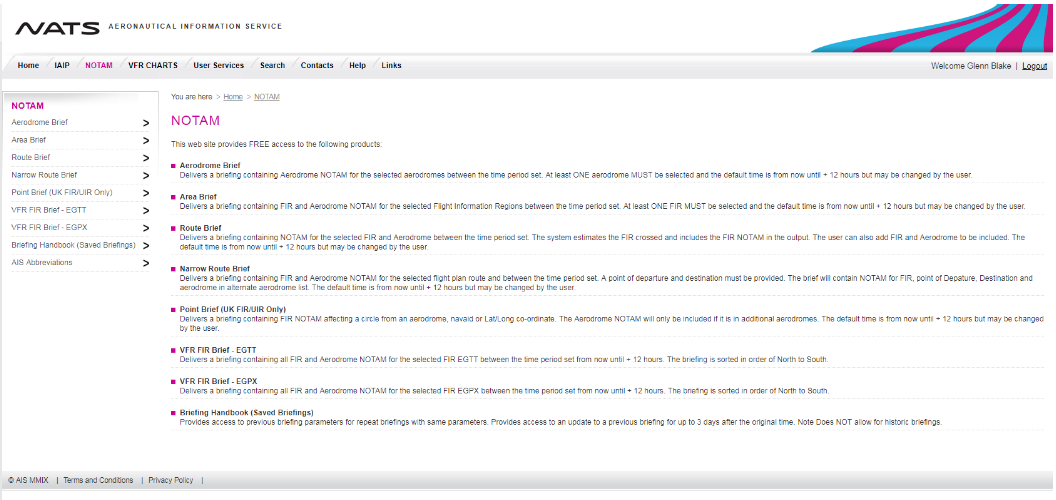
Standard operating procedures should be established and strictly adhered to when operating at major incidents involving a multi-agency response and from bases with multiple helicopters.

21.16 NOTAMS

An important part of pre-flight process is the checking of NOTAMS. This can be done in various ways. NATS Aeronautical Information Service is the official source of NOTAMS in the UK, other websites/applications offer a "map" version of the NOTAMS.

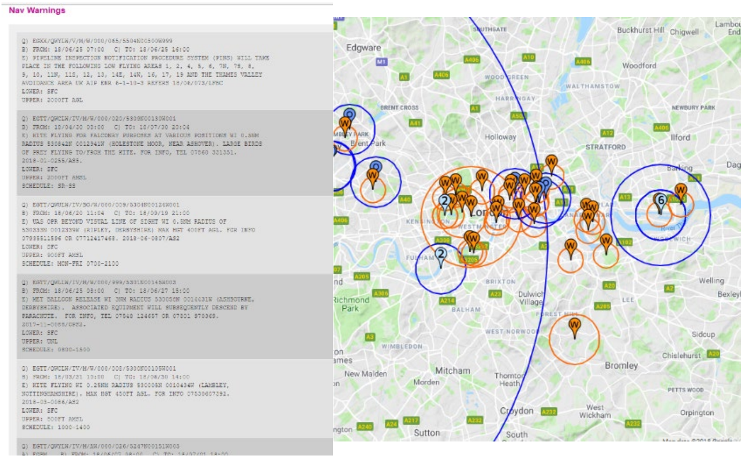
It should be noted the information on third party sites are extracted from the NATS web site and some information can be missed when extracted.

Figure 8 NATS NOTAM website



When viewing NOTAMS on the NATS website they are displayed in list form. This can be difficult to review and remember, as a result many pilots choose to use third party providers who display the NOTAMS on a map. This in general works very well, however due to the increasing popularity of drones and the number of cranes the NOTAM "picture" especially around London is extremely busy and almost unworkable.

Figure 9 NATS NOTAM list and NOTAMS displayed on a map



These NOTAMS displayed in map form initially only bring to your attention the presence of a NOTAM. Further interrogation is needed to find out the relevant information and how it might affect your flight. There is no doubt the map view is a great benefit to pilots however due to the large number of NOTAMs it is easy for some to be dismissed or forgotten about.

The issue of NOTAMS for drone operations in and around the London area can occasionally be of limited use, especially when it covers a long period for example:

Q) EGTT/QWULW/IV/BO/AW/000/004/5129N00023W001

B) **FROM: 18/07/19 08:00C) TO: 18/08/01 18:00**

E) UAS OPR WI 0.5NM RADIUS OF 512845N 0002255W (HESTON, LONDON) MAX

HGT 200FT AGL. FOR INFO 07XXXXXXX. 2018-07-0796/AS2

LOWER: SFC

UPPER: 700FT AMSL

SCHEDULE: 0800-1800

Pilots are expected to call the telephone number to find out if the UAV is operating on a particular day in that period. For emergency services this is not a practical solution.

Recent work on the proliferation of UAV NOTAMS in the London area has resulted in the removal of the requirement to NOTAM drone activity below 400ft. There is still a requirement to NOTAM any drone operations above 400ft.

21.17 Fatigue

Fatigue is an ever-present risk when crews operate 24/7. Flight Time Limitation Schemes are designed to minimise fatigue and ensure the crews achieve sufficient rest. There are times due to external factors crews where crews do become fatigued and a good Safety Management System will identify and address the situation.

To date there has been no UK Police helicopter accidents that had fatigue as a contributory factor however this is not the case worldwide.

Following the investigation into the accident involving the Maryland Police AS365 on 27 Sept 2008, the NTSB determined that fatigue may have been a contributing factor.

'Based on the late hour, the length of time awake, the risk factors for sleep apnoea exhibited by the pilot, and the decision to deviate from the published procedures, the pilot was likely less than fully alert, and fatigue may have contributed to his deficient decision-making'.

The increased use of Night Vision Goggles (NVG) brings with it the increased risk of fatigue. The increased helmet weight, eyestrain and additional scanning required when using NVG`s may lead to an increase in pilot fatigue. This can be reduced through appropriate training and strict application of rest and adherence to appropriate duty hours.

NPAS have recently run a Fatigue Safety Promotion for all staff, to highlight the issue and encourage crews to report fatigue

21.18 Lasers

There was a total of 1699 Laser attacks involving helicopters recorded on ECCAIRS between 2001 and 2018, 1343 were on Police aircraft. It can be seen over the period 2009-2015 the number of attacks was regularly over 130 per year, this number has reduced consistently over the following 2 years, 89 in 2016 and 81 in 2017.

Table 10 Laser Reports

YEAR	Police	Offshore	Onshore/Mil/SAR
2001	1		
2004	2		
2005	5		
2006	3		
2007	4		
2008	35		
2009	156		
2010	210		
2011	188		
2012	148		
2013	97		
2014	130		
2015	136		
2016	89		
2017	81		
2018	58		
Total	**1343**	**65**	**291**

This could be down to increased media attention and successful prosecutions which has resulted in offenders being sent to jail or fined.

New laws brought in on July 2018 meant that anyone who shines a device at an aircraft could face time in jail. Previously it had to be established that there was proof of “intention to endanger” which was sometimes extremely difficult to do.

Following trials NPAS have introduced laser protective eyewear.

Figure 11 Laser Flash

21.19 Ad Hoc Landings at Night

Due to the nature of police aviation there are times when the helicopter is required to conduct ad hoc landings, during the day this is not an issue however when operating at night there is an increased risk.

The pilot must ensure the landing area is suitably illuminated to identify obstructions, wires, members of the public etc, this can be done from the ground or using role equipment on the aircraft for example the night-sun.

The requirement to land at night varies, which results in some pilots only conducting a night landing once a year on their line check. This may not be enough to keep a pilot current in the practice.

21.20 Night Vision Imaging System (NVIS)

NVIS is not a new concept in police aviation, however there is no regulatory requirement for a police helicopter to be NVIS equipped. After the Strathclyde Police helicopter crash near Muirkirk in February 2002* the AAIB issued the following recommendation:

The CAA should require that Police Air Operators Certificate holders review the safety benefits provided by the use of helmet mounted night vision goggles (NVGs) with a view to the introduction of NVGs for helicopter operations conducted at night in support of the police in areas of limited cultural lighting, particularly in hilly or mountainous regions.

It is important to realise that the use of NVIS in police operations does not allow for any alleviations from the weather limits applied to police operations. NVIS aids spatial awareness and enhances safety especially when operating in rural areas.

HEMS operators can only conduct night landings with the aid of NVIS.

***Action*:**

A22 *The CAA will review the equipment and training requirements needed for safe ad hoc landings conducted by Police Operators at night with the aim of including the requirement for NVIS.*

21.21 AIRS

Operators for Police or Search and Rescue Operations to be fitted with Airborne Image Recording System (AIRS) for current in-service helicopters by 31st March 2020 and on delivery for all new helicopter with an individual C of A first issued on or after 1st January 2019.

Safety Directive 2018/0–2 - 1st May 2018.

21.22 Conclusions

Due to the nature of police aviation there is a need for helicopters to operate in areas where there are limited facilities in terms of ATC, weather and fuel.

Careful consideration is needed when planning and conducting these flights, the more information that can be provided to the pilot and crew the safer the flight will be. Technology is constantly evolving and the new products becoming available will no doubt increase the safety of police aviation.

These products however come at a cost which need to be subject to cost benefit analysis.

Controlled Flight into Terrain is an ever-present danger and consideration should be made into the requirement to have HTAWS fitted in helicopters used for police aviation.

Wire detection systems can be beneficial, the information provided to the pilot can vary depending on the system or product used.

One of the products available alerts the pilot using a moving map system to the presence of wires on the helicopters track. This provides additional situational awareness to the pilot especially when operating in demanding conditions and locations.

There are occasional times when the police service is required to operate and conduct ad hoc landings in rural locations at night to assist in an operation or attend an incident. The AAIB have previously recommended the use of NVIS when operating in “areas of limited cultural lighting”. This is not currently required by regulation however consideration should be given to only allowing ad hoc landings at night with the aid of NVIS.

Operating in congested airspace brings the risk of mid-air collisions, new products and technology available reduce this risk. Traffic awareness products like can be integrated into the existing mapping software to enhance situational awareness.

Similar products can be used to alert the pilot to the presence of drones, however this is relatively new software and with the increasing number of drones being operated needs to be monitored for reliability.

Operating from bases with multiple helicopters, especially from different emergency services special procedures should be established to ensure safe operations are conducted. There are occasions when there is a major incident that numerous helicopters attend the same location, it should be ensured that procedures are in place to enable operations to be conducted safely. This use of the Helicopter Emergency Liaison Plan (HELP) or similar should be considered standard.

The contents of the OPC and Line Checks for police operations should contain items that are relevant to the operation. However, areas of operation and technology has changed and evolved over the years. Prior to the formation of NPAS and Police Scotland pilots used to operate in the local area of the individual bases. There is now a requirement to cover larger areas and transit longer distances where the use of automation is beneficial. It has been commented that the knowledge of the autopilot system various greatly among pilots. Recent incidents and or recommendations need to be reviewed to ensure the contents of the OPC and Line check forms are relevant, and training is reflective of the operational requirements.

Full use of simulation to be recommended for Police Pilots training and testing

Chapter 22: Flight Operations: Helicopter Emergency Medical Service (HEMS) operations

22.1 Introduction

This section considers the safety risks specific to Helicopter Emergency Medical Services (HEMS) operations and the measures that can be taken to reduce those safety risks. The United Kingdom currently has 37 HEMS operating bases operated by 8 AOC holders.

A full list of HEMS operators, bases and aircraft types can be found at Appendix 1 to Chapter 21.

HEMS in England, Wales and Ireland are predominately funded by charitable organisations. Scotland has three HEMS bases two of which are funded by government. Most of the charitable organisations have contracts with established AOC operators who hold specific HEMS approvals. The AOC holder typically provides the helicopter, its maintenance and the pilots.

Whilst HEMS is primarily a daylight hours activity, there are also HEMS night operations doing so under a UK Safety Directive enforcing the use of Night Vision Imaging Systems (NVIS).

A variety of shift patterns are employed that vary throughout the year to maximise daylight coverage for those units operating day only. Those that operate day and night maintain two shifts per 24hrs to extend operational availability. Some offer 24hr coverage.

22.2. Safety Culture and Risk Management

Each organisation has its own Safety Management System, and they operate under the rules and regulations laid down by EASA, overseen by the UK CAA Flight Operations department. Thus far all evidence supports a mature sector in terms of reporting and safety culture. HEMS operators have flown collectively tens of thousands of sectors in each year of operation, and unsurprisingly there have been a few incidents. These incidents in the main tend to be either damage to the aircraft from Foreign Object Damage (FOD) or more frequently the result of damage to third party property caused by aircraft downwash at HEMS operating sites.

This report does not analyse in detail each incident. The report acknowledges that overall safety standards in the UK HEMS sector are good.

Notwithstanding the good track record on safety thus far, the industry is ever changing, embracing new technologies and continually evolving. Therefore, this report aims to look at each small piece of the picture and seek to identify if there are any areas that could possibly cause concern in the future.

22.3 HEMS Operations

The condition of a patient, and the time critical requirement to get that patient to an appropriate medical facility, or to deliver advanced medical intervention on scene, are the major reasons for HEMS to be tasked to support a medical emergency.

In the original HEMS model, helicopters were crewed by a pilot/s and two paramedics. In today's environment, there has been a shift toward crew that are delivering increased medical skills and pre-hospital procedures, this using highly qualified medical doctors and critical care paramedics. The type of tasking has also evolved over recent years. The first air ambulances in the UK were tasked by ambulance control, often when called for by road ambulance crews already at the patient or incident scene, who had identified the need for a faster mode of transport, to facilitate getting the patient to a specialist hospital where definitive care could be provided. This model often saw the patient 'packaged' by the crew on scene and ready for evacuation/retrieval once the helicopter arrived.

This 'swoop and scoop' technique allowed time for the landing site to be secured by resources already on scene, and further, it minimised the aircraft on ground time and the exposure to third parties.

UK HEMS units are now routinely crewed by Critical Care Paramedics and highly qualified doctors including A&E consultants, Surgeons and Anaesthetists. This change toward greater medical skills being deployed may influence the overall risk picture. Today, it is not just the provision of fast transport to hospital, but the delivery of advanced medical interventions and procedures directly to the scene, akin to taking the hospital to the patient. The overall crew interaction and human factors dynamic has the potential to become task and outcome focussed which therefore needs to be appropriately addressed through command and CRM/HF training.

Most HEMS operations are now tasked by a dedicated HEMS desk within ambulance control. Staff will triage these tasks assessing them against specific HEMS protocols.

22.4 HEMS Operating sites

The choice of HEMS operating sites is key to a safe outcome. A landing at a football pitch or field a short distance away from the casualty, rather than a road 'T' junction or builders' yard directly on scene is often the better choice. Crews are trained to assess risk vs patient benefit when making these choices.

Helicopter downwash causing risk of FOD to the aircraft, and damage to third party property, is an ongoing issue. The introduction of larger aircraft increased the incidences of damage due to the greater power of downwash, including that lateral flow from the tail rotor that, on smaller aircraft was not so much of an issue. This issue can only be mitigated by robust education and training of crews, who now routinely choose landing sites larger than 2D where possible to mitigate this.

The regulation stipulates that HEMS aircraft should not take off or land in areas smaller than 2D. (2D = twice the helicopters maximum dimension, typically the front edge of the main rotor disc to the aft most point of the tail). These dimensions must be seen as the absolute minimum.

All UK operators use the five S principle (size, shape, surrounds, surface and slope) to aid in HEMS site selection but there is some evidence that variation in this application exists with a number of reported inappropriate sites having been investigated by the CAA.

When tasked as one of the primary resources, the helicopter will often be first to arrive at the incident scene, with the additional risks associated with landing at sites not previously identified, and secured, by ground resources prior to arrival. On arrival overhead an incident, the pilot and crew will identify the most suitable landing site as close as possible to the patient. With potentially no ground ambulance available to reposition a patient, the crew may be drawn to a closer but smaller, potentially riskier landing site. This perceived need to land as close as possible to the incident is predicated solely on initial tasking reports from the person calling 999 (not necessarily a medic). This scenario has the potential for crews being drawn into using the full extent of the HEMS.SPA exemptions to land in areas that would be considered unsuitable for normal helicopter operations. Once on the ground the activity will often draw large crowds of onlookers and the crew may have to secure the site for a safe departure without the assistance of other resources.

The CAA should consider providing a standardised CAP guidance for operators to help set the HEMS operating site safety standards and procedures.

22.5 Hospital landing sites

Several hospital landing sites cannot be used today by one or more of the UK HEMS operator's due to their unsuitability in meeting the Class 1 performance requirements for certain aircraft types. There are however still a small number of Public Interest Sites which by definition cannot support full Class 1 and they remain registered with the CAA and invoke specific safety management by the operator. By their nature, hospital sites tend to be quite organic and the overall site often develops with time. This building development can affect the approach/departure paths since their inception, or the growth of surrounding trees etc. that limit the availability of these sites to some or all aircraft. There are new hospital landing sites being introduced around the country which should be designed in accordance with CAP1264 (Standards for helicopter landing areas at hospitals), but there is no mechanism for the site owner to promulgate the site information to all potential operators or use the guidance CAP. Rotor downwash continues to challenge operators and sites must be managed appropriately so that 3rd party risk is minimised. It is recognised that the newer generation HEMS types are heavier directly resulting in increased downwash. The SAR fleet have particular challenges in this area given the size of aircraft operated. Each HEMS operator is required to keep, monitor and update their own landing site guide specific to their helicopter type for the hospitals they use in their areas of operation.

<u>Action</u>:

A23: *The CAA will establish a work group with key stakeholders and operators to review the provision of Hospital Landing Site information with the aim of adopting a unified controlled source similar to that used for offshore helidecks.*

22.6 HEMS at night

To further expand the availability and usefulness of the helicopter in the HEMS role, several operators now conduct night HEMS operations. The current EASA regulations allow for night VFR HEMS operations but do not stipulate any requirements for NVIS. In the UK, prior to the introduction of night HEMS the CAA published a Safety Directive mandating the use of NVIS for HEMS operations at night (EASA rule making will introduce a similar requirement).

Currently there are 18 units approved for night HEMS operations. Most are flown multi-pilot (MP), although single pilot plus Technical Crew Member (TCM) is permitted within a defined geographical area. Typically, this restricts the area of operation to their normal daytime area.

A recent HEMS NVIS operations meeting was held with all emergency servicers users to establish common practices and share safety issues. It was agreed that this was a useful forum.

Operators and the CAA should consider a NVIS practise group forum to discuss and share information and standard practises.

22.7 Multi-Pilot HEMS operations

There is no current operating standard set for multi pilot operations in the UK HEMS environment, and it is important that multi-pilot procedures reflect the type of flying encountered in onshore HEMS. Under the previous JAR OPS 3 requirements two pilots were required for night operations but did offer TCM alleviation in specific geographic areas. Before this in the late 1980’s the UK also imposed a multi-pilot operation on the London Air Ambulance given its unique congested area operating environment. Both systems required the operator to establish appropriate procedures. Since then MP operations have been introduced by both customer request and the operator. HEMS has traditionally been VFR pilot operation. With the introduction of larger aircraft and the addition of night HEMS, there has been a shift toward multi-pilot operations. In the UK, multi-pilot operations are more typically found in the procedural IF operations such as the offshore oil and gas industry and VIP charter.

With this shift to multi pilot operations, some organisations are adopting the perceived safety benefits of MP ops. This is a very different environment to onshore HEMS and use of these procedures needs to be tailored to HEMS operations.

There is a possible risk that MP crews may lose situational awareness in modern automated aircraft by completing inappropriate procedural checklists and procedures.

Within the industry there are older pilots who will now be able to fly for longer, as part of a MP crew. This will help retain the vast experience gained in UK HEMS in recent years, thus facilitating a good HEMS role training environment to bring on new pilots. It is also now possible to crew the aircraft with two CPL(H) holders under a CAA Exemption, however, it is important that training and checking must include additional items and skills. HEMS operations are mainly short sector flights under VFR, so the duties of the TCM must be appreciated and are still very much required (both legally and practically). Throughout the UK there are a variety of crew combinations and some operators have both MP and SP/TCM HEMS operations.

The increasing use of larger aircraft for HEMS (AW169/EC145 for example) has facilitated this move toward multi pilot operations and night HEMS. But, there are some possible potentially negative consequences that should be identified and mitigated.

The use of increasingly automated and complex helicopters brings both advantage and disadvantage. Risk to/from third party and property though, is increased by the greater downwash from heavier aircraft. This greater downwash may mean that crews become less effective, in that they will need to operate from larger clearer sites further from the incident scene. This need to land in larger areas could actually mitigate somewhat the threats caused by higher downwash in the smaller sites.

Longer start up and shutdown procedures in the more complex aircraft, increase exposure time and therefore risk to third parties on the ground at incident sites. Procedures should be included in crew training to mitigate.

From a pilot rostering perspective, it is important to be mindful that a pilot may be tasked to fly a shift with another equally experienced pilot one day, followed by a shift with a TCM, followed by a shift with a low time co-pilot. Crew composition changes with different bases, can also lead to crew separation affecting CRM and safety.

The HEMS environment is not ideal for new pilots to rapidly gain flying experience. Ideally, the multi pilot operations would be crewed by two experienced pilots. During multi pilot operations in the HEMS role, each pilot can fly alternate missions or sectors enabling each pilot to maintain skill levels, experience and currency. Where the co-pilot has limited HEMS experience and/or has low total time this alternating of sectors also has value. This scenario could however lead to the experienced pilot having to ‘coax’ or teach the handling pilot into a challenging operating site, a site that he himself has only just recced, and possibly whilst unsighted. Irrespective of a pilot’s experience, in the MP role he is fully qualified to operate the aircraft. Operators have procedures for dealing with MP roles and the integration of on the job training.

It is foreseeable, that many junior pilots will seek employment elsewhere, once they amass the minimum PIC hours required say for a co-pilot position offshore. This situation could result in low time pilots perpetually being trained in the multi pilot HEMS co-pilot/TCM role. The operators that no longer operate single pilot will have lost the opportunity to recruit and train TCM’s regularly operating from a pilot’s seat. Current knowledge and skills held by existing TCM may well be lost and recruitment for non TCM rear cabin paramedics may suffer.

The CAA will continue to monitor crew reports/ safety reports/ MOR etc. to identify any trends or safety issues resulting from MP HEMS operations.

22.8 TCM training

AMC1 SPA.HEMS.130 Crew requirements

HEMS TECHNICAL CREW MEMBER

TCM training varies around the UK across the different operators. Some of the variance can be attributed to the variety of crew configuration, local geography, aircraft type and seating/ role demands. However, all TCM are trained to work as a team with the Pilot and other crew members, specifically to assess appropriate landing sites that are risk proportionate to the patient injuries, and commensurate with use of relevant exemptions as required.

22.9 Use of rear medics as crew

The regulation pertaining to medical passengers is. '.. *a medical person carried in a helicopter during a HEMS flight, including but not limited to doctors, nurses and paramedics';'*

The medical passenger is not technically part of the operating HEMS crew as required by regulation. However, it is entirely appropriate that doctors and medics who fly regularly to become fully integrated into the crew operations. Different operators offer a variety of training regimes for these medical passengers.

Whilst the regulations do not require the medical passenger to undergo full TCM training, other than that required for a passenger briefing, the regular medic can be a useful addition to the overall crew dynamic. This is working well in some operations and can add another level of safety when operating at HEMS operating sites.

22.10 CRM Training

HEMS pilots and TCMs will already be CRM aware as part of their training programme but also by the requirements of the role. EASA Part Ops states that HEMS crews and medical passengers are also expected to operate in accordance with good crew resource management (CRM) principles.

To operate HEMS safely, it is important that CRM training and checking not only meets the standards required of CAT operations, but that it is further developed to take account of the additional pressures brought to bear on crews when faced with life and death incidents. When responding to potentially serious incidents with limited information in poor weather or at night, the importance of good CRM from all crew cannot be over stressed. Most operators include regular medical passengers in CRM training programmes.

Recommendation:

R19 *It is recommended that industry through the CAA Human Factors Advisory Panel consider creating additional HEMS specific CRM guidance and/or training courses for HEMS operators. This to ensure standardisation and the effectiveness of crew communications, in this specialist sector where team work is essential for the desired safety outcomes.*

22.11 **Controlled Flight into Terrain (CFIT) and other fixed objects.**

Controlled flight into terrain (CFIT) including collision with objects such as wires and towers, is a significant risk in the HEMS environment, particularly in the take-off or landing phases of flight. CFIT is more usually encountered in the en-route phases of flight, but in the short sector HEMS environment it is more of a concern during low level operations near the incident sites. In recent years for example, there have been a proliferation of wind farms which are hazards in themselves, but more importantly, prior to erecting these structures developers often erect anemometers for wind research purposes. These tall (1-200’) whip aerial like structures can be almost impossible to see in certain light conditions and are not marked on any chart. They should not pose a problem generally if flights are conducted en-route at 500’ AGL (or higher) but in low level flights and DVE they become real threats. Closer to the landing site the biggest threat to HEMS operations is wire strike.

Once the helicopter is operating in the incident landing site area, the threat to the aircraft from FOD is high due to the unprepared nature of many landing areas. The downwash from the helicopter is very powerful and can cause quite large items to be drawn into the circulating airflow with potentially catastrophic consequences. In addition to the risk to the aircraft, the helicopter downwash can cause significant damage to property and persons. There have been a number of instances where helicopters have struck fixed objects within the landing site.

Recommendation:

R20 *It is recommended that operators ensure that crew training includes scene safety and downwash effects on property and persons.*

22.12 **ATC communications and fuel availability**

Communications problems with air traffic control (ATC), or a lack of communications due to remote locations and terrain, can increase the risk exposure of HEMS operations both by day and by night.

With the introduction of late and early shifts together with night flying, some HEMS operators are experiencing difficulties in obtaining the Air Traffic Service required, due to the limited hours of operation of some Air Traffic Service Unit (ATSU). Many operators have now fitted GPS flight tracking equipment and have flight following procedures to mitigate the potential issues arising where communications are poor or non-existent.

Flight Planning has also become more challenging regarding fuel availability outside normal operating hours, especially for late shift/night HEMS crews.

Operators must ensure that the availability of fuel sources is listed in their OM Part C material together with contingency plans.

22.13 Weather forecasting

The minimum weather conditions required for HEMS flights are detailed at SPA.HEMS.120 and its GM1. Obtaining accurate weather forecasts and actuals that cover the entire period of operation, is very difficult for those who are not operating within areas covered by larger airports. In many areas of the UK, weather forecasts are not available at certain times of day due to a reduction of reporting sites, or because the forecast is limited to a particular airfield and its opening times.

HEMS operators are under increasing pressure to provide their own weather measuring equipment at their own operating bases and other frequently used locations. This is due to the extended hours of operation being implemented. Risk can be reduced by providing a means of observing, recording, and reporting accurate and timely local weather conditions, including cloud base and visibility, at HEMS operating bases.

Whilst HEMS can be conducted by both day and night, with an IFR option, by far most is conducted under VFR and at times in poor weather operating to the legal minima. Crews may feel perceived pressure to carry out the mission regardless if too task or outcome focussed. The despatch, en-route, and operating site weather minima are considered prior to undertaking any tasking, however there can be a desire for crews to agree to assessing the weather conditions en-route especially when considering the short average distances flown by UK HEMS units. Often the nearest weather stations where actual (METAR) weather conditions can be obtained are further away than the incident itself.

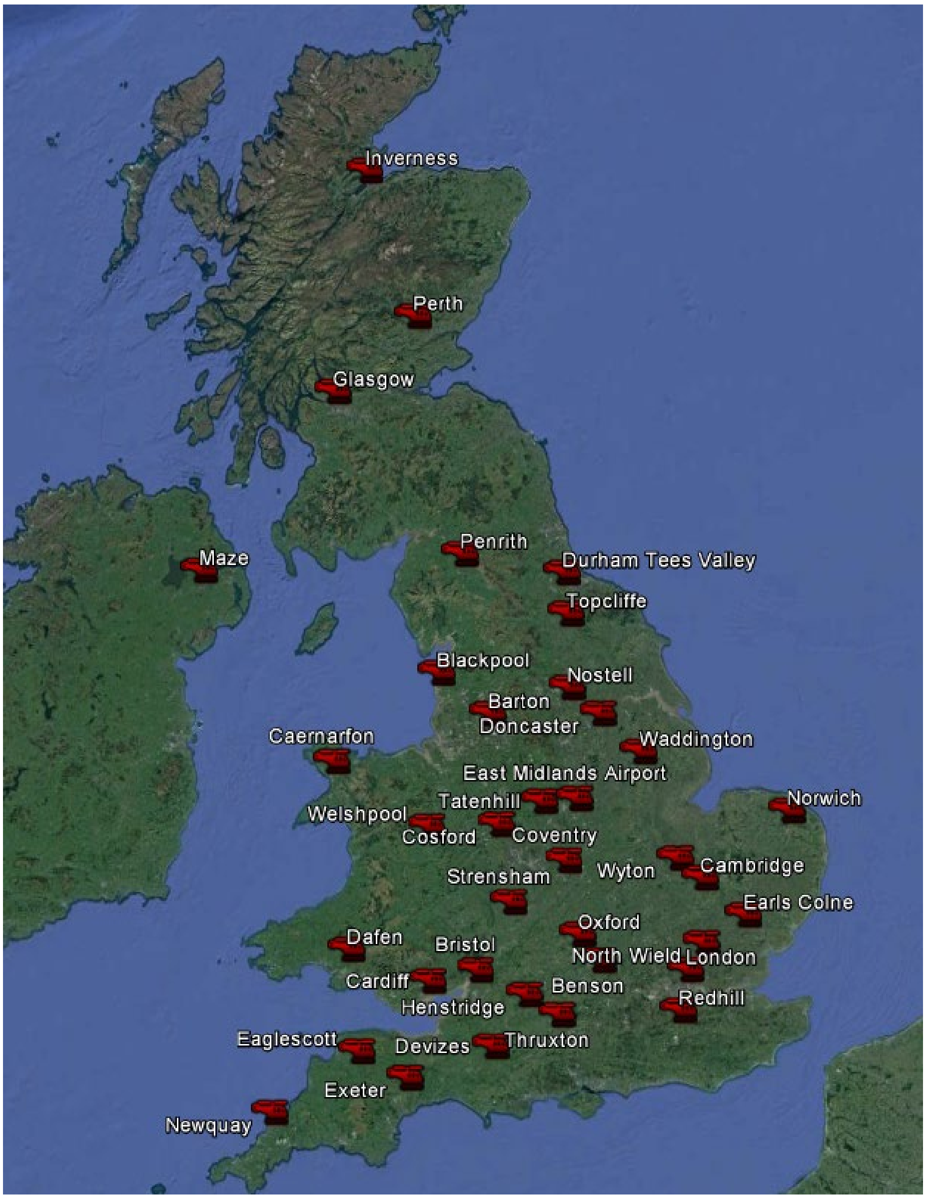
See section on Met provision.

22.14 Simulators for HEMS training/checking

Currently in the UK there is still limited availability of flight simulation for lighter helicopters, for the training and checking of a properly constituted crew of both pilots but also TCM's. For many of the well-established helicopter types in use, there are no available simulators. However, with the introduction of larger more complex aircraft into the HEMS role, it is becoming easier to find available simulators albeit in near Europe. Line Orientated Flying Training (LOFT) and experiencing typical events seen on the line can significantly raise crews' standards in dealing with emergency and abnormal scenarios.

Consideration should be given to integrating flight crew and TCM initial and recurrent training.

Figure 7.1 Map of UK HEMS/Air Ambulance locations



Chapter 23: Flight Operations – Search and Rescue (SAR)

23.1 Responsibility for Search and Rescue (SAR) for civil aircraft within the UK Search and Rescue Region rests with the Department for Transport (DfT).

Responsibility for Aeronautical SAR Coordination is discharged by the UK Aeronautical Coordination Centre (ARCC), which is manned by specialist personnel of Her Majesty’s Coastguard and which is embedded within the Maritime and Coastguard Agency (MCA) National Maritime Operations Centre.

SAR Helicopter Services are provided under contract to DfT by Bristow Helicopters Ltd, while fixed wing SAR Services are provided under contract to DfT by Reconnaissance Ventures Ltd.

The Ministry of Defence (MoD) maintains responsibility for Royal Air Force (RAF) Mountain Rescue Teams.

Current SAR provision is accomplished by 10 bases equipped with new or refurbished ground facilities and new aircraft, namely the Sikorsky S-92 and Leonardo AW 189

23.2 This SAR review concentrates on the matters listed below:

Weather provision

ANO 2016

CAP 999

Hospital Helicopter Landing Sites

Public Interest Sites

Standards for helicopter landing areas at hospitals

HHLS Safeguarding

Landing Site Directories

Air Operations Manuals

Standardisation

Technical Crew Members

Licensing

Medical Standards

Low-level Airspace Charts

NVIS Operations

Obstacle Lighting

SAR Tasking

CAP 1264

CAP 999

Aeronautical Databases

23.3 **Weather Provision**

a. ANO 2016

Under the current ANO 2016 Section 3 – Take-off and landing conditions – Article 75;

i. (1) ***Before commencing take-off***, the pilot in command – (b) ***of all other aircraft must be satisfied that***— (i) according to the information available, ***the weather at the aerodrome or operating site*** and the condition of the runway or final approach and take-off area intended to be used ***would not prevent a safe take-off and departure***;

ii. (2) ***Before commencing an approach to land***, the pilot in command must be satisfied that, according to the information available, ***the weather at the aerodrome or the operating site*** and the condition of the runway or final approach and take-off area intended to be used ***would not prevent a safe approach, landing or missed approach***.

b. CAP 999

Weather provision for SAR operations is contained in CAP 999, paragraph 3.18 which states:

At each operating base, **the crew are to be provided with:**

i. Cloud base and visibility indicating and recording systems;

ii. Facilities for obtaining current and forecast weather information; and

Satisfactory communications with the appropriate Air Traffic Services (ATS) unit.

c. Operational practice

Current practice sees the use of bespoke Met Office products in establishing the weather picture for the operating region. For bases operating from a licensed aerodrome the benefit of TAFs and METARs is felt but it is recognised that the current minimum requirement may not translate into providing the best operational information to aid recovery to base.

CAP 999 is currently undergoing a review by all stakeholders.

23.4 Hospital Helicopter Landing Sites (HHLS)

a. Public Interest Sites

CAT HEMS hospital sites conduct operations to Performance Class 1 standards unless recognised as a public interest sites i.a.w GM1 CAT.POL.H.225 to the EASA Ops Requirements. Whilst the current generation of HEMS helicopters are all capable of Class 1 helipad performance at operational weights, a small number of sites, mainly due to their obstacle environment, continue to be recognised under this alleviation. It is evident that National Search and Rescue activity into many hospital sites cannot be accomplished under full Class 1 standards given the performance characteristics of the types operated. Whilst an acceptable and mitigated means of operating within modified Class 2 has been established at ground level sites no alleviations are applied to roof top operations where the Class 1 standards must be met

b. Standards for helicopter landing areas at hospitals

CAP 1264 "Standards for helicopter landing areas at hospitals" was produced to replace 'Department of Health, Health Building Note 15- Hospital Helipads' leaflet. The CAP ensures any hospital heliport fulfils the international standards in ICAO Annex 14, Volume 11. The OSR discovered this document is not well known by both the Department of Health and Local planning authorities.

This was evidenced by planning authorities authorising new build at or near a HHLS resulting in the site not being able to accept the latest SAR helicopter models. (Norfolk and Norwich/Aberdeen Royal infirmary are examples)

c. HHLS Safeguarding

The review has highlighted that currently UK HHLS's are not safeguarded in the way major airports, and recently Battersea Heliport, are dealt with in terms of participation the local planning processes. Hospitals remain quite organic in their nature and sites are developed around an individual hospitals' needs. The Department of Health has dedicated trauma centres and centres of excellence for stated care, there is the risk that, these centres could become unusable to SAR and HEMS helicopters unless they are offered safeguarding protection to ensure a safe aviation operational environment.

The CAA should consider a dedicated review of the process for hospital development, associated planning and subsequent HHLS safeguarding needs to be carried out to ensure safe helicopter operations at 'Critical Infrastructure' HHLSs.

Landing Site Directories

a. EASA Requirements for defining operating sites – helicopters.

Listed in AMC1 CAT.OP.MPA.105 Use of aerodromes and operating sites, where the following should be taken into account;

i. Performance requirements and characteristics;
ii. Procedure for surveying the sites;
iii. Pre-surveyed sites should be specified in the Operations Manual;
iv. None pre-surveyed sites should have a procedure for aerial recces;
v. Flight to non-pre-surveyed sites should not be permitted.

b. EASA Air Operators Manuals Requirements

Operators are to provide information relating to landing sites available for operations in their Air Operations Manual Part C as listed in AMC3 ORO.MLR 100 C (2), Operations Manual – General, such as:

i. a description of the landing site (position, surface, slope, elevation, etc.);
ii. the preferred landing direction; and
iii. obstacles in the area.

c. Standardisation

There is no centralised UK wide product that provides hospital landing site information to all operators. There are commercial products available for all other recognised aerodromes and helipads, but it remains the operators responsibility to ensure it conducts its operation adapted to the aircraft types it operates. To that end, operators must provide crews with appropriate information on its established operating sites with Performance and overall operating safety in mind.

i. Military Flight Information Publications (Mil Flips)

The No.1 Aeronautical Information Documents Unit whose overriding responsibility is to deliver Aeronautical Information (AI) products and services to UK Defence Aviation worldwide continues to produce the Helicopter Landing Site Hospital (HELI HOSP) biannually which are available for purchase by Civil UK operators. However, this document does not take into account the full operating requirements for a civil SAR operation. It does however provide some rich information on all known hospital sites.

The OSR has identified that SAR operators are using a mix of locally produced landing site material and the RAF HLS publication. Whereas, HEMS operators are using self-produced directories as the norm and the ‘HELI HOSP’ as back up for out of area tasking.

Operators should review the provision of Hospital Landing Site information and be encouraged to adopt a unified controlled source such as that used for offshore helidecks.

Technical Crew Members (TCM)

a. Licensing

Pilots within the SAR hold licences with a type rating and the associated Class 1 Medical Certificate, however, it is noted that SAR crew winchman and winch-operator qualified TCMs do not hold any form of Licence or their equivalent. On transition from the military SAR model most rear seat SAR crews were taken from qualified and ‘certificated’ sources. The future UK operating model will require the selection and training of personnel who may not have had previous SAR experience.

b. Medical Standards

TCMs perform flight critical tasks, for example, conducting a commentary to ensure main and tail rotor clearances during rescue or even flying the aircraft in the hover from the rear door. However, the eye acuity of TCMs is not currently assessed in relation to their airborne duties which could result in TCMs flying with eyesight below the standard required to safely carry out such duties. Current medical guidance for TCM’s is given within CAP 999 Paragraph 4.5.

Operators should consider introducing Class 2 Medical Certificate standards for TCMs.

23.5 **Low-Level Airspace Charting**

SAR operations and training are required to operate in the poor weather at very low-level over the land and sea. SAR use both UK CAA Charts for flights above 500ft AGL and Military Charts for low-level operations.

Currently, the VFR charts made available to all operators from suppliers and produced by the UK Aeronautical Information Services (AIS), are as follows:

i. 1:500,000 (UK wide) which meet with the ICAO standards and recommended practises as defined in ICAO Annex 4 have obstacles above 300 ft AGL depicted.

ii. 1:250,000 (UK wide) again with obstacles above 300ft AGL depicted.

iii. 1:50,000 (UK wide) Ordnance Survey low-flying charts, with the option of the Defence Geographic Centre’s (DGC) powerline overprint.

iv. 1:500,000 UK Low Flying Charts and chart Amendment Low Flying (CALF)

The Defence Geographic Centre (DGC) provides a digital vertical obstacle file (DVOF) for the UK military and this data is provided to CAA, NATS and other civil commercial companies in developing its mapping products.

DGC have an established reporting system to manage uncharted obstructions and will fully research each instance with a view to adding them to the obstruction database. If these meet the specification of the chart, they will then appear on subsequent editions of the relevant chart. Those not meeting chart publication criteria can still be added to the database to support digital displays through AIRAC provisions of digital data.

Operators should continue to provide all suitable hard copy, or electronic charts on Electronic Flight Bag (EFB) approval, to all crews. The use of up-to-date in-flight data is to be encouraged to supplement any shortfall in obstacle data using DGCs reporting function at dvof@mod.gov.uk.

23.6 **Night Vision Imaging Systems (NVIS) Operations**

There has been a previous military requirement for all SAR Flight Crew who conduct Night Vision Operations, and who require correction to their eyesight, to be issued with either suitable contact lenses or flying spectacles. These items have been through a testing regime to meet a defence standard to ensure optimisation of optical and visual performance, and compatibility with their flying helmet and night vision goggles.

EASA Ops SPA NVIS does not establish such a standard and CAA audit activity has identified a wide variation in visual correction use by SAR crews.

***Action*:**

A24 *The CAA will review the minimum specification of visual correction when using NVG and propose suitable standards to ensure optimisation of optical and visual performance.*

23.7 **Obstacle Lighting**

ICAO Annex 15 Aeronautical Information Services, Chapter 10 shows the coverage areas and requirements for data provision; which is broken down into areas for air navigation purposes, in general;

- ii. **Area 1** is the entire territory of the state down to an elevation of 30 m’s;
- iii. **Area 2** is within the area covered by a 10-km radius from the ARP and is further subdivided but in general assessed to an elevation of 3m’s.

ANO 2016 Article 222 Lighting of en-route obstacles, (8) states that all ‘en-route obstacles’ which are 150 M or more must be illuminated at night.

There are currently many obstacles below this height, which present a hazard at night as they are unlit. Therefore, a real risk is present for operations below 500ft AGL, currently the MIL maps are marked with low level obstacles, these obstacles are indicated as lit or un-lit.

Consideration should be given to assessing the un-lit hazards below 150m’s to minimise the risk for low-level helicopter operations below 500ft, and to ensure the low-level lighting is compatible with NVG/NVIS.

23.8 SAR Tasking

Tasking of both SAR & HEMS assets have differing controls with their own priorities and differences. The Emergency Air Response Review from the Department of Health and the MCA dated 10 Mar 14, is still maturing the liaison between HEMS tasking centre and the UK ARCC.

23.9 CAP 1264 Standards for helicopter landing areas at hospitals

The OSR has identified that CAP 1264 continues to be the best practice guidance material for all new builds and the template for compliance and is required for helicopter landing site guidance, which is currently under review and amendment.

23.10 CAP 999 Helicopter Search and Rescue (SAR) in the UK National Approval Guidance

CAP 999 is the best practice guidance material for assisting organisations in determining procedures and Operations Manuals guidance to operate SAR helicopters in the UK is currently under review for amendment.

23.11 Aeronautical Databases

The Aeronautical Database is the solution for collecting all necessary data for PBN, Procedure Design (ICAO PANS-OPS, FAA TERPS), Terrain Data, Obstacle Data, Aerodrome Mapping Data (AMDB), NOTAM Management, publication of AIP and related publications as well as aeronautical maps.

EASA Decisions on Management of Aeronautical Databases / Part-DAT.

The European Aviation Safety Agency (EASA) has issued two Executive Director (ED) Decisions on the management of safety-critical aeronautical navigation databases from 1 January 2019 onwards.

SAR Bases in the UK

Section E: Airworthiness

Chapter 24: Role of the Type Certificate Holder – continued airworthiness

Introduction

24.1 The review considered the role of the Type Certificate Holder, in terms of Continuing Airworthiness. Continuing Airworthiness functions of the Type Certificate Holder are described in Part 21 subpart J and require the collection and analysis of in-service data and taking appropriate actions in response to events. Throughout the review it has been considered how operators, maintenance and continuing airworthiness organisations have engaged with the Type Certificate Holder and how they have responded to events.

Following the initial design and certification of the product the Type Certificate Holder is responsible for assuring the continuing airworthiness to which it has been designed and certified, ensuring it meets the standards of the certification basis. These responsibilities include.

24.2

a) A system for collecting, investigating and analysing reports and information related to failures, malfunctions, defects or other occurrences which may cause adverse effects on the continuing airworthiness deemed to have been issued under Part 21J.
b) Reporting to the competent authority, any failures, malfunctions, defects or other occurrences which has resulted in or may result in an unsafe condition.
c) Ensuring the preparation and updating of all maintenance and operating instructions (including Services Bulletins) needed to maintain airworthiness continuing airworthiness.

24.3 CS 27.1529 and CS29.1529 requires the Type Certificate holder to prepare Instructions for Continued Airworthiness, these include preparation of the Maintenance Manual, Maintenance Instructions; including airworthiness limitations containing component replacement times. The review noted, from its engagement with industry, that the provisioning of ICA's is an area that results in challenges for industry, particularly with the introduction of new helicopter types and existing types with missing, inaccurate or ambiguous instructions for continued airworthiness.

Reliability Programmes are not defined within the scope of the Certification Specification (CS) or within Part 21. The TCH may define the use of a reliability programme as part of its compliance during the initial certification process. The methodology chosen maybe from the Maintenance Steering Group (MSG) i.e. MSG-3. It should be noted that the use of reliability is not mandated through the Certification Specification.
Part M Regulation (EU 1321/2014) AMC for M.A.301 (2) – 3(a-d) and M.A.301 (4) requires licenced carriers, AOC's, and of Complex Motor-Powered Aircraft to monitor the control of defects and analyse the effectiveness of the maintenance programme. It should be noted that as some of the types, operated within the scope of this review are neither operated by AOC's nor are they complex types, therefore these regulatory requirements may not be applicable.

24.4 The review has considered, through its data analysis and industry engagement, the role of the Type Certificate Holder and how this may impact on the performance of the products; helicopters, and those who operate them, manage the airworthiness and, or maintain them.

24.5 The review of MOR's and organisational oversight data has looked to extract intelligence where it has been identified that the role of the Type Certificate Holder has had an adverse effect on the operators and maintenance of the type. For more information; refer to Chapter 7 (MOR section) and Chapter 12 (CAA Airworthiness oversight analysis section).

Chapter 25: Future regulatory rule changes

Introduction

25.1 This section covers future rule changes that may impact on the Initial and Continuing Airworthiness aspects of the onshore helicopter scope. The focus of the changes has been to CS27 Small Rotorcraft.

25.2 Table 1 provide a summary of future Rule Making Tasks and how these will impact on the sector.

25.3 The CAA has continued its engagement with the EASA Certification Directorate to communicate the CAA onshore sector safety risk picture which relate to State of Design activities. Risks related to rotorcraft operations, both onshore and offshore, are communicated to EASA through bi-annual safety risk meetings, the Offshore Helicopter Safety Leadership Group (OHSLG) and the newly introduced EASA and National Aviation Authority (NAA) sector safety meeting. Through these engagement meetings the CAA has understood there to be a number of safety enhancement workstreams. These are included in the European Plan for Aviation Safety (EPAS) and EASA Rotorcraft Roadmap for Safety launched in December 2018.

Table 1 EASA Future RMT relating to Onshore Helicopter Operations

Rule Making Task Number	Description
RMT.0251	Introduction of SMS to Part 21, Part 145, Part M
RMT.0255	Review of Part-66 – simplification for aircraft below 5700kg
RMT.0281	New training/teaching technologies for maintenance staff
RMT.0318	Single Engine Helicopter Operations – restrictions for hostile environment (piston engine) and congested environment
RMT.0325	HEMS performance and public interest sites
RMT.0712	Enhancement of the safety assessment processes for rotorcraft designs
RMT.0714	Enable the safe introduction of rotorcraft Fly-by-Wire technology

Chapter 26: Airworthiness directives and service bulletins

Summary

26.1 As part of the review all AD's of the helicopters within the scope were downloaded and analysed against each of the helicopter types. It should be noted that the AD's downloaded and reviewed were only in relation to the airframe and not associated engine installation. Subject matter expert review suggested that there were no specific trends, either by type, by ATA Chapter or against the competent authority for design, i.e. EASA or the FAA.

26.2 The number of engines, and their variants, utilised on the helicopters reviewed and their ability to be installed on many types meant that completing the review would have resulting in significant workload. It was deemed that the value in completing the engine AD review would be of limited value with the majority of engine related MOR's being associated with Magnetic Chip Detection lights.

26.3 A further review was completed for the top 5 helicopters by fleet numbers, the AD's by ATA Chapter were compared with the corresponding Service

Bulletins chapters to see if it could be determined how the Type Certificate Holder was supporting their products.

26.4 For all helicopters within scope, AD's and SB's for the top 5 by fleet type have been considered and deemed to offer limited intelligence in determining any trends relating to continuing airworthiness.

Chapter 27: Certification specification and role of the Type Certificate Holder

Introduction

27.1 The review of Onshore Helicopters considered those types of helicopter utilised and how these were certified. Principally the helicopter types within the review are 'Small Rotorcraft' and may have been certified to FAR27, JAR 27, or national standards prior to the advent of CS27 in 2003. It should be acknowledged that some operations involve helicopters certified to CS29, 'Large Rotorcraft'. This section of the review specifically looks at 'Small Rotorcraft' and the rules each type has been certified. A summary of the history and timeline of onshore helicopters certification regulatory developments is illustrated in Figure 1.

27.2 Given the diversity of the types operated a brief history is provided for the category of 'Small Rotorcraft' as defined within the current EASA Type Certificate Date Sheets. For a history of 'Large Rotorcraft' reference should be made to CAP 1145 which provides details on the development of FAR29, JAR29 and CS29

27.3 The CAA has continued to maintain and develop it relationship with EASA. As the competent authority for Certification, the development of Certification Specification is the responsibility of EASA. Our review has considered how Certification Specifications, CS 27, has developed since its introduction in 2003 to its latest amendment 5, in 2018, as well as looking at those specifications preceding it, plus those of the FAA, FAR 27. Further to this we have considered future developments of Small Rotorcraft and new product lines from the Type Certificate Holders.

27.4 To be used operationally, an aircraft design has first to be approved (certificated) to these standards. The Part 21 Design Organisation must be assessed as competent and approved by EASA or the competent NAA. 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.

27.5 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 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.

Review of the Regulatory (Certification) Developments for Small Rotorcraft between 1957 to 2017

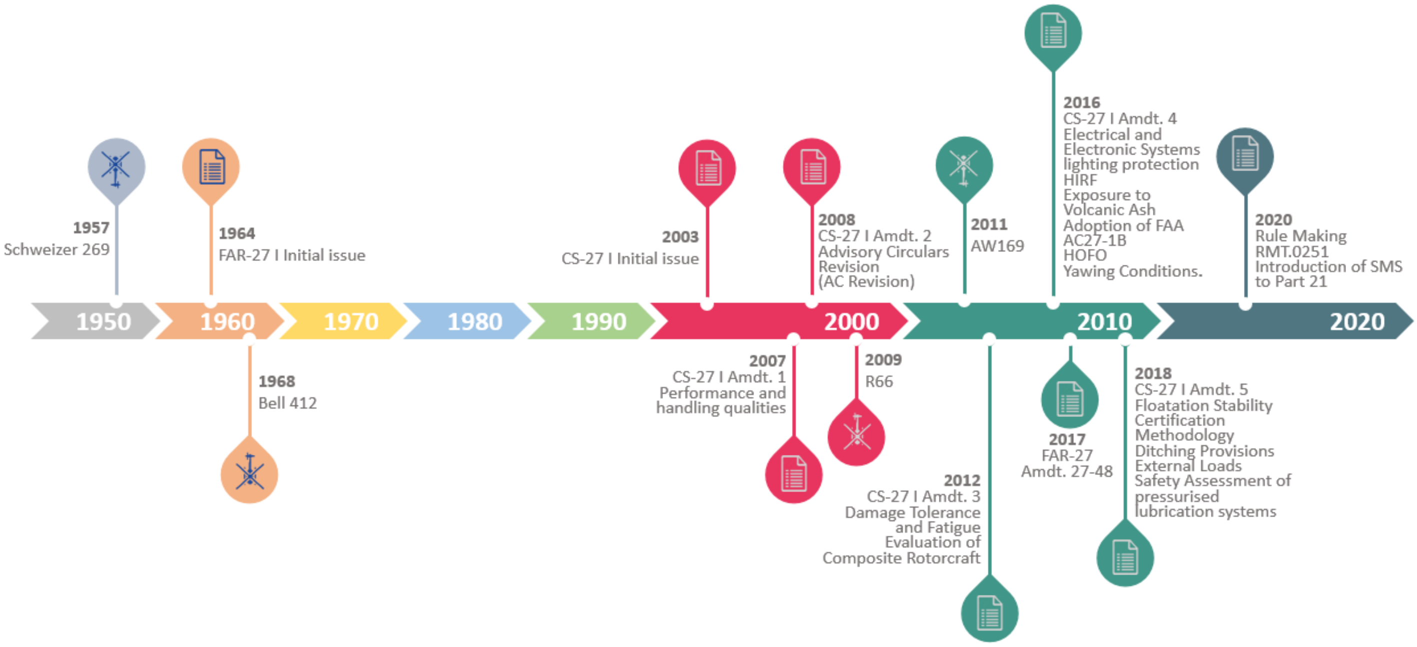
27.6 The review is divided into two parts for clarity;

a) The regulatory developments to the certification requirements for 'Part-27' [which is generic term including the FAA's FAR Part-27 'Normal Category Rotorcraft', and the European JAR-27 and CS-27 'Small Rotorcraft'] since the advent of JAR-27 in 1990.
b) A summary of the certification bases of the rotorcraft types identified, obtained from the most relevant Type Certificate Data Sheets (TCDSs) showing which if any of the more significant developments from (a) above were incorporated into the product's 'type design'.

Regulatory Developments

27.7 A summary certification timeline has been provided in Figure 1. Given the diverse range of certification standards, from the varied competent authorities/NAA's at the time of application, it has not been possible to provide all the details from 1957 to 2017.

Figure 1 Certification Timeline



27.8 Appendix 3 illustrates when the first type was certified, and against which regulation. It then illustrates in more detail, the transition between JAR 27 and CS27, and the subsequent amendments to CS27 to its current amendment 5 status of 2018. Further details of the amendments to CS27 can be accessed via the EASA website for more detail.

27.9 Since the introduction of CS27 in 2003 there has been 5 amendments issued. A summary of these changes is set out below in date order:

a) **Amdt.1**: Performance and Handling Qualities–s - NPA 11/2016

b) **Amdt.2**: Advisory Circular Revisions – NPA 2007 -17

c) **Amdt.3**: Damage Tolerance and Fatigue Evaluation of Composite 3 rotorcraft structures – NPA 2010-04

d) **Amdt.4**: Helicopter Offshore Operations (HOFO) – NPA 2013-10

(i) Yawing Conditions – NPA 2013-21
(ii) High Intensity Radiated Fields (HIRF) and Lighting – NPA 2014-16
(iii) Effects of operations in Volcanic Ash – NPA 2011-17

e) **Amdt 5:** Helicopter Ditching and water impact occupant survivability

(iv) NPA 2016-01
(v) Rotorcraft gearbox loss of lubrication – NPA 2017-07

27.10 Based on the above the Robinson R66 is the only small rotorcraft that has been certified fully to CS 27. The basis for certification was Amendment 2 in 2008. It can be seen from figure 1 and Appendix 3 that most of the helicopters operating onshore have been certified to either JAR 27 or FAR 27, with a few having used CS27 for later modification packages, and therefore have none of the latest design standards incorporated.

27.11 When considering the use of CS29 Large Rotorcraft the AW 169 & AW 189 were certified to Amendment 2 standards in 2008. This is the latest certified large rotorcraft utilised in the onshore sector.

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27.12 There are a number of CS29 certified helicopters that are operated within the onshore sector. All types that can carry greater than nine passengers or have take-off mass exceeding 3175kg are certified against FAR29/CS29 and therefore more likely to either have a VHM systems installed through the Type Certificate Holders manufacturing process or through a customer optional installation. Fitment of VHM equipment and systems to FAR29/CS 29 certified onshore helicopters illustrates the situation whereby; helicopters can be utilised in the same operational environment certified to either FAR27/CS27 or FAR29/CS29 with differing equipment fitted and systems operated.

27.13 Commission Regulation (EU) 2016/1199 adds to Annex V (Part-SPA) of Regulation (EU) No 965/2012 Subpart K, Helicopter Offshore Operations (HOFO). The introduction of HOFO is applicable to operations of greater occupancy than 9 passengers and operating within an offshore environment. operational requirements certification specifications. This regulation requires VHM system and equipment to be fitted and operated for Helicopter Offshore Operations (HOFO).

27.14 Consequently, although onshore helicopters certified to FAR29/CS29 may have the VHM equipment fitted, there is no regulatory requirement to operate the aircraft using the VHM system installed.

27.15 Further clarification on the use of VHM systems for onshore operation is provided in Chapter 25 of this report

Summary of the Certification Basis for the Onshore Helicopter type within scope of the review

27.16 The review of the certification basis for the scope of the onshore review highlights the significant time period deviation from the 1st ‘Small Rotorcraft’ type certified in 1957, Schweizer 269, to that of the latest ‘Small Rotorcraft’, the R66 certified in 2009. These were respectively certified to CAR Part 6, by the FAA and CS27.

27.17 Considering the advent of ‘Large Rotorcraft’ being used for onshore operations the period of certification also varied significantly. The Bell 212/412 was certified in 1968 against FAR29, whilst the AW 169 was certified in 2011 against CS29.

27.18 The types utilised for onshore operations, their Type Certificate Data Sheets and reference dates (application for certification standards) are provided in Appendix 3. The table demonstrates the range of certification standards applied to these types. Further consideration should be given that the variation of which amendment each type was also certified to, this adds further complexity to each type initial certification basis.

27.19 In comparison with the Offshore Helicopter types reviewed, as part of CAP 1145, there is greater time between the first and last type certified for the onshore helicopter types. The S61 was first certified in 1963, while the last type to be certified was the S76C++ in 2005; a period of 42 years. For Onshore Helicopters that time is greater taking both categories of helicopter types into consideration. 54 years have passed between the certification of the Schweizer 269, in 1957 and the AW 169 in 2011. Considering the time period passed, it would suggest that there is significant variation in the levels of safety standards in operation.

<u>Recommendation:</u>

***R21**: The onshore review has highlighted the significant time between first and last type certified and the variation in the levels of safety standards applied. EASA should provide an update on their strategic objectives for Onshore Helicopter types and the future developments of CS27, specifically how this will enhance both Operational and Continuing Airworthiness performance. Consideration being given to rotorcraft certified to earlier safety standards, support from the type certificate holder, product development, spares obsolescence and development of maintenance programmes. EASA should consider communicating their work and future strategy through seminars and industry forums.*

27.20 Considering the 54-year period, there is considerable evolution in technologies between a Schweizer 269 and the AW 169. Structurally helicopters have transitioned from full aluminium skins and frames, through to the introduction of composite technologies. Further advances have been introduced through aircraft systems both electrically and electronically. The introduction of Stability Augmentation Systems, to Multi-Axis Autopilot Systems, electronically controlled engines (FADEC’s) and the Digital

Instrumentation (Glass Cockpits). The combination of new and old technologies and the associated maintenance and continued airworthiness management is one of the many factors that contributes to challenges for the sector.

27.21 From discussions with EASA, it is understood that there is a limited number of new Small Rotorcraft in the certification pipeline. This represents an industry challenge with legacy designs, and their developments, being left operational within the sector. Figure 2 shows some of the average fleet age for each of the types covered within the review. EASA advised that, in the case of some types, requests are being made to extend the intend lives beyond that envisaged in the original certification basis. With fleet age continuing to grow, and limited new types entering the market the following summarises some of the significant challenge's operators face with maintaining and operating their respective fleets:

1) Helicopters certified to earlier safety standards
2) Limited support from the Type Certificate Holder
3) Limited product development,
4) Access to spare parts due to obsolescence
5) Limited development of maintenance programme

27.22 EASA and the CAA recognise that in comparison to the fixed wing sector, the turnover of old helicopters for newer models is limited. There is consideration for how industry could be encouraged to invest in newer helicopters, advanced safety technologies to enhance operational safety. The CAA will continue its engagement with EASA to support any initiatives that will enhance the safety performance of the onshore helicopter sector.

Chapter 28 – Review of VHM and Onshore Operators

Background

28.1 Vibration Health Monitoring (VHM) is the primary means of Health Monitoring provided by Health and Usage Monitoring Systems (HUMS) which have been used on Offshore helicopters since the 1990's. This technology is now regarded by the industry as an established approach to monitoring the health of critical rotating components and to aid in early failure detection. This is achieved by assessing the vibration signature and amplitude of specific components against either a fixed or a learnt threshold. It has typically been utilised for monitoring transmission components associated with gear wear, meshing or damage, bearing wear, shaft balance or misalignment and rotor head balance. The system is also normally used to comply with CAT.POL.305, which requires a Usage Monitoring System (UMS) to be fitted to record engine and other exceedances.

28.2 VHM systems continue to be developed by TCH's and STCH's to improve alert detection, generation and trend analysis. Recent advances in VHM systems from some aircraft manufacturers have begun to include chip detection and automatic fuzz burn as part of their functionality, known as 'Zap Events'. Most of the systems are downloaded from ground stations to web-based portals. Offshore operators and other members of HeliOffshore have continued to develop their use and understanding of the subject, demonstrated by the HUMS Best Practice Guide, that is available on their website.

28.3 Since its introduction and the early mandate from AAD 001-05-99, which came into force on 1 June 1999, further guidance was provided by CAP 693 Around the time that EASA took over responsibility for certification, CAA decided that it was more appropriate for VHM to be addressed by an operational regulation. Consequently, the requirement for VHM in the UK was placed in the ANO with acceptable means of compliance being provided in CAP 753. In 2014 CAP 1145 concluded that the CAA should focus further on the effectiveness of VHM download procedures, reliability and handling of alerts during audits of UK offshore operators. CAP 1145 also called for a review of CAP 753 to clarify alert generation and management for maintenance staff. To address this action the CAA has trained specific staff that carry out auditing of the Offshore Helicopter Operators and their maintenance organisations. This has already been extended to those carrying out audits of Onshore operators when required.

Current Requirements

28.4 The use of VHM operationally was mandated for UK helicopters used in the offshore environment by CAA Safety Directive SD-2018 003. From 1 January 2019 this SD was cancelled and VHM will be needed for most offshore operations as required by European Air Ops Regulation 965-2012, Sub Part K SPA.HOFO.155.

28.5 There are currently no defined maintenance schedule tasks included in the ICA (Instructions for Continued Airworthiness) issued by the TCH's for the mandatory use of a fitted VHM system. However, information is included in the aircraft maintenance manual, including, in at least one case, suggested download periodicity. This is not consistent across all helicopter types which have VHM systems installed. New helicopter types are now subject to MSG 3 analyses of maintenance tasks. Current guidance for MSG 3 volume 2, may allow for maintenance credits or MSG 3 tasks to be derived from the use of VHM. In such case the TCH may require the carriage of VHM and the associated procedures and these to be used by the operators

28.6 The FAA have amended AC 27 -1B CS to address airworthiness Approval of Rotorcraft Health Usage Monitoring Systems (HUMS), the certification of Certification of Normal Category Rotorcraft, now addresses the requirements.

28.7 The VHM system is also often used to comply with CAT.POL.305, which requires a Usage Monitoring System (UMS) to be fitted to record engine and other exceedances in some cases.

Using VHM In the Onshore Sector

28.8 There are currently seven aircraft types included in the Onshore Helicopter Safety Review that are CS29 compliant and therefore could benefit from enhanced safety through the use of this additional monitoring system. Table 1 below shows which aircraft are operating in the onshore sector, which currently may have a VHM system installed.

28.9 SAR aircraft have been excluded from this element of the review as they are being operated under the same VHM procedures and standards as their offshore counterparts. These rotorcraft types either have VHM fitted at build as a standard or could be fitted as optional equipment. On the types where VHM is a standard fit, the system often forms part of the aircraft integral avionic fit. This number is now increasing in the onshore sector with the introduction and popularity of the AW169 in the HEMS role and the increasing availability of offshore equipped helicopters, such as the AW139.

28.10 Newer helicopters types may claim transmission usage credits based on the VHM system as part of the MSG 3 process, however, this has not yet been widely realised.

28.11 The TCH ICA documents do not always recommend the periodicity for download (accept for one / two types), see Table 3. However, all VHM systems are supported within the aircraft maintenance manual procedures for their continued airworthiness. These instructions include fault isolation procedures and system maintenance instructions.

28.12 Helicopters operated in the offshore sector are required to have VHM. But there are no requirements for use of VHM in the onshore sector. Given the likelihood of lower annual utilisation and the shorter/varied flight profiles for the helicopters within this review, consideration should be given to whether a VHM system will collect enough data to form reliable trends or even give suitable alerts. Typically, a VHM system requires operation in flight for 10 to 30 minutes within specified flight regimes to carry out a complete data collection ready for analysis. This would mean that either no data will be analysed or that condition indicators will be missed from the data set. In this case there is the potential for insufficient data collection, thus reducing any meaningful benefit against possible increase in operational costs.

28.13 Whilst the onshore helicopter types already use early failure detection methods such as magnetic chip detection and spectrometric oil analysis on gearboxes, the use of VHM on any helicopter fitted with a type certified system, could provide an increase in early detection of some critical failure modes and therefore potential safety benefits. There would be additional costs associated with additional manpower and the operator may potentially have to enter into a service agreement with the TCH for support and alert analysis, as the procedures in the maintenance manual only allow for limited fault diagnosis and assessment.

28.14 VHM systems can give numerous alerts that are not always indicative of unserviceability, but rather acceptable changes in the transmission system characteristics. This includes scenarios that could result in;

- the system alerting, with no mechanical fault found
- a close monitoring period being observed (potentially with operational restrictions)
- TCH advice being sought
- the indicator threshold being learnt or relearnt
- the aircraft returned to normal operation

This is often carried out without any further positive maintenance action being done and will undoubtedly have a commercial cost as the TCH support is required in most cases due to the complexity of the analysis and the limited nature of the AMM information.

28.15 Operational logistics and costs for onshore use of VHM systems would be significant and requires evaluation. Looking at the performance of North Sea VHM systems, the current rate of alerts is typically around 1 alert every hour to 1 alert every 10 hours. This differs significantly between different systems on different helicopter types. Though an alert does not stop operation, it does require maintenance action to be taken, which is typically carried out before further flight. For offshore operations the amount of investigative maintenance needed to verify if each Alert is an Alarm, i.e. relates to mechanical issues with the rotor or rotor drive system, is high. Because this work is performed by trained staff who are available to work through the night, it is usually possible for the helicopter to be despatched for flight the next morning, thus not disrupting planned operations. For onshore operations, however, the situation is very different, as helicopters can operate away from base for extended periods without access to routine line and base maintenance capability. For such operations, introduction of VHM systems similar to those currently used in the North Sea could result in helicopters being frequently unavailable whilst engineers travel out to the helicopter to diagnose alerts, many of which would turn out to be false, or relate to the VHM/HUMS itself. This situation would clearly have an impact on certain types of operation including air ambulance / HEMS operations where availability is a critical aspect of the role.

28.16 As described earlier, the safety benefit of HUMS for offshore helicopters results largely from identification of unusual behaviour, e.g. something is misaligned or out of balance, which could be the result of wear, failure or maintenance intervention. VHM applications to monitor internal gearbox failure modes can be less effective where the failure propagation time is quick, e.g. in the case of bevel wheel failures experienced by G-CHCN and G-REDW. When considering the safety benefit for offshore helicopters, the affected helicopter types typically have a more complex rotor drive system because; they transmit more power, have two inputs, have provision for multiple accessories (generators, hydraulic pumps, air-con etc.) and may incorporate other features such as capability to operate in “hotel” or “APU” mode. This increased complexity of function can also result in increased complexity of the lubrication and cooling systems, involving multiple pumps and oil coolers. In short, there are more parts and maintenance tasks, and associated failure modes with a 10+ tonne helicopter than with a 600 kg piston helicopter which may not require oil coolers, oil pumps, hydraulics. Generally, the CS29 and CS27 Appendix C helicopters designs which are used for HEMS and police operations share more commonality with their heavier CS29 relatives. Consequently, the potential safety benefit of VHM to onshore operations will be less than that for offshore operations and generally become further reduced the lighter and simpler the design of helicopter. At the same time the cost of operating HUMS on a large helicopter is a much smaller contributor to the total operating costs that it would be on a small helicopter.

28.17 Before deciding the next steps for onshore VHM, it is recommended that a study assessing the potential safety benefit, maintenance workload, potential operational disruption and the associated costs of each of these aspects should be performed for the different primary roles of onshore Commercial Air Transport operation.

Action:

***A25**: The CAA will carry out a study to assess if and how VHM should be utilised for onshore helicopter operations. This will include an assessment of the potential safety benefit, additional maintenance workload and potential operational disruption resulting from introduction of VHM along with the associated costs of each of these aspects. This will be performed considering the impact separately on each of the different roles of onshore Commercial Air Transport operation.*

The study should assess the optimum functionality of onshore VHM systems which can be achieved to maximise the potential safety benefit whilst minimising levels operator maintenance input and disruption to operations.

Action:

***A26:** The CAA should understand the impact and use of VHM for onshore helicopters, where it is installed and not installed. The CAA should engage with the onshore AOC's and associated Part M organisations, with helicopters which have VHM systems installed to:*

(a) Determine the benefits and risks associated with VHM.
(b) Where there is an organisation SMS, ensure the organisations SMS has reviewed the benefits and risks associated with VHM, and where;
(c) The VHM system is not utilised a Risk Assessment has been completed to mitigate the system not being utilised.

Note this action should be undertaken with CAA Flight Operations

Recommendation:

***R22** The onshore review has highlighted TC holders differing requirements for VHM downloads resulting in aircraft equipped with VHM systems, were the information is not being captured, recorded, analysed or acted upon. EASA should standardise the ICA for VHM systems to include recommendations for the download frequencies for helicopters, where the system is installed and there is no operational requirement.*

Recommendation:

***R23** The onshore review has highlighted safety issues whereby TC holder Instructions for continuing airworthiness are incomplete with missing task instructions. This includes missing tasks from the Aircraft Maintenance Manual (AMM). EASA should update the CS27 and CS29 certification standards to require TC holders to complete the ICA's prior to certification and entry into service.*

Table 1 Helicopter currently operating in the onshore sector where VHM systems may be installed

Type	**Number currently registered to an onshore operator**
AS 365	11
EC 155	11
AW 169	14
AW139	3
AW 189	3
S76	9
S92	1

Table 2 Helicopter VHM Capture Rates and Flight Regime Requirements

Aircraft Type	Time at Regime	IAS	Combined Torque
AS365 / EC155	20 minutes	60 knots	60%
AW169 / AW189	15	From Engine Start	
AW139, pre BT139-480	35 - 45 minutes	130 - 160 knots	>50%
AW139, post BT139-480	35 - 45 minutes	from engine start, flight still required to collect all data	
S76	15	From Engine Start	
S92	23 minutes	from eng start flight still required to collect all data and 60 knots required	40%

Table 3 Helicopter Chapter VHM Download Requirements

Aircraft Type	MSM or Chap 4/5	Instructions from AMM	Aircraft Numbers
AS365	N	MET 45-11-02-301 Applicability: 365 N3 helicopters fitted with the FULL HUMS Frequency: it is recommended to download the data after each flight, when the mission permits, to detect any damage as soon as possible. Daily downloading remains acceptable. Data Transmission Procedure Figure 1: the data transmission procedure is used to inform the Airbus Helicopters (AH) Technical Support, of all the problems relating to the applications of the M'ARMS or its diagnostics. The data transmission reports concern two types of different defect: the defects related to the application of the M'ARMS, which lead to change to the installation design, change to the system design (H/W, S/W), the defects related to the M'ARMS diagnostic (MET 45-11-02-102).	11
EC155	N	AMM 45-11-02-611 Applicability: EC 155 helicopters on which the M'ARMS system is installed Frequency: it is recommended to download the data after each flight, when the mission permits, to detect any damage as soon as possible. Daily downloading remains acceptable. Data Transmission Procedure Figure 1: the data transmission procedure is used to inform the Airbus Helicopters (AH) Technical Support, of all the problems relating to the applications of the M'ARMS or its diagnostics. The data transmission reports concern two types of different defect: the defects related to the application of the M'ARMS, which lead to change to the installation design, change to the	11

Aircraft Type	MSM or Chap 4/5	Instructions from AMM	Aircraft Numbers
		system design (H/W, S/W), the defects related to the M'ARMS diagnostic (AMM 45-11-02-800).	
AW169	N	AMM data only relates to maintenance of the system and analysis without specifying any download frequency	14
AW139	N	AMM data only relates to maintenance of the system and analysis without specifying any download frequency	3
AW189	N	AMM data only relates to maintenance of the system and analysis without specifying any download frequency	3
S76	N	AMM data only relates to maintenance of the system and analysis without specifying any download frequency	9
S92	N	SA S92A-HUM-000 The typical HUMS operation cycle on a flight-by-flight basis consists of the following: **Data Card Initialization**: The GS is used to initialize a data card in preparation for use. **Pre-flight**: The Data Card is inserted into the DTU and the aircraft configuration is verified and/or changed if necessary. **In-flight**: The flight crew might initiate one or more event markers to mark specific events, such as a bird strike, smoke in the cockpit, small arms fire, etc., or change the Data Card if it becomes full. **Downloading Data to the GS**: The Data Card is removed from the aircraft and data is downloaded from the Data Card to the GS. **Debriefing**: The debriefing procedures are performed using the GS.	1

Aircraft Type	MSM or Chap 4/5	Instructions from AMM	Aircraft Numbers
		AMM 18-10-02 also provides procedures for HUMS usage.	

Section F: Meteorology

Chapter 29: Meteorological issues

29.1 The Civil Aviation Authority is the Meteorological Authority for the United Kingdom. The Meteorological Authority arranges for forecasting and climatological services for civil aviation to be provided by the MET Office which is designated by the CAA as the Meteorological Air Navigation Service Provider for the UK under EU Regulations. In accordance with international regulations (specifically ICAO Annex 3) the CAA's objective is to supply operators, flight crew members, ATS units, airport management and other civil aviation users with the meteorological information necessary for the performance of their respective functions, thus contributing towards the safety, regularity and efficiency of air navigation. The UK Aeronautical Information Publication at GEN 3.5 describes the UK arrangements and services available.

29.2 While in the UK weather information is made widely available, weather is often identified as one of the more significant causal factors in past accidents and therefore consideration has been given as to how to reduce the risk of incidents where weather is a significant causal factor.

29.3 To establish potential actions which may help to reduce the risk of weather-related incidents it is important to understand why particular weather conditions might contribute to an incident. For example, typical weather conditions that present the highest risks are:

a) low visibility,

b) cloud related conditions (e.g. low cloud base or convective clouds), and

c) thunderstorms

29.4 These conditions are assumed to be high-risk because there is a perception that when the weather conditions are starting to deteriorate it can be difficult for pilots to effectively judge the potential impact on flight-planning and therefore how quickly they may need to respond and make weather-related decisions, either pre-flight or in-flight, to avoid or be prepared for a change in conditions e.g. from VFR into IMC.

29.5 As these conditions often occur and don't always result in an incident, it is worth understanding why in some cases, these conditions result in an incident. From this it is possible consider potential mitigation for these high-risk weather conditions.

Possible Causes

29.6 For incidents where weather was a significant causal factor the most likely possible causes are:

a) Was the MET information inaccurate?

b) Was there an issue with the pilots MET knowledge?

c) Would additional or more up to date MET information have reduced or prevented the risk?

d) Did the pilot make the best use, of available MET information but then make a flawed weather-related decision?

29.7 To help our understanding of which of these are the most likely cause, or causes, it is useful to consider the meteorological reports requested by the AAIB following an incident. The reports describe the weather conditions at the time of the incident and provide the historic forecast information that would have been available to the pilot for pre-flight-planning. Generally, the forecasts available for flight planning align with the actual en-route and destination conditions most likely to have been experienced at the time of the incident.

29.8 This suggests that inaccurate, or insufficient or out of date MET information, are not a primary reason why adverse weather conditions result in incidents. However, this does not mean that these areas should be neglected and indeed a great deal of work goes into maintaining and developing the accuracy, the frequency and the availability of forecasts.

29.9 But because accuracy and availability of MET information do not seem to be a primary causal factor in incidents this therefore focuses attention on pilot MET knowledge and/or pilot's use of available MET information.

Risk Mitigation

29.10 One way to reduce the risk of incidents occurring where weather is a significant causal factor could be to support the development of pilot skills required to correctly interpret all the weather information that is available, and hence help to enhance the effectiveness of weather-related decisions both pre-flight and in-flight – in other words weather related threat and error management.

29.11 Most pilots acquire their MET knowledge during initial flight training. It is generally agreed that the MET topics covered in the syllabus is comprehensive, however, it may be beneficial to review the effectiveness of how the syllabus is trained and tested.

29.12 Additionally, it is noted that once qualified there are limited mandatory requirements for the ongoing development or assessment of MET. Therefore, a conclusion might be that there isn't a sufficient focus on developing the skills required to effectively use the MET information that was learnt during initial training.

Met Office Products and Services

29.13 The CAA arranges for all meteorological forecast information required for civil aviation to be provided by the Met Office and in recent years use of web technology has enabled the introduction of new services including bespoke products for helicopter emergency services, which are free at the point of use for Police, SAR and HEMS. There are also commercial options for specific sectors such as the Offshore Oil and Gas industry. These products are provided by the Met Office which works with operators to ensure that users requirements are understood.

29.14 However, Met Office statistics indicate that many pilots do not make full use of the service which enables pilots to clarify specific aspects of forecasts after they have self-briefed, additionally there is a “Talk to a Forecaster” service which for a fee pilots can request bespoke guidance for a particular flight or series of flights.

29.15 Whilst it is recognised that some products come at a cost, all efforts should be made by operators in ensuring that crews are provided with a range of methods to access MET information to make perhaps the most safety critical decision of all, that of to fly or not.

29.16 Whilst the Met Office provide a range of forecast products which are freely available to civil aviation users there are limited funds for this activity which are regulated under the European Commission Performance Scheme for all Air Navigation Service Providers. However, the Met Office holds an annual user forum with its customers to determine whether the service provided meets their requirements, and in specific instances where there is a demonstrated user requirement, it may be possible for new products to be provided. In addition, the CAA’s MET /AIM team attends various CAA working groups and committees from time to time to address specific user MET issues.

29.17 For example, as a direct consequence of the fatal A109 accident at Vauxhall the CAA worked with the Met Office and helicopter operators in introducing a London Area Forecast which effectively identifies cloud base and visibility minima portrayed in a traffic light system to enhance decision making.

29.18 The CAA is aware that a number of ex-military pilots have access to products provided by the Met Office at military aerodromes, in particular the ‘cross-section’ forecast, and many of these pilots believe that this product could be beneficial to civilian operations. It is believed that there is a perception amongst some ex-military pilots that the current civilian products and the form in which they are available do not readily interface with today’s flight planning methods which are now heavily biased towards apps and web-based systems. It has been suggested that the onshore helicopter industry requires simple products to use ‘in the field’ with minimal three-dimensional interpretation to plan and execute its mainly VFR operations.

Third-party providers of MET Products and Services

29.19 It is understood that in some cases pilots use webcams to visualise real time weather close to their ‘off aerodrome’ destination, operating area or routes, and additionally, when considering weather awareness and decision making, it is important to acknowledge the proliferation of other meteorological information service providers and weather app tools that are routinely used by pilots and which are the subject of focus in the UK, Europe and the USA via ‘weather-in-the-cockpit’ working groups. These groups recognise that there are some key issues experienced by users with weather Apps some of which are related to the limitations in the data which is used in these tools, which in turn means that the pilot interface cannot be fully optimized. The industry is developing use of digital aeronautical information and it is expected that in time this will significantly help providers of weather apps to enhance the user interface and functionality. In the interim operators should work with third party providers to discuss their requirements as appropriate (Note: Under current UK or EU legislation there are no regulatory requirements in place for third-party providers of MET products and services).

29.20 The Civil Aviation Authority is the Meteorological Authority for the United Kingdom. Meteorological forecasting and climatological services for civil aviation are provided by the Meteorological Office as the agent for the Civil Aviation Authority. The UK Met Authority's objective is to supply operators, flight crew members, ATS units, airport management and other civil aviation users with the meteorological information necessary for the performance of their respective functions, thus contributing towards the safety, regularity and efficiency of air navigation. The UK Aeronautical Publication at GEN 3.5 describes the UK system and services available.

29.21 Notwithstanding these existing arrangements operators cite that since the closure of military aerodromes and the associated Met services it is now very difficult to build a complete weather picture for parts of the UK. Conversely, existing military Met services, in particular the cross-section area forecast product, is something many ex-military pilots believe could bring great benefit to civilian operations. There is a perception that the current products and the form in which they are available do not readily interface with today's flight planning methods which are now heavily biased towards Apps and web based systems. The onshore helicopter industry requires simple products to use 'in the field' with minimal three-dimensional interpretation to plan and execute its mainly VFR operations. It is also evident that many operators do not use the 'phone a forecaster' service which will provide a bespoke product for that particular flight or series of flights.

29.22 Many operators augment their planning process by utilising other products and also Webcams to visualise real time weather close to their 'off aerodrome' destination, operating area or routes.

29.23 As a direct consequence of the fatal AW109 accident at Vauxhall the CAA worked with the Met Office, Met Authority and industry in introducing a London Area Forecast which effectively identifies cloud base and visibility minima portrayed in a traffic light system to enhance decision making.

29.24 Recent years has seen the introduction of bespoke commercial products like Helibrief, provided by the Met Office, which packages products together for specific sectors such as Oil and Gas and Police operations so that user defined requirements are met. It is recognised that such products come at a cost, but all efforts should be made by operators in ensuring that crews are provided with the most accurate and intuitive methods in making perhaps the most safety critical decision of all, that of to fly or not.

<u>Recommendation:</u>

R24 *It is recommended that the Meteorological Office establish a working group with onshore helicopter operators and the CAA to review weather information user requirements and methods of provision including third party providers of web or App based planning products to ensure that they meet onshore helicopter pilot needs.*

Recommendation:

R25 *It is recommended that the Met Authority investigate the possibilities of accessing military services to augment the civil system and inform the CAA of their findings.*

Section G

Chapter 30: Conclusion

This report contains the results of a systematic safety analysis of onshore helicopter commercial air transport operations, including emergency services, non-commercial complex (NCC) operations, and specialised operations (SPO). The review also considered the maintenance and continued airworthiness aspects associated with onshore operations. In doing so, it has focussed on the absolute primacy of the safety of the passengers and crew involved in such operations but also third parties that could be affected.

In its delivery, the CAA engaged the British Helicopter Association (BHA) and Cranfield University in providing a small team of subject matter experts to review the document and offer independent challenge to the content. As part of the process the CAA recognises that the diverse helicopter industry has a number of challenges within a complex and evolving operating environment.

A number of accidents and incidents occurred in the review period, but the broad occurrence data analysed indicates that the UK continues to have a safety orientated industry and a strong reporting culture showing a high level of safety maturity. The data gained demonstrates that in most areas when in comparison with European and international information the UK's standards are of at least equal status or exceed them in some.

Notwithstanding this, there are a number of interventions that collectively will improve the overall sector safety performance, and these have been identified within specific actions and recommendations.

Actions and recommendations

The report identifies the need for Safety Management Systems to be developed to cover processes, procedures and appropriate company assurances in flight operations such that tactical airborne decision making is kept to the minimum. In 2013 EUROCONTROL produced a White Paper entitled "From Safety I to Safety II", in which it articulates the concept of moving from a safety management perspective of focusing on the small number of things that go wrong to the many things that go right. The UK helicopter industry is incredibly diverse, and the individual sectors have become agile in reacting to industry events. The proactive principles within operator's safety management systems are still maturing but a shift in focus would benefit an industry which has experience in many different facets of aircraft operation.

There is no pure safety related onshore body such as that established post the review of Offshore Safety in CAP 1145. The Offshore Helicopter Safety Leadership Group (OHSLG) establishes high level governance in identifying and prioritising offshore aviation risks and devises workplans for safety sub-groups to ensure effective action is taken to minimise those risks. It shares, monitors and defines the top industry risks identified individually by each helicopter operator and the CAA, and maintains oversight of all work contributing to improvements in helicopter safety. Therefore, as hypothesised in the report introduction, the establishment of a pan-industry onshore safety leadership group would facilitate the raising of safety standards through onshore stakeholder collaboration and work groups.

Action:

A27 *The CAA will work with the onshore industry to develop and implement similar objectives to the OHSLG through an Onshore Safety Leadership Group for CAT and emergency service operations.*

Over half of the reported accidents and incidents cited in this report involved Non Commercial Complex and Specialised Operations. The CAA recognises that in NCC and SPO the industry would benefit from regular updates and workshops to help raise standards. Within such a programme, the CAA will continue to work with the helicopter industry to help increase their awareness and understanding of the need for effective root cause analysis.

The CAA would like to thank all those who gave their time, knowledge and expertise in helping to shape this review which will strengthen the safety of onshore helicopter operations in the UK.

The tables below outline the key recommendations and actions and a proposed timeline for their introduction.

Next steps

A number of strategies are already underway including the formation of the Onshore Safety Leadership Group. Recommendations made to industry will be discussed and if needed implemented through associated task and complete work groups. This

Group will publish its progress in these matters in the form of an annual update as well as minutes of meetings held.

The CAA will engage directly with EASA for recommendations that have a Europe-wide context through EASA legislation.

The focus of this review broadly encompassed commercial operators and professional pilot users of helicopters and the non-commercial other than complex sector (NCO) has therefore not been reported upon. It is the CAA’s intention to begin a similar review using the existing dataset to ensure that the light General Aviation sector is offered the opportunity to learn from such safety research and recommendations.

Section H

Chapter 31: Action & recommendations

Table 1. Summary of Actions

Action No.	Action Details
A1	*The CAA will consider developing guidance material on the principles of Safety II in appropriate Civil Aviation Publications (CAP) for each sector of UK helicopter operations so that best practice can be shared by all in meeting regulatory requirements.*
A2	The CAA will carry out focussed oversight on, small and medium complex Part 145, Part M organisations relating to the reporting of safety events as per the requirements of EU 376/2014 to ensure there is a consistent level of reporting across all areas of the industry..
A3	The CAA will invite a representative with experience of the Agusta/Leonardo product range to the Onshore A31 working group in order that events relating to the product range can be discussed
A4	*The CAA will communicate the importance of reporting occurrences in accordance with Regulation (EU) 376/2014 and in particularly to the non-commercial aviation community.*
A5	*The CAA will provide a review of industry reports and MOR's at each of its capability seminars. These reviews will be sector focussed highlighting significant safety events and adverse trends. Summary slides of these seminars will be shared via the CAA's website and highlighted via Skywise*.
A6	*The CAA will discuss and highlight its findings from the Design related MOR's with EASA and the competent authority for Design and Production to ensure there is awareness of the matters this review has raised.*
A7	*The CAA will carry out focussed oversight of onshore helicopter Continued Airworthiness Management Organisations to verify their compliance with the management of continued airworthiness, to include a Critical and Life Limited Components, maintenance programmes, instructions for continuing airworthiness (i.e.'SB's and 'AD's), resources, knowledge and experience of staff.*
A8	*The CAA will engage and deliver, via the Onshore Helicopter Maintenance Standards Improvement team (A31), further development of the Continuing Airworthiness Management*

Action No.	Action Details
	Organisation competencies to deliver guidance material for CAW functions.
A9	*The CAA will support industry in developing guidance material through the A31 working group structure to produce a framework to help CAMO staff gain the required knowledge and experience to progress through an organisation's structure and achieve specific roles within a CAMO.*
A10	*The CAA will work with the helicopter industry to help increase their awareness and understanding for the need of effective root cause analysis, via industry seminars and workshops.*
A11	*The CAA will ensure that the results of this onshore helicopter review, compliance performance section, are fed back to all CAA Surveyors and at Industry Seminars.*
A12	*The CAA will review the previous UK Instrument Night Qualification (INQ) with a view to assessing its suitability for re-introduction*
A13	*The CAA will formalise its programme of education, advice and awareness to operators of EASA NCC and SPO requirements.*
A14	*The CAA will review SERA 5015 and consider implementing a national position so that all IFR take-offs and landings are conducted in* accordance *with either notified or approved procedures.*
A15	CAA will liaise with NATS to review the NOTAM system with the aim of improving the presentation of information to end users. .
A16	*The CAA, with the assistance of the industry, will review CAP 1581 and* ensure *that wherever possible the recommendations therein are adopted.*
A17	*The CAA will conduct a review of all of its training, standards and guidance material associated with the onshore helicopter industry to ensure that it is relevant and up to date. .*
A18	*The CAA will instigate periodic Training Standards meetings with industry.*
A19	*The CAA, in conjunction with the Flight Crew Human Factors Advisory Panel (FCHFAP), will produce and provide focused CRM courses for industry that will meet industry's needs in respect of initial and recurrent CRM training.*
A20	*The CAA will review its policy and guidance to industry on the use of simulation for training and testing.*
A21	*The CAA will engage with Industry to review the training and testing of engine failures leading to autorotation to ensure that the appropriate skills and awareness are being addressed.*

Action No.	Action Details
A22	*The CAA* will *review the equipment and training requirements needed for safe ad hoc landings conducted by Police Operators at night with the aim of including the requirement for NVIS.*
A23	*The CAA will establish a work group with key stakeholders and operators to review the provision of Hospital Landing Site information with the aim of adopting a unified controlled source similar to that used for offshore helidecks.*
A24	*The CAA will review the minimum specification of visual correction when using NVG and propose suitable standards to ensure optimisation of optical and visual performance.*
A25	*The CAA will carry out a study to assess if and how VHM should be utilised for onshore helicopter operations. This will include an assessment of the potential safety benefit, additional maintenance workload and potential operational disruption resulting from introduction of VHM along with the associated costs of each of these aspects. This will be performed considering the impact separately on each of the different roles of onshore Commercial Air Transport operation.*
A26	*The CAA should understand the impact and use of VHM for onshore helicopters, where it is installed and not installed. The CAA should engage with the onshore AOC's and associated Part M organisations, with helicopters which have VHM systems installed to:* *(a) Determine the benefits and risks associated with VHM.* *(b) Where there is an organisation SMS, ensure the organisations SMS has reviewed the benefits and risks associated with VHM, and where;* *(c) The VHM system is not utilised a Risk Assessment has been completed to mitigate the system not being utilised.* Note this action should be undertaken with CAA Flight Operations
A27	*The CAA will work with the onshore industry to develop and implement similar objectives to the OHSLG through an Onshore Safety Leadership Group for CAT and emergency service operations.*

Table 2 Summary of Recommendations

Recommendation No.	Recommendation Details
R 1	*The onshore review has shown important safety related data is not being* captured *as part of the ECCAIRS occurrence reporting system. It is recommended that EASA propose, to the ECCAIRS working group, amendments to the existing taxonomy for Human Factors and the ability to identify the HF additional contributory factors in events*.
R 2	*The onshore review has shown important safety related data related to component life limits is not being captured as part of the ECCAIRS occurrence reporting system.* *To extract actionable intelligence regarding component performance, it is recommended that EASA propose to the* ECCAIRS *working group that an additional requirement be placed on the reporter to identify when a component has been replaced and whether the component is subject to a life limit*
R 3	*It is recommended that operators ensure that their procedures and training material appropriately address the risks associated with off-airfield landing sites and are monitored for effectiveness.*
R 4	*It is recommended that operators show clear evidence of operational* control *as defined in AMC1 ORO.GEN.110 (c), ensuring that there is a clear tasking process separating the customer and the flight crew.*
R 5	*It is recommended that operators create an Unusual Attitude training programme in line with the current Upset Prevention and Recovery Training (UPRT) as listed under Part ORO, ORO.FC. 220 & 230. The CAA will maintain oversight for the UPRT training within the current oversight program.*
R 6	*It is recommended that operators review their training manuals/Part D to ensure that:* *a) they are compliant with the Operational Suitability Data (OSD) including Training Areas of Specific Emphasis (TASE) for the types they operate; and* *b) their current ground and flying training is relevant and suitable for the operational needs.*
R 7	*It is recommended that the industry propose a case for rule change for the suitability of the pre-requisite experience required for Type Rating Examiners with a view to ensure that it is proportionate and attainable.*

Recommendation No.	Recommendation Details
R 8	*It is recommended that EASA encourage the Original Equipment Manufacturers (OEM) to produce Flight Crew Operating Manuals (FCOM) and Flight Crew Training Manuals (FCTM) for all current and future helicopter types.*
R 9	*It is recommended that the London CTR Working Group review the weather minima for SVFR helicopter operations within the London and London City CTRs with a view to establishing minima of 3km visibility and 1000ft cloud ceiling for all helicopter operations. However, operations under SPA.HEMS approval and State AOC's (Police and SAR) should be permitted to operate to current lower minima.*
R 10	*It is recommended that the London and London City CTR Air Navigation Service Provider (ANSP) provider investigate the possibility of formally closing the heli-routes according to the weather limits outlined above and formally opening them when weather is above the limits.*
R 11	*It is recommended that the Heli routes within the London and City CTR's be safeguarded to ensure safe and legal separation can be maintained at the minimum and/or maximum route altitudes. These should be rigorously safeguarded at holding points and approach and departure directions from/to the London Heliport*
R 12	*It is recommended that the The London Heliport Operator establish a baseline turbulence model such that the effect of future building work around or adjacent to the FATO and Ramp can be determined.*
R 13	*It is recommended that the London Heliport investigate the possibility of implementing a Local Flying Area to the north of the heliport*
R 14	*It is recommended that aircraft manufacturers and training organisations review CAA Paper 2003/01 with a view to providing reliable emergency procedures/advice/training for pilots to apply in the event of a tail rotor failure or loss of tail rotor effectiveness.*
R 15	*It is recommended that operators review the VFR minima in their operating procedures in the context of their operations and the flight characteristics (e.g. handling qualities) of their aircraft and adopt and apply higher minima where appropriate.*
R 16	*The Operational Control and Supervision of all Police Aviation activity should be undertaken by one entity to ensure that all airborne assets are under central control.*

Recommendation No.	Recommendation Details
R 17	*It is recommended that the UK Meteorological Office, Industry and the CAA review the availability of weather forecasting and reports in remote areas of the country.*
R 18	*It is recommended that Police/SAR/HEMS operators should include in their safety risk mitigations, fitting their helicopters with systems for the detection and avoidance of obstacles and wires*
R19	*It is recommended that industry through the CAA Human Factors Advisory Panel consider creating additional HEMS specific CRM guidance and/or training courses for HEMS operators. This to ensure standardisation and the effectiveness of crew communications, in this specialist sector where team work is essential for the desired safety outcomes*
R 20	*It is recommended that operators ensure that crew training includes scene safety and downwash effects on property and persons.*
R 21	*The onshore review has highlighted the significant time between first and last type certified and the variation in the levels of safety standards applied. EASA should provide an update on their strategic objectives for Onshore Helicopter types and the future developments of CS27, specifically how this will enhance both Operational and Continuing Airworthiness performance. Consideration being given to rotorcraft certified to earlier safety standards, support from the type certificate holder, product development, spares obsolescence and development of maintenance programmes. EASA should consider communicating their work and future strategy through seminars and industry forums.*
R22	*The onshore review has highlighted TC holders differing requirements for VHM downloads resulting in aircraft equipped with VHM systems, were the information is not being captured, recorded, analysed or acted upon. EASA should standardise the ICA for VHM systems to include recommendations for the download frequencies for helicopters, where the system is installed and there is no operational requirement*
R 23	*The onshore review has highlighted safety issues whereby TC holder Instructions for continuing airworthiness are incomplete with missing task instructions. This includes missing tasks from the Aircraft Maintenance Manual (AMM). EASA should update the CS27 and CS29 certification standards to require TC holders to complete the ICA's prior to certification and entry into service. .*

Recommendation No.	Recommendation Details
R 24	*It is recommended that the Meteorological Office establish a working group with onshore helicopter operators and the CAA to review weather information user requirements and methods of provision including third party providers of web or App based planning products to ensure that they meet onshore helicopter pilot needs.*
R 25	*It is recommended that the Met Authority investigate the possibilities of* accessing *military services to augment the civil system and inform the CAA of their findings.*

Section I

Flight Operations Appendices

Appendix 1 - Abbreviations

Abbreviations	
AAHK	Airport Authority Hong Kong
ACL	Airports Coordination Limited
AICC	Assets in the course of construction
AIO	Assets in operation
AMM	Aircraft Maintenance Manual
capex	Capital expenditure
CC	Competition Commission
CE	Constructive Engagement
CMA	Competition and Markets Authority
DAA	Dublin Airport Authority
DfT	Department of Transport
EU	European Union
FSC	Full service carrier
G2	A second runway at Gatwick to the south of the existing airport
GAL	Gatwick Airport Limited
H3	A runway at Heathrow, north west of the existing airport
HAL	Heathrow Airport Limited
HH	Westward extension of the northern runway at Heathrow Airport
HKIA	Hong Kong International Airport
IP	Infrastructure Provider
LBC	Licence Backed Commitments
LCC	Low cost carrier
LNG	Liquefied natural gas
MCC	Material change in circumstances
MPD	Market power determination
OFTOs	Offshore Transmission Owners
opex	Operational expenditure
PSDH	Project for the sustainable development of Heathrow
Q1, Q2, etc.	The first, second etc. quinquennium review periods
RAB	Regulatory asset base
rTPA	Regulated Third party access

Abbreviations	
SMP	Substantial market power
SPV	Special purpose vehicle
STAL	Stansted Airport Limited
the Act	Civil Aviation Act 2012
the Commission	Airports Commission
WACC	Weighted average cost of capital
WCML	West Coast Main Line

Appendix 2 – Previous Research

1. CAA Paper 99001, Pilot Intervention Times in Helicopter Emergencies - Executive Summary

Executive Summary

Total power failure, tail rotor control failure and tail rotor drive failure in helicopters are time critical emergencies. Automatic flight control system failures may also demand a prompt response in some circumstances. Detection times and response times to total power failures were measured during routine training sorties in Chinook, S61N and Super Puma simulators. The effects of distraction on reaction time were investigated by introducing a minor failure immediately before total power failure on some sorties in the Super Puma. Data were also collected during routine training sorties for responses to tail rotor drive failure and tail rotor control failure in the Super Puma simulator. The required response for all these emergencies was lowering of the collective lever. Detection times for automatic flight control system pitch runaways were measured in the S61N during dedicated experimental sorties. The response in this case was a cyclic input. An attempt was made to identify the principal alerting cues for each failure in each simulator.

Total power failure: The mean detection time was in the range 1.07 to 2.22s and the 90th percentile was in the range 2.07 to 2.95s. The mean response time was in the range 1.24 to 1.82s and the 90th percentile was in the range 1.95 to 3.85s. The mean total reaction time was in the range 2.3 to 4.13s and the 90th percentile was in the range 4.42 to 5.72s. There was no significant effect due to distraction: The mean detection time for these trials was 2.31s and the 90th percentile was 4.82s; the mean response time was 1.65s and the 90th percentile was 2.77s; the mean total reaction time was 4.16s and the 90th percentile was 5.1s.

Tail rotor control failure: The mean detection time was 0.9s and the 90th percentile was 1.22s. The mean response time was 1.53s and the 90th percentile was 3.78s. The mean total reaction time was 2.57s and the 90th percentile was 4.65s.

Tail rotor drive failure: The mean detection time was 1.53s and the 90th percentile was 2.94s. The mean response time was 2.74 s and the 90th percentile was 6.06 s. The mean total reaction time was 4.9s and the 90th percentile was 7.79s.

Automatic flight control system failure: The mean detection time was 0.4s in the hover and 1.59s in the cruise; the 90th percentile was 0.69s in the hover and 2.4s in the cruise. The mean effective total time required to control the failure was 1.62s in the hover and 2.24s in the cruise; the 90th percentile was 1.83s in the hover and 2.61s in the cruise.

The difference in detection times for automatic flying control system failures in the hover and the cruise (90th percentiles of 0.69s and 2.4s respectively) demonstrates the effect of the pilot paying close attention to a control variable which is immediately disturbed by the failure. A safe regulatory approach would in general have to cater for less focused attention.

Excluding the automatic flying control system failure in the hover (as a case of focused attention) leaves a range of 90th percentile detection times generally between 2 and 3s. Only the tail rotor control failure case provides a shorter 90th percentile detection time. Acceptance of a 10% failure rate would in general require an allowance of at least 2 and preferably 3s for detection time. Current regulations should be reviewed with this in mind.

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2. CAA Paper 95009, Pilot Intervention Times in Helicopter Emergencies - Summary

Summary

Air Accident Investigation Branch (AAIB) reports into accidents that have occurred to civil helicopters operating in the UK, have highlighted the failure to control rotor rpm following power failure as a contributory factor in numerous accidents, some of which have resulted in loss of life.

The CAA's Mandatory Occurrence Report (MOR) database has been interrogated during this study to ascertain the historical significance of rotor speed control problems on the accident record of civil helicopters registered in the UK. From this study, it has been judged that had a requirement been in force to fit an enhanced rotor speed protection system since 1976, a significant reduction (82%) in the number of reportable accidents where rotor speed excursions have been a contributory factor may have been achieved. This includes the potential to have prevented, or at least to have reduced the severity of 9 fatal accidents, that resulted in the loss of 29 lives.

While it is acknowledged that helicopter systems, and in particular the engine, have improved in reliability through the years, the design of modern helicopters can make the consequences of any such failure far more severe. Commercial considerations and aircraft performance criteria have tended to influence modern design trends towards low inertia rotor systems which compound the power failure problem by increasing the rotor speed decay rate. This has resulted in a reduction in the time available to the pilot to recover from such a failure.

The unforeseen loss of engine power in any air vehicle has potentially severe consequences. The helicopter, however, has some distinct advantages over fixed wing aircraft, due to its ability to autorotate. Following total power loss, autorotation is possible from virtually anywhere within the flight envelope, provided that the aircraft's height is sufficient and that the pilot acts in a timely manner. The problem which faces the helicopter pilot is that, in the absence of immediate corrective action, power failure may lead to a rapid loss of rotor rpm and that, unless the loss is constrained, safe entry into autorotation will not be achieved. Once autorotation is achieved, the pilot must still maintain control of the rotor speed throughout the subsequent descent and landing. This can result in a very high workload being placed on the pilot, who as well as performing a multitude of other tasks, must continually monitor the rotor speed.

Any increase in available intervention time, achieved through a fundamental change in rotor inertia, could only be realised at the expense of restricting the performance and operational use of the vehicle. This would be commercially unacceptable to operators. The alternative approach is to reduce pilots' actual intervention time by providing improved cues and warnings, or to fit automatic systems which would detect low rotor speed and automatically take the necessary corrective action.

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This study was initiated to investigate the extent to which actual intervention time could be reduced using enhancements to current warning systems or by the introduction of automatic systems. In consultation with helicopter pilots and operators, and from the experience of Westland Helicopters Ltd and the UK CAA, a number of possible solutions were postulated, including: enhanced visual systems, various auditory warnings, tactile cues and automatic intervention systems capable of taking appropriate corrective action. All of these strategies have undergone an assessment in this study, both analytically in off-line studies (where applicable), and in a piloted simulation trial.

The most promising systems to emerge from this study are summarized below.

1 **The phase advance filter** – Offers the potential to minimise the delay time between the failure occurring and the pilot being warned of the failure. Typical reductions were found to be between 0·5–1·4 seconds depending on the flight condition and the rotor's power requirement at the time of failure.

2 **Modulated tone** – Believed to offer the best short term method of improving rotor speed warnings, particularly for the control of rotor speed during autorotative descent.

3 **Automatic collective reduction** – Has the potential for a significant improvement in flight safety, although integrity issues would undoubtedly need to be resolved. Inclusion in existing helicopters may also be found to be impractical/uneconomic as may applications to smaller, less sophisticated new types.

4 **Automatic flare system** – This system offers a limited rotor speed protection capability. However, by operating within the limits of existing ASE equipment, integrity issues may be easier to resolve, and the cost of the system reduced compared to the automatic collective reduction system.

3. CAA Paper 2003/01, Helicopter Tail Rotor Failures - Summary

Executive summary

This report is the deliverable from the QinetiQ research project 'Helicopter Tail Rotor Failures' carried out for the Civil Aviation Authority (CAA) under contract 7D/S/980, awarded to the Defence Evaluation and Research Agency (DERA) in 1997. The project was co-funded by the Ministry of Defence (MOD) Defence Procurement Agency. DERA and/or QinetiQ are referred to hereafter as QinetiQ.

The project comprised a study of tail rotor failures (TRFs) and their consequences. The motivation for the study was the overwhelming evidence gathered by the UK Tail Rotor Action Committee (TRAC) that TRFs were occurring at rates much greater than the airworthiness design standards require. This was true for both tail rotor drive and control systems, the former in particular, and applied to both civil and military types. The principal aims of the study were to analyse and quantify the nature and extent of the problem, and explore ways to reduce failure/accident rates and/or mitigate their effects in the future. In addition, existing training procedures and handling advice were examined and means of improvement suggested to prepare aircrew better for the effects of TRFs. Such failures are usually time critical events, requiring the pilot to take specific actions within a couple of seconds to avoid an uncontrollable, and hence catastrophic, situation developing. The study was not intended to address type-specific solutions, but rather to identify key airworthiness, technology and training aspects that may ultimately reduce the incidence and/or criticality of TRFs. It should be noted, however, that advice to aircrew on TRF management and recovery must be defined on a type-specific basis.

There are two major types of TRF:

a) A TR drive failure (TRDF) is a failure within the TR drive system with consequent (usually total) loss of TR thrust. Example causes are internal fatigue or external impact resulting in a broken drive shaft.

b) A TR control failure (TRCF) is a failure within the TR control system such that normal pilot control of TR thrust has been partially or totally lost. Example causes are internal wear or external impact resulting in a severed control cable. The resultant TR applied pitch, or power, could be free to fluctuate, or may be fixed anywhere between high pitch (HP) or low pitch (LP) setting, including that of the current trim pitch (TP).

Both of these TRFs are time critical emergencies. The pilot has to identify and diagnose the TRF type and react with the correct control strategy within a few seconds (or less), to prevent the aircraft departing into an uncontrollable flight state. Even if the pilot recovers from the initial transients, yaw (pedal) control will have been lost and the ability to manoeuvre safely and carry out a safe landing will have been significantly degraded. The TR and its drive and control systems are clearly flight critical components and should be designed so that their probability of failure is 'extremely remote'. The airworthiness design requirements for UK military and civil aircraft define 'extremely remote' as being less than 10-6 [1] and between 10-7 and 10-9 [2,3] per flight hour respectively.

Royal Air Force Handling Squadron expressed concerns over the advice provided to UK military aircrew in the event of TRFs over many years and, as a result, the MOD/ CAA/industry TRAC was formed [4]. This group had the objective of reviewing UK military and civil accident and incident data (collectively described as occurrences) in detail, and recommended actions that would reduce TRFs and mitigate against their

causes and consequences. The concept of technical and operational causes was developed:

- Technical causes are where component/system failures are the causes of occurrences. These comprise those internal to the drive train/controls and those external, which include aircraft parts (e.g. detached panels) striking the TR.
- Operational causes are where component/system failures are the result of occurrences. These include the TR striking the ground, obstructions or Foreign Object Damage (excluding aircraft parts), and the apparent loss of yaw control previously known as Gazelle 'Fenestron stall'.

The review of occurrence data indicated that the TRF rate due to technical causes is significantly worse than even the military requirement. Another concern was the relatively high TRF accident rate due to operational causes. The operating environment is such that the risk of collision with obstacles is relatively high and the TR is particularly vulnerable to damage. Deficiencies in the aircrew advice were also highlighted and programmes leading to the development of type-specific advice were recommended. At the time of writing, the only such study that has been completed is that for the Lynx [5]; however, QinetiQ and industry plans have been presented to the UK MOD for reviewing and revising military aircrew advice for the Merlin, Puma and Sea King types.

In addition to initiating the TRF advice activities, TRAC also recommended the need for a review of airworthiness requirements for helicopter TR systems. The evidence that TRs were, generally speaking, not meeting the spirit of airworthiness requirements, was stark and compelling. TRAC judged that work was required to establish how the airworthiness requirements could be changed to reinforce the criticality of the TR system, and what kind of technologies could mitigate against the adverse effects of TRFs.

The present project flowed from these recommendations, and the following primary objective was defined:

> 'To build on previous work to establish improved requirements, improve aircrew emergency advice and to make recommendations on emergency systems that might ultimately reduce the incidence and/or criticality of a tail rotor failure.'

The outline plan included a literature search, analysis of occurrence data, ground-based piloted simulation trials on the QinetiQ Bedford Advanced Flight Simulator (AFS) to investigate both handling qualities aspects of TRFs and potential mitigating technologies, and an assessment of extant training simulators. The defined tasks were:

a) To review and update the nature and extent of the TRF problem. This section of the research would: extend the review of occurrence data performed by TRAC to include available foreign civil and military data; update the UK civil and military data content; and characterise and summarise the complete occurrence experience. A search and review of all literature was also to be performed and reported.

b) To review relevant technologies which could potentially be utilised either to reduce the incidence of TRFs or mitigate their effects. In particular, the relevance of the conclusions of the ground-based simulator trials (conducted previously for the MOD) and any other work identified by the literature survey to civil aircraft operation was to be established and reported.

c) To assess potential solutions for reducing the occurrence and/or mitigating the effects of TRFs. These included a larger fin, emergency deployable fin, air brake devices, TRDF annunciator, Spring Bias Unit (SBU), Health and Usage Monitoring Systems (HUMS), TR strike warning, power chop function and Back-up Control Systems (BUCS). These measures were to be assessed with reference to the occurrence data, practicability, and benefits.

d) To review the existing airworthiness requirements material and make recommendations for additions and/or changes. The material relating to TR systems contained in the current military [1] and civil [2,3] certification requirements were to be reviewed in light of the findings of 1, 2 and 3, above. Recommendations for any additions and/or modifications were to be substantiated. This review was to include an examination of the handling qualities requirements associated with the three phases of a TRF (recovery, post-TRF flight and landing).

e) To review the existing emergency procedures and handling advice and make recommendations for change. This section of the project was to review the emergency procedures and handling advice relating to TRFs for all current UK military helicopter types and all civil aircraft types currently on the UK register, commenting on its usefulness. Means of establishing optimum handling advice and techniques for validating them were to be investigated and reported. It should be noted, however, that generation of new aircrew advice for individual types was not within the scope of this project.

f) To review military and civil practice regarding pilot training and make recommendations for simulator requirements to improve the effectiveness of training. The issues of fidelity and means of validation of the flight simulators utilised for pilot training were also to be reviewed and reported. Allowance was to be made for visiting and assessing two representative flight training simulators.

Task 1 was carried out principally by Stewart Hughes Limited (now trading as Smiths Aerospace Electronic Systems – Southampton (SAES-S), part of the Smiths Group, and referred to hereafter as SAES-S) [6]. Task 2 was performed by SAES-S and GKN Westland Helicopters Limited (now Westland Helicopters Limited (WHL), part of AgustaWestland, and referred to hereafter as WHL) [6,7]. Task 3 was carried out by WHL [7] and QinetiQ who conducted a simulation trial using the QinetiQ Bedford AFS. Task 4 was carried out within QinetiQ and included a second ground-based simulation trial. Task 5 was performed by WHL [8], who also supported QinetiQ in conducting Task 6. The simulation trials were conducted using a Lynx AH Mk 7 model, modified as appropriate to represent a variety of yaw stiffness and damping characteristics, and to simulate the effects of mitigating technologies. The main rotor stiffness was also modified to investigate the response of a lower effective hinge offset main rotor, typical of civilian helicopters. Almost 50 hours of motion-based, pilot-in-the-loop simulation were performed over the two simulation trials.

The summarised conclusions of the project are as follows:

The nature of TRFs: The management and control of a TRF can be assessed in three phases:

a) Transient: the failure transient and recovery to a safe flight condition.

b) Manoeuvre: manoeuvring in the failed condition.

c) Landing: the ability to perform a successful landing.

The ability of the aircrew to fly the aircraft within defined safety and performance standards within the three phases will depend on a number of key aspects. These include aircraft configuration, the flight condition prior to failure (including speed and altitude), the pilot's attentiveness, the pilot's training and skill, the TRF type and cues, and the responsiveness of the aircraft. Depending on the phase of flight and the TRF type, TRFs result in rapid pitch, roll and yaw excursions. Even if immediate and appropriate action is taken, pilot workload and disorientation can be very high. If such action is not taken, there is a serious risk of aircrew injury and airframe and collateral damage. With a standard pilot intervention time (PIT) of 2 seconds, it was shown that TRDF at high speed results in a transient sideslip which is likely to be beyond the structural limits of the aircraft. Height lost can be as much as 600 feet depending on the collective control strategy used. In the hover, there appears to be little that can be done to avoid the spin entry caused by a TRDF with the same PIT. Simulated recovery from HP TRCFs in both forward flight and in the hover was very difficult. A failure in the hover leads to a rapid build-up in yaw and the survival chances without significant damage are low, even in the low hover unless a landing is made positively and rapidly. LP TRCFs are similar in some respects to TRDFs, except that the TR continues to provide some yaw stiffness and damping in forward flight, and damping in the hover. TP TRCFs are very benign compared to the other TRF types.

The extent of TRFs: Analysis of a database of 344 TRF occurrences, constructed for this study from UK, US, Canadian and New Zealand sources, showed that accident rates across the various fleets averaged between 9.2 and 15.8 per million flying hours. The largest causes of TRF are either the TR striking or being struck by an object, which causes approximately one half of all TRF occurrences and fatalities, and failure of the TR drive system, which causes approximately one third of all TRF occurrences and fatalities. TR drive shafts, gearboxes and couplings are chiefly responsible for the latter. The largest number of TRF occurrences (27%) and fatalities (56%) for any single phase of flight occur during transit. TR torque is typically higher in the hover, take-off and landing phases (where 51% of occurrences take place) when compared with the other phases of flight (41% of occurrences). Thus, with respect to the relative duration spent in these phases, the high torque phases exhibit disproportionately large numbers of occurrences, including those caused by failure of the tail drive system, but particularly for tail/object impact. The UK MOD type most subject to failure is the Lynx (combined Service rate of 33.2 per million flying hours). Other types which stand out as exceeding the airworthiness design requirements by a dangerous margin are the MOD Puma (24.0) and Sea King (22.8) and the US Navy and Marine Corps AH-1 (19.5) and SH-2 (19.3).

Airworthiness design requirements: The attitude excursions during the transient phase of a TRF are critical to the pilot being able to achieve a successful recovery and featured as the primary response characteristics of interest during the piloted simulation trials. In the US handling qualities requirements standard ADS-33D [9], the allowable response transients following system failures are described in terms of handling qualities defined as Levels 1, 2 and 3 (in increasing order of handling qualities deficiencies). The attitude and acceleration response criteria, without failure warning and cueing devices, applicable to hover/low speed and near-Earth forward flight conditions are based on the aircraft displacement after 3 seconds without any pilot action. The aircraft would be displaced by about 30 feet (10 m) in all directions at the upper excursion limits. This military standard considers nap-of-the-Earth operations where tactical use is made of the ground for stealth, and such transient excursions are likely to result in a collision. It is suggested that such criteria are equally applicable to civil helicopter operations close to the ground. For up-and-away forward flight conditions, the requirements are based solely on staying within the Operation Flight Envelope (OFE).

Having recovered from the failure, the pilot's next action will depend upon the type of failure and the initial flight condition. The critical response that determines the capability to manoeuvre with power on will be the yaw response to collective which are described in ADS-33D in terms of yaw rate to height rate response. In terms of manoeuvrability, the ability to turn on cyclic without losing control is characterised by the turn co-ordination criteria, expressed in ADS-33D in terms of the ratio of sideslip to roll attitude following a control input designed to generate a step change in aircraft attitude.

A review of the Joint Aviation Requirements JAR-27 [2] and JAR-29 [3] by QinetiQ identified a regulatory gap relating to TR control system failures – current designs are neither pushed, by regulation, towards fail-safe solutions through redundancy (the preferred option where practical), nor to higher 'simplex' integrity through detailed design assessment. A two-path solution has been proposed as practicable and appropriate:

a) To require all practicable precautions to be taken to prevent single failures causing loss of continued safe flight and landing (i.e. require redundancy along the lines of that found in JAR25.671).

b) Where it is considered that redundant systems are impractical, to require justification of this and require that a design assessment be performed on the solution selected. This assessment shall include a detailed failure analysis to identify all failure modes that will prevent continued safe flight and landing, and identification of the means provided to minimise the likelihood of their occurrence.

Prevention and mitigation of TRFs using HUMS technology: Monitoring functions provided by current HUMS were assumed to be:

- TR drive shaft vibration
- TR drive shaft hanger bearing vibration
- Intermediate and TR gearbox vibration
- TR vibration
- Airframe vibration

Functions requiring HUMS development were:

- Gearbox and bearing temperature monitoring
- On-demand vibration checks
- Continuous rotor vibration monitoring
- TR rotational speed monitoring
- TR control input/output monitoring
- TR control mapping against flight parameters
- TR drive torque monitoring
- Gearbox oil level sensing
- Cockpit indication for vibration monitoring functions

Based on a detailed analysis of 31 example occurrence reports, coupled with estimated HUMS detection effectiveness, conservative estimates are that 49% of TRFs caused by failure of the TR drive system, and 18% of TRFs overall could have been prevented by current HUMS. This is achieved primarily through monitoring of the TR drive system using current HUMS technology as an aid to maintenance. In addition, it is estimated that a development of the existing HUMS technology would have prevented or mitigated a further 15% of TRFs caused by failure of the TR drive system and 5% of TRFs overall. Furthermore, a detailed review of flight deck indications by the HHMAG [10] concluded that any HUMS flight deck indications should be presented as 'supplementary data' only (i.e. not 'alerts') unless acceptable false alarm rates can be achieved. Any indication provided must be associated with unequivocal crew action. The use of current and developed HUMS technologies alone will not bring the occurrence rate to an acceptable level; 78% of TRFs are unlikely to be prevented by HUMS and are caused predominantly through the TR striking, or being struck by an object. Other means are required to help avoid hazards, make the TR system less susceptible to damage (e.g. existing Fenestron and NOTAR technologies), and maximise the chances of a pilot successfully dealing with a failure that occurs in flight. Another technology proposed is a scanning laser tip strike warning system that would draw the pilot's attention to the actual position of an obstacle. The effectiveness of this technology in helicopters is so far unproven, but might have prevented a further 8% of all TRF occurrences.

Prevention and mitigation of TRFs using non-HUMS technologies: TRCF problems can be addressed by improved design of the control circuit, in particular, the incorporation of a fail-safe pitch (such as provided on operation of some types of SBU or Negative Force Gradient (NFG) spring). Activation of such a system in the event of a control rod disconnection between the pedals and the servo or between the servo and the TR (e.g. failure of control cables or hydraulic systems depending on the individual system type), can result in relatively benign TP TRCF conditions. A well designed warning device, which directed the pilot rapidly to the failure recovery, could be effective at reducing the PIT. An attitude command/attitude hold control system response type, particularly when associated with large (i.e. 20% or more) attitude hold authority, will significantly reduce the failure transients when compared to rate command systems. The use of controllable main rotor (MR) speed, together with appropriate collective control inputs, provides a very effective means of changing MR torque and reducing yaw rates during TRCFs in the hover.

The piloted simulation trials showed that additional fin area can be used to off-load the TR in forward flight, however considerable area is required to contain the initial yaw motion resulting from a TRDF. Additional fin area can also dramatically reduce the sideways flight capability. Assuming it is fixed (i.e. no rudder), such a fin could be a disadvantage in TRCF cases that have resulted in high TR thrust conditions since the high fin lift will exacerbate the situation. A drag parachute has the ability to be retrofitted, requires a relatively small area to produce significant yaw stiffness and does not affect low speed performance. The deployment of the drag parachute helps to constrain heading and the drag component results in a reduced speed for the given power level. It should be noted, however, that deployable devices such as this may not suppress the initial transients depending on the deployment time. A twin TR system could offer many benefits; however, it should be associated with a twin drive shaft system and duplex controls for the maximum benefit to be realised.

From a detailed analysis of 29 example occurrence reports, it is considered that the various prevention and mitigation technologies would have produced a beneficial effect in 90% of all the cases and in 88% of the cases caused by failure of the TR drive system. If the retrofit devices alone are considered (i.e. precluding twin TR/fan with duplex TR drive) these proportions would be 79% of all cases and 69% of cases caused by failure of the TR drive system. All cases caused by impact between the TR and an object would have benefited. In many cases more than one technology would have been beneficial. The technologies providing benefit in most cases were the drag parachute, inflatable fin and twin TR/fan with duplex TR drive. The in-line ducted fan and variable camber fin solutions also featured to a lesser extent and, for the TRCF cases, the SBU-type devices were largely beneficial. Most of the other technologies were not judged to be beneficial in the limited number of cases studied.

Emergency procedures and advice: The only complete method of determining the applicability of the advice given to aircrews would be to undertake a validation exercise on each aircraft type. The validation exercise cannot be generic because of the variation in possible failure modes, the basic fuselage stability characteristics and control systems characteristics. It must therefore be type-specific and is beyond the scope of this study. The validation process has to be undertaken against a set of defined criteria, which should be stated with the advice given. During the previous Lynx validation exercise [5] the following criteria were developed and are considered to be generally applicable[1]:

Type 1: Validation provided by a full in-flight demonstration of the recovery technique.

Type 2: Validation provided for the recovery technique being demonstrated using the best available engineering calculations coupled with piloted simulation.

Type 3: Validation provided for the recovery technique based on the best engineering calculations only.

Ideally, all validation of advice and recovery techniques should aim to achieve Type 1 validation. However, from a practical standpoint, TRDFs can only be demonstrated by piloted simulation and therefore the associated recovery techniques can, at best, only achieve Type 2 validation. On this basis, the Lynx TRF advice was validated to Type 1 for TRCFs and Type 2 for TRDFs. Of the 36 types whose advice was analysed, only the Lynx provides validated advice for both TRDFs and TRCFs. The standard of advice varies not only between manufacturers but also between marks of aircraft. The majority described the major symptoms associated with TRDFs, however, only 14% considered the loss of components at the tail pylon and identified the possible consequences of a major change in the aircraft centre of gravity. Only 17% discussed a defined TR pitch condition in the event of a control circuit failure. Advice on the appropriateness of using a power and speed combination during recovery from a TRDF was offered by only 53%. Control circuit failure was not considered at all by one third of the types. The variation in the standard of advice would suggest that there is considerable room for improving the level of advice currently given in the Aircrew or Flight Manuals (AM/FMs).

Training: Nine training simulator facilities responded to a questionnaire aimed at assessing the level of TRF simulation training provided to aircrews and instructors. More than half of the facilities were commissioned in the 1980s, and two thirds employ simulators equipped with six degree of freedom motion systems. Two thirds reported some degree of flight data validation over the OFE, but only the three Lynx simulators are likely to have benefited from any form of TRF validation. All of the respondents provide some form of TRF diagnosis and recovery instruction, although this was not a formal part of the teaching course in at least one case. Both TRDFs and TRCFs are covered in some form by most, but it is unclear how realistically they are modelled. In some cases it was stated that the rate of recovery from simulated TRFs is improved dramatically by the training provided, but it remains unclear how successful these recovery techniques would be in the actual aircraft. The highest confidence is thought to lie with the Lynx simulators due to the techniques having been validated through QinetiQ/WHL flight test and ground-based simulation studies.

1. In [5] the term Levels was used to denote the degree of advice validation. The term Level has been superseded by Type to avoid an association with Handling Quality Levels. Thus Level 1 is superseded by Type 1 etc.

There is evidence that some flying training schools discuss TRFs and demonstrate TRCFs in flight to a limited extent.

Criteria for validation of training simulators were formulated by the US Federal Aviation Administration in 1994 and are in the process of being formulated in a similar fashion by the Joint Aviation Authorities Committee [11]. There are four standards ranging from Level A to Level D (the highest). The first rotary wing facilities to be certified to Level C and Level D (currently only one Level D) were commissioned in 1998.

The investment that the UK MOD is providing over the next few years will result in half of all European military motion-based helicopter training simulators being situated in the UK [12]. Recommendations have been made to the UK MOD for further study into how the civil simulator requirements may be tailored to the military environment.

Recommendations: The recommendations of the project are numerous and are detailed within individual Sections of this report. The major recommendations are as follows:

- It is recommended that the JARs be amended to provide the two-path solution to closing the regulatory gap in respect of TR control systems:
  - i) To require all practicable precautions to be taken to prevent single failures causing loss of continued safe flight and landing (i.e. require redundancy along the lines of that found in JAR25.671).
  - ii) Where it is considered that redundant systems are impractical, to require justification of this and require that a design assessment be performed on the solution selected. This assessment shall include a detailed failure analysis to identify all failure modes that will prevent continued safe flight and landing, and identification of the means provided to minimise the likelihood of their occurrence.

It is recommended that the ADS-33D failure transient limits, collective to yaw requirements and sideslip excursion limitations are used as a means of quantification in the failure modes and effects analysis, as part of the two-path solution.

Manufacturers should be required to analyse the effect of TRFs and, where these effects are significant, provide at least Type 2 validated aircrew advice. Where such advice is not provided, it is recommended that advisory operational restrictions be provided (similar to the H-V diagram for engine failures). Such restrictions could also be realised through the inclusion of a reference to flight control/handling characteristics following TRFs in Sub-Part B of JAR-27 and JAR-29.

- The fitting of appropriately designed HUMS, focussed on (but not limited to) monitoring TR drive system failure is strongly recommended.
- Action should be taken to further define the HUMS required for specific types or categories of helicopter. This should take into account the specific failure types, the handling qualities of the aircraft post-failure and economic factors.
- TRCF problems should be addressed by improved design of the control circuit, in particular, the incorporation of a fail-safe pitch (e.g. as currently used in some types of SBU). The fail-safe pitch should function in the event of a control rod disconnection between the pedals and the servo or between the servo and the TR. Further type-specific studies should be carried out to determine the mechanisms and settings required, and to investigate the transient behaviour on TRCF and activation of the device.

- MR speed control (increase and decrease from trim) should be provided to the aircrew to assist in recovery from TRCFs in the hover.
- Deployable devices, such as an inflatable fin and drag parachute, should be investigated for retrofit on existing types and incorporated in the design of future types to provide additional yaw stiffness in the event of TRF.
- It is strongly recommended that type-specific piloted simulation and, where possible, flight test programmes are put in place to develop advice validated to a minimum of Type 2 (demonstration using the best available engineering calculations coupled with piloted simulation) for TRFs in general, and Type 1 (full in-flight demonstration of the recovery technique) for TRCFs.
- The minimum training simulator certification level appropriate for TRF training should be Level C as defined in US Federal Aviation Administration Advisory Circular AC 120-63. Inherent in this is the recommendation that all training simulators are built with motion available in all six degrees of freedom (surge, sway, heave, roll, pitch and yaw), and that the field of view be as representative as possible, particularly with respect to the provision of ground speed visual cues.
- Where TRF flight test data or validated TRF advice cannot be provided, subjective assessment of training simulators should be carried out against the experience of those who have suffered failures. Where not undertaken already, such experience should be shared within the piloting community, perhaps collated by the civil authorities or pilots associations and made readily available to the training organisations.
- Although full realism cannot be provided in most cases, it is recommended that all flying schools at least demonstrate the effects of extreme TR pitch jams to aid diagnosis, and that techniques are explored by the students where it is safe to do so.

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4. CAA Paper 2007/03, Helicopter Flight in Degraded Visual Conditions - Executive Summary

Executive Summary

This report summarises the research carried out by QinetiQ for the Civil Aviation Authority (CAA) under Contract 7D/S/980/Y 'Ego-Motion and Optical Cues Applied to Helicopter Flight'. It constitutes the final programme report and its aim is to present and summarise all research activities carried out under programme Phases 1 and 2, including the methodology used, results obtained and the associated conclusions and recommendations derived. In addition, the findings of an earlier research activity carried out by QinetiQ for the CAA, which concerned the related topic of pilot field of view (FOV), are also considered.

The CAA research was undertaken in collaboration with a MoD Corporate Research Programme (CRP) study into how pilots use visual cues in the process of helicopter flight guidance and stabilisation, where the general objective was to improve the operational effectiveness and safety of military helicopter operations in degraded visual conditions. This work focused primarily on establishing experimental designs and test techniques for examination of pilot control strategy through piloted simulation experiments, where the aim was to investigate the visual information requirements for typical operational flight tasks under controlled, simulated visual conditions.

The CAA's motivation for the collaboration stemmed from the continuing incidence of serious accidents involving civil helicopter operations in degraded visual cueing conditions, where poor aircrew situational awareness, and ultimately spatial disorientation or controlled flight into terrain, have been identified as primary causal factors. The CRP study was likely to give insight into the causes of such accidents, and the CAA's objective was to identify potential developments of the civil regulations and/or associated guidance material that might help to prevent and/or mitigate accident-prone scenarios.

The approach adopted to meet this objective was, firstly, to review the relevant civil accident data to identify the principal causal factors and establish the nature and extent of the problem (Phase 1). This was followed by further investigation of these factors through piloted simulation experiments involving flight and operating conditions taken from typical accident scenarios (Phase 2/1). Data from these experiments were then analysed using special techniques developed under the CRP study, and the results compared with the findings of a review of the relevant civil regulations (Phase 2/2).

The Phase 1 review of accident data covered the period from 1975 to 2004 and was carried out using the CAA's Mandatory Occurrence Reporting System (MORS) database. The aim was to identify cases where loss of pilot situational awareness and spatial disorientation were primary causal factors. It was found that there has been a continuing incidence of such accidents, involving both private and public transport helicopter operations during the review period. A primary set of 53 Scenario 2 (controlled flight into terrain) and Scenario 3 (spatial disorientation and loss of control) cases and 1 Scenario 1 (obstacle/terrain strikes in low level flight) case was identified where degraded visual cues, poor pilot situational awareness and/ or spatial disorientation were the primary causal factors. These cases involved 100 fatalities overall. Of note, Scenario 2 and 3 cases together form the single largest cause of small helicopter fatal accidents. Total occurrences per year increased over the period from 1975 to 2004 from 1 per year to approximately 2.5. From the mid-1990s onwards, the average number of Scenario 3 cases per year (1-2 cases) overtook the number of scenario 2 cases, which has remained relatively constant at 1 per year throughout the review period. This result indicates an increase in the number of accidents resulting from spatial disorientation in degraded visual conditions. A detailed case study exercise was carried out on a sub-set of seven cases selected from the primary set, which was based on source material taken from associated Air Accidents Investigation Branch (AAIB) reports and bulletins.

The Phase 2/1 simulation experiments were carried out in trial EMOCUES2 using QinetiQ's Real Time All Vehicle Simulator, where two qualified and experienced test pilots evaluated a test matrix of manoeuvres and visual conditions that was based on information extracted from the accident case studies. These experiments were designed specifically to investigate the applicability of the Aeronautical Design Standard-33 (ADS-33) Useable Cue Environment (UCE) concept and response type criteria to civil operations. To this end, test cases involved aircraft types with unstabilised rate (Basic) or Attitude Command – Attitude Hold (ACAH) responses, and visual conditions ranging from visual meteorological conditions (VMC), i.e. UCEs of 1, 2 or 3, to instrument meteorological conditions (IMC), i.e. a UCE of poorer than 3. These two types were evaluated in five different test manoeuvres, including Hover Taxi, Fly Away, Turn, Climb and Approach. The trial met its objectives and was successful in demonstrating how pilot situational awareness can be eroded in VFR operations as visual conditions degrade, a key factor being the division of attention between the guidance and stabilisation tasks.

For Phase 2/2, pilot ratings and objective data from the simulation experiments were examined further through image analysis and tau analysis, where the objective was to investigate how pilot control strategy, task performance, workload and, ultimately, flight path safety were influenced by the visual conditions, i.e. level of UCE. For image analysis, the application of a predictive model based on image metrics was demonstrated as a means of predicting pilot's HQRs, VCRs and UCE. Four image metrics that are based on fractal geometry were considered: k, β, D, α, which relate to smoothness, clutter strength (intensity), clutter uniformity and clutter density respectively. It was found that the best measures of visual cues for pilot handling were D, α and β, with D being the most important. Tau analysis was used to demonstrate the applicability of an intrinsic tau-guide model (with taudot constant) of the form [$\tau_m = k_g t + c$], (where k_g is the gradient of τ_m over T, the time to complete the manoeuvre) to the height, speed, heading and attitude control in the test manoeuvres evaluated in EMOCUES2. Results from examination of a motion tau-coupling model of the form [$\tau_v = k_m \tau_h + c$], (where k_m is the gradient of τ_v over time T) showed that, in general, there was no firm evidence of a tau coupling between speed and height in the Fly Away, Climb and Approach manoeuvres.

The aim of the review of civil regulations was to identify any deficiencies and omissions concerning degraded visual environment (DVE) operations of the type that featured in the review of accident data. Documents reviewed included JAR 27/29 and associated ACs, the relevant parts of JAR-OPS 3 and ICAO Annexes 6 and 14, and various CAA FODCOMS. The report presents the overall findings of the review and discusses potential measures that might help to reduce the likelihood of civil helicopter accidents in conditions of poor visibility, taking account of the results and findings from the earlier research activities. In addition, the findings of an earlier CAA sponsored review of pilot FOV issues are also considered. To underpin the discussion, a conceptual framework is presented which illustrates the strong inter-dependency between handling qualities and visual cues and the way that these impact civil operations and requirements, and ultimately flight safety. The mapping of the EMOCUES2 trials results onto this framework supports the case that the ADS-33 UCE and associated response type criteria provide the basis for safer operations in the DVE and, specifically, that the ACAH response type is essential for these types of operations.

Conclusions and recommendations stemming from the programme and its activities are summarised in the following.

1 Accident data

a) A primary set of 53 Scenario 2 and 3 accidents and one Scenario 1 case was identified for the period 1975 to 2004 where degraded visual cues, poor pilot situational awareness and/or spatial disorientation were the primary causal factors.

b) These Scenario 2 and 3 accidents involved a total of 100 fatalities and, together, form the single largest cause of small helicopter fatal accidents.

c) Total occurrences per year over the period from 1975 to 2004 increase from 1 per year to approximately 2.5, largely due to increasing numbers of accidents resulting from spatial disorientation in a DVE, i.e. Scenario 3 cases.

d) The majority of cases occurred during daytime and out of close contact with the surface. Although the accidents identified were the result of a number of contributory causal factors, inadvertent entry into IMC (IIMC) was probably the most significant factor.

e) Serious consideration must be given to the measures that need to be taken to reverse this trend, taking into account improvements to regulations, operating procedures and requirements or pilot training requirements.

2 Simulator investigations

a) A conceptual framework has been presented, which illustrates the strong inter-dependency between visual scene and handling qualities as represented by level of UCE and handling qualities according to ADS-33 Level 1, 2, 3 criteria.

b) The way in which the framework can be linked to civil requirements for handling qualities, operational constraints, training and navigation aids has also been illustrated. HQR evaluations from EMOCUES2 show good correlation, qualitatively, with the conceptual case for both the ACAH and Basic configurations.

c) The underlying argument on which the framework is based is that ACAH response types confer reduced workload through minimising the effort required for closed-loop stabilisation. In DVE conditions, this can free critical attention to enable the pilot to concentrate on the guidance aspect of flight management.

d) Regarding stability, types similar to Basic are likely to be HQR Level 2, Level 2-3 and Level 3 for UCE 1, 2 and 3 operations respectively, but ACAH would be Level 1, Level 1-2 and Level 2.

e) The Level 3 characteristics of the Basic type are likely to present a serious flight safety hazard in inadvertent DVE situations such as IIMC.

f) Associated handling problems will be exacerbated by poor/inappropriate flight controls mechanical characteristics (FCMCs). Hence, the impact of FCMCs on pilot workload should be taken into account, and better guidance is needed concerning acceptable FCMCs for all civil operations.

g) The results support the case that adoption of the ADS-33 UCE and associated response type criteria would lead to significant safety benefits for civil helicopter operations in the DVE and, specifically, that the ACAH response type should be mandatory for DVE operations.

3 Civil regulations and requirements

a) Civil regulations and requirements in the area of handling qualities are very subjective and open to interpretation by manufacturers and qualification test pilots.

b) The regulations divide operations into either VFR or IFR categories, with no consideration given to DVE operations, e.g. there are no detailed requirements or guidance given for night operations.

c) In the accident cases considered pilot workload was a key contributor, driven by circumstantial factors such as vehicle stability, poor visual cues and division of attention. The JARs do not clearly address DVE and division of attention operations, suggesting that greater clarity is required concerning the possibility of such circumstances.

d) There is a need for objective criteria with appropriate qualification boundaries that will determine and eliminate potentially accident-prone configurations such as Basic; adoption of the JAR dynamic stability requirements for both VFR and IFR types would meet this requirement.

e) Military criteria such as the ADS-33 attitude bandwidth and associated gust rejection criteria, and the related criteria for DVE (response type versus UCE) and divided attention operations could provide advisory material to improve JARs.

f) JAR-27 does not specify an attitude indicator for VFR operations; small rotorcraft should be required to be fitted with an attitude indicator to mitigate the consequences of inadvertent encounters with DVE conditions.

g) The JAR-OPS 3 requirement for the chart holder for IFR operations should be extended to all operations at night.

4 Aircraft and equipment design issues

a) The regulations do not address the need for an adequate visual reference for attitude cueing through the cockpit structure; this is essential for operations in poor visual conditions.

b) The advisory guidance concerning cockpit FOV should be made mandatory, supported by limitations regarding the permissible encroachment on FOV of additional cockpit equipment.

c) Consideration should be given to the development of improved forms of instrumentation displays to cater for the IIMC case.

5 Operational issues

a) Statistics based on the CAA's MORS database indicate that accidents tend to occur for VFR operations en-route in unrestricted airspace; this suggests that requirements (minima) need to be reviewed and strengthened as necessary.

b) When addressing requirements for visibility minima, factors such as the height that the aircraft should be permitted to fly at versus the available view over the nose of the aircraft should be taken into consideration. For a given cockpit view, the pilot's forward view diminishes with increasing aircraft height, and look down angles associated with heights of greater than 1000 ft (i.e. greater than 15-20 deg) would impose severe restrictions on the available visual cues. The likely effect of aircraft pitch attitude on pilot view should also be taken into account.

6 Pilot training issues

a) The regulations address requirements for communications to provide appropriate navigation and meteorological information, but pilots still become lost when navigating by visual references at night. Improved guidance and training for aircrew is needed.

b) FODCOMs attempt to address issues such as those noted at paragraph 5 b) and paragraph 6 a), but such measures need to be applied more widely to all civil aircraft operations. Critical training issues that might be addressed more rigorously through such measures include: recovery from visual to instrument visual flight, and divided attention operations when navigating by external references.

c) Pilots should be better trained to make informed decisions on whether to fly or not in marginal conditions, or when IMC conditions are developing enroute. This might be achieved by developing a probability index based on factors that contribute to a high risk accident scenario (e.g. meteorological conditions, visual conditions, visual range, acuity of the visual horizon, aircraft configuration, aircraft handling qualities).

d) IIMC can occur due to reduced visibility and/or an insufficiency of visual cues to support flight by visual references, e.g. over the sea or remote moorland at night. Pilot training and awareness for such cases could be supported by image analysis of digital images of typical operating conditions and UCEs, similar to those used from the simulator trial to develop the image analysis application.

7 Recommendations

a) Introduction of the IFR dynamic stability requirements as a general requirement for all operations, including VFR.

b) Introduction of appropriate requirements (or guidance) on criteria for DVE operations based on consideration, but not full adoption, of all IFR requirements for:

i) night operations; and

ii) operations in visual ranges of less than a 'specified' minima, which takes account of permitted aircraft height and associated view over the nose. Look down angles associated with heights of greater than 1000 ft (i.e. greater than 15-20 deg) would impose severe restrictions on the available visual cues.

c) Introduction of specific requirements (or guidance) on criteria for FCMCs.

d) Introduction of a requirement for an attitude indicator flight instrument for all operations, including VFR.

e) Specification and adoption of FODCOM training requirements for all civil helicopter operations that fall into the DVE category specified at b) above.

f) Raise pilot awareness of the problems associated with operations in the DVE, i.e. the interaction between vehicle handling qualities and visual cueing conditions.

g) Reduce the probability of pilots encountering DVE conditions by providing guidance on whether to fly or not in marginal conditions with the potential for DVE encounters. This could be achieved using a simple probability index based on consideration of those factors that contribute to a high accident risk scenario, including:

i) meteorological conditions (precipitation, cloud base etc.),

ii) visual conditions (time of day, fog/mist/haze conditions, visual range, acuity of the visual horizon etc.),

iii) aircraft configuration (navigation aids, flight instruments, pilot FOV and layout etc.),

iv) aircraft handling qualities (SAS, FCMCs).

h) Image analysis using the techniques presented in this report should be investigated as a means of supporting the pilot training in g), using digital images of typical operating conditions and UCEs.

Appendix 3 to Chapter 8 – List of Accidents

Table 1. List of accidents

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/ Bulletin No	Headline	CICTT Group	CICCT Code	CICTT Breakdown
2000	02/01/2000	D-HCKV	Agusta 109 A MK II	1 nm south-west Newby Bridge, Cumbria	200000009	3/2000	Main rotor blades struck trees in poor weather/visibility. Substantial damage. No injuries to 6 POB.	Operational (F)	UIMC	
	14/01/2000	G-JRSL	Agusta A109E	Wheelgate Farm, near Romney Marsh, Kent	200000141	2/2001	Loss of control and sudden loss of electrical power. Heavy landing. Minor injuries. AAIB Field investigation.	Technical (M)	SCF-NP	
	07/02/2000	G-RNLD	Agusta A109C	Near Coventry Airport, West Midlands	200000657	12/2000	Mayday call. Precautionary landing carried out safely. Main rotor blade tip separated in flight.	Technical (D)	SCF-NP	
	21/04/2000	G-SAEW	Aerospatiale (eurocopter) AS355F2	9 Coryton Drive, Cardiff, Wales) (Glamorgan)	200002669	1/2001	Tail rotor pitch change unit failure. Helicopter descended into roof of house. Substantial damage. No injuries to 3 POB.	Technical (M)	SCF-NP	
	03/06/2000	G-EPOL	AS355F2	Boreham Airfield, Essex	200003771	2/2001	Nr1 engine fire warning. Engine shutdown. Smoke and fumes in cockpit. Forced landing.	Technical (D)	F-NI	
	17/06/2000	G-TVAA	Agusta A109E Power	Arborfield Cross (Berkshire)	200004201	2/2001	Forced landing into field after loss of power. Substantial damage. 3 POB suffered minor injuries.	Technical (M)	SCF-NP	

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/ Bulletin No	Headline	CICTT Group	CICCT Code	CICTT Breakdown
	18/06/2000	G-NUTY	AS350B Ecureuil	2 nm north-east of Porthmadog, Gwynedd	200004203	9/2000	Main rotor struck tail boom in severe turbulence. Aircraft destroyed during forced landing. 3 POB - 1 serious and 2 minor injuries.	Operational (F)	CFIT	
	23/08/2000	G-BZBD	Westland Scout AH1	Streatley (Berkshire)	200006206	12/2000	Main rotor struck tail boom in severe turbulence. Aircraft destroyed during forced landing. 3 POB - 1 serious and 2 minor injuries.	Operational (F)	LOC-I	
	05/09/2000	G-AZOR	Bolkow BO-105DB	5 nm north of Brentwood, Essex	200006536	12/2000	Crashed on a hillside. Aircraft destroyed. Minor injuries to 2 POB.	Operational (F)	LALT	
	11/09/2000	G-LGRM	Bell 206B	Approximately 8 to 10 miles SE of Caernarvon, Wales	200006730	2/2001	Rotor overspeed resulting in partial detachment of tail boom. No injuries to 1 POB.	Operational (F)	UIMC	
2000	13/09/2000	G-BYHE	Robinson R22 Beta	Wycombe Air Park (Booker) Buckinghamshire	200006772	3/2001	Hard landing. Landing gear crosstubes deformed. No injury to 1 POB.	Operational (G)	LOC-G	
	11/09/2000	G-WMAA	Bolkow BO-105DBS-4	RAF Cosford, Wolverhampton	200006811	1/2001	Rolled over during forced landing after encountering deteriorating weather conditions. Aircraft destroyed. No injury to 2 POB.	Operational (F)	ARC	
	24/09/2000	G-BYNZ	Westland Scout AH1	In a field - 4m north north-east	200007072	12/2000	Rolled over during forced landing after encountering deteriorating weather	Operational (F)	UIMC	

				of Ludgershall, Wiltshire			conditions. Aircraft destroyed. No injury to 2 POB.			
2001	07/01/2001	N-206DD	Bell 206L-1	British Virgin Islands	200100071	7/2001	Engine stopped. Aircraft ditched in shallow water and rolled over. Substantial damage. No injury to 7 POB.	Technical (M)	FUEL	
	12/07/2001	G-BMAL	Sikorsky S76A (Modified)	North Denes Aerodrome, Norfolk UK	200104756	10/2001	Inadvertent application of collective, resulting in tail strike. No injury to 2 POB.	Operational (G)	LOC-G	
	19/11/2001	G-BXSL	Westland Scout AH1	8 miles south-west of Cambridge	200107871	7/2002	Inadvertent application of collective, resulting in tail strike. No injury to 2 POB.	Operational (F)	FUEL	
	25/12/2001	G-DPPH	Agusta A109E	Cross Hands, Wales	200108528	2/2003	Aircraft overturned during forced landing following partial engine failure. Substantial damage. No injury to 2 POB.	Operational (F)	FUEL	
2002	17/02/2002	G-SPAU	Eurocopter EC135T1	Near Muirkirk, East Ayrshire, Scotland	200200915	8/2003	Aircraft entered thick cloud and crashed after inadvertent autopilot disconnection. Aircraft destroyed. 3 POB - 1 serious and 2 minor injuries.	Operational (F)	LOC-I	
	11/03/2002	G-XXEA	Sikorsky S76C+	Blackbushe Airport, Hampshire	200201508	9/2002	Heavy landing. Substantial damage. No injury to 2 POB. AAIB Field investigation.	Operational (F)	ARC	
	24/05/2002	G-DNLB	Bolkow BO 105DBS-4	Brough of Birsay, Isle of Orkney	200203334	8/2003	Underslung load became unstable and struck the tail rotor. The aircraft crashed into the sea and sank. 1 POB fatal	Operational (F)	EXTL + LOC-I	

	15/07/2002	G-BBHM	Sikorsky S-61N	Poole Harbour, Dorset	200204849	S2/2002	Burning smell followed by nr2 then nr1 engine fire warning. Forced landing. Aircraft destroyed by fire. No injury to 4 POB.	Technical (D/M)	SCF-PP + F-NI	
	25/12/2002	G-ESAM	Bolkow BO 105DBS-4	Epping (Theydon Bois), Essex	200209214	4/2003	Aircraft drifted backwards on take-off and main rotor blades struck the branches of a tree. No injury to 4 POB	Operational (F)	LALT	

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/ Bulletin No	Headline	CICTT Group	CICCT Code	CICTT Breakdown
2003	23/02/2003	G-BVJE	Aerospatiale AS350B1 Ecureuil	Loch a' Ghlinne Dhuirch, near Kyle of Lochalsh, Scotland	200301191	7/2003	Tail rotor struck surface of loch while collecting water. Damage to tail rotor and associated gearbox. No injury to 1 POB.	Operational (F)	LALT	
	30/04/2003	G-IANG	Bell 206L Longranger	Longfaugh Farm near Pathhead, Midlothian	200302567	3/2004	Tail of helicopter struck power cables in low cloud. Forced landing in field. Aircraft destroyed. Minor injuries to3 POB.	Operational (F)	CFIT	
	30/05/2003	G-BAML	Bell 206B Jet Ranger III	Crag Lough, 4 miles North East of Haltwhistle, Northumberland	200303275	1/2004	Aircraft began to yaw right and rotate before striking ground at low speed and rolling onto side. Aircraft destroyed. Minor injuries to 3 POB.	Operational (F)	LOC-I	
	29/08/2003	G-PLMB	Aerospatiale AS350B Squirrel	1.5 nm south-west of Fort Augustus, Scotland	200305909	2/2004	Tail rotor contacted power cables. Forced landing in field. No injury to 3 POB.	Operational (F)	CFIT	
	24/09/2003	G-STRO	Robinson R22	Porto Christo (SPAIN)	200306717	A-061/2003	During photographic sortie, skids contacted water and a/ctipped onto	Operational (F)	CFIT	

							surface of sea. Substantial damage. No injuries to two POB.			
	11/10/2003	G-JCBJ	Sikorsky S76C Spirit	Cranfield (CIT) (Bedfordshire)	200307120	5/2004	Hard landing. Substantial damage. No injuries to 2 POB.	Operational (F)	ARC	
2004	17/03/2004	G-EMCM	Eurocopter EC120B	Kidlington, Oxfordshire	200401601	5/2004	On take-off, the skid caught the ground and the helicopter rolled over. Substantial damage. No injury to 3 POB.	Operational (G)	LOC-G	
	30/03/2004	G-HPOL	MD 902 Explorer (NOTAR)	Airborne, near Worksop, Nottinghamshire	200402087	9/2004	Nine out of thirteen NOTAR fan blades found damaged.	Technical (D/M)	UNK	
	05/04/2004	G-AYMW	Bell 206B JetRanger-II	Overhead Newgrange	200402073	AAIU File No: 2004/0014	Aircraft entered right yaw and spiralled down to heavy ground impact. Substantial damage. 3 POB, 1 serious and 2 minor injuries.	Operational (F)	LOC-I	
	19/07/2004	G-FFRI	Aerospatiale AS355F1	Near Lasham Airfield, Hampshire	200404803	10/2005	Nr2 engine ran down in-flight due to failure of flexible coupling.	Technical (D)	SCF-NP	
	15/09/2004	G-BDOC	Sikorsky S-61N	Near Sullom Voe, Shetland	200406638	5/2005	During winch transfer of a pilot to a tanker, underside of main rotor contacted a mast. All 4 blades damaged. No injuries.	Operational (F)	CTOL	

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/ Bulletin No	Headline	CICTT Group	CICTT Code	CICTT Breakdown
2004	18/10/2004	G-BZVG	Eurocopter AS350B3 ‘Ecureuil’	Oxford Kidlington Airport	200407483	5/2006	Loss of control following simulated hydraulic failure on approach. A/c rolled left and struck ground. Substantial damage. Two POB - 1 serious injury.	Operational (F)	LOC-I	

2005	11/03/2005	G-CCAU	EC135	EGBO : WOLVERHAMPTON	200502181	N/A	Nr1 engine started with rotor brake engaged.	Operational (G)	LOC-G	
	21/12/2005	G-WLLY	Bell 206B Jet Ranger II	3 nm north-east of Coupar Angus, Tayside	200510450	12/2006	Vertical stabiliser detached in flight, causing tail rotor and associated gearbox to separate. Two POB fatal.	Technical (M)	SCF-NP	
2006	20/01/2006	G-BXGA	Eurocopter AS350B2 Squirrel	Corrie of Clova, 16 nm north-west of Forfar, Scotland	200600442	4/2006	Main rotor blades struck boulder on steep hillside. All three rotor blades damaged. No injury to 1 POB.	Operational (F)	CFIT	
	04/06/2006	G-EHMS	MD Helicopters MD 900	Walworth Road, London Borough of Southwark)	200604637	9/2007	As the helicopter landed on a garage forecourt, a metal sign detached from the wall and was blown into the main rotor disc. Substantial damage. No injuries to four POB.	Operational (G)	RAMP	
	21/06/2006	G-HBEK	Agusta A109C	Private helicopter landing site at High Legh, Cheshire	200605382	1/2007	Main rotor blades struck fuel bowser on landing. Extensive damage to main rotor head assembly and rotor blades	Operational (G)	RAMP	
	08/08/2006	G-BTNC	SA365	Humberside Airport	200607135	N/A	During training flight, nr1 engine runaway during running landing. High NG and NR with associated engine noise. Aircraft returned to hangar.	Technical (M)	SCF-PP	
	23/09/2006	G-JESI	Eurocopter AS 350	Dunkerrin, Co Offaly	200608688	AAIU File No: 2006/0070	Precautionary landing due to critically low fuel contents35 minutes into flight with 2.5 hours endurance expected.	Operational (G)	FUEL	
	09/10/2006	G-DNHI	Agusta A109A	2 nm west of Biggin Hill Airport, Kent	200609167	12/2007	Engine exhaust duct separated and struck tail rotor, causing gearbox to separate followed by part of upper	Technical (D)	SCF-NP	

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/ Bulletin No	Headline	CICTT Group	CICCT Code	CICTT Breakdown
							vertical stabiliser. Forced landing made without further damage.			
2007	07/04/2007	G-CAMB	AS355F2, Twin Squirrel	Shobdon Airfield, Herefordshire	200703351	9/2007	Aircraft sustained hard landing during simulated OEI rejected take-off. Substantial damage. Two POB - one minor injury.	Operational (F)	ARC	
2007	16/09/2007	G-IWRC	Eurocopter EC135 T2	East of North Weald Airfield, Essex	200708989	9/2008	A/c crashed following uncommanded autotrim disengagement. Substantial damage. No injuries to two POB.	Operational (F)	LOC-I	
	20/11/2007	G-CHCF	AS332L2 Super Puma	Aberdeen Airport, Scotland	200711418	2/2009	Nr2 engine freewheel failed during simulated nr1 engine failure. A/c dropped to runway from 30-40ft. No damage or injuries reported.	Technical (M)	SCF-PP	
	22/11/2007	G-DPJR	Sikorsky S-76B Spirit	Approaching Coventry Airport	200711471	4/2009	Auxiliary heater overheated in flight, filling cockpit with smoke. MAYDaylight declared. A/c landed safely.	Technical (M)	F-NI	
2008	04/02/2008	G-TAMA	Schweizer 269D Configuration A (Schweizer 333)	Sheffield City Airport	200801029	8/2008	While parked with engine running, main rotor gearbox pinion outer bearing seized and a/c began to vibrate violently. Substantial damage. No injury.	Technical (M)	SCF-NP	
	02/05/2008	G-ELTE	Agusta A109A II	Redhill Aerodrome, Surrey	200804359	1/2010	Gear lever became loose. Unable to lower gear. Diverted. PAX & 1 crew member disembarked in low hover. 6 POB, no injuries. Landed wheels up on tyres.	Technical (D)	SCF-NP	

	04/12/2008	G-CCAU	EC135 T1	Hindlip Hall, Hindlip, Worcestershire	200813042	1/2010	When landing and with collective lowered, loud bang with severe tail rotor vibration / continuous banging. Scissor/driving link had detached.	Technical (M)	SCF-NP	
2009	13/01/2009	N-745HA	Agusta A109 A2	Fairoaks Airport, Chobham, Surrey	200900405	8/2009	During double engine failure exercise, trainee was going to miss target. Instructor took over & touched down on grass. Two POB, no injuries.	Operational (F)	LOC-I	
	21/05/2009	G-BPIJ	Brantly B2B	Hardwick Airfield, , Barondale Lane, Hardwick, near Norwich	200904996	8/2009	Loss of tail rotor effectiveness in hover. A/c crashed and was destroyed. No injuries to two POB.	Operational (F)	LOC-I	
2010	18/01/2010	G-TYCN	Agusta Westland 109	Private field, Blandford Forum, Dorset	201000519	5/2010	Heavy landing, aircraft bounced and yawed to the right followed by second heavy landing. Substantial damage. Two POB, no injuries.	Operational (F)	LOC-I + ARC	
	17/06/2010	G-HEMS	Aerospatiale SA365N Dauphin	En-route to Durham Tees Valley Airport	201005704	11/2010	Rear quarter door opened during flight with several items falling from the a/c. One of the items struck a person on the ground.	Operational (G)	RAMP	

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/ Bulletin No	Headline	CICTT Group	CICTT Code	CICTT Breakdown
2010	09/07/2010	G-SARC	Sikorsky S-92A	Harris Hills, Isle of Harris, Scotland	201006825	2/2011	Automatic Flight Control System (AFCS) selection failure.	Operational (F)	LOC-I	
	28/10/2010	G-SEWP	AS355F2 Twin Squirrel	31 nm south of Belfast Aldergrove	201012129	6/2011	A/c crashed near accident site of another a/c whilst conducting ops related with the first accident. Four	Operational (F)	LOC-I	

				Airport, Northern Ireland			POB, minor injuries. Substantial a/c damage.			
2011	05/03/2011	G-BZPP	Westland Wasp HAS1	RNAS Yeovilton, Somerset	201102294	7/2011	During landing Starduster collided into Wasp which was hovering approx. 5ft above runway. One POB Starduster, minor injuries. Two POB Wasp, no injuries.	Operational (F)	MAC	
	11/06/2011	G-SASH	MD 900 Explorer	Leeds Bradford Airport	201106446	10/2011	Downwash from hover taxiing helicopter spun a parked and empty DA40 a/c into a parked and empty PA28 a/c. No reported damage or injuries. AAIB AARF investigation.	Operational (G)	ADRM	
	19/07/2011	G-GCMM	Agusta A109E	Fiveways Trading Estate, Corsham, Wiltshire	201108319	2/2012	The tail rotor clipped a hedge/fence post during landing. Two POB, no injuries.	Operational (F)	CTOL	
	29/07/2011	G-CEMS	MD Helicopters MD900 Explorer	Leeds Bradford Airport	201108837	5/2012	Loud cracking noise heard as a/c put down on grass. Front skid plate mounting found to have cracked and support tube bent. AAIB Field investigation.	Technical (M)	SCF-NP	
2012	20/02/2012	G-SUEZ	Agusta Bell 206B Jet Ranger II	Approx 3.4 miles NW of Perth, Scotland	201201848	1/2013	"Bang" heard during flight with left yaw and engine spooling down. 'Engine Out' warning. MAYDAY declared. Entered autorotation. Landed safely.	Technical (M)	SCF-PP	
	24/03/2012	G-BXRR	Westland Scout AH1	Near Collingtree, Northamptonshire	201203202	7/2012	A/c planning to land at hotel, lost control and fell to the ground. Four POB, no injuries.	Operational (F)	ARC	
	02/05/2012	M-EMLI	Agusta AW-109	West London Shooting School, Northolt, Middlesex	201204734	9/2012	During landing, main rotor made contact with a branch. Three POB, no injuries. Damage to rotor tips and possible shock loading to engine.	Operational (F)	CTOL	

	04/05/2012	G-STGR	Agusta A109S Grand	Helsby, Cheshire	201204821	9/2012	A/c drifted slightly backwards on landing and tail rotor struck hedge at the back of the helipad. Two POB, no injuries.	Operational (F)	CTOL	
	03/05/2012	G-WIWI	Sikorsky S-76C++	Peasmarsh, East Sussex	201207682	12/2014	Handling pilot lost visual references and carried out a missed approach during which a 'Tail Too Low' EGPWS warning was heard. A/c diverted.	Operational (F)	CTOL	

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/ Bulletin No	Headline	CICTT Group	CICTT Code	CICTT Breakdown
2012	08/07/2012	G-LVDC	Bell 206L-3 Longranger III	Near Silverstone, Northampton	201207748	11/2012	Low rotor rpm warning horn sounded. A/c carried out autorotation and landed in a field during which main rotor struck vertical fin. One POB, no injuries.	Technical (M)		
	08/10/2012	G-ORKY	AS350B2 Ecureuil	Cairngorms National Park, Scotland	201212449	2/2013	Lifting equipment contacted tail rotor during turbulence. Damage to vertical stabiliser and TR blades.	Met	LOC-I +EXTL	
	16/10/2012	G-BXGA	AS350B2 Ecureuil	1.5 nm south of Kettlewell, Yorkshire	201212752	2/2013	Chain sling contacted tail rotor drive cover, horizontal stabiliser and both tail rotor blades during lifting operation.	Operational (F)	LOC-I +EXTL	
2013	16/01/2013	G-CRST	Agusta A109E	St George Wharf, Vauxhall, London	201300351	S1/2013	Helicopter collided with a crane and impacted the ground. One POB, fatal injuries and one fatal injury to person on the ground.	Operational (F)	CFIT	
	29/11/2013	G-SPAO	Eurocopter EC135 T2+	Glasgow City Centre, Scotland	201315564	S2/2014	Fatally injured. Total of ten people fatally injured, including ground fatalities and a further 11 seriously injured. AAIB Field investigation.	Operational (F)	FUEL	
2014	13/03/2014	G-LBAL	Agusta Westland AW139	Private Landing Site - Gillingham Hall	201402992	10/2015	Aircraft crashed on farmland shortly after take-off. Four POB all fatally injured. Aircraft destroyed. AAIB Field investigation.	Operational (F)	CFIT	

	21/03/2014	G-OLCP	AS355N Ecureuil II	Peterborough Conington Airport, Cambridgeshire	201403464	9/2014	As helicopter hover taxied, the rotor wash caused a parked aircraft to overturn.	Operational (F)	RAMP	
	16/09/2014	G-SUEX	Agusta Bell 206B Jet Ranger II	Flamborough Head, Yorkshire	201412406	1/2016	Descended below cliff tops prior to crashing. Two POB, both fatally injured. Aircraft destroyed.	Technical (M)	SCF-PP	
2015	25/11/2015	G-NWPS	EC135 T1	Bilsdale, North Yorkshire	201517340	4/2016	Helicopter suffered FOD damage to fenestron cowling and fenestron blades during landing phase at remote site. Damage: Fenestron tail rotor. 3 POB.	Operational (F)	RAMP	
	29/12/2015	G-BYRX	Westland Scout AH1	Barn Farm, Ruddington	201519099	2/2017	Aircraft crashed while in hover and damaged beyond economic repair. Two POB, one minor injury.	Technical (M)	SCF-NP	

Year of Accident	Date of Accident	Aircraft Reg.	Helicopter Type	Location of Accident	MOR No.	AAIB Report/ Bulletin No	Headline	CICTT Group	CICTT Code	CICTT Breakdown
2016	11/07/2016	G-VGMG	Eurocopter AS350B2 Ecureuil	Lake Farm, Old Race Course, Bideford, Devon	201616276	2/2017	Lost control during hydraulic failure practice manoeuvre. Substantial damage. 2 POB No injuries.	Operational (F)	LOC-I	
	23/09/2016	G-KAXT	Westland Wasp HAS1	Bishopstone, Salisbury, Wiltshire	201624161	6/2017	Loss of collective pitch control in flight and further tail rotor control problems to hard landing in a turnip field. Two POB, no injuries.	Technical (D)	SCF-NP	
2017	29/03/2017	G-OHCP	Airbus Helicopters AS355F1 Ecureuil II	Summit of Rhinog Fawr, Snowdonia	201705998	3/2018	Helicopter struck mountain 5 POB, Fatal injuries.	Operational (F)	UIMC	
	05/05/2017	G-PBWR	Agusta A109S Grand	London Stansted Airport	201709512	9/2017	Horizontal Stabiliser Failure during flight. Two POB, no injuries. Damage to horizontal stabiliser.	Technical (D)	SCF-NP	
	10/05/2017	G-HKCN	Airbus Helicopter AS 350 B3	Bergen harbour, Norway	201710001	N/A	Helicopter hit the sea in connection with attempting to land on yacht. 3 POB, 2 persons with minor injuries.	Technical (D)	RAMP	
	02/08/2017	G-HLCM	AW109SP Grand New	Private landing site near Clifton Dykes, Penrith, Cumbria	201718645	11/2017	Helicopter performed emergency landing. One main rotor blade tip cap detached. 1 POB, no injuries.	Operational (G)	SCF-NP	
	27/11/2017	G-IWFC	AW109SP Grand New	Sywell Aerodrome, Northamptonshire	201729526	6/2018	Engine cowling detached during a test flight after maintenance. 2 rotor blades damaged.	Technical (M)	SCF-NP	

Appendix 4 – SPS Taxonomy

Standard Problem Statement (SPS) Taxonomy Breakdown

Table 1. SPS Taxonomy Breakdown

Ground Duties			
100	Mission Planning		
100	10	101010	Inadequate consideration of aircraft operational limits
100	10	101020	Inadequate consideration of aircraft performance
100	10	101030	Inadequate consideration of weather/wind
100	10	101040	Pilot experience leads to inadequate planning regarding weather/wind
100	10	101050	Mission requirements/contingencies planning inadequate
100	10	101060	Pilot did not adequately consider and plan for alternate
100	10	101070	Incorrect fuel planning/calculations
100	10	101080	Weather – Accurate weather information not available to Flight Crews and dispatchers.
100	10	101090	Inadequate consideration of obstacles
100	10	101100	Use of out of date or inadequate operational data
100	10	101099	Mission Planning – Other
100	Weight and Balance		
100	20	102010	Incorrect weight and balance calculations
100	20	102020	Incorrect aircraft loading, out of CG/weight limits
100	20	102030	Company procedures not followed
100	20	102099	Weight and Balance – Other
100	Aircraft Pre-flight		
100	30	103010	Aircraft Pre-flight procedure inadequate
100	30	103020	Performance of Aircraft Pre-flight inadequate
100	30	103030	Doors/cowlings not properly secured
100	30	103040	Diverted attention, distraction
100	30	103050	Tie downs not removed
100	30	103099	Aircraft Pre-flight – Other
100	Pre-flight Briefings		
100	40	104010	Passenger safety briefing inadequate
100	40	104020	Inadequate flight crew briefing

100	40	104099	Pre-flight Briefings – Other
100	Post flight Duties		
100	50	105010	Inlet covers not installed
100	50	105099	Post flight Duties - Other
Safety Management			
200	Management		
200	10	201010	Non-aviation dispatcher/comm centre
200	10	201020	Management policies/oversight inadequate
200	10	201030	Failure of company to realize the unintended consequences of new flight operations policies
200	10	201040	Failure to enforce company SOPs
200	10	201050	Management disregard of crew aeromedical factors
200	10	201060	Management disregard of human performance factors i.e. Duty/flight time, fatigue
200	10	201070	Management disregard of known safety risk
200	10	201080	Customer/company pressure
200	10	201090	Crew hiring criteria
200	10	201100	Lack of local supervision of remote operations
200	10	201110	Lack of supervision of remote maintenance
200	10	201115	Management of combined fixed wing and rotary ground operations
200	10	201120	Operating below civil regulatory standards
200	10	201125	Inadequate provision of operational information
200	10	201099	Management - Other
200	Safety Program		
200	20	202010	Safety program inadequate
200	20	202020	Lack of a formal system for threat-free reporting of safety-related incidents within the company/industry.
200	20	202030	Risk Management inadequate
200	20	202040	Insufficient employee performance monitoring
200	20	202050	Inadequate lessee risk awareness
200	20	202099	Safety Program - Other
200	Equipment (Safety Management)		
200	30	203010	Helicopter inadequately equipped for mission

200	30	203020	Personal Protection Equipment inadequate or not provided
200	30	203099	Equipment – Other
200	Pilot		
200	40	204010	Disregard of known safety risk
200	40	204020	Pilot-In-Command self-induced pressure
200	40	204099	Pilot –Other
200	Scheduling/Dispatch		
200	50	205010	Crew assignment
200	50	205020	Crew – crew matching
200	50	205030	Crew – mission assignment
200	50	205040	Lack of monitoring of flight ops data
200	50	205099	Scheduling/Dispatch – Other
200	Training Program Management		
200	60	206010	Training vehicle too unforgiving for use
200	60	206020	Training inadequate for inadvertent IMC
200	60	206030	CFI preparation and planning
200	60	206040	Inadequate flightcrew training due to cultural/economic
200	60	206050	Inadequate CRM training
200	60	206060	Inadequate crew-mission training
200	60	206099	Training Program Management – Other
200	Flight Procedure Training		
200	70	207010	Emergency training inadequate
200	70	207020	Inadequate post Vortex ring state (“settling with power”) or loss of tail rotor effectiveness avoidance, recognition and recovery training.
200	70	207030	Inadequate systems failure training
200	70	207040	Autorotation Training Inadequate
200	70	207050	Special operations training inadequate
200	70	207060	Specialist role equipment training inadequate
200	70	207099	Flight Procedure Training – Other
200	Transition Training		
200	80	208010	Pilot transition training
200	80	208020	Transition to aircraft make/model

200	80	208030	Transition from one engine type to another
200	80	208040	Transition from one geographic area to another
200	80	208050	Transition between fixed wing and rotary
200	80	208060	Transition to and between operational roles
200	80	208099	Transition Training – Other
200	Inadequate Pilot Experience		
200	90	209010	Pilot inexperienced
200	90	209020	Pilot inexperienced with area and/or mission
200	90	209030	Pilot lacking experience in make/model
200	90	209040	Student Pilot
200	90	209050	Inadequate pilot knowledge
200	90	209099	Inadequate Pilot Experience – Other
200	Ground/Passenger Training		
200	100	210010	Inadequate Ground/Landing Zone personnel training
200	100	210020	Inadequate training – Other personnel onboard
200	100	210099	Ground/Passenger Training – Other
200	Survival training		
200	110	211010	Egress training land
200	110	211020	Egress training water (dunker)
200	110	211099	Survival training – Other
Maintenance			
300	Maintenance Procedures/Management		
300	10	301010	Failure of QA or supervisory oversight (supervision)
300	10	301020	Inadequate documentation of aircraft records
300	10	301030	Mechanic insufficient training/experience
300	10	301040	Aircraft released in unairworthy condition
300	10	301050	Pre-Functional Check Flight maintenance settings lead to hazardous conditions
300	10	301060	No post maintenance Functional Check Flight
300	10	301070	Lack of Functional Check Flight procedures
300	10	301099	Maintenance Procedures/Management – Other
300	Performance of MX Duties		

300	20	302010	Maintenance did not detect impending failure
300	20	302020	Failure to perform proper maintenance procedure
300	20	302030	Failure of personnel to coordinate
300	20	302040	Maintainer interrupted
300	20	302050	Intentional non-compliance
300	20	302060	Maintenance induced Foreign Object Damage
300	20	302070	Loss/degradation of flight control system due to inadequate maintenance
300	20	302080	Loss/degradation of Tail Rotor drive system due to inadequate maintenance
300	20	302099	Performance of MX Duties – Other
300	Aircraft Design (related to maintenance)		
300	30	303010	Lack of airborne equipment to detect impending part failure
300	30	303020	Lack of ground equipment to detect impending part failure
300	30	303099	Aircraft Design (related to maintenance)- Other
300	Quality of Parts		
300	40	304010	Bogus or surplus or unapproved parts used
300	40	304020	Tracking/cert military/surplus parts
300	40	304030	Fuel Contamination by/during maintenance
300	40	304040	Manufacturing defect not detected
300	40	304050	Defect in overhauled part not detected
300	40	304099	Quality of Parts – Other
Infrastructure			
400	Oversight/Regulation (Infrastructure)		
400	50	405010	(NOT USED, see 1305040) Fixed-wing to rotary wing transition training requirements
400	50	405020	Inadequate oversight/regulations
400	50	405030	Inadequate tower/wire markings
400	50	405099	Infrastructure Oversight/Regulation – Other
400	Equipment (Infrastructure)		
400	60	406010	Lack of compatible air/ground communication equipment
400	60	406020	IFR system incompatible with helicopter missions
400	60	406030	Weather information for departure/enroute/destination inadequate or not available

400	60	406040	Improper modification of weather/navigational aids
400	60	406050	Lack of navigation/approach aids
400	60	406060	Failure of non-aircraft-based navigation/approach aids
400	50	406070	Aerodrome/landing site related factor
400	50	406075	Dirty landing site/Foreign objects at landing site
400	60	406099	Infrastructure Equipment – Other
Pilot judgment & actions			
500	Human Factors - Pilot's Decision		
500	10	501010	Poor resource management
500	10	501020	Disregarded cues that should have led to termination of current course of action or manoeuvre
500	10	501030	Pilot decision making
500	10	501040	Wilful disregard of aircraft limitations
500	10	501050	Wilful disregard for rules and SOPs
500	10	501060	Used unauthorized equipment
500	10	501070	Failed to follow procedures
500	10	501080	Disregard for rules and SOPs
500	10	501090	Pilot disabled warning system
500	10	501100	Pilot misjudged own limitations/capabilities
500	10	501099	Human Factors – Pilot's Decision – Other
500	Human Factors - Pilot/Aircraft Interface		
500	20	502010	Sense of urgency led to risk taking
500	20	502020	Diverted attention, distraction
500	20	502030	Perceptual judgment errors
500	20	502040	Visual Illusions
500	20	502050	Crew Disregard of crew aeromedical factors
500	20	502060	Crew Disregard of human performance factors i.e. duty/flight time, fatigue
500	20	502099	Human Factors – Pilot/Aircraft Interface – Other
500	Flight Profile		
500	30	503010	Pilot's flight profile unsafe for conditions
500	30	503020	Pilot's flight profile unsafe – Altitude
500	30	503030	Pilot's flight profile unsafe – Airspeed

500	30	503040	Pilot's flight profile unsafe – Unsuitable terrain
500	30	503050	Pilot's flight profile unsafe – Approach
500	30	503060	Pilot's flight profile unsafe – Take-off
500	30	503070	Pilot's flight profile unsafe – Rotor RPM
500	30	503080	Pilot's flight profile unsafe – Power margins
500	30	503099	Flight Profile – Other
500	Landing Procedures		
500	40	504010	Selection of inappropriate landing site
500	40	504020	Landing site reconnaissance
500	40	504030	Misperception of stability and motion cues in hover
500	40	504040	Inadequate Autorotation – Forced
500	40	504050	Inadequate Autorotation – Practice
500	40	504060	Improper termination of precautionary landing
500	40	504099	Landing Procedures – Other
500	Crew Resource Management		
500	50	505010	Inadequate and untimely PiC action to correct 2nd pilot action
500	50	505015	Inadequate and/or untimely intervention by other crew member
500	50	505020	Inadequate and untimely CFI action to correct student action
500	50	505099	Crew Resource Management – Other
500	Procedure Implementation		
500	60	506010	Pilot improper action due to misdiagnosis
500	60	506020	Pilot control/handling deficiencies
500	60	506030	Inadequate response to Loss of tail rotor effectiveness
500	60	506040	Inappropriate Energy/power management
500	60	506050	Improper recognition and response to dynamic rollover
500	60	506060	Lack of Inflight fuel quantity monitoring
500	60	506099	Procedure Implementation – Other
Communications			
600	Controlling Agencies		
600	10	601010	Coordination with Ground/Landing Zone personnel
600	10	601020	Coordination with ATC

600	10	601099	Controlling Agencies – Other
600	Other Crew Members		
600	20	602010	Coordination with other pilots
600	20	602020	Coordination with other crew members
600	20	602030	Handoff of helicopter from one pilot to another pilot on ground
600	20	602040	Lack of positive transfer of control
600	20	602099	Other crew members – Other
600	Inadequate Procedures		
600	30	603010	Hot expedited loading process inadequate
600	30	603020	Inadequate flight following/operational company communications
600	30	603030	Inadequate coordination with tactical operations control
600	30	603099	Inadequate Procedures – Other
Pilot situation awareness			
700	Visibility/Weather		
700	10	701005	Inadvertent entry into IMC
700	10	701010	Reduced visibility-darkness, night
700	10	701020	Reduced visibility--fog, rain, snow, smoke
700	10	701030	Reduced visibility--whiteout, brownout
700	10	701040	Reduced visibility--sun/glare
700	10	701050	Local and enroute weather
700	10	701099	Visibility/Weather - Other
700	External Environment Awareness		
700	20	702010	Aircraft position and hazards
700	20	702015	Failure to detect and/or avoid conflicting traffic
700	20	702020	Altitude
700	20	702030	Aircraft state
700	20	702040	Lack of knowledge of aircraft's aerodynamic state (envelope)
700	20	702050	Pilot unaware aircraft restrained by the ground or ground obstruction/obstacle
700	20	702060	Failed to recognize cues to terminate current course of action or manoeuvre
700	20	702070	Low flight near wires

700	20	702080	Use of Enhanced Vision Systems in inappropriate environmental conditions
700	20	702090	Use of thermal imaging in inappropriate environmental conditions
700	20	702099	External Environment Awareness – Other
700	Internal Aircraft Awareness		
700	30	703010	Unaware of low fuel status leading to fuel exhaustion
700	30	703099	Internal Aircraft Awareness – Other
700	Crew Impairment		
700	40	704010	Pilot/crew impaired
Part/system failure			
800	Aircraft		
800	10	801010	Airframe component failure
800	10	801015	Failure of aircraft component due to lighting strike
800	10	801017	Failure of aircraft component due to Manufacturing defect
800	10	801018	Failure of aircraft component due to Design Defect
800	10	801020	Main Rotor Drive system component failure
800	10	801030	Main Rotor Blade failure
800	10	801035	Main rotor hub failure
800	10	801040	Tail Rotor Drive system component failure
800	10	801050	Tail Rotor Blade Failure
800	10	801055	Tail rotor hub failure
800	10	801060	Tail Rotor Gearbox lubrication starvation
800	10	801065	Intermediate gearbox lubrication starvation
800	10	801070	Transmission system component failure
800	10	801080	Main Gearbox Lubrication starvation
800	10	801090	Flight control (non-Avionics Flight Control System) Failure
800	10	801095	Main rotor control failure
800	10	801097	Tail rotor control failure
800	10	801100	Components used did not conform to type design
800	10	801110	Avionics system component failure (incl AFCS)
800	10	801120	Electrical system component failure
800	10	801130	Hydraulic system component failure

800	10	801140	Hydraulic fluid loss
800	10	801150	Fuel System Failure/Mechanical failure leading to fuel starvation
800	10	801160	Landing Gear/Skids
800	10	801170	Fuel Quantity System Failure
800	10	801180	Failure of data recording equipment
800	10	801099	Aircraft - Other
800	Powerplant		
800	20	802010	Engine Component failure
800	20	802015	Failure of powerplant due to Design defect
800	20	802020	Engine Oil Starvation
800	20	802099	Powerplant – Other
800	Operational FOD		
800	30	803010	Part/system failure due to Operational FOD (not maintenance related)
800	Mission Specific Equipment		
800	40	804010	Mission specific equipment - civil
800	40	804020	Mission specific equipment - military
Mission Risk			
900	Terrain/Obstacles		
900	10	901010	Mission involves flying near hazards, obstacles, wires
900	10	901020	Mission involves selection of remote landing sites
900	10	901030	Mission involves flight over unsuitable emergency landing terrain
900	10	901035	Mission involves operations at high density altitudes
900	10	901037	Mission involves operations with limited power margins
900	10	901040	Lack of operating site reconnaissance
900	10	901099	Terrain/Obstacles - Other
900	Pilot Intensive		
900	20	902010	Mission involved flying in inclement weather conditions
900	20	902020	Mission involves flight in high traffic areas
900	20	902030	Mission requirements place pressure on crew to fly
900	20	902040	Mission requires low/slow flight
900	20	902050	Mission involves operations at high density altitudes

900	20	902060	Mission involves operations with limited power margins
900	20	902070	Mission involves operations to moving decks
900	20	902080	Mission involves repetitive/high frequency tasks
900	20	902099	Pilot Intensive - Other
900	Aircraft Intensive		
900	30	903010	Mission involves repeated heavy lift
900	30	903099	Aircraft Intensive – Other
900	Environment		
900	40	904010	Mission involves operations in high turbulence and/or temperature fluctuations
900	40	904020	Mission involves operations at high density altitudes
900	40	904030	Mission involves operations to moving decks
900	40	904099	Environment – Other
900	Crew Intensive (e.g. winching, HEMS, load lifting etc.)		
900	50	905010	Mission introduced crew member hazard
900	50	905020	Mission involves high level crew interaction - e.g. winching, short haul
900	50	905099	Crew Intensive – Other
Post-crash survival			
1000	Safety Equipment		
1000	10	1001010	Safety equipment not installed
1000	10	1001020	Safety equipment installed by OEM removed
1000	10	1001030	Safety equipment failed
1000	10	1001033	Safety equipment malfunctioned
1000	10	1001035	Safety equipment failed to deploy
1000	10	1001037	Safety equipment not deployed/operated by crew
1000	10	1001040	Passenger/crew survival gear not used
1000	10	1001045	Personal Safety Equipment not provided
1000	10	1001099	Safety Equipment – Other
1000	Crashworthiness		
1000	20	1002005	Vehicle did not withstand impact
1000	20	1002010	Vehicle sank and/or capsized
1000	20	1002015	Inadequate provisions for emergency egress

1000	20	1002020	Post-crash fire
1000	20	1002030	Lack of standard for water impact (i.e. not ditching)
1000	20	1002099	Crashworthiness – Other
1000	Delayed rescue		
1000	30	1003010	ELT inoperative/damaged by impact
1000	30	1003020	Inaccessible accident site
1000	30	1003030	Bad Weather
1000	30	1003040	No flight following - slow to locate site
1000	30	1003050	Night-Darkness
1000	30	1003060	Inadequate communications between survivor(s) and rescue
1000	30	1003099	Delayed rescue – Other
Data issues			
1100	Inadequate information in report		
1100	10	1101010	Information missing/incomplete in report
1100	10	1101020	Information unavailable to investigators
1100	10	1101025	Incomplete data from recorder
1100	10	1101030	Inadequate human factors information
1100	10	1101040	Inadequate control of accident scene
1100	10	1101050	Use and availability of info for flight path unknown
1100	10	1101060	Inadequate Investigation
1100	10	1101099	Inadequate information in report – Other
Ground personnel			
1200	Ground personnel		
1200	10	1201010	Failure to disconnect all ground/aircraft connections
1200	10	1201020	Fuel servicing
1200	10	1201030	Marshalling
1200	10	1201099	Ground personnel – Other
Regulatory			
1300	Accident Prevention		
1300	10	1301010	Failure to require data recording capability sufficient to understand accident sequence.

1300	10	1301020	Insufficient analysis of previous incidents and lack of available incident information to the operators due to lack of oversight on the part of the regulator(s).
1300	10	1301099	Regulatory Accident Prevention – Other
1300	Safety Culture		
1300	20	1302010	Lack of a formalized system for threat free reporting of safety-related incidents from operators to manufacturers.
1300	20	1302020	Lack of a formalized system for threat-free reporting of safety-related incidents from operators to the Authority
1300	20	1302099	Regulatory Safety Culture – Other
1300	Safety System		
1300	30	1303010	Lack of a reliable process for reviewing/revising safety decisions based on field data collected after certification.
1300	30	1303020	Failed to disseminate pertinent flight safety information.
1300	30	1303030	Inadequate regulatory oversight/regulations for Sightseeing Ops not regulated as Commercial Air Transport
1300	30	1303099	Regulatory Safety System - Other
1300	Oversight and Regulations (Regulatory)		
1300	40	1304010	Inadequate application of government/industry standards and regulations
1300	40	1304020	Inadequate government/industry standards and regulations
1300	40	1304030	(NOT USED - see 1304020) Regulations inadequate to ensure proper flight crew proficiency for the type of operations being conducted.
1300	40	1304040	Inadequate oversight by the Authority
1300	40	1304050	Inadequate Authority control of military surplus aircraft/parts
1300	40	1304099	Regulatory Oversight and Regulations – Other
1300	Operations		
1300	50	1305010	General Aviation vs Commercial Air Transport Pax-carrying operations
1300	50	1305020	Training requirements for Transition from one engine type to another
1300	50	1305030	Transition training requirements - general
1300	50	1305040	Fixed-wing to rotary wing transition training requirements
1300	50	1305099	Regulatory Operations – Other
Aircraft Design			
1400	Aircraft Design (level 2)		

1400	10	1401010	Cockpit design allowed critical controls to be selected inadvertently/inappropriately
1400	10	1401020	Safety assessments did not adequately identify system failure consequences
1400	10	1401030	Intolerance to wire strike
1400	10	1401040	Lack of annunciation/caution/warning of critical condition (including low rotor RPM)
1400	10	1401050	Engine flameout from snow/ice ingestion
1400	10	1401060	Lack of warning of incipient flight critical failures
1400	10	1401070	Intolerance to bird strike
1400	10	1401080	Intolerance to directional control failure (e.g. tail rotor, fenestron, NOTAR)
1400	10	1401090	Design of helicopter does not permit recovery from flight into degraded visual environments (e.g. IIMC, low textual environment, insufficient light sources at night)
1400	10	1401100	Intervention times for time-critical emergencies do not reflect “human performance limitations"
1400	10	1401110	Emergency exits do not permit evacuation within 'breath hold' time
1400	10	1401120	Inadequate airframe protection from flight in icing conditions
1400	10	1401099	Aircraft Design – Other
1400	RFM		
1400	20	1402010	Inadequate or missing procedures
1400	20	1402020	Missing or inadequate performance data
1400	20	1402030	Limitations absent from Flight Manual
1400	20	1402099	RFM - Other
1400	Human Machine Interface (HMI)		
1400	30	1403010	System failure/alert warning not present
1400	30	1403020	System failure/alert warning inadequate
1400	30	1403099	HMI - Other

Appendix 5 to Chapter 8 – AAIB Accident Review Flt Ops

2.1 Introduction

The accident review covers the period from the beginning of 2000 up to the end of 2017. This section purely consists the analysis of Air Accident Investigation Unit (AAIB) reports.

The accident reviews were restricted to commercial transport operations including emergency services, non-commercial complex (NCC) and specialised operations (SPO). To provide a complete and accurate passenger and third-party risk, which could be compared with European Helicopter Analysis (EHEST).

The overall Onshore Commercial sector accident statistics for the period 2000 to 2017 are:

a. All Accidents:

   i. 81 accidents
   ii. 4.76 per year (approx. 5 per year)
   iii. 3.54 accidents per 100,000 flights

a. Fatal accidents:

   i. 7 fatal accidents
   ii. 0.41 per year (approx. 2 every 5 years)
   iii. 0.36 fatal accidents per 100,000 flights

In comparison to the combined EU figures stated in the EHEST annual safety review 2017:

a. All accidents:

   4.7 per year (over 10 years)

b. Fatal accidents

   2.8 per year (over 10 years)

This comparison incorporates onshore CAT including HEMS, NCC and the combined SPO figures but no Police or SAR activity.

A list of the accidents in the analysis is shown in Appendix 1.

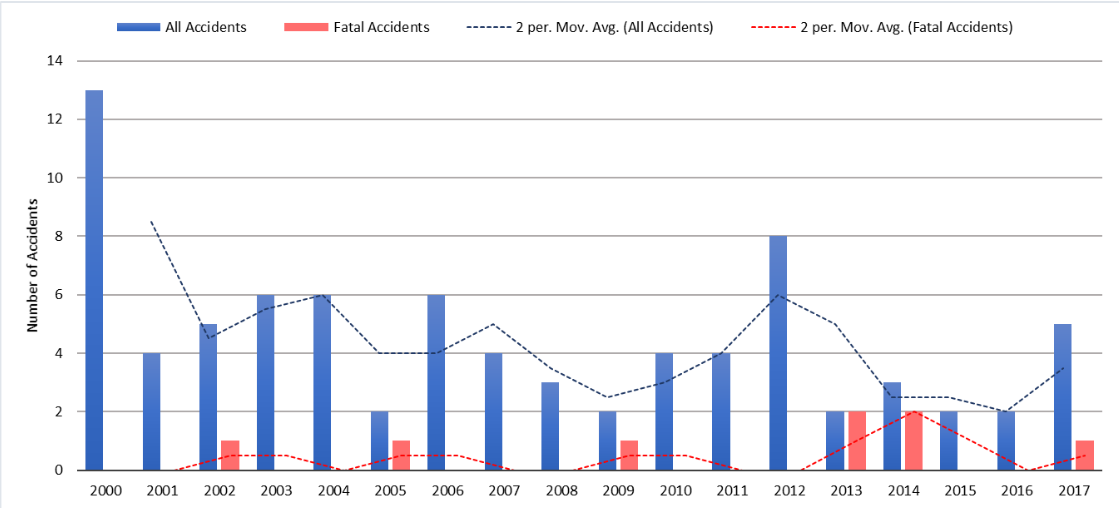
2.2 Chronology of Accidents (2000 – 2017)

The number of occurrences are represented in blue for all accidents and in red for fatal accidents. The use of a two-year moving average, as shown in figure 1 is to smooth out the fluctuations within the data and to assist identifying any underlying trends.

The accidents represented in Figure 1 shows a substantial decrease in 2001, 2005, 2009 & 2015 from its previous year. There is no apparent pattern when the rate is separated per sector. However, several external factors could have influenced the fluctuation in the data set such as the slowdown in the UK economy and commensurate reduction in flying hours.

Figure 1 demonstrates the chronology of accidents, the numbers of all accidents (blue) and fatal accidents (red) for each year. Including a two-year moving average.

Figure 1 Chronology of reportable accidents – Classification of Accidents 2000 -



2017

2.3 A standard taxonomy for classifying accidents was used, for classifying accidents accordingly, so that can be compared with other similar research. However, it is common to find accident data sets that do not always fit within standard and recognised taxonomies. The level of granularity can be a weakness forcing the data into the taxonomy, which may dilute crucial significance to accidents.

For this reason, the CAST/ICAO Taxonomy Team (CICTT) codes were used. The team found, this taxonomy group code selection allowed the results to express its true illustration of the data content.

Furthermore, the CICTT taxonomy also allows for codes to be associated with operational groupings and below is the selection of codes available in this scheme: Airborne

2.4 **Airborne**

Abrupt Manoeuvre	**AMAN**
Airprox/ TCAS Alert/ Loss of Control/ Near Mid-air Collisions/ Mid-air Collisions	**MAC**
Control Flight into Terrain	**CFIT**
Fuel Related	**FUEL**
Glider Towing Related Events	**GTOW**
Loss of Control - Inflight	**LOC-I**
Loss of Lifting Conditions – En-route	**LOLI**
Low Altitude Operations	**LALT**
Unintended Flight in IMC	**UIMC**

2.5 **Ground Operations**

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

2.6 **Aircraft**

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

2.7 **Non-Aircraft Related**

Aerodrome	**ADRM**
ATM/ CNS	**ATM**

2.8 **Miscellaneous**

Bird	**BIRD**
Cabin Safety Events	**CABIN**
External load Related Occurrences	**EXTL**
Other	**OTHR**
Security Related	**SEC**
Unknown or Undetermined	**UNK**

2.9 **Weather**

Icing	**ICE**
Turbulence Encounter	**TURB**
Wind Shear or Thunderstorm	**WSTRW**

2.10 **Take-off and landing**

Abnormal Runway Contact	**ARC**
Collision with Obstacle(s) During Take Off & Landing	**CTOL**
Undershoot/ Overshoot	**USOS**

Figure 2 illustrate the results of the grouping classification. It is noticeably clear, Operational flight represents most of the proportion, with 54%. However, this should be viewed in context with the broad scope of the code, contributing factors such as: operating environment, human factors, pilot interface with aircraft and regulatory subjects are not differentiated, but incorporated in the code itself, which must be explored.

Figure 2 Onshore helicopter accidents for the period 2000-2017 by CICTT operational groupings

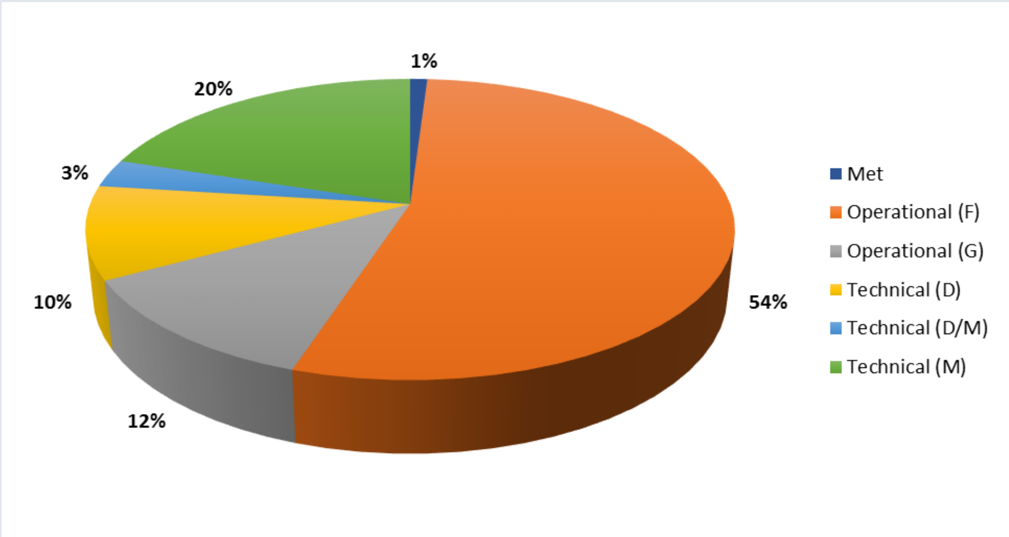
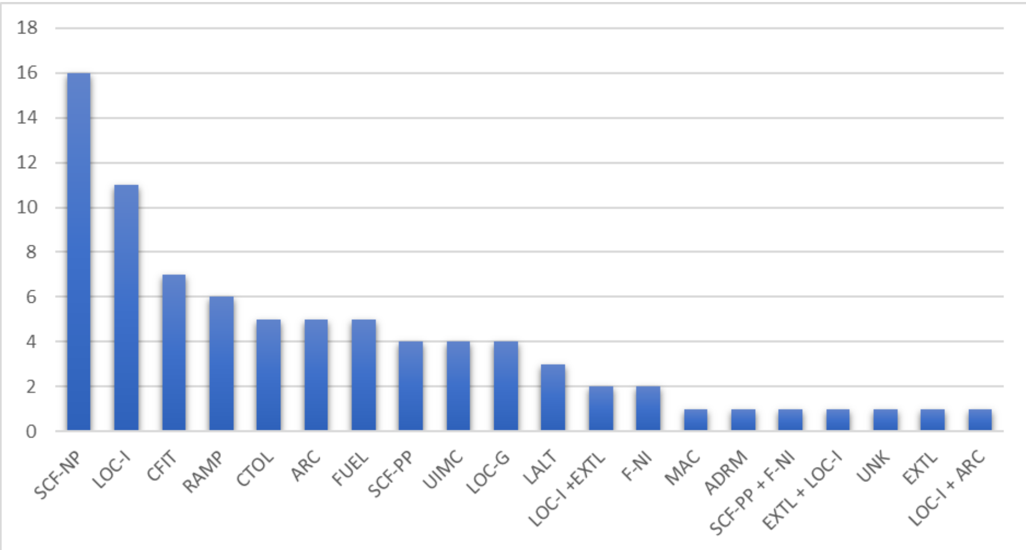


Figure 3 illustrates CICTT code classification with a deeper level of detail and is able to demonstrate a more defined representation of the reportable accidents.

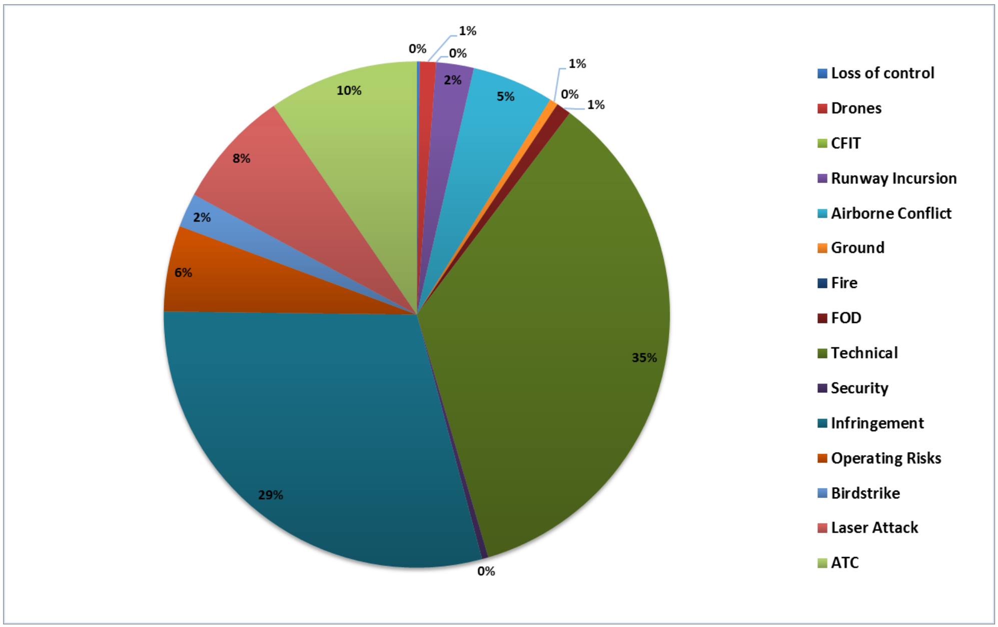
Figure 3 CICTT classification of onshore helicopter accidents for the period 2000-2017



Although the CICTT code **SCF-NP** 'System/ Component Failure or Malfunction (Non-Powerplant)' represents the highest proportion of events it can obscure the picture as there is a dominance of operational flight overall as detailed in Figure 3 given that many of the above CICTT codes are grouped under 'operational flight' and therefore may not necessarily represent a true evaluation of the grouping format.

MOR data was used to support the results gathered from the safety data. To rationalise the MOR data the drivers of each MOR were categorised and grouped. This gives more definition and granularity to the MOR data set by proportionally dispersing the MORs as shown in Figure App 9.4. The areas identified with the biggest fraction are Technical and Loss of control. This corresponds with the CICTT codes as shown in Figure 3.

Figure 4 MOR, Mandatory Occurrence Reports, data set



2.11 **Factor Identification of CAT reportable accidents 2000 – 2017**

The review accidents analysis aims to investigate in depth all contributing factors. To facilitate this, two taxonomy systems were utilised to enrich the data: Standard Problem Statements (SPS) and Human Factors Analysis and Classification System (HFACS) codes. The SPS taxonomy (developed by the IHST) and the HFACS model primarily focuses on human factors.

The HFACS taxonomy was applied to all the accidents in the accident dataset to help elicit where there might be Human Factors aspects at play within an operator's management system. The HFACS framework was developed in the early 1990's for the United States Navy, who at the time were experiencing a high rate of accidents, in order to assist in ascertaining the issues at play using a system based upon the James Reason 'swiss cheese' model.

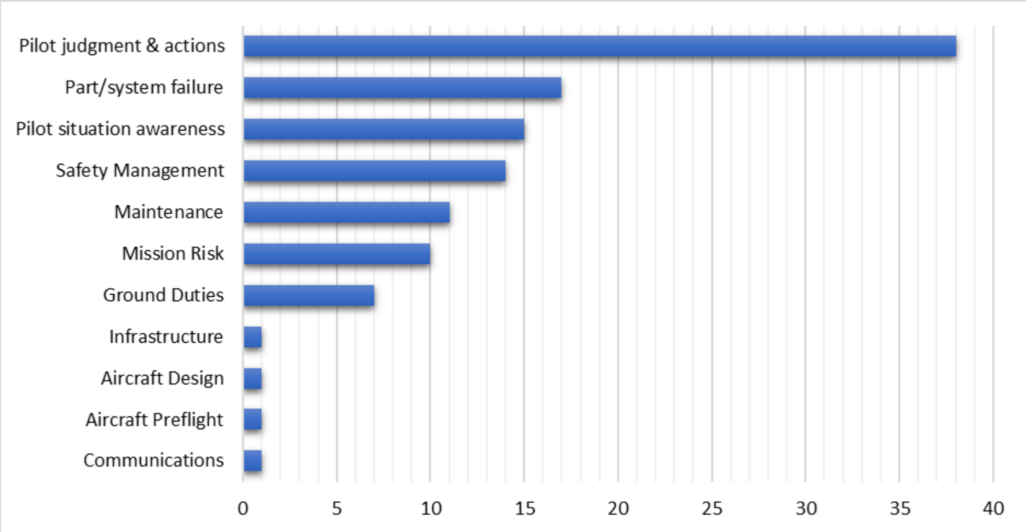
It must be recognised that the derived data is highly subjective as the process was only applied to the published accident narrative rather than as part of a wider accident investigation, which is what HFACS was designed for as an investigative tool. It must also be recognised that an EASA compliant management system has only been required since October 2014 but there has always been a similar requirement in place for operators to manage operational control and supervision through earlier regulatory guises such as JAR OPS and the Air Navigation Order.

This simplified application of the HFACS system clearly indicates issues within organisational influences and subsequent unsafe acts which include violations and errors.

The SPS system consists of a three-level taxonomy and lists over 400 codes in 14 different areas. The data set illustrating the SPS taxonomy is found in Appendix 3 to Chapter 5. A supplementary benefit of utilising this two-taxonomy approach is that it allows the team to compare the results in a manner consistent with other worldwide safety groups including EHEST and IHST.

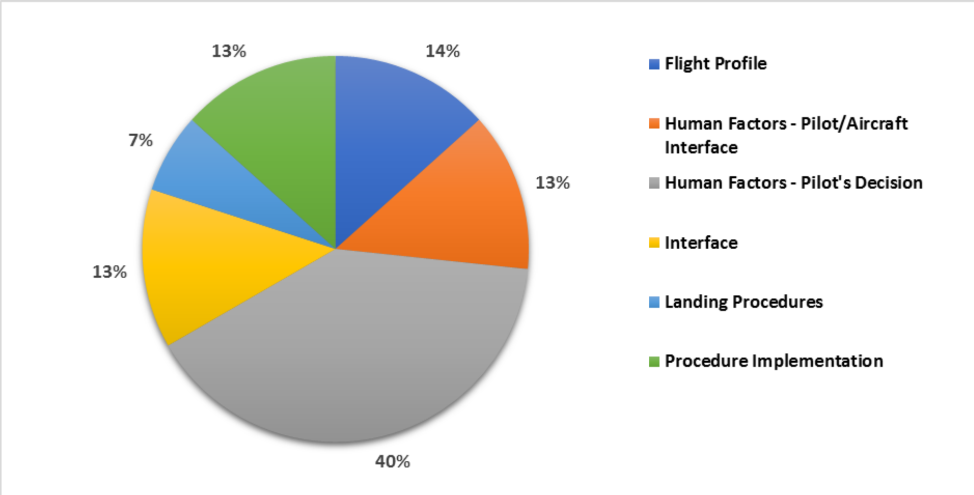
Figure 5 illustrates the results of the SPS taxonomy for the complete picture of operations within the agreed scope.

Figure 5 Total agreed scope operations distribution SPS Level 1



It is evident that the greatest trend identified in the dataset is pilot judgement & actions. The highest level of Standard Problem Statement, Level 1, is limited to provide only information on a generic level. To further investigate the factors involved within the dataset further investigation at Level 2 was carried out and were identified as: flight profile, human factors- pilot/ aircraft interface, pilot's decision, interface, landing procedures and procedure implementation, as shown in Figure 6.

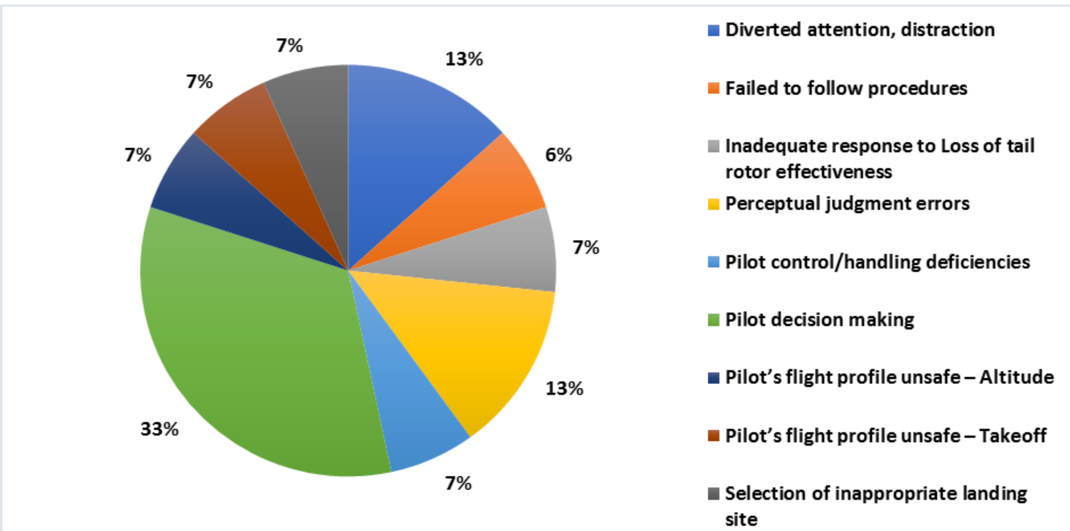
Figure 6 CAT SPS "Pilot Judgement & Actions" Level 2 distribution



Due to the limited human factor analysis covered within the accident reports it is difficult for the team to understand fully the contributing factors of the accidents. However, the trend is clear that human factors are prominent. To further understand the latter HFACS was applied in section 5 for a more complete breakdown and better understanding of the HF issues and to help support the team's understanding of the reasoning behind certain crew decisions.

It is important to also put into context the complexity behind operating environments. Human factors should certainly not be considered as the only contributing factor as others such as degraded visual environment (DVE) along with commercial pressure are also present. Additional factors shown in Figure A4 may well support this statement but as previously stated it is difficult to prove such statement without having, a factual evidence analysis in the accident report. Figure 7 illustrate a level 3 breakdown of SPS pilot judgement and actions.

Figure 7 CAT SPS "Pilot Judgment & Actions" Level 3 distribution



2.12 **Geographic location of all accidents**

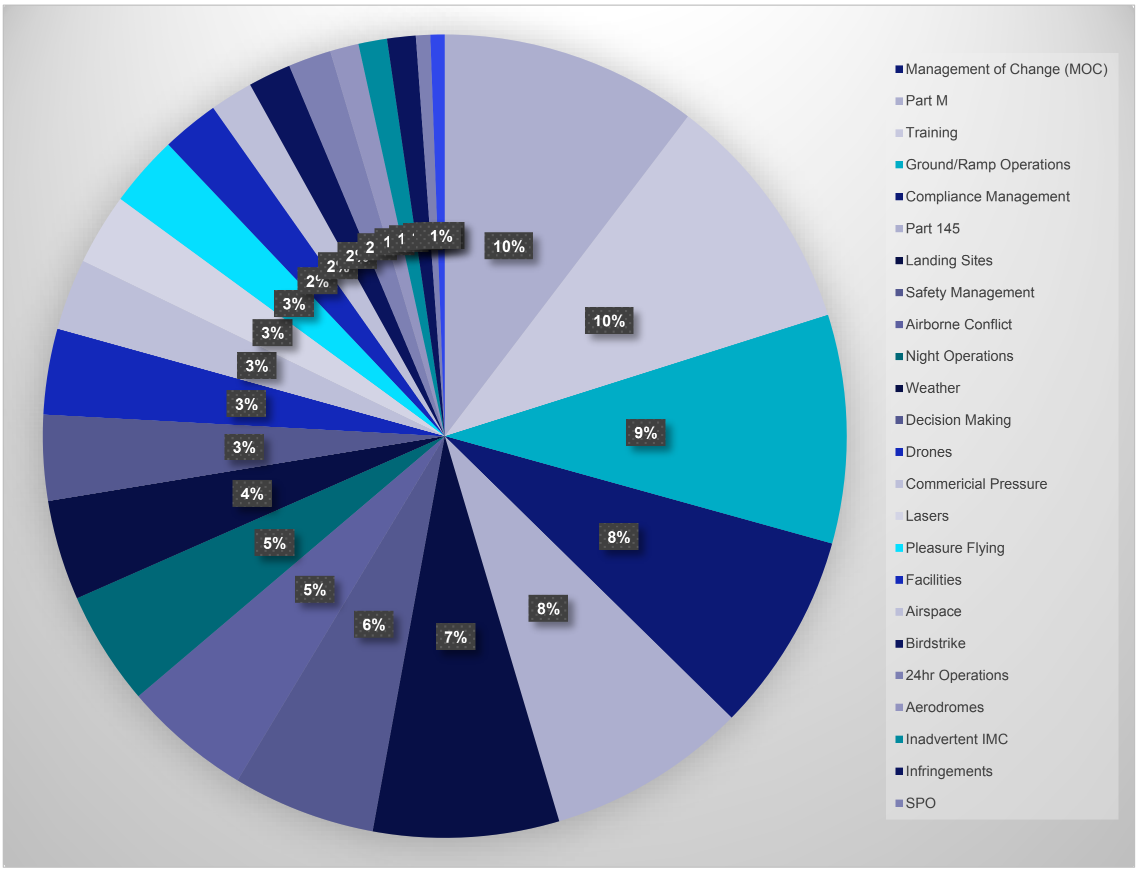
It was agreed that the team should review the locations for all the accidents to elicit any connection with operators concerns with regard to terrain, airspace, aviation services or even weather factors. As such the locations are given in Figure 8. The research concludes there is no obvious connection to the event type and a geographic location. However, the wider report does cite those concerns further.

Figure 8 Locations of all accidents

2.13 **Review of CAAs Safety Risks as Agreed by Accountable Manager**

The CAA through its oversight activity agrees with the AOC Accountable Manager its most significant risks as managed through the AOC management system for the forthcoming oversight cycle. These risks are also used to derive an overall sector risk picture. Figure 9 shows the current data but it is interesting to note that risks managed within an AOC are not necessary the same as those derived from the accident and incident data. It follows therefore that there is an indication that recorded risks are therefore being managed. There is also good corroboration with the identified overall concerns in all data gathering including the pilot and engineer surveys.

Figure 9 Safety Risks from Accountable Manager



2.14 Conclusions

The analysis concludes that Human Factors remains a prevalent issue within the industry and should be highlighted for attention. Pilot Decision Making represents the largest factor at 33% but there is a growing trend with Perceptual Judgment Errors and Diverted Attention including distraction. Also, Management Systems are cited within the HFACS analysis as an area for improvement.

System/ Component Failure or Malfunction (Non-Powerplant, SCF-NP) as represented in Figure App 9.3 is the origin of a large proportion of accidents. However, as evidence suggests within Figures 4 and 5 there is a correlation between the origin of the accident and human factors, both pilot and in some cases engineering. Reaction times and the correct decision/action by a pilot determines the continuity of the consequence and therefore the outcome. This leads to the following areas of concern and recommended attention:

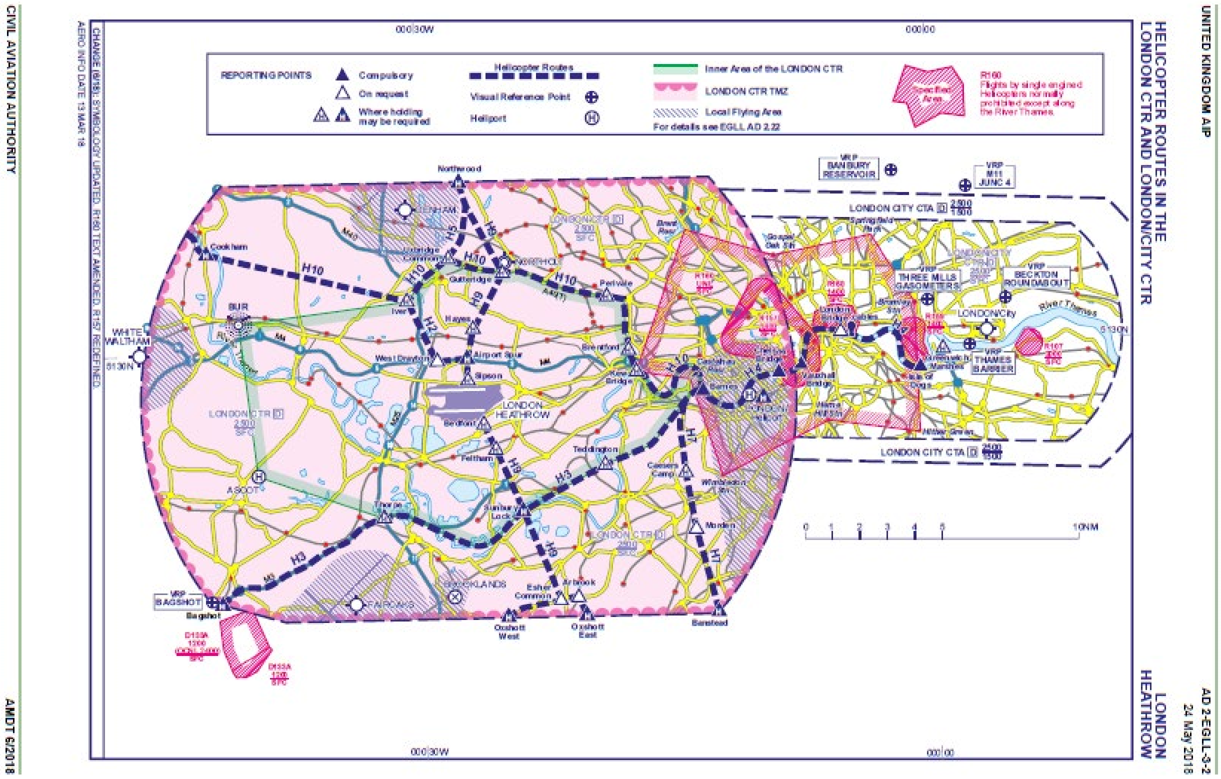
a. Emergency procedures
b. Emergency drills training
c. Adequate flight planning
d. Pilot's attitude and behaviours
e. Management systems
f. Adequate transitioning from PPL to CPL

Appendix 6 to Chapter 17 – VFR & Special VFR Helicopter Flights in London CTR

1 General Arrangements

VFR and Special VFR helicopter flying in the London CTR is mostly restricted to flights at or below specified altitudes along defined routes. These routes have been selected to provide maximum safety by avoiding built up areas as much as possible. Details of the major landmarks on these routes, the altitudes and reporting points are listed at paragraph 12 and are illustrated at AD 2-EGLL-3-2 pictorial below:

Figure 1 London CTR



Abbreviations:

H—Holding Point ▲—Compulsory Reporting Point Δ—On Request Reporting Point Map references are to the 1: 50 000 Ordnance Survey Map of Great Britain

The precise routes which must be adhered to are portrayed on the 1: 50 000 Map entitled Helicopter Routes in the London Control Zone. An indication of the routes network is shown on the illustration at AD 2-EGLL-3-2.

Pilots are required to be at the lower altitudes on arrival at the point at which the lower altitude applies.

On all notified helicopter routes within the London Control Zone and London/City Control Zone and for the purposes of SERA.3105 Minimum Heights and SERA.5005 (f) Visual Flight Rules an aircraft operated on the notified helicopter routes is permitted to fly below 1000 ft above the highest obstacle within a radius of 600 m but no closer than 500 ft to any person, vessel, vehicle or structure.

13.1 The precise routes are also overprinted on a 1:50 000 chart entitled – Helicopter Routes in the London Control Zone.

1.2 The illustration also shows the Specified Area of Central London (EG R160) over which flight by single-engined helicopters is virtually prohibited except along the River Thames because of the requirement to be able to land clear of the area in the event of engine failure. Permission in writing from the Civil Aviation Authority is required for flight within the Specified Area by single-engined helicopters.

(ii) All VFR and Special VFR helicopter flying in the London CTR is subject to ATC clearance, except for the Local Flying Areas of Brooklands, Denham, Fairoaks and White Waltham where VFR flights may operate subject to agreed conditions which appear in the relevant AD sections.

(iii) The following routes are not available to single-engined helicopters at night: H7, H9 (Hayes to Gutteridge) and H10 (Gutteridge to Kew Bridge).

MET. MINIMA FOR SVFR/VFR OPERATIONS IN THE LONDON/LONDON/HEATHROW/CITY CTRS

Visibility	Cloud Base / Ceiling	Traffic / Routes	Reference
10km	1200 ft	SVFR fixed wing inbounds	MATS pt 1
1900 m	600 ft	SVFR fixed wind outbounds	MATS pt 1
2000m		SVFR rotary in/out/overflights London/Heathrow	AIP
6 km	1000 ft ceiling	Visual separation permitted at London/Heathrow	
6 km		Visual separation on designated helicopter routes	AIP
6 km	1000 ft	Met Police Helicopters security checks	
1000 m		SVFR helicopters on designated routes	AIP
	1200 ft	H10 traffic (not mandated, but due to altitudes involved, required)	
	1500 ft	SVFR traffic 020 to 140 degrees (not mandated, but due to altitudes involved, required)	MATS pt 2
5km		VFR flights in/out of an Adme in Class 'D', based on reported Met. Visibility	AIP
3000 m		Denham, Fairoaks, White Waltham and Brooklands LFA	
1000 m	600 ft	Battersea. No SVFR clearance if less than	MATS pt 2
6 km		Hold at Gutteridge if IFR (flight visibility and London/Heathrow METAR)	Northolt
6 km	1200 ft	Visual Approaches	Northolt
800 m		Visual Approaches (military traffic)	Northolt
1000 m		RVR for IAPs	Northolt

2.0 Procedures for flight along Helicopter Routes

i. VFR and Special VFR flights in the London Control Zone are not to be operated unless helicopters can remain in a flight visibility of at least 1 km. Weather minima for crossing, taking-off from, or landing at London Heathrow are detailed at AD 2.20 paragraph 5.

(ii) VFR and Special VFR helicopters must remain clear of cloud with the surface in sight.

(ii) Altimeter setting will be London Heathrow QNH.

(iv) Maximum route altitudes are shown in column 3 at paragraph 12. ATC will refer to these altitudes as ‘Standard Operating Altitudes’ when issuing clearances. Pilots may fly at altitudes below the maximum route altitude except for between Perivale and Chiswick Bridge on H10 where the maximum published altitude must be flown accurately. ATC may restrict aircraft to altitudes below the published route maximum as necessary to provide separation from other aircraft.

(v).... Pilots should fly the precise routes as depicted on the 1: 50 000 Map entitled Helicopter Routes in the London Control Zone. 'Corner cutting' is to be avoided. In order to obtain sufficient lateral separation from opposite direction traffic, pilots may temporarily deviate to the right of the route.

(vi)... When flying along the River Thames within the Specified Area (EG R160), pilots should normally fly over that part of the river bed lying between high water marks, but not so near the banks as to become a nuisance on account of noise. When deviating from the river, in accordance with paragraph (v) above, single-engined helicopters must at all times be able to return to the river in the event of engine failure, in order to alight clear of the Specified Area.

3.0 Noise

(i) On all notified helicopter routes, in order to minimize noise nuisance, pilots should maintain the maximum altitude compatible with their ATC clearance and with the prevailing cloud conditions. For the purposes of SERA.3105 Minimum Heights and SERA.5005(f) an aircraft operated on the notified helicopter routes is permitted to fly below 1000 ft above the highest obstacle within a radius of 600 m but no closer than 500 ft to any person, vessel, vehicle or structure.

(ii) Pilots are requested wherever possible to avoid overflying hospitals, palaces, schools and prisons.

4.0 Air Traffic Control Clearance

Pilots must obtain a VFR or Special VFR clearance from Heathrow Radar (125.625 MHz). Heathrow Radar provides a service to transit aircraft operating in the London CTR and London City CTR/CTA. Pilots are requested to contact Heathrow Radar three minutes before reaching the Zone Boundary, giving details of call sign, aircraft type, route, ETA at the CTR boundary, entry point and destination.

5.0 **Holding**

(i) VFR and Special VFR helicopters, particularly those using London Heathrow or the routes close to it, may be required to hold at any of the locations on the route, shown in column 1 at paragraph 12 and on the illustration at AD 2-EGLL-3-2 except on that portion of H4 that lies between Vauxhall and Westminster Bridges.

6.0 **Communications**

(i) Helicopters using London Heliport via the Local Flying Area or any other routes must be able to communicate with the Heliport (Battersea Tower 134.275 MHz).

(ii) Helicopters flying along the routes in the London CTR and London City CTR must be able to communicate with Heathrow Radar, and in the case of H9 and H10, also with Northolt Approach Control (126.450 MHz). ‘Compulsory’ and ‘On-Request’ reporting points are shown in column 1 at paragraph 12.

Helicopters using London Heathrow must also be able to communicate with Heathrow Tower.

7.0 **Loss of Communications Procedures**

(i) In the event of a communications failure in a helicopter operating in accordance with these procedures, the pilot is to adopt the procedure detailed at ENR 1.1 except as described below.

(ii) If a VFR or Special VFR clearance has been received to transit the CTR along a Helicopter Route continue the flight in accordance with the clearance.

(iii) Where an intermediate clearance limit has been given (or clearance issued for only a part of the requested transit), proceed to the specified clearance limit and hold for 3 minutes. Then proceed via the requested Helicopter Route at the published maximum altitude for the Route.

(iii) If no onward clearance has been received before reaching, or when holding at, Sipson or Bedfont, reverse track and leave the CTR via H2-H10-Cookham if approaching Sipson, or H9 if approaching Bedfont. Do not attempt to cross London Heathrow Airport.

For helicopters overflying or landing at London Heathrow Airport, see EGLL AD 2.20 paragraph 5.

8.0 **Separation between Special VFR helicopters**

(i) Separation may be decided between Special VFR helicopters on the Helicopter Routes, on the basis that pilots of helicopters will be asked by ATC to maintain visual separation from other helicopter traffic, provided that:

(1) the visibility at London Heathrow is 5 km or more and the helicopters can operate clear of cloud and in sight of the ground or water and remain in a flight visibility of at least 5 km;

(2) there is agreement between the helicopter pilots concerned;

(3) the current route structure, the altitudes applicable and communication procedures are adhered to;

(4) appropriate traffic information is passed to the helicopter pilots. (Normally for this purpose it will only be necessary for ATC to pass general traffic information eg..... 'Two helicopters westbound along H10 at 1000 ft in the vicinity of Perivale - acknowledge.

(ii) If a pilot refuses, or considers that the conditions are such that he is unable to maintain visual separation, he will be provided with the Special VFR separations currently in force.

9.0 **Inner Area of the London Control Zone**

(i).....The Inner Area of the London CTR is that part of the London CTR from surface to altitude 2500 ft contained within the area enclosed by: BUR NDB – Iver RP – Helicopter Route H10 – Barnes RP – Helicopter Route H3 – Thorpe RP – Ascot Heliport – BUR NDB.

With the exception of those aircraft categories listed below, all VFR and Special VFR aircraft requesting to enter the Inner Area of the London CTR are subject to Prior Permission Required (PPR) from London Terminal Control, via the Senior Watch Assistant on 02380-401110:

(ii) Flight Priority Category A, B, C, D, E traffic who shall follow their own notification procedures where appropriate;

(iii) Aircraft subject to an Airspace Coordination Notice (ACN) who shall follow the notification process detailed within the ACN;

(iv) Aircraft subject to a Non-Standard Flight (NSF) who shall follow the notification process detailed within the NSF;

(v) Helicopters that remain on the published helicopter routes without landing or departing inside the Inner Area; All other VFR and Special VFR aircraft are required to obtain PPR (by telephone) to enter the Inner Area of the London CTR on the same day at least 60 minutes before entry clearance is required. Approved aircraft will be given a PPR approval code to quote over the radio when requesting entry clearance from controllers.

Due to the intense Heathrow IFR operations and very high ATC workload within the Inner Area of the London CTR during the hours 0430-2300 local time, it is unlikely that aircraft will receive approval to operate inside the Inner Area within these times, unless there is a specific task that can only be completed within that airspace, e.g. helicopters accessing private landing sites.

The following procedures have been established to ensure safe integration with IFR traffic, avoid excessive airborne holding, and reduce delays to both Heathrow movements and helicopter operators wishing to use landing sites within the Inner Area of London CTR.

(i) Inbound

(1) Contact the London Terminal Control Senior Watch Assistant (02380-401110) on the day of operation at least 60 minutes prior to the estimated time of arrival;

(2) Provide the name, latitude and longitude of the landing site, the requested routing, the estimated time of arrival and a contact telephone number;

(3) Heathrow Tower Supervisor and Heathrow Radar will be consulted to determine the route that the pilot can expect (subject to the Heathrow runway configuration, meteorological conditions and the likelihood of being able to utilise reduced separation in the vicinity of the aerodrome);

(4) If the safe integration of the inbound flight will cause delay to Heathrow traffic it will be subject to the equivalent Heathrow delay. The pilot will be contacted by telephone and advised the route that can be expected and, if appropriate, an amended ETA incorporating the Heathrow inbound delay;

(5) The pilot must arrange the flight to arrive at the site within 10 minutes of the approved ETA. Failure to adhere to this time window may result in further delay or, in extreme circumstances, refusal of clearance. Upon establishing two-way communications, the helicopter will be cleared to the landing site as soon as practicable commensurate with the safe integration with IFR traffic.

(ii) Outbound

(1) Prior to departing the site contact LTC SWA at least 60 minutes in advance of the estimated time of departure from the site to provide the name, latitude and longitude of the site, requested routing, planned ETD and a contact telephone number;

(2) If the outbound flight will cause delay to Heathrow traffic it will be subject to the equivalent Heathrow delay. The pilot will be contacted by telephone and advised the route that can be expected and, if appropriate, an amended ETD incorporating the Heathrow outbound delay;

(3) Within 10 minutes of the approved ETD, the pilot must contact ATC on the ground. If two way contact with ATC cannot be established on the ground either directly or via relay from other aircraft, the pilot must remain on the ground and contact London Terminal Control Group Supervisor Airports (02380-401106) to agree an exact departure time and initial altitude with the controllers concerned in order that safe integration with IFR traffic can be ensured.

Note: If the intention is to be on the ground for less than 60 minutes, both the inbound and outbound arrangements may be agreed during the initial contact with LTC SWA.

Standardised Rules of the Air (SERA)

SERA 3105 (f) – Minimum heights

Except when necessary for take-off or landing, or except by permission from the competent authority, aircraft shall not be flown over the congested areas of cities, towns or settlements or over an open-air assembly of persons, unless at such a height as will permit, in the event of an emergency arising, a landing to be made without undue hazard to persons or property on the surface. The minimum heights for VFR flights shall be those specified in SERA.5005(f) and minimum levels for IFR flights shall be those specified in SERA.5015(b).

SERA 5005 (f) - Except when necessary for take-off or landing, or except by permission from the competent authority, a VFR flight shall not be flown:

(1) over the congested areas of cities, towns or settlements or over an open-air assembly of persons at a height less than 300 m (1 000 ft) above the highest obstacle within a radius of 600 m from the aircraft;

(2) elsewhere than as specified in (1), at a height less than 150 m (500 ft) above the ground or water, or 150 m (500 ft) above the highest obstacle within a radius of 150 m (500 ft) from the aircraft.

The Rules of the Air Regulations 2015 (S.I 2015 No. 840)

Landing and taking off within congested areas and near open-air assemblies

Rule 5.— (1) An aircraft must not take off or land within a congested area of any city, town or settlement except—

(a) at an aerodrome in accordance with procedures notified by the CAA; or

(b) at a landing sit e which is not an aerodrome in accordance with the permission of the CAA.

(2) An aircraft must not land or take-off within 1,000 metres of an open-air assembly of more than 1,000 persons except—

(a) at an aerodrome in accordance with procedures notified by the CAA; or

(b) at a landing site which is not an aerodrome in accordance with procedures notified by the CAA and with the written permission of the organiser of the assembly.

Appendix 7 to Chapter 17 –Report Extract of the London CTR Review Group

2.0 **Recommendations:**

2.1 NATS, in conjunction with the CAA, should consider the re-classification of the London CTR and London/City CTR with a view to a common airspace classification. NATS should consider the use of Class ‘C’ airspace with the addition of specific rules to limit access for GA VFR fixed-wing flight.

2.2 NATS should include a review of the separation criteria applied within the entire volume of both London and London/City CTRs to ensure that consistent rules apply irrespective of the service provider and that adequate documentation exits for the application of “deemed” separation. Additionally, NATS should review the current separation deeming arrangements within the London CTR, in the context of current safety management requirements.

2.3 NATS, in conjunction with the peripheral aerodrome operators, should review the overall lateral dimensions of the London CTR with a view to reducing the dimensions, or providing appropriate stepped CTAs, to facilitate VFR flights to these aerodromes.

2.4 The CAA should review the meteorological criteria applied within the London and London/City CTRs with a view to simplifying the criteria and identifying which minima are required for the operation of aircraft and which are required for the management of the airspace. The use of pilot determined flight visibility or ATC reported visibility, should be reviewed and clarified.

2.5 NATS should conduct an assessment to determine the maximum operating altitude on that portion of H4, east of Battersea, which would provide standard separation with traffic inbound to London/City. This should include an environmental assessment.

2.6 NATS should assess the feasibility of extending H4 eastwards to the vicinity of London/City airport, in order to minimise overflight of Greenwich Park and Blackheath, or holding in these areas.

2.7 The CAA should review the dimensions and applicability of the Restricted Area R160. In addition, the CAA should consider the measures required to exclude access to the Lea Valley by single engined fixed-wing aircraft.

2.8 NATS, in conjunction with Battersea Heliport and the CAA, should consider revised arrival and departure routes to expedite the flow of traffic to London Battersea Heliport from the north (twin-engined only) and south-east (single and multi-engined), including the use of appropriate Visual Reference Points. This should include an environmental assessment.

2.9 NATS should develop proposals to formalise arrangements for the use of a Cookham - Burnham - Ascot routeing (similar to the special events route “H11”) within the London CTR, subject to the review of the dimensions of the London CTR.

2.10 The operation of Northolt ATC should be reviewed to ensure consistent application of separation standards and meteorological criteria within the portion of the London CTR airspace delegated to it.

2.11 The CAA should review the AIP entry to ensure that the operating restrictions on H3 are compatible with operational practice.

2.12 The NATS airspace management arrangements and operating practice for approval of off-route operations within the London CTR should be reviewed and clarified.

2.13 The CAA should review the compulsory classification of all SFN Police flights as Category B and consider the possibility of using the flight priority as a callsign suffix.

2.14 NATS should review the requirement for the “All/Nothing/Twin” procedures within the London CTR.

2.15 NATS should develop standard operating arrangements to restrict or enable airspace activity in connection with special events or security requirements within the London and London/City CTRs, subject to the requirements placed upon them by the CAA, the DfT or the Security Services.

2.16 The CAA should consider that a warning is depicted on the relevant instrument approach charts in order to provide awareness to pilots inbound to London/Heathrow of helicopter routes passing beneath the final approach paths.

2.17 Consideration should be given to the closure of the relevant section of the helicopter routes to single-engine helicopters when a major sporting or commercial event is taking place on the River Thames.

Appendix 8 to Chapter 17 – Westland/London Heliport

Westland/London Heliport Movements 1959 – 2018

Year	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Cum.
1959	1,515	0	0	0	54	124	172	387	143	306	165	79	85	1,515	1,515
1960	1,868	69	132	112	190	176	229	247	201	285	113	90	24	1,868	3,383
1961	1,851	63	40	162	217	232	338	222	79	216	136	102	44	1,851	5,234
1962	1,436	66	50	96	96	142	134	163	115	298	175	70	31	1,436	6,670
1963	1,492	37	60	141	100	166	238	222	168	106	122	90	42	1,492	8,162
1964	1,509	36	78	78	108	116	230	252	86	324	82	86	33	1,509	9,671
1965	1,800	87	72	122	311	189	291	239	114	96	139	73	67	1,800	11,471
1966	2,767	59	116	192	105	237	369	427	200	435	215	159	253	2,767	14,238
1967	2,979	189	151	275	437	359	317	402	177	220	225	109	118	2,979	17,217
1968	4,087	67	140	337	275	454	371	530	305	830	391	269	118	4,087	21,304
1969	5,248	291	273	378	504	599	680	625	359	456	508	358	217	5,248	26,552
1970	6,884	245	362	462	485	640	792	739	567	896	714	556	426	6,884	33,436
1971	7,484	325	400	727	525	931	819	935	619	823	637	447	296	7,484	40,920
1972	9,087	234	377	665	844	1,153	1,138	1,049	785	1,085	896	490	371	9,087	50,007
1973	12,380	434	582	1,248	932	1,234	1,521	1,545	997	1,269	1,143	1,019	456	12,380	62,387
1974	11,621	504	694	644	967	1,490	1,533	1,533	959	1,239	911	593	554	11,621	74,008
1975	9,114	554	547	695	820	897	1,353	1,156	743	782	689	492	386	9,114	83,122
1976	9,239	490	397	797	728	973	1,272	1,160	716	1,160	595	561	390	9,239	92,361
1977	8,661	396	491	795	754	882	977	1,089	725	828	785	611	328	8,661	101,022
1978	9,558	423	423	660	740	896	1,296	1,268	811	1,191	872	668	310	9,558	110,580
1979	9,638	452	368	642	779	928	1,329	1,259	912	915	904	676	474	9,638	120,218

1980	10,319	555	627	667	884	1,037	1,274	1,240	833	1,380	775	539	508	10,319	130,537
1981	7,329	250	448	463	580	657	1,141	1,257	525	607	636	442	323	7,329	137,866
1982	9,034	444	356	685	807	746	1,213	1,235	510	1,499	539	541	459	9,034	146,900
1983	8,431	394	332	680	662	771	1,329	1,090	602	849	744	486	492	8,431	155,331
1984	10,173	298	444	737	727	1,105	1,234	1,255	618	1,526	935	770	524	10,173	165,504
1985	11,039	491	525	851	930	1,121	1,620	1,551	698	853	1,101	772	526	11,039	176,543
1986	11,660	541	558	614	847	1,044	1,463	1,527	799	1,862	1,025	730	650	11,660	188,203
1987	12,201	660	726	929	875	1,150	1,644	1,584	828	1,274	1,055	787	689	12,201	200,404
1988	14,153	585	857	1,065	965	1,048	1,514	1,656	1,064	2,197	1,228	1,215	759	14,153	214,557
1989	13,013	779	873	1,169	1,238	1,810	2,337	1,116	801	933	737	730	490	13,013	227,570
1990	12,898	616	500	1,044	957	1,471	1,769	1,572	987	1,568	1,078	810	526	12,898	240,468
1991	10,211	584	488	758	799	1,171	1,359	1,213	612	991	890	812	534	10,211	250,679
1992	9,990	456	612	901	733	876	1,295	1,142	559	1,244	870	736	566	9,990	260,669
1993	8,355	464	384	696	642	778	1,162	1,101	540	725	726	631	506	8,355	269,024
1994	10,135	531	466	954	874	927	1,320	1,160	628	1,307	706	732	530	10,135	279,159
1995	10,215	508	600	842	711	964	1,481	1,312	702	896	839	892	468	10,215	289,374
1996	10,758	367	600	684	724	1,073	1,420	1,359	925	1,327	1,005	817	457	10,758	300,132
1997	11,057	403	584	867	1,103	1,183	1,255	1,442	733	1,075	964	821	627	11,057	311,189
1998	10,641	618	580	648	748	1,063	1,442	1,317	649	1,370	882	807	517	10,641	321,830
1999	11,666	570	765	869	800	1,114	1,435	1,540	843	1,109	967	971	683	11,666	333,496
2000	12,875	608	661	1,035	874	1,232	1,589	1,687	1,086	1,061	1,108	1,220	714	12,875	346,371
2001	11,410	621	641	772	743	1,226	1,505	1,271	807	908	1,001	1,131	784	11,410	357,781
2002	11,667	648	735	875	981	1,148	1,382	1,527	719	1,100	1,116	850	586	11,667	369,448
2003	10,834	686	576	838	748	1,014	1,400	1,468	718	1,152	882	818	534	10,834	380,282
2004	11,164	612	676	920	839	1,085	1,522	1,352	632	1,018	900	962	646	11,164	391,446

2005	12,018	618	593	845	1,216	1,254	1,426	1,120	778	1,202	1,030	1,074	862	12,018	403,464
2006	14,258	752	774	1,108	948	1,348	1,850	1,712	994	1,396	1,195	1,365	816	14,258	417,722
2007	13,124	838	916	1,376	1,090	1,254	1,570	1,325	801	1,012	1,132	1,036	774	13,124	430,846
2008	11,336	677	833	876	978	1,040	1,550	1,530	620	986	1,004	698	544	11,336	442,182
2009	8,392	434	400	722	626	724	1,098	836	622	764	875	781	510	8,392	450,574
2010	8,214	388	476	881	519	636	1,029	1,173	493	770	777	718	354	8,214	458,788
2011	8,442	518	490	760	645	813	1,060	1,003	460	803	740	596	554	8,442	467,230
2012	7,170	416	463	525	463	731	856	1,100	464	552	574	660	366	7,170	474,400
2013	7,650	230	373	437	410	763	1,183	868	588	848	804	650	496	7,650	482,050
2014	8,925	514	582	674	655	911	1,186	1,018	638	819	757	627	544	8,925	490,975
2015	10,354	476	564	739	855	978	1,478	1,232	814	1,000	974	692	552	10,354	501,329
2016	11,353	558	693	733	846	1,178	1,211	1,461	874	1,158	1,063	1,007	571	11,353	512,682
2017	11,899	505	593	915	983	1,164	1,543	1,411	829	1,129	1,113	1,055	659	11,899	524,581
2018	6,802	621	717	740	842	1,096	1,408	1,378						6,802	531,383

Appendix 9 to Chapter 17 – MORs for London CTR

London and London City CTR Helicopter MOR's 2000 -2017

Summary	Aircraft	Date
A109 ATM software glitch	ATC	16/6/2017
Airprox Vauxhall Bridge vs AS355	R22	24/6/2000
Airprox vs EC135	AS355	3/7/2014
Airprox vs Military Chinook at Victoria Park HLS	EC135	21/5/2015
Airprox with A321 at LHR 1500'	AS355	15/8/2001
Alleged misrepresentation of landing site to get clearance	EC155	4/5/2012
AS355 ATC Ground issues	ATC	30/9/2007
ATC lost separation against an S76 at Windsor	S76	5/3/2011
Cleared 1000' climbed 1400	AS355	20/6/2012
Cleared H9/H10 without coordinating A319 climbing from LHR	AS355	7/7/2012
Conflict with A319 at 1500' (S76 held at 1000')	S76	15/6/2003
Failed to follow ATC instructions	R22	4/6/2006
Failed to follow ATC instructions	AS341	8/10/2017
Failed to follow ATC instructions Deviated from clearance	R44	3/6/2015
Failed to follow ATC instructions Failed to hold at Isle of Dogs	R44	28/3/2007
Failed to follow ATC instructions at 750' moved west of Kew Bridge	R44	15/7/2011
Failed to follow ATC instructions At Kew cleared H4/H10 but left the routes	EC135	9/7/2011
Failed to follow ATC instructions Chelsea Barracks	AS355	7/12/2003
Failed to follow ATC instructions Climbed 600'– loss of separation at Ascot	Bell 206	24/9/2002
Failed to follow ATC instructions Crossing clearance read back correctly	AS365	5/6/2007
Failed to follow ATC instructions flew beyond clearance limit RJ85 T/O Cx	H369	10/4/2008
Failed to follow ATC instructions H10 deviation from route	EC120	10/5/2003
Failed to follow ATC instructions H2 routing without clearance from ATC	R44	7/7/2010
Failed to follow ATC instructions H7	EC135	9/6/2007
Failed to follow ATC instructions Left H3 lost separation	EC120	7/11/2000
Infringement CTR	SA341	18/9/2000
Infringement CTR	R22	12/10/2001
Infringement CTR	B206	17/5/2002
Infringement CTR	SA341	27/7/2003
Infringement CTR	SA341	31/8/2005
Infringement CTR	R22	10/10/2005
Infringement CTR	S76	17/1/2007
Infringement CTR	B206	28/10/2008
Infringement CTR	R44	11/9/2010
Infringement CTR	EC225	13/5/2011

Infringement CTR	H369	4/10/2012
Infringement CTR	EC135	5/10/2013
Infringement CTR	EC145	22/10/2014
Infringement CTR At Denham	R44	26/8/2008
Infringement CTR At LCY	AS350	13/5/2006
Infringement CTR departed Staines without clearance	A109	22/5/2003
Infringement CTR Hendon	EC120	6/6/2009
Infringement CTR LCY	A109	13/5/2005
Infringement CTR LCY	AS322L2	6/3/2015
Infringement CTR LCY	AS355	9/2/2001
Infringement CTR LCY	R44	1/4/2002
Infringement CTR LCY DO 328 TCAS RA	A109	5/10/2004
Infringement CTR LGW	SA365	26/4/2004
Infringement CTR LHR Departures Stopped	R44	14/5/2004
Infringement CTR LHR Departures Stopped	A109	6/10/2004
Infringement CTR LHR Inbound broken off	R22	22/3/2003
Infringement CTR LHR Northbound deps stopped	Unknown	30/3/2001
Infringement CTR LHR Northbound deps stopped	SA341	2/9/2003
Infringement CTR R159	AS355	17/2/2012
Infringement EGR107 Belmarsh	AS355	17/11/2005
Landed without Clearance from LHR ATC	Bell407	20/6/2006
Landing at Poyle resulted in G/A at LHR	EC135	19/4/2011
Laser	AS355	24/4/2017
Laser	Unknown	7/1/2014
Laser	EGLC	13/9/2017
Laser	Barking	8/2/2017
Laser	MD900	30/4/2017
LCY TCAS RA vs RJ85	AS355	14/11/2016
LHR Crossing Degraded engine failed to inform ATC	R44	29/11/2006
LHR Crossing did not know where Dual taxiways were	A109	12/9/2008
LHR Crossing Failed to comply holding Instruction	AS355	18/11/2001
LHR Crossing Failed to comply holding Instruction LHR	Bell 47	1/9/2002
LHR Crossing Failed to comply holding Instruction LHR	EC120	24/9/2002
LHR Crossing gave ATC cause for concern	R44	19/4/2009
Loss Separation against another heli at Brent	EC135	1/7/2017
Loss Separation against SVFR A109 and A340– TCAS RA	A109	10/11/2003
Loss separation vs AS355 (300’ vertical)	MD900	14/7/2006
Lost Comms	AS355	27/9/2011
Lost Comms London Bridge	AS355	16/9/2007
No mode C	EC135	1/3/2017
PAN Engine Chip	AS355	5/11/2004
Poor NAV H3/H10/H3	R44	24/9/2003

Poor SVFR Coordination	ATC	15/1/2015
R44 holding told to hold Sipson instead of Bedfont where he was	ATC	19/3/2011
Routed North through climb out RW 27 LCY	AS355	23/8/2009
Take Off without Clearance from EGLW	MD900	19/7/2009
Taxied without Clearance	A109	4/2/2003
TCAS RA	R44	16/4/2014
TCAS RA DHC8 200 Crystal Palace	S76	7/3/2006
TCAS RA vs D0328 at Greenwich Dome	SA365	8/7/2009
Thorpe Loss separation vs A109	S76	10/12/2014
Wrong aircraft identified to cross behind LHR Crossing	AS355	21/12/2001

Links:

UK AIP EGLL

http://www.ead.eurocontrol.int/eadbasic/pamslight-4C432C46A756FC5FF42EE634DB7E8593/7FE5QZZF3FXUS/EN/AIP/AD/EG_AD_2_EGLL_en_2018-05-24.pdf

http://www.ead.eurocontrol.int/eadbasic/pamslight-4C432C46A756FC5FF42EE634DB7E8593/7FE5QZZF3FXUS/EN/Charts/AD/AIRAC/EG_AD_2_EGLL_3-2_en_2018-05-24.pdf

Report of the London CTR Review Group

https://www.caa.co.uk/WorkArea/DownloadAsset.aspx?id=4294972751

CAP1456 Graphical summary of London helicopter crossing statistics

http://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=7567

Appendix 10 to Chapter 16 – Heliports

Risks	Evidence	Recommendation
DVE G-PWER 03 Mar 04	The pilot was flying a visual approach to Bournemouth Airport in poor weather at night; radar data indicated that the aircraft was tracking the extended centreline of Runway 26 at between 800 to 1,000 feet amsl. The pilot declared that he was visual with the airport but, shortly afterwards, the radar data indicated that the aircraft had entered a turn to the left. The aircraft turned through about 540° before striking the ground, fatally injuring both the pilot and the passenger. The pilot had probably become disorientated, and his limited instrument flying background did not equip him to cope with degraded visual environment.	Training Instrument Rating or, at least Instrument Night Qualification
Weather – Landing G-WIWI 03 May 12	The helicopter descended towards the tops of trees following a discontinued night approach to a private landing site in conditions of reduced visibility and low cloud, when no go-around procedure or routing was available or briefed.	Regulation Weather Limits PBN – PinS Training Decision Making
Weather – Night G-IOOZ 08 Dec 13	The aircraft was making a night approach in misty conditions to a private landing ground which was marked by the lights from a vehicle. As he neared the site, the pilot switched on his landing light and was immediately dazzled by the glare reflected from the mist. Although he quickly switched the light off again, the distraction led him to strike the tail rotor on a tree and the helicopter was damaged in the rapid forced landing which ensued.	Regulation Weather Limits Training Night Approaches Instrument Night Qualification
Weather – Take-off G-LBAL 13 Mar 14	The helicopter departed from a private site with little cultural lighting at night and in fog. Although the commander had briefed a vertical departure, the helicopter pitched progressively nose-down until impacting the ground. The four occupants were fatally injured.	Regulation Weather Limits Training Profiles Decision Making
Loss of control – In-Flight G-SEWP 28 Oct 10	The pilot lost control of the helicopter whilst manoeuvring at low speed to approach a hilltop landing site in quite strong wind conditions. It descended rapidly with increasing forward ground speed, before striking the ground short of the point of intended landing and passing through a substantial stone wall. The helicopter was	Training Downwind Operations

	destroyed but the occupants suffered only minor injuries.	
Risks	**Evidence**	**Recommendation**
Landing Site Selection G-BPRI 23 Oct 10	After confirming that the surrounding area was clear, the pilot started the helicopter's engines. Shortly after starting the second engine, he noticed a golf cart on his right side that was "travelling at some speed, clearly out of control". The cart passed behind the helicopter, sustaining damage to its roof when it passed through the tail rotor disc, and continued for approximately 40 m before stopping. The pilot was told that a young child had climbed into the cart with an adult and had inadvertently stepped on the accelerator pedal.	Security
FOD G-NWPS 25 Nov 15	While landing at an unmarked site adjacent to a television mast, the helicopter's downwash disturbed a metal object which caused damage when it was ingested into the fenestron tail rotor. The pilot felt a jolt, together with vibration through the tail rotor pedals, but retained control and landed normally.	Oversight Ground/Ramp Operations
Handling G-TYCN 03 May 12	At approximately 100 ft agl during an approach to land, the pilot noticed an increased rate of descent, which he tried to arrest by raising the collective control and the aircraft nose. This had little effect and the aircraft landed heavily despite the application of maximum torque just before touchdown. The aircraft bounced into the air and swung through approximately 250° before coming to rest.	Training Downwind Operations VRS Recognition

Appendix 11 to Chapter 16 – Night Landing Aids

The Case for Portable Night Approach Aids

The Challenges for Off Airfield Night Approaches and Landings

The capability for a helicopter to land off-airfield is clearly one of the key justifications for operating this type of aircraft over a conventional fixed wing aircraft. The very nature of off-airfield necessarily elevates the inherent risk of operation, because otherwise the justification for Aerodrome Licensing would not exist. This is not a reason to avoid utilising the advantages of the helicopter, but it is a cause or prerequisite for any approved operation to manage this risk as low as reasonably practicable, so as to meet necessary regulatory commitments and social expectations.

The challenges for any pilot are both skill based and knowledge based. The pilot will only have certain percent of necessary information available to accurately assess their position relative to obstacles; and they will have the additional challenge of flying a complex approach path based on limited visual cues.

Typical risk influencing factors (or RIFs) include:

- Late identification of the landing site, resulting in a propensity for a rushed or unstable approach.
- Risk of developing high rates of descent, possibly combined with low airspeed
- Poor height control, resulting in Insufficient clearance from obstacles
- Lack of mental capacity to handle unexpected (or startle) events.

Advantages of Advanced Portable Approach Aids

The first advantage that an advanced portable approach aid provides is the ability to confirm the landing site early, and to establish the approach path early – typically 6 to 8 miles from the landing site. This means that the pilot naturally relaxes a little bit that they have correctly identified their landing site, and their mental capacity then goes into positioning the aircraft for a stable approach with time in hand to conduct proper checks and a proper crew briefing.

The second advantage is that the pilot will intercept their chosen approach path from below, and this is generally accepted as being the safer place to commence the approach. As opposed to being late on the descent, because, in the absence of any other visual information, you are naturally concerned about obstacle clearance.

The third advantage is that it provides the capability to utilise the automation in the aircraft for the majority of the approach. The initial point, final approach point, final approach track, and the rate of descent (although still a visual manoeuvre) can all be set up with automation coupled, and with the flying pilot gaining extra capacity to watch out for the unusual or unexpected (and to be in a position to make a better decision should such an event occur).

The Company can write very robust SOPs for the use of these units, and the ground training required for the set-up is no more than 1 to 2 hours, and an annual refresher. The setup on the ground can be completed within 15 minutes.

The units are very robust and require little maintenance, and have minimal running costs (electricity to charge the batteries).

The costs of these units are now equivalent to just 5 hours flying in a medium twin helicopter, and for the safety benefit provided – it is a cost that can easily be justified.

DR SIMON MITCHELL, STARSPEED

REFERENCES

a. ICAO Annex 14 Volume II Heliports

b. Cover Regulation (EU) 965/2012 Air Operations Annex I Definitions

c. ORS 4 No. 1222 21 Apr 2017, General exemption E 4452 and Permission

d. EHEST HE3 Off Airfield Landing Site Operations

e. CAP 753 Guidance Material for Operators Utilising VHM in Rotor and Rotor Drive Systems of Helicopters

f. CAP 789 The Requirements and Guidance Material for Operators

g. CAP 1264 Standards for Helicopter Landing Areas at hospitals

h. CAP 1519 Offshore Helicopter Terrain Awareness Warning System Alert Envelopes

i. BHA Helicopter Site Keepers – Guidelines

Appendix 12 to Chapter 18 – Point in Space

1. European Geostationary Navigation Overlay Service (EGNOS), is a Satellite based Augmentation System (SBAS), which improves GPS performance, by increasing accuracy and providing integrity which is crucial for safety critical applications.

Figure 1 Interoperability with SBAS Systems

EGNOS will give a unique opportunity to extend operational capabilities in HEMS and onshore operations whilst improving flight safety.

2 Galileo, the European Based Global Navigation Satellite System (GNSS), which through EGNOS will have an autonomous infrastructure of 4 services, giving worldwide coverage with 18 satellites in orbit, providing;

a. Accuracy

b. Availability

c. Integrity

d. Availability

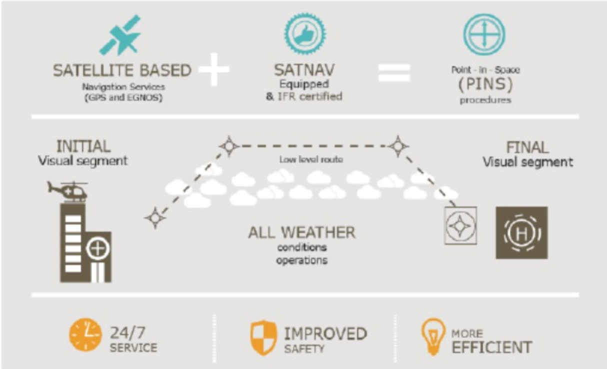
Statement:

The EU has said its rules mean the UK will be excluded from the more militarily sensitive parts of Galileo and the UK government has said that it will not continue to seek access to these for military purposes after Brexit.

The EU's Brexit negotiator, Michel Barnier, has said that "Galileo's civil and commercial signal will obviously still be accessible to the United Kingdom and its businesses." 4th Dec 2018

https://fullfact.org/europe/where-does-brexit-leave-us-regards-galileo-project/PinS

Figure 2 EGNOS for rotorcraft



This will bring;

a. Improved IFR operations

b. Low-level RNAV routes

c. Point in space

d. Curved procedures

e. Direct approach with vertical guidance (LPV)

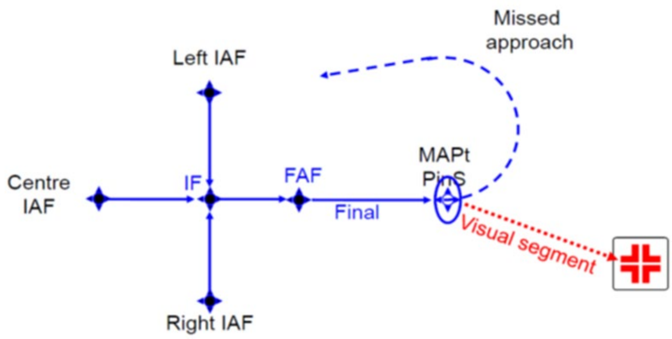
f. Simultaneous non-interfering operations

3 Point in Space, offers:

a. An approach procedure designed for helicopters only, that includes both an instrument and a visual segment.

b. PinS approach is a non-precision approach (2D).

Figure 3 PinS Approach



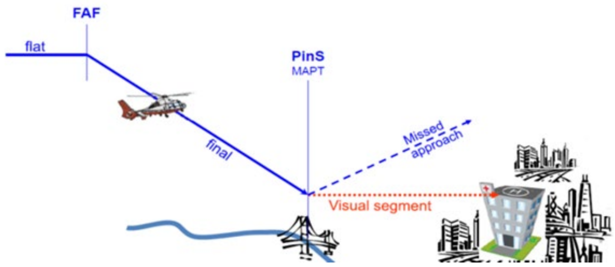
c. This approach is an RNAV approach for Helicopters, only with basic GNSS receiver approved by the national authority for the operator.

d. All approaches will be up to a point in space. After that the pilot should have visual reference to continue to the intended landing site or initiate a missed approach.

e. This visual segment connects the point-in-space (PinS) to the landing location.

f. The flexibility that offers the free positioning of the MAPt is the main advantage of this concept.

Figure 4 PinS Approach



4 The Visual segment; ‘Proceed Visually’ or ‘Proceed VFR’

A ‘PinS’ approach is an instrument RNP APCH procedure flown to a point-in-space. It may be published with LNAV minima or LPV minima.

The PinS approach procedure includes either a “proceed visually” or a “proceed VFR” instruction from the MAPt to the heliport or landing location.

c. Proceed Visually

The PinS instrument approach segment delivers the helicopter to a MAPt. The visual segment connects the MAPt to the heliport or landing location, by a direct visual segment. If the heliport or landing location and visual references associated with it can be acquired visually prior to the MAPt, the pilot may decide to proceed visually to the heliport or landing location otherwise a missed approach shall be executed.

d. Proceed VFR

Under ‘Proceed VFR’ there is no obstacle protection in the visual segment.

The pilot shall comply with VFR to see and avoid obstacles when proceeding from the MAPt. to the heliport or landing location.

The visibility for these approaches is the visibility published on the chart, or VFR minima as per the requirement of the class of airspace, or State regulations.

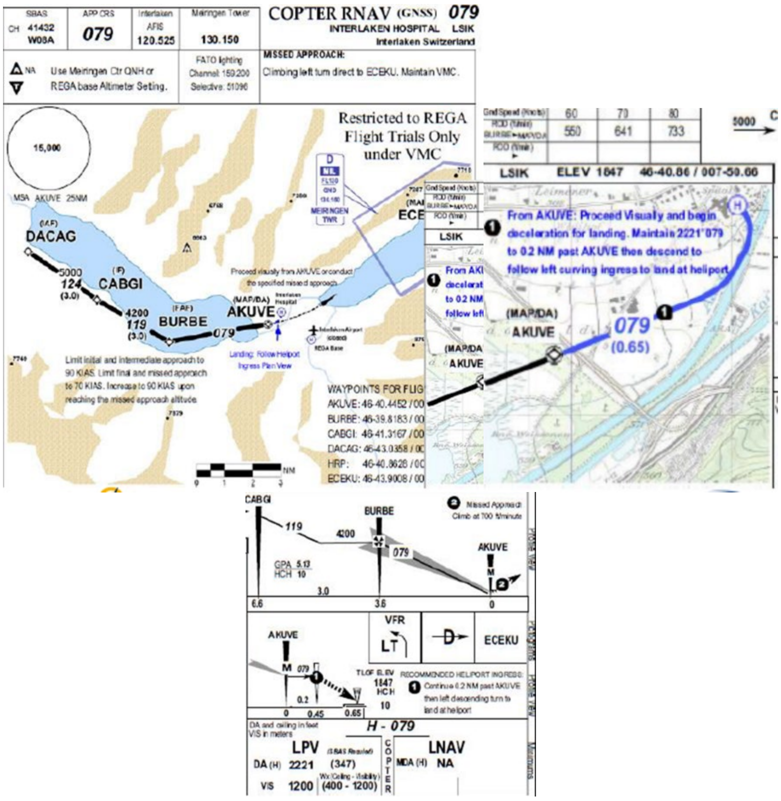
e. Adjustment of the OCA/H and protection

In order to ensure adequate transition between the instrument phase of flight and the visual phase of flight, the final OCA/H is calculated by including an ‘add on’ value to the OCA/Hps.

This ‘add-on’ value is directly linked to the GPA and is calculated by using the following formula: ‘add-on’ value (ft0 = 1460/102° GPA (degree))

f. Approach, example of RNAV Approach

Figure 5 RNAV Approach



REFERENCES

a. Safety Notice SN-2014/005

b. Safety Notice SN-2016/001

c. Aeronautical Information Circular P067/2013

d. Doc 8168 PANS OPS Annex 14 Volume II Part IV

e. Doc 8168 PANS OPS Annex 14 Volume I Chapter 3 & 4

f. Doc 9613 PBN Manual

g. CAP 1122 instrument Approach without instrument runway

h. Regulation (EU) 965/2012 Air Operations Annex I Definitions

Appendix 13 to Chapter 19 – Unmanned Aerial Systems

References:

Drone safe

Association of Remotely Piloted Aircraft Systems

DJI Aeroscope

https://flarm.com/

http://www.aveillant.com/products/gamekeeper-16u/

http://notaminfo.com/ukmap

https://www.altitudeangel.com/

Appendix 14 to Chapter 21 – Police Operations

Date	AAIB Summary	Notes from Report
15 May 1985 G-KATY Edgley Optica	The aircraft was orbiting Ringwood on a photography task when it was seen to descend slowly from about 800 feet to 150 feet and enter a steep but apparently controlled turn to the right. A few seconds later the bank angle suddenly increased to 90 degrees and the aircraft spiralled steeply into the wood destroying the aircraft and killing both occupants. The Commander was a police officer who held a private pilot's licence and operated with an "Exemption" from the necessity to hold a Commercial Pilots Licence when flying on police duties.	The CAA were asked to reconsider the process for allowing private pilot's licence holders to conduct this type of operation.
24 January 1990 G-EYEI Bell 206	During a police flight in the Barrhead area and operating under VFR, the helicopter was 'suddenly engulfed in a severe snow storm'. The pilot descended to about 200 feet agl, in order to maintain visual contact with the ground and is then believed to have attempted to find the nearby Rouken Glen Park in order to carry out a precautionary landing. However, shortly before reaching the park, whilst in a steep left turn and probably flying relatively slowly the helicopter's engine failed. The helicopter subsequently flew into the top of a five-storey building and fell to the ground.	
09 Oct 1998 G-EMAU AS355	The evidence indicates that the pilot became disorientated after he lost external visual attitude references. He was then unable to control the helicopter by sole reference to the flight instruments, and the helicopter crashed into trees adjacent to its operating base.	Following the accident, the ASU with the assistance of the CAA considered possible alternatives that would improve the safety of departures and arrivals at the helicopter base in the hour of darkness. An illuminated strip was constructed on adjacent farmland.
21 April 2000 G-SEAW AS355	The Twin Squirrel helicopter was operating in a 500 to 600 feet hover in the Cardiff area when it suffered a tail rotor failure which resulted in an uncommanded yaw to the left through some 180 degrees. The pilot immediately applied full right pedal to counter this yaw. This stabilised the	

	helicopter for a moment before it yawed more rapidly to the left. The pilot realised he would not be able to recover full control and concentrated on keeping the helicopter as level as possible as he descended towards the surface, just prior to impact the pilot pulled up on the collective to cushion the impact. The helicopter came to rest embedded in the roof of a house.	
25 Dec 2001 G-DPPH A109	The aircraft was returning from Morriston Hospital, Swansea to the operator's base near Carmarthen with a pilot and two passengers onboard when it suffered a double engine failure due to fuel starvation at height of approximately 400 feet above ground level (agl).	The CAA should ensure Air Operators Certificate Holders Minimum Equipment List states the relevant actions and procedures for dispatching an aircraft with any unserviceable item. The Emergency and Malfunction procedures should be reviewed with regards "Failure of a Fuel Pump". The confirmation that any drill is completed or continues onto the next page should be clearly indicated.
17 Feb 2002 G-SPAU EC135	The aircraft was returning from Muirkirk, Ayrshire to its base in Glasgow at an altitude of approximately 2000 feet (1200 feet agl) when it entered "thick cloud". The pilot started a descent using the radio altimeter as his height reference and descended to 1000 feet agl, still in cloud , the pilot selected "ALT" and "HDG" mode. The helicopter entered a turn to the right with approximatley 15 degree angle of bank. The pilot manually overrode the autopilot; eventually the warnings for autopilt disconnect appeared and the helicopter entered a steep nose down attitude whilst turning to the right at about 45 degrees. The pilot was unable to prevent the helicopter striking the ground.	The CAA should require that Police Air Operators Certificate (AOC) holders review the safety benefits provided by the use of helmet mounted night vision goggles (NVGs) with a view to the introduction of NVGs for helicopter operations conducted at night in support of the police in areas of limited cultural lighting, particularly in hilly or mountainous regions. The CAA should review the Police Air Operators Manual (PAOM) to ensure that training in the use of autopilot systems is required to be covered by the operator during initial and recurrent line training and the PAOM Part II contains instructions for the use of autopilot systems by pilots during normal operations
28 October 2010 G-SEWP AS355	The pilot lost control of the helicopter whilst manoeuvring at low speed to approach a hilltop landing site in quite strong wind conditions. It descended rapidly with increasing forward ground speed, before striking the ground short of the point of intended landing and passing through a substantial stone wall. The helicopter was destroyed but the	

	occupants suffered only minor injuries. The investigation determined that an error of judgement or perception led the pilot to attempt a downwind approach. A combination of human factors was thought to have contributed to the accident.	
29 Nov 2013 G-SPAO EC135	The helicopter departed Glasgow City Heliport (GCH) at 2044 hrs on 29 November 2013, in support of Police Scotland operations. On board were the pilot and two Police Observers. After their initial task, south of Glasgow City Centre, they completed four more tasks; one in Dalkeith, Midlothian, and three others to the east of Glasgow, before routing back towards the heliport. When the helicopter was about 2.7 nm from GCH, the right engine flamed out. Shortly afterwards, the left engine also flamed out. An autorotation, flare recovery and landing were not achieved and the helicopter descended at a high rate onto the roof of the Clutha Vaults Bar, which collapsed.	It is recommended that, when the European Aviation Safety Agency requires a radio altimeter to be fitted to a helicopter operating under an Air Operator's Certificate, it also stipulates that the equipment is capable of being powered in all phases of flight, including emergency situations, without intervention by the crew. A recommendation was made that all helicopters operating under a Police Air Operators Certificate and Helicopter Emergency Service operations are equipped with a recording capability that captures data, audio and images in crash survivable memory. They should be capable of recording the last two hours operation, including at least 10 minutes after the loss of the normal electrical supply.
Foreign Incidents		
21 Mar 2013 AS332 & EC155	Three helicopters transporting German Federal Police Forces on exercise collided during landing in whiteout conditions. One pilot killed and several suffered severe or minor injuries from flying aircraft parts following the collision. During the approach and landing there was insufficient crew communication and the pilot lost visual contact with the marshaller and the ground due to recirculating snow. There was also not enough distances between the landing spots and the vehicles on the ground.	New procedures and simulator training programme was introduced for take-off and landings under whiteout/brownout conditions. A minimum distance of 70 metres between landing helicopters was introduced. It was recommended that an independent supervisory body for all police helicopter squadrons should be established. Aviation regulations should be established for the operation of the police helicopter squadrons such that the specific requirements of police missions are met and a safety level similar to that ruling the commercial use of helicopters is ensured.

04 Apr 2007 SE-HPS EC135	The helicopter was being used in a training exercise with the Swedish Police Wing. (SPW) The final part of the exercise involved environment training where police officers were to be given experience of "*the feeling of the violent effects on passengers of tactical helicopter flying".* During this "training" the helicopter impacted the ground. The investigation found that the flight was performed with departures from the approved procedures and outside the specified limits of the helicopter`s operational capacity. It also highlighted the "*deficiencies and direction of SPW and the unclear granting of permits by the Civil Aviation Authority and its inadequate inspection which permitted a dangerous flying activity*"	National regulations should be developed and adapted to the activities of the Swedish Police Air Wing. These should also include procedures for the type of operation specific to the Police Air Wing including for crew configuration and crew so-operation. A review of the internal routines of the Civil Aviation Authority for granting permission for the inspection of commercial flight activities.
17 Nov 2012 Two Bell 206	The landing pilot's failure to maintain clearance with from obstacles a parked prior to landing helicopter and the other pilot's failure to park the helicopter inside of a marked parking pad. Contributing to the accident was the landing pilot's obscured visibility due to moisture on the windscreen. Also contributing to the accident was the other pilot's action of placing the helicopter outside of a marked parking pad.	

References:

International Helicopter Safety Team

Air Accidents Investigation Branch (AAIB)

Airprox Board

Swedish Accident Investigation Authority

German Aircraft Accident Investigation

European Co-ordination Centre for Accident and Incident Reporting Systems

The Met Office

SKYbrary

NTSB

NOTAMinfo

EHEST “The Potential of Technologies to Mitigate Helicopters Accident Factors”

Skylink Pro weather system

https://publicapps.caa.co.uk/modalapplication.aspx?catid=1&pagetype=65&appid=11&mode=list&type=sercat&id=17

Appendix 15 to Chapter 22 - SAR

Abbreviations and acronyms:	
AIDU	Aeronautical Information Documents Unit
ANO	Air Navigation Order
AGL	Above Ground Level
ARCC	Aeronautical Coordination Centre
ATC	Air Traffic Services
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
DfT	Department of transport
DefSTAN	Defence Standardisation
ETOD	Elevation Terrain and Obstacle data
HEMS	Helicopter Emergency Medical Services
HLS	Helicopter Landing Site
HHLS	Hospital Helicopter Landing Site
HMCG	Her Majesty's Coast Guard
ICAO	International Civil Aviation Organisation
MCA	Maritime and Coastguard Agency
MOD	Ministry of Defence
NMOC	National Maritime Operations Centre
NVG	Night vision Goggles
NVIS	Night Vision Imaging Systems
OSR	Onshore Review
RAF	Royal Air Force
SAR	Search and Rescue
TCM	Technical Crewman

References:

Commission Regulation (EU) No 965/2012 on Air Operations

Commission Regulation (EU) No 1178/2011 Technical Requirement and Administrative Procedures, including Annex IV Part-Med

CAP 999 UK Helicopter Search and Rescue (SAR) National Approval Guidance

No 1 AIDU Products and Services

ICAO Annex 4 Aeronautical Charts Chapter 6

ICAO Annex 11 Air Traffic Services Appendix 5

ICAO Annex 14 Aerodromes Chapter 2.5

ICAO Annex 15 Aeronautical Information Services Chapter 10 & Appendix 8

Appendix 16 to Chapter 29 – Meteorology

Making effective weather-related decisions

20.1 Introduction

This section provides supplementary guidance material on the use and understanding of regulated aviation meteorological products and services, and provides details on recommended best practices for threat and error management in the context of making weather-related decisions.

20.2 Background/Current Situation

a. Throughout this document it is referenced that there have been a number of incidents where weather or weather-related decisions were a factor;

b. As a rule, when a pilot has qualified, there is no further mandatory Met training requirement and only minimal assessment during PC/OPC;

c. Thereby, noting that current training may not always effectively achieve the desired level of understanding of the subtleties of regulated products and services, this section provides further guidance on threat and error management in the context of making weather-related decisions.

20.3 Objective

The intent is to reduce the number of incidents where weather has been a significant contributory factor and that the information in this section is provided in order to support this objective by helping pilots to enhance their knowledge and also by helping examiners to more effectively assess the level of pilot skills in the use of weather products and weather-related decision-making.

20.4 Regulated Aviation Meteorological Products, Services and Guidance

This section is not to 're-teach' the basics about these products but to provide further, practical 'simple English', guidance to users on how to interpret and 'read' the forecasts and to help them to be able to use the information they contain more effectively.

For example:

a. TAFs/METARs give the cloud based on the ground level at the reporting aerodrome.

b. Values in TAFs do not represent a single forecast value but rather a range of potential values.

Within in the Appendices there are a number of examples of the subtleties and types of forecasts, which are known to most likely give rise to confusion, or be open to misinterpretation.

By way of a reminder, whilst planning and operating the guidance for the suitability of the weather en-route can be found in the following formats:

a. TAFs/METARs.

b. Aerodrome Warnings.

c. F214/215.

d. Forecast clarification.

e. Verbal briefs from the Met Office.

f. Resources and Guidance Material – source of Met information (Skyways Code, EASA/EHEST, Met Office, etc.)

20.5 Other Sources of Meteorological Products, Services and Guidance

More guidance on the use of other information such as public weather forecasts, rainfall and radar imagery, synoptic charts etc can be found in conjunction with regulated products with further detail provided on each of the products:

a. Public Weather.

b. Rainfall and radar imagery.

c. Synoptic charts.

d. Weather apps – aviation and non-aviation – you'll need to recognise the limitations and possible risks of using any of these.

20.6 Threat and Error Management in the context of making weather-related decisions

The principles of TEM are to encourage pilots to have situational awareness of the risks that might put them in danger and to consider plans to mitigate those risks. Identifying weather related risks is an important factor, so an understanding of how to manage risks such as unexpected weather changes is a fundamental part of good airmanship. Possible areas of specific risk areas are:

a. Low Visibility (including Fog).

b. Cloud (Low cloud base, Convective clouds etc).

c. Showers and Thunderstorms.

d. Wind and turbulence.

e. Making the decision – pre-flight risk assessment (en-route, at destination and alternatives).

f. Operating to/from/between 'green-field' sites.

20.7 Weather-related Scenario Examples

In the appendices, we have added some examples of likely scenarios that might arise and the risks they may pose, plus some suggested best practice mitigants and decisions that could be made.

These example scenarios (based on real events which have been sanitised) include:

a. Overview – describe a proposed flight from A to B.

b. Provides 'example' TAFs/METARs and charts for the proposed flight.

c. Considers TEM in the planning and operational stage.

When looking at the three examples, we will assess the weather forecast, the potential threats and plan how to mitigate against these risks.

Note: US NOAA analysis identified the most common pilot error (of small aircraft) was continued flight into IMC (often resulting in loss of control due to spatial disorientation) – we need to focus on where the forecast predicts or indicates that IMC may occur pilots should take more time to consider potential contingency plans and diverts in order to make effective decisions en-route or at destination.

a. *ATOs/Flying Schools/Instructors*

Review courses and training and consider enhancing coverage of the topics included in this publication. Arrange aviation weather safety presentations.

b. *Examiners/Senior Examiners*

Review the assessment of the level of pilot (new and recurrent) skills in the use of weather products to support effective weather-related decision-making (giving consideration to how a pilot might respond in different weather scenarios).

c. *Pilots*

i. *Enhance your confidence in weather decision-making, for example watch forecasts on TV, keep an eye on METARs and TAFs even when not flying, study radar and satellite imagery, talk to fellow pilots, share weather experiences, read books and articles and attend aviation meteorological courses.*

ii. *Review the weather-related decision-making aspects of your pre-flight risk assessment routine.*

iii. *Focus on flight safety in IMC conditions – i.e. making decisions when assessing whether, or where, to fly when IMC conditions exist or are forecast.*

iv. *Train/practice basic flight instruments in case of inadvertent entry into adverse conditions.*

Case 1

Route: Southampton to Norwich (VFR) / Date: 27th August 2017, departing 08 UTC

a. **Synoptic situation**

What are the broad features in the synoptic chart, what is the main type of airmass covering the region and what kind of weather can we expect from it? How strong is the wind likely to be and what will its direction be?

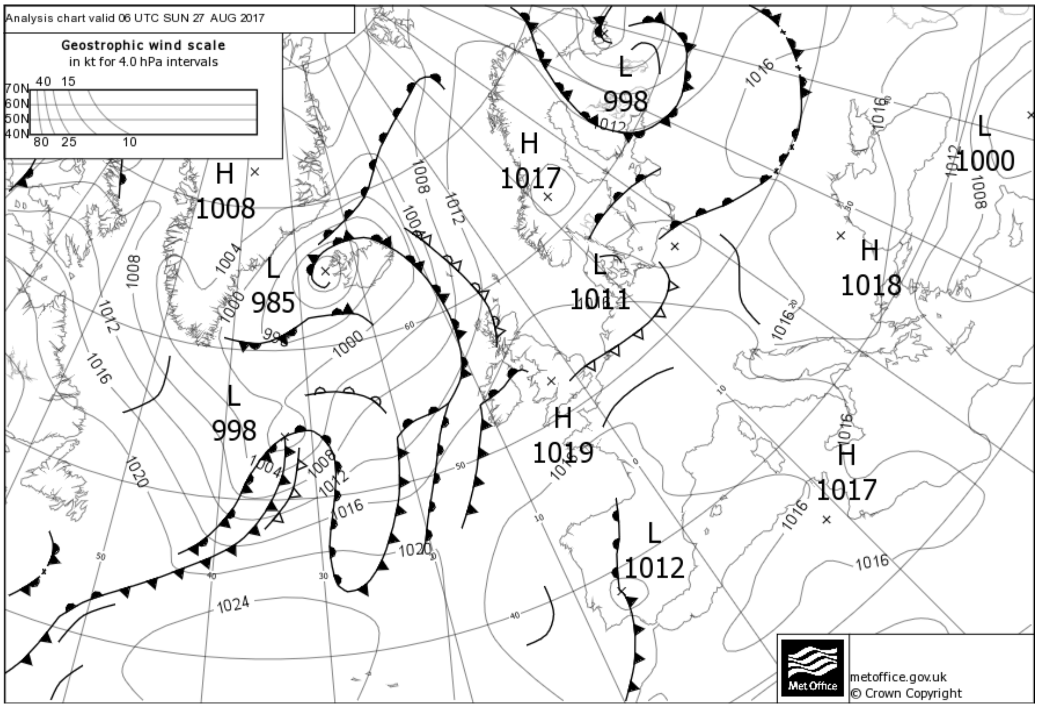


Figure 12.1 Synoptic Chart 27 Aug 2017

The south of the UK is dominated by an anticyclone (1019 hPa), giving predominantly fair weather and gentle winds. There are not many isobars on the chart so we can assume that the winds will be light and variable although mainly north-easterly on the planned route and, when considering the time of year, it is possible for sea breezes to develop around the coasts. Looking at the wider flow, the airmass seems to have a mixture of maritime and continental influences; the air is likely to be warm and predominantly dry, generating just fair-weather clouds but with some lower cloud bases in moister air to the west. The presence of an upper cold front to the east of England complicates the picture somewhat and will need investigating. What is the cloud base associated with it? Does it produce rain and if so, how much of it is reaching the ground? How much does it affect the visibility?

Anticyclones (high pressure) are normally associated with clear skies and good weather, so it is often assumed that there are no aviation hazards to be considered. However, the clear skies can allow overnight temperatures to fall and early / late radiation mist and fog can occur. Furthermore, the generally subsiding air beneath an anticyclone can trap pollution, smoke, dust and other microscopic solids to make the atmosphere particularly hazy. This can adversely affect visibility, particularly from the air to the ground (slant visibility). Finally, under clear skies the ground can heat quickly during the day and this can trigger convective processes leading to turbulence, gusty winds, sea breezes, spreading cloud, showers or even thunderstorms. Sinking air under high pressure does tend to suppress convection, but ***not always*** and usually not in the first few thousand feet – don't get caught out!

So, what kind of hazards may be associated with convection?

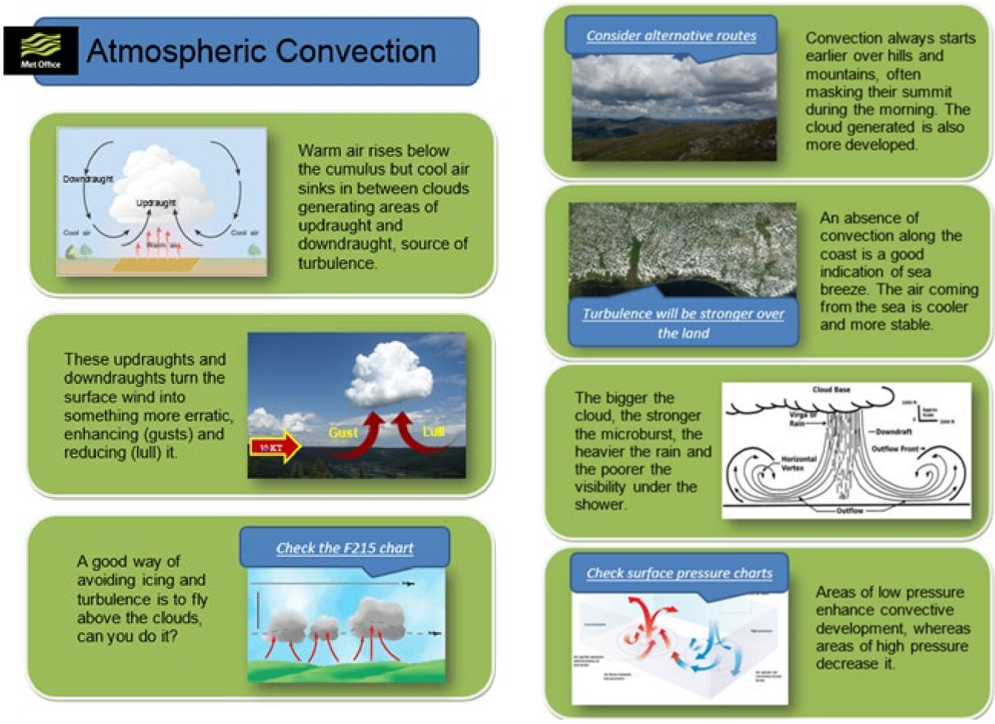


Figure 12.2 Atmospheric Convection

b. **Area Forecast**

Looking at the F215 chart, is there anything along the route that I should be taking into consideration? What are the main cloud base and visibility? What is the altitude of the freezing level? Can I expect any fronts, weather, turbulence or icing?

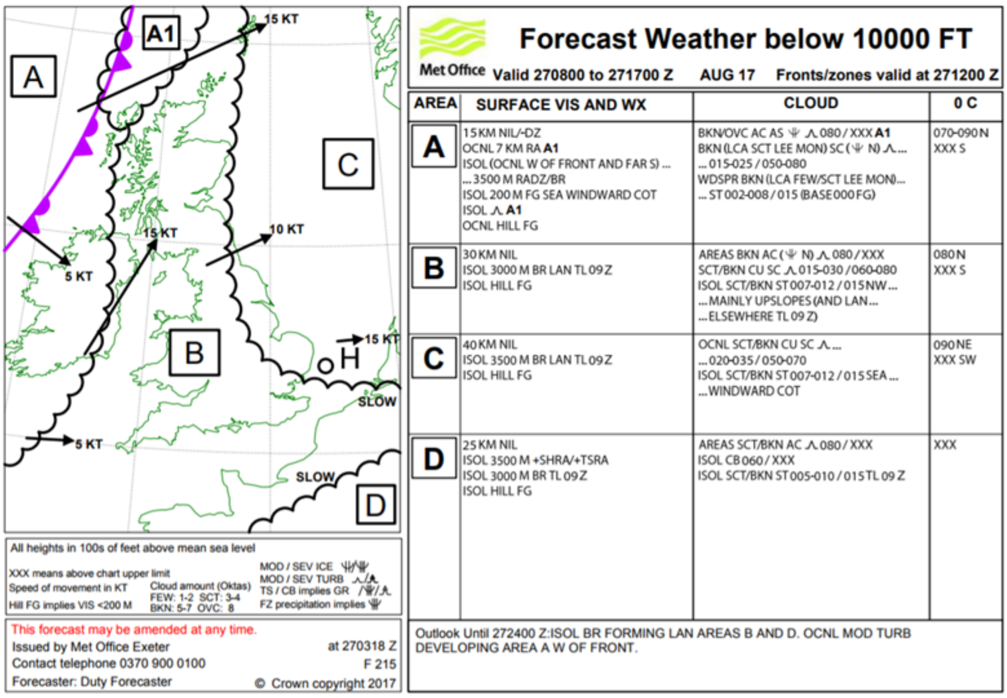


Figure 12.3 F215 27 0800 to 27 1700 Aug 2017

For the flight from Southampton to Norwich I need to focus on areas B & C. Visibility is, generally, excellent but I may encounter patches of mist until 09Z. Hill fog may even be possible on windward slopes, with cloud as low as 500ft.

There are extensive areas of cumulus and stratocumulus with a cloud base of around 1500-2000 FT. Considering the highest point of the Cotswolds is ~1100 ft, that doesn't leave much of a gap. Additionally, areas of stratus are possible early in the planned flight period and near windward coasts. The freezing level is, thankfully, high at this time of year and should not be an issue and this is confirmed on the chart. The upper front on the synoptic chart appears to be no more than residual cloud, hence not precipitating nor reducing the visibility and with no significant turbulence.

c. **Site specific information**

Let's have a look at the METARs/TAFs along the route, do they confirm the information contained in the F215? Have you checked possible diversion airfield(s) along your track as well as your destination? Are they suitable?

METAR EGHI 270650Z 01005KT 330V040 CAVOK 15/12 Q1018=

METAR EGLF 270650Z 31001KT CAVOK 15/14 Q1018=

METAR EGUB 270650Z 34002KT CAVOK 15/13 Q1018 BLU=

METAR COR EGLL 270650Z AUTO 04005KT 9999 NCD 17/11 Q1018 NOSIG=

METAR EGGW 270650Z AUTO 02006KT 350V060 9999 NCD 14/11 Q1019=

METAR EGSS 270650Z AUTO 36005KT 330V040 9999 NCD 15/11 Q1019=

METAR EGSC 270650Z VRB01KT CAVOK 14/11 Q1019=

METAR EGYM 270650Z AUTO 33003KT 9999 NCD 13/12 Q1018=

METAR COR EGSH 270650Z 29004KT 250V320 CAVOK 15/12 Q1018 NOSIG=

TAF EGHI 270625Z 2706/2715 VRB03KT 9999 FEW045=

TAF EGSC 270659Z 2706/2715 35003KT CAVOK=

TAF AMD EGSH 270557Z 2706/2715 VRB03KT 9999 FEW045=

The METARs are looking promising, most airfields reporting CAVOK (Cloud and Visibility OK), implying that the visibility is 10 KM or more, or NCD (No Cloud Detected). Some airfields are not yet opened but the few TAFs available indicate good conditions too. Based on these, it looks like the early visibility problems that are highlighted on the F215 have now cleared.

d. **Threat & Error Management**

ANTICIPATION: The weather seems fine – but what could go wrong to spoil your day?

a. Visibility is already good at Southampton, but what about the surroundings in the event of an emergency in the early phases of flight?

b. Can you fly your planned route in appropriate airspace when constrained by the terrain and forecast cloud? EGHI to EGSH involves some busy airspace with limited scope for manoeuvre.

c. The surface visibility may be over 10km, but how far and how clearly can you see the ground in the cruise? Will it be far / clear enough to allow accurate navigation in busy airspace?

d. How will variable wind (albeit light) affect your navigation?

e. What is your plan for convection? Whilst it's not specifically forecast for your area it can occur in these conditions in the first few thousand feet without generating cloud or weather (what glider pilots call "blue thermals"). Vertical motion and turbulence from convection may make it more difficult to maintain a constant height/altitude.

f. If convective cloud, showers or even thunderstorms do develop unexpectedly what is your avoidance plan? (there are thunderstorms forecast across the English Channel in area D.

g. Some METARS are showing 15 – 17°C at 0700UTC. What is the maximum temperature for the day and how will it affect your aircraft's performance?

RECOGNITION: A safe flight depends on being able to conduct safe VFR navigation and respond to unexpected hazards.

a. Could you consider delaying departure for an hour or two to ensure clearance of mist / fog patches?

b. With possibly limited air-to-ground visibility, do you intend making more regular navigation (gross error) checks and plan more regular waypoint checks?

c. What is the variable wind doing to your track in relation to navigation & airspace limitations?

d. Are you maintaining height/altitude accurately? Are you aware of vertical airspace limitations?

e. If you need to avoid convective cloud or even showers, what are your plans for diversion, delay, extended fuel use etc?

RECOVERY: The potential combination of relatively poor visibility from the air and the development of apparently random convection / turbulence makes planning particularly difficult.

a. Do you have diversion information for appropriate airfields along your planned track?

b. Have diversion plans and clear go / no-go decision points for the flight. Be prepared to develop and adapt recovery plans as situations develop.

c. What is your plan for becoming unsure of your position? When did you last practise with London Centre / D&D on VHF 121.5MHz?

d. Ensure careful monitoring of fuel, distance, speed and elapsed time when dealing with delays (e.g. showers).

e. During take-off and landing be ready to deal with convective gusts and reduced performance due to high temperatures. Be ready to go around!

e. **Summary**

Anticyclonic conditions should mean a pleasant and straightforward flying day. Conditions for this flight are forecast to improve after a misty or foggy start and METARS suggest that this is already true. It’s looking good!

However, be aware that while winds may be light they can also be variable, so monitor the impact on navigation and airspace avoidance. High pressure can trap haze in the lower atmosphere, affecting air-to-ground visibility. Higher ground temperatures can introduce hazards that are not explicitly forecast such as convection / thermals, associated turbulence, gusty ground winds and high-density altitude values. Don’t let fine weather cause complacency.

Finally – warm summer air can be surprisingly humid.

Case 2

Route: Cambridge to Gloucester (VFR) / Date: 11th March 2017, departing 08 UTC

a. **Synoptic situation**
Describe the broad features in the synoptic chart, what is the main type of airmass covering the region and what kind of weather can we expect from it? How strong is the wind likely to be and what will its direction be?

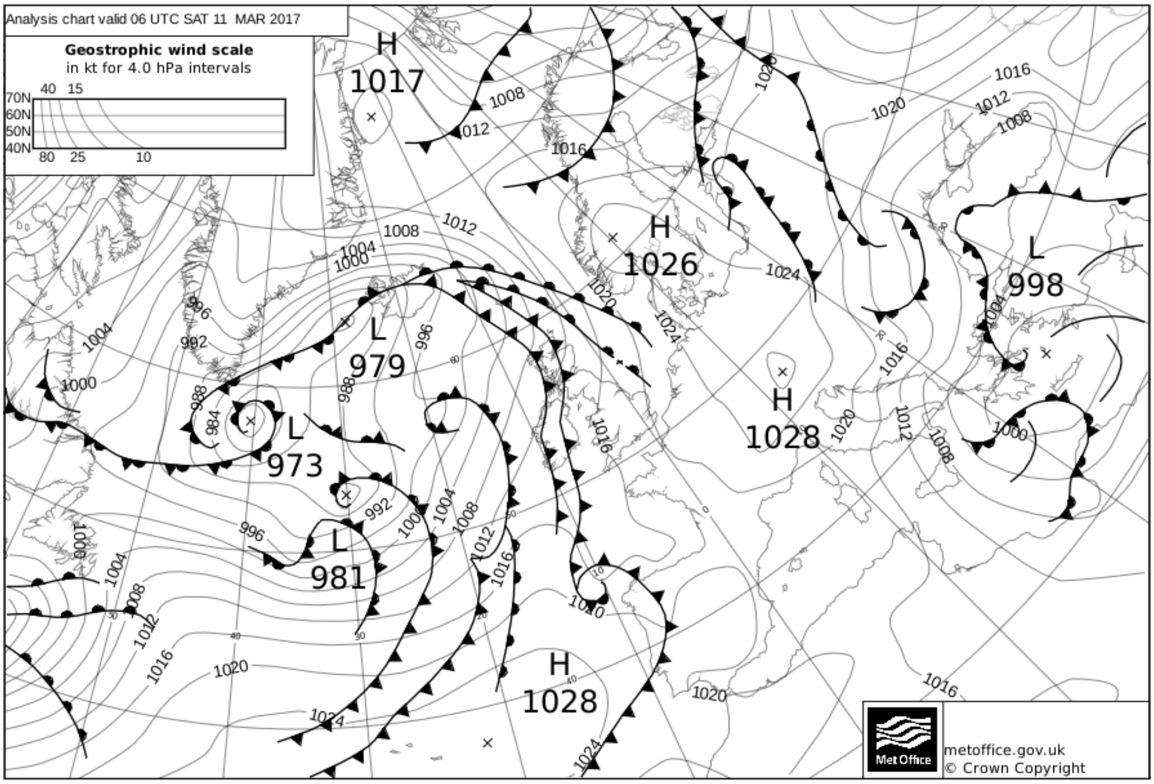


Figure 12.4 Synoptic Chart 11 Mar 2017

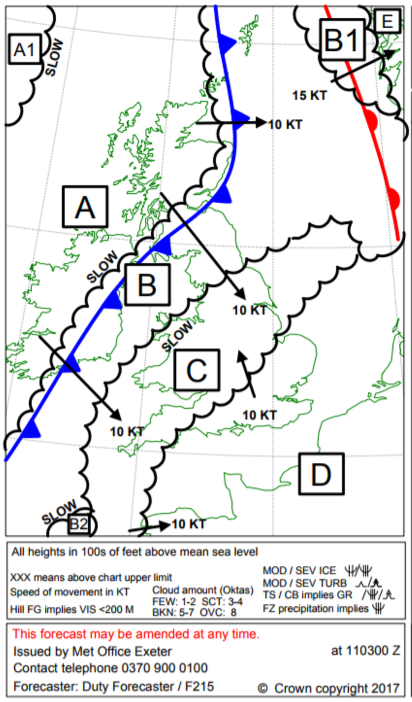
Most of the UK is covered by a south to south-westerly Tropical Maritime airstream. This airmass is mild and moist in its lowest layers, particularly over coastal areas and hills where it brings low clouds, drizzle and local hill fog. Judging from the number of isobars the gradient wind does not seem to be an issue but the complexity of the frontal system over the Atlantic indicates that conditions will deteriorate quickly and for quite a long time. The window of opportunity is brief and closing in!

So, what kind of hazards are usually associated with this airmass?

Figure 12.5 Tropical Maritime (TM) Airmass

b. **Area Forecast**

Looking at the F215 chart, is there anything along the route that I should be taking into consideration? What are the main cloud base and visibility? What is the altitude of the freezing level? Can I expect any fronts, weather, turbulence or icing?



Forecast Weather below 10000 FT

Met Office Valid 110800 to 111700 Z MAR 17 Fronts/zones valid at 111200 Z

AREA	SURFACE VIS AND WX	CLOUD	0 C
A	30 KM NIL ISOL 7 KM SHRA ISOL 2000 M BR SE OCNL **A1** ISOL HILL FG	SCT/BKN CU SC 015-030 / 050-080 ISOL SCT/BKN ST 007-012 / 015 ... ... (LCA BASE 004 SE)	040 N 070 S
B	15 KM NIL/-RA OCNL 7 KM -RADZ/RA ISOL 5000 M TSRA **B2** OCNL (ISOL LEE MON) 2000 M -DZ/BR LCA 1000 M SN MON NORWAY ISOL 200 M FG MAINLY SEA ... ... WINDWARD COT OCNL (ISOL NE FM 14 Z) **B1** WDSPR HILL FG	ISOL EMBD CB 060-080 / XXX **B2** BKN/OVC SC AC AS (ISOL 040 / 080 ... ... **B1**) 040-060 / XXX BKN/OVC (LCA SCT LEE MON) SC ... ... 015-025 / 040-060 BKN (LCA FEW/SCT LEE MON) ST ... ... 004-010 / 015 (BASE 000 FG)	050-070 ... ... LCA 030 **B1**
C	20 KM NIL AREAS 6 KM HZ ISOL (OCNL SEA WINDWARD COT) ... ... 3000 M BR/-DZ ISOL 200 M FG MAINLY SEA ... ... WINDWARD COT WDSPR HILL FG	AREAS BKN AC 080 / XXX BKN (LCA FEW LEE MON) CU SC ... ... 015-025 / 030-050 AREAS SCT/BKN (LCA NIL LEE MON) ST ... ... 004-010 / 015 (BASE 000 FG)	080
D	20 KM NIL ISOL 6 KM HZ ISOL 3000 M BR LAN TL 11 Z ISOL 200 M FG LAN TL 10 Z ISOL HILL FG	ISOL (AREAS NW) SCT/BKN CU SC ... ... 020-030 / 040-050 ISOL SCT/BKN ST 004-010 / 015 LAN ... ... TL 11 Z (BASE 000 FG)	060 E 090 W
E	30 KM NIL ISOL 200 M FG/FZFG VAL ISOL HILL FG	ISOL SCT/BKN CU SC 020-040 / 050 ISOL SCT/BKN ST 000 / 010 VAL	005-020

Outlook Until 120000 Z:SIMILAR

Figure 12.6 F215 11 0800 to 11 1700 Mar 2017

For the flight from Cambridge to Gloucester I need to focus on areas C & D where visibility may be reduced in haze, fog or hill fog and where the cloud base may be as low as 400ft at times. The conditions are expected to improve, but will deteriorate further to the west later: not a great forecast for VFR flight. The freezing level is above 8000ft (AMSL) so there is no risk of icing at low level. Turbulence is expected along the route but it is only slight. The possible restricted visibility means that you need to check the latest conditions at Gloucester (and the surrounding area) and make sure it will not be below minima for your arrival. In these conditions, it is simply not a good idea to "see how it looks when we get there"!

c. **Site specific information**
Let's have a look at the METARs & TAFs along the route, do they confirm the information contained in the F215? Have you checked possible diversion airfield(s) along your track as well as your destination? Are they suitable?

METAR EGSC 110650Z NIL=

METAR EGGW 110650Z AUTO 16004KT 2900 BR OVC003 09/09 Q1018=

METAR EGTK 110650Z 16005KT 2500 BR OVC005 10/10 Q1018=

METAR EGVN 110650Z 17003KT 2000 BR OVC004 10/10 Q1018 YLO2 TEMPO 0600 FG BKN001 RED=

METAR COR EGBB 110650Z 16006KT 4800 BR BKN007 10/10 Q1017=

METAR EGBJ 110650Z NIL=

TAF AMD EGBB 110712Z 1107/1206 17005KT 3000 BR BKN004

BECMG 1107/1110 9999 NSW SCT010

TEMPO 1110/1114 8000 BKN009

PROB40 TEMPO 1201/1206 7000 RA BKN004=

TAF EGVN 110741Z 1109/1209 17005KT 2500 BR BKN004

BECMG 1109/1112 9999 NSW SCT018

BECMG 1113/1115 FEW020

BECMG 1200/1203 BKN012

TEMPO 1201/1206 3000 RADZ SCT005=

The METARs are actually not very encouraging and indicate that the stratus is quite extensive. The TREND at Brize Norton also suggest a risk of fog during the next two hours. Cambridge and Gloucester airfields are not opened yet but there is no reason to believe that conditions will be any different there. Conditions described by the METARS confirm the information contained in the F215 chart but the TAFs indicate a potential improvement during the morning, with greater visibility and a higher cloud base.

d. **Threat & Error Management**
ANTICIPATION: Consider your limits and how the forecast cloud and visibility may present a threat:

a. Is your departure and arrival time realistic given the forecast conditions at Cambridge and Gloucester?

b. Can you fly your planned route in appropriate airspace when constrained by the terrain and forecast cloud?

c. What is your safety altitude for the flight? Can you achieve this and remain VFR given the forecast?

RECOGNITION: A safe flight depends on conditions improving as forecast and not deteriorating faster than expected.

a. As well as keeping a good lookout, what is your plan to get en-route METARS or other weather updates?

b. How does this fit in with your wider communications plan?

c. Where and when are your decision points on the route if conditions are doubtful?

RECOVERY: At each decision point you MUST have planned actions for the eventuality that the weather has not improved or is deteriorating further on your route. Given the forecast, it is likely that the best weather will always be behind you and away from exposed southern areas.

a. Do you have diversion information for appropriate airfields to the north and east?

b. Have you planned alternative routes to these diversions from each decision point?

e. **Summary**

The main concerns in this Tropical Maritime situation are low-level cloud and visibility along the route and possible deteriorating conditions on the approaching cold front. Conditions are forecast to improve after a misty or foggy start. The Brize Norton TAF is encouraging, but also note Birmingham's best cloud conditions of scattered at 1000ft. This is expected to increase and lower to become broken at 900ft at times. This is probably due to the fact that Brize Norton is slightly protected in the Thames Valley while Birmingham (and, importantly, Gloucester) are more exposed to the Bristol Channel and Severn Valley. The movement of the cold front in the west will be key to conditions at Gloucester and this should be monitored carefully.

The flight should only be started once you are confident that en-route conditions are safe and you should make regular checks on conditions at the destination before continuing past planned decision points. You must *always* have an alternate plan for deteriorating conditions AND PUT IT INTO ACTION AT THE FIRST SIGN OF DETERIORATION.

Case 3

Route: East Midlands to Cambridge (VFR) / Date: 15th March 2017, departing 08 UTC

Weather Briefing:

a. **Synoptic situation**

Describe the broad features in the synoptic chart, what is the main type of airmass covering the region and what kind of weather can we expect from it? How strong is the wind likely to be and what will its direction be?

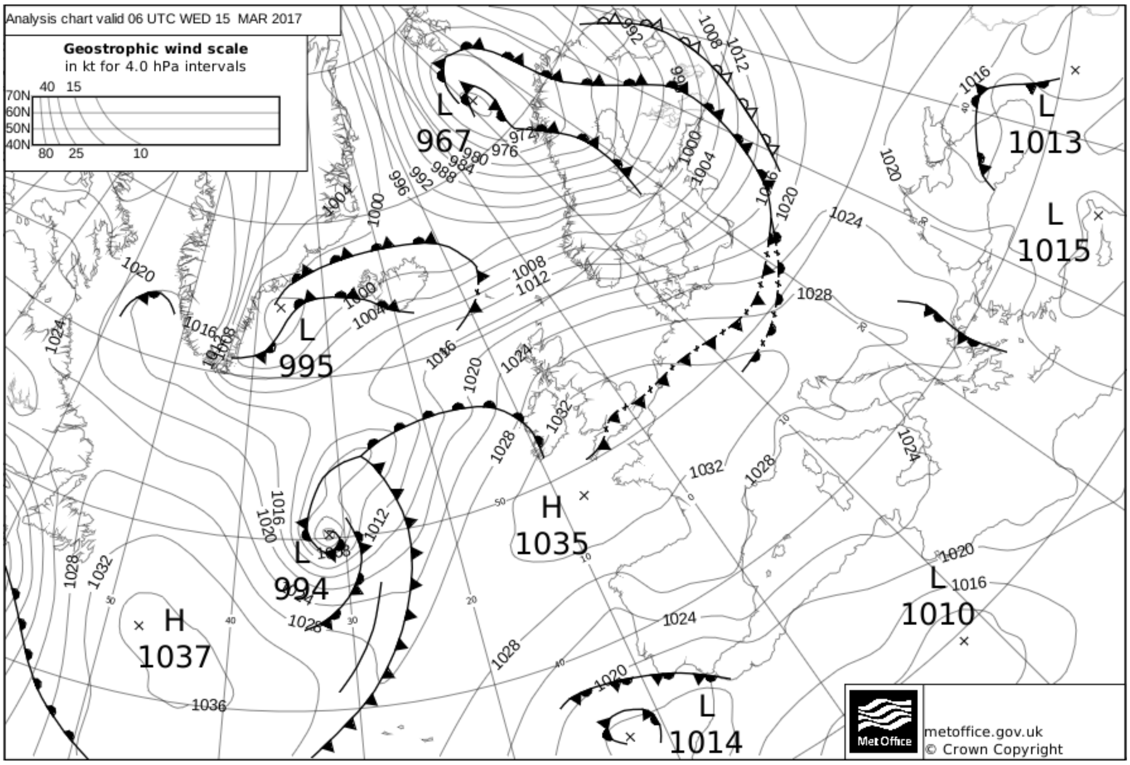


Figure 12.7 Synoptic Chart 15 Mar 2017

An anticyclone (1035hPa) extends a ridge over the south of the UK, suggesting settled conditions. A decaying cold front is slow-moving across southern England (the crosses on the front indicate that it is weakening). Despite becoming less active this front retains some of its characteristics. It is likely that significant amounts of cloud will be trapped under the ridge and this could be thick enough to generate rain and drizzle thus a risk of poor visibility in places.

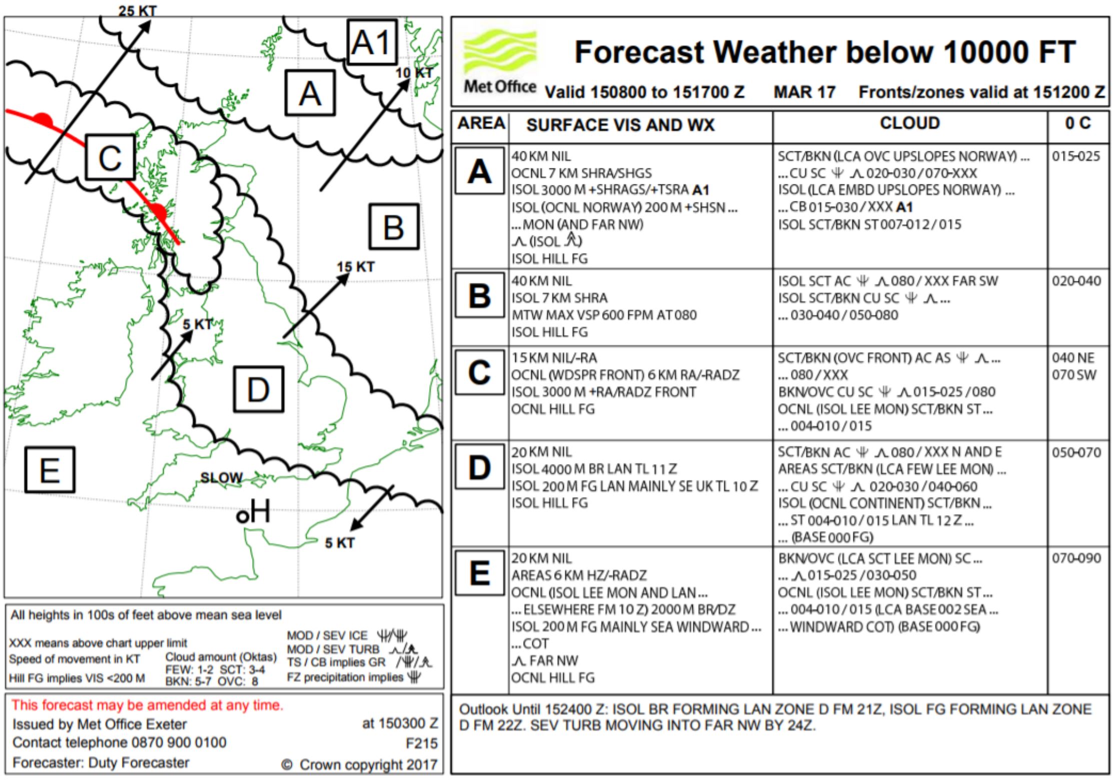
The time of year is a key consideration for this forecast; it's almost the March equinox so the length of day and night are nearly equal. The nights can still be cold and under such high pressure, it would not take long for fog to form in places. Additionally, away from the front and under any clear sky, the temperature can rise significantly and improve conditions during daytime.

So, what kind of hazards are usually associated with spring or autumn weather? Let's have a look at the cheat sheet below.

Figure 12.8 Flying in Spring & Autumn

b. **Area Forecast**

Looking at the F215 chart, is there anything along the route that I should be taking into consideration? What are the main cloud base and visibility? What is the altitude of the freezing level? Can I expect any fronts, weather, turbulence or icing?



AREA	SURFACE VIS AND WX	CLOUD	0 C
A	40 KM NIL OCNL 7 KM SHRA/SHGS ISOL 3000 M +SHRAGS/+TSRA **A1** ISOL (OCNL NORWAY) 200 M +SHSN … … MON (AND FAR NW) (ISOL) ISOL HILL FG	SCT/BKN (LCA OVC UPSLOPES NORWAY) … … CU SC 020-030 / 070-XXX ISOL (LCA EMBD UPSLOPES NORWAY) … … CB 015-030 / XXX **A1** ISOL SCT/BKN ST 007-012 / 015	015-025
B	40 KM NIL ISOL 7 KM SHRA MTW MAX VSP 600 FPM AT 080 ISOL HILL FG	ISOL SCT AC 080 / XXX FAR SW ISOL SCT/BKN CU SC … … 030-040 / 050-080	020-040
C	15 KM NIL/-RA OCNL (WDSPR FRONT) 6 KM RA/-RADZ ISOL 3000 M +RA/RADZ FRONT OCNL HILL FG	SCT/BKN (OVC FRONT) AC AS … … 080 / XXX BKN/OVC CU SC 015-025 / 080 OCNL (ISOL LEE MON) SCT/BKN ST … … 004-010 / 015	040 NE 070 SW
D	20 KM NIL ISOL 4000 M BR LAN TL 11 Z ISOL 200 M FG LAN MAINLY SE UK TL 10 Z ISOL HILL FG	SCT/BKN AC 080 / XXX N AND E AREAS SCT/BKN (LCA FEW LEE MON) … … CU SC 020-030 / 040-060 ISOL (OCNL CONTINENT) SCT/BKN … … ST 004-010 / 015 LAN TL 12 Z … … (BASE 000 FG)	050-070
E	20 KM NIL AREAS 6 KM HZ/-RADZ OCNL (ISOL LEE MON AND LAN … … ELSEWHERE FM 10 Z) 2000 M BR/DZ ISOL 200 M FG MAINLY SEA WINDWARD … … COT FAR NW OCNL HILL FG	BKN/OVC (LCA SCT LEE MON) SC … … 015-025 / 030-050 OCNL (ISOL LEE MON) SCT/BKN ST … … 004-010 / 015 (LCA BASE 002 SEA … … WINDWARD COT) (BASE 000 FG)	070-090

Outlook Until 152400 Z: ISOL BR FORMING LAN ZONE D FM 21Z, ISOL FG FORMING LAN ZONE D FM 22Z. SEV TURB MOVING INTO FAR NW BY 24Z.

Figure 12.9 F215 15 0800 to 15 1700 Mar 17

Focusing on the route from East Midlands to Cambridge and area D specifically, there seems to be a lot of cloud, all at various levels and accompanied by turbulence. Some moderate icing is expected but the lowest freezing level is expected to be 5000ft. The main cloud base is expected to be quite low at around 2000-3000ft but there will also be significant amounts (BKN) of stratus in some areas at very low level (400-1000ft), which will persist until midday, so navigation may be challenging. The visibility does not seem to be badly affected by the anticyclone; there will be patches of fog but these are expected to be isolated and mainly to the south-east of the UK. Although the medium level cloud (above 8000ft) may not affect you directly, it will slow the process of heating the surface to clear mist and fog patches.

c. **Site specific information**

Let's have a look at the METARs/TAFs along the route, do they confirm the information contained in the F215? Have you checked your destination airfield as well as the diversion(s) airfield(s), are they suitable?

METAR EGNX 150650Z 22005KT CAVOK 06/05 Q1033=

METAR EGBB 150650Z VRB03KT 9999 MIFG VCFG NSC 05/05 Q1033=

METAR EGXT 150650Z AUTO 27008KT 4600 BR SCT150/// 06/05 Q1032=

METAR EGGW 150650Z AUTO 30003KT 0150 R26/0275 FG VV/// 06/06 Q1033=

METAR EGSC 150650Z NIL=

METAR EGSS 150650Z 32003KT 2500 R22/0400 BCFG NSC 05/05 Q1033=

METAR EGYM 150650Z 23004KT CAVOK 08/07 Q1033 BLU NOSIG=

TAF EGNX 150503Z 1506/1606 24006KT 9999 SCT030

PROB30 TEMPO 1506/1509 8000

BECMG 1602/1605 BKN007

TEMPO 1602/1606 2000 BR BKN002=

TAF EGGW 150500Z 1506/1606 28007KT 3000 BR FEW020

TEMPO 1506/1509 0300 FG BKN001 BECMG 1509/1512 9999 NSW

PROB30 TEMPO 1509/1512 BKN008 TEMPO 1520/1606 3000 BR

PROB30 TEMPO 1523/1606 0800 FG BKN001 BECMG 1603/1606 22010KT=

TAF EGYM 150740Z 1509/1518 24008KT 9999 SCT025=

A few airfields are reporting visibility problems as previously discussed with the synoptic chart analysis but these are not expected to last past 1100UTC. Cambridge airfield is not yet opened but, looking in the vicinity, both Luton and Stanstead are reporting fog or fog patches. Marham is CAVOK (Ceiling and Visibility OK) with a NOSIG (No Significant changes) trend. Of note, Luton (EGGW) is expecting temporary spells of broken cloud at 800ft until midday. This all agrees with the F215 chart regarding the forecast cloud and the fog patches being mainly in the south-east of the UK.

d. **Threat & Error Management**

ANTICIPATION: Consider your limits and how the forecast cloud and visibility may present a threat:

a. Is your departure and arrival time realistic given the forecast conditions at East Midlands and Cambridge and the possibility of low cloud along the route?

b. Can you fly your planned route in appropriate airspace when constrained by the terrain and forecast cloud and visibility? Remember those low cloud patches!

c. What is your safety altitude for the flight? Can you achieve this and remain VMC, below the freezing level given the forecast?

RECOGNITION: A safe flight depends on conditions improving as forecast and cloud.

a. What is your plan to get up to date METARS or other weather information? On line? Phone ahead before departure? Web cams?

b. Can you check destination conditions en-route? How does this fit in with your wider communications plan?

c. Where and when are your decision points on the route if conditions become unsuitable to continue?

RECOVERY: At each decision point you MUST have planned actions for the eventuality that the weather does not improve or is unsuitable on your route. Given the forecast, it is likely that the best weather will always be behind you and away from the SE.

a. Can you delay departure until you are certain that conditions are suitable along your entire route?

b. Do you have diversion information for appropriate airfields away from the greatest fog / mist and low cloud risk?

c. Have you planned alternative routes to these diversions from each decision point?

e. **Summary**

The main concern in this spring high pressure situation is how quickly the early mist/fog will clear and the variability of low cloud from the weakening cold front. Having analysed the situation, it seems the worst of the conditions are located to the south-east of the UK and may persist until midday. Cloud base is set to be around 2000-3000ft with visibility greater than 10km (after 09Z). However, the anticyclone is likely to trap low level moisture and there is a risk of low level cloud until midday. Do you really have to go at 0800UTC? Consider the duration of your flight, weather improvement times and the length of remaining daylight and good conditions.

The flight should only be started once you are confident that en-route conditions are safe and you should make regular checks on conditions at the destination before continuing past planned decision points. You must *always* have an alternate plan for unsuitable conditions AND PUT IT INTO ACTION AT THE FIRST SIGN OF DETERIORATION.

Section J

Airworthiness Appendices

Appendix 1 - Airworthiness Scope Definition

1.1 The scope of the Onshore Helicopter review was defined around the following considerations:

a. Operational sectors, Commercial Air Transport (CAT), Part NCC (Non-Commercial flights in Complex Power Helicopters) and SPO (Specialised Operations);

b. The types of helicopters that may be engaged in the activities defined above;

c. A review of the Certification Specification Development (CS) and the Certification Basis for the current types operated within the sector;

d. Future Regulatory changes, affecting operations and the types of helicopters operated;

e. A review of AAIB accident reports from 2003 – 2017 focusing on the Technical, Design and Maintenance elements of the reported events;

f. A review of the Mandatory Occurrence Reports (MOR) submissions for the sector, including four mini 'Deep Dive' reviews that had been completed as part of industry engagement;

g. A review of Airworthiness Directives and Service Bulletins issued from 2003 – 2017 for the types operated within the Sector;

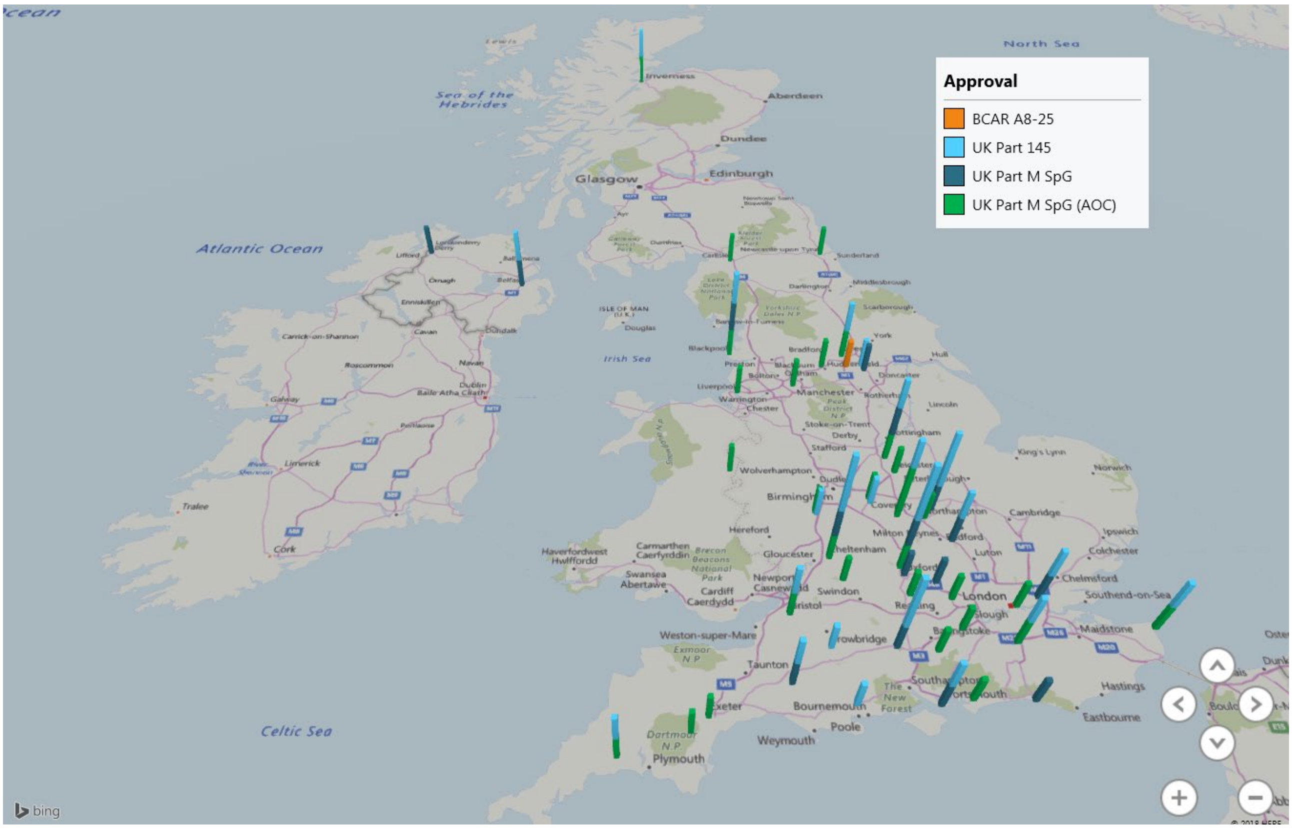
h. A review of CAA safety intelligence sources, including those that support Performance Based Regulation (PBR) and the Regulatory Safety Management System (RSMS);

i. CAP 1145, Offshore Helicopter Review, and where synergies may apply to either the operation or the helicopter types;

j. Industry engagement via the Maintenance Standards Improvement Team (A31) Onshore Helicopter working group and a survey distributed to airworthiness related organisations;

1.2 The Airworthiness organisations that were considered as part of the review; information in figure 1 summarises where the airworthiness organisations are positioned across the UK.

Figure 1 Onshore Helicopter Operators (AOC's), Part M and Part 145 Organisations



Appendix 2 - Airworthiness Abbreviation Definitions

Definition maybe referred to within the body of the airworthiness review:

Abbreviation	Definition
AAIB	Air Accident Investigation Branch.
A26	Action 26 from CAP 1145 - Review of Offshore Helicopter Operations. The CAA engage with offshore and onshore organisations periodically to review MOR's and how this relates to in-service technical difficulties.
A31	Action 31 from CAP 1145 - Review of Offshore Helicopter Operations. The CAA engaged with industry to improve maintenance standards.
AD	Airworthiness Directives are issued to address known unsafe conditions on aircraft where a safety deficiency is identified.
AMC	Acceptable Means of Compliance.
Certificate of Airworthiness	Certificate of Airworthiness is issued by the State of Registry to confirm that the aircraft meets the applicable type certification standards.
Certification Specification 27 (CS-27)	Certification is the process of ensuring that the helicopter meets all of the applicable airworthiness standards. CS-27 is the EASA requirements for certification of the design for small helicopters.
Certification Specification 29 (CS-29)	Certification is the process of ensuring that the helicopter meets all of the applicable airworthiness standards. CS-29 is the EASA requirements for certification of the design for large helicopters.
Complex Motor-Powered Helicopter	A helicopter certificated: a) for a maximum take-off mass exceeding 3175 kg, or b) for a maximum passenger seating configuration of more than nine, or c) for operation with a minimum crew of at least two pilots, or d) a tilt rotor aircraft
Non-Complex Motor-Powered Helicopters	Helicopters that are considered non-complex have the opposite criteria applied to Complex Motor-Powered Helicopters. E.g. Equal to or less than 3175 kg or maximum seating of nine or less.

Abbreviation	Definition
ECCAIR's	European Coordination Centre for Accident and Incident Reporting Systems Computer systems utilised for the storage, management and analysis of Mandatory Occurrence Reports (MOR's) across all EU Member States.
Entity	An organisation or individual considered as an independent group. E.g. AOC organisation – Flight Operations and Airworthiness approvals grouped together.
FAA	Federal Aviation Administration is the National Aviation Authority of the United States of America. It regulates all aspects of Civil Aviation with the USA.
GM	Guidance Material – Additional instructions in order to comply with regulations.
Helicopter	Helicopter a powered flying machine where lift and thrust is provided by rotors.
JAR-27	The Joint Aviation Requirements for certification of the design for small rotorcraft.
JAR-29	The Joint Aviation Requirements for certification of the design for large rotorcraft.
Maintenance Overflown	Aircraft have prescribed intervals (E.g. hours, cycles, calendar) for maintenance tasks to be completed in accordance with the approved maintenance programme. Maintenance overflown is a condition of when the maintenance task has gone beyond the prescribed limit.
MOR Grading	Mandatory Occurrence reports are graded on receipt by the CAA's Safety Data team. Grade A is the highest grade and is given to accidents. Grade E are not considered to meet the reporting requirements of EU regulation 376/2014.
Notice of Proposed Amendments	NPA is the method of circulating draft amendments for comment.
Part-21	The requirement defining the role and responsibilities of the type certificate holders and production organisations.
Part-145	The regulations for approval for organisations that carry out maintenance of aircraft and components used for commercial air transport.
Part-M	The regulations for approval of organisations which manage the continuing airworthiness of aircraft. This includes establishing the maintenance tasks to be carried out based on the manufacturer's instructions.
PEF	Primary Error Factor - a factor that is applied to each Mandatory Occurrence Report on receipt, allowing allocation to a specific capability for subject matter review.

Abbreviation	Definition
Rotorcraft	This terminology is used when making reference to a helicopter in terms of certification and design. The CAA also refers to its capability area as Rotorcraft Sector.
SB	Service Bulletin – an instruction issued by the Type Certificate (TC) holder or Supplementary Type Certificate (STC) holder to improve or address an issue with aircraft/helicopter. These can be optionally embodied or mandatory embodied when instructed by AD. In the latter these would normally be issued as an Emergency Alert Service Bulletin (EASB).
RFM	Rotorcraft Flight Manual - The instructions and limitation to which the pilot operates the helicopter within.
TCDS	Type Certification Data Sheet; the document that records the set of requirements that the aircraft type has been certificated against.
The Certification Basis	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.
UK BCAR	British Civil Airworthiness Requirements. The UK requirements used prior to the introduction of Joint Airworthiness and subsequently the EASA requirements.
Validation or Validating	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.

Appendix 3 – Onshore Helicopter Types and Certification References

TCDS	Type	TCDS Issue	Certification Basis	Amendment
EASA.R.005	A109	20	FAR 27	1 to 8
			FAR 29	Cat A engine ops
	A109SP	20	FAR 27	Ref. CRI A-1 Issue 3/4
			CS27	
	A109N	21	FAR 27	Ref.CRI A-1 Issue 5
			CS27	
EASA.R.008	AS 350/EC 130	11	FAR 27	1 to 10
	EC130B4/T2	11	JAR 27	1
EASA.R.105	AS 355	6	FAR 27	16
	AS 365 C1/C2/C3	4	FAR 29	1
	AS 365 N1/N2/N3	4	FAR 29	1 to 16
	EC 155 B	4	JAR 29	1
	EC 155 B1	4	JAR 29	1
EASA.R.006	AW 139	2	JAR 29	3
EASA.R.509	AW 169	8	CS-29	2
EASA.R.510	AW 189	8	CS-29	2
EASA.R.140	AB 206	3	CAR 6	6-1 through 6-4 CAR 6.307 (b) and 6.637 of Amdt. 6-5
EASA.IM.R.512	Bell 206/B/L/L-1/L-3	2	CAR 6	6-1 through 6-4 CAR 6.307 (b) and 6.637 of Amdt. 6-5
	Bell 206 L-4		FAR 27	Amdt 27-1 to 27-24
	Bell 407		FAR 27	Amdt 27-1 to 27-30
EASA.IM.R.106	Bell 212	2	FAR 29	Amdt. 29-1 and 29-2
	Bell 412		FAR 29	Amdt. 29-1 and 29-2
EASA.IM.R.506	Bell 429	2	CS 27	Amdt.1
EASA.IM.R.122	Enstrom F28/C/C-2/F/F-R/F-X	4	As per compliance with Part 6 of the Civil Air Regulation effective 20 December 1956, as amended by 6-1 through 6-5 and included in the original Type	N/A

TCDS	Type	TCDS Issue	Certification Basis	Amendment
			Design Standard	
	Enstrom 480/B		FAR 27	Amdt. 27-1 through 27-23
	Enstrom 280C/F		As per compliance with Part 6 of the Civil Air Regulation effective 20 December 1956, as amended by 6-1 through 6-5 and included in the original Type Design Standard	N/A
EASA.R.508	Eurocopter EC 120B	3	JAR 27	1
EASA.R.508	Eurocopter EC135P1 (CDS/CPDS) P2 (CPDS) P2+/T1(CDS/CPDS)	14	JAR 27	1
	Eurocopter EC135P3/P3H		JAR 27 CS27	1 Amdt.2
	Eurocopter T1(CDS/CPDS) T2 (CPDS) T2+		JAR 27 JAR 29 (supplements)	1 1
	Eurocopter EC135T3/T3H		JAR 27 CS27	1 Amdt.2
EASA.R.010	MBB BK117 A-1/A-3/A-4/B-1	15	FAR 29	Amdt.29-1 through 29-16
	MBB BK117 B-2/C-1		FAR 29 JAR 29	Amdt.29-1 through 29-16 1st issue
	MBB BK117 C-2		FAR 29	Amdt.29-1 through 29-40
	MBB BK117 C-2e/D-2/D-2m		FAR 29 CS29	Amdt.29-1 through 29-40 Amdt.2
EASA.R.011	MBB Bo 105 A	3	FAR27	Amdts. 27-1 through 27-3
	MBB Bo 105 C/CB-4/CB-5/CS/CBS/CBS-5/CBS-5		FAR27 JAR29 (CB-4/5)	Amdts. 27-1 through 27-3 first issue

TCDS	**Type**	**TCDS Issue**	**Certification Basis**	**Amendment**
	MBB Bo 105 D, DS, DB, DBS, DB-4, DBS-4, DBS-5		FAR27 JAR27	Amdts. 27-1 through 27-3 1
EASA.R.145	Guimbal Cabri G2	8	CS 27	CRI A-01
	MD Helicopter MD900			
EASA.IM.R.120	Robinson R22/Alpha/Beta/Mariner	4	14 CFR Part 27	Amdts. 27-1 through 27-10
EASA.IM.R.121	Robinson R44	6	14 CFR Part 27	Amdts. 27-1 through 27-24
EASA.IM.R.507	Robinson R66	2	CS27	Amdt.2
EASA.IM.R.113	S76A/B/C	3	FAR29	Amdt. 29-1 through 29-11
	S76D		CS29 FAR29	Amdt.2 Amdt.29-1 to 29-32
EASA.IM.R.001	S92A	7	JAR29	1
EASA.IM.R.131	Schweizer 269A/B/C	1	CAR Part 6	Amdts. 6-1 through 6-7 and 6-8
	Schweizer 269C-1/D/D Configuration A		CAR Part 6 FAR27	Amdt.27-2

Appendix 4 to Chapter 8 - AAIB Accident Review

Introduction

1.1 The scope of review defined that accidents from 2003 – 2017 where the AAIB had conducted an investigation should be considered. The data review concluded that 143 reportable accidents were within the scope of the review. These accident reports were allocated to the Flight Operations and Airworthiness teams within the CAA based on their allocated ICAO CICTT Taxonomy allocation. The team within Airworthiness considered 43 reports within the period to be within scope, based on the helicopter types and the event types. 100 reports were considered non-airworthiness related, these being either operational, unknown cause, or in some cases still under investigation.

1.2 The 43 reports were subjected to a detailed review by the airworthiness team, this focussed on ensuring the root cause was accurate and where there were actions and recommendations made that the statuses of these were fully understood.

1.3 The ICAO CICTT taxonomy, despite its levels of breaking down reports, benefitted from further analysis of the narrative content with consideration for placing the Root Causes of these events into that more aligned with that utilised for the analysis of MOR's. Benefits from using this methodology allowed the review to focus more specifically on the area of causation, whether this be Airworthiness Management, Design, Maintenance or Production / Manufacturing issue.

1.4 The objective of the accident review was to identify any trends, be these by helicopter type or cause. Consideration was given to the small size of the data set and the ability to draw trends or conclusive insights.

1.5 CAP 1145 recommended that the CAA's management systems be reviewed to ensure that all accident actions and recommendations have been addressed were embedded within business as usual processes currently applied. This review has captured the requirement set out in CAP 1145.

1.6 As a consequence of the airworthiness related accidents there were a total of 10 fatalities, 6 were crew and 4 were passengers.

1.7 **Accident Trends - Airworthiness**

By Root Cause

Given the size of the data set there was limited ability, and value in trying to establish whether any trend exists within the accident reports reviewed. The causation was allocated to one of the following areas to establish if there were any high-level trends:

1) Airworthiness Management – Continuing Airworthiness management including the provision of Maintenance Programme Management (M.A.708).
2) Design – Initial Design, including the responsibilities of the Design Organisation (Part 21).
3) Maintenance – The provision of maintenance support under Part 145 approvals, including the training.
4) Production – Manufacturing and production of components to support initial build or through life support of the helicopter and engines within scope of the review.
5) Unknown – Where the investigation could not readily identify the primary cause of the event.

1.8 Figures 1 defines the breakdown of the AAIB reportable events where an Airworthiness element was considered to have been either the root cause or a causal factor.

Figure 1 2003 – 2017 AAIB Reportable Accidents – Root Cause by Primary Factor

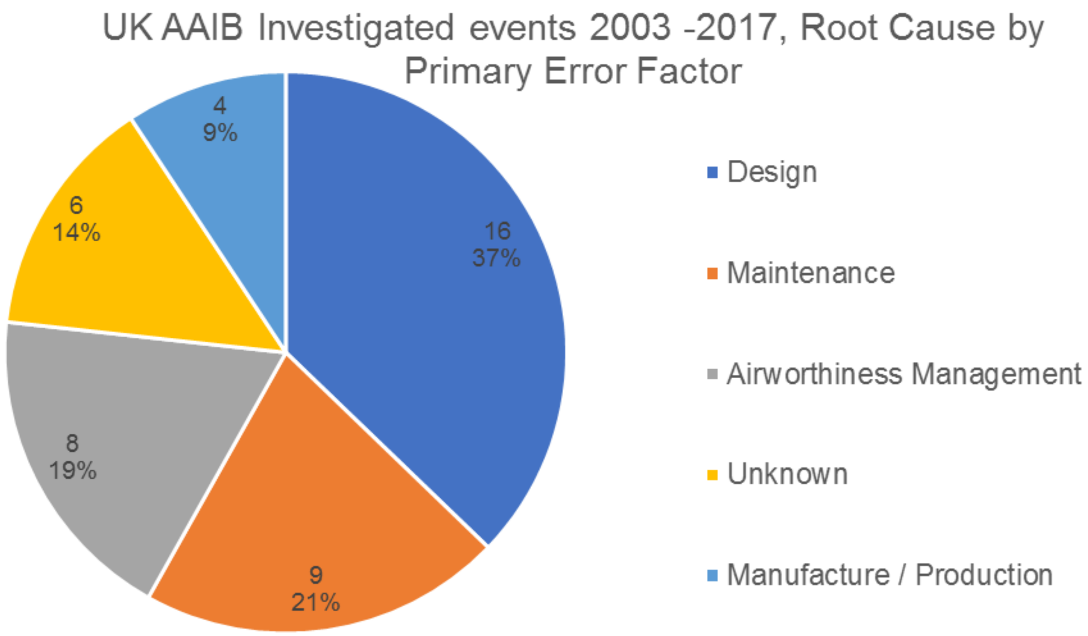
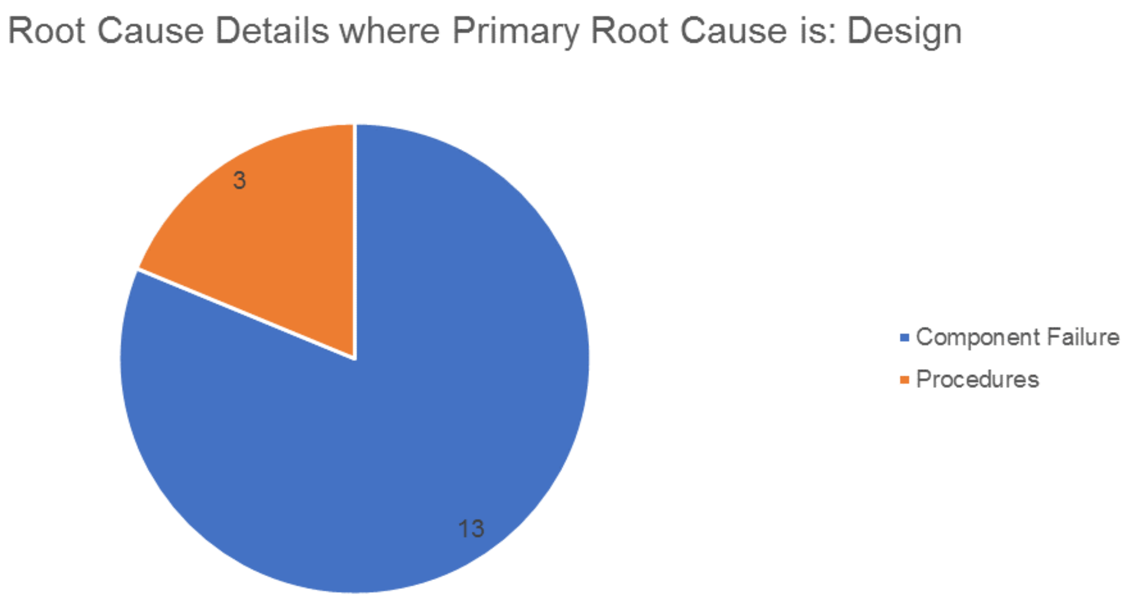


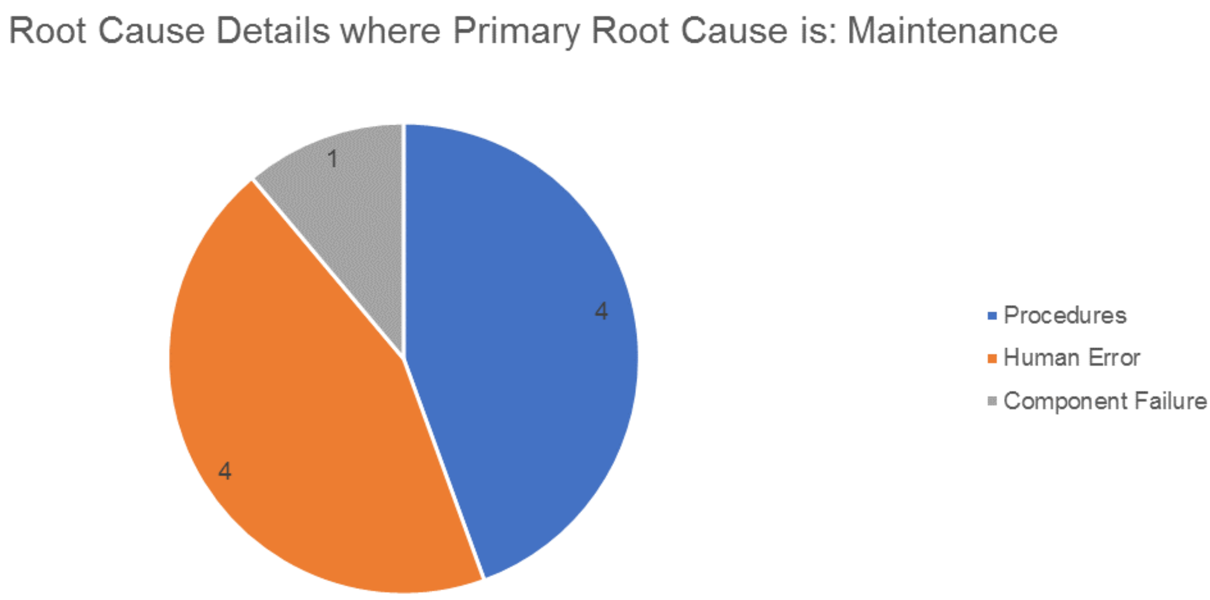
Figure 2 2003 – 2017 AAIB Reportable Accidents – Root Cause is Design



1.9 Sixteen (16) of the 43 accidents, figure 2, were attributed to design related root causes. These were further broken down with thirteen (13) of the events being caused by component failure and three (3) being caused by procedural failings. The sixteen events were spread across a number of helicopters types with the highest number being attributed to the Robinson types. No adverse component failure trend was identified however it was noted that in most cases the component related to a critical system, i.e. main rotor system, tail rotor drive or engine (in the case of single engine types). One (1) of the reported events resulted in the failure of the horizontal stabiliser that was subject of an Airworthiness Directive and was the subject of a 50-flight hour repetitive inspection. Following the event, the Type Certificate Holder reduced the inspection by 50% suggesting that the calculated crack propagation rate, to component failure, was outside of the previous inspection interval. One (1) engine related event resulted in the inflight failure of a turbine bearing (Critical Component) on a single engine helicopter which due to its operating outside of the operator's permissible limits, did not allow a successful autorotation to be entered. The three (3) events where it was noted a failing of procedures related to, one (1) event that resulted in a main gearbox seizure which could be attributed to a lack of technical procedures. In this case the torque loading was not defined by the Type Certificate holder, resulting in engineers using an unapproved method to remove a blanking plug, with the resultant being the induction of a foreign object to the oil system. Subsequently a bearing was starved of oil due to disrupted oil flow and starvation. The two (2) other events result in amendment to the Instructions for Continuing Airworthiness in the application of additional instructions for completing torque checks.

1.10

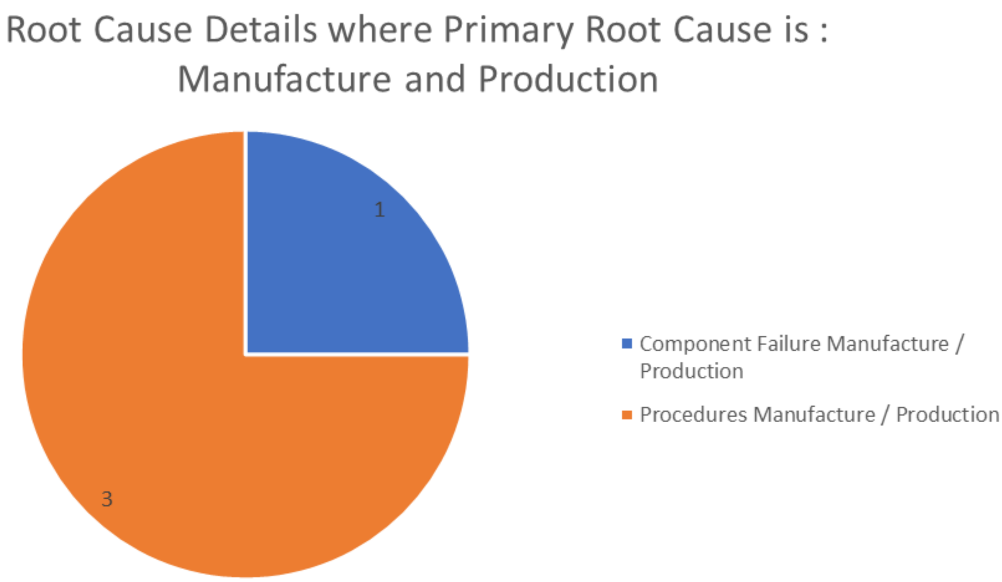
Figure 3 2003 – 2017 AAIB Reportable Accidents – Root Cause is Maintenance



1.11 Nine (9) Maintenance related events, figure 3, contributed to the 43 accidents that were reviewed. These events we further broken down to failings to follow procedures and human error. Four events related to incorrect installation of a component during maintenance activity. These events relate to the incorrect installation of a main rotor drive link (1), a main rotor head (1), a hydraulic component (1) and engine to main gearbox drive shaft coupling (1). Two other events of interest, (1) related to the insecurity of engine cowlings by the flight crew, resulting in the cowl contacting the main rotor blades in flight. In this case the crew had been distracted during their pre-flight inspection. One (1) event was the consequence of the pilot undertaking a repair to the wiring of the main gearbox magnetic chip detector system. The failure of the repair resulted in no indication being given during the failing of a bearing due to lack of lubrication.

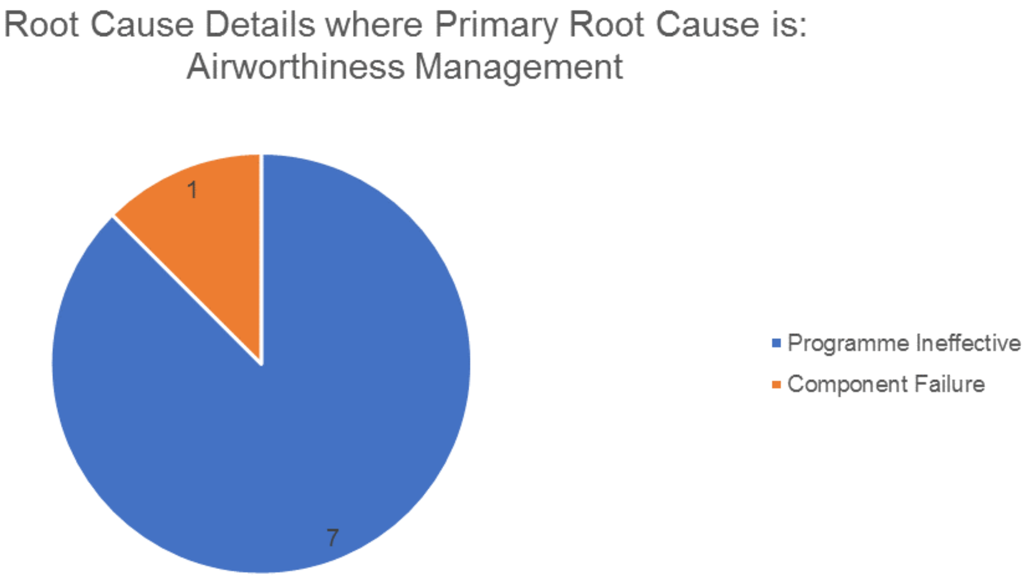
1.12 In consideration of improving maintenance standards; the CAA currently has an action in progress from the review of Offshore Helicopter Operations as detailed in CAP1145. Action 31 encompasses CAA engagement with industry to improve maintenance standards through a number of workstreams including competence assessment, procedures writing and other guidance material for the benefit of industry.

Figure 4 2003 – 2017 AAIB Reportable Accidents – Root Cause is Manufacture and Production



1.13 Four (4) events, figure 4, were assigned to Manufacture and Production Primary Error Factor (figure 4). Three of these events were because of the incorrect procedures being applied. These including incorrect manufacturing of a freewheel component resulting in its failure in flight, incorrect torque procedure being applied during manufacturing process, and the incorrect procedure being applied during the manufacturing process of a main rotor blade. One (1) event resulted in the failure of a pedal trim actuator that was most likely caused by anomaly in the heat treatment process during manufacture.

Figure 5 2003 – 2017 AAIB Reportable Accidents – Root Cause is Airworthiness Management



1.15 Eight (8) Airworthiness Management events contributed to the 43 events that were reviewed (figure 5). Seven events (7) related to the ineffectiveness of the maintenance programme. Of these seven events one (1) event resulted in the structural failure of the Tail Rotor Gearbox mounting, whilst the other one (1) event resulted in the failure of an engine compressor assembly, due the aircraft operating in a saline environment without the correct Original Equipment Manufacturers (OEM's) maintenance schedule being applied. Further events resulted in the failure of a tail spar, undercarriage cross tube, tail rotor drive shaft bearing, drive belts and spark plugs. The one (1) event of component failure was assigned as the component was on condition and failed following the aircraft having been imported from Japan where it had been stored for a prolonged period without any operations or maintenance.

1.16 Five (5) events were assigned to unknown. These events all resulted in component failure, but it was not possible to formally assign a root cause to these events.

1.17 **Accident Trends - Airworthiness**

By Helicopter Type

The airworthiness review of the accidents from 2003 – 2017 also focussed on whether there were any trends that could be associated with the types of helicopters included within the scope of the review.

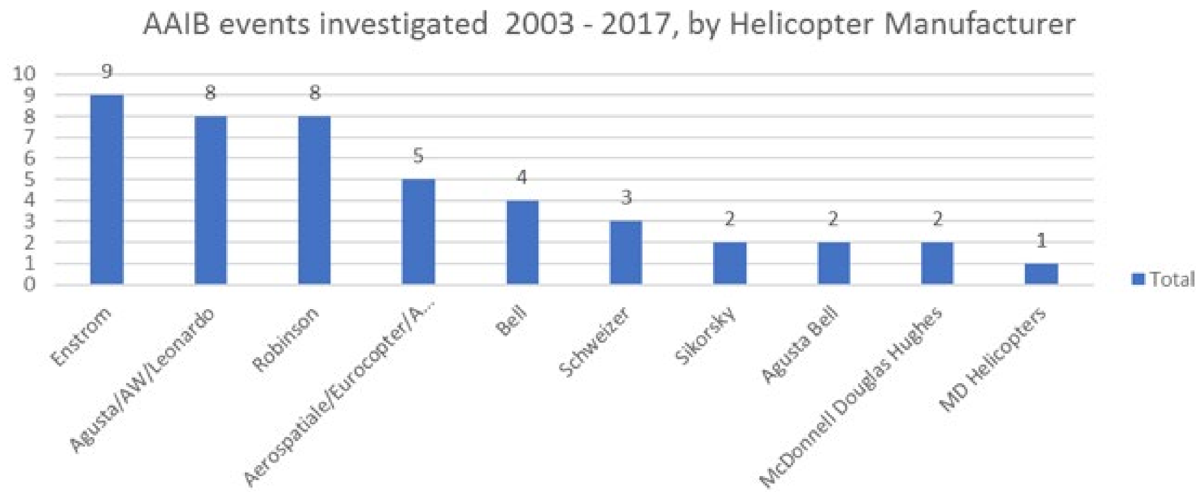
To produce a consolidated prospective, given the size of the data set, each event was grouped against the respective Type Certificate Data Sheet, rather than against an individual type. i.e. A109A and A109SP were grouped against the A109.

To provide a consolidated picture, given the diversity of the types involved in the review, a breakdown is provided by manufacturer, figure 6.

1.18 In terms of events investigated, by manufacturer the top three comprised of non-complex and complex types;

1) Enstrom – 9 events
2) Agusta – 8 events
3) Robinson – 8 events

Figure 6 2003 – 2017 AAIB events investigated, by helicopter manufacturer

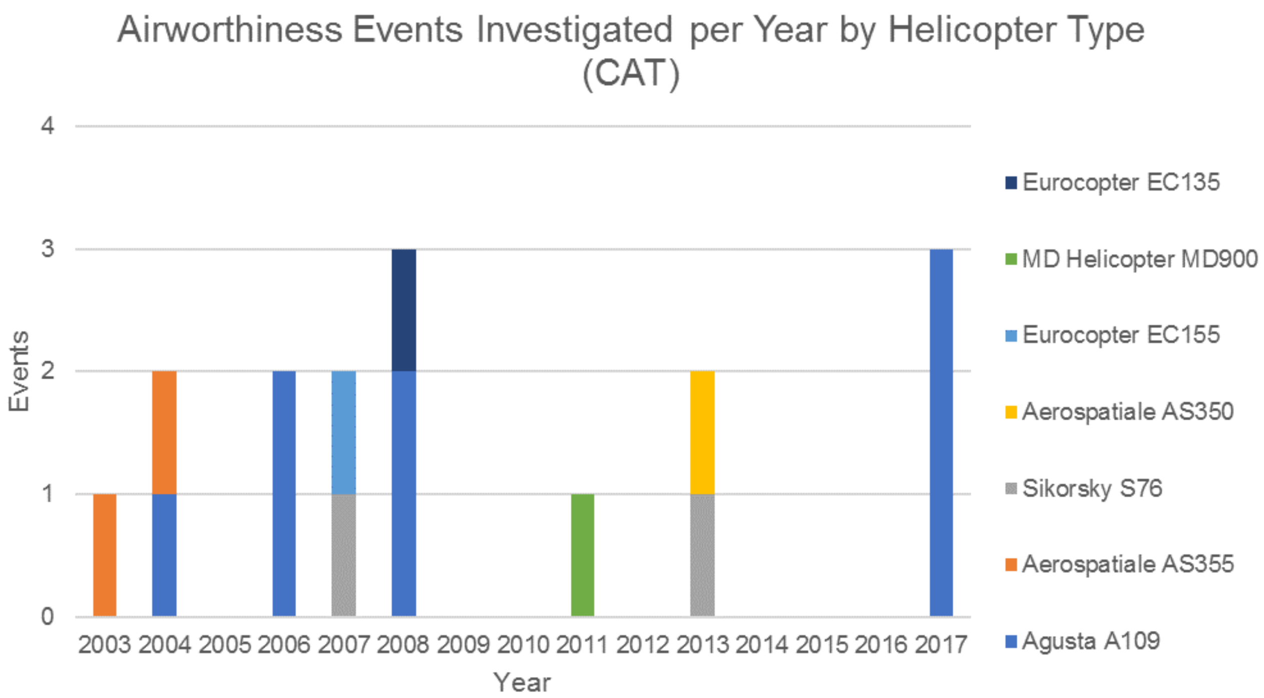


1.19 To produce a more detailed, understanding of event investigations, by type, year on year, the types were broken down to complex and non-complex types. Of the events investigated, sixteen (16) of the 43 involved a complex type helicopter. These types are generally more likely to be used for CAT, Part NCC or SPO operations. The top 3 helicopters involved were:

1) Agusta/Agusta Westland/Leonardo A109 – 8 events
2) Aerospatiale AS355 – 2 events
3) Sikorsky S76 – 2 events

1.20 Figure 7 highlights the number of events per year by type for the turbine engine types that are likely to be used for CAT, Part NCC and SPO operations.

Figure 7 2003 – 2017 AAIB events investigated - CAT, Part NCC, SPO types (Turbine Engine)



1)

1.21 The remaining twenty-seven (27) events of the 43 were deemed to be on non-complex types. These types are in general used for non-commercial type operations and would normally be overseen by the CAA's General Aviation Unit. The top three included three types being joint 1st with 5 events each:

1) Enstrom 280 - 5 events
2) Robinson R22 – 5 events
3) Bell 206 – 5 events
4) Enstrom F28 – 4 events
5) Hughes/Schweizer 269 – 3 events
6) Robinson R44 – 3 events

1.22 Figure 8 highlights the number of events per year by type for the non-complex types that are likely to be used for Non-Commercial operations and General Aviation.

1.23 2 accidents, in 2003 and 2005 made recommendations regarding the introduction, development and mandating the use CVR and FDR's. These included:

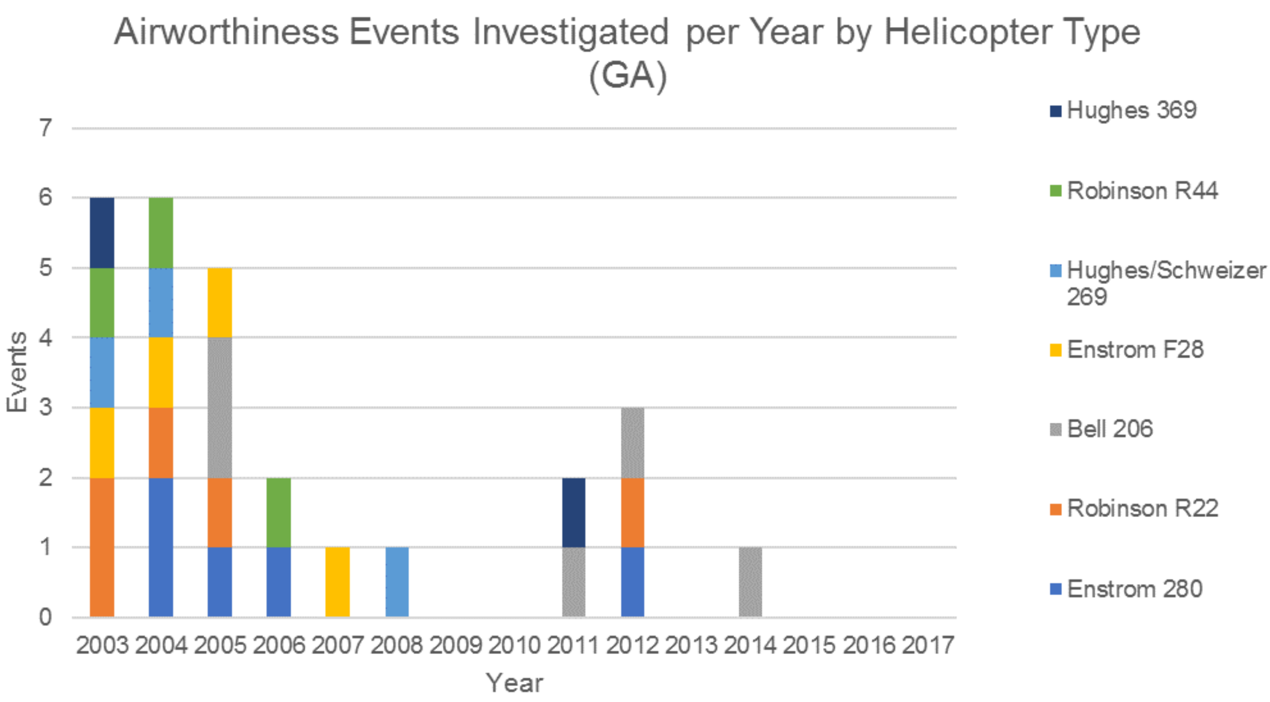
1) Department for Transport should urge ICAO to promote the safety benefits of fitting, as a minimum, cockpit voice recording equipment to all aircraft operating with a Certificate of

Airworthiness in the Commercial Air Transport category, regardless of weight or age.

2) The Department for Transport should urge the International Civil Aviation Organisation (ICAO) to promote research into the design and development of inexpensive, lightweight, airborne flight data and voice recording equipment.
3) The European Aviation Safety Agency (EASA) should promote research into the design and development of inexpensive, lightweight, airborne flight data and voice recording equipment
4) The European Aviation Safety Agency should promote the safety benefits of fitting, as a minimum, cockpit voice recording equipment to all aircraft operated for commercial air transport, regardless of weight or age.

1.24 It is noted the Department for Transport accepted the recommendations made in a letter dated 14th October 2004. The CAA has engaged with EASA regarding strategic plans on the installation of CVFDR on 'small rotorcraft'.

Figure 8 2003 – 2017 AAIB events investigated, NCC, SPO Piston Engine Helicopters (Non-CAT/GA)



1.25 The size of each of these fleet was considered to make comparable assessments of the accident rate based on fleet size. The report acknowledges that to make a more accurate assessment, of accident rates, flight hours would ideally be used as the factor. Given the diversity of the onshore review it is not possible to gain an accurate picture of the utilisation for the onshore fleet from the CAA's existing data bases.

1.26 **CAA and Type Certificate Holder responses to accidents**

The accidents within the review were analysed to look at the specific actions placed on the CAA and the Type Certificate Holder. Table 1 summarises the accidents and the associated actions and recommendations.

1.27 Since the issue of CAP 1145 the CAA has reviewed its management systems and processes. One element of the review has been the introduction of a revised CAA MOR review process. The process in place, ensures that MORs received are subject of a technical review and assessed on a weekly basis. Events that are considered to meet the criteria of an 'Unsafe Condition' are now communicated with EASA. Two (2) events in 2017 resulted in the Type Certificate Holder responding to events deemed to meet the criteria of 'Unsafe Condition'. In both cases the CAA were involved directly with EASA and the operators to ensure all information was made available in the most expedient manner.

1.28 A further review of the accident data focused on specific reaction of the type certificate holder as required by Regulation (EU) No 748/2012. 21.A.3A Failures, Malfunctions and Defects requires the holder of a type certificate, restricted type certificate, supplemental type certificate, European Technical Standard Order (ETSO), major repair design approval to collect, analyse reports of and information related to failures, malfunctions, defects or other occurrences which might cause adverse effects on the continuing airworthiness of the product, part or appliance. The review included an analysis of actions taken by the Type Certificate Holder in response to the events.

Table 1 2003 – 2017 AAIB Reportable Accidents – CAA and Type Certificate Holder Actions/Recommendations

Aircraft Registration	Helicopter Type	AAIB Bulletin No.	CAA recommendations	CAA recommendations status	Type Certificate Holder Action
G-LEDA	Robinson R22	1/2004	None	N/A	
G-ODNH	Hughes/Schweizer 269	8/2004	None	N/A	
VH-ZZ	Robinson R22	200302820 (Australian)	None	N/A	
G-KAZZ	Robinson R44	1/2004	None	N/A	
G-BXXW	Enstrom F28	6/2004	None	N/A	
G-XCEL	Aerospatiale AS355	7/2006	None	N/A	Yes
G-LOGO	Hughes 369	11/2004	None	N/A	
G-BYKF	Enstrom F28	4/2004	None	N/A	
G-HIMJ	Agusta A109	5/2005	None	N/A	
G-TASS	Hughes/Schweizer 269	10/2004	None	N/A	
G-BRPO	Enstrom 280	1/2005	None	N/A	
G-FFRI	Aerospatiale AS355	10/2005	None	N/A	
G-ECHO	Enstrom 280	2007/28 (Norwegian)	None	N/A	
G-IVEN	Robinson R44	2005/024 (AAIU)	None	N/A	Revised installation procedure be issued
G-DERB	Robinson R22	8/2005	None	N/A	
G-MHCK	Enstrom 280	10/2005	None	N/A	
G-BBHE	Enstrom F28	2006/014 (AAIU)	None	N/A	The manufacturer should revise SDB0076 with a view to stipulating that the SDB should be carried out at the aircraft annual inspection if it has not been carried out since the previous annual inspection. (SR 05 of 2006) The FAA should consider an amendment to AD 88-11-06 with a view to stipulating that the AD should be carried

Aircraft Registration	Helicopter Type	AAIB Bulletin No.	CAA recommendations	CAA recommendations status	Type Certificate Holder Action
					out at the aircraft annual inspection if it has not been carried out since the previous annual inspection.(SR 06 of 2006)
G-CVIP	Bell 206	2/2006	None	N/A	
G-CBPT	Robinson R22	4/2006	None	N/A	
G-WLLY	Bell 206	12/2006	Yes*	Closed*	
G-CGRI	Agusta A109	11/2006	None	N/A	The helicopter manufacturer has amended the maintenance manual for the A109S to introduce torque loading figures for the trunnion flange caps. It also issued an Alert Bulletin **(BT 109S-2 issued)** to instruct operators to inspect the tail-rotor trunnion for any damage and correct installation of the flange caps. **EASA AD 2006-0120-E issued 15/05/2006**
G-VVWW	Enstrom 280	4/2007	None	N/A	
G-DNHI	Agusta A109	12/2007	None	N/A	
G-CEFR	Robinson R44	10/2007	None	N/A	
G-ISSV	Eurocopter EC155	11/2007	None	N/A	Yes **Safety Recommendation 2007-072** It is recommended that Eurocopter modify the method of sealing the hoist connector '24 DELTA' on EC155 aircraft, to ensure that it is effective in preventing moisture ingress into

Aircraft Registration	Helicopter Type	AAIB Bulletin No.	CAA recommendations	CAA recommendations status	Type Certificate Holder Action
					the connector. **Safety Recommendation 2007-073** It is recommended that Eurocopter determine the most appropriate orientation for mounting the EC155 hoist fixed connector to minimise its susceptibility to shorting from moisture ingress **Safety Recommendation 2007-074** It is recommended that Eurocopter provide a suitable means to flight crew to allow them to switch off the 28 volt DC power supply to the hoist connector '24 DELTA' on EC155 helicopters
G-WSEC	Enstrom F28	2008/017 (AAIU)	None	N/A	
G-DPJR	Sikorsky S76	4/2009	None	N/A	
G-TAMA	Hughes/Schweizer 269	8/2008	None	N/A	
EI-SBM	Agusta A109	2009-018	None	N/A	
G-ELTE	Agusta A109	1/2010	None	N/A	
G-CCAU	Eurocopter EC135	1/2010	None	N/A	
G-PTOO	Bell 206	7/2011	None	N/A	
G-KSWI	Hughes 369	2/2012	None	N/A	
G-CEMS	MD Helicopter MD900	5/2012	None	N/A	
G-OJMF	Enstrom 280	9/2012	None	N/A	

Aircraft Registration	Helicopter Type	AAIB Bulletin No.	CAA recommendations	CAA recommendations status	Type Certificate Holder Action
G-SUEZ	Bell 206	1/2013	None	N/A	
G-BTHI	Robinson R22	2/2013	None	N/A	
G-XXEB	Sikorsky S76	1/2014	None	N/A	The helicopter manufacturer is in the process of issuing a Sikorsky Safety Advisory, and a Rotorcraft Flight Manual revision, to inform operators of the symptoms of a PDTA fault and actions to be taken by the crew.
G-JESI	Aerospatiale AS350	12/2013	None	N/A	
G-SUEX	Bell 206	1/2016	None	N/A	
G-PBWR	Agusta A109	9/2017	None	N/A	Airworthiness Directive
G-HLCM	Agusta A109	11/2017	None	N/A	Emergency Airworthiness Directive
G-IWFC	Agusta A109	6/2018	None	N/A	

1.29 AAIB Bulletin 12/2006 made 1 Safety Recommendations to the UK CAA:

Safety Action 2006-039
It is recommended that the United Kingdom Civil Aviation Authority require a one-off inspection, within a reasonable timescale, of the vertical fin supports of all Bell and Agusta-Bell 206 series helicopters on the UK register. The inspection should be conducted with the fin removed to obtain adequate access.

1.30 The UK CAA responded to the recommendation with CAA Response (F49/2006).

The CAA accepted the AAIB recommendation for a one-off inspection of the Bell and Agusta-Bell 206 series helicopters on the UK register insofar as this supports the AAIB's need to gather information to assist the next 100-hour maintenance input. The LTO will leave the inspection to be at the operator's discretion since it is the responsibility of Transport Canada and EASA to determine whether the inspection should be made mandatory.

1.31 The Recommendation was received in February and the Letter to Operators (LTO) was subsequently published in June 2006.

Appendix 5 MOR Review

MOR Review

Introduction

1.1 The MOR requirements have been in existence since 1976 and has developed over years to the latest requirement in EU376/2014, supported with further guidance in EU2015/1018. The objective of the regulation is to improve aviation safety by ensuring relevant safety information is reported, collect, stored, protected, exchanged, disseminated and analysed.

1.2 MOR's are assigned to a Primary Error Factor, of which Airworthiness related MOR's are assigned to three Primary Error Factors (PEF), these being Design & Manufacture, Maintenance and Technical Malfunction. In some cases, reports received are classified as Not Assessable, or No Fault. Some of these MOR's, in the case of this review, have been included in the overall data set but have not been subject to review.

1.3 Each MOR is graded A - E on receipt based on the severity and probability. This work is undertaken internally by the CAA, who deal with increasing number of MOR's annually. In 2017 31,000 reports, across all capability areas were received by the UK CAA. The development and continuous improvements of this process are discussed later within this section.

1.4 All Design & Manufacture and Maintenance reports have been subject of detailed narrative review to allow a root cause to be allocated. The root causes have been grouped into four key areas, these being:

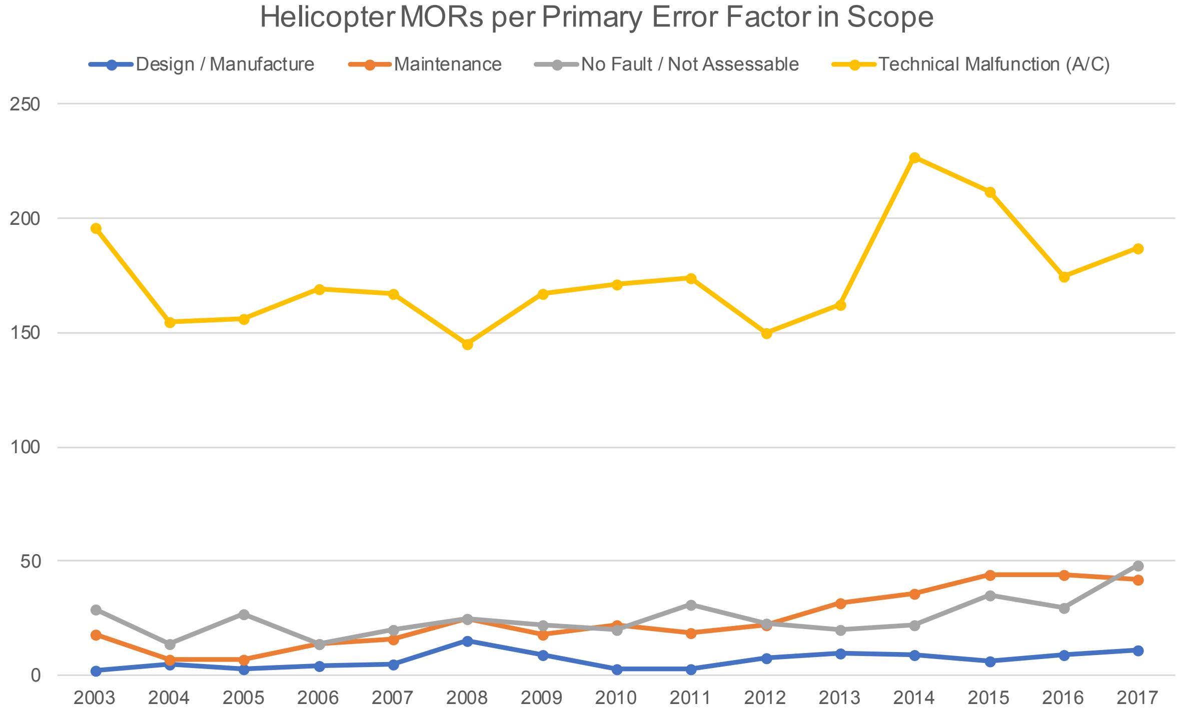
(a) Relationships and Communications
(b) Type Certificate Holder and OEM Support
(c) Maintenance Standards and Human Performance (Human Factors)
(d) Airworthiness Management

1.5 Each of these four key areas has been further broken with a taxonomy that provides further clarity of the causal factor. During the review of each MOR, where possible, allocation has been made to one of the key areas and its lower level taxonomy. Where the cause is unclear, the report has not been allocated. The purpose of this exercise was to understand where the significant issues are in relation to the MOR submissions.

1.6 Following the issue of CAP 1145 the CAA recommended, via Action 26 (A26) that they would continue to engage with offshore operators on the submission of MOR's and their relationship to in-service difficulties and reliability data to establish a complete risk picture. As part of the engagement with the Onshore Helicopter A31 working group, the CAA has extended the initiative to understand whether there are any benefits of the A26 workstream, specifically given the onshore helicopter types, in most cases are not required to have any reliability reports.

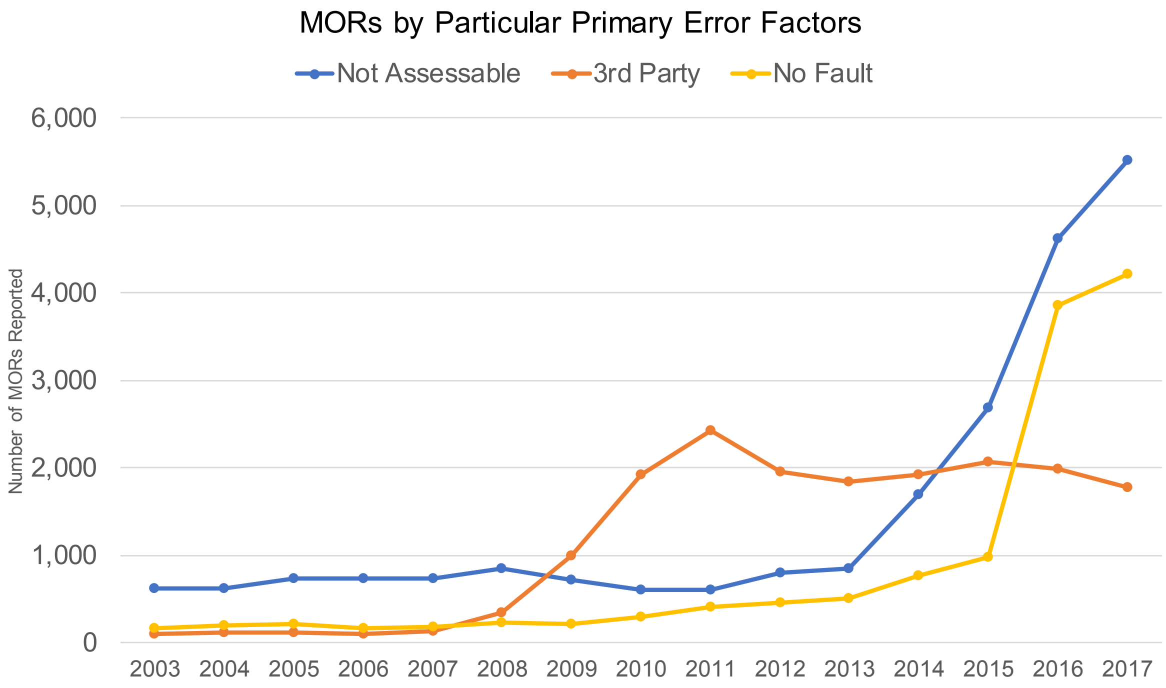
1.7 Primary Error Factors are assigned to each MOR on receipt from industry and are in general consistent in their proportionality whether looking at Fixed Wing operations or Rotorcraft operations. It would be expected that, out of the reports assigned one of the three airworthiness PEFs, c.70% of reports would be allocated to Technical Malfunction factor, whilst 20% would be assigned to Maintenance and 10% to Design.

Figure 1



1.8 Not Assessable, No Fault/ 3rd Party reports over the period have shown some explainable increases. Figure 2 shows an increase in the level of 3rd party reports from 2008. These mainly related to the number of reported laser attacks on aircraft. The increase in “Not Assessable” and “No Fault” MORs suggests that the new reporting regulations have caused an increase in the reporting of the type of events which are not easy to analyse.

Figure 2



Design and Manufacture

1.9 During the review period 102 (3%) reports of the 3,461 reports were allocated to design. Recognising this is a relatively small number, 5 key factors could be assigned from the review.

a) The largest number of reports (39) related to production standards, Production standards whereby component and helicopters had been received with defects from the manufacturer. There was no common theme within these reports and these were generally spread across multiple organisations.
b) (18) reports could be attributed to the failure of the Type Certificate Holder or OEM to analyse and respond to in-service events. The reporter noted that these events had previously occurred and had been reported to the manufacture.
c) Relating to Production Standards and Issues (14) reports could be attributed to incomplete maintenance, maintenance (production)

errors and break in task. Typically, these events included incorrect assembly, incorrect part being fitted. In many cases these were contributed to by ambiguities in maintenance data.

d) Critical or Life Limited part failure, due to either poor design or non-conformity to design data was the 4th largest number of reports. (10) events were reported where a critical part had degraded outside of permissible limits and it was found that either a redesign of the component was required, or it was due to a non-conformity during either the manufacturing or assembly process. Of the 10 reports received no trends could be identified and the reports were spread across aircraft types.

e) A small proportion (4) of the design reports could be assigned to the provision of Instructions for Continued Airworthiness (ICA). Reporter noted that there were no instructions to carry out the activities required resulting an individual making an error in their actions. It is noted that there were also several events where the reporter suggested instructions contributed to the individual making an error.

1.10 The number of design related reports are low, and the main area of focus would be on the poor production and maintenance errors. Over 50% of the design reports relate to this area. One other area of concern, albeit not the highest number of events, are the 10 reports that relate to the failure of a critical component. These failures have the potential cause unsafe conditions that lead to a lower of safety standards.

Maintenance

1.11 Maintenance reports were the 2nd largest sub-set of MOR's over the reporting period with 366 (11%) being allocated the PEF. Each of the maintenance reports was reviewed by a Subject Matter Expert to understand the narrative and allocate to a more detailed taxonomy. Given the higher number of reports allocated to the Maintenance PEF it was easier to highlight some more significant trends. The top 5 causal factors are as follows.

a) Maintenance Standards causal factors contribute to 3 of the top 5 number of reports within the Maintenance PEF, a total of 216 (60%) reported events. 174 events were allocated to incomplete maintenance, maintenance error, break in task. Typically, these involved incorrect installation, parts not installed, and un-secured panels. The 3rd the highest number of reported events (23) could be attributed to resource competence. Events relating to competency involved personnel knowingly carrying out the incorrect actions, examples include unauthorised repairs and the use of unapproved, household wiring, to repair GPS system. The 5th highest number of reported events related to organisations working outside the scope of their approvals. The events include both Part 145 and Part M organisations. Examples include the maintenance of components without the approved capability and the issue of ARC's without the type being on the organisation's approval.

b) Continued Airworthiness Management represented the 2nd highest number of reported maintenance MOR's. 82 reports were deemed to be caused by poor maintenance programme/continued airworthiness management, leading to maintenance being overflown. Other events related to the acceptance of the incorrect parts being installed and subsequently being identified by the continuing airworthiness management organisation. To understand fully the extent of maintenance being overflown, each overfly event was analysed in more detail to establish what type of maintenance event was overflown and where possible by what amount. Figure 3 shows the type maintenance events overflown. Figure 4 shows the rising trend in the number of reported events relating to Airworthiness Management activities.

Figure 3

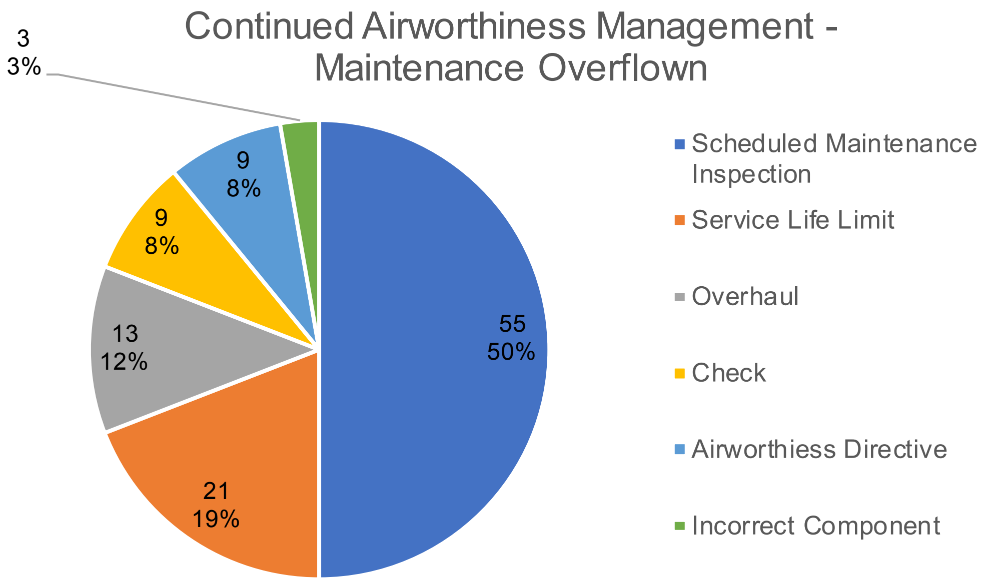
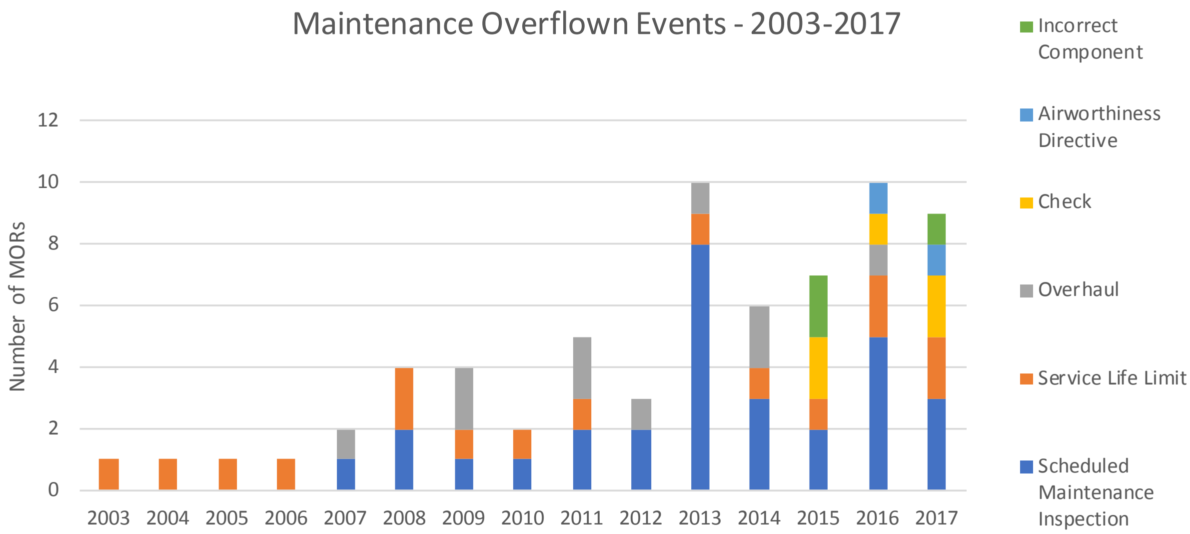


Figure 4



1.12 The highest number of overflown maintenance events related to Scheduled Maintenance Inspections (SMI) with the 2nd highest relating to Service Life Limited components being overflown. The latter of these two would have the higher potential to eroded safety barriers put in place by the Type Certificate Holders, during their original certification requirements.

1.13 Overflown maintenance varied from <1% to 300% of the manufacturer's allowable limits. The most safety significant events related to the Service Life Limited of a Tail Rotor Gearbox and Tail Rotor Flight Control being overflown by 85% and 300% of the manufacturers recommended lives.

1.14 Whilst difficult to define the cause of maintenance being overflown from one single data source, when combining MOR with CAA regulatory oversight data it is evident that there are multiple contributing factors to these events, these include:

a) Complexity of Manufacturers Maintenance Programmes, SB's and AD's, tasks with applied penalty factors based on operational criteria.
b) Volumes of maintenance requirements / interventions.
c) Extended scope of organisations approvals with multiple aircraft types.
d) Diversity and complexity of databases utilised to manage maintenance programmes.
e) Industry challenge in availability, retention and recruitment of Continuing Airworthiness Management staff.

f) Competency of Continuing Airworthiness Management staff to perform continued airworthiness management activities.

1.15 The 4th highest number of reports (19) were allocated to Poor/Lack of Timely Technical Data, including work instructions. The reports were highly linked to maintenance being overflown, where the Continuing Airworthiness Management Organisation had failed, or incorrectly advised the Maintenance Organisation to carry out the required maintenance checks.

Human Factors – Maintenance Related Human Factors

1.16 This section considers a review of the Maintenance related MOR's.

1.17 The structured review of Human Factors events (see Fig 5) in the Onshore sector utilised the taxonomy from the ECCAIRS reporting system. The taxonomy used within ECCAIRs has been structured to permit a common wording and approach to flight crew reports. The taxonomy and error factors are based on the methodology used in the Boeing MEDA investigation tool, a system that is widely used in Maintenance Error Management System throughout the aviation industry.

1.18 The purpose of the review, each of the 164 reports were reviewed and manually classified to the error factors. These included a number of reports that pre-dated amendments that had been made to the ECCAIRS taxonomy, which introduced the HF classification.

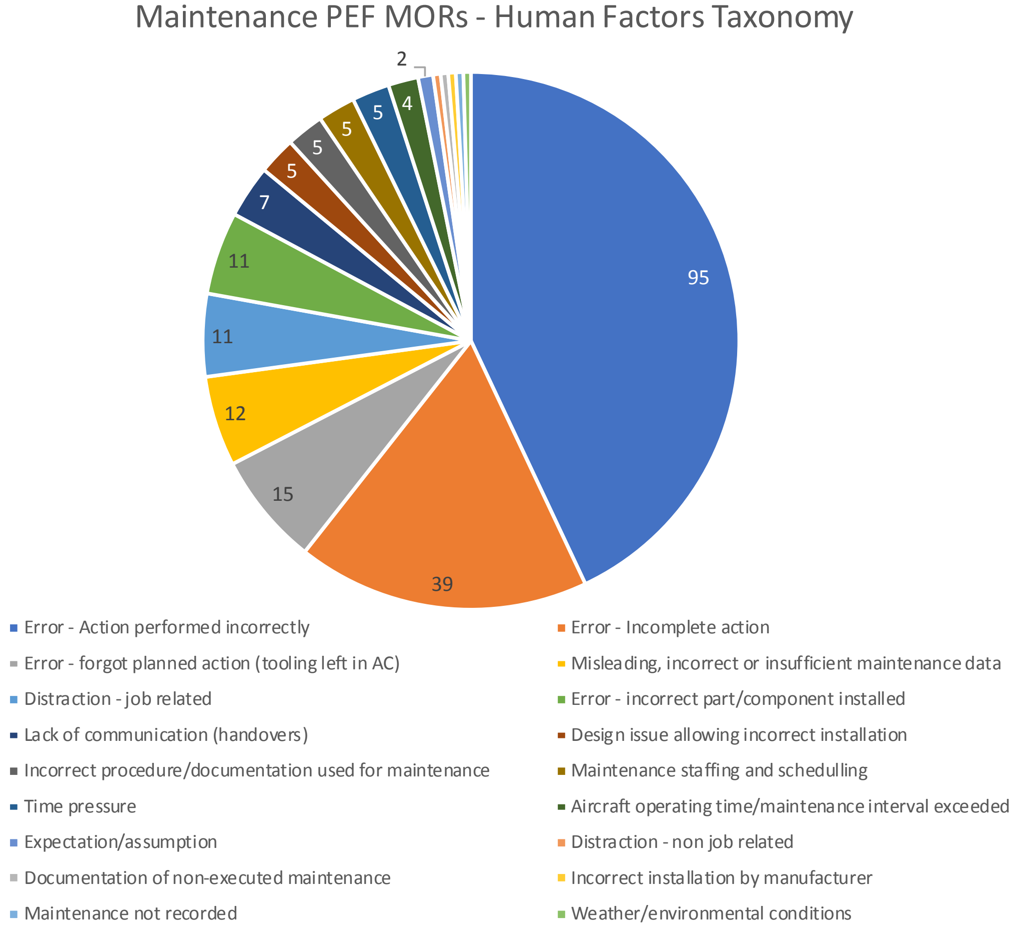
1.19 The review of MORs, published in CAP 1145, indicated that the Offshore sector suffered Part-M overruns as one of the largest numbers of reported errors (30%). Within the review of Onshore HF events the sampled sections of the taxonomy are referred to as "operating time/maintenance interval exceeded". The onshore review has highlighted, in previous sections of the report, that maintenance being overflown (operating time/maintenance interval exceeded) remains an issue. The Human Factors review noted that only 4 reports have been allocated to this group. It is possible that due to the lower operational utilisation, smaller fleet sizes, variations in reporting levels, and the consequential lower number of maintenance interventions per year, that the lower numbers of maintenance events overflown, being reported as Human Factor events is understood.

1.20 Figure 5 indicates that "incomplete action" and "action performed incorrectly" were the highest two root causes. The Offshore review used the term "incorrect installation" for the most significant root cause identified. It should be noted that fundamentally both the onshore and offshore reviews highest root causes are the same, where an action is either performed incorrectly or incompletely by the engineer. It should be noted that the allocation to these taxonomies is based on the information that is provided by the reporter, which may be limited. The 3rd highest identified issue relating to the HF was “forgot planned action”. This identifies the error but does not allow the identification of root cause, for example, was it the environment that led the individual to making the error.

1.21 It should be noted that the ECCAIRS taxonomy focuses on the identification of the “root cause”. The review noted that most of the events had contributing factors that led to the event occurring in the first instance. The figure below shows there were 212 contributing factors or root causes, for the 166 reports reviewed.

1.22 The review noted that it remains difficult to assess the root cause from the reporter’s narrative and the limited information this often contains. Unless the reporter identifies the root cause and the contributing factors using the ECCAIRS taxonomy it remains difficult to have a clear industry pictures of HF performance.

Figure 5



Technical Malfunction

1.23 Technical Malfunction MOR's are in general assigned to events occurring during the operation of the helicopter, either on the ground and in flight. In most cases these are reported by the flight crew rather than airworthiness or engineering staff. Typical examples of a Technical Malfunction MOR would be, 'Number 1 engine fire warning in flight' or 'Lack of power during ground taxi'. There are cases were the reports lack enough clarity of what the root cause of the issues were. In the cases of above, was the Number 1 engine fire warning a broken wire or was it caused by the degradation of the fire detection sensor? Was the lack of power due to a fuel, or an air issue and what component was at fault? For the CAA to extract the information we rely on the reporting organisation to provide the information. Consistent and accurate follow up to these types of events is varied and often lacks clarity to make a judgment on the root cause.

1.24 Technical Malfunction is consistently the largest PEF across all sectors of the industry and therefore the review of these type of MOR's becomes an area where the CAA has recognised the benefit of improving its MOR process. The introduction of the new MOR processes, described in this review, ensure that all technical malfunction events are subject to SME triage process, focusing on the root cause of the safety significant events. There was a challenge in applying the same methodology, retrospectively, to the 2,613 Technical Malfunction events from 2003 – 2017. Different methodologies applied, including key word searches of narratives, presented inaccurate and inconsistent view of these reports. A view of the Top 5 ATA's Chapters and Top 5 Helicopter types is provided and discussed below as a high-level summary of the data set reviewed.

1.25 It is evident that to extract actionable intelligence from Technical Malfunction MOR's a more prescribed review, typical of the performed for the Mini Deep Dives, described within this report allow a greater understanding of any technical issues, or adverse trends of a typical helicopter type. To complete this level of review requires subject matter expertise to extract, review and align each report line by line. The benefits of completing this type of review ensure that a complete and accurate picture of technical malfunctions, by type, are captured and where necessary actions taken on specific matters.

1.26 Off the 2,613 technical malfunction MOR's, the top five ATA Chapters reported related to the following ATA Chapters, Figure 6.

a) 7200 Turbine Engine (637)
b) 6300 Main Rotor Drive System (387)
c) 7900 Engine Oil System (344)
d) 2800 Fuel System (221)
e) 5300 Aircraft Fuselage Structure (217)

1.27 It is likely that technical malfunction MOR's resulted in a degree of increasing pilot workload. Typically, these may be an indication that requires the crew to take an action as defined in the RFM. The degree of crew workload would depend upon the event and the helicopter type. In relation to the top 5 ATA Chapters these might include the following:

a) Turbine Engine;
   i. Chip Light
   ii. FADEC failure
   iii. Over temperature

   iv. Engine surge

b) Main Rotor Drive System
   i. Chip Light
   ii. Rotor brake caption
   iii. High operating temperature

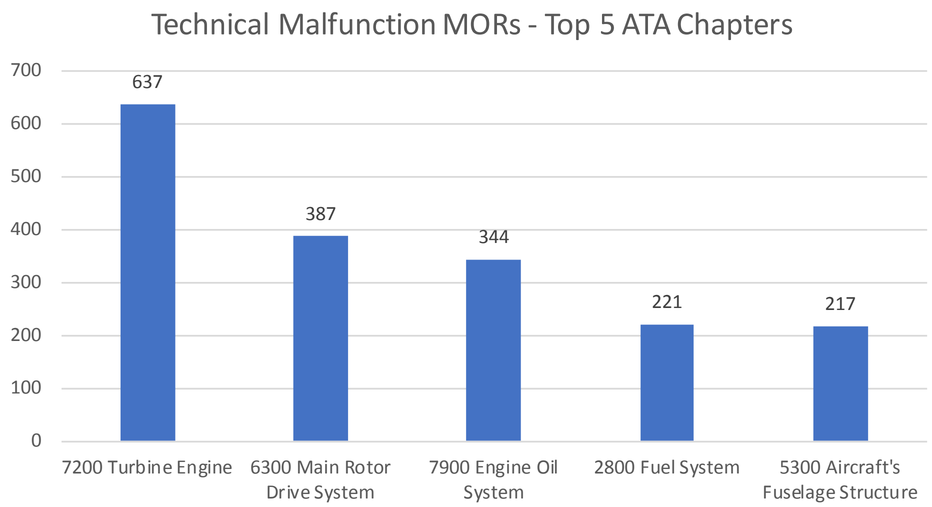
c) Engine Oil System
   i. High Oil Temperature
   ii. Oil Filter indication
   iii. Low oil pressure

d) Fuel System
   i. Fuel pressure caption
   ii. Fuel quantity indications
   iii. Smell of fuel in cabin

e) Aircraft Fuselage Structure
   i. Departing of structure in flight, including windows, doors and stabilisers.

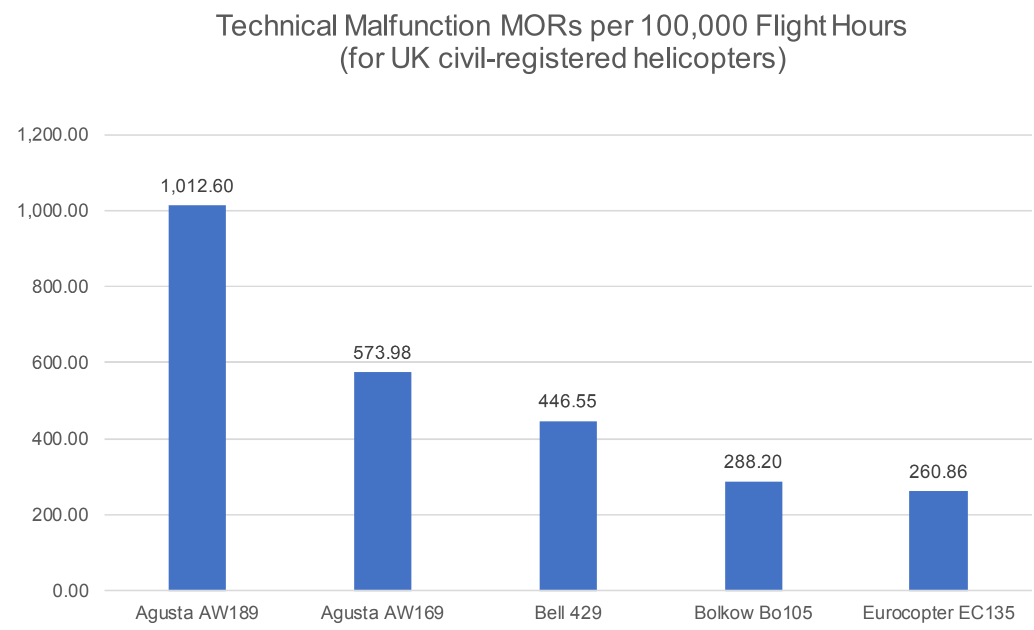
1.28 It should be noted that many of the events related to Aircraft Fuselage Structure relate to events identified during maintenance inspections.

Figure 6



1.29 Figure 7, Technical Malfunction MOR's by ATA type, highlights the number of technical malfunction MOR's by type per 100,000 flight hours. The top 5 types are shown to provide an insight into the helicopter with the most numbers of technical malfunction MOR's per flight hour. It should be acknowledged that this does not represent any definitive airworthiness issues as this maybe a function of the operators of the type and the organisational reporting culture.

Figure 7



1.30 Further analysis of the Top 5 ATA's was conducted at a helicopter level. Figure 8 to 12 illustrate the Top 5 ATA Chapters plotted against each of the helicopter types included within the scope the review. The ATA's are plotted against flight hours to present a representative picture of the number of reported events to each ATA.

1.31 Figure 11 & Figure 12, Bo 105 Chapter 72 & 79 relate to the number of events of reported chip lights. Given the aircraft, and its engine generation, its utilisation on air ambulance operations these events are understood and effectively managed by operators.

1.32 Figure 8, EC 135 Chapter 28 events relate to the increase reporting of fuel contents discrepancies and contamination events post an accident in 2013 involving the helicopter type.

Figure 8Technical Malfunction MORs –ATA 28 Fuel System by Helicopter Type

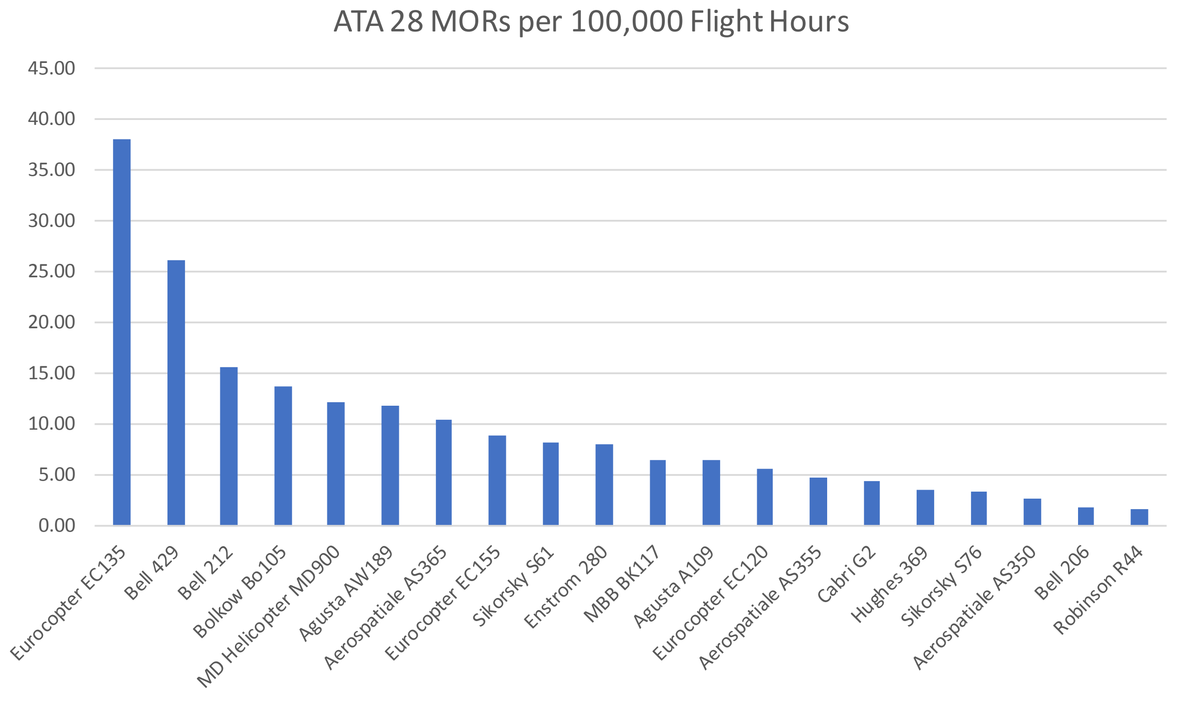


Figure 9 Technical Malfunction MORs – ATA 63 Main Rotor Drive System by Helicopter Type

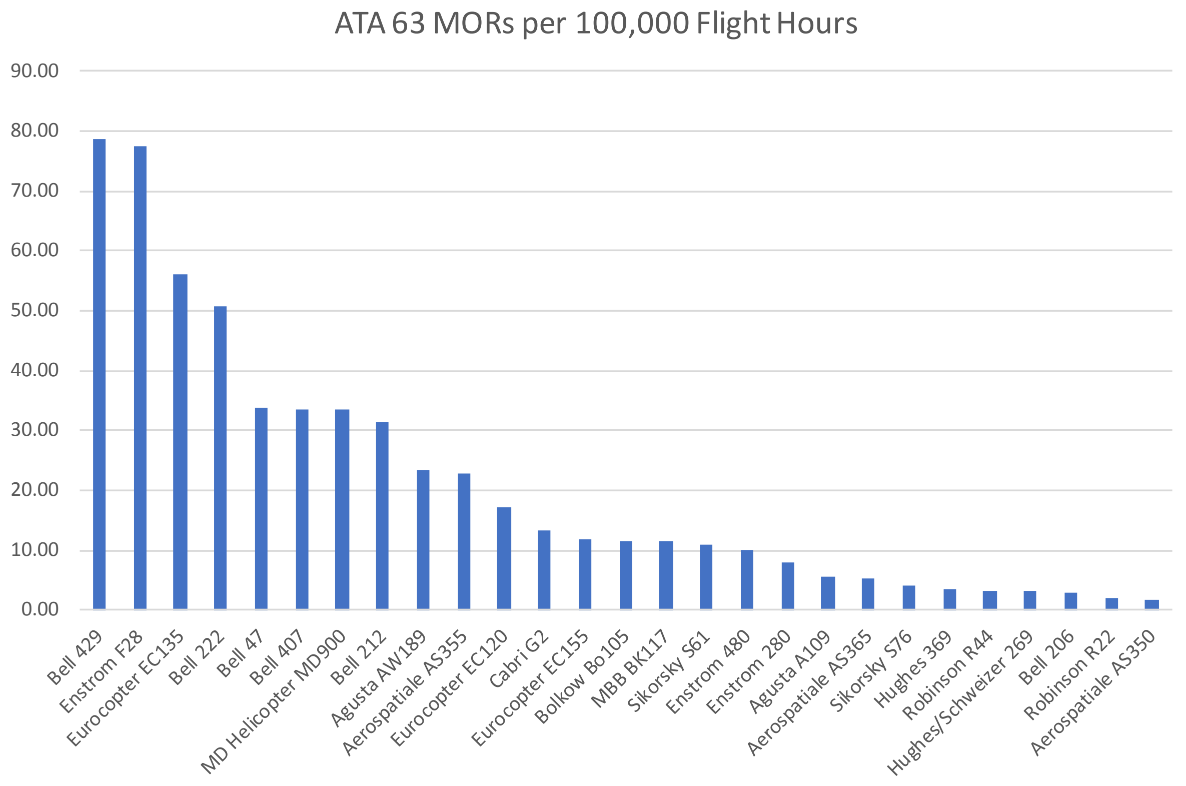


Figure 10 Technical Malfunction MOR's –ATA 53 Aircraft Fuselage Structure by Helicopter Type

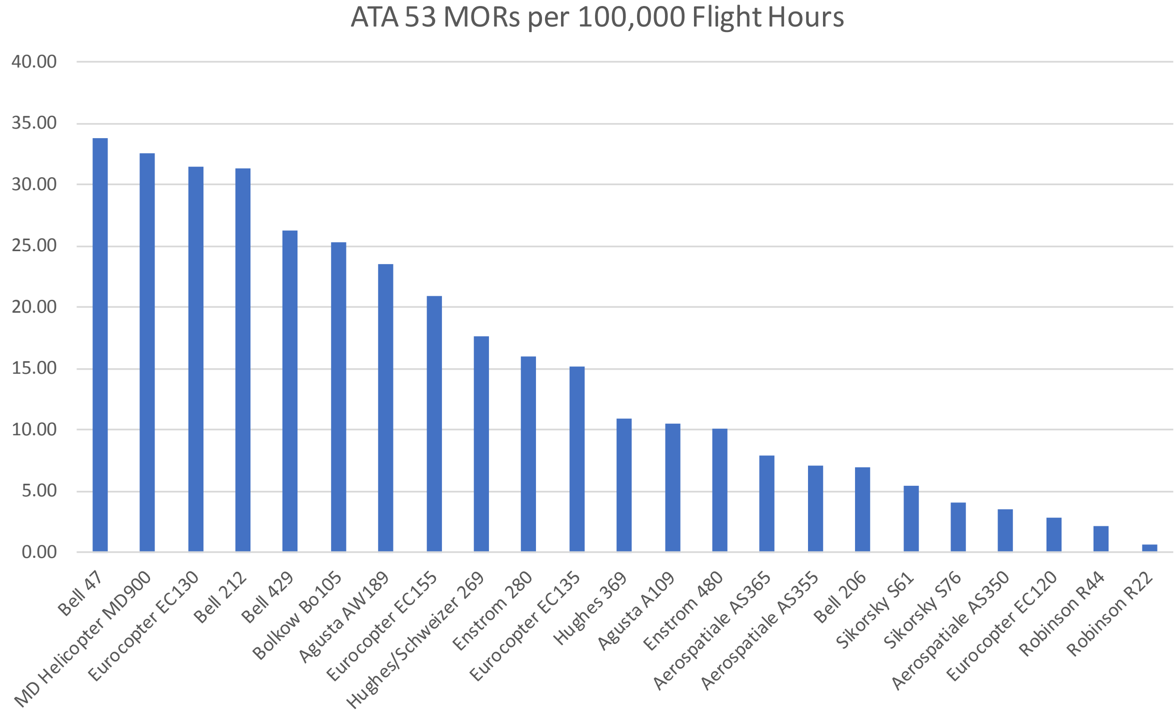


Figure 11 Technical Malfunction MORs –ATA 72 Turbine Engine by Helicopter Type

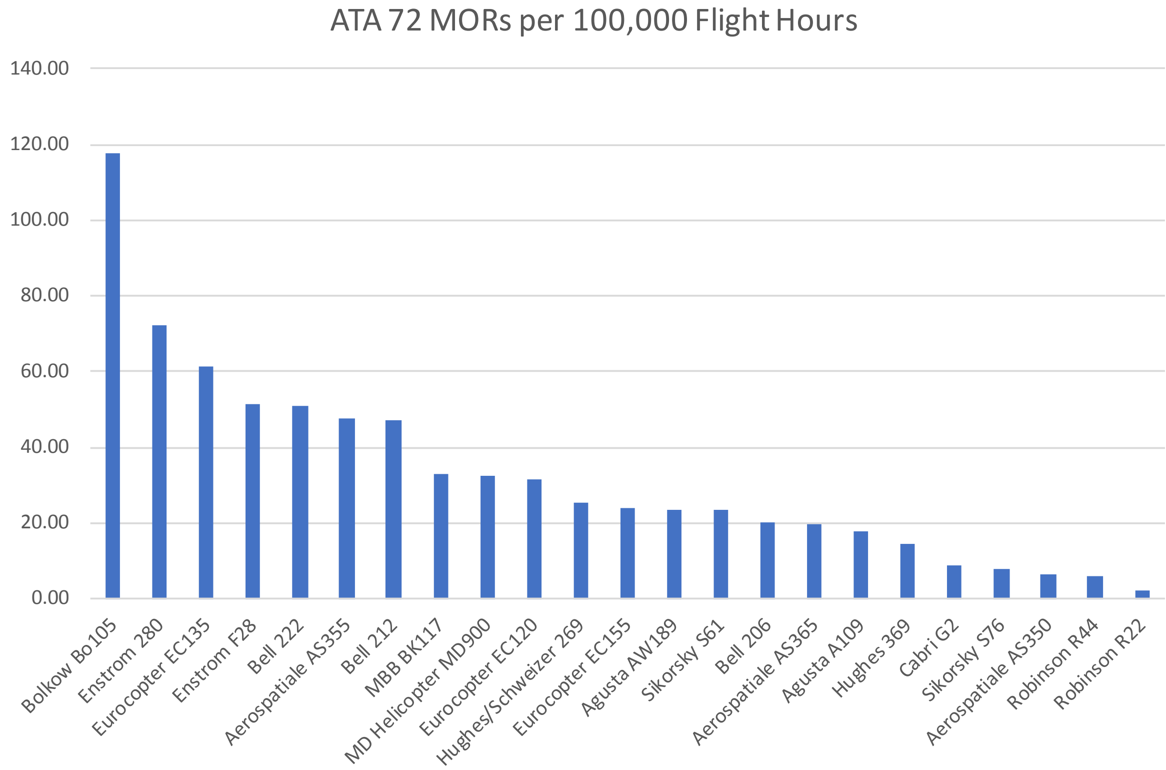
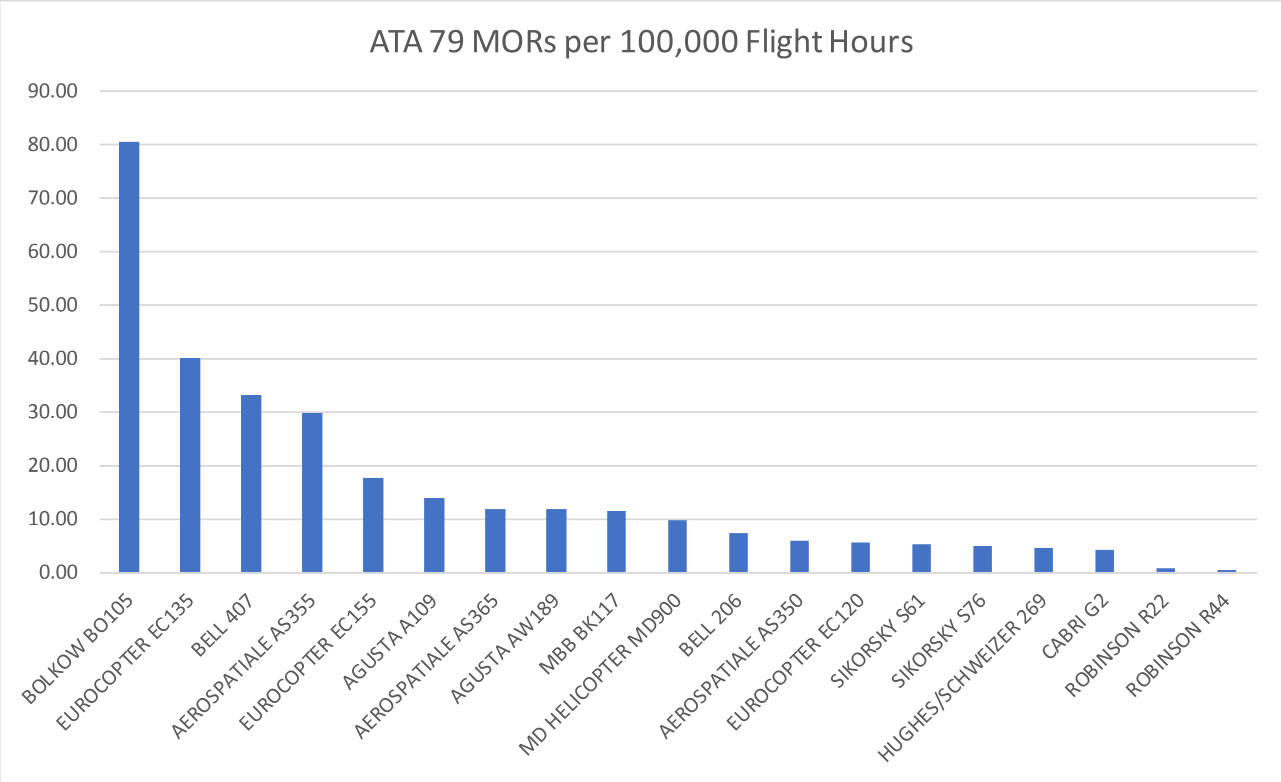


Figure 12 Technical Malfunction MORs –ATA 79 Engine Oil System by Helicopter Type

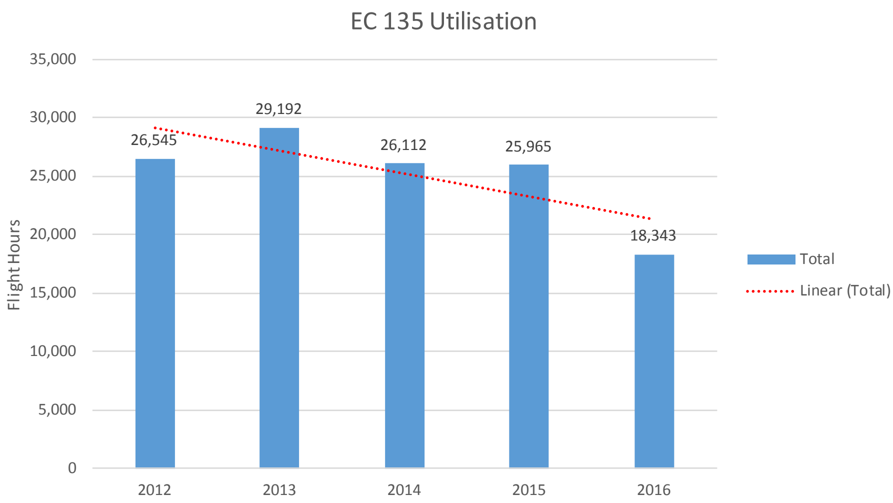


Onshore Review Deep Dives (5-year Period)

EC 135 Deep Dive Review

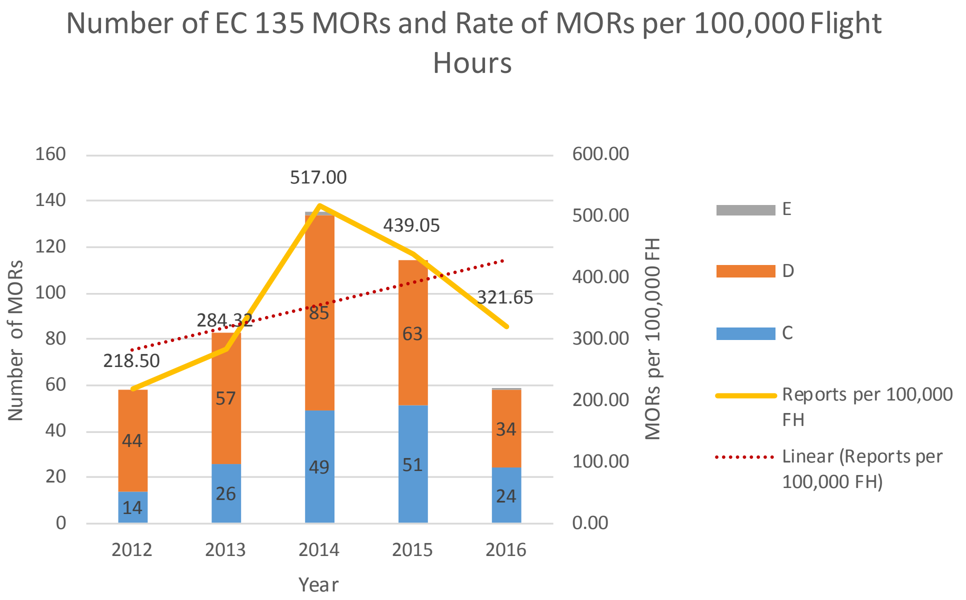
1.33 At the time of the review circa 60 aircraft were on the UK register. Overall the fleet utilisation was in decline having peaked in 2013 when 29192 flight hours were flown. It is likely the decline is contributed to by both fleet size reduction and operators transitioning to alternative helicopter types during the 5-year period.

Figure 13 EC 135 Fleet Utilisation 2012 - 2016



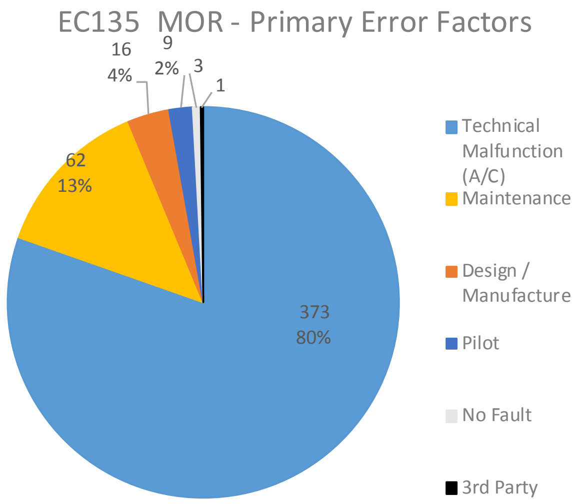
1.34 464 MOR's were received during the reporting period. The highest graded MOR received during the reporting period was graded at C1 medium severity and high probability. Peak reporting levels were between 2014 and 2015 and could be attributed to increased levels of reporting of fuel quantity issues, following the Glasgow Clutha accident and subsequent release of EASA AD's and TC holder Service Bulletins on the issue. Overall MOR reporting levels, per 100,000 Flight Hours were declining in 2015 and 2016. Reference

Figure 14 EC 135 MOR reporting levels and Grades 2012 - 2016



1.35 The Primary Error Factors applied to each MOR is generally consistent with that of wider industry. The highest error factor could be attributed to Technical Malfunction, 80% (373 reports), the 2nd highest factor related to Maintenance 13% (62 reports) and the 3rd highest factor related to Design 4% (16 reports). 14 reports were unable to be fully determined or related to operational or 3rd party.

Figure 15 EC 135 Primary Error Factors 2012 - 2016



1.36 The analysis of the 464 MOR's reviewed, specifically focussed on those reports that could be attributed to Maintenance Standards and Human Factors. 42 (9%) of these reports could be considered to fit within the common themes highlighted below:

a) Incorrect installation
b) Parts not installed
c) Panels not secured

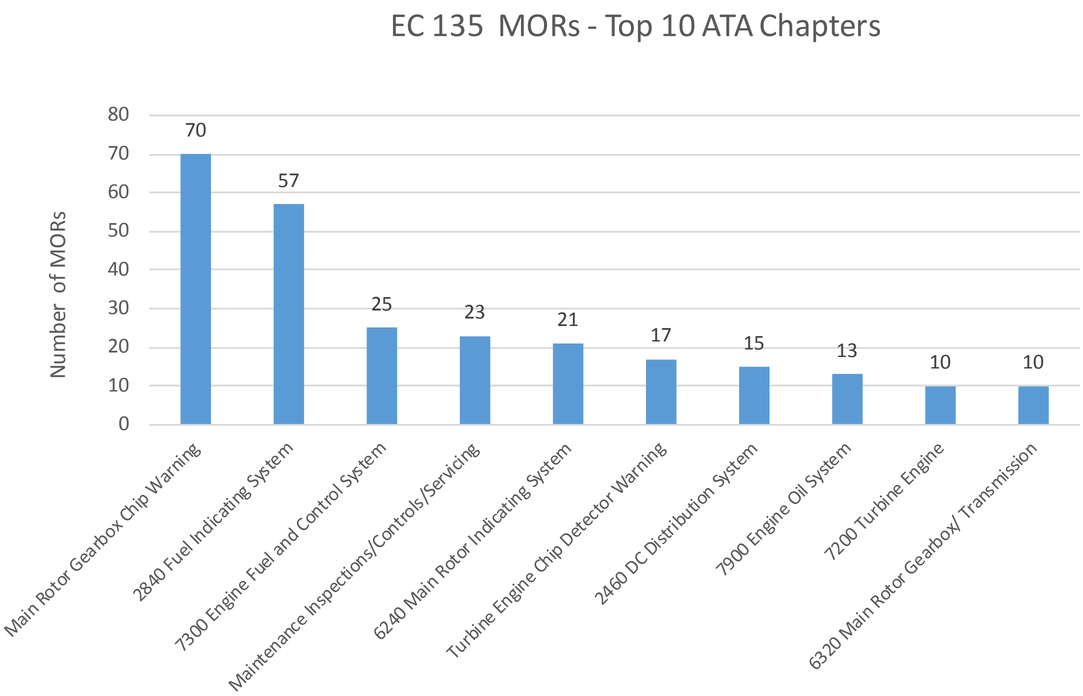
1.37 Analysis also confirmed that 30 (6%) of MOR reports of the 464 related to activity that was conducted by Continuing Airworthiness Management organisations, Part M. Events included:

a) Maintenance Overflown – Due to procedures not being followed or reforecasting of checks
b) Technical Support – Incorrect procedures applied

1.38 To understand whether there were any specific technical issues the analysis considered the Top 10 ATA for each of the helicopter types reviewed. The EC 135 top 10 highlighted that main rotor chip indications was the no.1 technical event, with 70 (15%) occurrences during the period. In most cases it was not possible to establish the action taken to rectify the event. 3 (<1%) events resulted in a Main Gearbox replacement. 57 (12%) events could be attributed to Fuel indicating System, with a peak reporting level of 32 (7%) reports in 2014. The increase in reports followed advice and instructions from the Type Certificate Holder following the Glasgow Clutha an event in 2013 and operator's awareness of a technical issues, reported issues relating to the Fuel Indicating System in 2015 (18) (4%) and

2016 (4) (<1%) suggest the additional maintenance actions taken by the Type Certificate holder have been effective in reducing reportable events. The 3rd highest reported ATA related to Engine Fuel and Control System. 25 (5%) events were reported with 50% of events resulting the replacement of either the Engine Fuel Control Unit (Hydro Mechanical Unit HMU) or the Fuel Control Valve. It is notable that 23 (5%) events related to Maintenance Inspection/Control and Servicing – Maintenance being overflown.

Figure 16 EC 135 Top 10 ATA Chapters 2012 - 2016



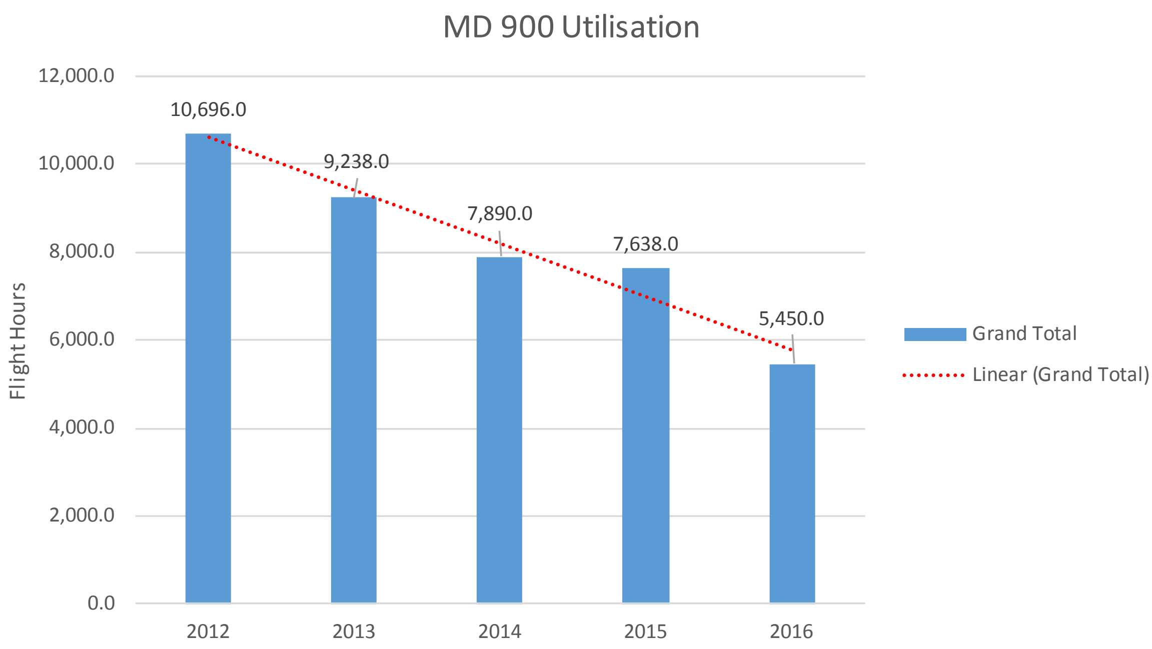
1.39 Approx. 153 (33%) reports of the 464 reports resulted in the replacement of a component. Of these 153 component replacements 19 (4%) components relating the Engine Fuel Control system were replaced, 15 (3%) components relating to the fuel indicating system and 13 (3%) relating to the rotor indicating system.

1.40 Discussions with the Onshore working group confirmed that the CAA's analysis was a representative picture of the EC 135 fleet in service issues. The top issues relating to main rotor chip indications, engine fuel control, fuel system indicating and rotor indicating system had been, or were in the process of being addressed by the Type Certificate Holder. There were no new areas of technical concern highlighted during the analysis.

MD 900 Deep Dive review

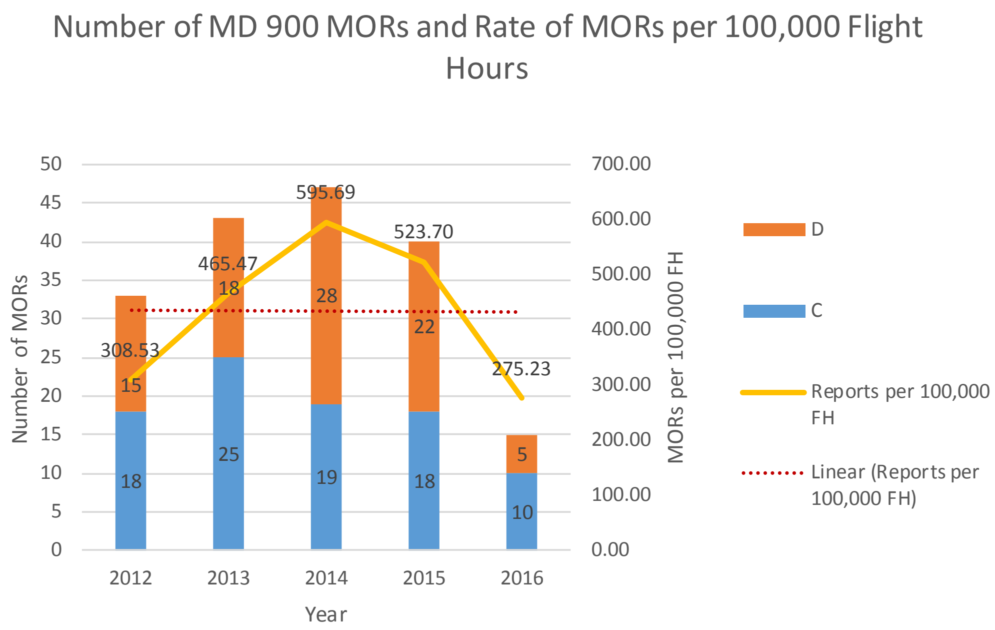
1.41 At the time of the review circa 23 aircraft were on the UK register. Overall the fleet utilisation was in decline having peaked in 2012 when 10,696 flight Hours were flown. From 2012 onwards, the utilisation of the MD 900 fleet has declined as fleet size has reduced.

Figure17 MD 900 Fleet Utilisation 2012 – 2016



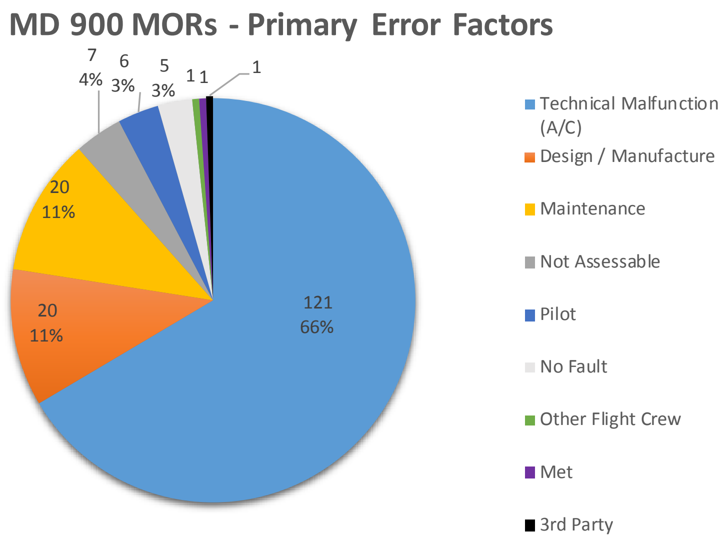
1.42 182 MOR’s were received during the reporting period. The highest graded MOR received during the reporting period was graded at C1, medium severity and high probability. Reporting levels peaked in 2014 and could be aligned with increased utilisation. Overall the reporting levels were slightly higher than that of the EC 135, although the grades were not significantly dissimilar.

Figure 18 MD900 MOR reporting levels and Grades 2012 – 2016



1.43 The Primary Error Factors applied to each MOR is generally consistent with that of wider industry. The highest error factor could be attributed to Technical Malfunction, 66% (121 reports), Design and Maintenance were 2nd and 3rd receiving an equal number of reports, 11% (20) reports each. Design related reports were higher than that of the EC 135 and were caused by a number of component rejections that were known to relate to design matters. These components included the Main Rotor Blades Bolts and Sleeves. Both of these matters have been subject of Airworthiness Directives. 21 reports were not assessible or related to operational or 3rd party.

Figure 19 MD900 Primary Error Factors 2012 - 2016



1.44 The analysis of the 161 MOR's reviewed, specifically focussed on those reports that could be attributed to Maintenance Standards and Human Factors. 14 (9%) of these reports could be considered to fit within the common themes highlighted below:

a) Incorrect installation / assembly
b) Procedures not followed – In correct servicing
c) Panels and doors not secured – Break in task

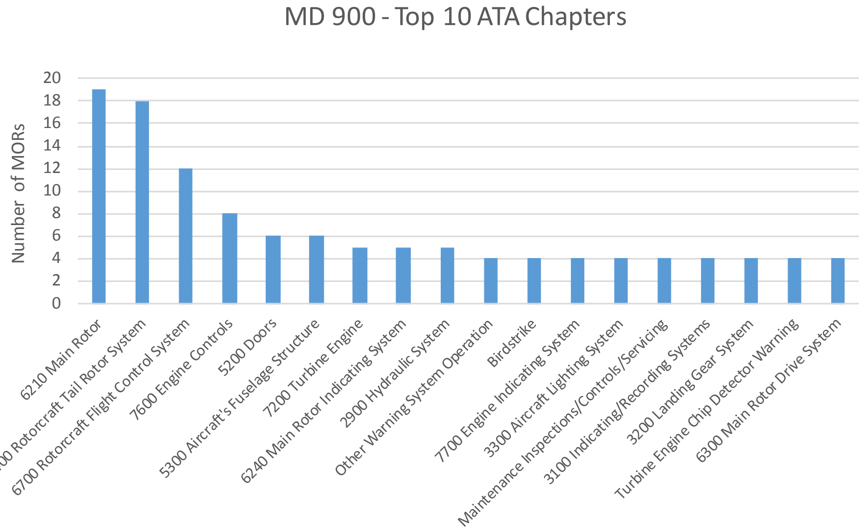
1.45 Analysis confirmed that 5 (3%) MOR reports of the 161 related to the management of Continuing Airworthiness by the Part M organisation. This differed by -3% from that of the EC 135 with less reported events of maintenance being overflown. Events included:

a) Maintenance Overflown – Due to;
   i. Incorrect loading
   ii. Miscalculations
   iii. Misinterpretation

b) Incorrect Forecasting – Poor Communication of Instruction

   i. As per the EC 135 a review of the MOR's focussed on understanding if there were any technical trends for the type. The detailed analysis of the Top 10 ATA's was completed. The MD900 top 10 highlighted that Main Rotor system was the no.1 technical event, with 19 (10%) occurrences during the period. These occurrences related to Main Rotor Blade Bolts and Main Rotor Flexible Beams, both known matters to operators and the Type Certificate Holder. The no. 2 technical event, with 18 (10%) occurrences, related to the tail rotor system, (NOTAR in the case of the MD 900). The no. 3 technical event, with 12 (7%) occurrences, related to Rotor Flight Controls with several events relating to trim, stabilisers and collective friction.

Figure 20 MD900 Top 10 ATA Chapters 2012 – 2016



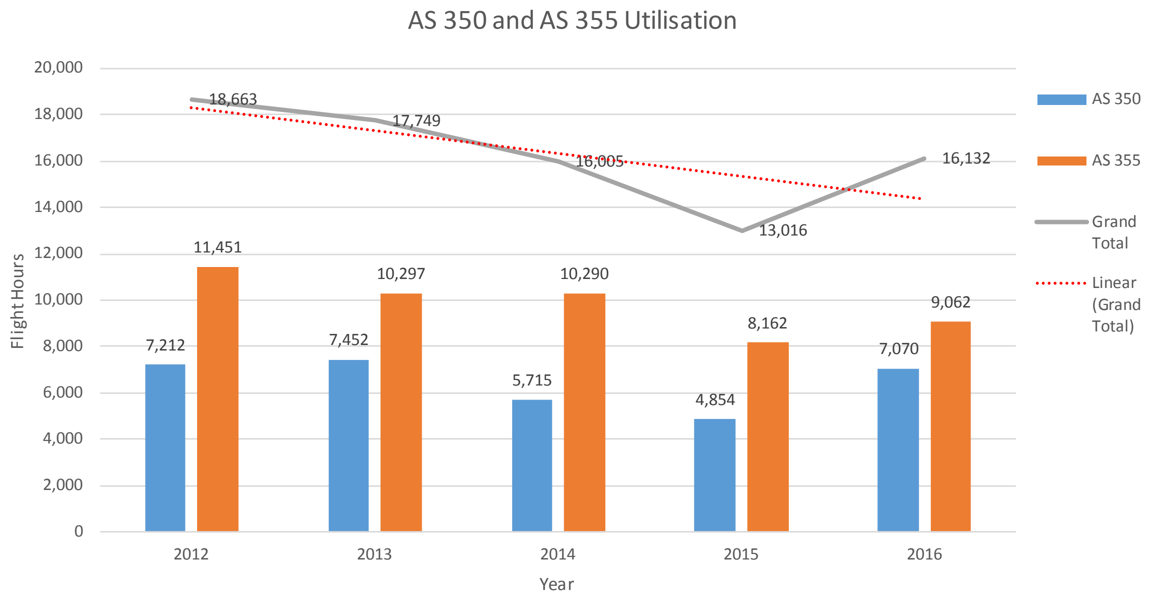
1.46 85 (52%) reports could be determined to have resulted in the replacement of a component. This is comparable with the EC 135 that had 53% of reports resulting in the replacement of a component. Of these component replacements 16 (9%) events related to the replacement of components on the Main Rotor. 12 (7%) of these events relate to one component that has been subject of a redesign with improved in-service performance. 10 (5%) events related to having to replace a component on the Tail Rotor system and 5 (3%) events related to the replacement of component associated with the flight control system.

1.47 As with the EC 135 analysis discussions with the onshore working group confirmed that the CAA's analysis was a representative picture of the MD 900 fleet in service issues. There were no new areas of technical concern highlighted during the analysis.

AS350 & AS355 Deep Dive Review

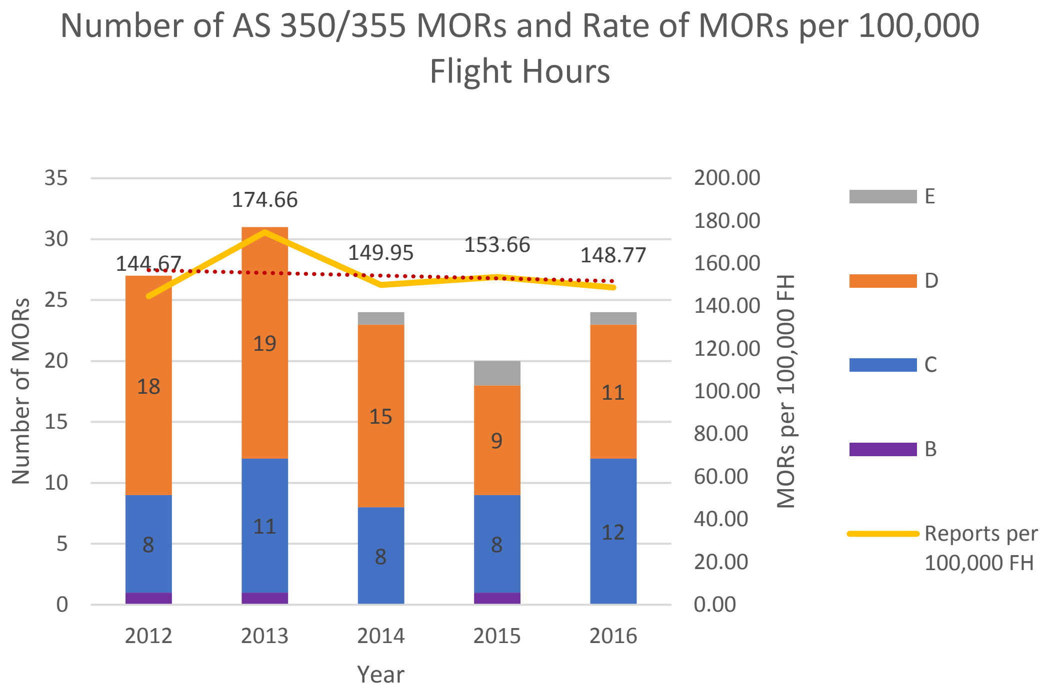
1.48 At the time of the review circa 110 aircraft were on the UK register, 51 AS 350's and 59 AS 355's. Overall the fleet utilisation was relatively stable between 2012 – 2016 with a small decline in operating hours over the review period. Utilisation peaked in 2012 when 18,663 flight hours were flown. The hours of the military operated aircraft were not included in the analysis. Given the diversity of operators of the AS 350 and AS 355 a more detailed analysis was carried out of how the hours were split over the AOC operators. Evidence from the analysis showed that of AOC operators the flight hours varied from 12 flight hours to 18000 flight hours over the review period. These significant variations in operational hours may contribute to some of the observations from the deep dive review of these types and the variation from the EC 135 and MD 900.

Figure 21 AS350 and AS355 Fleet Utilisation 2012 – 2016



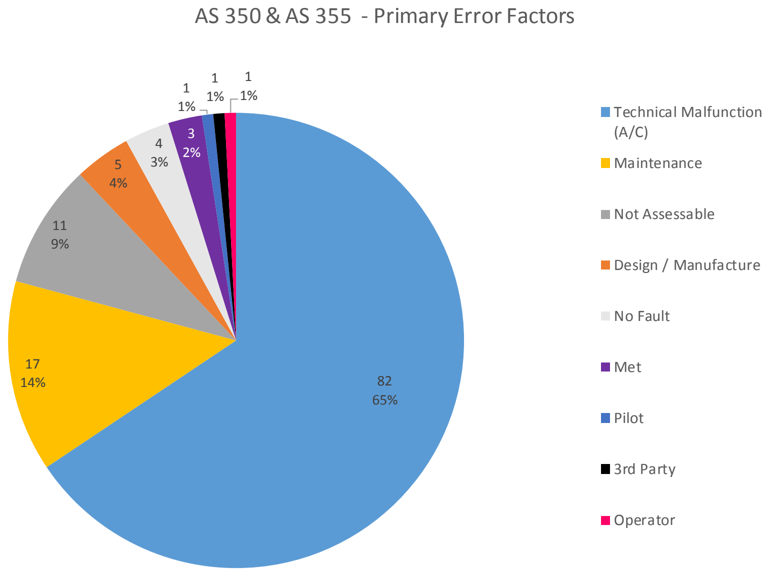
1.49 125 MOR's were received during the reporting period. There were differences of the grading of the reports received for the types, with 3 (1%) reports graded B1-B2, these being serious incidents. No grade B Graded reports were noted on the EC 135 or MD 900. Evidence suggested that reporting levels differed from that of the EC 135 and MD 900, with reporting levels ranging from 198 to 284 per 100,000 per flight hours. This would suggest that the reporting of events from the operators of these types is lower than those utilising the other types and may not provide an accurate reflection of reportable events, as required by Regulation 376/2014. Figure 22.

Figure 22 AS350 and AS355 MOR reporting levels and Grades 2012 - 2016



1.50 The Primary Error Factors applied to each MOR differed from that of the other types reviewed and wider industry norms. The highest Primary Error Factor could be attributed to Technical Malfunction, 105 reports (64%) Maintenance was the 2nd highest factor, 22 reports (14%) relating. Design, which is normally the 3rd highest industry factor, was not so for the AS350 & AS 355 with only 5 reports (3%) being attributed to this. More reports, 32% (53 reports) for these types were either found to be no fault, not assessible, or other factors.

Figure 23 AS350 and AS355 Primary Error Factors 2012 – 2016



1.51 The analysis of the 179 MOR's reviewed, specifically focussed on those reports that could be attributed to Maintenance Standards and Human Factors. 16 (8%) of these reports could be considered to fit within the common themes highlighted below:

a) Incorrect installation / assembly
b) Panels and doors not secured – Break in task

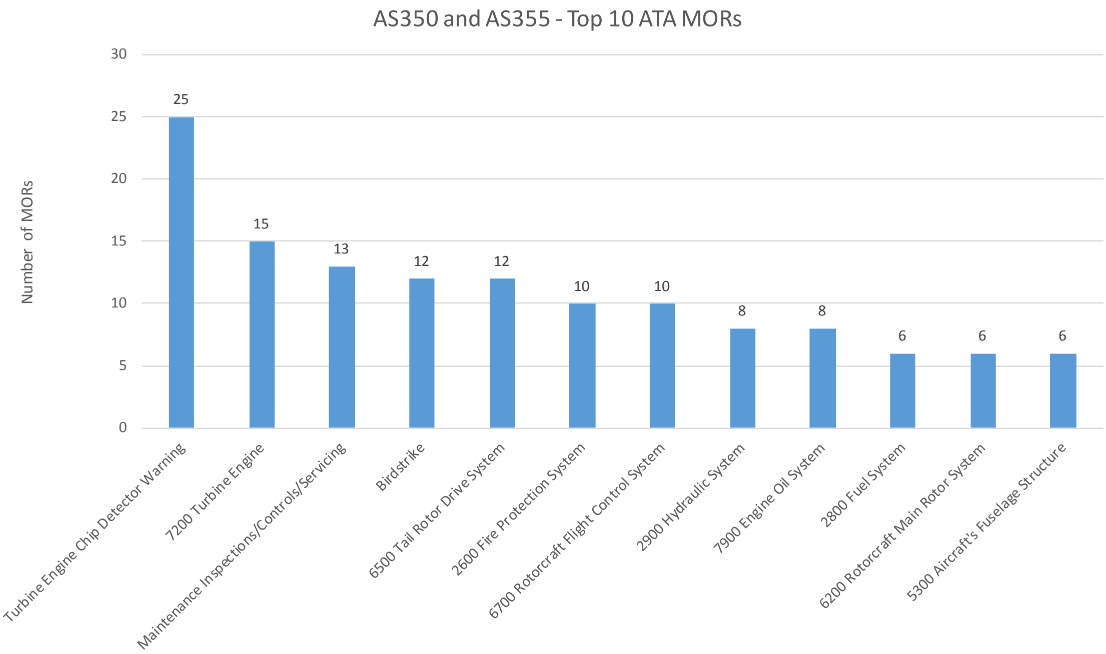
1.52 Analysis confirmed a higher level of issues relating to the continuing airworthiness management activities on these types. 14 (7%) MOR reports of the 179 related to activity that was conducted by Continuing Airworthiness Management Organisations, Part M. Reported events were higher than both the EC 135 and MD 900. Events included:

a) Maintenance Overflown – Due to;
   i. Incorrect loading
   ii. Miscalculations
   iii. Misinterpretation

b) Incorrect Forecasting – Poor Communication of Instruction

1.53 The Top 10 technical issues, by ATA, provided a different picture to the other types reviewed. The highest reported number of events related to the engine in flight chip warning indications, with 25 (12%) events being reported during the period. Consideration should be given that various engine types are installed on these types. No trend was identified for one particular engine type. The 2nd highest number of events, 15 (7%) in total, related to other turbine engine events, including core engine and system issues. 3rd highest reported events 13 (6%) related to maintenance inspection and control; Part M Continuing Airworthiness functions. Like the other types reviewed this was a recurring theme from the review. 4th highest were bird strikes and Tail Rotor drive system, both with 12 (6%) events reported. Of interest were the 8 (4%) reported events of hydraulic failure, 2 (<1%) events resulted in significant damage to aircraft and injury to the occupants.

Figure 24 AS350 and AS355 Top 10 ATA Chapters 2012 - 2016



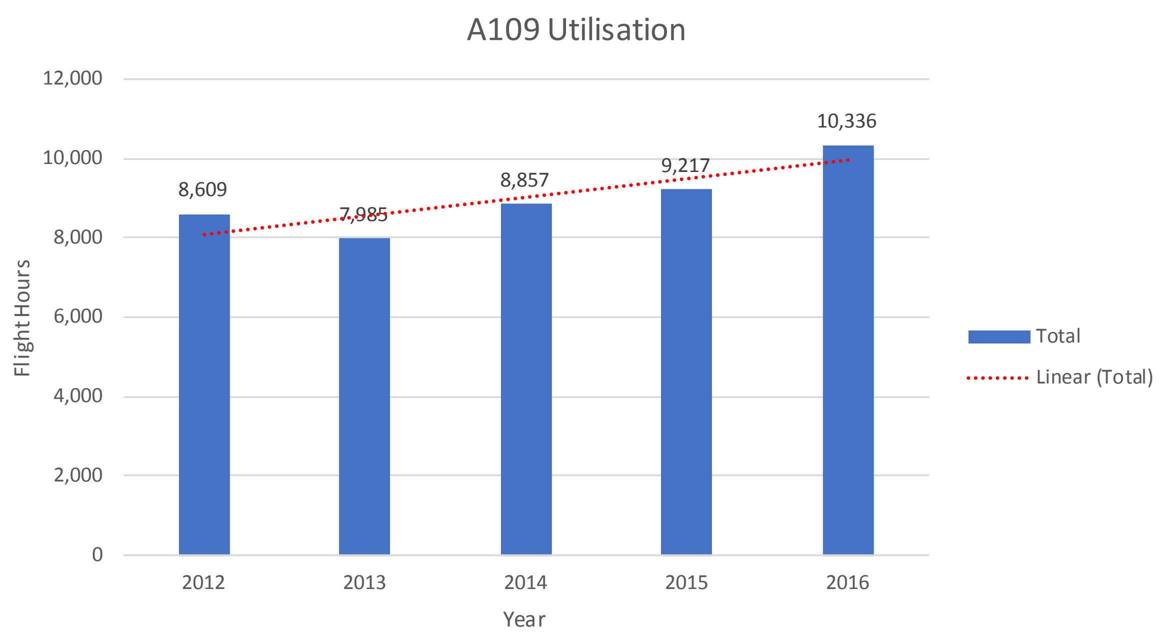
1.54 37 (17%) reports could be determined to have resulted in the replacement of a component. The number of reported component replacements is significantly less than the other types reviewed, however consideration should be given to whether this is a true representation of component replacement events. Given the small number of replacement events it was not possible to establish any trends.

1.55 As with the other types reviewed the analysis was discussed directly with the onshore A31/ A26 working group. Three of the group members are operators or maintainers of the types and confirmed the analysis to be a reasoned reflection of the in-service issues. The group discussed some concerns that they believed were not captured, obsolescence and how this impacted on supporting the older helicopters. This matter impacted on the supply of parts and is referred to within this report under the role of the Type Certificate Holder.

A109 Series Deep Dive review

1.56 At the time of the review circa 76 aircraft were on the UK register. Overall the fleet utilisation has increased from 2012 to 2016 and is aligned with overall increase in fleet size. Utilisation during the five-year review period, peaked at 10,336 Flight Hours.

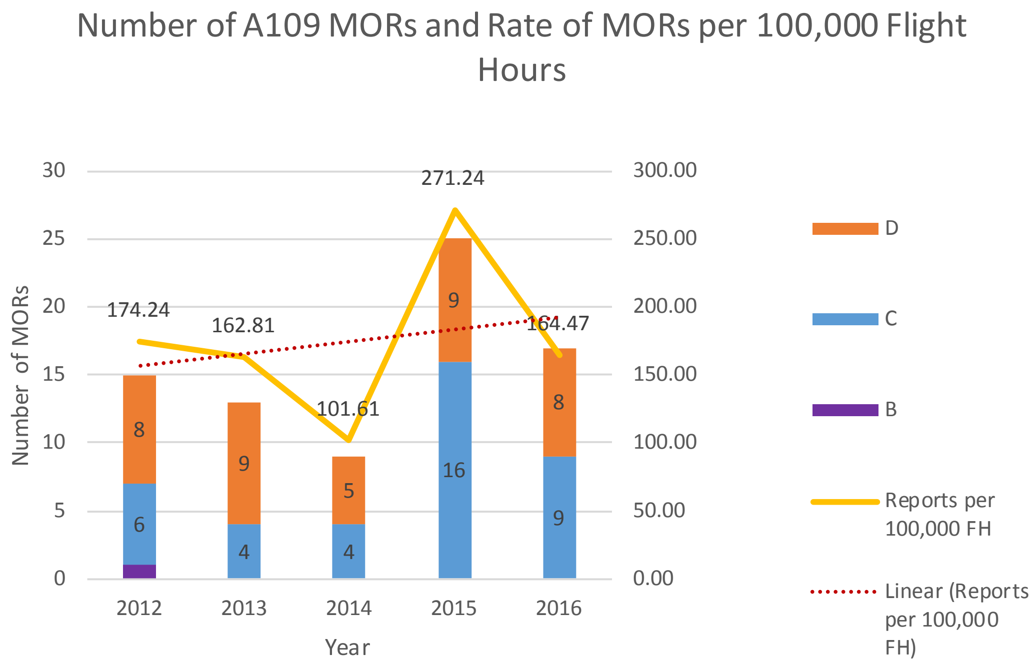
Figure 25 A109 Series Fleet Utilisation 2012 – 2016



1.57 Evidence suggested that reporting levels differed from that of the EC 135 and MD 900, with the reporting levels being more aligned with that of the AS 350 and AS 355, with reporting levels ranging from 101 to 271 per 100,000 per flight hours. This would suggest that the reporting of events from the operators of the A109 is lower than those utilising the other types and may not provide an accurate reflection of reportable events, as required by Regulation 376/2014.

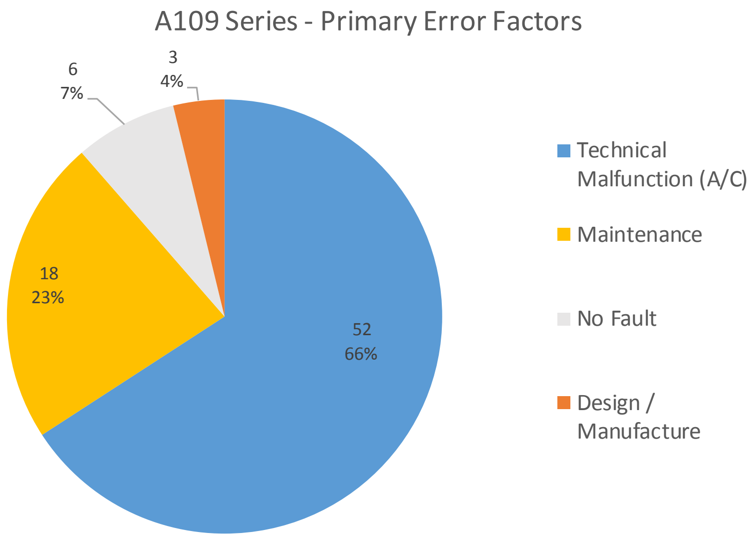
79 MOR's were received during the reporting period if the military reports were included. 68 (86%) of these reports were related to G-Registered Aircraft, 11 (14%) were for Military Registered aircraft. Like the AS 350 and AS 355 the reported events differed in their grading from that of the EC 135 and MD900. 1 (1%) was graded at B1, relating to a serious incident. No grade B Graded reports were noted on the EC 135 or MD 900. Other reports were categorised at C or D.

Figure 26 A109 MOR reporting levels and Grades 2012 – 2016



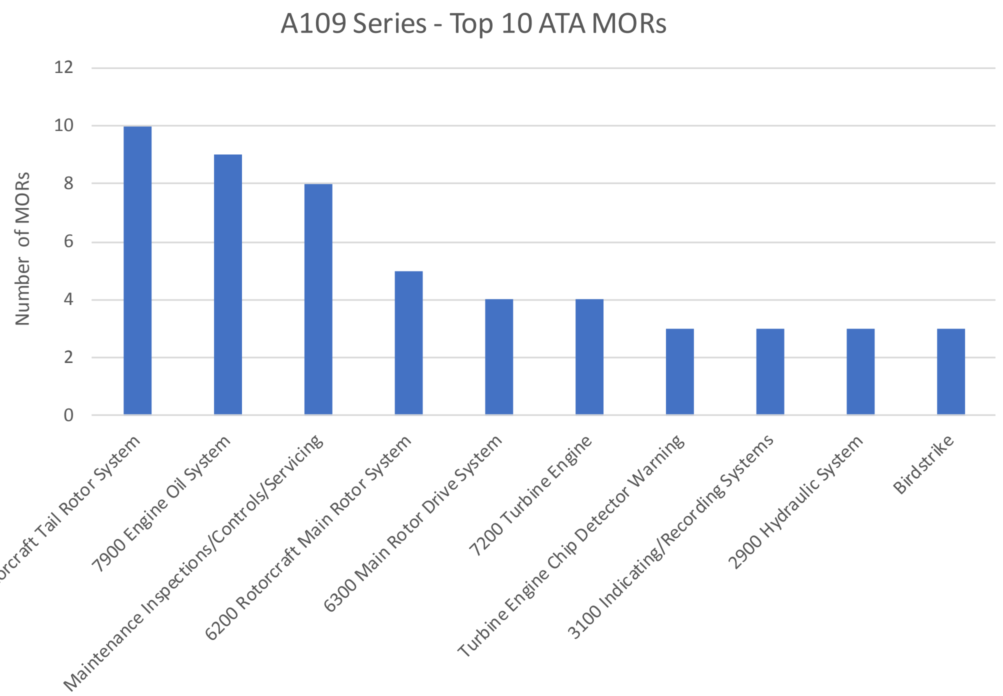
1.58 The Primary Error Factors applied to each MOR differed from that of the other types reviewed and wider industry norms. The highest Primary Error Factor could be attributed to Technical Malfunction, 52 reports (66%) Maintenance was the 2nd highest factor, 18 reports (23%) relating. Design, which is normally the 3rd highest industry factor, was not so for the A109 with only 3 reports (3%) being attributed to this. 6 (7%) of the total reports were deemed to be no fault.

Figure 27 A109 Primary Error Factors 2012 – 2016



1.59 The top 10 technical issues, by ATA, provided an insightful picture into the type, with some differing trends from that of the other types reviewed. The highest number 10 (13%) of reported events by ATA Chapter related to the Tail Rotor System. 7 (10%) of these events related to the installation of the Tail Rotor assembly, including its controls. These events were generally noted during inspections, post flight or scheduled, whereby it was observed that the tail rotor assembly had excessive play. These events had occurred throughout the 5-year review period and were neither specific to one organisation or helicopter. With further review it was evident that the installation of the tail rotor assembly on the A109 is susceptible to installation error. The 2nd highest number of events, 9 (11%) in total, related to engine oil system. Recognising the A109 series has a number of engine variants it was noted that 6 (8%) of these events related to one engine type, the other 3 (3%) were not recorded. Like the other types reviewed the maintenance inspection and control; Part M Continuing Airworthiness functions appeared in the top 10 ATA's, in this instance 3rd like the AS350 and AS355. 8 (10%) reports were attributed to the function of the Part M. 4 (5%) of these events related to maintenance and component life's being overflown. 1 (1%) reported event of a Tail Rotor Gearbox being 30% over its recommended life due to a forecasting error was the most significant event relating to overflown maintenance.

Figure 28 A109 Top 10 ATA Chapters 2012 – 2016



1.60 Of the 79 reports reviewed it was worth noting that 39 (49%) of the reports suggested that a component had been replaced following the event. The number of components replaced could therefore be deemed higher than on the other helicopter types reviewed. A number of common components that were noted as being replaced included Tail Rotor Assembly Components, Main Rotor Blades; including tip caps, oil cooler components, including bearings and belts.

Appendix 6

Airworthiness Regulatory Framework

Onshore Helicopters Subject to EASA Regulations

Continuing Airworthiness

1.1 The continuing airworthiness management accountabilities and responsibilities for onshore helicopters are based upon EASA Regulation Implementing Rule (EU) 1321/2014, Annex I (Part M). The application of the rule, the associated responsibilities and accountabilities are based on the type of operation and whether the aircraft type is considered a complex motor-powered aircraft or non-complex motor-powered aircraft.

Maintenance

1.2 The maintenance accountabilities and responsibilities for onshore helicopters are based upon EASA Regulation implementing Rule (EU) 1321/2014, Annex II (Part 145) or EASA Regulation implementing Rule (EU) 1321/2014, Annex 1 (Part Subpart F). As with Continuing Airworthiness the application of the rule, the associated responsibilities and accountabilities are based on the type of operation and whether the aircraft type is considered a complex motor-powered aircraft or non-complex motor-powered aircraft.

1.3 Table 1 summarises the regulatory requirements and associated notes illustrate the Continuing Airworthiness and Maintenance accountabilities and responsibilities for helicopters including commercial specialised operations (SPO). The table based on the Part M and Part 145 rule and guidance material M.A.201 regulation which has been amended to cover the scope of the onshore review. For further clarification reference should be made to the applicable rule.

Onshore Helicopters Subject to National Regulations

1.4 Given the scope of the review some helicopters remain governed by the rules of the National Aviation Authority, the CAA, and not those defined by EASA. These helicopters sit outside of the aircraft covered in Table 1. The aircraft are defined as National / Non EASA aircraft and fit within the categories of Annex II of Regulation (EC) No. 216/2008 (reference to Article 4 of the Regulation). National aircraft are subject to the requirements set out in British Civil Airworthiness Requirements Section A.

1.5 The aircraft within the National Regulations are typically those engaged in military, customs, and police, even if other aircraft of the same type is subject to regulation by EASA, an example of this would be the EC 135 that is subject to both National Regulations, for police operations, and EASA regulations for all other operations within the EASA framework.

1.6 The continued airworthiness and maintenance support applicable rules are detailed in Table 2.

Notes associated with Table 1

Note 1 – the operator must ensure that tasks associated with continued airworthiness are performed by an approved CAMO, when the operator is not a CAMO then the operator should establish a contract in accordance with Part M Appendix I with such an organisation.

Note 2 – The operator shall be approved in accordance Part 145 or establish a contract in accordance with Part M.A.708 (c) with such an organisation.

Note 3 – The **contracted CAMO** with responsibility for managing the continued airworthiness of the aircraft should be approved in accordance Part M Subpart F or Part 145 for the maintenance of the aircraft or it has established a contract in accordance M.A.708 (c) with such an organisation. Thus, the contracted CAMO must have the contract with the maintenance organisation and not the owner/operator.

Note 4 – The **contracted CAMO** with responsibility for managing the continued airworthiness of the aircraft should be approved in accordance Part M Subpart F or Part 145 for the maintenance of the aircraft or it has established a contract in accordance M.A.708 (c) with such an organisation. Thus, the contracted CAMO must have the contract with the maintenance organisation and not the owner/operator.

Note 5 - the **owner** must ensure that tasks associated with continued airworthiness are performed by an approved CAMO, when the **owner** is not a CAMO then the owner should establish a contract in accordance with Part M Appendix I with such an organisation.

Note 6 – For non-complex aircraft the **owne**r is responsible for ensuring that no flight takes place unless;

a) The aircraft is maintained in an airworthy condition, and:
b) Contract the tasks associated with continuing airworthiness to an approved CAMO through a written contract in accordance with Part M Appendix I, which will transfer the responsibility for the accomplishment of the tasks to the contracted CAMO, or:
c) Manage the continued airworthiness of the aircraft under its own responsibility, without contracting a CAMO, or;
d) Manage the continued airworthiness of the aircraft under its own responsibility and establish a limited contract for the development of the maintenance programme and for processing its approval in accordance with Part M.A.302 with an approved CAMO.

<table>
<tr><th colspan="7">Maintenance and Continued Airworthiness Responsibilities EASA Aircraft</th></tr>
<tr><th colspan="3" rowspan="2">Type of Operation</th><th colspan="2">Complex motor-powered aircraft</th><th colspan="2">Other than motor-powered aircraft (non-complex)</th></tr>
<tr><th>Is a CAMO required to manage airworthiness?</th><th>What kind of maintenance is required?</th><th>Is a CAMO required to manage airworthiness</th><th>What kind of maintenance is required?</th></tr>
<tr><td rowspan="3">Commercial Operations</td><td rowspan="2">Commercial Air Transport (CAT)</td><td>Operators licensed in accordance with Regulation (EU) No 1008/2008 (A to B Operators)</td><td>Yes, a CAMO is required, and it shall be part of the AOC.</td><td>Yes, Part 145 maintenance is required. See Note 2</td><td>Yes, a CAMO is required, and it shall be part of the AOC</td><td>Yes, Part 145 maintenance is required. See Note 2</td></tr>
<tr><td>CAT other than Operators licensed in accordance with Regulation (EC) No 1008/2008 E.g. (A to A operators)</td><td>Yes, a CAMO is required. See Note 1</td><td>Yes, Part 145 maintenance is required. See Note 3</td><td>Yes, a CAMO is required. See Note 1</td><td>Yes, maintenance by a Subpart F or by a Part 145 organisation is required. See Note 4</td></tr>
<tr><td>Non-Commercial Air transport</td><td>Commercial Specialised Operations (SPO)</td><td>Yes, a CAMO is required. See Note 1</td><td>Yes, Part 145 maintenance is required. See Note 3</td><td>Yes, a CAMO is required. See Note 1</td><td>Yes, maintenance by a Subpart F or by a Part 145 organisation is required. See Note 4</td></tr>
<tr><td colspan="3">Non-Commercial Operations (NCO)</td><td>Yes, a CAMO is required. See Note 1</td><td>Yes, Part 145 maintenance is required. See Note 3</td><td>No, A CAMO is not required. See Note 5</td><td>No, maintenance by Subpart F or Part 145 organisatio</td></tr>
</table>

				n is not required. See Note 6

Table 1 Maintenance and Continued Airworthiness Responsibilities for EASA Aircraft

Table 2 Maintenance and Continued Airworthiness Responsibilities for EASA Aircraft

Maintenance and Continued Airworthiness Responsibilities National Aircraft	
Continued Airworthiness	Maintenance
BCAR Section Chapter A8-25 Continuing Airworthiness Management Organisation (CAMO) - See note 1.	BCAR A8-23 Approval of Organisations Responsible for Maintenance and Restoration of Non-EASA Aircraft – See note 2 & 3

Note 1: BCAR Chapter A8-25 broadly follows and has been derived from EC Regulation No.1321/2014, Annex I, Part M.

Note 2: BCAR Chapter A8-23 has been adapted from EC Regulation No. 1321/2104, Annex **II**, Part 145.

Note 3: The requirements of A8-23 are applicable to organisations maintaining and restoring aircraft above 5700 kg, classified as complex aircraft.

Appendix 7

Airworthiness Industry Survey

Introduction

1.7 The CAA carried out an industry survey of personnel connected with Onshore Helicopter operations, a list of fifty (50) personnel were drawn from the CAA's database of airworthiness Accountable Managers and or nominated Post Holders within either Part 145 or Part M organisation.

1.8 The survey consisted of eight questions relating to airworthiness activities, focusing on areas of risk and integration of airworthiness aspects of operations into the wider operational SMS.

1.9 The survey was sent using a piece of software that would allow the results to be co-ordinated on receipt. The survey was sent directly to the accountable managers of the organisations, who were requested to disseminate the survey accordingly.

Response Rate

1.10 It was unclear whether the original target of 50 personnel received the survey as had been intention of the original plan. Responses were initially very low but follow engagement with industry rates appeared to improve although the responses from the original intended audience was low.

1.11 Many of the responses were from personnel that had not originally been the intended audience. In many cases the engineering responses had been completed by the Accountable Managers of the AOC or from other people within the Airworthiness areas of the operation.

1.12 The overall airworthiness response rate therefore is difficult measure. If calculated against the overall distribution of the survey, including flight operations personnel, the response rate is in the range of 44%. It was evident of this 44% many were from non-airworthiness related backgrounds.

Results

1.13 The results to the survey were in general varied and made difficult to gain a valid insight into onshore operations due to the wider than intended target audience.

1.14 The results demonstrated the difficulty in the data set and responses received. When surveyed regarding organisational risks the responses varied so much that in most cases, only one risk was reported.

1.15 In applying a simple form of taxonomy and interpretation of the responses shown, it was possible to turn the data into intelligence that had greater meaning. Grouping responses into themes provided potentially more of an insight into, in this case, the top 5 airworthiness risks.

1.16 It was evident that the responses to the 8 questions were neither a true representation of the Onshore Helicopter Sector, given the responses were dependent upon the dissemination of the Accountable Managers, nor were they completed purely by airworthiness staff. Furthermore, the responses were so varied it made it difficult, without applying some interpretation, to determine what the main issues were that were affecting the sector.

Action13:
Axx

The CAA will conduct a wider industry survey of all Airworthiness Post Holders, licenced B1.3, B1.4, and B2 staff (with a rotorcraft type rating) to gain an understanding of operational matters impacting on their ability to perform their duties. The survey should be completed using a surveying tool and communicated to industry via Skywise in order to maximise target audience.

1.17 Engagement with the onshore helicopter A31 working group identified one key issue, that was not necessarily captured through the industry survey. The issue related to the provisioning of Instructions for Continued Airworthiness, specifically newly introduced types to their respective operations. ICA's were often incomplete, missing or ambiguous resulting in additional burden and pressure on operations and engineering personnel when they were faced with performing certain maintenance tasks. The CAA has engaged with operators to capture current issues relating to the provisioning of ICA data and has shared this with EASA. It is recommended that a review of the provisioning of ICA's is conducted to ensure future helicopter entries to service is improved to mitigate the burden and pressure placed on operators.

Figure 1 Survey Response