



# **Air Accident Investigation Unit Ireland**

**INTERIM STATEMENT**

**ACCIDENT**

**Sikorsky S-92A, EI-ICR**

**Black Rock, Co. Mayo, Ireland**

**14 March 2017**



**An Roinn Iompair  
Turasóireachta agus Spóirt**

Department of Transport,  
Tourism and Sport

## Foreword

This safety investigation is exclusively of a technical nature and this Interim Statement details the progress of the investigation and any safety issues raised to date.

In accordance with the provisions of Annex 13<sup>1</sup> to the Convention on International Civil Aviation, Regulation (EU) No 996/2010<sup>2</sup> and Statutory Instrument No. 460 of 2009<sup>3</sup>, safety investigations are in no case concerned with apportioning blame or liability. They are independent of, separate from and without prejudice to any judicial or administrative proceedings to apportion blame or liability. The sole objective of a safety investigation is the prevention of accidents and incidents.

Accordingly, AAIU Reports or Statements should not be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

Extracts from this Interim Statement may be published providing that the source is acknowledged, the material is accurately reproduced and that it is not used in a derogatory or misleading context.

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<sup>1</sup> **Annex 13:** International Civil Aviation Organization (ICAO), Annex 13, Aircraft Accident and Incident Investigation.

<sup>2</sup> **Regulation (EU) No 996/2010** of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.

<sup>3</sup> **Statutory Instrument (SI) No. 460 of 2009:** Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009.



## INTERIM STATEMENT

Report No: 2018-004

State File No: IRL00917016

Published: 16 March 2018

**Accident to Sikorsky S-92A, EI-ICR at Black Rock, Co. Mayo on 14 March 2017**

## 1 INTRODUCTION

The accident occurred on 14 March 2017, at Black Rock, Co. Mayo. An Investigation commenced immediately. A Preliminary Report (AAIU Report No. 2017-006) was issued on 13 April 2017, which set out factual information known at the time.

On 30 January 2018, the Chief Inspector of Air Accidents, in consultation with the Investigator-in-Charge, issued a press release advising that due to the depth and breadth of this particular Investigation, a Final Report would not be issued within 12 months of the date of the accident and therefore an Interim Statement would be published.

This Interim Statement is primarily factual in nature. However, where the AAIU, as the Safety Investigation Authority of the State, deems it necessary to issue Interim Safety Recommendations to enhance aviation safety, these are included.

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## 2 PROGRESS REPORT

### 2.1 General

The purpose of this Interim Statement is to detail the progress of the Investigation and any safety issues identified, including those which may not have directly contributed to the accident. For completeness, this Interim Statement should be read in conjunction with the [Preliminary Report](#).

In accordance with ICAO Annex 13, a number of agencies, both national and international, are providing assistance to the Investigation.

### 2.2 Interviews and Review of Records

To allow the Investigation to properly consider certain issues, it has been necessary to request and review data and records from a number of sources for periods spanning several years. A substantial amount of data, in a variety of formats, has already been provided and the analysis of this data is ongoing. This process will take some time to complete. Furthermore, the Investigation is awaiting the provision of additional data and records.

The Investigation has conducted more than 75 hours of interviews with a large number of personnel from a range of agencies. These agencies were associated with the occurrence flight and the operation, regulation, tasking and oversight of helicopter Search and Rescue (SAR) operations in Ireland. Further interviews are planned.

## 2.3 Wreckage Examination

Examination of the helicopter wreckage is ongoing. This examination is to enable the Investigation to develop the best possible understanding of the flight dynamics and structural disruption sequence associated with the accident.

A large number of items, some of which were related to the accident helicopter, have been recovered sporadically from both sea and shoreline over the period since the accident. All recovered items were secured by An Garda Síochána at Belmullet Garda Station and are subject to consideration by the Investigation.

## 2.4 Recorded Data

Recorded data from several sources was available to the Investigation and is the subject of ongoing analysis. The primary sources of this data were the Multi-Purpose Flight Recorder (MPFR)<sup>4</sup> and the Helicopter Health and Usage Monitoring System (HUMS<sup>5</sup>).

In the course of this Investigation, concerns of a technical nature related to the protective coating on the memory units of the MPFR were identified by the UK Air Accidents Investigation Branch (AAIB), which was providing subject matter expertise to the Investigation. Additionally, when the latitude and longitude information recorded on the Flight Data Recorder component of the MPFR was studied, it was found that the position information was a *coarse* record of the aircraft position.

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The Manufacturer of the helicopter informed the Investigation that it has established that the data values available to the on board navigation and flight control systems were not affected by this issue and that the coarseness of aircraft position data was solely related to the data values recorded on the MPFR. The MPFR is the only crash protected source of flight data available to Safety Investigation Authorities and is an essential element of accident investigations. Accordingly, an Interim Safety Recommendation is being made to the helicopter Manufacturer regarding this issue (**Section 3.2**).

A Digital Video Recorder, capable of recording imagery from the helicopter's Electro-Optic and Infrared (EO/IR) Camera, was recovered from the seabed and analysed by the US National Transportation Safety Board (NTSB) at the request of the Investigation. No data pertaining to the accident flight was recovered.

More detailed information on recorded data is provided in **Appendix A**.

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<sup>4</sup> **MPFR:** The helicopter was equipped with a Penny & Giles D51615-102 MPFR, which served the dual purpose of Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR). The MPFR records the most recent 25 hours of flight data and just over two hours of audio data.

<sup>5</sup> **HUMS:** The helicopter was equipped with a Goodrich HUMS. The HUMS was designed to record the status of critical systems and components on the helicopter so that early detection of progressive defects is possible through trend monitoring, thereby enabling rectification of defects before there is an effect on operational safety or efficiency. In addition the HUMS records a subset of the data which is collected by the FDR.



Data from ground based sources is also being reviewed. This includes Automatic Identification System (AIS) data—a transponder-based system that is operated in Ireland by the Irish Coast Guard (IRCG); SkyTrac—a satellite tracking service which the Operator’s helicopters use; and recordings of communications at Marine Rescue Co-ordination Centre (MRCC) in Dublin and Marine Rescue Sub-Centre (MRSC) at Malin Head.

## 2.5 Operator’s Safety Management System (SMS)

### 2.5.1 Background

Annex 19 to the Convention on International Civil Aviation titled “*Safety Management*”, defines SMS as “*A systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures.*” The ICAO Safety Management Manual states that an SMS “*is designed to continuously improve safety by identifying hazards, collecting and analysing data and continuously assessing safety risks. The SMS seeks to proactively contain or mitigate risks before they result in aviation accidents and incidents*”.

### 2.5.2 SMS Review

At this stage the Investigation has reviewed:

- The Operator’s Safety and Compliance Monitoring Manual
- Minutes from 55 meetings of the Operator’s Occurrence Review Board between January 2011 and March 2017
- Minutes from 130 base Flight Safety Meetings held between January 2012 and December 2016
- A number of risk assessment documents provided to the Investigation
- A number of SQID<sup>6</sup> reports on a range of topics

Work is continuing to obtain and analyse all relevant information in relation to the Operator’s SMS; however, based on the information reviewed to date, the Investigation has concerns regarding its efficacy. Consequently, an Interim Safety Recommendation is being made to the Operator in this regard (**Section 3.2**).

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<sup>6</sup> **SQID**: Safety and Quality Information Database

## 2.6 Oversight of SAR helicopter Operations in Ireland

### 2.6.1 General

The Investigation is obliged under ICAO Annex 13 to consider organizational and management information which includes:

*Pertinent information concerning the organizations and their management involved in influencing the operation of the aircraft. The organizations include, for example, the operator; the air traffic services, airway, aerodrome and weather service agencies; and the regulatory authority. The information could include, but not be limited to, organizational structure and functions, resources, economic status, management policies and practices, and regulatory framework.*

In this context, the Investigation has reviewed a large number of documents in relation to the organizational aspects and oversight of SAR helicopter operations in Ireland. These documents include:

- The Irish Aviation Authority [IAA] Act, 1993
- S.I. No. 171 of 1995 - Irish Aviation Authority Act, 1993 (Amendment of Schedule) Order, 1995
- S.I. No. 172 of 1995 - Annex 12 (Standards and Recommended Practices Search and Rescue) (Designation of Authorities) Order, 1995
- Statutory Instruments S.I. No. 72 of 2004 Irish Aviation Authority (Rules of the Air) Order, 2004
- Statutory Instruments S.I. No. 61 of 2006 Irish Aviation Authority (Operations) Order, 2006
- Regulation (EC) No 216/2008 of The European Parliament and of The Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency [EASA]
- Regulation (EC) No 1108/2009 of The European Parliament and of The Council of 21 October 2009 amending Regulation (EC) No 216/2008 in the field of aerodromes, air traffic management and air navigation services
- The Irish National Maritime Search and Rescue (SAR) Framework, Final Version, 2 March 2010
- Report of the ICAO Universal Safety Oversight Audit Programme (USOAP) for Ireland (2010)
- Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008
- Regulation (EU) No 923/2012 (SERA) as amended



- The Irish Aviation Authority's Annual Safety Review of Aviation in Ireland during 2012
- The Irish Aviation Authority's Annual Safety Review of Aviation in Ireland 2013
- The Irish Aviation Authority's Aeronautical Notice O.76, 1 October 2014; titled "*The Conduct of Search and Rescue (SAR) Operations in Ireland*"
- The Irish Aviation Authority's Annual Safety Review of Aviation in Ireland 2014
- The Irish Aviation Authority's Review of Aviation Safety Performance in Ireland during 2015
- The Irish Aviation Authority's Review of Aviation Safety Performance in Ireland during 2016
- The Irish Aviation Authority's Irish National Search and Rescue Approval – No. 1 of 2014, as amended, issued to the Operator
- The Irish Aviation Authority's State Safety Plan 2017–2020
- Annex 6 to the Convention on International Civil Aviation, Part III International Operations — Helicopters
- Annex 12 to the Convention on International Civil Aviation, Search and Rescue

Following the review of these documents, the Investigation notes the following, which are presented in reverse chronological order:

## 2.6.2 State Safety Plan 2017-2020

On 7 June 2017, the IAA published the State Safety Plan 2017–2020 in which it stated:

*The issue of off shore helicopter operations has been brought into sharp focus in Ireland in 2017 following the fatal crash of an Irish helicopter involved in an off shore Search and Rescue mission. Search and Rescue (SAR) is excluded from the regulatory framework of civil aviation and thus is outside the remit of the EASA or the IAA,*

...

*The IAA has initiated a comprehensive review of the safety oversight structure for helicopter operations in Ireland that involve both civil and State functions, in order to ensure that there are no gaps in the oversight process (New Action a) below).*

...

*[New Action a] The IAA, in conjunction with the DTTaS [Department of Transport, Tourism and Sport], will conduct a comprehensive review of the safety oversight structure for helicopter operations in Ireland that involve both civil and state functions, in order to ensure that there are no gaps in the oversight process.*



### 2.6.3 IAA Review of Aviation Safety Performance in Ireland During 2016

In May 2017, the IAA published its *“Irish Aviation Authority Review of Aviation Safety Performance in Ireland during 2016”*, which included the following:

*On 31st December 2016 there were 13 helicopters providing CAT [Commercial Air Transport], Search and Rescue, Helicopter Emergency Medical Services or Specialised Operations on the Irish aircraft register. These helicopters were not involved in any accidents or serious incidents during 2016.*

*At the close of 2016 the Operators conducting these types of missions under a Permission and / or Approval and / or Authorisation issued by SRD [Safety Regulation Division of the IAA] were ... [The Operator and two other named operators].*

### 2.6.4 Irish National SAR approval

The Irish Aviation Authority first granted an Irish National Search and Rescue approval to the Operator on 1 October 2014. This was re-issued as: Issue 2 on 12 November 2014; Issue 3 on 3 December 2014 and Issue 4 on 8 February 2017. The accident flight was being operated under this Issue 4 of the approval. On 25 April 2017 (subsequent to the accident), Issue 5 of this Irish National Search and Rescue approval was issued to the Operator by the IAA.

### 2.6.5 Aeronautical Notice O.76

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The basis for granting the Operator's National Search and Rescue approval was set out in the IAA's Aeronautical Notice O.76, Issue 1 on 1 October 2014; titled *“The Conduct of Search and Rescue (SAR) Operations in Ireland”*. This direction states:

#### *DIRECTION*

*In accordance with EC Regulation 216/2008 - Article 1,(2)(a), the European Aviation Safety Agency (EASA)<sup>7</sup> has deemed that the requirements of the ‘Basic Regulation’ shall not apply to the conduct of Search and Rescue operations and that such operations are to be classified as a ‘State’ activity which is to be regulated by the National Aviation Authority.*

*In compliance with this regulation the Irish Aviation Authority, in accordance with its powers as set out in the Irish Aviation Authority (Operations) Order, 2006; Article 7(1) and the Irish Aviation Authority (Rules of the Air) Order, 2004; Articles 3 and 16, hereby directs that operations carried out for the purpose of Search and Rescue by a commercial operator shall be deemed to be for the purpose of Commercial Air Transport and therefore subject to the operator being the holder of an Irish National Search and Rescue Approval (SAR APP).*

<sup>7</sup> EASA informed the Investigation that *“It is not an EASA position to delegate the SAR operations to the NAA regulations. It comes from the EC Regulation 216/2008 which is not an EASA document but a European Regulation (issued by the Commission) and specifically is the Regulation (which repealed older Council Directive and Regulation on same topic) which established a European Aviation Safety Agency (EASA).”*





*Prior to 28 October 2014, an Approval issued for the sole purpose of SAR shall be based on the requirements set out in JAR-OPS 3. Following that date, an Approval shall be based on the requirements of European Union Regulation (EU) 965/2012, as amended. Additional requirements to be complied with by the holder of a SAR APP are set out in Annex 1<sup>8</sup> to this Aeronautical Notice.*

#### **2.6.6 The Irish Aviation Authority's Annual Safety Review of Aviation in Ireland 2013**

The Irish Aviation Authority's Annual Safety Review of Aviation in Ireland 2013 stated:

*The Irish AOC holders who provide helicopter transport are [the Operator and four others]. These Operators are active within Ireland and some also operate abroad. They conduct commercial air transport operations – both onshore and offshore, carry out search and rescue (SAR) operations ... Currently training for SAR operations takes place under an AOC and SAR operations are conducted under an aerial works permission. During 2014 legislation will come into effect so that SAR operations will also take place under an AOC.*

#### **2.6.7 ICAO Universal Safety Oversight Audit Programme (USOAP)–Ireland Audit 2010**

In 2010, the International Civil Aviation Organisation (ICAO) conducted an audit of the Irish State's compliance with the provisions of all extant Annexes to the Convention on International Civil Aviation, including Annex 12 (Search and Rescue). The USOAP Audit Report contained a finding that:

*The IAA has established a mechanism to carry out safety oversight of the search and rescue services (SAR) (rescue co-ordination centre [RCC] and rescue co-ordination subcentre [RCSC]) under its responsibility; however, the DoT [Department of Transport] has not established a mechanism to ensure that effective safety oversight is being carried out for those entities for which it is responsible.*

It also contained the following recommendation:

*The DoT should establish a mechanism to ensure the safety oversight of the entities under its responsibility who provide SAR. In addition, the DoT should ensure that:*

- a) the SAR inspectorate is comprised of a sufficient number of qualified staff;*
- b) functions, job descriptions and minimum qualifications requirements of SAR inspectors are established;*
- c) a training programme detailing types of training, a training plan highlighting priorities and satisfactory completion of on-the-job training are established for SAR inspectors;*

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<sup>8</sup> There is no Annex 1 published with this document on the IAA website.

*d) a manual/handbook which incorporates applicable procedures for all functional areas to be covered (including procedures for the conduct of oversight of all SAR entities) is developed; and*

*e) a mechanism with timeframe for the elimination of the deficiencies identified is established and implemented.*

The corrective actions proposed by the DTTAS in the Final Report of the ICAO USOAP of Ireland 2010 were as follows:

#### *Appendix 3-7-3*

#### *Corrective Action Plan Proposed By Ireland Related To Air Navigation Services State's Comments And Observations*

*Ireland partially accepts this finding. However, we wish to point out that in the opinion of the DoT and the IAA, the State's SAR system is fully in accordance with the internationally agreed ICAO/IMO [International Maritime Organisation] arrangements for the purposes of Annex 12 through a synergy of marine and aeronautical resources (Ref: IAM<sup>9</sup>/SAR Manual Doc 9731-AN958).*

*The ICAO and IMO acknowledge the desirability of fostering co-operation between aviation and maritime authorities to handle Search and Rescue and the IAMSAR Manual sets out arrangements which are acceptable to ICAO for the provision of SAR.*

<b>Corrective Action (S) Proposed</b>	<b>Action Office</b>	<b>Estimated Implementation Date(S)</b>
<i>The DoT will make appropriate arrangements to engage a suitably qualified entity to develop an inspection model.</i>	<i>DoT</i>	<i>June 2011</i>
<i>The DoT will make appropriate arrangements to engage a suitably qualified entity to carry out safety oversight of those entities carrying out maritime SAR for which it is responsible. This will be conducted in consultation with the IAA and relevant competent organisations. Particular emphasis will be placed on supervision of the maritime SAR functions as outlined in the finding.</i>	<i>DoT</i>	<i>December 2011</i>
<i>The DoT in conjunction with the IAA will explore the possibility of moving towards a national JRCC [Joint Rescue Coordination Centre].</i>	<i>DoT &amp; IAA</i>	<i>June 2012</i>

<sup>9</sup> **IAM:** International Aeronautical and Maritime  
*Air Accident Investigation Unit Report 2018-004*



DTTAS informed the Investigation that records held by its Aviation Safety and Security Division (ASSD) show that in 2014/2015 the UK Maritime Coastal Agency (MCA) agreed to provide SAR safety oversight functions with regard to the Marine RCC and RCSCs of the IRCG of DTTAS, and that access would be given for IRCG to all records in order to satisfy itself concerning the SAR Inspectors' functions, responsibilities, job description, qualifications, experience and training programme, plan and records.

The IAA has informed the AAIU that it is of the understanding that this finding remains open.

Correspondence from DTTAS to the Investigation stated that the IAA has informed the Department's ASSD that it was the understanding of the IAA that this ICAO finding cannot be closed out until a site visit has been conducted by ICAO or EASA on its behalf, which will be done at the next available opportunity.

## **2.6.8 Irish National Maritime Search and Rescue Framework**

The Irish National Maritime Search and Rescue (SAR) Framework, Final Version, was published by the Minister for Transport on 2 March 2010. It states:

*1.4.2 No provisions of this Framework are to be construed in such a way as to contravene responsibilities and authorities of any participant as defined by statutes, executive orders or international agreements or of established responsibilities of other agencies and organisations that regularly assist persons and property in distress.*

...

*1.6.1 The Department of Transport (DoT) exercises overarching responsibility for maritime and aviation SAR services and for maritime and aviation safety through its Divisions, agencies, the IAA, airport, port and harbour authorities.*

...

*1.6.3 The Irish Aviation Authority (IAA) is a semi state agency responsible to the DoT for the provision of Air Traffic Services including Air Traffic Control and the coordination of Aeronautical SAR emergency response. The IAA maintains an Aviation Rescue Co-ordination Centre (ARCC) at Shannon Airport and an Aviation Rescue Sub-Centre (ARSC) at Dublin Airport. The Safety Regulation Division of the IAA is the body responsible for the regulation and oversight of aircraft operations, including aeronautical Search and Rescue, within the State.*

...

*2.3.4: The Safety Regulation Division of the Irish Aviation Authority has the function with regard to aviation legislation and regulatory oversight of all civilian aircraft operations, including in this case Search and Rescue.*

## 2.6.9 European Regulations

Both Regulation (EC) No 216/2008 (as amended) and Regulation (EC) No 1108/2009 state that:

*This Regulation shall not apply to: (a) products, parts, appliances, personnel and organisations referred to in paragraph 1(a) and (b) while carrying out military, customs, police, search and rescue, firefighting, coastguard or similar activities or services. The Member States shall undertake to ensure that such activities or services have due regard as far as practicable to the objectives of this Regulation.*

## 2.6.10 Oversight of SAR Aviation Operations in Ireland - Summary

The Investigation has engaged directly with the IAA, the Department of Transport, Tourism and Sport, IRCG, the Operator and EASA in relation to the oversight of SAR operations. Whilst examination of this oversight function is continuing, and acknowledging the “*New Action a*” in the IAA’s State Safety Plan 2017-2020, the Investigation believes that greater clarity regarding the individual and collective responsibilities for oversight of all aspects of SAR aviation operations in Ireland is required. Accordingly, an Interim Safety Recommendation is issued to the Minister for Transport, Tourism and Sport in this regard (Section 3.2).

## 3 INTERIM SAFETY RECOMMENDATIONS

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### 3.1 Preliminary Report

The [Preliminary Report](#) contained two Interim Safety Recommendations. Each was replied to by its addressee and the current situation regarding these is set out below.

#### 3.1.1 Interim Safety Recommendation IRLD2017005

CHC Ireland should review/re-evaluate all route guides in use by its SAR helicopters in Ireland, with a view to enhancing the information provided on obstacle heights and positions, terrain clearance, vertical profile, the positions of waypoints in relation to obstacles and EGPWS database terrain and obstacle limitations ([IRLD2017005](#)).

On 10 October 2017, the Operator advised the AAIU by letter that:

1. CHCI Manager of Flight Operations (MFO) issued Flight Staff Instruction (FSI) – 030 CHCI Route Guide on 14th April 2017 (see attached<sup>10</sup>). This FSI put immediate additional weather controls on the use of all routes within the current route guide, pending the full review in accordance with the Safety Recommendation, and is still in force today.

<sup>10</sup> Files which were provided to the AAIU as supporting material will not be made available by the AAIU to any third party.



2. *A review of all routes in the CHCI route guide was conducted between April and June 2017 culminating in a general communication sent to all staff by email on the 4th July 2017 (see attached files:*
  - a. *Email sent to all CHCI flight and technical crew which provided an update to all personnel on the progress and methodology being used to review the route guide.*
  - b. *Plates\_Preamble\_and\_Guides\_2017-Jun-30 which provides a detailed explanation of the process for 'proving' the routes as well as introducing the new format and content of each route.*
  - c. *Proving flight check list\_v2 which is the actual checklist to be completed by the crews allocated to conduct each of the proving flights.*
3. *The first review of 'proving flight check lists' provided by crew having flown the revised routes, was conducted on 5th September 2017. The review takes into consideration obstacle heights and positions, terrain clearance, vertical profile, positions of waypoints in relation to obstacles and EGPWS database terrain and obstacle limitations. Any revisions required are currently being input and this process is due for completion by 30th October 2017.*

The operator further advised by email on 12th March 2018 that:

*The Route Guide has been reviewed and re-evaluated in line with the Safety Recommendation contained within the Preliminary Report dated 14 April 2017. Following an extended period of 'proving' the revised routes (a process undertaken by a number of crews from across the bases), pre-publication of the revised FMS Route Guide details had been circulated to crews via a company Ops Memo. The new FMS Route Guide will be formally encapsulated in the relevant Operations Manual (OMC) as part of the next scheduled revision to be submitted to the IAA at the end of March 2018.*

The Investigation considers that this Interim Safety Recommendation remains open.

### **3.1.2 Interim Safety Recommendation IRLD2017006**

RFD Beaufort Ltd should review the viability of the installation provisions and instructions for locator beacons on Mk 44 lifejackets and if necessary amend or update these provisions and instructions taking into consideration the beacon manufacturer's recommendations for effective operation ([IRLD2017006](#)).

On 7 July 2017 RFD Beaufort informed the AAIU by email that:

*Following our review with [the Operator] concerning the Mk44 lifejacket and integration of the SARBE 6 406 beacon, we have performed a number of modifications to the lifejacket to optimize the performance of the beacon unit. These changes have also been validated through a trial with [the Operator] and MRCC last month, as the report attached refers.*

*Our next action is to formalize the service bulletin advising of the change and have one of our Part 145 organizations preform the necessary revision to [the Operator's] lifejackets. An advance draft of the service bulletin is included within the report and we will provide you with a copy of the final version when it is released. We will also advise when all the [the Operator's] lifejackets have been updated and returned to them.*

On 8 March 2018, RFD Beaufort provided the following update to the AAIU:

*In May 2017 we (RFD Beaufort), in conjunction with the Operator, carried out a review of the Mk44 lifejacket and the integration of the SARBE 6 406 beacon. Following this review we performed a number of modifications to the lifejacket and validated the changes through a trial with the Operator and MRCC held in June 2017. In August 2017, we formalised the modification by issuing Service Bulletin 25-147, Version 1. This service bulletin describes the components, tools and method required to install the SARBE 6 406 Beacon in the Mk 44 lifejacket such that the signals from the beacon antennas meet requirements.*

*In February 2018 we issued Service Bulletin 25-147, Version 2, to provide the maintenance and service personnel more detailed instructions on the installation of the beacon, the routing of cables and positioning of the antennas. A copy of this service bulletin has been provided to EASA.*

The Investigation considers that this Interim Safety Recommendation remains open.

## 3.2 New Interim Safety Recommendations

Whilst the process of gathering and analysing information continues, the Investigation is making three further Interim Safety Recommendations at this time.

### 3.2.1 Flight Data Recording System

As a consequence of the issues identified with the coarseness of the latitude and longitude position information recorded on the FDR, as outlined in **Section 2.4** and as further detailed in **Appendix A**, the Investigation makes the following Interim Safety Recommendation to the helicopter Manufacturer:

The Sikorsky Aircraft Corporation should make the necessary updates/modifications to the S-92A helicopter to ensure that the latitude and longitude information recorded on the Flight Data Recorder reflects the most accurate position information available during all flight regimes and mission profiles ([IRLD2018001](#)).





### 3.2.2 Operator's Safety Management System (SMS)

Arising from the Investigation's data gathering and analysis of the Operator's SMS to date, as outlined in **Section 2.5**, and notwithstanding that work is continuing to obtain and analyse all relevant information, the following Interim Safety Recommendation is issued to the Operator:

CHCI, with external input, should conduct a review of its SMS and ensure that the design of its processes and procedural adherence are sufficiently robust to maximize the safety dividend; this review should consider extant risk assessments and a thematic examination of the corpus of all safety information available to the Operator, both internally and externally ([IRLD2018002](#)).

### 3.2.3 Oversight of SAR helicopter Operations in Ireland

The Investigation continues to engage with the IAA, the Department of Transport, Tourism and Sport, IRCG, the Operator and EASA in relation to the oversight of SAR operations (**Section 2.6**). Notwithstanding this ongoing engagement, the following Interim Safety Recommendation is issued to the Minister for Transport, Tourism and Sport:

The Minister for Transport, Tourism and Sport, as the issuing authority for the Irish National Maritime Search and Rescue Framework, should carry out a thorough review of SAR aviation operations in Ireland to ensure that there are appropriate processes, resources and personnel in place to provide effective, continuous, comprehensive and independent oversight of all aspects of these operations ([IRLD2018003](#)).



## 4 ONGOING ACTIVITIES

The Investigation continues to examine a number of areas, including but not limited to:

- The proximate and contributory factors of the accident sequence
- The Operator's Safety Management System (SMS)
- The Operator's Operations Manuals
- The Operator's training and arrangements for safety critical activities defined as secondary roles
- Cockpit ergonomics during night operations
- The Operator's Route Guide
- Navigation information, procedures and charting
- Warning systems, including the Enhanced Ground Proximity Warning System (EGPWS)<sup>11</sup>
- IRCG tasking procedures
- The Irish National Maritime Search And Rescue (SAR) Framework
- Oversight of National SAR aviation operations in Ireland
- The utilisation profile of SAR helicopters in Ireland in recent years

The Investigation is ongoing and the AAIU will publish a Final Report in due course.

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<sup>11</sup> The EGPWS manufacturer (Honeywell) informed the Investigation that "Black Rock Island was added to the terrain database in release 485/585. The database was posted on Honeywell's website on June 14, 2017."  
*Air Accident Investigation Unit Report 2018-004*



## Appendix A: Recorded Data

### 1 MPFR Examination

The helicopter was equipped with a Penny & Giles D51615-102 MPFR, which served the dual purpose of CVR and FDR. The MPFR records 25 hours of the most recent flight data and just over two hours of the most recent audio data, both of which are recorded on a continuous loop. The MPFR was recovered by Irish Naval Service divers on 24 March 2017, after 10 days immersed in sea water at a depth of approximately 40 m. The MPFR was transported in a bespoke container to the AAIB at Farnborough, UK, under the escort of an AAIU Inspector of Air Accidents. The recovery process required the disassembly of the MPFR at the AAIB laboratory. During the disassembly, some minor external damage was noted on the chassis of the recorder. However, the *Accident Protected Memory Board* (APMB) containing the CVR and FDR data did not show any signs of impact damage.

It was noted that water had penetrated the inside of the crash protected enclosure (**Photo No. 1**). Examination of the memory board showed evidence of corrosion on the contacts of several of the memory devices. Electrical testing revealed short circuits which necessitated additional measures to recover the CVR and FDR recordings. These measures included de-soldering individual memory devices and re-installing them on a functional memory board provided by the manufacturer of the MPFR.



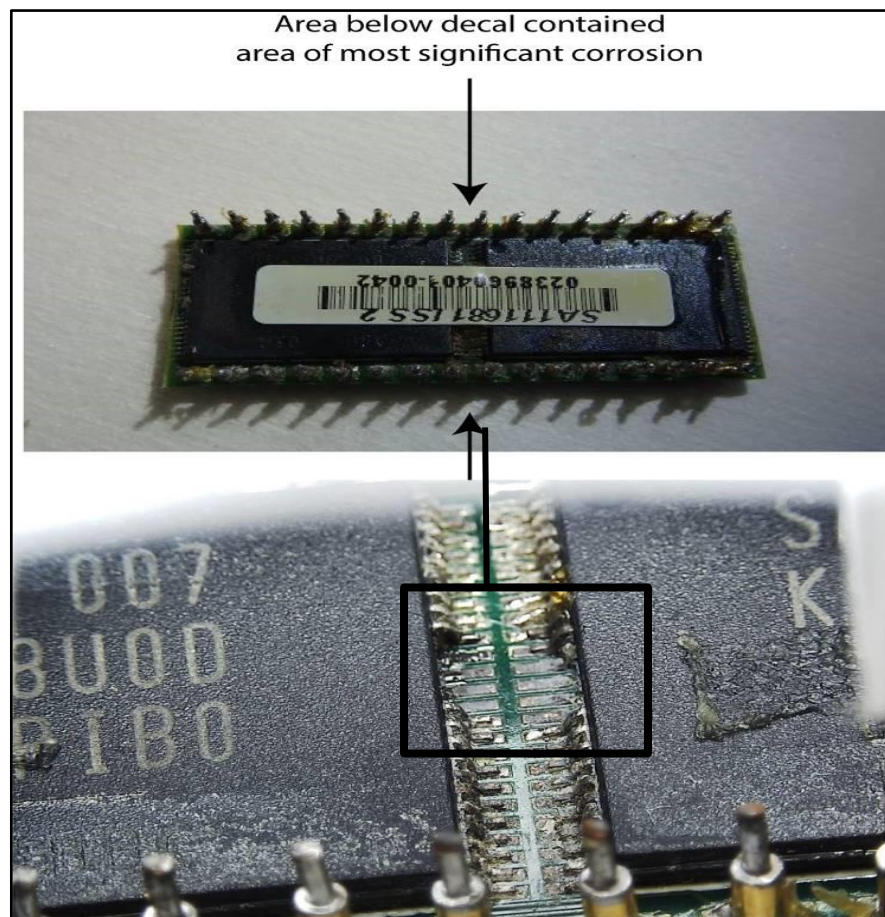
**Photo No. 1:** APMB from EI-ICR showing copper based insulation staining of glass beads

At the request of the AAIU Investigation, the AAIB undertook a comprehensive study of the corrosion on the MPFR to establish whether there were wider safety implications associated with the observed corrosion<sup>12</sup>. The study revealed that the '*first generation (GEN1)*' of this particular type of MPFR was manufactured in 2001.

<sup>12</sup> Further details of the AAIB study will be included in the Final Report.

However, in 2006 the manufacturer reviewed the design of the MPFR and identified that a change in the composition of an insulation material from boric acid to a copper-based product would improve the performance of the device if subjected to fire. This change was classified by the manufacturer as '*minor*'. As such, it was not deemed necessary to consult with EASA for certification considerations and was approved under the manufacturer's design authorisation. MPFRs with this modification were termed '*second generation (GEN2)*' MPFRs by the manufacturer.

The AAIB's study identified that, of 15 reported cases of MPFR's that had been submerged in sea water, five had suffered from corrosion of the *Accident Protected Memory Board* (APMB). All five of these units were fitted with the GEN2 *Crash Survivable Memory Module* (CSMM) incorporating a combination of copper based insulation and APMBs coated in Polyurethane. Four out of five of these units suffered from the loss of electrical pins on the memory devices due to corrosion (**Photo No. 2**).



**Photo No. 2:** Underside of FDR1 from EI-ICR showing missing pins due to corrosion

In 2013, a '*third generation (GEN3)*', alternative design<sup>13</sup> of the APMB was introduced. The CSMM insulation materials remained the same, but the conformal coating applied to the APMB was changed to '*Parylene*'<sup>14</sup>.

<sup>13</sup> Referred to by the manufacturer as the *Replacement Crash Survivable Memory Module* (RCSMM).

<sup>14</sup> Parylene is the trade name for a variety of chemical vapour deposited poly (p-xylylene) polymers used as moisture and dielectric barriers.



The manufacturer advised that this type of conformal coating had been demonstrated to provide improved protection compared to the Polyurethane used in the first and second generation CSMM. The CSMM with the alternative design of APMB was retested and passed all crash survivability requirements<sup>15</sup>. Based on data provided by the manufacturer, it is estimated that up to 1,950 GEN2 MPFRs were manufactured between 2001 and 2013.

### Safety Action Taken

During discussions regarding the content of the UK AAIB study, the following safety actions were identified and acted on by the manufacturer of the MPFR:

- As of December 2017, the MPFR manufacturer started to replace second generation CSMMs fitted to commercial aircraft with third generation CSMMs.
- In February 2018, the manufacturer of the MPFR issued *Service Bulletin (SB) No. D51615-31-22* requiring the replacement of second generation memory modules with third generation memory modules in the affected MPFRs.
- On 8 February 2018, EASA issued *Safety Information Bulletin (SIB) No. 2018-05 Multi-Purpose Flight Recorders* which recommends that owners and operators of the second generation MPFR accomplish the actions specified in the manufacturer's SB No. D51615-31-22.
- EASA has recommended that the MPFR modification program is to be completed by September 2023.

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### Further Safety Action

The manufacturer of the MPFR is also developing specialist techniques to recover data from memory devices fitted to second generation CSMMs if they suffer from a loss of pins due to water immersion.

In light of the identified safety action being taken by the MPFR manufacturer and EASA, the Investigation does not consider that an Interim Safety Recommendation is necessary at this time. The Investigation will review the progress of the associated safety actions prior to the publication of a Final Report.

## 2 Flight Data Recorder Information

The FDR component of the MPFR recorded in excess of 900 parameters over a period of 25 hours. The MPFR recorded two copies of the data (FDR1 and FDR2) to the memory card. The Investigation had previously noted (*AAIU Preliminary Report No. 2017-006*) that during an initial review of the data, there appeared to be a discrepancy of approximately 20 minutes between FDR1 and FDR2 recording durations.

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<sup>15</sup> European Organization for Civil Aviation Equipment (EUROCAE) ED-55 'Minimum Operational Performance Specification For Flight Data Recorder Systems' Category A115, ED-56A 'Minimum Operational Performance Specification For Cockpit Voice Recorder System' Amendment 1, (J)TSO-C123a and (J)TSO-C124a.



Further review of the data has established that this apparent discrepancy was due to a software processing issue (during downloading of the recorder) and that no discrepancy exists between the data recorded on FDR1 and FDR2. Accordingly, the data is an accurate recording of the parameters provided to the MPFR.

During the examination of the data recovered from the FDR, the Investigation noted that the latitude and longitude position information, whilst generally consistent with the expected flight path, appeared to contain anomalies (**Figure No. 1**).



**Figure No. 1:** Position data from FDR1 showing the flight path of EI-ICR

It was noted that the position information recorded on FDR1 produced a jagged or 'zigzag' flight path. The Investigation reviewed the position information for FDR2 for comparative purposes; this data also indicated a jagged flight path (**Figure No. 2**). The helicopter Manufacturer conducted an examination of the data processing and recording system for present position on the S-92A helicopter.



**Figure No. 2:** Position data from FDR1 and FDR2 showing the flight path of EI-ICR



The primary navigation interface between the helicopter and the flight crew is the Flight Management System (FMS). Raw GPS data is received by the FMS from satellite sensors and is provided as an input to the various aircraft systems including the *Attitude Heading and Reference System* (AHRS) and the *Multi-Function Displays* (MFDs) in order to enable accurate navigation of the helicopter. Thereafter, the position data is provided to the various recording systems on board the helicopter, such as the FDR and HUMS. The helicopter Manufacturer informed the Investigation that the position data being supplied from the AHRS to the MFD and HUMS is formatted in four parts; a *coarse* position for latitude, a *coarse* position for longitude, a *fine* position for latitude and a *fine* position for longitude. The *coarse* position is accurate to within approximately 61 ft, and the addition of *fine* position increases the accuracy of the overall position to within approximately 2 ft. It was noted by the Investigation that the MFD did not supply the four components of the position data to the FDR at all times.

The helicopter Manufacturer informed the Investigation that the MFD logic was designed to provide both *coarse* and *fine* position data to the FDR if the helicopter was travelling at a groundspeed of less than 50 kts and/or in SAR APP2 (SAR Approach Mode 2). At all other times, only *coarse* data was to be provided to the FDR, which reduced the accuracy from within 2 ft to within 61 ft approximately. During the flight of R116 on 13/14<sup>th</sup> March 2017, the helicopter departed from EIDW and accelerated to normal cruising speed. Thereafter, the FDR data indicated that it remained above 50 kts groundspeed until the end of the recording.

The helicopter Manufacturer informed the Investigation that the difference between the *coarse* and *fine* position was insufficient to account for the jagged flight path that was recorded on the FDR of EI-ICR. The MFD supplies the position data through a Data Concentrator Unit (DCU) to the FDR. This data consists of 20 bits<sup>16</sup> of information for each of the two parameters (*coarse* latitude and *coarse* longitude). Following further examination of the FDR data recording process, the Manufacturer informed the Investigation that a formatting error in the data output from the MFD to the DCU caused two bits of data to be masked (hidden) from view. This error resulted in 18 bits rather than the original 20 bits of data being recorded on the FDR for the position of the helicopter. This masking resulted in a reduction in the accuracy of the *coarse* position recorded from approximately 61 ft to 247 ft. This existence of this error has been confirmed by the helicopter Manufacturer through laboratory and flight testing.

### Safety Action

The Manufacturer advised the Investigation that the formatting error will be addressed by a future software update.

The Manufacturer has confirmed to the Investigation that the error in the formatting of position data does not affect the navigation functions of the helicopter, pilot displays, AHRS or HUMS recorded data. The error is limited to the data passed from the MFD through the DCU to the FDR. The Manufacturer also confirmed that the data processing system is unique to the S-92A helicopter and is not used in the Manufacturer's other types or variants of helicopter.

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<sup>16</sup> **Bit:** Binary Digit; a single piece of digital data, consisting of either a '1' or '0' binary value.

The Investigation acknowledges the positive engagement of the helicopter Manufacturer in identifying the root cause of the position data discrepancy in the FDR recordings. Notwithstanding the Safety Action commenced by the Manufacturer, *coarse* position data is still being provided to the FDR of S-92A helicopters. The *Manual of Accident and Incident Investigation* (ICAO DOC9756) states that ‘*The primary purpose of a modern FDR system is to capture all significant data related to the operation and performance of the aircraft*’. The Investigation is of the view that the most accurate available position should be recorded on the FDR, regardless of groundspeed, SAR mode or any other flight phase. Consequently, the Investigation makes the following Interim Safety Recommendation (as contained in **Section 3.2.1** and repeated here for continuity):

The Sikorsky Aircraft Corporation should make the necessary updates/modifications to the S-92A helicopter to ensure that the latitude and longitude information recorded on the Flight Data Recorder reflects the most accurate position information available during all flight regimes and mission profiles (IRLD2018001).

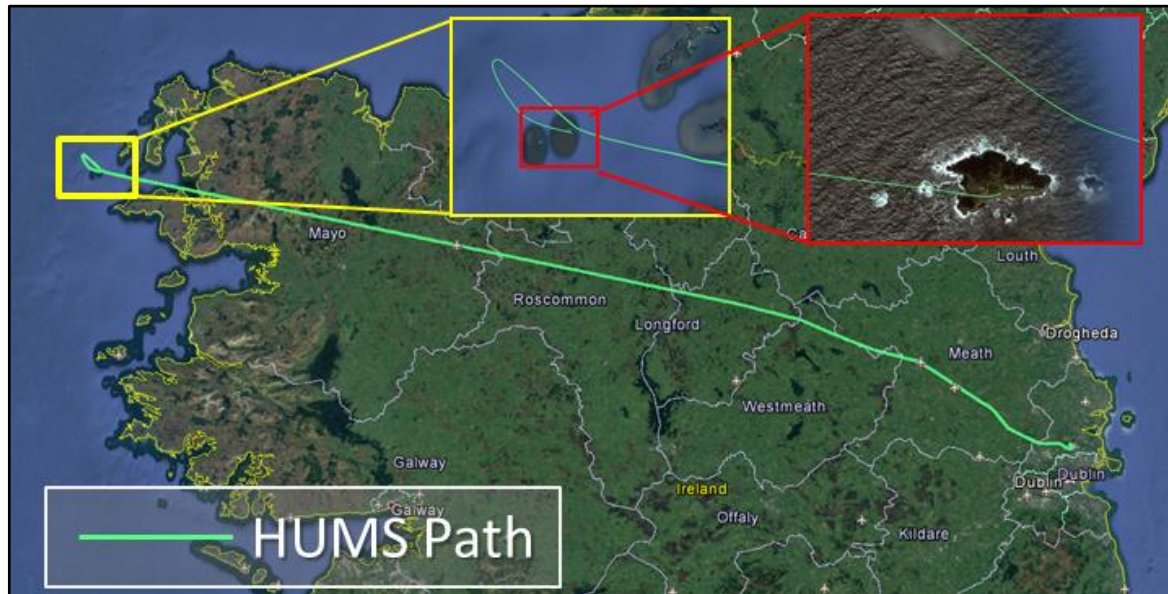
### 3 Health and Usage Monitoring System (HUMS)

The helicopter was equipped with a Goodrich HUMS. The HUMS was designed to record the status of critical systems and components on the helicopter so that early detection of progressive defects is possible through trend monitoring, thereby enabling rectification of defects before there is an effect on operational safety or efficiency. As previously described, Raw GPS data is received by the FMS from satellite sensors and is provided as an input to the various aircraft systems such as the *Attitude Heading and Reference System* (AHRS) and the *Multi-Function Displays* (MFDs) in order to enable accurate navigation of the helicopter. Thereafter, the position data is provided to the various recording systems on board the helicopter, such as the FDR and HUMS.

While the FDR receives position information from the MFDs through the DCU, the HUMS receives position data directly from the AHRS in the form of latitude and longitude. These coordinates include both *coarse* and *fine* latitude and longitude. The position accuracy is not dependent on specific flight parameters of the helicopter, such as groundspeed or SAR mode.

The position provided by the AHRS to the HUMS (**Figure No. 3**) is not subject to the data masking error previously identified by the Investigation in relation to the FDR system. Analysis conducted by the helicopter Manufacturer of the aircraft position recorded by HUMS revealed that HUMS position was not as precise as the AHRS due to the resolution of the aircraft position data in HUMS. Understanding of the resolution limitation allowed the helicopter Manufacturer to analytically correct the aircraft position data.





**Figure No. 3:** Helicopter flight path based on HUMS position data

The corrected position data is estimated by the Manufacturer to be within a margin of error of 2 ft approximately. In light of the errors previously identified in the FDR position data, the Investigation will use the corrected position data recorded on the HUMS for all analysis of the helicopter's flight path or position. The helicopter Manufacturer advised the Investigation that it is changing the HUMS software to increase resolution of aircraft position data to be as precise as the AHRS output.

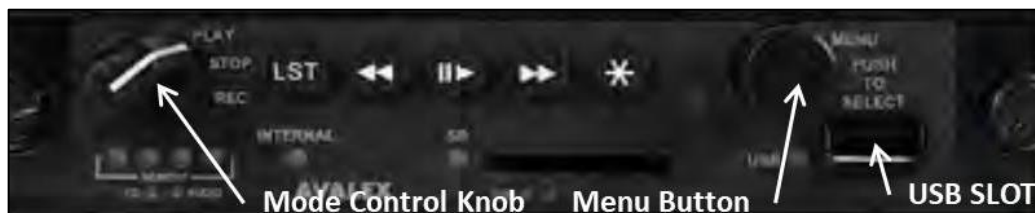
#### 4 Avalex DVR

The helicopter was fitted with an AVR-8240-XM Digital Video Recorder (DVR) manufactured by Avalex Technologies Corporation (**Photo No. 3**). The DVR provides the capability of recording video from the Wescam MX-15i EO/IR<sup>17</sup> Camera System. The system is self-contained within the control panel in the SAR Operator's console and interfaced to the SAR Operator's mission video display for EO/IR video playback. The DVR contained 16 GB<sup>18</sup> internal memory, and the capability to add either a SD Flash Card or a USB<sup>19</sup> Flash drive for recording. Both memory devices are removable. The DVR was controlled by the use of a *Mode Control* knob to select PLAY, STOP or REC (record) functions, and a *Menu* button which provided access to optional functions such as video quality selection and storage locations for the recorded video data.

<sup>17</sup> **EO/IR:** Electro-optic and infrared

<sup>18</sup> **GB:** Gigabyte; one gigabyte is equivalent to 1,000,000,000 bytes.

<sup>19</sup> **USB:** Universal Serial Bus



**Photo No. 3:** Avalex AVR-8240-XM Digital Video Recorder

The DVR (**Photo No. 4**) was recovered from the seabed on 23 July 2017. The unit was damaged and both the *Menu* button and *Mode Control* knob were missing from the panel. It was not possible to determine by visual inspection of the panel which position the Mode Control knob was set to at the time of the accident. It was also not possible to determine which media (USB, SD Card, internal) was selected as the storage location for recorded data.



**Photo No. 4:** Avalex AVR-8240-XM Digital Video Recorder from EI-ICR

The unit was brought to the NTSB Vehicle Recorder Section for analysis. Three video files were recovered from a USB flash drive which was present in the USB slot on the front panel of the DVR, including a video file from a mission conducted by a different crew in EI-ICR on 12 March 2017. The files occupied 1 GB of space on the USB drive. There were no files relating to any flights after 12 March 2017 on the USB device, which had approximately 15 GB of free space remaining.

- END -

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No. 996/2010, and Statutory Instrument No. 460 of 2009, Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulation, 2009, the sole purpose of this investigation is to prevent aviation accidents and serious incidents. It is not the purpose of any such investigation and the associated investigation report to apportion blame or liability.

A safety recommendation shall in no case create a presumption of blame or liability for an occurrence.

Produced by the Air Accident Investigation Unit

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