

**Alauda Airspeeder
Mk II**

**Goodwood
Aerodrome, West
Sussex**

4 July 2019

Accident

Investigation Synopsis

Whilst performing a demonstration flight, the remote pilot lost control of the 95 kg Alauda Airspeeder Mk II scale demonstrator. After the loss of control had been confirmed by the remote pilot, the safety 'kill switch' was operated but had no effect. The Unmanned Aircraft then climbed to approximately 8,000 ft, entering controlled airspace at a holding point for flights arriving at Gatwick Airport, before its battery depleted and it fell to the ground. It crashed in a field of crops approximately 40 m from occupied houses and 700 m outside of its designated operating area. There were no injuries.

The AAIB found that the Alauda Airspeeder Mk II was not designed, built or tested to any recognisable standards and that its design and build quality were of a poor standard. The operator's Operating Safety Case contained several statements that were shown to be untrue.

The Civil Aviation Authority's Unmanned Aircraft Systems (UAS) Unit had assessed the operator's application and, after clarification and amendment of some aspects, issued an exemption to the Air Navigation Order to allow flights in accordance with the operator's Operating Safety Case. The Civil Aviation Authority did not meet the operator or inspect the Alauda Airspeeder Mk II before the accident flight.

There have been many other similar events where control of an unmanned aircraft has been lost, resulting in either it falling to the ground or flying away. Even a small unmanned aircraft falling from a few metres could cause a fatal injury if it struck a person.

The Civil Aviation Authority and the organisation which designed and operated the Airspeeder Mk II have introduced measures to address a number of issues identified during the course of the investigation. In addition to the actions already taken this investigation report makes 15 Safety Recommendations regarding the operator's procedures, airworthiness standards and the regulatory oversight.

Safety Recommendation 2021-001

Justification

During the course of the investigation the operator demonstrated little knowledge or understanding of appropriate industry standards, in particular, those relating to airworthiness and for developing electronic hardware and software.

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-001

It is recommended that Riotplan Proprietary Limited, trading as Alauda Racing, amends its processes to ensure that it designs, builds and tests unmanned and manned aircraft in accordance with appropriate standards to ensure the safety of those who may be affected by their operation.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 12 May 2021

Immediately following the incident, Alauda discontinued use of the Airspeeder MkII aircraft in all operations. To formally remove the aircraft from use, this included re-submission of manuals to the Australian Civil Aviation Safety Authority (CASA) and updating subsequent company approvals to remove the MkII from our Australian Remote Operating Certificate (ReOC). Alauda continues to develop the uncrewed Airspeeder Mk3, and has recently undertaken a comprehensive flight test with a Civil Aviation Safety Authority (CASA) RPAS inspector on 28 April 2021 that consisted of a formal assessment and acceptance by a Delegate of the Australian Director of Aviation Safety to include the Airspeeder Mk3 on the companies Remote Operating Certificate (ReOC) to commercially operate this Remotely Piloted Aircraft System (RPAS). At the time of sending this response we are awaiting the outcome of our formal assessment. Alauda has also implemented electronic reporting software (AVCRM) to ensure ongoing compliance with CASA Part 101 (Unmanned Aircraft and Rockets) Manual of Standards, Chapter 10. AVCRM software also supports the implementation of Alauda's Safety Management System (SMS).

Alauda has proactively introduced an aviation SMS. This exceeds the regulatory requirement and ensures safety is at the highest priority in development and operation of our aircraft and this system is under continuous improvement as the company continues to grow.

In addition, as set out in the Engineering Management Plan, which was previously shared with the AAIB, Alauda has employed key personnel to ensure ongoing compliance and safety, with experience in the aviation industry. In the design of the Airspeeder Mk3 and in all facets of the operation, Alauda has built processes and procedures with a total commitment to aviation safety and continuous improvement. Our processes have been redesigned to include the following measures:

Powertrain system architecture design and analysis processes to ensure redundancy of the system. This analysis includes failure modes and effect (FMEA) analysis and fault tree system safety analysis of the entire system and subsystems. This analysis takes into account the probability of failure of individual components and the effects of such failures.

Safety Recommendation Status **Closed**

AAIB Assessment **Adequate**

Action Status **Planned Action Completed**

Feedback rationale

(EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

N/A

(SRIS Reference:)

Safety Recommendation 2021-002

Justification

The investigation identified that the operator identified 16 hazards with potentially catastrophic outcomes. Each was given a mitigation which reduced the likelihood and consequence to a level considered acceptable by the CAA. As these mitigation measures relied on airworthy systems, this could not be assured without detailed scrutiny of the design and manufacture of the aircraft. There was no requirement to carry out a detailed evaluation of such systems in CAP722

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-002

It is recommended that the Civil Aviation Authority update Civil Aviation Publication 722, Unmanned Aircraft System Operations in UK Airspace – Guidance & Policy, to require detailed evaluation of any Unmanned Aircraft Systems that use onboard systems to mitigate risks with Risk Severity Classifications of 'Major', 'Hazardous' or 'Catastrophic'.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 20 December 2022

We have recently updated our risk assessment methodology in CAP 722A to include a ten step method designed to assist with the identification of functional hazards, failure modes and mitigation means. In the longer term, this Safety Recommendation will be satisfied through the introduction of the UK Specific Operational Risk Assessment (SORA). SORA, as developed by the Joint Authorities for Rulemaking on Unmanned Systems (JARUS), remains a developing piece of work where version 2.5 has recently been published for external consultation on the JARUS website. We have been engaged with JARUS throughout this process and are expecting to start a comprehensive review of this latest version which will kick off the development of the UK SORA. Whilst we believe this satisfies the intent of Safety Recommendation 2021-022, this work is not expected to be complete until Q1/2 of 2024 and consequently, if this Safety Recommendation is to remain open, an update will not be available until the UK SORA is in place.

Safety Recommendation Status Closed

AAIB Assessment Adequate

Action Status Planned Action Completed

Feedback rationale

(EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 25 July 2022

The Remotely Piloted Aircraft System (RPAS) Cyber engagement procedure has been updated to include an initial audit meeting between the assigned Cyber Certification Specialist and the RPAS Lead Auditor. This is conducted before commencing an OSC assessment and is like that which the Cyber Team conducts with the Project Certification Manager prior to an Initial Airworthiness assessment. The purpose of this meeting is to evaluate:

1. The complexity of the application.
2. The level of cyber requirements for the application; based on the complexity and the type of operation.
3. The subsequent level of involvement of the CAA for the application.

Additionally, the RPAS Sector Team is conducting a targeted recruitment campaign where three positions have so far been filled introducing new skill sets such as Structures, Operations, and Dangerous Goods. Budgetary approval has also been given to recruit additional resource in the form of two Software, one Battery and one Rotary Wing specialists.

This SR will be satisfied through the introduction of the Specific Operational Risk Assessment (SORA) however, given the sizeable nature of this work-strand it is not expected to be complete until the first half of 2024. In the interim, the current regulatory framework, particularly Article 11 and Article 12 to 'UK Regulation (EU) 2019/947', coupled with the extant CAP 722A and the newly developed AMC and GM will partially address the intent of this SR.

AAIB Assessment – Partially Adequate Open

Response received: 23 December 2021

A new edition of CAP722A is scheduled for publication in first quarter of 2022. This will address all the above recommendations.

AAIB Assessment – Partially Adequate Open

Response received: 11 May 2021

The CAA accepts this recommendation:

The RPASU has recruited an RPAS Technical Inspector with a specific background in airworthiness and avionics engineering, who has spent recent years working as an SMS and safety specialist for complex RPAS operations. This allows the RPAS Sector Team (RPASST), who have responsibility for the assessment of Operating Safety Cases (OSCs), to deploy in-house airworthiness experience for the analysis of specific aircraft or systems.

A policy has been built and will be approved in the near future to trigger the involvement of other capability areas when in-house expertise is insufficient, calling on resources from the CAA's Cyber and Airworthiness capability teams. The other capability teams will be consulted on 'triggers' that would result in their involvement being requested, so they are able to help inform if assistance is required. If an onboard system is used to mitigate a risk originally classified as Major or above, the internal and external airworthiness experts will be specifically consulted.

Coincidentally with, but not as a result of, the accident, the risk assessment process and methodology was moved from its location as Appendices B, C and D of CAP 722, into its own, self-contained document entitled "CAP 722A - Unmanned Aircraft System Operations in UK Airspace – Operating Safety Cases";

This move took place in July 2019 and some elements of content were updated at the time. As a result, this recommendation is interpreted to apply to CAP 722A rather than the 'parent' CAP 722 document.

As a result of the introduction of the new UAS regulations, which became applicable on 31 December 2020, the CAA has been undertaking a wholesale update of CAP 722A to be published during Spring 2021. The points relating to this recommendation will included in this update.

The new edition of CAP 722A will also include the Specific Operations Risk Assessment (SORA) methodology, affirming the CAA's aim to meet safety objectives to continue to mitigate these risks.

AAIB Assessment – Adequate Open

(SRIS Reference:)

Safety Recommendation 2021-003

Justification

To ensure that UAS operators carefully consider radio surveys as part of their pre-flight preparations, further emphasis should be included in CAP 722 to ensure UAS operators carefully consider radio surveys as part of pre-flight preparations.

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-003

It is recommended that the Civil Aviation Authority update Civil Aviation Publication 722, Unmanned Aircraft System Operations in UK Airspace – Guidance & Policy, to provide guidance on the planning, completion and documenting of Radio Frequency surveys to reduce the risk of Radio Frequency interference or signal loss when operating Unmanned Aircraft Systems.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 20 December 2022

As previously reported, CAP 722A describes the Command and Control (C2) performance reduction considerations necessary due to potential Radio Frequency interference and introduces the need to conduct a site survey to assess hazards associated with high-intensity radio transmissions. This guidance has now been enhanced through the introduction of GM1 UAS.SPEC.050(1)(c) whereby the UAS Operator should consider the integrity of the C2 link. This includes a detailed description of the C2 architecture and the operational link management system, including the provision of any contingency measures against loss of C2 link. We believe this satisfies the intent of SR 2021-003.

Safety Recommendation Status Closed

AAIB Assessment Adequate

Action Status Planned Action Completed

Feedback rationale

(EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 25 July 2022

CAP 722A currently describes the Command and Control (C2) performance reduction considerations necessary due to potential Radio Frequency interference and introduces the need to conduct a site survey to assess hazards associated with high-intensity radio transmissions. This guidance will be bolstered through the introduction of new GM where a detailed description of the C2 architecture and operational link management system, including contingency measures against loss of C2 link, is required. This can be found under GM1 UAS.SPEC.050(1)(c) of the new AMC & GM. A further update will be provided by 31 December

2022.

AAIB Assessment – Partially Adequate Open

Response received: 23 December 2021

A new edition of CAP722A is scheduled for publication in first quarter of 2022. This will address all the above recommendations.

AAIB Assessment – Partially Adequate Open

Response received: 11 May 2021

The CAA accepts this recommendation:

CAP 722A; Unmanned Aircraft Operations in UK Airspace – Operating Safety Cases; is the source document that provides guidance to applicants in the specific category on what should be included in an OSC that supports their application. Guidance detailing possible methods to prove how robust a Command and Control (C2) link is will be provided and the potential efficacy of RF surveys will be highlighted, although the emphasis will be on the requirement for the applicant to prove and evidence a secure link.

As noted in the response to SR2021-002 above. CAP 722A has replaced the text that was previously contained within CAP 722's Appendices B, C and D; as a result, this recommendation is interpreted to apply to CAP 722A rather than the 'parent' CAP 722 document.

As a result of the introduction of the new UAS regulations, which became applicable on 31 December 2020, the CAA has been undertaking a wholesale update of CAP 722A to be published during 2021. The points relating to this recommendation will included in this update.

AAIB Assessment – Adequate Open

(SRIS Reference:)

Safety Recommendation 2021-004

Justification

The investigation found that the failure of the only safety system installed in the Airspeeder Mk 2 was probably due to a loss of signal for 'poor signal'. If an RF survey has been stated as a mitigating factor to reduce the risk of a "poor signal" related failure, or to support the use of an RF-enabled safety system, then proof of example surveys should be provided as part of the approval process.

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-004

It is recommended that the Civil Aviation Authority require Unmanned Aircraft System operators, that use unmanned aircraft which rely on a radio link to operate safety systems, to provide Radio Frequency survey reports to the Civil Aviation Authority for review, to ensure they are suitable and sufficient.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 20 December 2022

In line with our previous update, we remain engaged with both the Communication, Navigation and Surveillance (CNS) Team and Ofcom. Currently, there is no legal requirement within the UK Regulation (EU) 2019/947 for UAS Operators to provide separate radio frequency reports to the CAA. However, guidance has been developed and is contained within CAP 722A5 and AMC1 UAS.SPEC.050(1)(g) advising UAS Operators to retain records in order to assist ongoing oversight by the CAA. We believe this meets the intent of SR 2021-004.

Safety Recommendation Status Closed

AAIB Assessment Not Adequate

Action Status Planned Action Completed

Feedback rationale

The AAIB recognises the work done by the CAA in developing the guidance is contained within CAP 722A5 and AMC1 UAS.SPEC.050(1)(g) requesting operators retain records of radio frequency reports but it does not meet the intent of the Safety Recommendation.

The guidance provides advice to operators but there is no requirement for the CAA to independently review the reports to ensure they are suitable and sufficient prior to commencing operations.

RESPONSE HISTORY

Response received: 25 July 2022

Regular engagement with the Communication, Navigation and Surveillance (CNS) Team has been established for when the use of sensors, such as Electronic Conspicuity and VHF-VHF communications, is

identified. The CAA is also working with Ofcom to create an authorisation process for a spectrum to be used for RPAS operations as well as to create an authorisation process for the safe use of RF equipment, which will include technology, spectrum, and licensing options; this process will be subject to Public Consultation. Additionally, a workshop with Ofcom is to be set up which, coupled with the CNS engagement, will ensure spectrum interference issues are being addressed. A further update will be provided by 31 December 2022.

AAIB Assessment – Partially Adequate Open

Response received: 23 December 2021

If an Operator relies on a technical safety feature which requires RF triggering, following the incident that generated these recommendations, it is unlikely to be accepted. Only systems that fail safe or activate in the event of a loss of link would be considered as acceptable.

If a loss of RF link, or an inability to establish a link, would result in an unsafe condition, then a comprehensive approach to RF surveys would be required and would be assessed. The RPAS Sector Team are producing an appropriate policy. An initial internal action has been identified to liaise with a spectrum specialist in the CNS team at the CAA to understand what a good RF survey may look like.

The likelihood of this type of requirement appearing is considered very small given the lessons learned from the Alauda Airspeeder incident.

AAIB Assessment – Partially Adequate Open

Response received: 11 May 2021

The CAA partially accepts this recommendation:

Following the advice to be published in response to SR2020-003 above, any RF surveys or similar produced must be made available to the CAA on request. The new UAS Regulations include a requirement for any documentation to be made available to the CAA on request.

If an RF survey has been stated as a mitigating factor to reduce the risk of a C2-related failure, or to support the use of an RF-enabled safety system as per this accident, then proof of example surveys will be required as part of the approval process. Reference to RF surveys, methodology for conducting them, and their suitability as a safety mitigation has been added to the RPASST checklist for assessing audits.

For other typical cases, the RPASST have added to their renewal assessment audit checklist an opportunity to request examination of example RF survey reports to check compliance.

AAIB Assessment – Adequate Open

(SRIS Reference:)

Safety Recommendation 2021-005

Justification

The definition of UAS operational and safety areas relies on the use of accurate mapping or imagery together with trajectory calculations which take into account human or automated safety system reaction times and the UAS' maximum speed and altitude. CAP 722 does not contain any guidance on how operational and safety areas should be defined.

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-005

It is recommended that the Civil Aviation Authority update Civil Aviation Publication 722, Unmanned Aircraft System Operations in UK Airspace – Guidance & Policy, with guidance on how to define an Unmanned Aircraft System's operational and safety areas, using up-to-date maps, accurate trajectory analysis and human or automated safety system reaction times, to ensure a safe operation.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 20 December 2022

Guidance for UAS Operators to conduct a thorough examination of current and relevant mapping and planning tools is now located in GM1 UAS.SPEC.050(1)(h), and is supported in CAP 722A. It also contains guidance on Remote Pilot 'reaction time analysis' to help address potential latency issues that may affect the time taken to execute a command resulting in the Unmanned Aircraft inadvertently leaving the Operational Volume. We believe this meets the intent of Safety Recommendation 2021-005.

Safety Recommendation Status Closed

AAIB Assessment Adequate

Action Status Planned Action Completed

Feedback rationale

(EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 25 July 2022

New GM will include guidance for Unmanned Aircraft System (UAS) Operators to conduct a thorough examination of current and relevant mapping and planning tools. It will also contain guidance on Remote Pilot reaction time analysis and UAS trajectory calculations in the event of a critical system failure. Some of the text is still under development but will be found under GM1 UAS.SPEC.050(1)(h) of the new AMC & GM. A further update will be provided by 31 December 2022.

AAIB Assessment – Partially Adequate Open

Response received: 23 December 2021

A new edition of CAP722A is scheduled for publication in first quarter of 2022. This will address all the above recommendations.

AAIB Assessment – Partially Adequate Open

Response received: 11 May 2021

The CAA accepts this recommendation:

The RPAS Policy Team (RPASPT) will introduce this in a future edition of either CAP 722 or one of its subordinate documents.

Reference is already made in CAP722A to aeronautical charts and the AIP, and it makes clear that ‘non-established’ sites require an assessment for suitability; however, it does not make clear what a ‘non-established’ site is, and therefore when a site assessment is not required. Furthermore, it does not make clear that any digital imagery (Google maps etc) used must be verified as being correct, and that site layouts (particularly aerodromes) may change, since digital imagery was captured.

The CAA will update CAP 722A to clarify these points and will ensure that these aspects are fully considered when assessing future risk assessments.

CAP 722A provides limited guidance in regard to the use of trajectory estimation when determining the emergency buffer zone around the flight volume. The CAA will update CAP 722A with further guidance on this, and the inclusion of reaction times where manual systems are involved. The updated CAP 722A also introduces the concept of operational volume, and emergency buffer, including factors to take into account when determining their size. The operational volume is the area within which the RPAS operation is planned to be contained within, while the emergency buffer is an extension to this area that may be used, but only in the event of a failure.

AAIB Assessment – Adequate Open

(SRIS Reference:)

Safety Recommendation 2021-006

Justification

CAP 722 does not require the installation of safety systems or detail any examples of safety systems. In addition, not all UAS operating with an exemption to the ANO or an Operational Authorisation are required to be fitted with safety systems. The use of such systems provides additional protection in the event of a malfunction of the UAS.

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-006

It is recommended that the Civil Aviation Authority update Civil Aviation Publication 722, Unmanned Aircraft System Operations in UK Airspace – Guidance & Policy, to provide examples of Unmanned Aircraft System safety systems.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 20 December 2022

UAS safety system examples can now be found under GM1 UAS.SPEC.050(1)(h). Whilst it is not mandated to have an installed safety system, the Guidance Material (GM) ensures UAS Operators give due consideration to any safety system that could substantially reduce risk to both the aircraft and the public. Additional guidance on the systems description is provided in CAP 722A. We believe this meets the intent of Safety Recommendation 2021-006.

Safety Recommendation Status Closed

AAIB Assessment Adequate

Action Status Planned Action Completed

Feedback rationale

(EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 25 July 2022

The CAA provides several UAS safety system examples within the extant CAP 722A which have now been transferred into the new AMC and GM. Additionally, whilst it is not mandated to have an installed Unmanned Aircraft (UA) safety system, GM will also ensure UAS Operators give due consideration to any safety system that could substantially reduce risk to both the aircraft and the public. This can be found under GM1 UAS.SPEC.050(1)(h) of the new AMC and GM. A further update will be provided by 31 December 2022.

AAIB Assessment – Partially Adequate Open

Response received: 23 December 2021

A new edition of CAP722A is scheduled for publication in first quarter of 2022. This will address all the above recommendations.

AAIB Assessment – Partially Adequate Open

Response received: 11 May 2021

The CAA accepts this recommendation:

The existing guidance on RPAS safety systems is included in CAP 722A Section 2, para 1.13. This will be expanded during the rewrite occurring in early 2021. The safety improvement provided by multiple, layered safety systems will be emphasised. Examples of some typical mass-market systems such as ballistic recovery systems will be included.

Internal audit checklists referring to the technical volume of OSCs already required the auditor to assess whether any safety systems are appropriately installed and maintained.

Examples of some typical mass-market systems such as ballistic recovery systems will be included.

AAIB Assessment – Adequate Open

(SRIS Reference:)

Safety Recommendation 2021-007

Justification

CAP 722 does not require the installation of safety systems or detail any examples of safety systems. In addition, not all UAS operating with an exemption to the ANO or an Operational Authorisation are required to be fitted with safety systems. The use of such systems provides additional protection in the event of a malfunction of the UAS.

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-007

It is recommended that the Civil Aviation Authority introduce requirements to define a minimum standard for safety systems to be installed in Unmanned Aircraft Systems operating under an Operational Authorisation, to ensure adequate mitigation in the event of a malfunction.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 20 December 2022

We continue to monitor Industry standards as they develop and, once established, will decide whether they are to be reviewed and, if considered appropriate, adopted by the UK.

Whilst the current assessment process for the Specific category remains subjective the new Acceptable Means of Compliance and Guidance Material (AMC and GM) and revised CAP 722A provide more robust guidance to applicants when they are considering suitable platforms for their intended operations. When complete, UK Specific Operational Risk Assessment (SORA) will focus assessments more on the UASs durability as well as the appropriate technical and operational factors. This will ensure that minimum performance criteria are properly addressed and, where possible, minimum operating performance standards adhered to.

Given the extended timelines associated with this work, if one is required, it could be sometime before an update would be available. We believe this meets the intent of Safety Recommendation 2021-007 and Safety Recommendation 2021-014.

Safety Recommendation Status Closed

AAIB Assessment Adequate

Action Status Planned Action Completed

Feedback rationale

It is recognised that, while the actions taken by the CAA do not define a minimum standard for safety systems installed in Unmanned Aircraft Systems operating with an Operational Authorisation, the revisions to CAP 722A, improved guidance material and the UK SORA will meet the intent of the Safety Recommendation.

RESPONSE HISTORY

Response received: 25 July 2022

The CAA is closely following the development of Standards by the EURCAE, ASTM and RTCA though most are still under development. Once established and subsequently adopted by the UK, Standards will then be considered for inclusion into the GM.

The current assessment process for the Specific category includes the consideration of safety mitigations against each hazard as well as the robustness of the safety systems. Submissions are allocated to a Case Inspector, on a case-by-case basis, and are intended to match skill-set and experience with the complexity of the application; however, it is acknowledged that this can be a subjective process.

As introduced at CAA Update to Recommendation 2021-002 above, when the SORA process is in place assessments will focus more on UAS reliability, durability, and other technical and operational factors. This will ensure minimum performance requirements are addressed in a quantified manner, including adherence to performance standards wherever possible.

AAIB Assessment – Partially Adequate Open

Response received: 23 December 2021

Primary safety modes such as the use of lost link 'return to home' modes in system software are not yet subject to certification. Other systems such as ballistic recovery & parachute systems may adhere to standards such as ASTM F3322-18, but this is not mandatory and the number of available systems on the market that adhere to this is low.

The RPAS Sector Team have begun to request any evidence that any systems used on a UAS for safety purposes adhere to any standard and are building a library of relevant standards as cases begin to present them. This process is potentially complicated by the development of the Certified Category which may mandate standards for some systems, and the conflict between standards released by competing bodies such as EUROCAE, ASTM, ISO and BSi. Nevertheless, any standards that are produced and identified will be considered for inclusion in any guidance material.

The RPAS Sector Team already consider the robustness of any safety mitigation measure, in terms of its performance and integrity. All mitigations provided by technical systems are assessed to check:

- Performance relative to claimed reductions in severity
- Position and relevance in any bow ties or fault tree diagrams
- Integrity of function and assurance that the mitigation will function as claimed at all times or with an appropriate MTBF
- Its overall position within the Safety Risk Assurance Process, to understand how the applicant has formally assured the above, as well as how they selected the system as an appropriate mitigation.

As the Specific Category works on a case-by-case basis, every safety system is assessed individually for the use case described by the UAS Operator. Rather than a minimum performance requirement, each mitigation is checked to see if it achieves the claimed level of performance, and whether it can function as a mitigation as described.

AAIB Assessment – Partially Adequate Open

Response received: 11 May 2021

The CAA partially accepts this recommendation:

The current OSC methodology in CAP722A for managing risk already considers operational and technical mitigations in the event of any failure or hazard and assesses whether they are appropriate. Additionally, the RPASPT have pointed out that the CAA does not make regulations, this is the remit of DfT; their recommendation was that we consider the introduction of a policy that states we will adopt standards for UAS safety systems as they are developed and become available.

However, due to the very wide range of possible operations within the Specific category, the use of 'safety systems' per se will not be necessary for every operational authorisation.

As yet, no relevant minimum standards for the safety systems referred to in this recommendation have been defined; once the appropriate safety system standards have been developed and become available, we will consider the introduction of an appropriate requirement where it is considered necessary.

Where the use of a safety system has been stated as a safety mitigating factor in a risk assessment, the minimum performance requirements of that safety system will be included as a condition of the resultant operational authorisation that is issued.

AAIB Assessment – Partially Adequate Open

(SRIS Reference:)

Safety Recommendation 2021-008

Justification

Data recording systems provide significant benefits during the design and development of a UAS as well as to accident and incident investigation. In addition, recorded data could be used to demonstrate the maturity and suitability of the UAS for the operation and compliance with the conditions of an Operational Authorisation

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-008

It is recommended that the Civil Aviation Authority require Unmanned Aircraft System operations under an Operational Authorisation to be fitted with a data recording system which is capable of demonstrating: compliance with the Authorisation's conditions, safe operation and the logging of any failures which may affect the safe operation of the Unmanned Aircraft System.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 20 December 2022

Whilst there is no legal requirement to make use of a flight data recording system we have recommended, under GM1 UAS.SPEC.050(1)(g)(iii), that UAS Operators should consider the importance of such a system. This is intended to promote good practice across the regulated community highlighting the significant value it would provide in both occurrence investigation, and when attempting to demonstrate regulatory compliance as described in UK Regulation (EU) 2019/947 UAS.SPEC.090 Access. We believe this meets the intent of Safety Recommendation 2021-008.

Safety Recommendation Status Closed

AAIB Assessment Partially Adequate

Action Status Planned Action Completed

Feedback rationale

It is recognised that, while the actions taken by the CAA do not require the installation of flight data recording systems, the recommendations in GM1 UAS.SPEC.050(1)(g)(iii), that UAS Operators should consider the importance of such a system and the promotion of the the significant value it would provide in both occurrence investigation, and when attempting to demonstrate regulatory compliance as described in UK Regulation (EU) 2019/947 UAS.SPEC.090 partially achieves the intent of the Safety Recommendation.

RESPONSE HISTORY

Response received: 25 July 2022

To promote 'good practice' across all UAS Operators the intent is for a recommendation to be inserted within the new GM. This can be found under GM1 UAS.SPEC.050(1)(g)(iii). A further update will be

provided by 31 December 2022.

AAIB Assessment – Partially Adequate Open

Response received: 23 December 2021

A new edition of CAP722A is scheduled for publication in first quarter of 2022. This will address all the above recommendations.

AAIB Assessment – Partially Adequate Open

Response received: 11 May 2021

The CAA partially accepts this recommendation:

The RPASST checklists for initial audits include a requirement to check whether an applicant can measure and maintain the limitations they are applying for. Where no direct metric (such as speed in m/s) is available, the authorisation will be written to reflect an example speed such as “a fast walking pace.”

Due to the very wide range of possible operations within the Specific category, for which an operational authorisation is required, and the wide range of RPAS types that may be used, it would not be practicable, nor indeed proportionate, to require a data recording system to be fitted in every case. It is for this reason that data recording is not mandated within the Specific category.

Most of the smaller RPAS types that are on the market, and presently fill the majority of the specific category operations we see in the UK, have the ability to log some forms of operational data within the system. But this is not generally a capability that can be activated, or subsequently installed, by the UAS operator. In addition, it is already a condition of all operational authorisations that records of all operations are maintained for audit purposes.

However, when considering the larger, more bespoke, RPAS types such as those that are similar to the subject of this accident, then it would be appropriate to require additional data recording capabilities to be included as the complexity of both the RPAS and the type of operation increases. This will be covered within the revised CAP 722A document.

AAIB Assessment – Adequate Open

(SRIS Reference:)

Safety Recommendation 2021-009

Justification

The first responders to this accident were presented with the wreckage of a large UAS which had no external markings other than the sponsor's names. The damaged main battery was hazardous but there were no warnings of the risks of explosion or electric shock. There was also no battery self-monitoring system for temperature or voltage.

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-009

It is recommended that the Civil Aviation Authority specify the minimum requirements for the monitoring of Unmanned Aircraft System high-voltage stored energy devices, to ensure safety of operation

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 20 December 2022

As mentioned in 'CAA Update to Recommendation 2021-008' above, there is no legal requirement to enforce the use of flight data recording systems however, we have taken this opportunity to include direction under GM1 UAS.SPEC.050(1)(g)(iii) whereby UAS Operators should consider the benefits such a system could bring in monitoring the performance of high-voltage energy storage devices. It is worth noting that it is the equipment manufacturer who is responsible for specifying minimum requirements for the monitoring of UAS high-voltage stored energy devices, and the UAS Operator who is responsible for defining the necessary processes, that satisfy those minimum requirements, as part of their risk assessment. We believe this meets with the intent of Safety Recommendation 2021-009.

Safety Recommendation Status Closed

AAIB Assessment Adequate

Action Status Planned Action Completed

Feedback rationale

(EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 25 July 2022

The CAA has taken opportunity to highlight this matter to applicants in the new AMC and GM. This can be found under GM1 UAS.SPEC.050(1)(g)(iii). A further update will be provided by 31 December 2022.

AAIB Assessment – Partially Adequate Open

Response received: 23 December 2021

A new edition of CAP722A is scheduled for publication in first quarter of 2022. This will address all the above recommendations.

AAIB Assessment – Partially Adequate Open

Response received: 11 May 2021

The CAA accepts this recommendation:

The policy will need to be developed and included in a future guidance document. The new airworthiness-focused Inspector on the RPASST will help with current assessments of battery use, carriage and storage for applications, and any application with “self-made” (i.e. non-COTS) batteries will be exposed to extra scrutiny.

In the meantime, an increased focus on this subject will be made during audits and any pre-authorisation assessment visits.

AAIB Assessment – Partially Adequate Open

(SRIS Reference:)

Safety Recommendation 2021-010

Justification

The first responders to this accident were presented with the wreckage of a large UAS which had no external markings other than the sponsor's names. The damaged main battery was hazardous but there were no warnings of the risks of explosion or electric shock.

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-010

It is recommended that the Civil Aviation Authority specify the minimum requirements for readily identifiable warnings and safety information on Unmanned Aircraft high-voltage stored energy devices to inform 3rd parties of the potential hazard.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 20 December 2022

We have introduced new guidance under GM1 UAS.SPEC.050(1)(a)(i) to highlight this to applicants. It is also worth noting that equipment manufacturers of high-voltage stored energy devices are labelling their equipment and identifying potential hazards to the user. We believe this satisfies the intent of Safety Recommendation 2021-010.

Safety Recommendation Status Closed

AAIB Assessment Adequate

Action Status Planned Action Completed

Feedback rationale

(EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 25 July 2022

The CAA has taken opportunity to highlight this to applicants in the new AMC and GM. This can be found under GM1 UAS.SPEC.050(1)(a)(i). In addition, the OEM of high-voltage stored energy devices are already labelling their equipment and identifying potential hazards to the user. A further update will be provided by 31 December 2022.

AAIB Assessment – Partially Adequate Open

Response received: 23 December 2021

A new edition of CAP722A is scheduled for publication in first quarter of 2022. This will address all the above recommendations.

AAIB Assessment – Partially Adequate Open

Response received: 11 May 2021

The CAA accepts this recommendation:

These minimum requirements will require development and consideration of the most appropriate location for this guidance, either within the technical chapter of CAP 722, or in a separate document.

In addition, this aspect would be required to be included within the risk assessment provided by the UAS operator and this will be covered within the revision to CAP 722A. An increased focus on this will be made during pre-authorisation assessments and, where appropriate, will be included as a condition of the operational authorisation.

AAIB Assessment – Partially Adequate Open

(SRIS Reference:)

Safety Recommendation 2021-011

Justification

The operator did not have a Safety Management System in place. Their lack of consideration for compliance, quality control and safety contributed to this accident. In addition, the absence of internal oversight, cross checking and management by accountable personnel were key factors and demonstrated that the organisation did not have an effective, proactive approach to managing safety. Safety management extends beyond compliance with regulations to a systemic approach to the identification and management of safety risks

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-011

It is recommended that the Civil Aviation Authority ensure that operators of Unmanned Aircraft Systems have an effective Safety Management System in place prior to issuing an Operational Authorisation.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 11 May 2021

The CAA partially accepts this recommendation:

CAP 722 already covers elements of SMS that operators could use for best practice and to manage safety risks.

The regulation only states a requirement for an SMS for Light UAS Certificate (LUC) approval holders under Part C UAS.LUC.030 of the Implementing Regulations for UAS. Due to the very wide range of possible operations within the Specific category for which an operational authorisation is required, it would not be practicable, nor indeed proportionate, to require every UAS operator to have a safety management system in place.

The RPASST exercise a proportional, performance based approach to applications, and required that elements of an SMS such as functional reporting and investigation processes are included as the complexity of the RPAS and operation increase.

Safety Recommendation Status Closed

AAIB Assessment Partially Adequate

Action Status Planned Action Completed

Feedback rationale

The AAIB acknowledge that elements of SMS are included in CAP 722 to allow operators to manage safety risks and that the use of Performance Based Oversight should result in operators being required to adopt additional elements of SMS as the complexity and operation of UAS' increases. While this approach partially addresses the Safety Recommendation 2021-011, it does not ensure that operators of UAS have

an effective SMS in place prior to receiving an Operational Authorisation therefore the response has been assessed as Partially Adequate - Closed (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

N/A

(SRIS Reference:)

Safety Recommendation 2021-012

Justification

Performance Based Oversight relies on previous experience of an operator or aircraft to allow an accurate assessment of the operational risk. As the CAA had not had previous experience with either the operator or the UAS, they did not have any information, other than that supplied by the operator, on which to assess the safety of the operation. A physical inspection of the UAS, prior to granting the exemption to the ANO, would have provided the opportunity to identify the shortcomings in the UA's build standard and that it was not compliant with the OSC. Had the CAA required a demonstration of the aircraft's operation, the operator may have been more vigilant in ensuring that they complied with their own procedures and the conditions of the exemption to the ANO.

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-012

It is recommended that the Civil Aviation Authority, before issuing an Operational Authorisation to operate an Unmanned Aircraft System they have not previously had experience with, carry out a physical examination of the Unmanned Aircraft System to ensure that it is designed and built to suitable standards, and observe a test flight to confirm operation in accordance with the Operating Safety Case.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 11 May 2021

The CAA partially accepts this recommendation:

When considering larger, more bespoke RPAS types such as the subject of this accident, then this is the approach that will be taken. However, in other cases, dependent on the type of operation that is being authorised, such an approach may prove to be impractical. Where any features of design and construction have been included as mitigations in any risk assessment, then it would be appropriate for a pre-flight physical examination and an observation of an initial test flight to be conducted (bearing in mind that any test flight also requires an Operational Authorisation to be issued).

The RPASST will apply Performance Based Oversight (PBO) principles in order to target resource to risk. When a new platform is used that is likely to attract a high risk score, it will be prioritised for both physical direct inspection from an airworthiness Inspector and a flight test depending on the likely requirements. Even with COTS systems, the RPASST will use PBO to assess dynamically whether applications need a demonstration or test flight to show the requisite safety levels.

The RPASST also carry out sector-level reviews of risk metrics to help assess where PBO assets are best deployed.

Safety Recommendation Status Closed

AAIB Assessment Partially Adequate

Action Status

Planned Action Completed 31 December 2021

Feedback rationale

The AAIB acknowledges that the CAA will use Performance Based Oversight principles to assess the risk of new UAS and that those with a high risk score may be subject to a physical inspection and flight test. As a result this AAIB consider that the response to the Safety Recommendation as Partially Adequate - Closed (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

N/A

(SRIS Reference:)

Safety Recommendation 2021-013

Justification

CAP 722 and the CAA exemption documentation do not contain any information on the consequences of non-compliance and the action that organisations such as the CAA and Ofcom can take in the event of a breach of the regulations and requirements.

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-013

It is recommended that the Civil Aviation Authority update Civil Aviation Publication 722, Unmanned Aircraft System Operations in UK Airspace – Guidance & Policy, to include reference to the consequences of not complying with the conditions of an Operational Authorisation to operate an Unmanned Aircraft System.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 11 May 2021

The CAA accepts this recommendation:

The Air Navigation (Amendment) Order 2020 (SI 2020/1555) introduced a number of new articles into the Air Navigation Order 2016. These create criminal offences, if the requirements of the UAS regulations that became applicable on 31 December 2020 are not complied with, along with the associated penalties.

This amendment was explained in guidance for UAS users within CAP 2013 (published 17 December 2020) and has been included in amendment 2021/01 to CAP 722 Chapter 4, Section 4.1.3 (March 2021).

Safety Recommendation Status Closed

AAIB Assessment Adequate

Action Status Planned Action Completed

Feedback rationale

(EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

N/A

(SRIS Reference:)

Safety Recommendation 2021-014

Justification

The frequent reports of UAS loss of control and fly-away events indicates the potential hazard to uninvolved persons. The kinetic energy level of these impacts, even for a typical small UA, is likely to be well above the 80 joules of kinetic energy limit for a UAS operated intentionally over 'uninvolved people', set in EU Commission Implementing Regulation (IR) (EU) 2019/947, It would be prudent to take appropriate action to reduce the risk of this type of event to avoid a fatal accident.

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-014

It is recommended that the Civil Aviation Authority adopt appropriate design, production, maintenance and reliability standards for all Unmanned Aircraft Systems with aircraft capable of imparting over 80 joules of energy.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 20 December 2022

We continue to monitor Industry standards as they develop and, once established, will decide whether they are to be reviewed and, if considered appropriate, adopted by the UK.

Whilst the current assessment process for the Specific category remains subjective the new Acceptable Means of Compliance and Guidance Material (AMC and GM) and revised CAP 722A provide more robust guidance to applicants when they are considering suitable platforms for their intended operations. When complete, UK SORA will focus assessments more on the UASs durability as well as the appropriate technical and operational factors. This will ensure that minimum performance criteria are properly addressed and, where possible, minimum operating performance standards adhered to.

Given the extended timelines associated with this work, if one is required, it could be sometime before an update would be available. We believe this meets the intent of Safety Recommendation 2021-007 and Safety Recommendation 2021-014.

Safety Recommendation Status Closed

AAIB Assessment Adequate

Action Status Planned Action Completed

Feedback rationale

It is recognised that, while the actions taken by the CAA do not introduce appropriate design, production and reliability standards for Unmanned Aircraft Systems with aircraft capable of imparting over 80 joules of energy, the revisions to CAP 722A, improved guidance material and the UK SORA will meet the intent of the Safety Recommendation.

RESPONSE HISTORY

Response received: 25 July 2022

The CAA is closely following the development of Standards by the EURCAE, ASTM and RTCA though most are still under development. Once established and subsequently adopted by the UK, Standards will then be considered for inclusion into the GM.

The current assessment process for the Specific category includes the consideration of safety mitigations against each hazard as well as the robustness of the safety systems. Submissions are allocated to a Case Inspector, on a case-by-case basis, and are intended to match skill-set and experience with the complexity of the application; however, it is acknowledged that this can be a subjective process.

As introduced at CAA Update to Recommendation 2021-002 above, when the SORA process is in place assessments will focus more on UAS reliability, durability, and other technical and operational factors. This will ensure minimum performance requirements are addressed in a quantified manner, including adherence to performance standards wherever possible.

AAIB Assessment – Partially Adequate Open

Response received: 23 December 2021

There is currently no standard of this type agreed upon and accepted by the CAA. While some generic standards that could be utilised have been generated, such as ASTM F2910- 14 (Standard Specification for Design and Construction of a Small Unmanned Aircraft System), ASTM F3002-14a (Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft System), and ASTM F2909-19 (Standard Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems), the decision to accept these into UK use and relevant publications would need to be managed in concert with the CAA's work on the development of the Certified Category.

In the Specific Category, procedures within the RPAS Sector Team have changed so that applicants are advised to demonstrate adherence to any relevant standards when able. No standards will be automatically accepted as proof of compliance with regulation, but conformance with any relevant standard shows a degree of safety assurance.

AAIB Assessment – Partially Adequate Open

Response received: 11 May 2021

The CAA partially accepts this recommendation:

This is covered within the Delegated Regulation for Open Category UA and for the Specific Category work is ongoing within a number of standards bodies, including EUROCAE, ASTM and RTCA. The CAA will review standards as they become available and decide on the frameworks required to adopt these from a regulatory perspective.

AAIB Assessment – Partially Adequate Open

(SRIS Reference:)

Safety Recommendation 2021-015

Justification

The frequent reports of UAS loss of control and fly-away events indicates the potential hazard to uninvolved persons. The kinetic energy level of these impacts, even for a typical small UA, is likely to be well above the 80 joules of kinetic energy limit for a UAS operated intentionally over 'uninvolved people', set in EU Commission Implementing Regulation (IR) (EU) 2019/947, It would be prudent to take appropriate action to reduce the risk of this type of event to avoid a fatal accident.

Therefore, the following safety recommendation was made:

Safety Recommendation 2021-015

It is recommended that the European Union Aviation Safety Agency adopt appropriate design, production, maintenance and reliability standards for all Unmanned Aircraft Systems with aircraft capable of imparting over 80 joules of energy.

Date Safety Recommendation made: 11 February 2021

LATEST RESPONSE

Response received: 26 April 2021

Following European Union Aviation Safety Agency (EASA) Opinion 2018-01, the European Commission adopted Regulations (EU) 2019/945 and 2019/947 (from now on the 'UAS Regulations') on 1 July 2019 that establish the technical and operational requirements for Unmanned Aircraft Systems (UAS), respectively. The UAS Regulations became applicable on 31 December 2020, after the occurrence of this event.

The UAS Regulation defines the process for assessing the risk of UAS operations and contains instructions on how to define the technical (e.g. design, production and maintenance), operations and pilot competence requirements, proportionate to the level of risk of the operation. Notably, different sets of technical requirements are defined directly in the UAS Regulation (for UAS operated in the lower level of risk, the 'open' category) or derived by the definition of a certification basis for operations with higher risk (the 'specific' category). The operation causing the accident would be classified in the 'specific' category.

EASA also published a set of technical requirements in the form of a 'Special Condition - Light UAS' (published on the EASA website in December 2020). These technical requirements cover all UAS, including those transferring an energy lower than 80 joules to a human body. The UAS regulations identify this energy threshold as the one posing risk to people and it requires, for UAS exceeding this threshold, to meet appropriate design, production and maintenance requirements.

Lastly, EASA is supporting standards bodies in developing appropriate industry standards to meet the technical requirements defined in the UAS Regulation. The preliminary version of these industry standards is planned to be available by mid-2021, and the final version in early 2022.

Safety Recommendation Status Open

AAIB Assessment Adequate

Action Status**Planned Action Ongoing Update Due 31 December 2022****Feedback rationale**

It is recognised that EASA are supporting the development of appropriate industry standards to meet the technical requirements defined in the UAS Regulation and that the preliminary version of these industry standards is planned to be available by mid-2021. The AAIB request and update on the progress of the development of industry standards on or before 31st Dec 2021.

RESPONSE HISTORY

N/A

(SRIS Reference:)