CAA Response to AAIB Recommendation 2016-037/2016-038

Requirement

Following the tragic crash of Hunter G-BXFI at Shoreham in 2015, the following Safety Recommendations 2016-037 and 2016-038 were made:

Safety Recommendation 2016-037 'It is recommended that the Civil Aviation Authority require that displaying aircraft are separated from the public by a sufficient distance to minimise the risk of injury to the public in the event of an accident to the displaying aircraft'

Safety Recommendation 2016-038 '*It is recommended that the Civil Aviation Authority specify the minimum separation distances between secondary crowd areas and display aircraft before issuing a Permission under Article 162 of the Air Navigation Order.*

Following discussions between AAIB and CAA it was agreed for the CAA's response to recommendations 2016-037 and 2016-038 to be combined as detailed below:

The CAA will conduct a review, within six months of publication by the MAA of a study by Frazer-Nash, to consider whether any changes are required to the minimum distance that display aircraft are to be separated from the public (primary and secondary crowds) to effectively minimise the risk of injury to the public in the event of an accident to the displaying aircraft. In the event that this study does not deliver a clear output or is terminated, for any reason, the CAA will consider what additional work will be needed to resolve this Recommendation. Subject to the findings of the study and the outcome of the review, the CAA shall make any necessary revisions to the application process for Permissions granted under Article 86 of the Air Navigation Order 2016.

This combined response to AAIB 2016-037 and AAIB 2016-038 was assessed by AAIB as 'Adequate-Closed' in 'Aircraft Accident Report (AAR) 1/2017 – G-BXFI'.

Actions

The CAA:

- Reviewed the analysis contained in the 1993 Cranfield report into Airshow Separation Distances.
- Conducted a review of the MAA's own Study into Air Display Crowd Distances, to consider whether any changes were required to the minimum distance that (civil) display aircraft are to be separated from the public.
- Incorporated actions to prevent the gathering of secondary crowds protect third parties into CAP 403: Flying Displays and Special Events: Safety and Administrative Requirements and Guidance.

Recommendations

The CAA will:

- **Continue to use the extant display separation distances** as it has been determined that moving the display line closer to the crowd would increase the risk to the public.

- **Review light aircraft exemptions** where such aircraft are exempted from the standard separation distance inside the 150 metre crowd-to-display line to establish whether existing risk analysis around light aircraft exemptions continues to provide adequate protection for the public.

Background

Following the tragic crash of Hunter G-BXFI at Shoreham in 2015, a number of safety recommendations were made by the AAIB. AAIB recommendation 2016-037 and 2016-038 required that the CAA to set a minimum separation distance for display aircraft from the public.

2016-037

Safety Recommendation 2016-037 '*It is recommended that the Civil Aviation Authority require that displaying aircraft are separated from the public by a sufficient distance to minimise the risk of injury to the public in the event of an accident to the displaying aircraft'*

The initial CAA response (09 June 2016) to AAIB 2016-037 was:

The CAA understands that this recommendation relates to members of the public attending a flying display. The CAA accepts this recommendation. The MAA has commissioned an independent study into crowd separation distances. This research is ongoing and should report in 2017. As the MAA research is ongoing, the CAA decided in its review of UK civil air displays that, as an interim measure, where current MAA crowd separation distances are higher it would align with them. The increased distances were announced in April this year in the final report of the CAA's Review of UK Civil Air Displays. The CAA will confirm crowd separation distances after the independent study commissioned by the MAA into crowd separation distances reports in 2017.

This response was regarded as 'Not Adequate' by the AAIB and remained open. The CAA response to this recommendation was updated on 24 January 2017 which was considered as 'Adequate' by the AAIB and 'closed'.

2016-038

Safety Recommendation 2016-38 '*It is recommended that the Civil Aviation Authority specify the minimum separation distances between secondary crowd areas and display aircraft before issuing a Permission under Article 162 of the Air Navigation Order.*

The initial CAA response (09 June 2016) to AAIB 2016-038 was:

The CAA does not accept this recommendation. It is the responsibility of the flying display organiser and the FDD to identify all the risks to which the public may be exposed from wherever they may choose to view the air display and to mitigate and manage those risks. Details of how the flying display organiser and the FDD have identified the risks and then intend to mitigate or manage them must be set out in the risk assessment they submit to the CAA when requesting Permission to hold an air display.

This response was regarded as 'Not Adequate' by the AAIB and remained open.

2016-037 and 2016-038 Combined

The CAA will conduct a review, within six months of publication by the MAA of a study by Frazer-Nash, to consider whether any changes are required to the minimum distance that display aircraft are to be separated from the public (primary and secondary crowds) to effectively minimise the risk of injury to the public in the event of an accident to the displaying aircraft. In the event that this study does not deliver a clear output or is terminated, for any reason, the CAA will consider what additional work will be needed to resolve this Recommendation. Subject to the findings of the study and the outcome of the review, the CAA shall make any necessary revisions to the application process for Permissions granted under Article 86 of the Air Navigation Order 2016.

The combined CAA response to 2016-037 and 2016-038 was released on 24 January 2017 and was considered as 'Adequate Closed' by the AAIB.

Cranfield Report into Airshow Separation Distances

In 1993 Cranfield University undertook a study on behalf of the CAA into the separation distances published in CAP 403[1]. The CAA reviewed the analysis contained within this report in conjunction with the MAA modelling software to determine whether an acceptable level of spectator safety exists.

Protection of Secondary Crowds

Whilst the Frazer-Nash study is concerned with display distances from the primary crowd, there remains a requirement to ensure that displaying aircraft are suitably separated from any secondary crowds or third parties. To ensure that aircraft do not pose a risk to secondary crowds, CAP 403: Flying Displays and Special Events: Safety and Administrative Requirements and Guidance has been updated to incorporate a number of changes that achieve this. The amendments include:

- The designing of a display area prior to the event within which non-essential personnel are not permitted.
- The identification and management of areas of potential secondary spectator build up, along with actions that can be put in place to help prevent such gatherings.
- Highlighting any specific areas of concern such as major / minor roads, adjacent congested / built up areas, likely areas for gatherings of secondary spectators,

[1] Airshow Separation Distances, Department of Air Transport, College of Aeronautics, Cranfield Institute of Technology, July 1993.

terrain, etc. Once identified these issues will assist in the production of the Flying Display Risk Assessment and help define appropriate mitigating actions.

- The prevention of Display Pilots performing over any building, vessel or vehicle which the commander has reason to believe is occupied by non-essential personnel or known secondary spectator crowds.

Review of the study by Frazer-Nash

In May 2015, the MAA commissioned Frazer-Nash Consultancy to conduct a 3-phase study into the provenance of the prescribed spectator safety separation distances defined in Regulatory Article 2335(3) for UK military flying displays[2]. The initial investigation conducted by Frazer-Nash was unable to provide historical or empirical data to assure RA 2335 and recommended that the minimum distances remain unchanged but that a software tool (Aeschylus) should be developed to provide modelling of the risk to personnel on the ground from display flying.

Aeschylus was delivered to the MAA in July 2018 and, since then, the MAA has conducted a trial of the software to understand its usability and how the data that Aeschylus produces may assist in the validation of the current distances[3]; the trial report was published by the MAA in Dec 18[4].

The Aeschylus trial used a set of clearly-defined display manoeuvres over an artificial location and uniform-density crowd in order to generate assessable, repeatable data. The manoeuvres collectively represented the most dynamic manoeuvres which could be performed at the minimum distances permitted in the extant regulations.

Once display data had been produced for each manoeuvre at a variety of heights and distances from the crowd, the Expectation Values (EV)[5] were plotted and examined for trends. The MAA's trial report concluded that:

- In all cases EV increased as the display was moved closer to a crowd; similarly, the EV decreased as the display was moved further away. This supports the notion that the closer a display is to a crowd then the greater the expected number of casualties i.e. the risk to the crowd is increased as the display is moved closer to the crowd.

- For Fast Jet and Military Transport aircraft, in most cases, the relationship between EV and display line distance is roughly linear; these results did not provide evidence to suggest the current display line distances are unsuitable.

- For Light Aircraft, in most cases, there is a notable increase in EV as a display is moved closer than 150m (for low energy) or 230m (for high energy); however,

[2] FNC 47812/43101R, Flying Display Risk Modelling Phase 1 Report produced for the MAA on 4 March 2016.
[3] The modelling was independently assured by a consulting fellow from the Defence Science and Technology Laboratory who confirmed the validity of the trial methodology, results and conclusions at a meeting with the MAA on 9 Nov 18.
[4] 20181212-Aeschylus_Initial_Trial_Report-O
[5] Aeschylus primarily reports risk as an Expectation Value (EV), defined as the casualty expectation within each 20m x 20m pixel within the defined crowd enclosure. The sum of the values across all pixels produces the Overall EV number; this is the predicted number of casualties from a single performance. A value of 0.001 could mean that 1 casualty would be expected in every 1,000 air displays; alternatively, it would also be consistent with observing no accidents in 99,999 air displays followed by one that causes 100 casualties.

there is no significant decrease as the display is moved further way; these results support the distances currently detailed in RA 2335 for Light Aircraft displays.

- There is no obvious relationship between EV and altitude - an increase in height may reduce EV in one manoeuvre but increase EV for another.

The CAA has conducted a detailed review of the MAA's trial report, including the Frazer-Nash study. The purpose was to consider whether changes were required to the minimum distance that display aircraft are to be separated from the public at civil air displays (primary and secondary crowds) to effectively minimise the risk of injury to the public in the event of an accident. The results, as set out above do not provide evidence to suggest the current display distances published by the CAA in CAP 403 are unsuitable.

Conclusion

The analysis conducted by both the MAA and CAA does not indicate that separation distances should be revised**. Therefore, the CAA will not change the minimum distance that display aircraft are to be separated from the public and will continue to use the extant display distances.** The analysis has determined that moving the display line closer to the crowd increases the EV and therefore increases the risk to the public. As such, there is no requirement for the CAA to revise the application process for Permissions granted under Article 86 of the Air Navigation Order 2016.

The CAA considers that it would be beneficial to conduct further analysis of the aircraft in the Light Aircraft category to establish whether the exemptions issued inside 150m require revision. There are no safety concerns arising from the existing protocols for applying separation distances in this category.

The CAA will continue to work closely with the MAA, including the use of safety analysis utilising Aeschylus software and review periodically the effectiveness of the separation distances published in CAP 403.

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