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| Title | Volcanic ash ingestion in turbine engines |
| NPA Number | A-NPA 2012-21 |

UK CAA (European.Affairs@caa.co.uk) has placed **16** unique comments on this NPA:

| Cmt | Segment description | Page | Comment | Attachment |
|------------|--|-------------|--|-------------------|
| 25 | B. Possible courses of action — IX. The case against setting engine ash ingestion limits | 9 - 10 | <p>Page No: 10 of 18</p> <p>Paragraph No: <u>Question 1</u>: Is there any rationale to depart from the current ICAO approach: i.e. operation is the responsibility of the operator, based on a safety risk assessment and supported by existing data streams?</p> <p>Comment: We believe that the approach of providing responsibility to the operator based on a safety risk assessment (SRA) supported by existing data streams is correct, however, we believe that by having a greater understanding as to acceptable ash operability limits for engines and airframes it will provide greater levels of confidence in the safety standards. UK CAA believes that more can be done to evaluate permitting existing types to operate under safety risk assessments, and also to establish safe operational limits during the certification of new engine and airframe types.</p> <p>Justification: Experience from the recent eruption has indicated that there is scope for improvement in understanding tolerance to ash and controlling aircraft operations in dispersed ash conditions. With a greater understanding in place it would become evident whether safe operations could be ensured during the course of prolonged, dispersed volcanic ash activity.</p> | |
| 26 | B. Possible courses of action — X. The case for setting engine ash ingestion limits | 10 | <p>Page No: 10 of 18</p> <p>Paragraph No: <u>Question 2</u>: Is there a clear, objective-based safety benefit that would be achieved by imposing a new certification standard?</p> <p>Comment: The safety objective of newly certificated products would be to establish more clearly defined safety standards for operations in dispersed volcanic ash. Rather than for the CS to establish a target minimum ash tolerance level, we believe that a more objective approach would be for the engine manufacturer to declare an operability tolerance to ash, which takes into account both ash concentration and exposure time/duration.</p> <p>Justification: For new products a new CS would establish and verify acceptable ash concentration levels that airframes and engines could operate within. Although there</p> | |

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| | | | could be benefits in clarifying, “avoiding operations in visible ash”, there could be safety benefits in establishing and maintaining better standards for operation, particularly with respect to operations in night and IMC conditions. |
| 27 | B. Possible courses of action — X. The case for setting engine ash ingestion limits | 10 | <p>Page No: 10 of 18</p> <p>Paragraph No: <u>Question 3</u>: Given the high traffic densities of European airspace and the frequent requirement for operation in IMC, and given also the enhanced capabilities in Europe to detect and track volcanic ash, should EASA propose a standard applicable only in European airspace?</p> <p>Comment: It is always preferable to have a harmonised engine/airframe certification specification relevant to all new certificated products. Volcanic activity does occur in other high air traffic regions in the world, which would benefit from the lessons learnt from the European/Icelandic volcanic experiences. If the CS was to stipulate a declaration of operability tolerance to ash (as opposed to requiring new products to meet a declared minimum standard) then it would be possible to apply the CS standard as only applicable to air traffic movements in a European environment, should this be necessary.</p> <p>Justification: Europe could lead in enhancing safe operations in a dispersed ash environment, and other world regions would have the option of following should they wish, subject to lessons learned and infrastructure capability.</p> |
| 28 | B. Possible courses of action — X. The case for setting engine ash ingestion limits | 10 | <p>Page No: 10 of 18</p> <p>Paragraph No: <u>Question 4</u>: Is harmonisation of EASA standards with those of other States of Design (e.g. USA and Canada) of such importance in respect of volcanic ash that it should take priority over a solution for Europe?</p> <p>Comment: Harmonisation of Certification Specifications is always the preferred ideal, and every effort should be made to achieve a harmonised standard but this should not take priority over achieving a satisfactory design objective. In the worst case, the end result could lead to a Significant Regulatory Difference (SRD) being developed. If all the manufacturers, however, could be committed to supporting research programmes into the effects of ash, then this would be a less likely outcome. In a situation where the CS requires a declaration of capability (in terms of operability in dispersed low ash concentration environments) rather than meeting a clear design specification, harmonisation and SRDs then become less arduous.</p> <p>Justification: The priority in Europe is, where possible, to ensure the safe operation of aircraft in a dispersed ash environment should a future volcano erupt and threaten to disrupt air traffic in that region. To achieve this activity within a reasonable timeframe it could require Europe to</p> |

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| | | | introduce the appropriate changes to Certification Specifications before other NAAs. |
| 29 | B. Possible courses of action — XII. Options identified | 11 - 13 | <p>Page No: 12 of 18</p> <p>Paragraph No: <u>Question 5</u>: Could sand testing provide any benefit to enhance the information available to operators for use within their VA SRAs?</p> <p>Comment: Sand testing could be of limited use in understanding the degradation effects of operating in a VA environment, although some useful compressor blade erosion data could be obtained and possibly be of some use.</p> <p>Justification: Sand testing would not simulate the glassing effects of VA particles melting in the combustor, fuel nozzle and turbine areas, which has been found to be the significant degradation factor in high density ash events.</p> |
| 30 | B. Possible courses of action — XII. Options identified | 11 - 13 | <p>Page No: 12 of 18</p> <p>Paragraph No: <u>Question 6</u>: What activities could be considered in this context and which would merit prioritisation?</p> <p>Comment: The industry would benefit from greater knowledge of the effects of ash contamination when operating in a dispersed VA environment, after some development testing has been carried out to date. For this reason, testing of the following areas should be considered;</p> <p>a) Gas turbine ash ingestion testing representative of modern GT engines in terms of elevated TGTs (turbine gas temperatures) and reduced surge margins etc. b) Predictive ash dispersion forecasting models. c) In flight ash detection sensor equipment, installed on aircraft. d) Real time and enhanced engine health monitoring.</p> <p>Justification: All of the above listed activities have the potential to improve safe operations in a dispersed ash environment, however, some of these are in early stages of development and would benefit from some formalised research and development. The capability of measuring ash concentrations and durations on board commercial aircraft operating in dispersed ash environments could assist operators to monitor exposure to ash and enhance safe operations under a safety risk assessment (SRA).</p> |
| 31 | B. Possible courses of action — XII. Options identified | 11 - 13 | <p>Page No: 12 of 18</p> <p>Paragraph No: <u>Question 7</u>: What characteristics would on-board equipment need to have in order to deliver significant operational benefit?</p> <p>Comment: The operational and reliability requirements for</p> |

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| | | | <p>any on-board equipment used would have to be defined and the benefits clearly established. The criticality for operation in ash contaminated environments, and hence the qualification process to be used for such systems would also have to be clearly defined.</p> <p>Justification: Part of the certification of any on-board equipment would have to assess the safety benefit and the qualification process necessary.</p> | |
| 32 | B. Possible courses of action — XII. Options identified | 11 - 13 | <p>Page No: 13 of 18</p> <p>Paragraph No: <u>Question 8</u>: The introduction of a Certification Specification may drive engine manufacturers to design an ash tolerant engine that detrimentally impacts emissions, fuel burn, required maintenance actions and cost. What would be an acceptable compromise to stakeholders?</p> <p>Comment: If the CS were to make a declaration of capability (in terms of operability in dispersed low ash concentration environments) rather than meeting a clear design specification, then it is unlikely to compromise design targets regarding emissions, fuel burn etc.</p> <p>Justification: Making a design declaration regarding operations in dispersed ash are unlikely to affect other design criteria, unless perhaps, there are intentions to make engines more ash tolerant.</p> | |
| 33 | B. Possible courses of action — XII. Options identified | 11 - 13 | <p>Page No: 13 of 18</p> <p>Paragraph No: <u>Question 9</u>: Can a certification test be adequately defined to address a globally acceptable requirement?</p> <p>Comment: Based on internationally agreed scientific knowledge and generally accepted criteria such as volcanic ash composition, concentration levels and possibly duration should be utilised in this proposed CS. Some guidelines on volcanic ash composition have been specified in the International Volcanic Ash Task Force 2nd (IVATF/2) meeting in Appendix 2B, and these should be utilised in clarifying a future certification test. If the CS were to make an ash tolerance declaration for new engines, then this declaration can be applied globally as necessary or as possible. Similarly a CS declaration can be applied purely in the European airspace environment to enhance SRAs.</p> <p>Justification: Internationally accepted guidelines in IVATF/2 have already been accepted as a starting point for a VA composition specification. The CS operability declaration option provides the greatest flexibility for global acceptance.</p> | |
| 34 | B. Possible courses of action — XII. Options identified | 11 - 13 | <p>Page No: 13 of 18</p> <p>Paragraph No: <u>Question 10</u>: Have engine TC holders</p> | |

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| | identified | | <p>already foreseen the need to undertake specific engine volcanic ash testing? If so, can you give details of the test specification to be used?</p> <p>Comment: Question appears to be addressed to TC Holders.</p> <p>Justification: Question not applicable to NAAs.</p> | |
| 35 | B. Possible courses of action — XII. Options identified | 11 - 13 | <p>Page No: 13 of 18</p> <p>Paragraph No: <u>Question 11</u>: What benefits could generic module testing produce and would those benefits merit taking this work forward?</p> <p>Comment: This approach could be useful in establishing the resilience of some in-service designs, but would need to be accepted by all major engine TC Holders to have some benefit.</p> <p>Justification: There appears to be insufficient information available on the subject of turbine engine volcanic ash ingestion at lower ash concentration levels.</p> | |
| 36 | B. Possible courses of action — XII. Options identified | 11 - 13 | <p>Page No: 13 of 18</p> <p>Paragraph No: <u>Question 12</u>: Would such information offer benefits sufficient to merit taking this work forward?</p> <p>Comment: This could provide some useful theoretical data that could establish the resilience of gas turbine engines currently in service, particularly in the area of VA ingestion at the lower ash concentrations, of the type predicted in the 2010/2011 Icelandic volcano eruptions.</p> <p>Justification: There appears to be insufficient information available on the subject of turbine engine volcanic ash ingestion at lower ash concentration levels.</p> | |
| 37 | B. Possible courses of action — XIII. Regulatory Impact Assessment | 14 - 18 | <p>Page No: 18 of 18</p> <p>Paragraph No: <u>Question 13</u>: What option(s) do you consider to be most appropriate and why? Add others if none of the above.</p> <p>Comment: Option 2: Research Programme would be necessary/useful to obtain more information regarding turbine engine ash ingestion at low concentration levels before a certification specification can be clearly or realistically defined. This would also assist with establishing the resilience of existing types/models in service and in the provision of adequate continuing airworthiness tasks. Research would also be useful in the area of aircraft on-board volcanic ash detection systems.</p> <p>Option 3: A new CS-E VA ingestion requirement would ultimately require the other certification specifications (such as CS 23, 25, 27, 29, P and APU) to declare safe</p> | |

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| | | | <p>operations in ash criteria. A new CS-E declaration requirement would be necessary to ensure that newly certificated products meet or establish acceptable operations in low VA concentrations.</p> <p>Justification: Option 2 is necessary because insufficient data currently exists in the areas of operations in low volcanic ash, and because on-board ash detection is a relatively new development which would benefit further verification and testing. By adopting a CS declaration in Option 3, it would enhance operator SRAs for safe operations in dispersed ash environments.</p> | |
| 38 | B. Possible courses of action — XIII. Regulatory Impact Assessment | 14 - 18 | <p>Page No: 18 of 18</p> <p>Paragraph No: <u>Question 14</u>: What is needed to move towards establishing engine ingestion limits?</p> <p>Comment: Analysis of any tests carried out (whether these are generic or type-specific) on VA ingestion to establish feasible ash concentration target levels, and the level of the claimed side effects (such as perceived specific fuel consumption (sfc) and emissions increases, surge margin degradation etc.).</p> <p>Justification: Barriers to establishing engine ingestion limits are largely due to a perceived lack of knowledge or data available.</p> | |
| 39 | B. Possible courses of action — XIII. Regulatory Impact Assessment | 14 - 18 | <p>Page No: 18 of 18</p> <p>Paragraph No: <u>Question 15</u>: In the absence of a Certification Specification for ash ingestion capability, how will volcanic ash tolerance be ensured for future engines?</p> <p>Comment: UK CAA believes that ultimately a certification specification will be required to ensure ash tolerance for future engines when undergoing the certification process.</p> <p>Justification: Certification specifications are the ideal means of establishing acceptable operations in volcanic ash criteria for future types, in much the same way as other environmental hazards (rain, hail, ice and birds etc.) are addressed.</p> | |
| 40 | B. Possible courses of action — XIII. Regulatory Impact Assessment | 14 - 18 | <p>Page No: 18 of 18</p> <p>Paragraph No: <u>Question 16</u>: Can you specify expected costs and other impacts for the various options?</p> <p>Comment: This question is considered to be addressed to TC Holders.</p> <p>Justification: Question not applicable to NAAs.</p> | |