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Lessons to be learned and recommendations following

The Eruption of Eyjafjöll volcano in April 2010

and its consequences on European air traffic flow

The Opinions

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Lessons to be learned and recommendations established by the Air and Space Academy following

THE ERUPTION OF THE EYJAFJÖLL VOLCANO IN APRIL 2010

and its consequences on European air traffic flow

with the participation of representatives from French aerospace industries association GIFAS and French Aerospace Society 3AF

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Photo credits: Eruption of the Soufrière Hills volcano in Montserrat, 11 February 2010 © Mary Jo Penkala/Solent

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1. FOREWORD

Following the eruption of the Eyjafjöll volcano in April 2010 and the extensive negative economic fallout felt in Europe, the decision was taken by the "Applied science and technology" section, at the Air and Space Academy's session of June 2010, to set up a working group incorporating members from all sections of the Academy.

The subsequent in-depth reflexions, embracing both technical and regulatory aspects and drawing on concrete piloting experience, led to this document, dated 16 May 2011, which takes stock of the situation, analyses the causes of this disorder and the resulting financial losses, and puts forward actions to be taken in the very short term, the short-term and the medium term to prevent the repeat of such a situation.

On the following 25 May this study was presented to the French Director General for Civil Aviation, who adopted it and used it during the ICAO meeting on the subject in September 2011. Many decisions taken at the time and since were informed by this document.

2. BEFORE THE ERUPTION OF THE EYJAFJÖLL VOLCANO IN APRIL 2010

Volcanic phenomena are not new and are common in certain areas of the world. Indeed traces of volcanic ash are permanently present in the atmosphere all around the globe. They can be found in much higher concentrations in the direct vicinity or downwind of major eruptions. To date, they have caused no aircraft loss. The most serious incidents in the past thirty years have been ten cases of engine failure on C-130, 747, DC-10, 767 and Gulfstream aircraft, in the US, Indonesia, the Philippines, Japan, the Caribbean and Papua New Guinea, in particular the two 747 incidents involving British Airways in 1982 in Indonesia, and KLM in 1989 in Alaska. In all cases crews managed to reach an airstrip safely, but some of these incidents were nonetheless very serious.

ICAO – through its dedicated working group, the International Airways Volcano Watch Operations Group (IAVWOPSG) and with the support of the World Meteorological Organization – coordinates work and reflections in this area on a global level and recommends merely that flight "*into visible ash*" should be avoided and that the decision to fly should remain "*at the operators' discretion*" (ICAO documents no.9691, 2007 edition, and no.9766, 2004 edition, updated 29.5.09). This position is consistent with experience: the engine power losses previously referred to appeared during involuntary encounters with visible ash clouds.

In particularly high-risk zones such as Alaska and Japan, official bodies have been in place permanently for some years on the basis of these recommendations. There, as elsewhere, procedures developed by the airlines have helped maintain aviation safety.

3. THE ERUPTION OF THE EYJAFJÖLL VOLCANO AND ITS CONSEQUENCES

Between 14 and 21 April 2010, the Icelandic volcano Eyjafjöll went into eruption. The ash cloud spread over the whole of Europe. The UK Met Office's "Volcanic Ash Advisory Centre" (VAAC) sounded the alert and the British air traffic control organisation NATS was the first to prohibit flights through British airspace, followed subsequently by the different states. For the first time, the event occurred in Europe in a dense traffic zone and Europe took the decision to close its main airports and its airspace.

These decisions, within the framework of an assumption of responsibility which might be questioned, were made by national aviation safety authorities:

- on the basis of ICAO recommendations not to fly into a visible volcanic ash cloud; the figure of 2 mg/m^3 defined by manufacturers, following a pooling of experience and data, as the maximum tolerable concentration threshold for engines made it possible to limit the contaminated zone established by deduction from atmospheric models after the 20 April.
- on the basis of maps published by the UK VAAC indicating the presence of ash and based on calculated default concentrations.

The consequences of these decisions were disastrous, entailing a cost of 1.7 billion euros to world civil aviation and a similar loss to the tourism industry.

The conditions under which the decision to close the airspace was made (not always in concerted fashion on a European level) provoked lively debate as to the real risk assessment and the decision process itself.

Following these debates, ICAO set up the International Volcanic Ash Task Force on July 2010, which issued more precise recommendations on 15 December 2010.

4. EUROPEAN DEFICIENCIES LEADING TO NON-OPTIMAL DECISIONS

The crisis was handled by national authorities according to a state culture of risk avoidance (precautionary principle), contrary to successfully tested ICAO recommendations which stipulate on the contrary that this type of situation should be dealt with by airlines according to a risk management approach, as is the case for other threats and major meteorological phenomena such as sandstorms, storms, icing …

The risk zone was defined mainly by means of insufficiently validated, complex numerical models (volcanic emission + atmospheric dispersion) based on a limited amount of experimental data, resulting in airspace zones wrongly being declared dangerous, as was confirmed later by in situ measurements and observations. Observation flights and inspections after resumption of flights confirmed that concentration levels issued by the London VAAC were overestimated.

The European air transport system was not equipped to deal with such an eventuality: no prior experience, no existing network between the different experts and specialists (of whom few were available) and insufficient coordination among countries, compounded by the absence of means and resources previously referred to.

5. VERY SHORT-TERM ACTIONS "should such a phenomenon reoccur"

Go back to former ICAO guidelines. These reappear in the recommendations issued in April 2010 based on work of the ICAO NAT EUR (Ref.7) and especially those published by the UK CAA (Ref.8): treat volcanic ash clouds in the same way as other obstacles which airlines and their pilots have entire responsibility to handle on the basis of a risk management approach since, in real time, air traffic control organisations have only a duty to inform, and certification bodies have a duty to monitor a priori airline procedures well before the phenomenon.

VAACs, in particular, must provide airlines with comprehensive, detailed information rather than information subject to caution, as was the case in 2010.

6. SHORT-TERM ACTIONS

There are two VAACs in Europe: a British centre, responsible for sounding the alert for the numerous Icelandic volcanoes, and a French centre, which covers almost the entire European airspace, plus the African airspace. Cooperation between these two centres must be reinforced. In particular, it is important to make combined use of the two atmospheric models NAME (Numerical Atmospheric dispersion Modelling Environment) and MOCAGE (Modèle de Chimie Atmosphérique à Grande Echelle) in the event of a serious eruption.

Effective communication networks must be set up between all players so that information circulates in a coherent manner, whilst at the same time preserving each player's area of responsibility as determined by the texts. The first information network involves the VAACs, which must assemble data and measurements provided by satellite, aircraft and ground sensors and set up calculation codes to assess the current state of the plume and forecast its evolution, with priority given to dimensions and altitude, then concentration. The second network, under the responsibility of airlines, links the latter with airports and control bodies for all decisional aspects and the monitoring of operations. An overall modus operandi should be set up and running tests involving materials and operators should be periodically carried out.

Based on methods elaborated by the American organisation Enhanced Weather Information Network System, which provides information as a basis for decisions made by US airlines, ICAO's International Volcanic Ash Task Force should be asked to suggest a procedure framework for decisions which be the object of an agreement between European airlines, before being transmitted to national authorities and the European Aviation Safety Agency EASA.

7. MEDIUM-TERM ACTIONS

It is vital to enhance our understanding of ash impact on aircraft/engines.

The large variation of the physical and chemical characteristics of ash, the rating and the state of engines at the moment of exposure, as well as length of exposure, make any simple certification criterion impossible. Neither does the flight safety argument justify the creation of a certification standard. But on an economic level, to optimise flight outside of visible cloud, it would be advisable to improve our knowledge of how engine and aircraft systems behave during prolonged exposure to moderate concentrations of volcanic ash and gas. Technical data would help optimise airlines' risk management approach, particularly in the area of maintenance.

Funding for this complex, long-term action would have to be found on a national or European level.

The main priority in terms of safety is to identify the volcanic plume and to predict its evolution in the following hours.

Positioning the cloud must involve combined use of models and observations by satellite imagery, aircraft and 3D lidars, in situ measurements, pilots' reports …

Calculation tools are essential in order to forecast the cloud's evolution. A European scientific programme should be set up to improve forecasting calculations and statistical, dynamic and forecasting models, with particular regard to turbulence on different scales. Information on entry data, characteristics and volume of ash emissions should also be improved. Periodic (hourly or daily) readjustment of simulations and forecasts to take account of new measurements should also be enhanced.

Existing sensors which are partially operational in Europe must be put into full operational use as quickly as possible, including the following systems:

- the IASI Infrared Atmospheric Sounding Interferometer on board the MetOp satellite, which observes sensitive zones twice daily and provides a 2D image of the plume and a vertical average of particle density.
- Sciamachy ultraviolet spectrometers on Envisat and GOME-2 on MetOp.
- the SEVIRI sensor on board MSG which, with the help of measurement methods currently under study, will be capable of providing quantitative values (height of plume, size of particles, concentrations).
- the CALIOP lidar on board the CALIPSO satellite, which provides a vertical profile of underneath the satellite's path and therefore the altitude of the plume.
- the future ADM-Aeolus and Earth Care lidars, due to be launched in a few years.
- instruments on board aircraft or drones capable of positioning volcanic clouds.

Although such concepts do exist, much development and validation work remains to be done and their utilisation clarified.

In addition, a greater number of ground-based lidars should be deployed, capable of other meteorological applications, such as the 13 retrodiffusion lidars and the 6 doppler lidars installed by IPSL and Météo-France. A lidar-equipped aircraft would be used mainly for scientific research but would also enhance the operational network in the event of an eruption. These lidars should be connected to a European network still to be set up.

REFERENCES

- **Reference no.1:** ICAO International Airways Volcano Watch (IAVW) Handbook (ICAO Doc 9766), second edition 2004, last update 29.5.09
- **Reference no.2:** Flying through an Era of Volcanic Ash, Tuesday 9 November 2010, RAeS lecture by Andrew Haines, Chief Executive, Civil Aviation Authority
- **Reference no.3:** ICAO Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds (ICAO Doc 9691), Second Edition, 2007
- **Reference no.4:** Alaska Interagency Operating Plan for Volcanic Ash Episodes, May 2008
- **Reference no.5:** French Parliamentary Office for Scientific and Technological Assessment - Report on Lessons to be learnt from the eruption of the volcano Eyjafjöll - Public hearing of 8 July 2010
- **Reference no.6:** http://www.metoffice.gov.uk/aviation/vaac/vaacuk_vag.html
- **Reference no.7:** ICAO International Volcanic Ash Task Force - Supplementary guidance material/management of flight operations with known or forecast volcanic ash cloud contamination - preliminary issue Draft Version 3 -15 December 2010
- **Reference no.8:** Guidance Regarding Flight Operations in the Vicinity of Volcanic Ash - UK Civil Aviation Authority, 10 February 2011
- **Reference no.9:** EASA Volcanic Ash Operations Workshop, Cologne, 20/01/2011