U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SPACE AND AERONAUTICS

HEARING CHARTER

Mitigating the Impact of Volcanic Ash Clouds on Aviation—
What Do We Need to Know?

May 5, 2010
10 a.m. – 12 p.m
2318 Rayburn House Office Building

I. Purpose

On May 5, 2010 the Subcommittee on Space and Aeronautics will hold a hearing on the research needed to improve our understanding of the impact of volcanic ash clouds on aircraft and aircraft operations and what can be done to mitigate that impact. Last year, when the *Mount Redoubt* volcano erupted southwest of Anchorage, one of the operating airlines grounded its fleet, diverted flights and wrapped the engines of its parked planes in plastic sealant. Most recently, the eruption of Iceland's *Eyjafjallajökull* volcano paralyzed air travel in Europe for six days, is reported to have inconvenienced hundreds of thousands of passengers around the world, and is projected to cause airline revenue losses of at least $1.7 billion. At this hearing, the Subcommittee will examine the role federal research can play in:

- Characterizing the damage volcanic ash causes to aircraft and aircraft engines;
- Devising ways to minimize the negative effects of volcanic ash on aircraft and aircraft systems such as engines;
- Improving the modeling, detection, and prediction of how volcanic ash clouds propagate and dissipate, particularly through the integrated use of civil space-based assets;
- Informing guidelines and regulations that establish what aircraft should do when encountering volcanic ash clouds and when it is safe to fly in airspace contaminated with volcanic ash; and
- Improving air traffic management procedures, capabilities and features, including those planned for the new NextGen air traffic control system, to efficiently circumvent contaminated airspace.

II. Planned Witnesses:

Dr. Tony Strazisar
Senior Technical Advisor
Aeronautics Research Mission Directorate
National Aeronautics and Space Administration
[Substituting for Associate Administrator Jaiwon Shin]

Dr. Jack A. Kaye
Earth Science Division
National Aeronautics and Space Administration

Ms. Victoria Cox
Senior VP, NextGen and Operations Planning
Air Traffic Organization
Federal Aviation Administration

Captain Linda M. Orlady
Executive Air Safety Vice Chair
Air Line Pilots Association, International

Mr. Roger Dinius
Flight Safety Director
GE Aviation

III. Overview

Following the biggest disruption in air travel since September 11, 2001, there is much discussion in Europe about the response to the volcanic ash cloud emergency created by the *Eyjafjallajökull* volcano. Some of the discussion focuses on whether the closure of European airspace and its duration were necessary in the first place. The controversy in Europe over the United Kingdom's Civil Aviation Authority's (CAA) decision to close British airspace and the authority's subsequent permission to allow resumption of flights in specified areas highlights the challenge aviation regulators face in light of insufficient scientific data to establish (1) the volcanic ash contaminant level below which air travel is safe and permissible; (2) the atmospheric location and concentrations of ash such that safe flying corridors can be determined on a real-time basis; and (3) the damage, both immediate and long-term, that volcanic ash inflicts on aircraft, particularly their engines.

Although the disruption caused by the Icelandic volcano is not the first time air travel has been impacted by volcanic ash, the magnitude of the disruption is the greatest experienced to date. Anecdotal evidence from several incidents where aircraft have previously encountered volcanic ash alerted aviation regulatory bodies on the dangers of flying through such conditions. Several near-catastrophic incidents involving volcanic ash have occurred:

- In 1982, after flying through an ash cloud, a British Airways Boeing 747 near Jakarta, Indonesia lost all four of its engines as they choked on the ash and flamed out. Ash was reported to have filled the cabin through air vents and the cockpit window was severely scratched. Subsequently, the pilots were able to restart three of the four engines and land safely in Jakarta.

- In 1982, one month after the British Airways incident, a Singapore Airlines Boeing 747 lost two of its four engines and was forced to land in Jakarta because of an ash encounter.
- In 1989, a KLM Royal Dutch Airlines Boeing 747 encountered an ash cloud caused by *Mount Redoubt* while descending into Anchorage International Airport. The aircraft lost all four engines and about half of its instruments failed. Pilots were able to restart all four engines and landed safely.

In response to these incidents, and because there were no agreed upon values of ash concentration that constitute a hazard to aircraft engines, the International Civil Aviation Organization (ICAO), a U.N. agency, recommended avoidance of volcanic ash clouds as the preferred course of action. ICAO also created a worldwide monitoring system composed of 9 Volcanic Ash Advisory Centers (VAAC). The Washington VAAC and Anchorage VAAC are operated by the National Oceanic and Atmospheric Administration (NOAA). [Attachment I shows the VAACs and their areas of responsibility]. According to the Federal Aviation Administration (FAA), the problem of ash clouds in the United States generally occurs in Alaska, Hawaii or the Pacific Northwest. In addition, in part to address the hazard posed by airborne volcanic ash in the North Pacific, the U.S. Geological Survey (USGS), in cooperation with the University of Alaska Fairbanks Geophysical Institute and the Alaska Division of Geological and Geophysical Surveys, established the Alaska Volcano Observatory (AVO) with offices in Anchorage and Fairbanks. The AVO provides hazard assessments, updates and warnings of volcanic activity in Alaska.

NASA has first-hand knowledge of the effects of flying through volcanic ash clouds and the delayed effect on jet engine performance. When its scientists were flying in a DC-8 research aircraft en route to Sweden in February 2000, they flew for about 8 minutes through an ash cloud, a fact unknown to the pilots until they were alerted by on-board scientists who had noticed the event using special instrumentation; conventional radar equipment is incapable of discerning volcanic ash clouds. Although the pilots saw no change in performance in the aircraft, either immediately after being told of the encounter or even after 60 hours of flying in Sweden, a borescopic inspection was performed on all four engines following the aircraft's return to the U.S. Results of the analysis caused NASA to send one of the engines for an overhaul. The agency found that ash clogged holes that provide bleed air cooling to turbine blades, and also left deposits on the turbine blades after ash entered the combustion chamber and melted. [See pictures of damage to one of the engines in Attachment II] The maintenance factory told NASA that they had substantially decreased the life of the engines and that they would have noticed a degradation in performance in as little as a hundred flight hours because of overheating of the engine fan blades. All four engines were subsequently overhauled. Dr. Jaiwon Shin, a witness at the hearing, can provide details on NASA's related aeronautics research activities. He will be accompanied by Mr. Thomas Grindle who is familiar with the events associated with the February 2000 flight.

NASA does not have operational responsibility for observation and analysis of volcanic gas and aerosol emissions. However, its fleet of research spacecraft provides data that are directly applicable to understanding the hazards presented by these phenomena. According to NASA, in response to the recent European situation, it is providing near-real-time information on volcanic sulfur dioxide and ash aerosols from the Ozone Monitoring Instrument aboard the Aura satellite for the VAACs in London and Toulouse, in collaboration with NOAA. NASA states that the information provided to the London and Toulouse VAACs had been previously available for sectors covering the Americas and the Pacific (in collaboration with the Anchorage and Washington VAACs). Numerous other NASA spacecraft instruments provide important data relevant to the problem of volcanic ash clouds. One example is data recently acquired by the Multi-angle Imaging SpectroRadiometer instrument on the Terra spacecraft that provide not only the horizontal extent of the plume over Iceland but detailed information about its vertical extent as well. In addition to providing measurements and information to aid decision-makers in responding to the volcanic event and its aftermath, these data from NASA's research satellites are being utilized in several ongoing NASA-sponsored scientific studies of solid Earth processes, atmospheric composition and air quality, Earth's radiation balance and aviation forecasting improvement methodologies within NASA's Earth Science Division's Research and Analysis (R&A) and Applied Sciences programs. Dr. Jack Kaye, a witness at the hearing, can provide additional details on the capabilities of NASA's Earth observation satellites.

The Airline Pilots Association (ALPA), the largest airline pilot union in the world, representing nearly 53,000 pilots at 38 U.S. and Canadian airlines, has devoted several years to expanding the database of operationally relevant information on the potential hazard caused by volcanic ash and improving the warning system necessary to reduce unplanned encounters with hazardous ash clouds. ALPA believes its information may be useful towards understanding the hazard; understanding recommended practices for avoidance, if possible; achieving survival in the event of an unexpected encounter; and finally, reporting the experience. Regarding the recent situation in Europe, it warned members to identify alternate routes to avoid ash clouds. Captain Linda Orlady, a witness at the hearing, can provide additional details on ALPA's relevant activities.

When the ban over air travel was lifted in Europe, officials broke the affected areas of airspace into three tiers: normal flight zones where ash no longer poses a risk, no-fly zones where ash remains in high concentrations, and intermediate, potentially hazardous zones where flights can proceed with caution, subject to route restrictions and other limitations. The UK Civil Aviation Authority (UK's equivalent of the FAA) lifted flight restrictions after consulting with many parties, including the FAA and aircraft and engine manufacturers. In a statement, the FAA indicated its support for the decision by the European Commission to resume air traffic in parts of continental Europe. The FAA said, in its press release, that "*This gradual, cautious return of operations is reliant on the track of the volcanic ash cloud which is being monitored closely. The FAA is continuing to work with the European Union and is sharing technical information and guidance based on previous experience managing weather and volcanic events that have affected portions of U.S. airspace. The FAA remains ready to assist both the air carriers and our colleagues in Europe to do whatever is necessary to help stranded passengers and to safely return air service between our continents*." In addition, the FAA released on April

22, 2010 a Special Airworthiness Information Bulletin (SAIB) advising "*owners and operators of aircraft equipped with turbine engines that operate in airspace where volcanic ash may be present, of recently issued communications from engine manufacturers*." SAIB Number NE-10-28 recommends that:

> *"Before flying from the United States to Europe or within Europe, aircraft owners and operators should review the following recommendations:*
>
> - *Although the FAA does not recommend engine operation or flight into a visible volcanic ash cloud, we do recommend that you obtain definitive information on operational limitations around ash clouds, if any, from each of the European National Authority of the State(s), of which you plan flight operations.*
> - *Follow all aircraft and engine manufacturer's operating and maintenance instructions pertaining to operations in airspace where volcanic ash may be near or present.*
> - *Report any inadvertent encounter with volcanic ash or relevant findings, including abnormal engine behavior, to the respective type certificate holders of the aircraft and engines*."

Ms. Victoria Cox, a witness at the hearing, can provide additional details on FAA's collaborative efforts to assist other aviation regulators as well as how similar situations may be managed under the NextGen air traffic control system. In addition, Mr. Roger Dinius, also a witness at the hearing, can provide details on GE Aviation's role in helping European aviation regulators establish conditions for flight resumption.

There is widespread agreement on the need for a better understanding of the effects of volcanic ash on aircraft and how particulates propagate in the atmosphere. Of particular concern is the small amount of research so far on the cumulative impact of flying for extended amounts of time through even low levels of volcanic ash. What knowledge we still lack and how we go about gaining that better understanding—possibly through additional research, data collection and computer modeling—will be discussed during this hearing.

IV. Issues

<u>Aeronautics Research and Information Needs</u>

- *What is known about the impact of aircraft flying through volcanic ash clouds? What are the areas of greatest uncertainty in our knowledge and what research is needed to reduce that uncertainty?*
- *What research is needed to better understand when and under what conditions (e.g., size of particulates, ash concentration, and height of the cloud) it is safe to fly through airspace that has been contaminated with volcanic ash particulates? Is there a way to characterize the risk of flying under different conditions?*

- *What research is needed to develop sensors and instrumentation to warn aircraft operators of volcanic ash conditions?*
- *Can human factors research enhance the training of pilots who might deal with volcanic ash conditions?*
- *What is known about how much damage volcanic ash can inflict on aircraft engines? What research can help engine designers determine the extent to which the safety of aircraft engines could be enhanced on future aircraft that inadvertently fly through volcanic ash conditions?*
- *What is the extent of research on the effects of aircraft flying through volcanic ash clouds by the National Aeronautics and Space Administration (NASA) and the Federal Aviation Administration (FAA)? What has been learned?*
- *What additional research is needed to help establish limits and conditions under which it is safe to fly in contaminated airspace? What level of resources would such research entail?*
- *To what extent are federal research programs on aircraft flying through volcanic ash coordinated and how easy or difficult is it to share the research results with relevant stakeholders? To what extent are U.S. and international research programs coordinated?*
- *Are there other sources of research (e.g. by the commercial, or private, non-government sectors) on the effects of aircraft flying in volcanic ash conditions?*

Detection, Monitoring and Modeling Activities and Assets

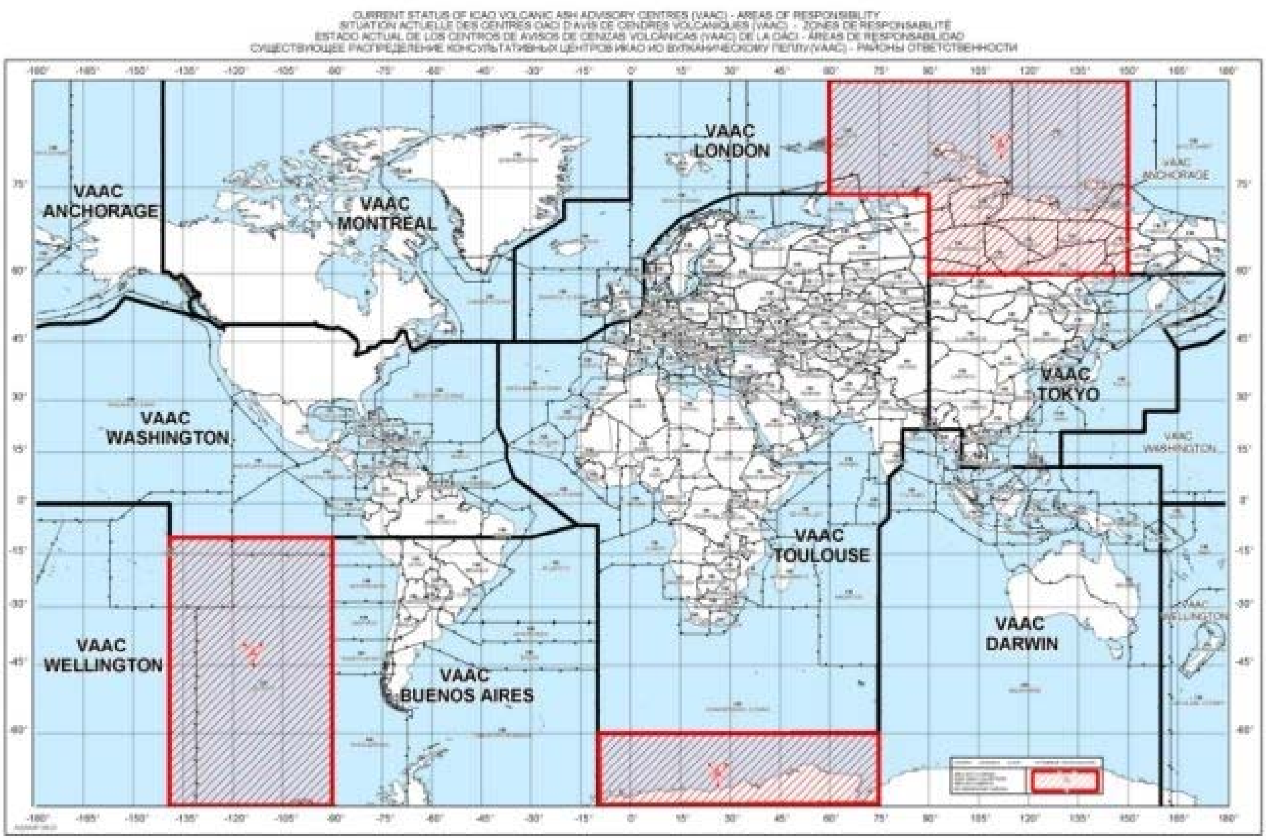
- *What civil federal capabilities, such as Earth-observation satellites, are used to assist in detecting and monitoring volcanic ash cloud propagation and dispersion? How effective are they?*
- *To what extent will planned Earth observing satellites contribute to the detection, monitoring and understanding of volcanic ash clouds and their composition?*
- *What enhancements to space-based or airborne sensors, technologies, or techniques are needed to further our understanding of volcanic ash clouds and particulate dispersion?*
- *How effective are current modeling techniques in forecasting the propagation of volcanic ash clouds?*
- *How are the scientific results of research and monitoring of volcanic ash clouds coordinated, analyzed, filtered and disseminated to decision makers who are responsible for determining when it is safe to fly, and what, if any, improvements need to be made to ensure the effectiveness of coordinating and disseminating the information?*
- *What is the extent of collaboration, both nationally and internationally, in the detection and monitoring of atmospheric volcanic ash conditions and dissemination of warnings?*

Air Traffic Management/NextGen and Voluntary Reporting Mechanisms

- *What air traffic regulations are currently in effect to manage aircraft operations in the event of a volcanic ash cloud event, such as those experienced in Alaska? Are there contingency plans for dealing with such events? What information is needed to establish "safe" flight corridors?*
- *What was FAA's role in collaborating with international aviation regulatory bodies to establish safe conditions for resumption of air travel following the eruption of the Eyjafjallajokull volcano?*
- *Can research help inform the establishment of airspace management and air traffic control procedures in the event of a volcanic ash cloud situation? If so, in what areas is research needed and who should conduct such research in the U.S.?*
- *Will the management of aircraft flying in volcanic ash situations be handled differently under NextGen? What information does NextGen need to automatically assign safer air traffic routes? Is that information available today?*
- *Have any of the voluntary safety reporting mechanisms, such as the Aviation Safety Information and Sharing (ASIAS) System, identified issues associated with aircraft flying through volcanic ash clouds?*

ATTACHMENT I

Volcanic Ash Advisory Centers Worldwide



Source: NOAA Satellite and Information Service

ATTACHMENT II

Photographs of Damaged Turbine Blades from Engine number 692632 on NASA DC-8-72 Following Encounter with Volcanic Ash Cloud

Source: NASA

Excerpt from NASA's report (NASA/TM-2003-212030)

"Even though this was a diffuse ash cloud, the exposure was long enough and engine temperatures were high enough that engine hot section blades and vanes were coated and cooling air passages were partially or completely blocked. The uncooled blades still performed aerodynamically but necessitated expensive overhauls. The insidious nature of this encounter and the resulting damage was such that engine trending did not reveal a problem, yet hot section parts may have begun to fail (through blade erosion) if flown another 100 hr."

Source: NASA