



## INTERNATIONAL VOLCANIC ASH TASK FORCE (IVATF)

May 2010 to June 2012

### SUMMARY OF THE ACCOMPLISHMENTS OF THE INTERNATIONAL VOLCANIC ASH TASK FORCE

#### SUMMARY

The International Volcanic Ash Task Force (IVATF) was established in May 2010 in response to the disruptions of civil aviation that resulted from the eruption of the Eyjafjallajökull volcano in Iceland in April and May of the same year. The task force, which would be complementary to the existing International Airways Volcano Watch Operations Group (IAVWOPSG), was tasked to assist in the urgent development of a global safety risk management framework that would make it possible to determine the safe levels of operation in airspace contaminated by volcanic ash.

In June 2012, after four meetings in ICAO Headquarters and intensive work by correspondence between meetings, the task force delivered its results and was dissolved.

This Summary provides an overview of the accomplishments of the IVATF. Detailed reports of the meetings, together with working documentation, are published on the [IVATF website](#)<sup>1</sup>.

## 1. BACKGROUND

1.1 On 14 April 2010, the Eyjafjallajökull volcano in Iceland erupted, ejecting large volumes of volcanic material high into the atmosphere. Prevailing meteorological conditions were such that the resultant volcanic ash cloud was transported during the early days of the eruption south and east from Iceland across large swathes of European and North Atlantic airspace. The eruption, while episodic in nature at times, lasted until 23 May 2010.

1.2 The impact of the eruption on commercial air traffic in Europe was severe, particularly during the first week of the eruption when airports directly affected by volcanic ash experienced a 70% reduction of normal traffic and 75% of the European network was closed<sup>2</sup>. Owing to the global nature of

<sup>1</sup> <http://www.icao.int/safety/meteorology/ivatf/>

<sup>2</sup> Information provided by EUROCONTROL at IVATF/1

today's air transportation system, the socio-economic consequences of these closures were felt in Europe and beyond.

1.3 While the conservation of *safety* had remained the over-riding consideration during the closures, strenuous efforts were made to develop solutions that would optimize the balance between safety preservation *and* economic consequences. These efforts required the commitment, skills and resources of aircraft operators, aircraft and engine manufacturers, geologists, meteorologists, volcanologists and a host of other specialists worldwide.

1.4 On 18 May 2010, in response to the disruption caused by the eruption, the Secretary General of ICAO established the multi-disciplinary International Volcanic Ash Task Force (IVATF), tasked to assist the Secretariat in the development of a global safety risk management framework that would make it possible to determine the safe levels of operation in airspace contaminated by volcanic ash. The work of the task force was to be complementary to existing work within the International Airways Volcano Watch Operations Group (IAVWOPSG).

## 2. WORKING METHODOLOGY

2.1 Recognizing the multi-disciplinary nature of the issues highlighted during the eruption, the IVATF adopted a project management approach – principally through the establishment of a programme coordinator and four project managers, each respectively responsible for overseeing the work of an Atmospheric Sciences Sub-Group, an Airworthiness Sub-Group, an Air Traffic Management Sub-Group and an International Airways Volcano Watch Coordination Group. Experts nominated by States and international organizations contributed to one or more of the sub-groups depending on their particular area of expertise.

2.2 The first meeting of the IVATF (IVATF/1) was held at ICAO Headquarters, Montreal, 27 to 30 July 2010, attracting around 90 experts from 13 States and 13 International Organizations. The opening meeting served to evaluate the Eyjafjallajökull eruption, share experiences and lessons learned, review the operational response to aircraft encounters with volcanic ash and the notification and warning system, consider ash concentration supplementary information, ways and means to improve volcanic ash detection by ground-based, satellite-based and airborne detection systems, and the refinement and harmonization of atmospheric transport and dispersion models used to forecast the movement of volcanic ash in the atmosphere. The IVATF/1 meeting developed a work programme, detailing tasks and expected deliverables, often inter-dependent, against each of the four IVATF sub-groups referenced above.

2.3 Two further meetings of the IVATF, with similar levels of attendance, were held at ICAO Headquarters over the following 18 months – namely IVATF/2 held 11 to 15 July 2011 and IVATF/3 held 15 to 17 February 2012. The task force agreed to conclude its activities at its fourth and final meeting (IVATF/4) on 13 to 15 June 2012. At each of the meetings, the task force reviewed the progress being made to accomplish the tasks/deliverables defined in the work programme. The task force developed a number of recommendations to ensure the appropriate follow-up and/or conclusion of a particular deliverable.

2.4 Between each meeting of the IVATF, the task force had agreed to monitor progress by way of quarterly sub-group progress reports and accompanying teleconferences. In total, six quarterly teleconferences were held (October 2010; January, April and October 2011; and January and April 2012). Additionally, several sub-groups elected to hold their own regular teleconferences to ensure the progress of assigned tasks. All working documentation relating to the IVATF, including the meeting reports and/or

executive summaries, have been posted on the (publically accessible) [IVATF website](#)<sup>3</sup> together with lists of recommendations from IVATF/2, /3 and /4, and IVATF sub-group progress reports supporting the quarterly teleconferences.

### 3. SUMMARY OF THE ACCOMPLISHMENTS

3.1 Having adopted a suitable working methodology with which to address the multi-disciplinary issues highlighted by the eruption of Eyjafjallajökull, the task force worked diligently during and between meetings to ensure necessary and appropriate follow-up of all the tasks/deliverables contained in the work programme of the IVATF. In total, almost 40 tasks, many interdependent, were addressed by the sub-groups of the task force.

3.2 The following provides a summary of the accomplishments of the IVATF since it was established in May 2010 and until its final meeting (IVATF/4) in June 2012. The summary is organized in accordance with the tasks/deliverables assigned to each of the sub groups, and the task identifiers and titles refer to the work programme that was decided by IVATF/1 and updated at subsequent meetings.

#### 3.3 Atmospheric Sciences

3.3.1 Through the Science Sub-Group, supported in particular by the World Meteorological Organization – International Union of Geodesy and Geophysics (WMO-IUGG) Volcanic Ash Scientific Advisory Group (VASAG), the IVATF made significant progress in the scientific understanding of volcanic eruptions and of the movement and dispersal of volcanic ash in the atmosphere.

3.3.2 With regard to task **TF-SCI01**: *Determine the ways and means to improve volcanic cloud detection/avoidance systems for pre-flight and en-route decisions by operators and regulators*, the task force identified technologies and recommended system requirements pertinent to ground-based, airborne and satellite-based volcanic ash detection systems. Guidance in this regard will be included in the *Handbook of the International Airways Volcano Watch — Operational Procedures and Contact List* (Doc 9766) and/or in the *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds* (Doc 9691). The task force progressed further activities related to ground-based, airborne and satellite-based volcanic ash detection systems through sub-tasks TF-SCI01.1, TF-SCI01.2 and TF-SCI01.3 as follows.

Sub-task **TF-SCI01.1** concerned the development of a *table of capabilities and accuracies of ground-based detection methods*. In this regard, the task force developed a comprehensive assessment of lidar techniques that can be used for specific ground-based volcanic ash cloud monitoring and related products. Recognizing that the Global Atmosphere Watch (GAW) Programme of WMO provides a strong framework for improving the use of lidar techniques and networks for detection and characterization of volcanic ash, the task force recommended that the work be continued by the GAW Programme.

Sub-task **TF-SCI01.2** concerned the *preparation of training material on satellite remote-sensing techniques*. In this regard, the task force conducted an assessment of existing, scientifically-based, training materials and protocols, which are available from national satellite agencies and government research groups that support operations at the volcanic ash advisory centres (VAACs). The task force found that while good progress continues

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<sup>3</sup> <http://www.icao.int/safety/meteorology/ivatf/>

to be made, there was a need to encourage the further development and refinement of suitable training materials to support the VAACs, taking into account the rollout of the next generation of satellite instruments. The task force therefore recommended that the International Airways Volcano Watch Operations Group (IAVWOPSG), in collaboration with the WMO-IUGG VASAG, continue to encourage the development and refinement of suitable training material supporting their operational use by the VAACs.

Sub-task **TF-SCI01.3** concerned the *finalizing of a guidance table concerning airborne sampling for inclusion in Doc 9766*. In this regard, the task force completed an assessment of aircraft instrumentation that can be used for volcanic ash cloud sampling and recommended, through the International Airways Volcano Watch Operations Group (IAVWOPSG), the incorporation of the guidance into the *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds* (Doc 9691).

3.3.3 With regard to task **TF-SCI02**: *Situational awareness improvements of impending volcanic eruptions and evaluation of volcano monitoring gaps worldwide*, the task force determined that increased monitoring of volcanoes, by States with active or potentially active volcanoes in their territory, and the increased use, by volcano observatories, of the aviation colour code and the volcano observatory notice for aviation, would result in improved situational awareness. The task force progressed further activities in this regard through sub-tasks TF-SCI02.1 and TF-SCI02.2 as follows.

Sub-task **TF-SCI02.1** concerned *an evaluation of volcano monitoring gaps worldwide*, in order to produce a list of volcanoes that threaten aviation and are unmonitored or inadequately monitored for the risks they pose. The development of such a list was considered as a necessary starting point towards the goal of increasing the number of monitored volcanoes, thus promoting enhanced aviation situational awareness through the International Airways Volcano Watch (IAVW). Through the combined efforts of the Smithsonian Institution and the United States Geological Survey, as well as the World Organization of Volcano Observatories (WOVO) through the International Union of Geophysics and Geodesy (IUGG), the development of the list is in progress, with results expected to be presented to the International Airways Volcano Watch Operations Group (IAVWOPSG) later in 2012 or in 2013.

Task **TF-SCI02.2** concerned means to *encourage the increased use of the aviation colour code among State volcano observatories*. In this regard, World Organization of Volcano Observatories (WOVO) developed and made available on its public [internet website](http://www.wovo.org/volcanic-alert-levels.html)<sup>4</sup> initial guidelines to promote the use of the aviation colour code and volcano observatory notice to aviation. Following consideration at the International Airways Volcano Watch Operations Group (IAVWOPSG), WOVO through the International Union of Geophysics and Geodesy (IUGG) has been tasked to promote the increased use, by volcano observatories, of the aviation colour code and the volcano observatory notice to aviation.

3.3.4 With regard to task **TF-SCI03**: *Support requirements for airworthiness determination*, the task force has significantly improved the scientific and operational understanding of the term ‘visible ash’, from qualitative and quantitative perspectives – where scientific analysis has identified that there exists considerable range (two or three orders of magnitude) in concentration values that could be used to represent ‘visible ash’, even under good viewing conditions. In addition, the task force developed recommendations on the types of volcanic ash material that may be used to conduct aircraft/jet engine

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<sup>4</sup> <http://www.wovo.org/volcanic-alert-levels.html>

airworthiness testing. The task force progressed further activities in this regard through sub-tasks TF-SCI03.1 and TF-SCI03.2 as follows.

Sub-task **TF-SCI03.1** concerned the *quantification of the detectability of 'visible ash*, in particular detection thresholds of satellite-based infrared sensors. In this regard, the task force performed a preliminary assessment of recent satellite measurements and observations of volcanic ash cloud thickness, and determined that the current best estimate of the *minimum detection threshold* for volcanic ash mass loading was  $0.2 \text{ g/m}^2$ , with a standard error of  $\pm 0.15 \text{ g/m}^2$  under favourable conditions and using the most advanced retrieval methodologies. Therefore, for a volcanic ash cloud of 1 km mean thickness and uniform vertical distribution, the lower detection threshold for volcanic ash concentration estimation from satellites would be  $200 \text{ }\mu\text{g/m}^3$ . The task force recommended that the World Meteorological Organization – International Union of Geodesy and Geophysics (WMO-IUGG) Volcanic Ash Scientific Advisory Group (VASAG), through the International Airways Volcano Watch Operations Group (IAVWOPSG), be tasked to support the establishment of a validation data-set for benchmarking current and future satellite-based retrieval schemes and encourage national and international space-based earth observation programmes to maintain and improve the level of coverage based on the current and future global coverage at infrared wavelengths. In addition, in order to improve the definition of the three-dimensional geometry of volcanic ash clouds and direct future volcanic-cloud research, the WMO-IUGG VASAG will be tasked to encourage further scientific investigations into volcanic-cloud thickness and stratification and to engage with the wider scientific community in pursuit of the research topics related to volcanic-cloud hazards respectively.

Sub-task **TF-SCI03.2** concerned the *development of recommendations on volcanic materials to be used to conduct airframe/engine airworthiness testing*. In this regard, the task force developed a comprehensive list of recommendations that will be included in the *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds* (Doc 9691).

3.3.5 With regard to task **TF-SCI04: Improved eruption source parameterization for dispersion models**, the task force developed guidance on technologies and systems that can be used to characterize eruption source parameters (ESP). The task force progressed further activities in this regard through sub-tasks TF-SCI04.1 and TF-SCI04.2 as follows.

Sub-task **TF-SCI04.1** specifically concerned *improved methods for estimating eruption source parameters*. The World Meteorological Organization – International Union of Geodesy and Geophysics (WMO-IUGG) Volcanic Ash Scientific Advisory Group (VASAG), through the International Airways Volcano Watch Operations Group (IAVWOPSG), has been tasked to continue efforts to improve eruption detection and measurement capability, improve knowledge and use of eruption source parameters (ESPs), characterize uncertainty, improve a global ESP database, and develop probability density functions for ESPs at individual volcanoes, with special attention to the most active ones. These endeavours will result in improved eruption source parameterization, and thus lead to improved capabilities of the Volcanic Ash Advisory Centres (VAACs) to predict the extent and evolution of volcanic ash in the atmosphere.

Sub-task **TF-SCI04.2** concerned means to improve the *gathering of meteorological data during a volcanic event*. In this regard, the task force identified that the World Meteorological Organization's (WMO's) Global Atmosphere Watch (GAW) Programme,

which was established to monitor the presence of atmospheric aerosols by means of space-based, ground-based remote and in-situ sensing by specialized aircraft, may be a suitable means with which to improve the gathering of those atmospheric parameters upon which the volcanic ash advisory centres can more reliably and more accurately initialise their forecasts, complementary to other observational sources such as meteorological satellites. The task force recommended that the International Airways Volcano Watch Operations Group (IAVWOPSG), in close cooperation with the WMO and national or regional agencies operating observing platforms, promote the availability of basic meteorological data, as well as data collection and exchange for aerosol data (and their respective contingencies), in accordance with the needs of the International Airways Volcano Watch (IAVW). Complementary to this activity, and recognizing a relationship with task TF-VAA07 concerning improvement to volcano observatory provisions, the task force highlighted that efforts have begun within the global volcanological community to assess volcanic monitoring capabilities and risk levels, and that strengthened communication between State volcano observatories and the aviation community is necessary to realize the benefits of improved volcano monitoring. In this regard, the task force recommended that States that maintain volcano observatories assess and enhance monitoring capabilities and channels of communication in support of the IAVW.

3.3.6 With regard to task **TF-SCI05: *Model improvements and validation***, the task force developed a comprehensive assessment of sources and significance of uncertainty in volcanic ash dispersion model forecasts (and the implications for operational products) and ensemble strategies to assess confidence in ash-cloud forecasts. The assessment highlighted that, at any given point in space and time, the *forecast uncertainty was at least one order of magnitude above or below the forecast value*. Consequently, the International Airways Volcano Watch Operations Group (IAVWOPSG) was undertaking a review of the findings in the context of the development of operational advisory and warning products. In addition, the World Meteorological Organization – International Union of Geodesy and Geophysics (WMO-IUGG) Volcanic Ash Scientific Advisory Group (VASAG) was tasked to work towards improvements in dispersion modelling and to explore the development of near-real-time ensemble capabilities and prototype probabilistic products.

3.3.7 With regard to task **TF-SCI06: *Health effects on aircraft occupants of exposure to volcanic sulphur dioxide***, the task force completed an assessment which highlighted that during a volcanic eruption, a number of toxic gases (including sulphur dioxide) may be emitted in addition to volcanic ash, and may exist separate to the volcanic ash cloud itself. Sulphur dioxide was considered of particular importance since it may be emitted in large quantities and potentially has significant health effects, producing minor symptoms for minor exposure levels and proportionately more serious symptoms as exposure increases – the most prominent effects being asthmatic symptoms, particularly in those susceptible to the condition. Notwithstanding existing ICAO guidance concerning sulphur dioxide detection and effects – principally in ICAO Docs 9691 and 9766 – the task force determined that more research should be conducted to better understand the airworthiness effects, potential significant risk of sulphur dioxide to aircraft occupants, and any associated expeditious mitigation of the risk. This research is on-going through the International Airways Volcano Watch Operations Group (IAVWOPSG).

## 3.4 **Airworthiness**

3.4.1 Significant progress in advancing the understanding of the airworthiness effects of flight into a volcanic ash cloud, and the mitigating actions and maintenance considerations that need to be taken in the event of an encounter, had been achieved by the IVATF through the Airworthiness Sub-Group.

3.4.2 With regard to task **TF-AIR01**: *Define unsafe factors for operations in volcanic ash*, the task force discussed operationally applicable characteristic(s) that may be used as a threshold value for the concept of ‘visible ash’. In this regard, the task force considered definitions of environmental threat and expected operations, assessed airworthiness implications, validation or amendment of the modelled volcanic ash concentrations that were adopted by some States during the Eyjafjallajökull eruption in 2010, and determined the viability of establishing ICAO Standards in this regard. As part of this effort, the task force determined that taking into account a lack of a global user requirement, the spread of uncertainties in volcanic ash observing and forecasting, and noting the scientific and operational progress in enhancing volcanic ash advisory centre best practices, work on developing modelled volcanic ash concentration information for users would be discontinued. The task force therefore recommended that future activities with regards to unsafe factors for operations in volcanic ash, in particular the concepts of *visible ash* and *discernible ash* should be undertaken by the International Airways Volcano Watch Operations Group (IAVWOPSG). The task force developed an initial set of definitions for visible ash and discernible ash which would be forwarded for the consideration of the International Airways Volcano Watch Operations Group (IAVWOPSG) in order to develop definitions for robust operational use for volcanic ash forecasting and flight-planning purposes.

3.4.3 With regard to task **TF-AIR02**: *Determine airframe, engine and components susceptible to volcanic ash or volcanic gases*, the task force developed comprehensive additional guidance material which will be introduced into the *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds* (Doc 9691).

3.4.4 With regard to tasks **TF-AIR03**: *Develop airworthiness criteria for States as a component of their decision-making process concerning operations in airspace that is potentially contaminated with volcanic ash* and **TF-AIR04**: *Develop pre-flight/dispatch guidance material and specific criteria to assist operators in their decision making process prior to operations in potential ash contaminated areas using risk management principles*, the task force developed comprehensive guidance material which resulted in the publication, in early 2012, of the manual on *Flight Safety and Volcanic Ash — Risk Management of Flight Operations with Known or Forecast Volcanic Ash Contamination* (Doc 9974). Doc 9974 is a co-branded industry publication involving ACI, CANSO, IATA, ICAO, ICCAIA, IFALPA and IFATCA, and provides guidance which States may recommend to operators and regulatory authorities where volcanic ash contamination may be a hazard for flight operations – the guiding principle for such operations being the use of a safety risk management approach. The task force recommended that Doc 9974 be maintained through the Operations Panel (OPSP), with input, as required, from the International Airways Volcano Watch Operations Group (IAVWOPSG).

3.4.6 With regard to task **TF-AIR05**: *Determine how best to relocate and revise guidance for flight into sulphur dioxide clouds within the Handbook on the International Airways Volcano Watch — Operational Procedures and Contact List* (Doc 9766), and taking into account the progress made under task TF-SCIO6, the task force developed a preliminary proposed revision to the existing guidance contained Doc 9766 in this regard. Taking into account existing deliverables of the International Airways Volcano Watch Operations Group (IAVWOPSG), the multi-disciplinary nature of determining thresholds for safe aircraft operations, and the need for the development of supporting advisory or warning products, the task force recommended that the IAVWOPSG continue to progress work in this area, including any associated amendment to Doc 9766 or other ICAO provisions.

3.4.7 With regard to task **TF-AIR06**: *Develop maintenance and operations considerations for international general aviation*, the task force completed an assessment of the technical and operational aspects of maintenance considerations. The task force developed appropriate guidance material and recommended that the Operations Panel (OPSP) consider the material for inclusion, through the

International Airways Volcano Watch Operations Group (IAVWOPSG), in the *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds* (Doc 9691).

3.4.8 With regard to task **TF-AIR07**: *Make recommendations on emerging technologies that measure volcanic cloud characteristics of concern to aircraft airworthiness*, the task force undertook an assessment which concluded that: i) emerging technologies to record multiple encounters (in-flight) and that correlate with wear and damage accumulation (on-ground maintenance) are not mature; ii) technologies to measure, record, monitor or warn flight crew of the degree of volcanic debris contamination or damage caused by volcanic cloud are not mature or are not commercially available; and iii) in-service experience of emerging technology is required to develop a minimum operational performance specification towards standardization of operational regulations. The task force therefore recommended that an appropriate technical organization be invited to develop a Minimum Operational Performance Specification to sense and display volcanic ash cloud characteristics of concern to aircraft airworthiness to flight crew, with a view to providing tactical guidance to avoid dangerous exposure to volcanic clouds. The task force also recommended that SAE International be invited to develop standards for aircraft health monitoring technologies and analytical processes that record the accumulative effects of volcanic ash encounters.

3.4.9 With regard to task **TF-AIR08**: *Provide airworthiness information to operators for use within their safety risk assessment process*, the task force developed, in the form of guidance, an original equipment manufacturers (OEM) crisis response plan which, during volcanic events impacting operations, will ensure that OEMs are able to responding urgently, and in a coherent and comprehensive manner, to requests for information from operators, air navigation service providers and regulatory authorities. This guidance will be included in the *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds* (Doc 9691).

### 3.5 Air Traffic Management

3.5.1 Significant progress in improving the understanding of the impact on airspace operations of volcanic ash in the atmosphere or of volcanic ash at aerodromes, and the associated contingency strategies needed, was achieved by the IVATF through the Air Traffic Management Sub-Group.

3.5.2 With regard to task **TF-ATM01**: *Air traffic management (ATM) contingency planning*, the task force developed an ATM volcanic ash contingency plan template that can be adapted, as necessary, for regional implementation. The contingency plan template provides standardized guidelines for the provision of information to operators before, during and after a volcanic eruption, supported by the necessary ICAO provisions, and instils a collaborative and consistent approach to the operational response by service providers, airspace users and regulatory authorities. The task force has recommended that the ICAO planning and implementation regional groups (PIRGs) use the template as the basis for development of regional ATM volcanic ash contingency plans, tailored to their region-specific needs, and that the Air Navigation Bureau, under the lead of the Chief, Air Traffic Management Section, be the custodian of the template.

3.5.3 With regard to task **TF-ATM02**: *Flight planning information dissemination*, the task force conducted a review of the use of volcanic ash advisories, SIGMET information for volcanic ash, NOTAM for volcanic ash and ASHTAM, since such aeronautical and meteorological information was related and, often, overlapping in its content. The task force also assessed the benefits of developing new products, taking into account technological solutions being developed both on the ground and on-board the aircraft. It is to be expected that discussions in this regard will be conducted through concerned ICAO groups with a view to determining what changes, if any, are required to existing ICAO provisions.



3.5.4 With regard to task **TF-ATM03: Operational information exchange**, the task force considered aspects concerning procedures and guidance for the improved issuance, dissemination and reception of pilot reports of volcanic activity – in particular in the context of in-flight special air-reporting and post-flight reporting using the volcano activity report (VAR) form. Threading into task TF-VAA12, the task force recommended that the International Airways Volcano Watch Operations Group (IAVWOPSG) continue the work on improvements to the VAR form, including possible near-future interactive electronic means for the in-flight completion of the form.

3.5.5 With regard to task **TF-ATM04: Issues concerning air traffic control (ATC) clearances through danger areas**, the task force developed a proposed amendment to the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444), paragraph 15.8 regarding procedures for an ATC unit when volcanic ash is reported or forecast. The proposed amendment to PANS-ATM, paragraph 15.8 was finalized by the Secretariat and was being processed in accordance with standard procedures, with a view to applicability in November 2014. It is to be expected that the *Air Traffic Management Volcanic Ash Contingency Plan for the European and North Atlantic Regions* (EUR Doc 019, NAT Doc 006, Part II) will be revised in accordance with the amended PANS-ATM.

3.5.6 With regard to task **TF-ATM05: Investigate danger area terminology and its relevance in today's operating environment**, the task force analysed the use of danger area terminology as currently described in the *Air Traffic Management Volcanic Ash Contingency Plan for the European and North Atlantic Regions*, and its implications. The analysis determined that States *should not* declare a danger or restricted area in respect of volcanic ash, *except* over and in proximity to an erupting volcano where considered appropriate; *however*, a State retains the right, under the ICAO Convention on International Civil Aviation, to restrict or prohibit flying over the whole or any part of its territory in exceptional circumstances. The task force developed a recommendation in this regard.

3.5.7 With regard to task **TF-ATM06: Review the current processes regarding the issuance of volcanic ash advisories, SIGMET information for volcanic ash, NOTAM for volcanic ash and ASHTAM**, the task force determined that such matters should be threaded into means to reduce or eliminate information overload during volcanic eruptions. Consequently, the task force agreed to progress these issues as part of task TF-VAA13.

### 3.6 **International Airways Volcano Watch coordination**

3.6.1 Significant progress in ways and means to improve the International Airways Volcano Watch (IAVW), taking into account the multi-disciplinary nature of the challenges faced before, during and after the eruption of Eyjafjallajökull in 2010, was achieved by the IVATF through the International Airways Volcano Watch Coordination Group.

3.6.2 With regard to task **TF-VAA01: Volcanic ash-related provisions and guidance**, the task force identified ICAO provisions related to volcanic ash, with a view to determining which, if any, would require update based on the accomplishments of the task force and other concerned ICAO groups. The *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds* (Doc 9691), the *Handbook on the International Airways Volcano Watch — Operational Procedures and Contact List* (Doc 9766) and *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) were the principal documents that have either been amended or are in the process of being amended based on the accomplishments of the task force.

3.6.3 With regard to task **TF-VAA02: Enhancement of Volcanic Ash Advisory Centre (VAAC) products**, the task force completed a comprehensive assessment of existing products (including enhancement thereof) and potential new products. Recognizing the good progress made to promote and

implement best practices among the VAACs, and that the enhancement of existing products or the development of new products cannot be done in isolation, the task force recommended that the International Airways Volcano Watch Operations Group (IAVWOPSG) be tasked to progress these matters further.

3.6.4 With regard to task **TF-VAA03**: *Collaborate decision-making (CDM) within the International Airways Volcano Watch (IAVW)*, the task force identified possible tools and associated procedures which may be suitable to foster the collaborative and consistent response to volcanic eruptions, wherever in the world they may occur. Acknowledging on-going or recently completed related work within the International Airways Volcano Watch Operations Group (IAVWOPSG), and taking into account *Flight and Flow Information for a Collaborative Environment — A Concept (FF-ICE)* (Doc 9965) which provides an excellent source of information on CDM within the future global air traffic management system, the task force recommended that the IAVWOPSG consider the need to develop ICAO provisions concerning collaborative forecasting tools among the Volcanic Ash Advisory Centres (VAACs) in the production of volcanic ash advisories in support of collaborative decision-making (CDM).

3.6.5 With regard to task **TF-VAA04**: *An assessment of transport and dispersion models*, the task force determined that this activity would be best accomplished through task TF-SCI05.

3.6.6 With regard to task **TF-VAA05**: *Investigation into the benefits of the VAACs providing CSV data files or alternative*, the task force conducted an assessment of possible data file formats in support of the IAVW. The task force determined that, taking into account that *all* meteorological information (including that related to volcanic ash) will need to be in an interoperable, exchangeable data file format to support the future system-wide information management (SWIM) environment, such as the extensible markup language/geography markup language (XML/GML), there would be benefits of having volcanic ash advisories in XML/GML. The task force recommended that the International Airways Volcano Watch Operations Group (IAVWOPSG) consider the development of necessary Annex 3 — *Meteorological Service for International Air Navigation* provisions that would enable the availability of volcanic ash advisories in XML/GML.

3.6.7 With regard to task **TF-VAA06**: *SIGMET information for volcanic ash*, the task force complemented work within the International Airways Volcano Watch Operations Group (IAVWOPSG) regarding an assessment of large and complex volcanic events, regional issuance of SIGMET information, and the incorporation of uncertainty. The task force decided on a specific option designed to resolve the issue faced with SIGMET production during such large complex events and recommended that the IAVWOPSG evaluate the option as an interim solution that may provide the necessary consistency within, and strategic direction for, the International Airways Volcano Watch (IAVW).

3.6.8 With regard to tasks **TF-VAA07**, **TF-VAA08** and **TF-VAA09**: *Volcano Observatory arrangements*, the task force proposed amendments to Annex 3 — *Meteorological Service for International Air Navigation*, paragraph 3.6, and to the *Handbook on the International Airways Volcano Watch — Operational Procedures and Contact List* (Doc 9766), which are designed to ensure appropriate volcanic eruption monitoring, volcano observatory response and notification within the International Airways Volcano Watch (IAVW). In addition, ICAO will be conducting, through Regional Offices and with the assistance of concerned Volcanic Ash Advisory Centres (VAACs), three Special Implementation Projects in 2012 (in the African, European, and Central American and Caribbean Regions) targeted at States which maintain volcano observatories to assist them in ensuring the effective implementation of the IAVW arrangements and associated ICAO provisions.

3.6.9 With regard to task **TF-VAA10**: *Development of a Concept of Operations for the International Airways Volcano Watch (IAVW)*, the task force developed an initial draft and recommended that the International Airways Volcano Watch Operations Group (IAVWOPSG) undertake a review in order to enable its further development.

3.6.10 With regard to task **TF-VAA11**: *Development of guidance to support regional volcanic ash exercises*, the task force developed guidance designed to assist concerned stakeholders within the IAVW in the establishment and maintenance of routine volcanic ash exercises in the ICAO Regions. The task force recommended that the International Airways Volcano Watch Operations Group (IAVWOPSG) consider the necessary inclusion of the guidance in the *Handbook on the International Airways Volcano Watch (IAVW) — Operational Procedures and Contact List* (Doc 9766).

3.6.11 With regard to task **TF-VAA12**: *Improvements to Volcanic Activity Report (VAR) form, including taxonomy and transmission, in support of the IAVW*, which was an extension of the activity conducted under task TF-ATM03, the task force completed a comparison of ICAO and non-ICAO VAR forms with a view to assisting the International Airways Volcano Watch Operations Group (IAVWOPSG) in the development of a revised VAR form, together with supporting provisions. The task force recommended that the IAVWOPSG continue the work on improvements to the VAR form, including possible near-future interactive electronic means for the in-flight completion of the form.

3.6.12 With regard to task **TF-VAA13**: *Reduction or elimination of information overload during volcanic eruptions*, which is an extension of the activity conducted under TF-ATM06 (outlined above), the task force identified the complexities and co-existing roles between the different aeronautical and meteorological message types that relate to volcanic ash – specifically volcanic ash advisories, SIGMET information for volcanic ash, NOTAM for volcanic ash and ASHTAM. The task force recommended that the International Airways Volcano Watch Operations Group (IAVWOPSG), in coordination with the Meteorological Warnings Study Group (METWSG) and the Aeronautical Information Services to Aeronautical Information Management Study Group (AIS-AIM SG), continue the work on strategies that can be invoked to reduce or eliminate information overload.

#### 4. **FUTURE WORK**

4.1 The events during and since the Eyjafjallajökull eruption in April and May 2010, and the work of the task force between its first and fourth meetings, demonstrated that the response to such events cannot be done in isolation, and that a coordinated and collaborative international response was, and would remain, essential. Meteorologists, volcanologists and other scientific experts would not have been able to progress in the excellent manner with which they have without the direct engagement with, and support of, airworthiness experts, air traffic management experts and alike. Likewise, airworthiness and air traffic management experts would not have been able to progress in the excellent manner with which they have without the sound scientific advice available upon which to base decisions.

4.2 The task force succeeded in bringing together multi-disciplinary groups with the common objective of improving the safety and efficiency of international air navigation in the face of a crisis that had far reaching impacts.

4.3 Following IVATF, much of the future work to enhance the International Airways Volcano Watch (IAVW) would return to the International Airways Volcano Watch Operations Group (IAVWOPSG), where, already, there was now engagement from airworthiness and air traffic management experts. Other ICAO groups (such as the Operations Panel, Airworthiness Panel and the AIS-AIM Study Group) would also be expected to fulfil respective obligations – supported by appropriate

voluntary expertise from States and international organizations – in order to ensure that the community is able to improve international arrangements relating to volcanic eruptions into the future.

## 5. CONCLUSION

5.1 The task force process was extraordinary in that it was conducted in a pressure situation, with urgent discussion needed on high profile issues. It brought together many disciplines under the imperative to work together and achieve progress. By and large, it succeeded in what it set out to achieve.

5.2 In his closing address to the task force, the Secretary General of ICAO, Mr. R. Benjamin, highlighted the significant accomplishments of the task force since its first meeting in July 2010, across multiple disciplines. He expressed his personal satisfaction in the efficiency and effectiveness with which the task force had progressed its work, and acknowledged that the task force had, among many other significant accomplishments, fulfilled the principle objective through the development and publication of the ICAO manual on *Flight Safety and Volcanic Ash — Risk management of flight operations with known or forecast volcanic ash contamination* (Doc 9974).

5.3 Notwithstanding the significant progress that had been made, the Secretary General acknowledged that some challenging issues remained. It was emphasized that any challenges should be viewed as opportunities for the community to further extend the collaborative scientific understanding and operational response to volcanic eruptions, whenever and wherever in the world they will occur, and the Secretary General expressed his personal commitment, as well as that of ICAO, to support future work.

5.4 The Secretary General extended his sincerest appreciation to all of the experts from States and international organizations who had assisted with the work of the task force, and who, in many instances, would continue to assist the international community to enhance the safety and efficiency of international civil aviation in the face of natural hazards such as volcanic eruptions through standing ICAO groups. In addition, the Secretary General acknowledged the significant contribution of the Secretariat, who had been assigned the responsibility of assisting the task force, in addition to fulfilling the regular work programme, at a time of limited resources.

5.5 Extending the sentiments of the Secretary General, the Director of the Air Navigation Bureau, Ms. N. Graham, also acknowledged the accomplishments of the task force, and paid special appreciation to all of the experts involved. In particular, Ms. Graham thanked the Programme Coordinator and the Sub-Group Project Managers of the task force for their considerable efforts during the past 24 months.