INTERNATIONAL VOLCANIC ASH TASK FORCE (IVATF)

THIRD MEETING

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Agenda Item 4: Progress report of the air traffic management sub-group (ATM SG)
4.1: ATM contingency planning, procedures and guidance

ATTACHMENT-ATM01TO IVATF/3 PPT/04

(Presented by the Project Manager of the IVATF ATM Sub-Group)

SUMMARY

This attachment is associated with deliverable of IVATF task TF-ATM01 concerning the maturation of an ATM volcanic ash contingency plan template.

The IVATF is invited to note the content of this attachment and, as necessary, develop a recommendation or further tasking for the consideration of the task force.

ATM VOLCANIC ASH CONTINGENCY PLAN TEMPLATE

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Editorial Note: The eventual inclusion of any or all of the optional appendices listed below is to be determined by the appropriate regional group.

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1. FOREWORD

1.1 This Air Traffic Management (ATM) Volcanic Ash Contingency Plan sets out standardised guidelines for the alerting of aircraft when volcanic eruptions occur, and procedures to be followed. Volcanic contaminations, of which volcanic ash is the most serious, may be a hazard for flight operations; the issue can not be resolved in isolation but through collaborative decision making (CDM) involving all entities concerned. During an eruption volcanic contamination can reach and exceed the cruising altitudes of turbine-powered aeroplanes within minutes and spread over vast geographical areas within a few days. Encounters with volcanic ash may result in one or more of the following and other problems:

- the malfunction, or failure, of one or more engines leading not only to reduction, or complete loss, of thrust but also to failures of electrical, pneumatic and hydraulic systems;
- blockage of pitot and static sensors resulting in unreliable airspeed indications and erroneous warnings;
- windscreens to be rendered partially or completely opaque;
- smoke, dust and/or toxic chemical contamination of cabin air requiring crew use of oxygen masks, thus impacting communications; electronic systems may also be affected;
- erosion of external and internal aircraft components;
- reduced electronic cooling efficiency leading to a wide range of aircraft system failures;
- aircraft to be manoeuvred in a manner that conflicts with other aircraft;
- deposits of volcanic ash on a runway degrading braking performance, most significantly if the ash is wet; in extreme cases, this can lead to runway closure.

1.2 Operators are required by ICAO Annex 6 – *Operation of Aircraft* to assess the risk of operation in volcanic ash and to implement appropriate mitigation measures in accordance with their safety management system (SMS) as approved by the State of the Operator/Registry, as appropriate. The suggested actions outlined in this document are based on the assumption that the ICAO requirements regarding safety management systems have been implemented by the operators. Detailed guidance on Safety Risk Assessments for flight operations with regard to volcanic contamination is available at .... (ICAO Doc####)

1.3 It should be noted that this document is an ATM contingency plan including its interfaces with supporting services such as Aeronautical Information Service (AIS) and Meteorological (MET) services and that the plan therefore primarily addresses the provider States. Where distinct actions by the Meteorological Watch Offices (MWOs) are described, these are additional procedures to be considered by MWOs. Where actions by Volcanic Ash Advisory Centres (VAACs) and operators are described, these are for clarification only. As volcanic events also affect people and industries that are not related to aviation, it is highly likely that contingency plans of a more generic “disaster response” nature exist in many States. Since they too rely on information sources, such as Volcanological Observatories, it is advisable to make arrangements to share information with institutions.

1.4 Volcanic ash can also affect the operation of aircraft on aerodromes. In extreme cases, aerodromes might no longer be available for operation at all, resulting in repercussions on the ATM system; e.g. diversions, revised traffic flows, etc.

1.5 These suggested procedures are not intended to establish or confirm a safe level of volcanic contamination. Operation through any area where volcanic ash is present or forecast is at the discretion of the operator. In this context it should be noted that some aircraft types or engine technologies are more vulnerable to volcanic contaminants; any specific measures to be applied would therefore have to take into account these variances. Considering that a commercial aircraft will travel about 150 km (80 NM) in 10 minutes and that volcanic ash can rise to flight levels commonly used by turbine-engine aeroplanes in half that time, a timely response to reports of volcanic ash is essential.

1.6 It is imperative that information on the volcanic activity is disseminated as soon as possible. In order to assist staff in expediting the process of originating and issuing relevant messages (VA SIGMET, NOTAM, and ASHTAM), a series of templates should be available for different stages of the volcanic activity. **[Optional:** Examples of VA SIGMET, NOTAM and ASHTAM announcing operational measures and volcanic activities in the different stages and are contained in Appendix X.**]** A list of ICAO registered volcanoes should be available at the international NOTAM office with volcano name, number and nominal position. In order to ensure the smooth implementation of the contingency plan in case of an actual volcanic eruption, annual VOLCEX exercises should be conducted.

2. TERMINOLOGY

2.1 *AREAS OF CONTAMINATION*

2.1.1 Areas of volcanic ash contamination are provided by means of volcanic ash advisories (VAAs) in accordance with the *Meteorological Service for International Air Navigation* (Annex 3).[1]

2.2 *PHASES OF AN EVENT*

2.2.1 The response to a volcanic event that affects air traffic has been divided into four distinct phases (Pre-Eruption Phase, Start of Eruption Phase, Ongoing Eruption Phase, and Recovery Phase) as described briefly below. The four phases cover an actual event only and do not describe activities that need to be performed before or after a volcanic event. However, it would be prudent to train all ATS personnel and to have regular exercises in how to deal with volcanic contaminations. In addition, following a volcanic event it would be good practice to perform a review of the actions, to identify lessons learnt, which should be taken into account in an update of the contingency plan. Volcanic activity at many locations is continuously monitored by the scientific community. Furthermore, flight crews are required to report observations of significant

[1] Optionally, contamination levels may be provided, where feasible, by means of ash concentration forecasts/charts in order to support operators in establishing their safety risk assessment (SRA) for flight operations in known or forecast volcanic ash contamination. Whenever ash products are mentioned in this document this means variously VAA or VAG and in the EUR and NAT Regions, volcanic ash concentration charts.

volcanic activity by means of a Special Air Report (AIREP). Arrangements should be put in place to ensure that such information is transferred without delay to the appropriate aeronautical institutions responsible for subsequent action. Reports (text to be included referring to Appendix C)

PRE-ERUPTION PHASE: The initial response, "raising the alert", commences when a volcanic eruption is expected. Alerting information will be provided by VA SIGMET, NOTAM or ASHTAM as appropriate and disseminated to affected aircraft in flight by the most expeditious means. In addition to the normal distribution list, the NOTAM/ASHTAM will be addressed to meteorological/volcanological agencies.

2.2.2 If it is considered that the event could pose a hazard to aviation, a danger area will be declared by NOTAM around the volcanic source. Normally, clearances will not be issued through the danger area unless explicitly requested by the flight crew. In this context it should be noted that the final responsibility for aircraft safety rests with the pilot, therefore the final decision regarding route, whether it will be to avoid or proceed through an area of volcanic activity, is the pilot's responsibility. Wherever this document discusses the possible establishment of danger areas, States are not prevented from establishing restricted or prohibited areas over the sovereign territory of the State if considered necessary by the State concerned.

START OF ERUPTION PHASE: The start of eruption phase commences at the outbreak of the volcanic eruption and entrance of volcanic ash into the atmosphere and mainly pertains to aircraft in flight. A "Start of Eruption VA SIGMET" will be issued and a danger area will be declared by NOTAM. Normally, clearances will not be issued through the danger area unless explicitly requested by the flight crew.

ONGOING ERUPTION PHASE: The ongoing eruption phase commences with the issuance of the first VAA after completion of reactive responses. The T+0 hours and T+6 hours forecasts of the contaminated area are to be issued as VA SIGMET. The T+12 hours and T+18 hours (and further into the future) forecasts of contaminated areas are to be issued as VAA forecasts. Significant changes may result in a reversion to a temporary start of eruption phase situation and unscheduled issuance of VAA, VA SIGMET and NOTAM/ASHTAM

RECOVERY PHASE: The recovery phase commences with the issuance of the first "No Volcanic Ash Expected VAA" which normally occurs when it is determined that the volcanic activity has reverted to its pre-eruption state.

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3. PRE-ERUPTION PHASE

3.1 *GENERAL*

3.1.1 Where flight operations are planned in areas that are susceptible to volcanic eruptions, a system of monitoring volcanoes should be established. As the lack of resources results in a large number of volcanoes unmonitored locally, pilots flying in the vicinity of a VA activity are frequently the first source of information on an eruption. Therefore, pilots operating in areas with unmonitored volcanoes should always be vigilant for signs of an eruption and should fully understand their importance as information providers. Operators should provide them with the ICAO Volcanic Activity Report form published in the *Procedures for Air Navigation Services – Air Traffic Management* (PANS-ATM, Doc 4444) Appendix 1, preferably in an easily useable electronic format, as part of the pre-flight briefing.

3.1.2 The focus of this phase is to gain early recognition of volcanic events. This phase is frequently characterised by a limited availability of information on the potential extent and severity of the upcoming eruption. The priority is to ensure the safety of aircraft in flight and there is therefore a requirement to promulgate information as a matter of urgency. Regardless of the extent of information available the pre-eruption phase actions should be carried out for every event.

3.1.3 The initial response, “raising the alert”, commences when a volcanic eruption is expected or has occurred without prior warning. Initial awareness of the event can be by means of an AIREP/Volcanic Activity Report and/or meteorological or volcanological agencies. Arrangements in each State between designated volcano observatories, meteorological and air traffic management agencies shall ensure that alerting information is provided expeditiuosly by the most appropriate means, VA SIGMET, NOTAM or ASHTAM or re-transmitted AIREPs, to ensure safety of flight.

3.1.4 Emphasis is placed on raising awareness of the hazard and to protect aircraft in flight. The actions are based on well-prepared contingency plans and standard operating procedures. Aircraft are expected to clear or avoid the affected area based on standard operating procedures. The alerting will trigger action, such as the collection of additional data and the preparation of specific safety risk assessments (SRAs).

3.2 *ORIGINATING ACC ACTIONS (eruption in its own flight information region)*

3.2.1 In the event of significant pre-eruption volcanic activity, a volcanic eruption occurring, or a volcanic ash cloud being reported which could pose a hazard to aviation, an area control centre (ACC)[2], on receiving information of such an occurrence, should carry out the following:

a) define an initial danger area in accordance with established procedures. The size of the danger area should encompass a volume of airspace in accordance with the limited information available, aiming to avoid undue disruption of flight operations;

i) if no such procedures have been established, the danger area should be defined as a circle with a radius of xxx km (xx NM)[3]. If the eruption has not

[2] Although the term “ACC” is used throughout this document, it applies also to flight information centre (FIC)
[3] The size of the area to be agreed in the region concerned.

commenced or if no information on upper winds is available, the circle should be centred on the estimated location of the volcanic activity;

ii) should a precautionary danger area be established, its size should encompass a reasonable volume of airspace in accordance with the limited information available aiming to avoid undue disruption of flight operations;

Note.– An area with a radius of 5 to 10 minutes flying time would result in only 2 – 3 minutes additional flying time.

iii) If the eruption has started and predicted upper wind information is available, the circle should be centred xxx km (xx NM)[4] downwind from the volcano whilst enclosing it. The purpose of this initial danger area is to ensure safety of flight in the absence of any prediction from a competent authority of the extent of contamination;

iv) although ATC would not normally initiate a clearance through a danger area, it will inform aircraft about the potential hazard and continue to provide normal services. It is the responsibility of the pilot-in-command to determine the safest course of action.

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b) advise the associated Meteorological Watch Office (MWO) and the appropriate VAAC (unless the initial notification originated from either of these entities). The VAAC will then inform the appropriate air traffic flow management (ATFM) units.

c) alert flights already within the danger area and offer assistance to enable aircraft to exit the area in the most expeditious and appropriate manner. Pilots should be provided with all necessary information required to make safe and efficient decisions while flying around the defined area. Aircraft that are close to the danger area should be offered assistance to keep clear of the area. Tactically re-clear flights which would penetrate the danger area onto routes that will keep them clear. The ACC should immediately notify other affected ACCs of the event and the location and dimensions of the danger area. It should also negotiate any re-routings necessary for flights already coordinated but still within adjacent flight information regions (FIRs). It is also expected that adjacent ACCs will be asked to reroute flights not yet coordinated to keep them clear of the danger area. It should be noted that pilots may make the decision not to completely avoid the danger area based on e.g. visual observations.

d) ensure that a NOTAM/ASHTAM is originated. This must provide as precise information as is available regarding the activity of the volcano. The name (where applicable), reference number and position of the volcano should be included along with the date and time of the start of the eruption (if appropriate). It is imperative that this information is issued by the international NOTAM office and disseminated as soon as possible.

e) in order to assist staff in expediting the process of composing the NOTAM/ASHTAM, a series of templates should be available for this stage of the

[4] The values to be agreed in the region concerned.

volcanic activity. **[Optional:** Sample NOTAM and ASHTAM are provided in Appendix xxx.**]**

3.2.2 In addition to sending the NOTAM/ASHTAM and any subsequent NOTAM/ASHTAM to the normal distribution list, it will be sent to the relevant meteorological agencies with the appropriate World Meteorological Organisation (WMO) header.

3.3 *ADJACENT ACC ACTIONS*

3.3.1 During the pre-eruption phase ATC will not normally initiate clearances through the danger area; however, it will inform aircraft about the potential hazard and continue to provide normal services. Any ash contamination should be contained within a limited area and disruption to traffic should not be excessive. Adjacent ACCs should take the following action to assist:

a) when advised, re-clear flights to which services are being provided and which will be affected by the danger area.

b) unless otherwise instructed, continue normal operations except:

i) if one or more routes are affected by the danger area, stop clearing aircraft on these routes and take steps to reroute onto routes clear of the danger area; and

ii) initiate a running plot of the affected area.

3.4 *ATFM UNIT ACTIONS*

3.4.1 The ATFM unit and the VAAC will determine how their initial communications will take place on the basis of bilateral agreements. Upon reception of preliminary information on volcanic activity from the VAAC, the ATFM unit should initiate actions in accordance with its procedures to ensure exchange of information in order to support CDM between air navigation service providers (ANSP), MWOs, VAACs and aircraft operators concerned.

4. START OF ERUPTION PHASE

4.1 *GENERAL*

4.1.1 This phase commences at the outbreak of volcanic eruption. The focus of the processes in this phase is to protect aircraft in flight and on aerodromes from the hazards of the eruption; to collect relevant information; and to combine the information available into reliable information about the volcanic cloud (horizontal and vertical extent; composition).

4.1.2 In addition to relevant actions described under the pre-eruption phase, major activities of the start of eruption phase are: Issuance of an eruption commenced VA SIGMET; eruption commenced NOTAM/ASHTAM; and rerouting of airborne traffic if necessary. As appropriate, danger areas will be notified via NOTAM. This phase will last until such time as the ongoing eruption phase can be activated.

4.2 *ORIGINATING ACC ACTIONS (eruption in its own FIR)*

4.2.1 The ACC providing services in the FIR within which the volcanic eruption takes place should inform flights about the existence, extent and forecast movement of volcanic ash and provide information useful for the safe conduct of flights.

4.2.2 If necessary, rerouting of traffic should commence immediately or may be in progress if the alerting time has been sufficient to facilitate activation of the pre-eruption phase. The ACC should assist in rerouting aircraft around the danger area as expeditiously as possible. Adjacent ACCs should also take the danger area into account and give similar assistance to aircraft as early as possible.

4.2.3 During the start of eruption phase, although ATC will not normally initiate a clearance through a danger area, it will inform aircraft about the hazard and will continue to provide normal services. It is expected that aircraft will attempt to remain clear of the danger area; however, it is the responsibility of the pilot-in-command to determine the safest course of action.

4.2.4 During the start of eruption phase the ACC should:

a) maintain close liaison with its associated MWO and the lead VAAC. The MWO should issue a “start of eruption” SIGMET message by the most expeditious means. It may simply contain information that an ash cloud has been reported and the date/time and location. A “start of eruption” message may also be promulgated by a VAA. During this phase information on the extent and severity of the volcanic event may be limited; however, when possible, the message should contain information on the extent and forecast movement of the ash cloud based on appropriate sources of information.

b) based on these forecasts and in cooperation (CDM) with aircraft operators and the adjacent ACCs, ATFM measures should be devised and updated when necessary to ensure safety of flight operations.

c) ensure a NOTAM is originated to define a danger area delineated cautiously so as to encompass a volume of airspace in accordance with the limited information available.

d) ensure that reported differences between published information and observations (pilot reports, airborne measurements, etc.) are forwarded as soon as possible to the appropriate authorities to ensure its dissemination to all concerned.

e) begin planning for the ongoing eruption phase in conjunction with the aircraft operators, the appropriate ATFM unit and ACCs concerned.

f) should significant reductions in intensity of volcanic activity take place during this phase and the airspace no longer is contaminated by volcanic ash, a NOTAMC cancelling the last active NOTAM shall be issued stating the cause for cancellation; new NOTAM/ASHTAM should be promulgated to update the situation. Otherwise, begin CDM planning for the ongoing eruption phase in

conjunction with aircraft operators, the appropriate ATFM unit and the affected ACCs.

4.3 *ADJACENT ACC ACTIONS*

4.3.1 During the start of eruption phase adjacent ACCs should take the following actions:

a) maintain close liaison with the appropriate ATFM unit and the originating ACC to design, implement and keep up to date ATFM measures which will enable aircraft to ensure safety of flight operations.

b) in the event that tactical measures additional to those issued by the appropriate ATFM unit are required, the adjacent ACC should, in cooperation with the originating ACC and aircraft operators, impose such measures.

c) maintain a running plot of the affected area.

d) begin planning for the ongoing eruption phase in conjunction with the aircraft operators, the appropriate ATFM unit and ACCs concerned.

4.4 *ATFM UNIT ACTIONS*

4.4.1 During the start of eruption phase, depending on the impact of the volcanic ash, the appropriate ATFM unit should organise the exchange of latest information on the developments with the VAAC, ANSPs, and MWOs and operators concerned in order to support CDM.

5. ONGOING ERUPTION PHASE

5.1 The ongoing eruption phase commences with the issuance of the first VAA/VAG by the VAAC after completion of the start of eruption phase responses. The VAA/VAG will contain the current position of the volcanic cloud and forecasts of the expected vertical and horizontal extent of the volcanic ash cloud, and its expected movement, at six-hourly time-steps for the period T+0 to T+18 hours. When the volcanic ash cloud is expected to move considerably during a 6 hour period, VA SIGMETs for shorter periods should be produced.

5.2 Volcanic cloud forecasts and/or VAA/VAGs may include (if available) quality indicators (e.g. accuracy, variability, etc.) and risk levels that can more easily be used in SRAs.

5.3 Following the start of eruption phase, the VAA/VAG should be used to define airspace volumes encompassing the furthest extent of contamination predicted for that period. These volumes should be used to:

a) publish NOTAM/ASHTAM indicating the extent of areas of volcanic ash contamination,;

b) issue VA SIGMET warning of potential hazard from areas of volcanic ash contamination; and

c) apply appropriate ATFM measures.

5.4 Longer term forecasts (i.e. beyond T+6 hours) should be used to generate VAA/VAG forecasts in order to ensure that adequate information is available to support flight planning

5.5 Operators should use the information published to plan their flights in accordance with their regulatory requirements and the service that will be provided in the airspace concerned. Operators should be aware that, depending on the State concerned, danger areas may be established. During this phase, operators should only operate into, above, below and lateral vicinity of the affected area in accordance with their SRA.

5.6 The volcanic contamination may affect any combination of airspace; therefore, it is impossible to prescribe measures to be taken for any particular situation. Nor is it possible to detail the actions to be taken by any particular ACC. The following guidance may prove useful during the ongoing eruption phase but should not be considered mandatory:

a) ACCs affected by the movement of the ash should ensure that NOTAM/ASHTAM continue to be originated at appropriate intervals. ACCs concerned and the appropriate ATFM unit should continue to publish details on measures taken to ensure dissemination to all concerned.

b) depending on the impact of the volcanic ash, the appropriate ATFM unit may take the initiative to organise teleconferences to exchange latest information on the developments, in order to support CDM, with the VAACs, ANSPs and MWOs and operators concerned.

c) during this phase the VAAC should endeavour to assess the vertical extent of the ash contamination and provide appropriate VAA/VAG to define the contaminated airspace as accurately as possible. For the purpose of flight planning, operators should treat the horizontal and vertical limits of the contaminated area to be over-flown as they would mountainous terrain. Operators are cautioned regarding the risk of cabin depressurisation or engine failure resulting in the inability to maintain level flight above the contaminated area, especially where extended range operations by turbine-engined airplanes (ETOPS) are involved.

d) any reported differences between published information and observations (pilot reports, airborne measurements, etc.) should be forwarded as soon as possible to the appropriate authorities including VAACs.

6. RECOVERY PHASE

6.1 The recovery phase commences with the issuance of the first “No Volcanic Ash Expected VAA” which normally occurs when it is determined that the volcanic activity has reverted to its pre-eruption state. Consequently, a NOTAMC cancelling the active NOTAM, and a new NOTAM/ASHTAM, shall be promulgated to update the situation for volcanic ash as soon as the volcano has reverted to its normal pre-eruption status, no further eruptions are expected by vulcanologists and no ash cloud is detectable or reported from the FIR concerned.

7. ATFM PROCEDURES

7.1 Depending on the impact of the volcanic ash and in order to support CDM, the appropriate ATFM unit should organize the exchange of latest information on the developments with the VAACs, ANSPs and MWOs and operators concerned.

7.2 The ATFM unit will apply ATFM measures on request of the ANSPs concerned. The measures should be reviewed and updated in accordance with updated information. Operators should also be advised to maintain watch for NOTAM/ASHTAM and VA SIGMET for the area.

8. AIR TRAFFIC CONTROL PROCEDURES5

8.1 If volcanic ash is reported or forecast in the FIR for which the ACC is responsible, the following procedures should be followed:

a) relay all available information immediately to pilots whose aircraft could be affected to ensure that they are aware of the horizontal and vertical extent of the ash contamination;

b) if requested, suggest appropriate rerouting to assist flights to avoid areas of known or forecast ash contamination;

c) when appropriate, remind pilots that volcanic ash cannot be detected by ATC radar systems;

d) normally, ATC will not initiate a clearance through a danger area during the pre-eruption phase and the start of eruption phase; however, on the explicit request of a flight crew, a clearance would be provided. The existence of a danger area due to the presence of volcanic ash indicates the presence and extent of the hazard, hence ATC will inform aircraft about the hazard and will continue to provide normal services. It is then the responsibility of the pilot-in-command to determine the safest course of action in accordance with the operator's SRA;

e) assistance to enable an aircraft to exit a danger area in the most expeditious and appropriate manner should be provided; and

f) if the ACC has been advised by an aircraft that it has entered an area of ash contamination and indicates that a distress situation exists:

   i) consider the aircraft to be in an emergency situation;

   ii) do not initiate any climb clearances to turbine-powered aircraft until the aircraft has exited the area of ash contamination; and

   iii) do not attempt to provide vectors without pilot concurrence.

8.2 Experience has shown that the recommended escape manoeuvre for an aircraft which has encountered volcanic ash is to reverse its course and begin a descent (if terrain permits). However, the final responsibility for this decision rests with the pilot.

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APPENDIX A

GENERAL GUIDANCE FOR THE DEVELOPMENT OF ATM CONTINGENCY PLANS FOR VOLCANIC ASH

(This information is adapted from the *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds* (Doc 9691). Refer to this document for full details.)

1. In a contingency plan relating to volcanic contamination certain steps need to be taken to provide a coordinated and controlled response for dealing with an event of this nature. Responsibilities should be clearly defined for the manager in charge, supervisors and air traffic controllers (ATCOs). The plan should also identify the officials who need to be contacted, the type of messages that are to be created, the proper distribution of the messages and how to conduct business.

2. ATCOs need to be trained and be made aware of the potential effects if aircraft encounter unsafe levels of volcanic ash.

3. Some particular points of guidance are as follows:

a) volcanic ash contamination may extend for hundreds of miles horizontally and reach the stratosphere vertically;

b) volcanic ash may block the pitot-static system of an aircraft, resulting in unreliable airspeed indications;

c) braking conditions at airports where volcanic ash has recently been deposited on the runway will affect the braking ability of the aircraft. This is more pronounced on runways contaminated with wet ash. Pilots and ATCOs should be aware of the consequences of volcanic ash being ingested into the engines during landing and taxiing. For departure it is recommended that pilots avoid operating in visible airborne ash; instead they should allow sufficient time for the particles to settle before initiating a take-off roll, in order to avoid ingestion of ash particles into the engine. In addition, the movement area to be used should be carefully swept before any engine is started;

d) volcanic ash may result in the failure or power loss of one or all engines of an aeroplane; and

e) airports might have to be declared unsafe for flight operations. This might have consequences for the ATM system.

4. The area control centre (ACC) in conjunction with air traffic flow management (ATFM) units serves as the critical communication link between affected aircraft in flight and the information providers during a volcanic eruption. During episodes of volcanic contamination within the FIR, the ACC has two major communication roles. First and of greatest importance is its ability to communicate directly with aircraft en route which may encounter the ash. Based on the information provided in the volcanic ash SIGMET and volcanic ash advisories (VAAs) and working with meteorological watch offices (MWOs), the ATCOs should be able to advise the pilot of which flight levels are affected by the ash and the projected trajectory and drift of the

contamination. Through the use of radio communication, ACCs have the capability to coordinate with the pilot alternative routes which would keep the aircraft away from the volcanic ash.

5. Similarly, through the origination of a NOTAM/ASHTAM for volcanic activity the ACC can disseminate information on the status and activity of a volcano even for pre-eruption increases in volcanic activity. NOTAM/ASHTAM and SIGMET together with AIREPs are critical to dispatchers for flight planning purposes. Operators need as much advance notification as possible on the status of a volcano for strategic planning of flights and the safety of the flying public. Dispatchers need to be in communication with pilots en route so that a coordinated decision can be made between the pilot, the dispatcher and ATS regarding alternative routes that are available. The ACC should advise the ATFM unit concerning the availability of alternative routes. It cannot be presumed, however, that an aircraft which is projected to encounter ash will be provided with the most desirable route to avoid the contamination. Other considerations have to be taken into account such as existing traffic levels on other routes and the amount of fuel reserve available for flights which may have to be diverted to other routes to allow for the affected aircraft to divert.

6. The NOTAM/ASHTAM for volcanic activity provide information on the status of activity of a volcano when a change in its activity is, or is expected to be, of operational significance. They are originated by the ACC and issued through the respective international NOTAM office based on the information received from any one of the observing sources and/or advisory information provided by the associated Volcanic Ash Advisory Centre (VAAC). In addition to providing the status of activity of a volcano, the NOTAM/ASHTAM also provides information on the location, extent and movement of the ash contamination and the air routes and flight levels affected. NOTAM can also be used to limit access to the airspace affected by the volcanic ash. Complete guidance on the issuance of NOTAM and ASHTAM is provided in Annex 15 — *Aeronautical Information Services*. Included in Annex 15 is a volcano level of activity colour code chart. The colour code chart alert may be used to provide information on the status of the volcano, with “red” being the most severe, i.e. volcanic eruption in progress with an ash column/cloud reported above flight level 250, and “green” at the other extreme being volcanic activity considered to have ceased and volcano reverted to its normal pre-eruption state. It is very important that NOTAM for volcanic ash be cancelled and ASHTAM be updated as soon as the volcano has reverted to its normal pre-eruption status, no further eruptions are expected by vulcanologists and no ash is detectable or reported from the flight information region (FIR) concerned.

7. It is essential that the procedures to be followed by ATS personnel, including supporting services such as MET, AIS and ATFM should follow during a volcanic eruption/ash cloud event described in the foregoing paragraphs are translated into local staff instructions (adjusted as necessary to take account of local circumstances). It is also essential that these procedures/instructions form part of the basic training for all ATS, AIS, ATFM and MET personnel whose jobs would require them to take action in accordance with the procedures. Background information to assist the ACC or flight information centre (FIC) in maintaining an awareness of the status of activity of volcanoes in their FIR(s) is provided in the monthly Scientific Event Alert Network Bulletin published by the United States Smithsonian Institution and sent free of charge to ACCs/FICs requesting it.

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APPENDIX B

ANTICIPATED PILOT ISSUES WHEN ENCOUNTERING VOLCANIC ASH

1. ATCOs should be aware that flight crews will be immediately dealing with some or all of the following issues when they encounter volcanic ash:

a) smoke or dust appearing in the cockpit which may prompt the flight crew to don oxygen masks (could interfere with the clarity of voice communications);

b) acrid odour similar to electrical smoke;

c) multiple engine malfunctions, such as stalls, increasing exhaust gas temperature (EGT), torching, flameout, and thrust loss causing an immediate departure from assigned altitude;

d) on engine restart attempts, engines may accelerate to idle very slowly, especially at high altitudes (could result in inability to maintain altitude or Mach number);

e) at night, St. Elmo's fire/static discharges may be observed around the windshield, accompanied by a bright orange glow in the engine inlet(s);

f) possible loss of visibility due to cockpit windows becoming cracked or discoloured, due to the sandblast effect of the ash;

g) because of the abrasive effects of volcanic ash on windshields and landing lights, visibility for approach and landing may be markedly reduced. Forward visibility may be limited to that which is available through the side windows; and/or

h) sharp distinct shadows cast by landing lights as compared to the diffused shadows observed in clouds (this affects visual perception of objects outside the aircraft).

2. Simultaneously, ATC can expect pilots to be executing contingency procedures such as the following:

a) if possible, the flight crew may immediately reduce thrust to idle;

b) turn autothrottles off;

c) exit volcanic ash cloud as quickly as possible. The shortest distance/time out of the ash may require an immediate, descending 180-degree turn (terrain permitting);

d) turn engine and wing anti-ice and all air conditioning packs on;

e) start the auxiliary power unit, if available;

f) put flight crew oxygen masks on at 100 per cent (if required);

g) restart engine according to aircraft operation manual procedures. If an engine fails to start the flight crew will try again immediately;

h) monitor airspeed and pitch attitude. If unreliable airspeed is suspected, or a complete loss of airspeed indication occurs (volcanic ash may block the pitot system), the flight crew will establish the appropriate pitch attitude;

i) land at the nearest suitable airport; and

j) on landing, reverses may be used as lightly as feasible.

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APPENDIX C

Reporting

Editorial Note: Awaiting input from IVATF Task TF-ATM03

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