INTERNATIONAL CIVIL AVIATION ORGANIZATION
South American Regional Office - Regional Project RLA/06/901
Assistance for the implementation of a Regional ATM System, taking into account the ATM operational concept and the corresponding CNS technological support
Eighth Workshop/Meeting of the SAM Implementation Group (SAM/IG/8)
(Lima, Peru, 10-14 October 2011)

SAM/IG/8-WP/03
02/09/11

Agenda Item 2: Optimisation of the ATS route structure

Volcanic Ash Contingency Plan

(Presented by the Secretariat)

Summary

This working paper presents information about the volcanic ash contingency plan prepared by experts Miriam Andrioli and Héctor Sánchez under Regional Project RLA/06/901.

References:

- Initial volcanic ash contingency plan model, ICAO IVATF.
- WP on the development of a volcanic ash contingency plan presented by Argentina at the Third Workshop/Meeting on SAM ATS Route Structure Optimisation (SAM ATSRO/3), Regional Project RLA/06/901.
- Reference documents used in the Contingency Plan for the South American Region, Appendix K to the aforementioned Plan (Appendix B).

ICAO strategic objectives:	*A – Safety* *C – Environmental protection* *D - Efficiency*

1 Background

1.1 The Fourth Meeting of the Coordination Committee (RCC/4) of Regional Project RLA/06/901, *Assistance for the Implementation of a Regional ATM System, taking into account the ATM Operational Concept and the corresponding CNS technological support* (Lima, Peru, 1-3 December 2010) reviewed the activities scheduled for 2011.

1.2 One of the priority tasks that were considered was the drafting of a volcanic ash contingency plan, since a series of volcanic eruptions had occurred in recent years throughout the world and particularly in the South American Region, which have affected significantly the normal operations of international civil aviation.

1.3 Likewise, in June and July 2011, air traffic at the main airports of Argentina and in the southern States of South America was affected by a volcanic ash cloud coming from Chile, in what has been considered one the most significant air traffic disruptions in the Region.

1.4 Hundreds of flights had to be cancelled from the moment the Puyehue-Cordón Caulle volcanic complex erupted in early June, releasing a tall plume of ashes that covered the southern and central part of Argentina, and that reached Australia.

1.5 At worldwide level, the eruption of the Eyjafjallaojokull volcano in Iceland in April 2010 had a significant impact on operations throughout Europe.

1.6 Consequently, based on this experience, ICAO and the European States developed a volcanic ash contingency plan for the Region, which was published as EUR Doc 019 NAT Doc. 006 Part II Volcanic Ash Contingency Plan – EUR and NAT Regions.

1.7 Likewise, the ICAO volcanic ash task force (IVATF) developed an initial volcanic ash contingency plan model covering all aspects related to volcanic ash that should be considered in a regional contingency plan. This model is a draft that will be enhanced as more experience is obtained in the management of, and procedures related to, volcanic ash emissions.

1.8 Accordingly, and in view of the critical situation experienced during the eruption of the Puyehue-Cordón Caulle volcano chain, SAM States requested ICAO to draft a contingency plan for events of this nature, to be applied in the Region when such events can affect one or more of its FIRs.

2 Discussion

2.1 Background and objective of the mission

2.2 The designation of the experts to be entrusted with the drafting of the contingency plan shown in the **Appendix** to this working paper was carried out on 12-23 September 2011. MET Officer Miriam Andrioli, and ATM Officer Héctor Sánchez, both experts from Argentina, participated in the drafting of the document.

2.3 The objectives and terms of reference of the task are shown below:

a) Analyse the information contained in ICAO volcanic ash documentation and on the manuals and/or plans of other Regions.

b) Define the content of the manual.

c) Develop the volcanic ash contingency plan for the South American Region.

d) Prepare an executive summary of the work done.

3 Summary of activities

3.1 The work plan proposed for the Project consisted in a preliminary analysis of volcanic ash information contained in ICAO documentation and in the manuals and regional plans of other Regions, such as the Volcanic Ash Contingency Plan for the EUR and NAT Regions, and Doc IVATF/2-WP/25 Air Traffic Management Contingency Planning, Procedures and Guidance (Report of the Air Traffic Management Subgroup), as reviewed by the sixth meeting of the International Airways Volcano Watch Operations Group (IAVWOPSG/6).

3.2 For the development of the plan, consideration was also given to the working paper on the drafting of a volcanic ash contingency plan, presented by Argentina at the third Workshop/Meeting on SAM ATS Route Network Optimisation (SAM ATSRO/3), Regional Project RLA/06/901, and the documentation based on the national experience obtained from the volcanic events occurred in recent times in said country.

4 Summary of the contents of the volcanic ash contingency plan for the South American Region

a) Brief history of global and regional experience with volcanic ash;
b) Definition of the terms and acronyms used;
c) Establishment of a national ATM contingency unit responsible for continuous surveillance, enforcement of the contingency plan, and establishment of contingency coordination arrangements;
d) Volcanic ash alert phases;
e) Procedures to be applied by VAACs and meteorological watch offices (MWO) in each phase of the volcanic event;
f) Coordination with aeronautical information services;
g) Procedures to be applied by the ATC in each phase of the volcanic event;
h) Procedures to be applied by the ATFM in each phase of the volcanic event;
i) Procedures to be applied by users, pilots and aircraft dispatchers in each phase of the volcanic event;
j) Procedures to be applied by civil aviation authorities;
k) Sample texts on volcanic ash and procedures to be inserted in ATC letters of operational agreement;
l) Examples of the texts to be included in the letter of operational agreement between MET offices and the ATC, on volcanic ash;
m) Examples of SIGMETs, NOTAMs, ASHTAMs;
n) Risk management;
o) Civil/military cooperation and coordination on volcanic ash issues;
p) References used for drafting the contingency plan;
q) Contingency handling in aerodrome operations.

5 Recommendations

5.1 The experts made the following recommendations:

a) It would be advisable for a study group to define methods for the development and dissemination of additional graphs containing the information provided in the volcanic ash advisory graphics (VAG) in combination with FIR boundaries, the international route network, and relevant airspace sectors. The Region could identify the best method for establishing unified criteria for assigning the responsibility for preparing and disseminating said illustrative graphs.

b) It would be advisable for ICAO to make arrangements to make Doc 9766, Handbook on the International Airways Volcano Watch (IAVW) available also in Spanish, which is the official language of most member countries of the SAM Region. It would also be advisable for personnel operating the VAACs and whose native language is not English to have an adequate level of such language for conducting their tasks, in accordance with ICAO requirements and comparable to the operational level 4 of English attained by holders of an aeronautical licence, such as controllers, pilots, etc.

5.2 As stated in the preamble of the draft Contingency Plan, the experience in the SAM Region has shown that volcanic pollution has a significant impact on airports, thus the need to develop guidelines on airport management for such events.

5.3 In this respect, it should be noted that States need to have more precise references or parameters to help them determine whether volcanic ash deposits or residues at the aerodrome require the suspension of operations or just a report to the user about their presence. Accordingly, it is recommended that aerodrome and ground aid (AGA) and meteorology experts of the SAM Region develop the procedures related to airport activity for their subsequent inclusion in the regional contingency plan.

5.4 Regarding the transmission of volcanic ash information, it has also been deemed advisable that it be sent to ATS and AIS operational units, and to FMU units responsible for ATFM. Therefore, it would be convenient to prepare a SIGMET WV message distribution list for the CAR/SAM Regions, and post it on the ICAO website for easy access by the States.

5.5 Finally, once this Contingency Plan has been approved and has reached a reasonable level of maturity, it would be advisable that it be posted on the website of the South American Regional Office for easy access by SAM States.

6 Conclusions

6.1 As may be noted from the previous paragraphs, the objective of this plan is to present a general action scheme for volcanic ash contingencies based on the recommendations, procedures, information, examples, etc. contained therein, to help ensure safe and orderly air traffic flow in our Region.

6.2 This plan establishes standard guidelines to alert aircraft of a volcanic ash event and the procedures to be followed. Volcanic ash may constitute a hazard for air operations that cannot be resolved in isolation but rather through collaborative decision-making (CDM), which requires an active participation by all those involved.

6.3 It is acknowledged that the volcanic ash contingency plan of the South American Region is a document that shall be reviewed and amended on a timely basis as progress is made by the ICAO IVATF Task Force with the volcanic ash studies being conducted and with the analysis being performed by the experts of the Region.

7 Suggested action

7.1 The Meeting is invited to:

a) take note of the information provided;

b) review the draft volcanic ash contingency plan that appears in the Appendix to this working paper; and

c) make comments on the document and on the action to be taken to achieve a plan sufficiently mature to be approved for regional application.

SAM/IG/8-WP/03

APPENDIX

PROJECT

INTERNATIONAL CIVIL AVIATION ORGANIZATION

SOUTH AMERICAN REGIONAL OFFICE

VOLCANIC ASH CONTINGENCY PLAN FOR THE SOUTH AMERICAN REGION

September 2011

VOLCANIC ASH CONTINGENCY PLAN FOR THE SOUTH AMERICAN REGION

CONTENTS

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1. FOREWORD

1.1 The severity, persistence and higher frequency of recent volcanic activity with dispersion of ash in the ICAO South American Region (SAM) (Hudson in 1991; Chaitén in 2008; the Caulle chain in 2011; and others), with their resulting repercussions on the provision of air navigation services, point to the need of developing a contingency plan for events of this nature to be applied at regional level when such events affect one or more FIRs. The purpose of this plan is to show a general scheme of actions to face these contingencies through the recommendations, procedures, information, examples, etc. included herein, to help ensure a safe and orderly flow of air traffic in our Region. This plan establishes standard guidelines for alerting aircraft of a volcanic eruption and the procedures to be followed. Volcanic ash may be a hazard for flight operations. This problem cannot be resolved in an isolated manner but rather through collaborative decision-making (CDM), which requires an active participation by all those involved.

1.2 The regulatory authorities of the State of the operator or of the State of registry, as applicable, should establish appropriate operational procedures to be applied by the flight crew in case of operating in or near airspaces that are contaminated with volcanic ash. Pursuant to ICAO Annex 6 (Operation of aircraft), operators are required to conduct a risk assessment of operations in volcanic ash, and to implement the appropriate mitigation measures in accordance with their safety management system (SMS), as approved by the State of the operator or by the State of registry, as applicable.

1.3 It should be noted that this document is a contingency plan that includes the interfaces with support services such as the aeronautical information service (AIS) and the meteorological service (MET). Where action by the Volcanic Ash Advisory Centres (VAAC) and by Meteorological Watch Offices (MWO) is mentioned in this Plan, and where operators are described, it will just be for clarification purposes. The ATS contingency plan should also be taken into account, which covers other abnormal situations that might interact with a volcanic ash contingency.

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, impacting air traffic management (ATM), causing, for example, diversions to alternate aerodromes and rerouting of traffic flow.

1.5 These suggested procedures are not intended to establish or confirm a safe level of ash concentration. Operation through any area where volcanic ash is forecast is at the discretion of the operator. Considering that commercial aircraft will travel about 150 km (80 NM) in 10 minutes and that volcanic ash can rise to flight levels commonly used by turbojet aeroplanes in half that time, timely response to volcanic ash reports 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, such as SIGMETs, NOTAMs, and ASHTAMs, templates thereof should be made available for each stage of the volcanic activity. Examples of SIGMETs, NOTAMs and ASHTAMs containing operational measures and the different stages of volcanic activity are shown in Appendix I. A list of ICAO registered volcanoes should be made available to the personnel at the international NOTAM office, containing with the name of the volcano, its

number and nominal position. In order to ensure a smooth implementation of the contingency plan in an actual volcanic eruption, annual simulation exercises, called VOLCEX, should be conducted.

2. DEFINITIONS

2.1 *AREAS OF CONTAMINATION*

Area of low contamination: Airspace of defined dimensions where volcanic ash may be encountered at concentrations equal to or less than X x 10^{-3} g/m^3.

Area of medium contamination: Airspace of defined dimensions where volcanic ash may be encountered at concentrations greater than X x 10^{-3} g/m^3, but less than X x 10^{-3} g/m^3.

Area of high contamination: Airspace of defined dimensions where volcanic ash may be encountered at concentrations equal to or greater than X x 10^{-3} g/m^3, or areas of contaminated airspace where no ash concentration guidance is available.

Note.– The term "defined dimensions" refers to horizontal and vertical limits.

2.2 PHASES OF AN EVENT

2.2.1 The response to a volcanic event that affects air traffic has been divided into three distinct phases as described below. The scientific community monitors volcanic activity. Nevertheless, flight crew are required to report volcanic activity observations by means of a Special Air Report (AIREP). Arrangements should be put in place to ensure that the information is transferred without delay to the corresponding aeronautical units for relevant action.

VOLCANIC ALERTING PHASE: This phase starts when it is believed that there is volcanic activity. Alerting information will be provided through a SIGMET, NOTAM or ASHTAM, as appropriate, and disseminated to affected aircraft in flight by the most expeditious means. NOTAM/ASHTAM messages shall be sent to ATS units and to meteorological/volcanological agencies.

2.2.2 If it is considered that the event could pose a hazard to aviation, a danger area could be created around the volcano and informed by NOTAM. Generally, clearances will not be issued through the danger area.

START OF ERUPTION PHASE: This phase starts with the volcanic eruption and entrance of volcanic ash into the atmosphere, mainly affecting aircraft in flight. A "Start of Eruption SIGMET" shall be issued and a danger area will be declared. In general terms, clearances will not be issued for flying in the danger area.

ONGOING ERUPTION PHASE: This phase starts with the issuance of the VAA after completing the previous phases. The T+0 information and T+6 forecasts of the contaminated area will be issued through a SIGMET. The T+12- and T+18-hour (and longer) forecasts of contaminated areas will be issued through

NOTAM/ASHTAM. Significant changes might occur, such as a temporary reversal to the start of eruption phase, generating the unscheduled issuance of VAA, SIGMET and NOTAM/ASHTAM. As appropriate, danger areas will be notified via NOTAM.

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3. VOLCANIC ALERTING PHASE

3.1 *GENERAL*

3.1.1 In general, aircraft pilots are the first source of information of an eruption, except when there is a volcano monitoring system has been established. Therefore, pilots operating in areas with unmonitored volcanoes should always be vigilant for signs of an eruption and should fully understand the importance of their role as information providers. Operators should provide pilots with the ICAO Volcanic Activity Report form (Doc 4444, Appendix 1), preferably in a user-friendly electronic format, as part of the pre-flight briefing. Accordingly, it would be desirable to have an ongoing volcano monitoring system to maximise safety of air operations.

3.1.2 The focus of this phase is to gain early recognition of volcanic events. This phase is characterised by a limited availability of information as to the extent and severity of the volcanic event. The purpose of this phase is to ensure the safety of aircraft in flight and to issue information as a matter of urgency. Regardless of the severity of the event, the actions corresponding to the alerting phase should be carried out in all cases.

3.1.3 The volcanic alerting phase starts when a volcanic eruption is presumed or when such volcanic eruption occurs unexpectedly. The source of this information can be pilots (AIREP/VAR) and/or meteorological or volcanological agencies. Arrangements in each State between volcanological or meteorological bodies and air traffic management agencies will ensure that alerting information is provided through SIGMET, NOTAM or ASHTAM or re-transmitted AIREPs, as appropriate, to affected aircraft in flight by the most expeditious means, and disseminated according to established procedures.

3.1.4 This phase focuses on drawing attention of aircraft to a (potential) hazard and protecting them from the hazards inherent to the eruption itself. 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. This alert will trigger action, such as the collection of additional data and the conduction of specific safety risk assessments (SRAs).

3.2 *ACTION BY THE ACC (eruption in its own flight information region)*

3.2.1 In the event of significant pre-eruption volcanic activity, an ongoing eruption, or a reported volcanic ash cloud that could pose a significant hazard to aviation, the area control centre (ACC) that receives such information should take the following action:

a) define an initial danger area in accordance with established procedures. The size of this danger area should encompass a reasonable volume of airspace in accordance with the limited information available, trying to avoid a 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 222 km (120 NM). If the eruption has not started 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, trying to avoid a disruption of flight operations;

Note.– An area with a radius of 5 to 10 minutes of flight time represents only 2 to 3 minutes of additional flight time.

iii) If the eruption has started and upper wind information is available, the circle should be centred 111 km (60 NM) in the direction of the prevailing wind in the lower airspace, whilst encompassing the volcano. The purpose of this initial danger area is to ensure safety until predictions of the contaminated area from the appropriate authority are done and published;

iv) although the ATC does not normally issue a clearance through a danger area, it is the responsibility of the pilot-in-command to determine the safest course of action.

b) advise the associated MWO and the appropriate VAACs (unless the initial report originated from any of these two entities). If the VAACs were the sources from where the first volcanic ash advisory (VAA) was originated, they will inform the air traffic flow management unit (FMU) of its jurisdiction.

c) alert flights already in the danger area and offer assistance to enable aircraft to exit the area in the most expeditious and appropriate manner. Aircraft that are close to the danger area should be offered assistance to keep clear of the area. Issue new tactical clearances for flights whose original route is affected by this area. The ACC should immediately notify other ACCs of the phenomenon, providing information of the location and dimensions of the danger area. Likewise, it should coordinate again and, in necessary, reroute flights already coordinated but still in adjacent flight information regions (FIRs). They will also require adjacent ACCs to reroute flights not yet coordinated in order to keep them clear of the danger area.

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. It is imperative that the 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, templates should be made available to them for each stage of the volcanic activity. Examples of NOTAM/ASHTAMs for these cases are provided in **Appendix I**.

3.2.2 The initial NOTAM/ASHTAM and its subsequent messages will be sent to all addressees of the distribution list and to meteorological offices involved, adding the corresponding header of the World Meteorological Organization (WMO). APPENDIX I contains examples of NOTAM/ASHTAMs for these cases.

3.3 *ACTION BY ADJACENT ACCs*

3.3.1 During the volcanic alerting phase, the ATC will not issue clearances to fly across the danger area; instead, aircraft will be tactically rerouted to avoid the area. Areas contaminated with ash should be contained within a limited area and disruption to traffic should not be excessive. Adjacent ACCs should take the following action to provide suitable assistance:

a) re-clear flights to which services are being provided and whose route will be affected by the establishment of the danger area, when so requested by the ACC responsible for the flight information region (FIR) affected by the volcanic contamination.

b) unless otherwise instructed, continue normal operations, except:

i) when one or more routes are affected by the danger area, in which case, the issuance of clearance to aircraft on these routes will cease and steps will be taken to reroute them to routes clear of the danger area; and

ii) start plotting the affected area for quick visualisation by air traffic controllers.

3.4 *ACTION BY THE FMU*

3.4.1 The FMU and the VAACs will determine how their initial communications will take place based on existing bilateral agreements. Upon receiving information on volcanic activity from the VAACs, the FMU should initiate actions in accordance with its procedures to ensure the exchange of information in support of the CDM between air navigation service providers (ANSPs), MWOs, VAACs and other aircraft operators involved.

4. START OF ERUPTION PHASE

4.1 *GENERAL*

4.1.1 This phase starts with the volcanic eruption. These processes are focused on protecting aircraft in flight and aerodromes from the hazards of the eruption; collecting relevant information; and converting available information on the volcanic ash cloud (horizontal and vertical size; composition; ash concentration levels, etc.) into reliable and precise information.

4.1.2 In addition to relevant actions described in the volcanic alerting phase, the main activities of the start of eruption phase are: Issuance of a “start of eruption” SIGMET; issuance of a “start of eruption” NOTAM/ASHTAM; and rerouting of air traffic. As appropriate, danger areas will be notified *via* NOTAM. This phase will last until the ongoing eruption phase is activated.

4.2 *ACTION BY THE ORIGINATING ACC (eruption in its own flight information region)*

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

4.2.2 Rerouting of air traffic shall start immediately or may be in progress if the volcanic alerting phase provides sufficient time. The ACC should assist in rerouting aircraft around the danger area as soon as possible. Adjacent ACCs should also take into account the danger area and give similar assistance to aircraft as early as possible.

4.2.3 During this phase the ACC should:

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

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

c) ensure a NOTAM has been originated to define a danger area that comprises a volume of airspace in accordance with the limited information available.

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

e) should a significant reduction in the intensity of volcanic activity occur during this phase and the airspace is no longer contaminated by volcanic ash, a NOTAMC cancelling the last active NOTAM should be issued stating the cause for the cancellation; a new ASHTAM should be issued to update the situation. Otherwise, start CDM planning for the ongoing eruption phase in conjunction with aircraft operators, the appropriate FMUs and the affected ACCs.

4.3 *ACTION BY ADJACENT ACCs*

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

a) maintain close contact with the associated FMU and the originating ACC to create, implement and keep up to date ATFM measures to ensure safety of flight operations.

b) in the event the FMU has required tactical measures in addition to those already issued, the adjacent ACC should impose such measures in cooperation with the originating ACC and aircraft operators.

c) maintain a plot of the affected area for quick visualisation by air traffic controllers.

d) start planning for the ongoing eruption phase together with aircraft operators, the appropriate FMUs and the ACCs concerned.

4.4 *ACTION BY THE FMU*

4.4.1 During the start of eruption phase, and depending on the impact of the volcanic ash, the appropriate FMU should organise the exchange of the latest information available on its evolution with the VAACs, ANSPs, and MWOs and operators involved, in support of CDM.

5. ONGOING ERUPTION PHASE

5.1 The ongoing eruption phase starts with the issuance of the first VAA/VAG (volcanic ash advisory/volcanic ash advisory graphics) by the VAAC. The VAA/VAG will contain the current position of the volcanic cloud and forecasts of the vertical and horizontal extent of the volcanic ash cloud, and its expected movement, at six-hour intervals, starting at T+0 until T+18 hours. In addition, the meteorological office co-located with the VAAC will, where feasible, issue ash concentration forecasts at six-hour intervals with a nominal time validity at 0000Z, 0600Z, 1200Z and 1800Z to supplement the VAA/VAGs, defining areas of low, medium and high contamination. When the volcanic ash cloud is expected to move considerably during the 6-hour period, SIGMETs at shorter intervals should be issued.

5.2 The volcanic cloud forecasts for T+12 and T+18 hours and beyond (if available) are used for the preparation of NOTAMs/ASHTAMs. Volcanic ash cloud forecasts and/or VAA/VAGs may include (if available) quality indicators (*e.g.* certainty, variability, etc.) and risk levels that can more easily be used in SRAs.

5.3 Following the start of eruption phase, the VAA/VAG and (where available) ash concentration forecasts should be used to define airspace volumes encompassing the largest extent of contamination foreseen for that period. These volumes should be used to:

a) publish a NOTAM indicating the extent of danger areas, indicating (where available) the forecast levels of contamination therein;

b) issue a SIGMET warning of the potential hazard in areas contaminated with volcanic ash;

c) publish a NOTAM to separately indicate the extent of areas of medium contamination, if not included in the danger area; and

d) apply appropriate ATFM measures.

5.4 Longer term forecasts (*i.e.*, beyond T+6 hours) should be used to generate a NOTAM/ASHTAM in order to ensure that adequate information is available to support flight planning. These messages should differentiate between levels of contamination.

5.5 Operators should use the information published regarding areas of low, medium and high contamination to plan their flights in accordance with the regulatory framework applicable to them and the service that they will receive in the airspace concerned. Operators should be aware that, depending on the State concerned, danger areas may be established to contain an area of high contamination, areas of medium/high contamination, or areas of low/medium/high contamination. During this phase, operators should only operate in the affected area in accordance with their SRAs.

5.6 The volcanic ash 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 each 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 the NOTAM/ASHTAM continues to be originated at appropriate intervals. The ACCs concerned and the appropriate FMUs 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 FMU may take the initiative to organise teleconferences with the VAACs, ANSPs, MWOs and operators concerned to exchange the latest developments, in support of CDM.

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

d) any difference between published information and observations (pilot reports, atmospheric measurements, etc.) should be forwarded as soon as possible to the appropriate authorities; and

e) once the airspace is no longer contaminated by volcanic ash, a NOTAMC cancelling the active NOTAM shall be issued. A new ASHTAM should be issued to update the situation.

6. ATFM PROCEDURE

6.1 Depending on the impact of the volcanic ash and in order to support CDM, the appropriate ATFM unit should arrange for the exchange of the latest information available on the volcanic event with the VAACs, ANSPs, MWOs and operators concerned.

6.2 The FMU will apply ATFM measures upon request of the ANSPs concerned. The measures should be reviewed and updated in accordance with the latest information. Operators will be advised to periodically review for NOTAMs/ASHTAMs and SIGMETs for the area.

6.3 The FMU should also take into account civil/military coordination for the implementation of the Flexible Use of Airspace (FUA) concept, which permits temporary use of alternate routes across restricted airspaces, thus avoiding long detours by aircraft to avoid such areas. Circular 330 AN/189 on civil/military cooperation in air traffic management provides a guide and examples on this topic.

7. AIR TRAFFIC CONTROL PROCEDURES

7.1 If volcanic ash is reported or forecast in the FIR under the responsibility of the ACC, the latter should follow the procedures listed below:

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

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

c) when appropriate, inform pilots that volcanic ash may not be detected by the ATC radar system;

d) the provider State may establish danger areas based on areas of low, medium and high contamination shown in modelled ash concentration charts. Depending on the State concerned, danger areas will be established to contain areas of high contamination, areas of medium/high contamination, or areas of low/medium/high contamination;

e) in the absence of ash concentration guidance, and for purposes of applying ATC procedures, the entire area in which it is forecast that volcanic ash will be present should be considered as an area of high contamination, until such information is available;

f) the ATC should not issue clearances for aircraft to enter or operate in a danger area. Required assistance should be provided to aircraft to exit a danger area as quickly as possible; and

g) if an aircraft has advised the ACC that it has entered an area contaminated with ash:

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

ii) do not initiate any climb clearances for turbine-powered aircraft until the aircraft has exited the ash cloud; and

iii) do not initiate vectoring without pilot concurrence.

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

7.3 These procedures transcribe and supplement those established in ICAO Doc *4444 –Air Traffic Management - Chapter 15, Procedures related to emergencies, communication failure and contingencies, Section 15.8, Procedures for an ATS unit when a volcanic ash cloud is reported or forecast*.

8. GENERAL GUIDANCE FOR THE DEVELOPMENT OF AN ATS CONTINGENCY PLAN 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.)

8.1 In a contingency plan relating to volcanic ash, certain sequential steps must be established to provide a coordinated and controlled response to an event of this nature. Responsibilities should be clearly defined for the heads/managers in charge of the ATS unit, supervisors and air traffic controllers (ATCOs). The plan should also identify the officials who need to be contacted, the type of messages that must be created, the proper distribution of such messages, and how to fulfil the task.

8.2 ATCOs need to be trained and be made aware of the potential consequences if an aircraft encounters unsafe levels of volcanic ash.

8.3 In this regard, some points to be taken into account follow:

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 erroneous speed indications;

c) braking conditions will be affected at airports where volcanic ash has recently been deposited on the runway. This is aggravated on runways contaminated with wet ash. Pilots and ATCOs should be made aware of the consequences of volcanic ash being ingested into the engines during landing and taxiing. For take-off, it is recommended that pilots avoid this operation under conditions of visible volcanic ash; instead, it is advisable that they allow sufficient time for the particles to settle before starting the take-off run, in order to avoid ingestion of ash particles into the engine. Likewise, the ashes from movement area to be used should be carefully cleaned before engines are started;

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

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

8.4 The ACC and the FMU will serve as a critical communication link between the pilot, the dispatcher and the meteorologists during a volcanic eruption. During episodes of volcanic ash contamination in the FIR, the ACC has two major communication roles: First and most important is its ability to communicate directly with the aircraft that has encounters ash en route. The ATCOs should be able to advise the pilot of what flight levels are affected by the ash and the projected trajectory and drift of the contamination, based on the information provided in the volcanic ash SIGMET, the VAAs, and information exchanged with the MWO. By means of radio communications, ACCs have the capability to coordinate with the pilot alternate routes to keep the aircraft away from the volcanic ash. In this latter case, it is extremely important to establish close civil/military coordination in order to apply the Flexible Use of Airspace (FUA) concept for temporary use of alternate routes that normally go through restricted airspaces, thus avoiding long detours to circumvent them. Circular 330 AN/189 on civil/military cooperation in air traffic management provides a guide and examples on this matter.

8.5 Similarly, through the issuance of a NOTAM/ASHTAM for volcanic activity, the ACC can disseminate information on the status and activity of the volcano and increased pre-volcanic activity. NOTAMs/ASHTAMs, SIGMETs, and AIREPs are critical to dispatchers for flight planning purposes. Operators need as much advance reports as possible on the status of a volcano for strategic planning of flights and the safety of passengers. Dispatchers need to be in communication with pilots en route so that coordinated decisions can be made between them and the ATC regarding alternate routes available. The ACC should advise the FMU concerning the availability of alternate routes. It must not be presumed, however, that there will always be the possibility of providing a desirable alternate route to an aircraft that is expected to encounter an ash cloud in its projected original route. Other considerations must be taken into account, such as traffic density on the other routes and fuel reserves available for flights that should be diverted, to allow the affected aircraft to decide on its own diversion.

8.6 The NOTAM/ASHTAM regarding volcanic activity provides information on the status of activity of a volcano, and on when an operationally significant change in its activity occurs or is expected to occur. This message is originated by the ACC and issued through the international NOTAM office, based on the information received from any one of the sources and/or the information provided by the associated VAACs. Likewise, the NOTAM/ASHTAM provides information on the location, extent and movement of the ash contamination and the air routes and flight levels affected. NOTAMs can also be used to limit access to the airspace affected by the volcanic ash. Complete guidance on the issuance of NOTAMs and ASHTAMs is provided in Annex 15 — *Aeronautical Information Services*. Included in Annex 15 is a colour code chart that indicates the level of volcano activity. The colour code chart alert may be used to provide information on the status of the volcano, with “red” being the most severe case*, i.e.* volcanic eruption in progress with an ash plume/cloud reported above flight level 250, and “green”, at the other extreme, indicating that volcanic activity has reverted to its pre-eruption state. It is of vital importance that volcanic ash NOTAMs are cancelled and the ASHTAM be updated as soon as the volcano has back to its pre-eruption state, no further eruptions are expected by volcanologists, and no ash is detected or reported from the FIR concerned.

8.7 It is essential that the procedures to be followed by ACC personnel and support services, such as MET, AIS and ATFM, continue to be applied during the volcanic eruption/presence of volcanic ash cloud, as described in the previous paragraphs, and that they are incorporated into the local manuals or instructions for the personnel (adjusted as necessary to local circumstances). It is also essential that these procedures/instructions form part of the basic training for ATS, AIS, ATFM and MET personnel whose tasks might require them to take action in accordance with the procedures. The Scientific Event Alert Network Bulletin published every month by the United States Smithsonian Institute, and sent free of charge to the ACCs or FICs that so require, contains global information on the status of activity of volcanoes.

8.8 Upon considering the need to develop a local contingency plan, each State should draft an Action Plan that includes at least three (3) phases, namely:

- Phase I: Drafting of the national contingency plan for volcanic ash;
- Phase II: Harmonisation of the national contingency plan with those of adjacent countries; and
- Phase III: Delivery of the national contingency plan to the corresponding ICAO Regional Office.

When preparing the national contingency plan, attention should be paid to the guidelines established in Attachment D to ICAO Annex 11 on contingency planning.

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APPENDIX A

ASPECTS TO BE CONSIDERED BY THE PILOT WHEN ENCOUNTERING VOLCANIC ASH

1. Flight crews may face some or all of the following situations as a result of a volcanic ash encounter. ATCOs must be vigilant of these facts:

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

b) acrid odour similar to electrical smoke;

c) multiple engine malfunction, such as stalling, increased exhaust gas temperature (EGT), torching, fire, and loss of thrust, causing an immediate departure from assigned altitude;

d) on engine restart attempts, engines may go idle, especially at high altitudes (could result in inability to keep height or maintain the Mach number);

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

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

g) cockpit windows could become completely opaque; and/or

h) at night, volcanic ash in front of landing lights may cast shadows with distinct borders (as compared to the diffused shadows normally cast by water clouds), affecting visual perception of objects outside of the aircraft.

2. Simultaneously, ATC will expect pilots to execute contingency procedures. This may include a possible course reversal and/or an emergency descent.

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APPENDIX B

ACTION TAKEN BY METEOROLOGICAL WATCH OFFICES IN THE EVENT OF A VOLCANIC ERUPTION

1. On receipt of information of a volcanic eruption and/or the existence of volcanic ash, the MWO shall:

a) notify the designated VAACs so that they may provide the FIRs under the jurisdiction of the ACC relevant details about the eruption, also requesting the corresponding volcanic ash advisory (VAA) with information about its extent and trajectory;

b) notify the ACC, as soon as possible, if the volcanic ash cloud can be identified through images of meteorological radars or images/data of meteorological satellites and, if so, provide, on a regular basis, information on the horizontal and vertical extent of the cloud and its trajectory using as a source the advisory received from the VAACs; and

c) issue a volcanic ash alert SIGMET with a validity of six (6) hours. Include in the SIGMET all VAACs, the London World Area Forecast Centre (WAFC), the international databank on International Operational Meteorology (OPMET) and the regional OPMET databank. Keep in constant coordination with the ACC to ensure consistency in the issuance and content of SIGMETs and NOTAMs.

2. Should an MWO become aware, from any other source, of the occurrence of pre-eruptive activity, a volcanic eruption, or the presence of an ash cloud, said information will be immediately sent to the ACC, and the aforementioned procedure will be followed.

3. Should any other meteorological office becomes aware, from any other source, of the occurrence of pre-eruptive activity, a volcanic eruption, or the presence of an ash cloud, said information will be immediately sent to the MWO to be relayed to the appropriate ACC and VAACs.

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APPENDIX C

ACTION TO BE TAKEN BY THE VOLCANIC ASH ADVISORY CENTRES (VAAC) IN THE EVENT OF A VOLCANIC ERUPTION

1. On receipt of information from an MWO or any other source, of the occurrence of pre-eruptive activity, a volcanic eruption, or the presence of an ash cloud, the VAACs shall:

a) start running the volcanic ash dispersion/trajectory models in order to provide the relevant advisories (VAA/VAG) to MWOs, ACCs, FMUs and the operators involved;

b) review satellite data/images and reports from pilots flying in the affected area during the event, in order to establish if the volcanic ash cloud is identifiable and, if so, determine its extent and movement;

c) inform the FMUs of the volcanic event;

d) prepare and issue advisories on the extent and forecast trajectory of the volcanic contamination (VAA) in message format for transmission to MWOs, ACCs, FMUs and operators within the VAAC area of responsibility, and to the three Regional OPMET Centres (ROCs) in London, Toulouse and Vienna. For inter-regional distribution, the ROCs will ensure dissemination of the advisory to all the VAACs, the London World Area Forecast Centre (WAFC), and the three Regional OPMET Data Banks (RODBs);

e) monitor subsequent satellite information and any other information available that will help to determine the movement of the volcanic ash cloud;

f) continue to issue advisories (VAA/VAG) to MWOs, ACCs, FMUs and operators involved. These VAAs/VAGs will be issued with a validity of T+0, T+6, T+12 and T+18 hours, at least at six (6) hour intervals, and more frequently if necessary. The procedure shall continue until such time as it is considered that the volcanic ash is no longer identifiable from satellite data, no further volcanic ash reports are received from the area, and no further eruptions of the volcano are reported; and

g) maintain regular contact with the VAACs and the meteorological offices concerned, and, if possible, with the Smithsonian Institute Global Volcanism Network in order to keep updated information on the status of the volcanoes in the area of responsibility.

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APPENDIX D

PROCEDURES FOR THE PRODUCTION OF MODELLED ASH CONCENTRATION CHARTS

1. The following procedures will be applied by the meteorological body of the provider State that has accepted, by regional air navigation agreement, the responsibility for establishing a VAAC within the framework of the International Airways Volcano Watch (IAVW).
2. All VAA and VAG information issued by the VAAC designated by the meteorological body within the framework of the IAVW shall be consistent with ICAO provisions.
3. Additionally, where feasible, the meteorological body may issued modelled ash concentration charts at six (6) hour intervals, indicating the areas with different ash concentrations for the validity periods of T+0, T+6, T+12 and T+18 hours from the time the event starts. These charts will show forecast ash distribution in terms of low, medium and high concentration, and will be published at the same time and with the same validity periods as the aforementioned VAAs/VAGs. Updated charts and files should be distributed before the end of the validity period.
4. The information described in item 3 may be used by the provider State for preparing SIGMETs, NOTAMs/ASHTAMs and for establishing a danger area, if appropriate.

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APPENDIX E

RECOMMENDED ACTION TO BE TAKEN BY THE STATES OF REGISTRY/OF THE OPERATOR WITH RESPECT TO AIRCRAFT OPERAITONS IN THE EVENT OF A VOLCANIC ERUPTION

Safety Risk Assessment for Flights in Airspace in the Proximity of Volcanic Ash

1 Introduction

1.1 It is recommended that States of registry or States of the operator, as applicable, that intend to allow operators under their jurisdiction to operate in areas of volcanic ash contamination require such operators to carry out a safety risk assessment before starting operations.

1.2 The safety risk assessment should be completed prior to planning operations in airspace or to/from aerodromes that might be contaminated by volcanic ash.

2 Applicability

2.1 All operators conducting flights in airspace and/or to/from aerodromes that could be affected by volcanic ash.

3 Recommendations

3.1 In accordance with *ICAO Annex 6, Chapter 3, paragraph 3.3 Safety Management,* it is recommended that States of registry or States of the operator, as appropriate, request operators planning to operate in areas where the presence of volcanic ash is forecast, to conduct safety risk assessments before planning their operations. Safety risk assessments should include a requirement for the operator to:

a) Conduct their own risk assessment and develop operational procedures to address any remaining risk;

b) Put in place appropriate maintenance ash damage maintenance inspections; and

c) Ensure that any incident related to volcanic ash is reported through an AIREP, followed by the corresponding volcanic activity report (VAR).

3.2 **APPENDIX F** provides guidance for the conduction of the safety risk assessment.

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APPENDIX F

EXAMPLE OF THE SAFETY RISK ASSESSMENT PROCESS

1 Introduction

1.1 The safety risk assessment process is described in the *Safety Management Manual (Doc 9859).* The process involves identifying the hazards associated with the activity (in this case, the airspace in the proximity of volcanic ash or the flight to/from aerodromes affected by volcanic ash), taking into account the seriousness of the consequences of the phenomenon (severity), the possibility or likelihood of its occurrence, if the resulting risk is acceptable and within the safety performance margins of the organisation (acceptability), and, finally, the adoption of measures to reduce the safety risk to an acceptable level (mitigation).

2 Hazard Identification

2.1 A hazard is any situation or condition that has the potential to cause adverse consequences. **APPENDIX G** contains a suggested list of topics that is not necessarily exhaustive.

3 The Safety Risk Assessment

3.1 Risk is the determination of the likelihood and severity of adverse consequences of a hazard.

3.2 All interested parties should be consulted in order to help the operator decide on the likelihood of a hazard causing harm, and with the mitigation of any safety risk perceived.

3.3 The safety risk should be assessed using a properly calibrated safety risk assessment matrix. A example of a safety assessment matrix can be found in the *Safety Management Manual (Doc 9859).* An alternative that is aligned with the safety management system (SMS) of the organisation would be equally appropriate. The safety risk analysis should take into account the severity of the adverse consequences of a particular hazard and the likelihood of their occurrence.

3.4 The severity of any adverse consequence of a particular hazard should be determined using a duly calibrated severity scale. The *Safety Management Manual (Doc. 9859)* contains examples of these scales. An alternative that is aligned with the safety management system (SMS) of the organisation would be equally appropriate. It should be noted that, for any flight, the safety impact of a volcanic ash encounter could be significant.

3.5 Risk Likelihood

3.5.1 The possibility or likelihood of adverse consequences resulting form a particular hazard should be determined. The likelihood must be consistent with the duly calibrated likelihood scale. The *Safety Management Manual (Doc 9859)* contains examples of these likelihood scales. An alternative that is aligned with the safety management system (SMS) of the organisation would be equally appropriate.

3.5.2 When assessing the likelihood or possibility of adverse consequences resulting from a particular hazard, the following factors should be taken into account:

- The degree of exposure to the hazard. The volcanic ash contingency plan for the South American Region.

- Any historical incident or data on a hazardous event affecting safety. This information can be obtained from the industry, the regulators, other operators, air navigation service providers, internal reports, etc.

- The expert judgment of the main stakeholders.

3.5.3 The results of this assessment should be recorded in a hazard log, also known as "risk register". **APPENDIX H** contains an example of a hazard log.

3.6 Risk Tolerance

3.6.1 At this stage of the process, safety risk should be classified in a range that varies from acceptable to unacceptable. The *Safety Management Manual (Doc 9859)* provides a suitable set of definitions for Risk Classification.

3.6.2 Appropriate mitigation measures for each identified hazard should be considered, recorded in the hazard log and implemented. Mitigation measures should be adopted to reduce safety risk to an acceptable level, but additional mitigation measures should also be considered when reasonably practicable and where they will reduce an already acceptable safety risk even further. Thus, the mitigation process would reduce safety risk to a level as low as reasonably practicable.

3.6.3 Not all hazards can be suitably mitigated, in which case the operation should cease.

3.7 Mitigation Measures

3.7.1 Risk mitigation measures, by themselves, can introduce new hazards. When organisations have an effective SMS, it will contain procedures for continuous monitoring of hazards and risks, involving qualified personnel to take mitigation action. Operators that do not have an effective SMS should repeat the safety risk assessment following any mitigation process and at regular intervals, as the circumstances on which the original assessment was predicated may have changed. This ensures ongoing safety management/monitoring.

3.8 Records

3.8.1 The results of safety risk assessments should be documented and disseminated throughout the organisation and submitted to the national safety authority of the

operator. Actions should be completed and mitigations verified and supported by evidence before starting operations.

3.8.2 Any assumptions should be clearly stated and the safety risk assessment reviewed at regular intervals to ensure those assumptions and decisions remain valid.

3.8.3 All safety performance monitoring requirements should also be identified and fulfilled through the safety management process of the organisation.

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APPENDIX G

SAMPLE TABLE OF CONSIDERATIONS FOR OPERATIONS PLANNED IN AIRSPACE OR TO/FROM AERODROMES THAT MIGHT BE CONTAMINATED WITH VOLCANIC ASH

Considerations	Guidance
Operator Procedures	
Guidance for the Type Certificate Holder	Operators must obtain advice from the Type Certificate Holder and engine manufacturer concerning operations in potentially contaminated airspace and/or to/from aerodromes contaminated with volcanic ash, including subsequent maintenance action.
Guidance for company personnel	Publish procedures for the planning of flights, operations and maintenance. Review of flight crew procedures for detection of volcanic ash and associated escape manoeuvres.

	Advice to the Type Certificate Holder on operations to/from aerodromes contaminated with volcanic ash, including performance.
Flight planning	These considerations will be applicable to all flights to be conducted in airspace that might be contaminated with volcanic ash or to/from aerodromes under those same conditions.
NOTAM and ASHTAM	The operator must closely monitor NOTAMs and ASHTAMs to ensure that the latest information concerning volcanic ash is available to crews.
SIGMET	The operator must closely monitor SIGMETs to ensure that the latest information concerning volcanic ash is available to crews.
Departures, destinations and alternate destinations	Degree of contamination, additional performance, procedures and maintenance.
Routing policy	Shortest period in and over contaminated area.
Diversion policy	Maximum allowed distance from a suitable alternative. Availability of alternatives outside of the contaminated area. Diversion policy after a volcanic ash encounter.
Minimum Equipment List (MEL) /Dispatch Deviation Guide	Consider additional restrictions for aircraft dispatch: Air conditioning systems; Engine inlets; Air data computers; Standby instruments; Navigation systems; Auxiliary power unit (APU); Airborne collision avoidance system (ACAS); Terrain awareness warning system (TAWS); Supply of oxygen for the crew; and Supplementary oxygen for passengers. (This list is not necessarily exhaustive)

Considerations	Guidance
Operator Procedures	
Provision of enhanced in-flight watch	Timely and updated information to/from crew.
Fuel policy	Consider the carriage of additional fuel.

Considerations	Guidance
Crew Procedures	These considerations will be applicable to all flights to be conducted in airspace or to/from aerodromes that

	might be contaminated with volcanic ash.
Pilot reports	Requirements for reporting in-flight volcanic ash. Post-flight report.
Mandatory reports	Reminder of the need to complete the MORs following an encounter.
Standard operating procedures	Review the procedures for shifting form normal to abnormal operation: Pre-flight planning; Operations to/from aerodromes contaminated with volcanic ash; Supplementary oxygen; Engine-out procedures; and Escape routes. (This list is not necessarily exhaustive.)
Technical log	Any actual or suspected volcanic ash encounter must be entered into a technical log and the appropriate maintenance actions taken before the subsequent flight. Penetration in airspace (details and duration) or operations to/from aerodromes that might be contaminated with volcanic ash shall be entered in the technical log.

Considerations	Guidance
Maintenance Procedures	Operators that are operating in areas contaminated with volcanic ash are recommended to improve surveillance and regular maintenance during inspections, and adjust them based on damage produced by ashes, in order to avoid unscheduled maintenance. Inspections should include the detection of signs of unusual or accelerated abrasion; corrosion and/or accumulation of ash. The cooperation of the operator is required in informing manufacturers and relevant authorities of their findings and experiences in operations in ash contaminated areas. If damage or significant changes beyond currently known variations are discovered, manufacturers will share these observations and any recommendation on improved maintenance practices with all operators and relevant authorities.

Note: *The aforementioned list is not necessarily exhaustive and operators must conduct their own safety risk assessments in their specific flight routes.*

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APENDICE H

EXAMPLE OF A HAZARD LOG (RISK REGISTER)

HAZARD		Sequential description of the incident	Existing controls	Result (Pre-mitigation)			Additional mitigation required	Event (Post-mitigation)			Actions and owners	Monitoring and review requirements
N°	Description			Severity	Likelihood	Risk		Severity	Likelihood	Risk		

(Add rows as required)

APPENDIX I

EXAMPLES OF SIGMET, NOTAM AND ASHTAM

WMO *N° 386 Volume I (Manual on the Global Telecommunication system) Part II (Operational procedures for the Global Telecommunication System)* contains guidance on the headers of the World Meteorological Organization (WMO) headers referred to in the Alerting Phase, paragraph 2.2.1.

NOTAM Offices are reminded that ASHTAMs (or volcanic ash NOTAMs) should be distributed *via* AFTN to their associated MWOs, to the SADIS Gateway and to all VAACs, in accordance with the provisions of ICAO Doc 9766, Chapter 4, paragraph 4.3.

1. SIGMET

2. NOTAM alerting on pre-eruptive activity.

3. NOTAM establishing a danger area following the initial eruption.

4. NOTAM establishing a danger area that includes a high (or high/medium or high/medium/low) contamination area.

5. NOTAM for defining a medium contamination area in the area not defined as danger area.

6. ASHTAM alerting on pre-eruptive activity.

7. ASHTAM alerting on eruptive activity.

8. ASHTAM alerting on reduced eruptive activity.

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