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HANDBOOK ON THE INTERNATIONAL AIRWAYS VOLCANO WATCH (IAVW)

OPERATIONAL PROCEDURES AND CONTACT LIST

Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION

DOCUMENT CHANGE RECORD

Parts 1 to 4

DATE	SECTION/PAGES AFFECTED	
31.3.26	Part 1	1.1.2 – included reference to PANS-MET 1.2 – Updated Volcanoes of the World Map
	Part 2	Updated MWO and ACC information for VAACs Anchorage, Darwin, London, Toulouse, Washington, Wellington Removed reference to viewing FIR information at ICAO GIS site
	Part 3	3.1 - Updated VAACs London and Montreal website addresses 3.3 – Reference to separate contact list included, updated eruption source parameter website address
	Part 4	Updated Part 4 title to include 'guidance' 4.1 to 4.3 – substantial rewrite to provide information to States on designating SVOs and use of GVP information 4.2 – substantial rewrite regarding actions to be taken by SVO 4.3 – clarification of use of VONA 4.4 – update on ASHTAM/NOTAM recipients 4.5 – Update on terminology, removal of EUR Gateway addresses, reference to use of QVA by MWOs 4.6 – substantial rewrite regarding QVA issuance, removal of VAA details in 4.6.1 c) and inclusion of PANS-MET reference, information on use of estimated volcanic ash area in VAA, information on event reviews 4.7 – clarification on use of VAR. 4.8 – inclusion of SVOs in test procedure information 4.9 – clarification on SO_2 and VAAC cloud separation and clarification on use of VAR 4.10 – removal of entire 4.10 and incorporation of relevant information into Appendix C 4.11 – new section on guidance for conducting post-event reviews Table 4-1 – removal of EGZZVANW from NOF address lists Table 4-2 – update to VAACs Anchorage, Darwin, London, Montreal and Wellington contact details Table 4-4 – new Note 2 on guidance for change in colour codes Table 4-5 – new table providing information on QVA issuance

DATE	SECTION/PAGES AFFECTED	
		Appendix A – Update to reflect updated definition of meteorological authority and new definition of meteorological service provider, update of terminology. Appendix B – removed London WAFC and SADIS gateway addresses, as no longer required. Appendix C – updated coordination guidance, new reference to QVA. Appendix D – new reference to QVA Appendix E - substantial rewrite regarding VONA issuance Appendix F – minor updates to refer to WG-MOG IAVW and PANS-MET Appendix G - substantial rewrite regarding SVO cost recovery Appendix H – new appendix containing information on supplemental QVA chart provision. Appendix I – new appendix containing guidance on use of QVA.
	Part 5	Separated into standalone document.
16.9.24	Part 1	Addition of an introduction to the document
	Part 2	Updates concerning VAAC Darwin and VAAC Toulouse Update to the map; inclusion of ICAO GIS Aeronautical Data website link.
	Part 3	Updates to 3.1 and 3.3.
	Part 4	4.1.1 b) – clarification on the provision of meteorological information to volcano observatories 4.1.1 g) – update regarding how the Smithsonian GVP volcano list is being kept up-to-date 4.1.4 – inclusion of text concerning the importance of volcanic ash information for flight safety Note 1 to 4.1.5 – updating to Sendai Framework goals Note 2 to 4.1.5 – information on coordination between SVOs regarding volcanoes located at State borders 4.2 – substantial rewrite regarding actions to be taken by SVO Note 1 to 4.5.1 a) – addition of a reference to regional air navigation plans for the complete list of MWOs and ACCs/FICs associated with each VAAC, together with their contact information 4.6.1 a) – removal of suggestion to send volcanic ash advisory information to SITA AFTN address 4.6.1 c) – update VAG dissemination to VAAC website only, clarification of the name of VAAC in back-up advisories 4.6.1 f) – update of Global Volcanism Program information Note 2 to 4.6.1 i) update to the location of eruption source parameter data 4.6.2 – update to suggested inclusions in volcanic ash advisory information for re-suspended volcanic ash Deletion of 4.6.4 – no longer required

DATE	SECTION/PAGES AFFECTED	
		4.8 – update to reflect status indicator in volcanic ash advisory information and SIGMET templates Table 4-1, update to VAAC Darwin and VAAC Wellington AFTN addresses Table 4-2, VAACs Anchorage, Buenos Aires, Darwin, London, Montreal, Tokyo, Toulouse, Washington, Wellington contact details Table 4-3 – addition of IWXXM headers, update of some back-up headers, addition of VAACs Montreal and Darwin as VAAC Washington back-up VAACs Table 4-4 – addition of 'UNASSIGNED' to aviation colour code and inclusion of explanatory note for re-suspended ash cases Appendix C – inclusion of Note to point 6 to clarify requirement for rebroadcast volcanic ash advisory information for ash near a VAAC boundary Appendix D – updates to VAAC backup requirements information Appendix F – addition of 'UNASSIGNED' to aviation colour code Appendix G – update of reference to ICAO Doc 9082, deletion point 6 due to broken link, deletion point 9 and following table as outdated Throughout – update to ensure consistent reference to State volcano observatories
	Part 5	See Part 5 change record
10.3.20	Part 2	Page 2-10, Washington
8.5.19	Part 5	Italy
6.1.19	Part 4	Table 4-2, VAAC Wellington contact numbers
8.11.18	Part 4	Editorial amendments (references)
	Appendix A	Editorial amendments (references)
6.4.18	Part 3	Updates to 3.1 and 3.2
	Part 4	Table 4-2, VAAC Anchorage e-mail address and homepage; VAAC Buenos Aires homepage, VAAC Tokyo e-mail address and homepage; and VAAC Washington e-mail address and homepage
2.3.18	Part 4	Table 4-2, VAAC Buenos Aires website address
30.11.17	Part 2	Update to VAACs Anchorage and Japan; update of VAAC Areas of Responsibility map
	Part 4	Amendment to 4.1.1 b); amendments to Sections 4.2 to 4.6, including new Note 5 to 4.2.1, new Note 3 to 4.5.1 d), new note to 4.6.1. c), and new 4.6.2; updates to Tables 4-2 and 4-3

DATE	SECTION/PAGES AFFECTED	
	Appendix A	Amendment to include “FIC(s)” and updating of references to MET tables, and amendment to 4.2.1
	Appendix F	Amendment to 4.1
	Appendix G	Amendment to paragraphs 2 and 3
16.8.16	Part 2	Updates to VAAC Toulouse MWO location names
	Part 4	Table 4-2, VAAC Tokyo e-mail address
27.1.16	Part 2	Updates to VAACs London and Toulouse MWO location names and location indicators
30.6.15	Part 2	Update of description of London VAAC area of responsibility and updates to VAACs Anchorage, London, Montreal, Tokyo, Toulouse and Washington MWO and ACC/FIC location names and location indicators
	Part 4	Table 4-2, VAAC Wellington contact numbers Table 4-3, VAAC Buenos Aires back–up VAAC and VAG bulletin headers
26.11.14	Part 4	Amendment to paragraph 4.6.1 h) and deletion of Notes 1 and 3
	Appendix C	Amendment to existing text and insertion of new text
21.11.14	T of C	Addition of new sections in Part 4, Table 4-4 and Appendix G, update of page numbers
	Part 2	Changes to descriptions of areas of responsibility and updates to VAAC Tokyo MWO and ACC/FIC location names and location indicators
	Part 3	Update of link to Canadian Meteorological Centre
	Part 4	Update of phases of eruption in Section 4.1, new Sections 4.7 and 4.10, and change to Table 4-3 (IAVWOPSG/8 report refers) New Section 4.2 Amendments to Section 4.3 corresponding to new Table 4-4 Corrections to contact information in paragraphs 4.6.1 and 4.6.3 Editorial improvements to paragraph 4.6.1 Table 4-2, VAAC Buenos Aires and VAAC Montreal contact numbers Table 4-3, VAAC London back-up VAAC VAA and VAG bulletin headers New Table 4-4
	Appendix A	Editorial amendments (references)
	Appendix E	Amendments to lines 3, 7, 11 and 16 and minor editorial amendments
	Appendix G	New appendix
7.8.13	T of C	Addition of Part 4, Appendix F
	Part 2	Change of notation used for latitude and longitude to degrees and minutes and update of corresponding map

DATE	SECTION/PAGES AFFECTED	
	Part 4	Correction to page 4-2 (“ISCS” replaced with “WIFS”), page 4-5 (numbering of sections of the NOTAM amended), insertion of new section 4.8
	Appendix C	Corrections (grammatical) to paragraph 1
	Appendix F	New appendix (Appendix G of IAVWOPSG/7 report refers)
6.11.12	Part 2	Addition of MWOs/ACCs to Tokyo and Toulouse VAACs
25.8.12	Part 3	Correction of website URLs for VAACs Anchorage and Tokyo
17.8.12	Part 2	Rewording of the coordinates for the Toulouse area of responsibility Changes to names and location indicators of aerodromes under Toulouse area of responsibility
	Part 4	Table 4-2, VAAC Washington contact numbers Table 4-3, VAAC Wellington VAA and VAG bulletin headers
21.6.12	Part 4	Update to Table 4-2, VAAC contact numbers – Buenos Aires VAAC
5.6.12	Part 4 and Appendix A	Deletion of references to Vienna International OPMET Data Bank
	Appendix B	Change to title of Appendix B Updating of AFTN addresses for MID and AFI regions
17.2.12	Part 2	Change to Anchorage, Darwin, Washington and Wellington VAAC areas of responsibility and update of corresponding map
	Part 3	Update of VAAC Buenos Aires website URLs (English and Spanish)
	Part 4	Amendment of Sections 4.1, 4.2 and 4.5 Replacement of Section 4.7 (Appendix F of IAVWOPSG/5 report refers.) Table 4-2, update of administrative e-mail for VAAC Anchorage and website URLs for VAAC Buenos Aires (English and Spanish) Table 4-3, update of Tokyo VAG and Wellington VAA bulletin headers
	Appendix C	Miscellaneous amendments
7.10.11	Part 4	Update page 4-13, para 4.7.4, changed para ref. no. 4.6.2 to 4.7.3.
31.8.11	Part 4	Update to Table 4-3, VAA bulletin header
16.8.11	Part 4	Update to Table 4-2, VAAC contact numbers – Anchorage VAAC
8.2.11	Part 4	Update to Table 4-2, VAAC contact numbers – Wellington VAAC
9.12.10	Part 4	Updated page 4-7 added para 4.3.4; page 4.9, para 4.5.1, line 1, added “*volcano observatory”* after “*WMO”*; para 4.5.1 a) added footnote no. 5; para 4.5.1 c) line 3, added “*using the PNG format*” after “*graphical format*” and deleted *“(in a position to do so*)”; page 4-10, added “*see Appendix E – VONA”;* page 4-17, Table 4-2. updated VAAC Buenos Aires URL.
25.8.10	Part 4	Updated page 4-7, para 4.3.3 changed the word “ASHTAM” to “NOTAM” and “airport” to “aerodrome”.

DATE	SECTION/PAGES AFFECTED	
12.7.10	Part 2	Updated Wellington (New Zealand) area of responsibility text Replaced VAAC Map
	Part 4	New paragraph 4.3.3
8.7.10	Part 4	Replaced Appendix E with updated version Appendix F (new) added
14.5.10	Part 2	Change to Toulouse VAAC area of responsibility
14.4.10	Part 4	VAAC Tokyo
26.11.09	Part 3	Amendment to the URL address for New Zealand VAAC
25.9.09	Part 3	Amendment to the URL address for Buenos Aires VAAC
	Part 4	URL address for the eruption source parameters for volcanoes of the world, and introduction of information regarding the availability of ESP
29.5.09	Part 4	Guidance regarding the transmission of information to aviation by selected State observatories Update regarding the distribution (addresses) of ASHTAM/NOTAM for VA.
14.5.09	Part 4	Introduction of new heading “4.7 Action to be taken by pilots in the event of entry into a SO_2 cloud” and “Table A4-3 – Volcanic ash advisory bulletin headers”
12.3.09	Part 4	Update to Table 4-2, VAAC contact numbers
25.2.09	Parts 3 and 4	Amendment to the URL for Toulouse VAAC
	Part 4	Introduction of new sub-paragraphs 4.5.1 h) recommended practice for “gradual” advisory cessation and 4.6 on standard format of the VA advisories and VA SIGMET used for test purposes
15.12.08	Parts 3 and 4	New web page for VAAC Montreal
24.11.08	Part 4	Pages 4-12 and 14, update of VAAC Buenos Aires AFTN address
19.11.08	Part 2	Page 2-10, Wellington
	Part 4	Page 4-13, Indonesia
22.5.07	Part 4	Buenos Aires
5.11.07	Part 4	Buenos Aires
6.8.07	Part 2 Part 4	Introduction of changes resulting from the IAVWOPSG/3 Meeting Appendices
30.7.07	Part 4	Update of AFTN addresses to be used for sending air-reports, SIGMETs and volcanic ash advisories to London WAFC and SADIS
16.6.07	Part 4	Updated volcano level of alert colour code
14.11.06	Part 4	Introduction of relevant aspects of the Hyogo framework
9.6.06	Part 2	Editorials

DATE	SECTION/PAGES AFFECTED	
	Part 3	Update of VAAC Tokyo homepage
	Part 4	Editorials
2.5.06	Part 4	VAAC Tokyo
24.4.06	Part 2	New format – Inclusion of location indicators for MWOs and ACCs
	Part 4	Deletion of WMO abbreviated headers for ASHTAM and NOTAMs, introduction of Appendix C on back-up procedures and update to VAACs London and Wellington
31.1.06	Part 2	VAACs areas of responsibility
28.11.05	Part 5	Ecuador , Panama
1.11.05	Part 5	Argentina, Chile, Paraguay
30.6.05	Part 5	El Salvador
25.4.05	Part 4	VAAC Buenos Aires
	Part 5	Peru
24.2.05	Part 5	Introduction of Appendix A – Sample letter of Agreement between the ATS, MET authorities and vulcanological authorities and procedures on the transmission of information related to aircraft encounters with volcanic ash (former Appendix A renumbered as B)
29.10.04	Part 4	Introduction of Appendix A on operational procedures for the coordination and transfer of responsibility between VAACs for volcanic ash events
25.10.04	Part 4	AFTN address for ASHTAM/NOTAM
14.9.04	Part 3	VAAC Montreal
1.9.04	Part 2	VAAC Toulouse
16.8.04	Part 2	VAACs Anchorage, London and Toulouse
29.7.04	Part 2	VAACs Buenos Aires, Tokyo and Washington
	Part 3	3.3
	Part 5	Canada, Russian Federation
19.4.04	Parts 3 and 4	VAACs London and Tokyo
3.3.04	Part 2	VAAC Toulouse
	Part 5	Argentina
22.1.04	Parts 3 and 4	VAAC Tokyo

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Part 1

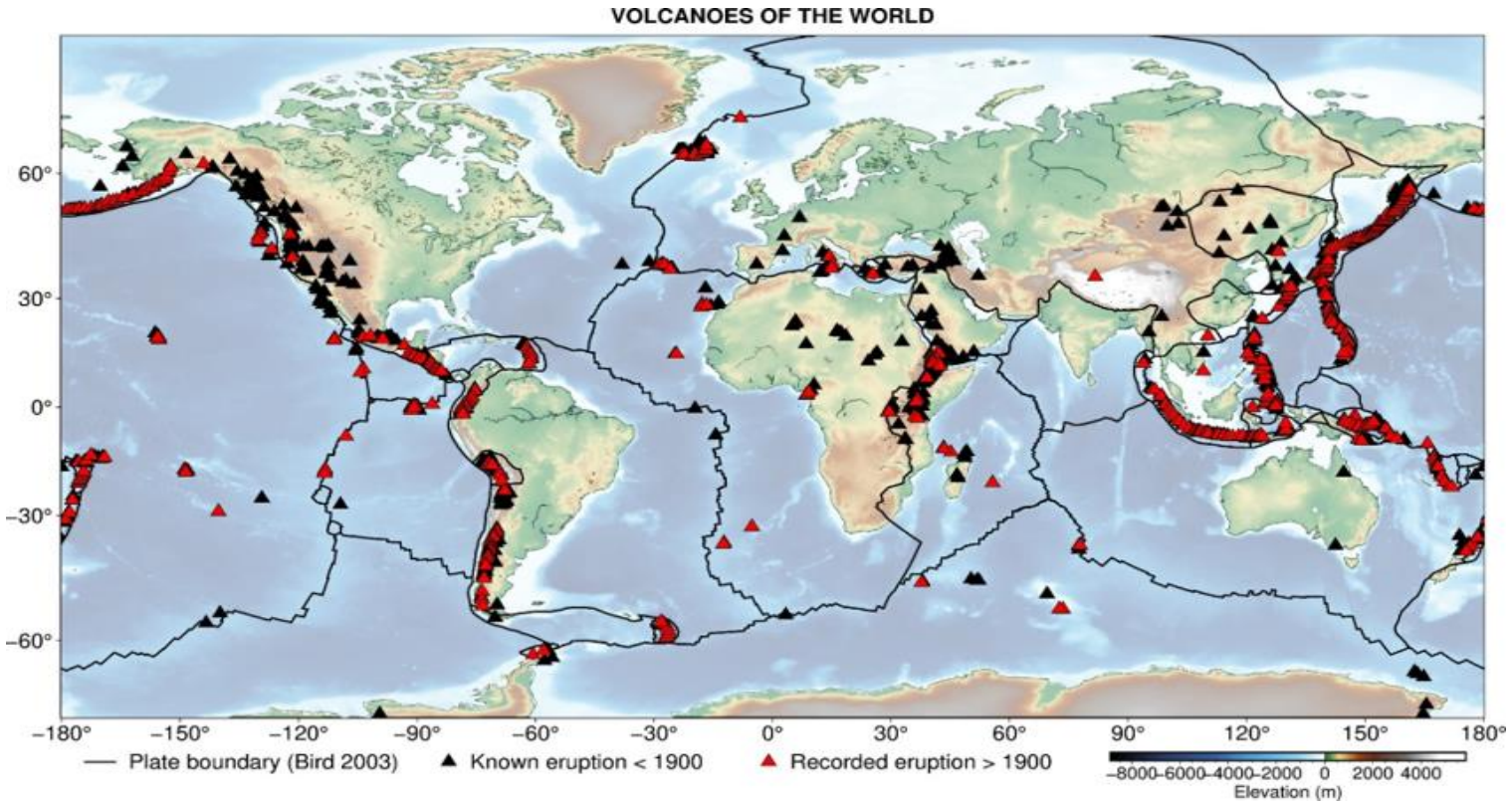
THE INTERNATIONAL AIRWAYS VOLCANO WATCH

1.1 INTRODUCTION

1.1.1 The international airways volcano watch (IAVW) defines a set of international arrangements for monitoring and providing warnings of volcanic ash in the atmosphere. The IAVW is based on the cooperation of both aviation and non-aviation operational units using information derived from observing sources and networks that are provided by States. The watch is coordinated by ICAO with the cooperation of other concerned international organizations.

1.1.2 The purpose of this handbook is to provide information on operational procedures and guidelines for the dissemination of information on volcanic eruptions and associated volcanic ash clouds and gas in areas which could affect routes used by international flights, and necessary arrangements prior to and during a volcanic eruption. It provides further context to the Standards and Recommended Practices (SARPs) provided in Annex 3 – *Meteorological Service for International Air Navigation* and ICAO *Procedures for Air Navigation Services – Meteorology* (PANS-MET, Doc 10157).

1.2 VOLCANOES ACTIVE DURING THE LAST 10 000 YEARS



Map of volcanoes with eruptions within the past 10 000 years (black symbols) and since 1900 (red symbols), and the main tectonic plate boundaries (black lines). Volcano location information from the Smithsonian Institute Global Volcanism Program[1]. Plate boundary information from Bird 2003[2]. Topographic information from Tozer et al. 2019[3]. British Geological Survey © UKRI 2025.

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[1] Smithsonian Institute Global Volcanism Program, https://volcano.si.edu/ , downloaded August 2024.
[2] Bird, P., 2003. An updated digital model of plate boundaries. *Geochemistry, Geophysics, Geosystems, 4*(3).
[3] Tozer, B., Sandwell, D.T., Smith, W.H., Olson, C., Beale, J.R. and Wessel, P., 2019. *Global bathymetry and topography at 15 arc sec: SRTM15+. Earth and space science, 6*(10), pp.1847-1864.

Part 2

VOLCANIC ASH ADVISORY CENTRES (VAACs) DESIGNATED BY ICAO AND THEIR RESPONSIBILITIES

(Note.— VAACs maintain a 24-hour watch)

EXPLANATION OF THE TABLE

Column

1. Location of the volcanic ash advisory centre (VAAC).

2. ICAO location indicator of VAAC (for use in the WMO header of advisory bulletin).

3. Area of responsibility for the preparation of advisory information on volcanic ash by the VAAC in Column 1.

4. MWOs to which the advisory information on volcanic ash should be sent.

5. ICAO location indicator of the MWOs in Column 4.

6. ACCs/FICs to which the advisory information on volcanic ash should be sent.

7. ICAO location indicator of the ACCs/FICs in Column 6.

			MWOs to which advisory information is to be sent		ACCs to which advisory information is to be sent	
Volcanic ash advisory centre	ICAO loc. ind.	Area of responsibility	Name	ICAO loc. ind	Name	ICAO loc. ind
1	2	3	4	5	6	7
Anchorage (United States)	PAWU	Anchorage Oceanic, Anchorage Continental, Oakland Oceanic North of N4300 E16500, N4812 W15000, N4812 W12800 Anchorage Arctic, and West to E15000, North of N6000	Anchorage	PAWU	Anchorage	PAZA
			Edmonton	CWEG	Edmonton	CZEG
					Fairbanks	PAFA
			Honolulu	PHFO	Oakland Oceanic	KZAK
			Kansas City	KKCI	Boston Chicago Cleveland Denver Minneapolis Oakland New York Salt Lake Seattle Washington	KSBW KORD KZOB KZDV KZMP KZOA KZNY KZLC KZSE KZDC
			Magadan	UHMM	Magadan	UHMM
			Tokyo	RJTD	Tokyo	RJTG
			Yakutsk	UEEE	Yakutsk	UEEE
			Yelizovo (Petropavlovsk-Kamchatsky)	UHPP	Petropavlovsk-Kamchatsky)	UHPP
Buenos Aires (Argentina)	SABM	South of S1000 between W01000 and W09000	Amazònica	SBEG	Amazònico	SBAZ
			Antofagasta	SCFA	Antofagasta	SCFZ
			Asunción	SGAS	Asunción	SGFA
			Brasilia	SBBR	Brasilia	SBBS
			Buenos Aires (Aeroparque)	SABE	Ezeiza	SAEF/SAEU
			Comodoro Rivadavia	SAVC	Comodoro Rivadavia	SAVF/SAVU
			Córdoba	SACO	Córdoba	SACF/SACU
			Curitiba	SBCT	Curitiba	SBCW
			La Paz	SLLP	La Paz	SLLF
			Lima-Callao	SPIM	Lima	SPIM
			Mendoza	SAME	Mendoza	SAMF/SAMV
			Montevideo	SUMU	Montevideo	SUEO
			Puerto Montt	SCTE	Puerto Montt	SCTZ
			Punta Arenas	SCCI	Punta Arenas	SCCZ
			Recife	SBRF	Recife Atlantico	SBRE SBAO
			Resistencia	SARE	Resistencia	SARR/SAEU
			Santiago	SCEL	Santiago	SCEZ

			MWOs to which advisory information is to be sent		ACCs to which advisory information is to be sent	
Volcanic ash advisory centre	ICAO loc. ind.	Area of responsibility	Name	ICAO loc. ind	Name	ICAO loc. ind
1	2	3	4	5	6	7
Darwin (Australia)	YMMC	Southward from N2000 and from E08200 to E10000, and Southward from N1000 and from E10000 to E16000, and the Colombo, Melbourne and Brisbane FIRs	Bangkok	VTBD	Bangkok	VTBB
			Brisbane	YBRF	Brisbane	YBBB
			Chennai	VOMM	Chennai	VOMF
			Colombo	VCBI	Colombo	VCBI
			Gia Lam	VVGL	Hanoi Ho-Chi-Minh	VVNB VVTS
			Honiara	AGGH	Honiara	AGGH
			Honolulu	PHFO	Honolulu	PHZH
			Jakarta	WIII	Jakarta	WIIF
			Kansas City	KKCI	Oakland Oceanic	KZAK
			Kolkata	VECC	Kolkata	VECF
			Kota Kinabalu	WBKK	Kota Kinabalu	WBFC
			Kuala Lumpur	WMKK	Kuala Lumpur	WMFC
			Manila	RPLL	Manila	RPHI
			Melbourne	YMRF	Melbourne	YMMM
			Phnom Penh	VDPP	Phnom Penh	VDPP
			Port Moresby	AYPY	Port Moresby	AYPM
			Singapore	WSSS	Singapore	WSJC
			Ujung Pandang	WAAA	Ujung Pandang	WAAF
			Yangon	VYYV	Yangon	VYYF
London (United Kingdom)	EGRR	South of the North Pole and North of N7100 between the Prime Meridian and E09000 Bødo Oceanic, Finland, Kobenhavn, London, Polaris, Reykjavik, Scottish Shannon Shanwick Oceanic and Sweden	Bergen	ENVV	Polaris	ENOR
					Bremen	EDWW
					Brest-Bretagne	LFRB
					Brussels	EBBU
			Chopina W Warszawie	EPWA	Warszava	EPWW
			Danish Meteorological Institute	EKMI	Kobenhavn	EKDK
			De Bilt	EHDB	Amsterdam	EHAA
			Edmonton	CWEG	Edmonton Gander	CZEG CZQX
			Helsinki (MET Institute)	EFKL	Finland	EFIN
					Kalingrad	UMKK
			Lisboa	LPPT	Lisboa	LPPC
					Madrid	LECM
			MET Office Exeter	EGRR	London Scottish	EGTT EGPX
			Oslo	ENMI	Polaris	ENOR
					Paris	LFFF
			Reykjavik	BIRK	Reykjavik	BIRD
					Riga	EVRR
					Sankt Peterburg/ Pulkovo	ULLI

			MWOs to which advisory information is to be sent		ACCs to which advisory information is to be sent	
Volcanic ash advisory centre	ICAO loc. ind.	Area of responsibility	Name	ICAO loc. ind	Name	ICAO loc. ind
1	2	3	4	5	6	7
			Shannon	EINN	Shannon Tallinn	EISN EETT
			Stockholm	ESSA	Sweden	ESSA
					Tallinn	EETT
			Tromso	ENVN	Polaris	ENOR
					Trondheim	ENVA
			Vilnius/Intl	EYVI	Vilnius	EYVL
Montreal (Canada)	CWAO	Søndrestrøm, Gander Oceanic, Canadian Continental FIRs (including the Arctic Ocean)	Edmonton	CWEG	Edmonton Gander Moncton Montreal	CZEG CZQX CZQM CZUL
			Reykjavik	BIRK	Reykjavic	BIRD
			Kangerlussuaq	BGSF	Søndrestrøm Toronto Vancouver Winnipeg	BGGL CZYZ CZVR CZWG
Tokyo (Japan)	RJTD	N9000 to N6000 and from E09000 to E15000 and N6000 to N1000 and from E09000 to Oakland Oceanic and Anchorage Oceanic and Continental FIR boundaries except the area within N2000 E09000 to N2000 E10000 to N1000 E10000 to N1000 E09000	Aktobe	UATT	Aktobe	UATT
			Almaty	UAAA	Almaty	UAAA
			Astana	UACC	Astana	UACC
			Bangkok	VTBS	Bangkok	VTBB
			Beijing	ZBAA	Beijing Huhhot Taiyuan	ZBPE ZBHH ZBYN
			Chulman	UELL	Chulman	UELL
			Gia Lam	VVLL	Ha Noi Ho Chi Minh	VVNB VVTS
			Guanzhou	ZGGG	Guandzhou Changsha Guillin Nanning	ZGGG ZGHA ZGKL ZGNN
			Hong Kong	VHHH	Hong Kong	VHHH
			Incheon	RKSI	Incheon	RKRR
			Irkutsk	UIII	Irkutsk	UIII
			Khabarovsky	UHHH	Khabarovsky	UHHH
			Krasnoyarsk	UNKL	Krasnoyarsk	UNKL
			Kunming	ZPPP	Kunming Chengdu Chongqing	ZPPP ZUUU ZUCK
			Lanzhou	ZLLL	Lanzhou Xi'an	ZLLL ZLXY
			Magadan	UHMM	Magadan	UHMM
			Manila	RPLL	Manila	RPHI
			Mirny	UERR	Mirny	UERR
			Murmanansk	ULMM	Murmanansk	ULMM
			Phnom-Penh	VDPP	Phnom-Penh	VDPP
			Pyongyang (Sunan)	ZKPY	Pyongyang	ZKKP
			Sanya	ZJSY	Sanya	ZJSY

			MWOs to which advisory information is to be sent		ACCs to which advisory information is to be sent	
Volcanic ash advisory centre	ICAO loc. ind.	Area of responsibility	Name	ICAO loc. ind	Name	ICAO loc. ind
1	2	3	4	5	6	7
			Shanghai	ZSSS	Shanghai Hefei Jinan Nanchang Nanjing Qingdao Xiamen	ZSSS ZSOF ZSJN ZSCN ZSNJ ZSQD ZSAM
			Shenyang	ZYTX	Shenyang Dalian Hailar Harbin	ZYTX ZYTL ZBLA ZYHB
			Shymkent	UAII	Shymkent	UAII
			Taibei	RCTP	Taibei	RCTP
			Tokyo	RJTD	Fukuoka JCAB ATMC Tokyo Fukuoka Naha Sapporo	RJJJ RJTG RJDG RORG RJCG
			Ulaanbaatar	ZMUB	Ulaanbaatar	ZMUB
			Urumqi	ZWWW	Urumqi	ZWWW
			Wuhan	ZHHH	Wuhan	ZHHH
			Yakutsk	UEEE	Yakutsk	UEEE
			Yelizovo (Petropavlovsk-Kamchatsky)	UHPP	Yelizovo (Petropavlovsk-Kamchatsky)	UHPP
Toulouse (France)	LFPW	Santa Maria Oceanic FIR, AFI Region down to the South Pole, EUR Region (except for Helsinki*, Kobenhavn, London, Polaris, Scottish, Shannon and Sweden FIRs) West of E09000 and South of N7100, MID Region, and ASIA Region West of E09000 North of N2000 (plus Mumbai, Chennai (West of E08200) and Male FIRs)	Abu Dhabi Intl	OMAA	Emirates FIR	OMAE
			Accra	DGAA	Accra	DGAC
			Addis Ababa	HAAB	Addis Ababa	HAAA
			Alger/CRT	DAMM	Alger	DAAA
			Amman/Queen Alia	OJAI	Amman (ACC/FIC)	OJAC
			Ankara	LTAC	Ankara	LTAA
			Antananarivo	FMMI	Antananarivo	FMMM
			Arkhangelisk	ULAA	Naryan-Mar	ULAM
			Ashgabat	UTAA	Ashgabat	UTAA
			Asmara	HHAS	Asmara	HHAA
			Athinai	LGAT	Athinai	LGGG
			Atyrau	UATG	Aktau	UATE
			Baghdad Intl	ORBI	Baghdad	ORBS*
			Bahrain Intl	OBBI	Bahrain FIR	OBBB
			Barcelona	LEBN	Barcelona	LECB
			Banja Luka	LQBK	Sarajevo	LQSB
			Beirut/Beirut Intl	OLBA	Beirut/Beirut Intl	OLBA
			Beograd	LYBE	Beograd	LYBA
			Bergen	ENVV	Bergen	ENTR
			Berlin	EDZB	Berlin	EDBB

			MWOs to which advisory information is to be sent		ACCs to which advisory information is to be sent	
Volcanic ash advisory centre	ICAO loc. ind.	Area of responsibility	Name	ICAO loc. ind	Name	ICAO loc. ind
1	2	3	4	5	6	7
			Bishkek/Manas	UCFM	Bishkek/Manas Osh	UCFM UAFO
			Bodo	ENVN	Bodø	ENOB
			Bordeaux	LFBD	Bordeaux	LFBB
			Bratislava/ M.R. Stefanik	LZIB	Bratislava	LZBB
			Brazzaville	FCBB	Brazzaville	FCCC
			Bremen	EDZM	Bremen	EDWW
			Brest	LFRN	Brest	LFRR
			Brindisi	LIBR	Brindisi	LIBB
			Brussels	EBBR	Brussels	EBBU
			Bucuresti	LROM	Bucuresti	LRBB
			Budapest Liszt Ferenc Intl	LHBP	Budapest FIR	LHCC
			Bujumbura	HBBA	Bujumbura	HBBA
			Cairo Intl	HECA	Cairo/ACC	HECC
			Canarias	GCGC	Canarias	GCCC
			Casablanca	GMMC	Casablanca	GMMM
			Chelyabinsk	USCC	Chelyabinsk	USCC
			Chennai	VOMM	Chennai (+Darwin)	VOMF
			Chisinau	LUKK	Chisinau	LUKK
			Chopina W. Warszawie	EPWA	Warszawa	EPWW
			Dakar	GOBD	Dakar	GOOO
			Damascus/Intl	OSDI	Damascus/Intl	OSDI
			Dar-es-Salaam	HTDA	Dar-es-Salaam	HTDC
			De Bilt	EHDB	Amsterdam	EHAA
			Delhi	VIDP	Delhi	VIDF
			Dhaka	VGZR	Dhaka (+Tokyo)	VGFR
			Dnepropetrovsk	UKDV	Dnepropetrovsk	UKDV
			Dushanbe	UTDD	Dushanbe	UTDD
			Dusseldof	EDZE	Dusseldorf	EDDL
			Entebbe	HUEN	Entebbe	HUEC
			Essen	EDZE	Frankfurt	EDYY
			Estonian Environment Agency	EEMH	Tallinn	EETT
			Frankfurt	EDZF	Langen	EDGG
			Gaborone/SSK	FBSK	Gaborone	FBGR
			Geneva	LSZH	Geneva	LSAG
			Gran Canaria (MET)	GCGC	Canarias	GCCC
			Hamburg MET Reg Centre	EDZH	Bremen Maastricht	EDWW EDYY
			Harare	FVHA	Harare	FVHA

			MWOs to which advisory information is to be sent		ACCs to which advisory information is to be sent	
Volcanic ash advisory centre	ICAO loc. ind.	Area of responsibility	Name	ICAO loc. ind	Name	ICAO loc. ind
1	2	3	4	5	6	7
			Hedyar Aliyev Intl	UBBB	Hedyar Aliyev Intl	UBBB
			Helisinki (MET Institute)	EFKL	Finland	EFIN
			(Israel) Meteorological Service	LLBD	Tel-Aviv	LLTA
			Istanbul	LTBA	Istanbul	LTBB
			Jeddah/King Abdulaziz Intl	OEJN	Jeddah FIR	OEJD
			Johannesburg	FAJS	Cape Town Johannesburg Johannesburg Oceanic	FACA FAJA FAJO
			Kabul	OAKB	Kabul	OAKX
			Kaliningrad	UMKK	Kaliningrad	UMKK
			Kano	DNKN	Kano	DNKK
			Karachi	OPKC	Karachi	OPKR
			Kathmandu	VNKT	Kathmandu	VNSM
			Kazan	UWKD	Kazan	UWKD
			Khartoum	HSSS	Khartoum FIR/SRR	HSSS
			Kigali	HRYR	Kigali	HRYR
			Kinshasa	FZAA	Kinshasa	FZAZ
			Kirov	USKK	Kirov	USKK
					København	EKDK
			Kolkata	VECC	Kolkata (+Darwin)	VECF
			Kotlas	ULKK	Kotlas	ULKK
			Kuwait/Intl	OKBK	ACC/Aerodrome Control Tower	OKAC
			Kyiv	UKBV	Kyiv	UKBV
			Lahore	OPLA	Lahore	OPLR
			Larnaka	LCLK	Nicosia	LCCC
			Lilongwe	FWLI	Lilongwe	FWLL
			Lisboa	LPPT	Lisboa Santa Maria	LPPC LPPO
			Ljubljana/Brnik	LJLJ	Ljubljana	LJLA
					London	EGTT
			Luanda	FNLU	Luanda	FNAN
			Luqa	LMML	Malta	LMMM
			Lusaka	FLLS	Lusaka	FLFI
			L'viv	UKLV	L'viv	UKLV
			Madrid	LEMM	Madrid	LECM
			Mahe	FSIA	Seychelles	FSSS
			Male	VRMM	Male	VRMF
			Malmo	ESSA	Malmo	ESMM

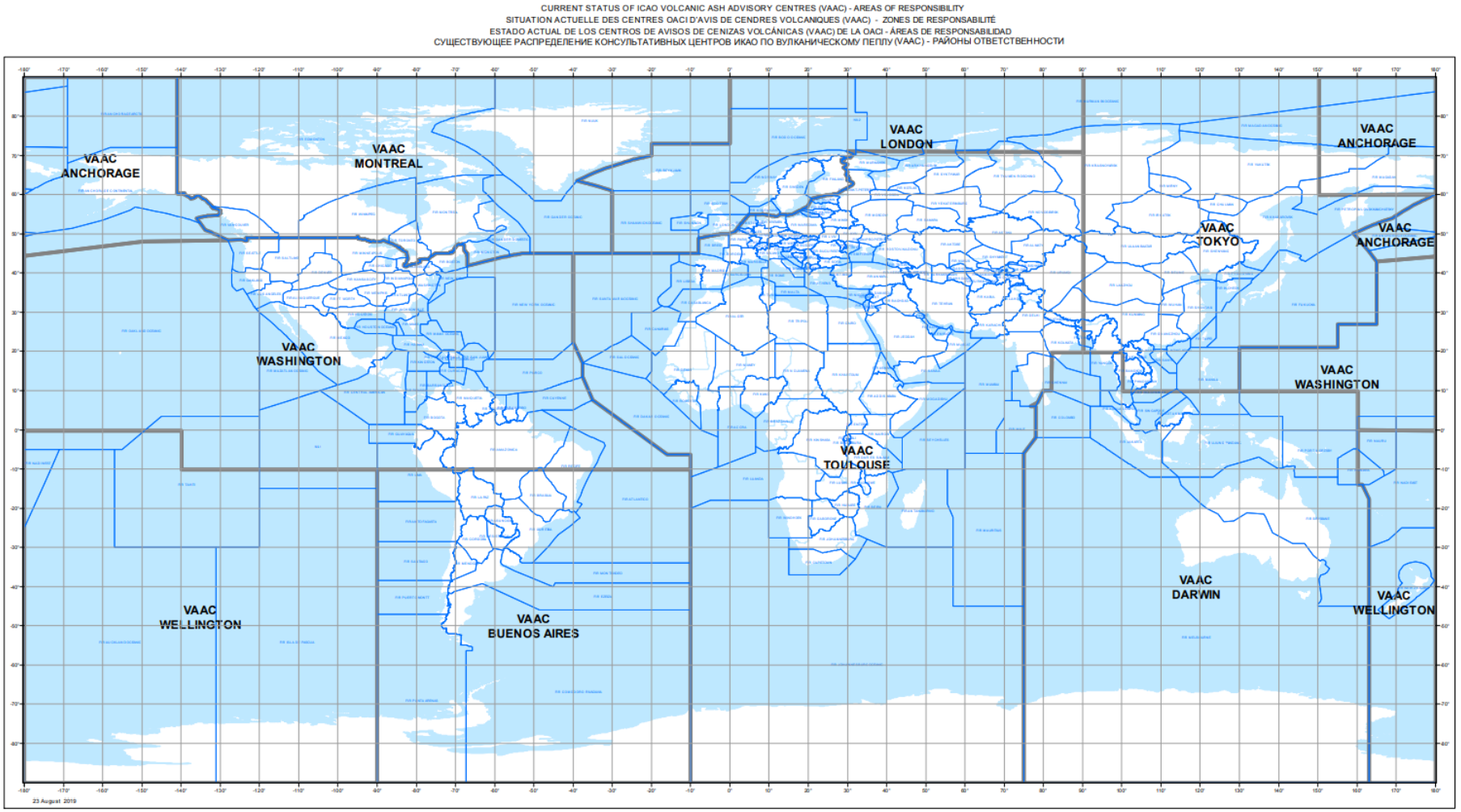
			MWOs to which advisory information is to be sent		ACCs to which advisory information is to be sent	
Volcanic ash advisory centre	ICAO loc. ind.	Area of responsibility	Name	ICAO loc. ind	Name	ICAO loc. ind
1	2	3	4	5	6	7
			Malta	LMML	Malta	LMMM
			Mauritius	FIMP	Mauritius	FIMM
			Maputo	FQMA	Beira	FQBE
			Milano	LIMM	Milano Padova	LIMM LIPP
			Minsk	UMMM	Minsk	UMMV
			Mogadishu	HCMM	Mogadishu	HCSM
			Monrovia	GLRB	Conakry	GUCY
			Moscow/Vnukovo	UUWW	Moscow/Vnukovo	UUWW
			Mumbai	VABB	Mumbai	VABF
			Munchen MET Reg Centre	EDZM	Munchen	EDMM
			Murmansk	ULMM	Murmansk	ULMM
			Muscat/Muscat Intl	OOMS	Muscat/FIR	OOMM
			N'Djamena	FTTJ	N'Djamena	FTTT
			Nairobi	HKJK	Nairobi	HKNA
			Niamey	DRRN	Niamey	DRRR
			Odesa	UKOV	Odesa	UKOO
			Ohrid	LWOH	Skopje	LWSK
			Osh	UCFO	Osh	UCFO
			Oslo	ENMI	Oslo	ENOS
			Palma de Mallorca	LEPA	Baleares	LECP
			Perm	USPP	Perm	USPP
			Praha	LKPR	Praha	LKAA
			Riga	EVRA	Riga	EVRR
			Rome Centro Met	LIBB	Brindisi Roma	LIBB LIRR
			Roberts	GLRB	Roberts	GLRB
			Rostov-na-donu	URRR	Rostov-na-donu	URRV
			Rovaniemi	EFRO	Rovaniemi	EFPS
			Sal	GVAC	Sal	GVSC
			Samara	UWWW	Samara	UWWW
			Samarkand	UTSS	Nukus FIR	UTNR
			Sana'a/Intl	OYSN	Sana'a/Intl	OYSN
			Sankt-Petersburg, AFTN/CIDIN Com Centre, FIR (AFTMU)	ULLL	Sankt-Petersburg	ULLI
			Seychelles	FSIA	Seychelles	FSSS
			Simferopol	UKFF	Simferopol	UKFF
			Skopje	LWSK	Skopje	LWSK
			Sofia	LBSF	Sofia	LBSR
					Sweden	ESAA

			MWOs to which advisory information is to be sent		ACCs to which advisory information is to be sent	
Volcanic ash advisory centre	ICAO loc. ind.	Area of responsibility	Name	ICAO loc. ind	Name	ICAO loc. ind
1	2	3	4	5	6	7
			Zurich	LSZH	Geneva Sweden	LSAW ESAA
			Syktyvkar	UUYY	Syktyvkar	UUYY
			Tallinn	EEMH	Tallinn	EETT
			Tashkent	UTTT	Samarkand FIR Tashkent/Yuzhny FIR	UTDS UTTR
			Tehran/Mehrabad	OIII	Tehran (ACC/FIC/FIR)	OIIX
			Tbilisi	UGTB	Tbilisi	UGGG
			Tirana	LATI	Tirana	LAAA
			Toulouse	LFPW	Bordeaux Reims Paris Marseille Brest	LFBB LFEE LFFF LFMM LFRR
			Tripoli	HLLT	Tripoli FIR/SRR	HLLL*
			Tromso	ENVN	Stavanger	ENSV
			Trondheim	ENVV	Trondheim	ENTR
			Tunis	DTTA	Tunis	DTTC
			Urumqi	ZWWW	Urumqi (+Tokyo)	ZWUQ
			Varna	LBWN	Varna	LBWR
			Valencia	LEVA	Barcelona Madrid	LECB LECM
			Vilnius/Intl	EYVI	Vilnius	EYVL
			Vologda	ULWW	Vologda	ULWW
			Wien	LOWW	Wien	LOVV
			Windhoek	FYWH	Windhoek	FYWH
			Yerevan	UDYZ	Yerevan	UDEE
			Zagreb	LDZA	Zagreb	LDZO
			Zurich	LSZH	Zurich	LSAZ

			MWOs to which advisory information is to be sent		ACCs to which advisory information is to be sent	
Volcanic ash advisory centre	ICAO loc. ind.	Area of responsibility	Name	ICAO loc. ind	Name	ICAO loc. ind
1	2	3	4	5	6	7
Washington (United States)	KNES	New York Oceanic Oakland Oceanic South of N4300 E16500 to N4820 W15000 to N4820 W12800, United States Continental FIRs, New York Oceanic FIR North of S1000 W14000 East of 0000 W14000 and North of S10000 W14000 to S1000 W03000 Nadi and Nauru FIRs North of Equator	Amazònico	SBEG	Amazònica	SBAZ
			Caracas	SVMI	Maiquetia	SVZM
			Fort de France	TFFF	Cayenne	SOOO
			Darwin	YDRM	Darwin	YPDN
			Edmonton	CWEG	Edmonton Gander	CZEG CZQX
			Guayaquil	SEGU	Guayaquil	SEGU
			Habana	MUHA	Habana	MUFH
			Honolulu	PHFO	Honolulu Oakland Oceanic Guam	PHZH KZAK PGZU
			Kansas City	KKCI	Albuquerque Atlanta Boston Chicago Cleveland Denver Ft. Worth Houston Houston Oceanic Indianapolis Jacksonville Kansas City Los Angeles Memphis Miami Miami Oceanic Minneapolis Nassau New York Oakland Oakland Oceanic Salt Lake City San Juan Seattle Washington	KZAB KZTL KZBW KZAU KZOH KZDV KZFW KZHU KZHU KZID KZJX KZKC KZLA KZME KZMA KZMA KZMP MYNA KZNY KZOA KZAK KZLC TJZS KZSE KZDC
			Kingston	MKJP	Kingston	MKJK
			Lima-Callao	SPIM	Lima	SPIM
			México	MMMX	Mazatllán México	MMZT MMEX
			Panamá	MPTO	Panamá	MPZL
			Port-au-Prince	MTPP	Port-au-Prince	MTEG
			Port-of-Spain	TTPP	Piarco	TTZP
			Recife	SBRF	Recife Atlantico	SBRE SBAO
			Santa Fé de Bogotá	SKBO	Barranquilla Bogotá	SKEC SKED
			Santo Domingo	MDSD	Santo Domingo	MDCS
			Tegucigalpa	MHTG	Central American	MHTG
			Timehri	STCJ	Georgetown	SYGC

			MWOs to which advisory information is to be sent		ACCs to which advisory information is to be sent	
Volcanic ash advisory centre	ICAO loc. ind.	Area of responsibility	Name	ICAO loc. ind	Name	ICAO loc. ind
1	2	3	4	5	6	7
			Tokyo	RJTD	Tokyo	RJTG
			Willemstad	TNCC	Curacao	TNCF
			Zandery	SMJP	Paramaribo	SMPM
Wellington (New Zealand)	NZKL	Southward from the Equator and from E16000 to W14000, except for the Melbourne and Brisbane FIRs, and Southward from S1000 and from W14000 to W09000	Brisbane	YBRF	Brisbane	YBBB
			Honiara	AGGH	Honiara	AGGH
			Honolulu	PHFO	Honolulu	PHZH
			Isla de Pascua	SCIP	Isla de Pascua	SCEL
			Melbourne	YMRF	Melbourne	YMMM
			Nadi	NFFN	Nadi	NFFF
			Tahiti	NTAA	Tahiti	NTTT
			Wellington	NZKL	Auckland Christchurch	NZZO NZZC

*Not listed in Doc 7910.



Note.— Flight information regions (FIRs) within each volcanic ash advisory centre's area of responsibility can also be viewed graphically at https://gis.icao.int/portal/home/index.html.

Part 3

USEFUL WEBSITES

Note.— These addresses are included for back-up information only, and it should be clearly understood that operational reliance on volcanic ash information obtained from websites cannot be assured.

3.1 VOLCANIC ASH ADVISORY CENTRES

Anchorage:	https://www.weather.gov/vaac
Buenos Aires:	https://ssl.smn.gob.ar/vaac/buenosaires/inicio.php?lang=en (English) https://ssl.smn.gob.ar/vaac/buenosaires/inicio.php?lang=es (Spanish)
Darwin:	http://www.bom.gov.au/aviation/volcanic-ash/
London:	https://www.metoffice.gov.uk/services/transport/aviation/regulated/international-aviation/vaac/index
Montreal:	https://weather.gc.ca/eer/vaac/index_e.html (English) http://meteo.gc.ca/eer/vaac/index_f.html (French)
Tokyo:	https://www.data.jma.go.jp/vaac/data/index.html
Toulouse:	http://vaac.meteo.fr
Washington	https://www.ospo.noaa.gov/products/atmosphere/vaac/messages.html https://www.ospo.noaa.gov/Products/atmosphere/vaac/index.html
Wellington:	http://vaac.metservice.com

Note.— The homepage of each VAAC normally contains hyperlinks to the homepages of the other VAACs.

3.2 WORLDWIDE WEEKLY VOLCANIC ACTIVITY REPORTS

Smithsonian Institution:	http://volcano.si.edu/reports_weekly.cfm
United States Geological Survey: (USA volcanoes only)	http://volcanoes.usgs.gov

Note.— These sites provide excellent up-to-date reports on active volcanoes.

3.3 OTHER SITES

Note.— Volcano observatory websites are included in Part 5, International Airways Volcano Watch Contact List (published separately).

Global Volcanism Program (GVP)	http://volcano.si.edu/
World Organization of Volcano Observatories (WOVO)	https://wovo.iavceivolcano.org/
WOVOdat – Data on Volcanic Unrest	https://wovo.iavceivolcano.org/wovodat
Eruption source parameters for volcanoes of the world	https://webapps.bgs.ac.uk/esp/
HYSPLIT dispersion model	https://www.ready.noaa.gov/HYSPLIT.php
NOAA/CIMSS Volcanic Cloud Monitoring Web Portal	https://volcano.ssec.wisc.edu
Support to Aviation Control Service (SACS)	https://sacs.aeronomie.be/
Catalogue of Icelandic Volcanoes	https://icelandicvolcanos.is
European Catalogue of Volcanoes and Volcanic Areas	https://volcanos.eurovolc.eu
Global Sulphur Dioxide Monitoring Home Page	https://so2.gsfc.nasa.gov/
NASA Worldview	https://worldview.earthdata.nasa.gov/
Global Volcanic Lightning Monitor	http://wwlln.net/USGS/Global/

Note.— Useful background information on volcanic ash and its impact on aviation may be found in the Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds *(Doc 9691). Information on obtaining ICAO documents is available on the ICAO Store at https://store.icao.int.*

Part 4

INTERNATIONAL AIRWAYS VOLCANO WATCH

OPERATIONAL PROCEDURES AND GUIDANCE FOR THE DISSEMINATION OF INFORMATION ON VOLCANIC ERUPTIONS AND ASSOCIATED VOLCANIC ASH CLOUDS IN AREAS WHICH COULD AFFECT ROUTES USED BY INTERNATIONAL FLIGHTS, AND NECESSARY ARRANGEMENTS PRIOR TO AND DURING A VOLCANIC ERUPTION

4.1. PROCEDURES PRIOR TO A VOLCANIC ERUPTION

4.1.1 In accordance with Annex 3 - Meteorological Services for International Air Navigation, States with active or potentially active volcanoes shall arrange that, in accordance with regional air navigation agreement, State volcano observatories (SVOs) monitor these volcanoes.

4.1.2 The Smithsonian Global Volcanism Program (GVP) categorizes Holocene volcanoes as being active or potentially active, due to the dormant intervals between major eruptions at a single volcano potentially lasting hundreds to thousands of years. The threat posed to aviation is the combination of the volcanic hazard (eruption style and frequency) and the exposure (people and infrastructure at risk). When prioritizing how volcano monitoring resources are allocated, SVOs should consider the threat that is posed to aviation as part of their deliberative process.

4.1.3 In order to permit efficient application of the measures noted in 4.2 to 4.8, States responsible for flight information regions (FIRs) in which there are active or potentially active volcanoes in proximity to routes used by international flights should make arrangements to ensure that:

a) information on increasing volcanic activity, volcanic eruption[4] or volcanic ash cloud in areas which could affect routes used by international flights, available from one or more observing sources, such as volcanological, seismological, geological, meteorological, or the police/military networks and domestic aviation, is passed **immediately** to the area control centre/flight information centre (ACC/FIC) and the meteorological watch office (MWO) concerned;

Note.— Where information comes from supplementary sources such as the research community, States are strongly encouraged to make arrangements consistent with the appropriate scientific protocols as advised by the International Union of Geodesy and Geophysics (*IUGG).*

b) systems and channels of communication are in place to make available to SVOs appropriate meteorological information useful for assessing volcanic plume height or height of a re-suspended volcanic ash cloud[5] (in particular data derived from weather radar, ceilometers, lidar, passive infrared sensors, satellite remote sensing and visual observations by trained meteorological observers);

c) 24-hour contact details are shared between the ACC/FIC, MWO and SVOs and the relevant volcanic ash advisory centre (VAAC);

d) the State international NOTAM office personnel are familiar with the issuance of ASHTAMs[6] (or NOTAMs for volcanic ash);

4 The term “eruption” in Part 4 of this document refers to the start or continuation of an eruption, or its cessation.

5. Re-suspended volcanic ash will typically be due to (strong) surface winds that have allowed previously deposited volcanic ash to be lifted above ground level and carried (potentially some distance) on the wind. A cloud of re-suspended volcanic ash may or may not be associated with an ongoing or recent eruption and, indeed, may be associated with an eruption that occurred at any point in the past. In some instances it may not be possible to determine the source volcano of the volcanic ash that has been re-suspended.

6. The ASHTAM is a special series NOTAM specifically for volcanic activity.

e) information, preferably supplemented by charts, concerning volcanoes in the FIRs for which the State is responsible is included in the State aeronautical information publication in accordance with the *Procedures for Air Navigation Services – Aeronautical Information Management* (PANS-AIM, Doc 10066), Appendix 2, Section ENR 5.3.2;

f) information concerning the State's active or potentially active volcanoes are reflected within the Smithsonian GVP volcano list[7] and all State agencies responsible for issuing information on volcanic activity ensure their operational volcano lists are kept up-to-date; and

g) air traffic management (ATM) contingency arrangements in respect of volcanic ash are made and promulgated, as necessary, for air routes crossing FIRs for which the State is responsible, in coordination with adjacent FIRs.

4.1.2 States must promulgate a requirement for pilots to make and transmit a special aircraft observation, in accordance with Annex 3, 5.5 g) and h), in the event that pre-eruption volcanic activity or a volcanic eruption is observed or a cloud of volcanic ash is encountered or observed (including a cloud of re-suspended volcanic ash) which may affect the safety of other aircraft operations, and to record a special air-report in accordance with PANS-MET, 3.1.5.1. In addition, the International Air Transport Association (IATA), the International Federation of Air Line Pilots' Associations (IFALPA) and the International Council of Aircraft Owner and Pilot Associations (IAOPA) should bring this requirement to the attention of pilots and airline operating centres and highlight its significance for the IAVW and the importance of transmitting these observations in a timely manner.

Note.— Pre-eruption volcanic activity in this context means unusual and/or increasing volcanic activity which could presage a volcanic eruption.

4.1.3 It is essential that the foregoing arrangements be made in every State concerned and their efficacy continually maintained. In the case of volcanic ash, the hazard to jet transport aircraft is greatest within the first few hours following an eruption; hence speed of notification between all links in the chain of communication is critical. States may wish to consider drawing up letters of agreement between the parties involved, in particular, the civil aviation authority, the meteorological service provider and the SVO, to record the agreed responsibilities of each party.

4.1.4 Given the initial eruption phase is the most safety critical period, airlines and other users need accurate and timely pre-eruption activity information. Together with the use of risk-based principles, this information will assist operators by providing the opportunity to avoid airspace, which they assess to be at high risk. The pre-flight risk assessment of the available information will determine how an airline will select a route in the vicinity of a volcano in pre-flight planning, which is exhibiting signs of activity. Updates applicable to aircraft in flight will indicate to pilots if avoidance of such high-risk airspace is warranted. Ensuring the consistent receipt of an up-to-date VONA is integral to the successful execution of these safety-related actions.

4.1.5 In order to assist States in enhancing the coordination between the different States' authorities/agencies involved in the IAVW, a sample letter of agreement covering the coordination and responsibilities between meteorological service providers, air traffic service (ATS) authorities and SVOs for the provision and exchange of information relevant to volcanic ash is provided in Appendix A.

Note 1.— Consistent with the Sendai Framework for Disaster Risk Reduction 2015–2030 and its global target to "substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030", together with relevant principles such as integration and local, regional and global partnership approaches, States are urged to consider the above as part of an integrated suite of arrangements for other related volcanic hazards, such as ashfall on airports, populated areas and agricultural zones, shipping hazards, volcanic tsunami and rainfall that may induce dome collapse, lahar activity or slope failure.

7. State volcano observatories may contact the Smithsonian GVP to update any necessary volcano data. Contact details are available on the Smithsonian GVP website (see Part 3, 3.3).

Note 2.— Given the variation between States in capacity and the cross-border nature of the volcanic ash hazard, all States are encouraged to take note of arrangements in the surrounding regions, and where appropriate and invited, to assist in any reasonable manner. For volcanoes located on the border of two or more States, agreements between State volcano observatories should be made in order to coordinate efforts, with appropriate communication protocols in place.

4.2 ACTION TO BE TAKEN BY THE STATE VOLCANO OBSERVATORY PRIOR TO AND DURING A VOLCANIC ERUPTION

4.2.1 A State volcano observatory (SVO) is a volcano observatory designated by regional air navigation agreement to monitor active or potentially active volcanoes within a State, and to provide information on volcanic activity and/or volcanic ash in the atmosphere. The designated SVOs in each ICAO Region are listed in the relevant regional electronic air navigation plan (eANP), Volume I, Part V – Meteorology (MET), Table MET I-1, respectively.

Note.— Links to the eANP for each ICAO Region are provided in Appendix E.

4.2.2 SVOs should ensure, to the extent that is possible, that volcanoes within their area of responsibility are monitored by appropriate means. Ideally this includes in-situ geophysical networks (supplemented by other techniques) that provide the ability to detect unrest and to forecast eruptive activity. In areas where this is logistically difficult or impossible, regional geophysical networks (seismic, infrasound, lightning), along with satellite data, should be employed to detect and characterize eruptive activity. Monitoring activities by SVOs should be supported by appropriate State authorities, financial resources and quality management systems.

4.2.3 Prior to an eruption, an SVO should take the following actions:

a) work with their national aviation authority to ensure a common understanding of the State obligations in relation to the provision of volcanic activity information for aviation purposes, including arranging access to Annex 3 and PANS-MET;

b) develop and maintain an operational plan that outlines the roles, responsibilities and contact details of relevant agencies (including their associate VAAC);

c) develop a means for dissemination of information about volcanic activity including, if needed, working with their associated meteorological service, air navigation service provider or VAAC to disseminate VONA over the aeronautical fixed services (AFS); and

d) ensure the functionality of dissemination channels through routine issuance of information products and/or routine testing.

Note.— The map of VAAC areas of responsibility is shown in Part 2. A list of SVOs, ACCs/FICs, MWOs and FIRs is given in Part 5 (published separately).

4.2.4 In the event of significant changes in pre-eruption volcanic activity, a volcanic eruption or a significant change in eruptive activity, and/or observation of volcanic ash in the atmosphere, an SVO should take the following actions:

a) immediately forward the available information to its associated ACCs/FIC, MWO and VAAC by telephone, or other agreed communication platform, to inform them of the significant activity; and

b) follow up with the issuance of a Volcano Observatory Notice for Aviation (VONA), in accordance with the provisions contained within Annex 3 and PANS-MET.

Note 1.— The VONA has been developed for SVOs to disseminate critical, operationally relevant information about volcanic activity.

Note 2.— There is no standardized definition of 'significant' pre-eruptive activity, to prompt a change in the aviation colour code, due to the varying behaviour of volcanoes in their "normal, non-eruptive state". Instead SVOs are encouraged to develop their own criteria to determine what level of activity prompts a change in alert level based on their experience of the volcanic history and, where available, analogue volcanoes.

Note 3.— A State may wish to further strengthen coordination among the agencies involved in dissemination and exchange of information relevant to volcanic ash, including the issuance of VONA, by writing a letter of agreement between the civil aviation authority, meteorological service provider and the volcanological agency. A sample letter of agreement is provided in Appendix A.

Note 4.— Where capability exists, SVOs may include re-suspended ash in the context of 4.2.4 above.

4.2.5 Along with basic volcano information (name, identifying number and location), the VONA is a summary of volcanic activity and observations about ash emission (or lack thereof). The VONA is intended for aviation users and not scientists.

4.2.6 The VONA includes fields for the current and previous volcano level of alert colour codes for aviation, as described in Table 4-4. The aviation colour code level is determined by the SVO and explicitly addresses the condition of the referenced volcano, and not the dispersed volcanic ash cloud resulting from an eruption. Thus, the aviation colour code could be decreased after eruptive activity has ended, while a dispersed ash cloud remains a concern to aviation. The aviation colour codes help dispatchers, pilots and air traffic controllers to quickly ascertain the status of numerous volcanoes as they plan and execute flights over broad regions of the globe. The volcano level of alert colour codes for aviation are a key component of the global standardization of information provided by SVOs to aviation users.

4.2.7 Aviation colour code **GREEN** should only be issued for volcanoes that are monitored by an SVO using ground-based instrumentation that are sufficient to establish that a volcano is in a typical background level. For volcanoes where the background level cannot be determined, the aviation colour code level **UNASSIGNED** should be applied. Should pre-eruption or eruptive activity at an unmonitored volcano be detected by remote sensing, distant geophysical networks or eyewitness reports, the aviation colour code (**YELLOW**-**ORANGE**-**RED**) may be utilized. When activity decreases, the volcano goes back to **UNASSIGNED**, without going through **GREEN**.

4.2.8 VONA should be in abbreviated plain language, using, where possible, approved ICAO abbreviations and numerical values of self-explanatory nature, and should be in accordance with the template shown in Appendix E. When no approved ICAO abbreviations are available, English plain language text, kept to a minimum, should be used to describe elements for which the template allows the use of free text. Detailed explanations of the VNA elements are provided in Appendix E.

4.2.9 An SVO should issue a VONA under the following circumstances:

a) whenever there is a change in the aviation colour code; or

b) at least once every 24 hours whenever the aviation colour code is unchanged at red; or

c) at least once every seven days whenever the aviation colour code is unchanged at orange; or

d) at least twice per month whenever the aviation colour code is unchanged at yellow.

In addition, where SVO capability exists, a VONA may also be issued for episodes of observed re-suspended ash that could pose a hazard to aviation.

Note.— SVOs may also issue VONA when observing changes in activity, such as a change in the plume height or movement (even if no aviation colour code change prompted). If emissions are intermittent but regular, a new VONA does not need to be issued for each new emission.

4.2.10 Re-suspended volcanic ash will typically be due to (strong) surface winds that have allowed previously deposited volcanic ash to be lifted above ground level and carried (potentially for some distance) on the wind. A cloud of re-suspended volcanic ash may or may not be associated with an ongoing or recent eruption and, indeed, may be associated with an eruption that occurred at any point of time in the past. Because the assigned aviation colour code is based on volcanic activity, VONA issued for re-suspended ash only (due to meteorological conditions), should not include an increase in aviation colour code level. In some instances, it may not be possible to determine the source volcano of the volcanic ash that has been re-suspended. In this case, the VONA may list the volcano details as **UNKNOWN** and the aviation colour code as **UNASSIGNED**.

Note.— In the event that a re-suspended volcanic ash event coincides with elevated volcanic unrest or eruption, the VONA for that volcano should clearly describe both sets of information.

4.2.11 The use of the aviation colour code by an SVO does not preclude or replace the use of other established alert level schema for ground-based hazards. Although it is recommended that SVOs assign volcano level of alert colour codes for aviation, if they do not, a VONA may still be issued, inserting 'NIL' in the aviation colour code fields.

4.2.12 A VONA should be disseminated via aeronautical fixed services (AFS) to the SVO's associated ACCs/FICs, MWOs, VAACs, NOTAM office and, in accordance with regional air navigation agreement, international OPMET databanks. If an SVO does not have access to the AFS, it is recommended that it works with its associated meteorological office, air navigation service provider or VAAC to facilitate the delivery of the VONA on its behalf. VONA may also be disseminated using e-mail and may also be made available via a public website.

4.2.13 VONA should be issued in both traditional alphanumeric code and IWXXM code forms. Information on disseminating VONA via the AFS is provided in Appendix E. It is important to ensure the VONA template is used exactly – aviation systems rely on being able to correctly ingest information by computer systems and so VONA must be well formatted, when distributed via AFS.

4.2.14 In the case of a volcano being located on the border between two States, the relevant SVOs are encouraged to agree which SVO will issue VONA for that volcano, to ensure no conflicting information is promulgated.

4.2.15 In accordance with *ICAO's Policies on Charges for Airports and Air Navigation Services* (Doc 9082), the proportional costs associated with the provision of information from SVOs to their associated ACCs/FICs, MWOs and VAAC are subject to cost recovery. Guidance on cost recovery by SVOs is provided in Appendix G.

4.3 ACTION TO BE TAKEN BY THE ACC PRIOR TO AND DURING A VOLCANIC ERUPTION

In the event of significant pre-eruption volcanic activity, a volcanic eruption occurring or a volcanic ash cloud being reported (including a cloud of re-suspended volcanic ash) in areas which could affect routes used by international flights, the ACC/FIC responsible for the FIR concerned, on receiving information of the occurrence, should take the following actions:

a) Pass this information **immediately** to aircraft in flight which could be affected by the volcanic ash cloud and advise ACCs/FICs in relevant adjacent FIRs. Issue an ASHTAM or a NOTAM through the State International NOTAM Office (NOF), in accordance with the PANS-AIM (Doc 10066), giving details of the pre-eruption activity, volcanic eruption and ash cloud, including the name and geographical coordinates of the volcano, the date and time of the eruption, the flight levels and routes or portions of routes which could be affected and, as necessary, routes temporarily closed to air traffic. Include in the address list for ASHTAMs or NOTAMs concerning volcanic activity the associated MWO (see Part 2 of this document), all VAACs and the SADIS WIFS gateway at EGZZVANW.

*Note 1.— In issuing an ASHTAM or a NOTAM concerning significant pre-eruption volcanic activity, or for volcanic eruptions **not** producing ash plumes, it is recommended that the ASHTAM or NOTAM text include the following actual wording, as appropriate:*

"INCREASED VOLCANIC ACTIVITY REPORTED IN VONA FOR VOLCANO (NAME AND LAT/LONG) AIRCRAFT ADVISED TO EXERCISE CAUTION UNTIL FURTHER NOTICE AND MAINTAIN WATCH FOR ASHTAM/NOTAM/ SIGMET FOR AREA".

or

"VOLCANO (NAME AND LAT/LONG) ERUPTED (DATE/TIME UTC) BUT NO ASH PLUME REPORTED IN VONA, AIRCRAFT ADVISED TO AVOID FLYING WITHIN … KM OF THE VOLCANO UNTIL FURTHER NOTICE, MAINTAIN WATCH FOR ASHTAM/NOTAM/SIGMET FOR AREA".

Use of such language in an ASHTAM or a NOTAM ensures that large volumes of airspace are not rendered unavailable to aircraft unnecessarily until such time as a volcanic ash plume/cloud is actually reported, or observed from satellite data and, where available, ground-based and airborne data.

Note 2.— In order to ensure speedy transmission of initial information to aircraft, the first ASHTAM or NOTAM issued may simply contain information that an eruption and/or ash cloud has been reported and the date/time and location. It is not necessary to await further detailed information; this may be included in subsequent ASHTAMs or NOTAMs as it becomes available.

Note 3.— Volcano level of aviation colour codes should be used by SVOs to report volcanic activity information within the VONA (see 4.2.5). The reported aviation colour code should be included in ASHTAMs or NOTAMs issued for volcanic activity.

b) Activate contingency arrangements, including the implementation of alternative routes bypassing the area likely to be affected by the volcanic ash cloud, in coordination with ACCs/FICs responsible for adjacent FIRs.

c) Advise the associated MWO(s) and VAAC of the volcanic eruption and/or the existence of volcanic ash cloud (including the forwarding of all special air-reports in accordance with existing provisions in Annex 11, 4.2.3) and maintain continuous coordination with the MWO to ensure consistency in the issuance and content of ASHTAMs or NOTAMs and SIGMETs.

d) Cancel the ASHTAM or NOTAM as soon as it is considered that the volcano has reverted to its normal state and the airspace is not contaminated by volcanic ash.

4.4 ACTION TO BE TAKEN BY THE NOF PRIOR TO AND DURING A VOLCANIC ERUPTION

4.4.1 In the event of significant pre-eruption volcanic activity, a volcanic eruption occurring or a volcanic ash cloud being reported (including a cloud of re-suspended volcanic ash) in areas which could affect airspace in the FIRs of the State in which the NOTAM Office (NOF) is designated, the NOF should issue an ASHTAM (or a NOTAM for volcanic activity) based on information provided by the SVO, MWO and/or VAAC, along with the ACC responsible for the FIR concerned. The ASHTAM or NOTAM must be cancelled, in consultation with the ACC, as soon as it is considered that the airspace is not contaminated by volcanic ash. Include in the address list for ASHTAM or NOTAM concerning volcanic activity the associated MWO (see Part 2 of this document), all VAACs and the appropriate regional OPMET Centre (ROC) or Inter-regional OPMET Gateway (IROG).

4.4.2 In addition to addressing the ASHTAM (or NOTAM) to other NOFs for whom the information is of direct operational significance, the NOF should include in the address list the VAAC responsible for the FIRs concerned. The States responsible for FIRs in which there are active volcanoes and the AFTN switching centres designated to receive NOTAM or ASHTAM are listed in Table 4-1.

As an example, an ASHTAM issued by the Tegucigalpa NOF would be sent to VAAC Washington as follows:

ZCZC
GG KWBCYMYX
170630 MHTGYNYX
VAMH0001 MHTG 04170630

ASHTAM

A. CENTRAL AMERICAN FIR
B. 04170555
C. VOLCAN SAN CRISTOBAL.14004-02
D. 124211N0870024W
E. YELLOW ALERT
F. SFC/11000FT
G. E/SE
H. VOR/DME MGA A317 TUKOR CNL
I. VOR/DME MGA A317 TUKOR RTE AVBL. ALT RTE
MGA VOR/DME A502 BERTA GABOS A317.
VOR/DME/CAT/ABVL
J. INSTITUTO NACIONAL DE ESTUDIOS TERRITORIALES. DPTO. DE SISMOLOGÍA
K. GNE AVIATION CTN WIND 60KM/H E/SE FM VOLCANO

NNNN

A similar example, this time showing a NOTAM issued by Guayaquil NOF, would be sent to VAAC Washington as follows, showing the three sections of the message:

1	ZCZC GG KWBCYMYX 151840 SEGUYNYX	USUAL AFTN HEADER ENVELOPE

2 A0623/00 NOTAMN — ACTUAL NOTAM
Q) SEGU/QWWXX/IV/NBO/W/000
/250/0128S 07826W030
A) SEGU
B) 0002151830
C) 0002171830
E) SIGNIFICANT VOLCANIC ACT
TUNGURAHUA VA MOV W.
AWY RESTRICTIONS AND ALT
RTE NOTIFIED BY ATC

3 NNNN — USUAL AFTN ENDING ENVELOPE

4.4.3 In case of a need to issue a NOTAM regarding volcanic ash deposition at an aerodrome, the following guidelines are suggested:

a) in cases when a forecast of impending ash deposition is available, a NOTAM should be issued stating the time period when ash is expected to commence at an aerodrome;

b) a NOTAM should be issued when ash reaches an aerodrome or begins to accumulate on the ground at an aerodrome. The NOTAM should report if the aerodrome is still open for operation;

c) a new NOTAM should be issued every 4 hours while deposition is occurring or present in the air at the aerodrome, or more frequently as needed for occurrence of heavy ash deposition. If a friction test of runway surfaces has been made with a mu-meter, that value and the time it was made should be reported; and

d) a final NOTAM should be issued when clean-up activities are completed and operations have resumed.

4.4.4 Since volcanic ash deposition at an aerodrome is a phenomenon which could prompt the issuance of an aerodrome warning, close coordination is recommended between each NOF and the aerodrome meteorological office(s) in its area of responsibility concerning the issuance of such warnings.

4.5 ACTION TO BE TAKEN BY THE MWO PRIOR TO AND DURING A VOLCANIC ERUPTION

4.5.1 On receipt from the ACC/FIC of information concerning a volcanic eruption and/or the existence of a volcanic ash cloud (including a cloud of re-suspended volcanic ash), the MWO should take the following steps:

a) notify the VAAC designated to provide volcanic ash information for the FIR for which the State is responsible that a volcanic eruption and/or ash cloud has been reported, provide available relevant details and request advisory information on observed and forecast areas of volcanic ash. In particular, special air-reports of pre-eruption volcanic activity, a volcanic eruption, volcanic ash cloud or aircraft encounter with volcanic ash received by MWOs should be transmitted to their associated ROC or IROG, and the appropriate VAACs.

Note 1.— The area of responsibility of the VAACs and the MWOs to which volcanic ash advisory information is to be sent are given in the ICAO regional air navigation plans and in Part 2 of this document. Where there is a difference, defer to the regional air navigation plan.

Note 2.— The contact numbers that the MWOs should use to notify volcanic eruptions/volcanic ash cloud to the VAAC are given in Table 4-2.

b) as soon as practicable, advise the associated ACC/FIC whether or not the volcanic ash cloud is identifiable from satellite images/data and, if possible,

c) provide regular information based on advice received from the VAAC on the horizontal and vertical extent of the cloud and the movement of the cloud; and

d) issue a SIGMET information for volcanic ash for a validity period of 6 hours in alphanumeric format and send it to the appropriate ACC/FIC and the appropriate ROC or IROG and, if in a position to do so, in graphical format based on the advisory information. Update SIGMET information at least every 6 hours while the volcanic ash cloud persists. Maintain continuous coordination with the associated VAAC and ACC/FIC to ensure consistency in the issuance and content of VAAs, SIGMETs, and ASHTAMs or NOTAMs.

Note 1.— In order to ensure speedy transmission of initial information to aircraft, the first SIGMET issued may simply contain information that an eruption has occurred and/or that an ash cloud has been reported and the date/time and location. It is not necessary to await further detailed information before issuing the first SIGMET. Such information may be included in subsequent SIGMETs as it becomes available.

Note 2.— A cloud of re-suspended volcanic ash is to be reported in a SIGMET information in exactly the same way as for a volcanic ash cloud, that is, using the abbreviation VA CLD and associated elements.

Note 3.— A MWO, in the position to do so, may use quantitative volcanic ash concentration information (QVA) issued by the associated VAAC to generate their volcanic ash SIGMET. Otherwise, the volcanic ash SIGMET should be based on the volcanic ash advisory to ensure consistency.

4.5.2 In the event that the MWO becomes aware of the occurrence of pre-eruption activity, a volcanic eruption or ash cloud from any source other than its associated ACC/FIC, that information should be passed **immediately** to the associated ACC/FIC. The procedures in 4.5.1 should then be followed, as necessary.

4.5.3 In the event that a meteorological office becomes aware of the occurrence of pre-eruption activity, a volcanic eruption or ash cloud from any source, the information should be passed **immediately** to its associated MWO for onward transmission to the ACC/FIC, and to the meteorological office's associated SVO and VAAC.

4.6 ACTION TO BE TAKEN BY VAACs IN THE EVENT OF A VOLCANIC ERUPTION

4.6.1 Upon detection of a volcanic eruption or a volcanic ash cloud or upon receipt of information from an ACC, MWO, SVO or any other source[8] that a volcanic eruption has been reported and/or a volcanic ash cloud has been observed (including a cloud of re-suspended volcanic ash) in the FIR for which the MWO is responsible, the VAAC should:

8. When initial notification of the eruption is received from a source other than an ACC/MWO, this information should be passed immediately by telephone to the relevant ACC and/or MWO. Thereafter, the procedures in a) to h) should be followed.

a) review satellite images/data of the area for the time of the event to ascertain whether a volcanic ash cloud is identifiable and, if so, its extent, as well as any other observations that may be available (VONA, pilot report, etc)[9];

b) if necessary, initiate the volcanic ash dispersion model in order to provide advisory information[10] on volcanic ash to the MWOs, ACCs and, to the extent possible, to the operators concerned;

Note.— To provide rapid access to eruption source parameters data for immediate use by forecasters in ash dispersion models, a database of eruption source parameters for volcanoes of the world is available at the British Geological Survey website provided in Part 3, 3.3 of this document.

c) prepare and issue advisory information on the observed and forecast areas of volcanic ash cloud in:

1) alphanumeric format, using abbreviated plain language;

2) digital ICAO meteorological information exchange model (IWXXM)[11]

3) graphical format[12] (using the PNG format) for transmission to the MWOs, ACCs/FICs and, to the extent possible, the operators concerned in the VAAC area of responsibility, and also to WAFC London and WAFC Washington.

The volcanic ash advisory information should contain the information contained in the PANS-MET template for advisory information on volcanic ash (Table A7.2). Additionally, if the advisory is being issued as a back-up volcanic ash advisory then the VAAC area should be used**Error! Bookmark not defined.** and a comment shall be added in the RMK section to notify users that the volcanic ash advisory for a volcano has been issued by the back-up VAAC. The agreed remark is 'Issued by VAAC nnnnn on behalf of VAAC nnnnn".

Note.— When issuing volcanic ash advisory information for a cloud of re-suspended volcanic ash, the components listed at 4.6.2 should be used by a VAAC in place of some of the components listed above.

In order for the VAAC to initiate the monitoring of volcanic ash from satellite data and the forecast of volcanic ash information, MWOs are expected to notify the relevant VAAC immediately on receipt of information that a volcanic eruption has occurred or volcanic ash has been observed in the FIR for which they are responsible in accordance with 4.5.1 a). In particular, any special air-reports of pre-eruption volcanic activity, a volcanic eruption or volcanic ash cloud, received by MWOs, should be transmitted without delay to the associated VAAC and to other addresses in accordance with 4.5.1 a);

d) if the volcanic ash cloud is considered significant (as indicated in 4.6.2), prepare and issue quantitative volcanic ash concentration information (QVA)[13] in gridded and IWXXM format. VAACs may also provide supplemental QVA graphics in accordance with Table 4.5;

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9 A VAAC may receive conflicting information related to a volcanic eruption and so must consider the strength of each piece of evidence to determine the most appropriate course of action.

10. On some occasions, the volcanic ash advisory could be the first information received by ACC/FIC concerning hazardous conditions which may be encountered by an aircraft in flight. The VAAC has the option to issue a volcanic ash advisory without forecast as a first piece of information to quickly warn the ACC/FIC. The first advisory will, as soon as possible, be followed by a volcanic ash advisory with complete forecast information included.

11. Digital IWXXM volcanic advisory information is accompanied by the appropriate metadata. The technical specifications for IWXXM are contained in the *Manual on Codes* (WMO-No. 306), Volume I.3, *Part D – Representation Derived from Data Models*. Guidance on the implementation of IWXXM is provided in the *Manual on the ICAO Meteorological Information Exchange Model* (Doc 10003).

12. Volcanic ash advisories in graphical format will be included on the WAFC London and WAFC Washington aeronautical fixed service Internet-based services. An example of the graphical format is given in Annex 3, Appendix 1.

13 Recommended for VAACs in a position to do so and recommended for all VAACs from November 2026. VAACs in a position to do so are indicated in Table 4-5.

e) monitor subsequent satellite information to assist in tracking the movement of volcanic ash cloud;

f) continue to issue updated advisory information to MWOs, ACCs/FICs and operators concerned, along with QVA information for significant volcanic ash clouds, as necessary. Volcanic ash information should be issued at a minimum of 6-hour intervals, until such time as it is considered that the volcanic ash cloud is no longer identifiable from observations, no further reports of volcanic ash are received from the area and no further eruptions of the volcano are reported;

Note 1.— If volcanic ash is not identifiable from satellite data, but is reported via ground-based and/or airborne observations, the VAAC should issue a volcanic ash advisory with estimated observed and forecast volcanic ash areas, based on ash dispersion models and observations, indicating the increased uncertainty in the REMARKS section of the volcanic ash advisory.

Note 2.— If volcanic ash has been identified from observations but is determined to be at the very low concentration threshold, or the observation data is of poor quality, or the size of the ash cloud is less than the model data resolution, then a VAA may be issued but QVA information may not be.

g) maintain regular contact with other VAACs. In the specific case of reception of information regarding an aircraft encounter with volcanic ash (PANS-MET, 3.1.5.1 refers), the information should be sent to the Smithsonian Institution Global Volcanism Program and to ICAO in order to keep up-to-date the database for encounters between aircraft ash clouds (Doc 9691, Appendix F refers). To that end the following e-mail address should be used: gvp@si.edu.

h) undertake a collaborative decision analysis and forecasting process when volcanic ash is approaching an adjacent VAAC's area of responsibility;

Note.— Collaborative decision analysis and forecasting procedures are described in 4.10.

i) in cases where a volcanic ash cloud is expected to approach within 300 NM of the boundary of another VAAC area of responsibility, the first (primary) VAAC will initiate the operational procedures for the coordination and may request transfer of responsibility between VAACs for volcanic ash events; and

Note 1.— Standardized operational procedures for the coordination and transfer of responsibility between VAACs for volcanic ash events are provided in Appendix C.

Note 2.— To facilitate VAACs' rapid access to volcanic ash advisories issued by other VAACs, Table 4-3 provides a listing of the WMO bulletin headers, for each product (volcanic ash in the advisory in the alphanumeric and graphical format, respectively) being used by the VAACs.

j) in the event of long-lived volcanic ash clouds no longer being identifiable on satellite imagery, and, where available ground-based and airborne data, for the VAA, use the method of "gradual" advisory cessation by extrapolating forecast ash boundaries such that the previous 6-, 12- and 18-hour forecasts become the current analysis position in 6-and 12-hour forecasts respectively, with no ash boundary specified for the 18-hour forecast.

Note.— The above procedure (which is reducing the outlook period of 6 hours at each issue) should be applied unless remote sensing data or air-reports suggest there has been an error in the forecasts issued.

4.6.2 For a volcanic ash cloud to be deemed significant, and so prompting the provision of QVA, a VAAC will consider the following points (subject to VAAC assessment and workload):

- whether the volcanic ash cloud is impacting an international airport or a busy domestic airport;
- whether the volcanic ash cloud is being transported a long way from the volcano and so impacting air routes;
- whether there is a user request for QVA issuance; and
- whether the volcanic ash cloud concentration is greater than 0.2 mg/m^3.

Note 1.— As the QVA service provision matures, it is expected that the guidance for assessing whether an ash cloud is significant will be refined.

Note 2.— QVA in gridded and IWXXM form may be accessed directly from the issuing VAAC, with information provided in Table 4-5 Quantitative Volcanic Ash Concentration Information Provision

4.6.3 Where there is a cloud of re-suspended volcanic ash for which there is no eruption and the source volcano is either unknown or known, the VAACs should use the following components in the volcanic ash advisory:

	Source volcano unknown	*Source volcano known*
Name of volcano and volcano reference number	Unknown	Volcano name (if known) and IAVCEI[14] number (as per Smithsonian Global Volcanism Program)
Location of the volcano	Unknown	Latitude/longitude of volcano
State or region in which the volcano is located	Unknown	Name of State or region
Summit elevation	Unknown	Height of the summit of the ash source being re-suspended
Details of the eruption	NO ERUPTION – RE-SUSPENDED VA	NO ERUPTION – RE-SUSPENDED VA
Remark	RE-SUSPENDED VA […]	RE-SUSPENDED VA […]

Note.— It may be more appropriate to use "Unknown" in some fields, when the volcano details may be significantly different from the volcanic ash field being re-suspended.

4.6.4 In the event of interruption of operation of one VAAC, its functions should be carried out by another VAAC, with bulletin headers used as outlined in Table 4-3. The back-up procedures agreed by the VAACs given in Appendix D should be applied in order to provide the VAAC services as needed.

4.6.5 Following a significant volcanic ash event, VAACs are encouraged to engage with their users and other stakeholders to review events with the aim of finding any opportunities for improvement as well as examples of what worked well. Reports containing this information should then be shared between VAACs to promote continuous improvement. Guidance on developing such reports is contained in 4.11.

[14] International Association of Volcanology and Chemistry of the Earth's Interior

4.7 ACTION TO BE TAKEN BY OPERATORS IN THE EVENT OF A VOLCANIC ERUPTION

In the event of an eruption, operators should request their pilots to report, when appropriate, any observation related to a volcanic ash cloud including the absence of visible ash and all other relevant information such as observational conditions. The operators should then forward this information to the associated VAAC in a timely manner, using the volcanic activity form (VAR), as contained in *Procedures for Air Navigation Services – Air Traffic Management* (PANS ATM, Doc 4444). Refer to section 4.9.6 for further information on using the VAR template.

Note.— Visible ash is defined in the Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds *(Doc 9691).*

4.8 ACTION TO BE TAKEN BY VAACs, MWOs AND SVOs REGARDING VOLCANIC ASH TEST PROCEDURES

When a volcanic ash test or exercise is carried out to check the IAVW procedures, a status indicator of either TEST or EXER shall be used, in accordance with the templates for the volcanic ash advisory information (PANS-MET, Table A7-2 refers), SIGMET information (PANS-MET, Table A7-5 refers) and VONA information (PANS-MET, Table A7-1A refers). In the volcanic ash advisory and VONA, further information on the name of the test or exercise may be provided in the RMK section.

4.9 GUIDANCE TO PILOTS ON THE DETECTION OF SULPHUROUS GASES ON THE FLIGHT DECK

4.9.1 The following paragraphs provide explanatory material and guidance about recommended actions to be taken by flight crew in the event of smelling sulphur gases during flight, with the understanding that the guidance constitutes examples and does not necessarily cover all practices being applied by operators.

4.9.2 Volcanic eruptions emit various gases along with magma, including sulphur dioxide (SO_2) and hydrogen sulphide (H_2S). Volcanoes are the only sources of large quantities of sulphur gases at cruise altitudes, and both SO_2 and H_2S are detectable by smell. Thus, the smell of sulphur gases in the cockpit may indicate volcanic activity that has not yet been detected or reported and/or possible entry into an ash-bearing cloud. In some cases when sulphur gases are smelled, there may be little ash in the cloud owing to ash fallout during prior dispersion of the cloud or due to ash and SO_2 clouds having separated due to being ejected - or moving to - different altitudes. However, flight crew do not have the means to determine directly that the cloud is non-hazardous and thus should seek to exit the cloud.

4.9.3 SO_2 is identifiable as the sharp, acrid odour of a freshly struck match. H_2S, also known as sewer gas, has the odour of rotten eggs. Sulphur gases may be detectable only for a short period of time because of "olfactory fatigue" (temporary loss of the ability to smell a particular odour).

4.9.4 Inhalation of SO_2, even at low concentrations (<5 ppm), can cause respiratory tract irritation especially in people with asthma and chronic obstructive pulmonary disease. When SO_2 gas combines with water in the atmosphere, a sulphate aerosol primarily composed of dilute sulphuric acid is formed. Flying through sulphuric acid aerosols has caused crazing of acrylic windows, fading of exterior paint and accumulation of sulphate deposits in engines. SO_2 gas is colourless, but under certain conditions of reflection and refraction of sunlight, a sulphuric acid aerosol may be a visible atmospheric feature, such as a layer of haze of variable colour (brownish, yellowish, bluish, or whitish). Ash particles likely will be present in aerosol haze but possibly in minor or trace amounts.

4.9.5 Electrical smoke and fire" and SO_2 are two odours described as somewhat similar. After determining there are no secondary indications that would result from and indicate an electrical fire, the flight crew must establish whether the sulphur odour is transient or not. This is best achieved by flight crew donning oxygen mask(s) and breathing 100% oxygen for the period of time that results in a complete change of air within the cockpit and also allows the sense of smell to be regained. After the appropriate time period, the flight crew should remove the oxygen mask and determine if the odour is still present.

4.9.6 If the flight crew affirms the continued presence of sulphur gas, the controlling area control centre and airline operation centres must be informed as soon as practicable to request information about any relevant volcanic activity and the whereabouts of possible volcanic clouds. It is recommended that the reporting pilot use the volcanic activity form (VAR), section 1, items 1-8, which is a special air-report. Upon landing, the flight crew should complete VAR (items 9-16, which is the post-flight report) and submit it to the associated VAAC, or, if not known, to VAAC Darwin.

4.10 GUIDANCE FOR CONDUCTING VOLCANIC ASH EXERCISES IN ICAO REGIONS

To facilitate the conduct of volcanic ash exercises intended to develop and practice the response to volcanic activity in the various ICAO regions, Appendix F provides appropriate guidance to be followed by States and stakeholders involved.

4.11 GUIDANCE FOR CONDUCTING POST EVENT REVIEWS

4.11.1 VAACs should conduct a post event review of any major eruption that had significant impact to aviation operations or multi-VAAC responses to an eruption. The post event reports should provide a detailed assessment of a significant volcanic eruption, including a review of operational procedures, analysis, dispersion modelling, forecasting and services.

4.11.2 The benefit of conducting a post event report is to review the service provided and consider any areas for improvement or recommendations that could be posed to the IAVW work stream, the VAACs or aviation stakeholders as considerations for best practice.

4.11.3 When preparing a post event report, consider who the target audience is for the report, as this will help tailor the information to meet user requirements. Some information may be for internal consumption while other information may be aimed at a wider audience.

4.11.4 Major eruptions can occur at any time with little to no warning. VAACs should ensure they have a process in place to archive or capture information and data, and log the decisions or actions taken during the major eruption so that the post event report can be compiled in the months following the event.

4.11.5 To aid with the composition of a post event report for a major event, it is advised that the VAACs should have a template to support staff compiling the necessary fields for each report. As guidance for the VAACs, some general topics to include in a post event report could be:

a) version control to show the review process;

b) eruption summary, consisting of a brief description of the eruption including some volcanological history of the volcano, recent behaviour, eruption time/type/height/duration, and anything else that is useful to the event;

c) timeline of events, involving a comprehensive recount of the sequence of events that occurred during the event. Where possible, it could include:

   1) the times of significant changes in volcano behaviour;
   2) eruption start time;
   3) times of key decision or analysis points made;
   4) volcanic ash advisories issued;
   5) when the eruption was determined as significant and QVA began;
   6) observations received;
   7) engagement with other VAACs;
   8) ash cloud handover;
   9) phone calls; and
   10) engagement with aviation industry.

d) observations and analysis, containing relevant satellite data, NWP, ash dispersion output, analysis and forecasting, ground reports, social media posts, pilot reports, collaboration communication, and ash dispersion comparisons;

e) areas for review, indicating where issues were encountered, uncertainties in processes or how improvements could be made. This could include issues involving technical systems, communication, products and data (VAA/VAG, QVA), tools, policy concerns and missing guidance; and

f) recommendations, outlining the lessons learned and any recommendations to provide to internal staff, VAACs, and the IAVW work stream to prompt service improvements, considerations, or requests for clarifications.

4.11.6 Once completed, the post event report (or a summary thereof) should be shared with internal staff to support knowledge transfer or training, the VAACs to share lessons learned, the IAVW work stream, as appropriate, to discuss procedures or changes, and with aviation stakeholders during industry engagement meetings or forums.

TABLES

Table 4-1. Addresses for NOFs to use to send ASHTAMs or NOTAMs on volcanic activity to their associated VAAC
(*4.4.2 refers)*

Argentina	– sent to SAZZMAMX
Cabo Verde	– sent to LFPWYMYX
Cameroon	– sent to LFPWYMYX
Canada	– sent to CWAOYMYU
Chile	– sent to SAZZMAMX
China	– sent to RJTDYMYX
Colombia	– sent to KWBCYMYX
Comoros	– sent to LFPWYMYX
Congo	– sent to LFPWYMYX
Costa Rica	– sent to KWBCYMYX

Ecuador	– sent to KWBCYMYX
El Salvador	– sent to KWBCYMYX
Eritrea	– sent to LFPWYMYX
Ethiopia	– sent to LFPWYMYX
France (Île de la Réunion)	– sent to LFPWYMYX
French Antilles (France)	– sent to KWBCYMYX
Greece	– sent to LFPWYMYX
Guatemala	– sent to KWBCYMYX
Guyana	– sent to KWBCYMYX
Iceland	– sent to EGRRYMYX
Indonesia	– sent to YMMCYMYX
Italy	– sent to LFPWYMYX
Japan	– sent to RJTDYMYX
Kenya	– sent to LFPWYMYX
Mexico	– sent to KWBCYMYX
Montserrat (United Kingdom)	– sent to KWBCYMYX
New Zealand	– sent to NZKLYMYX

Nicaragua – sent to KWBCYMYX

Papua New Guinea – sent to YMMCYMYX

Peru – sent to KWBCYMYX SAZZMAMX

Philippines – sent to RJTDYMYX YMMCYMYX

Portugal – sent to LFPWYMYX

Russian Federation – sent to KWBCYMYX RJTDYMYX

Solomon Islands – sent to NZKLYMYX YMMCYMYX

Spain – sent to LFPWYMYX

Trinidad and Tobago – sent to KWBCYMYX

Vanuatu – sent to NZKLYMYX

Table 4-2. VAAC contact numbers

(4.5.1 a) refers)

Note.— Telephone numbers should always be used first. E mail addresses and fax numbers are provided as back-up.

VAAC Anchorage

Tel:	Operational	+1 (907) 266-5110
	Administrative	+1 (907) 266-5116
AFTN:		via KWBCYMYX
E-mail:	Operational	a-vaac@noaa.gov
	Administrative	albert.pietrycha@noaa.gov nathan.eckstein@noaa.gov
Homepage:		https://www.weather.gov/vaac https://www.weather.gov/aawu

VAAC Buenos Aires

Tel:	Operational	+(54 11) 5197 5391 +(54 11) 5167 6767, Ext. 18913 +(54 11) 5167 6767, Ext. 18821
	Administrative	+(54 11) 5167 6767, Ext. 18905
Tel:		+(54 11) 5167 6767, Ext. 18838/39 +(54 11) 5167 6707 +(54 11) 5197 5391
AFTN:		SAZZMAMX
E-mail:	Operational	bue.vaac@smn.gob.ar
	Administrative	jadiaz@smn.gob.ar cribero@smn.gob.ar
Homepage:		https://ssl.smn.gob.ar/vaac/buenosaires/inicio.php?lang=es https://ssl.smn.gob.ar/vaac/buenosaires/inicio.php?lang=en

VAAC Darwin

Tel:	Operational	+61 (3) 9910 1721 +61 (3) 9910 1720
	Administrative	+61 (3) 9669 4973
AFTN:		YMMCYMYX
E-mail:	Operational	darwin.vaac@bom.gov.au
	Administrative	darwin.vaac.admin@bom.gov.au
Homepage:		http://www.bom.gov.au/aviation/volcanic-ash/

VAAC London

Tel:	Operational	+44 330 135 4267 +44 330 135 4271 or +44 1392 44 7947 (emergency line)
AFTN:		EGZZVANW
E-mail:	Operational	vaac@metoffice.gov.uk
	Administrative	mark.seltzer@metoffice.gov.uk
Homepage:		https://www.metoffice.gov.uk/services/transport/aviation/regulated/international-aviation/vaac/index

VAAC Montreal

Tel:	Operational	+1 (514) 421 4635
Fax:	Operational	+1 (514) 421 4639
AFTN:		CWAOYMYU
E-mail:	Operational	vaac@ec.gc.ca
	Administrative	dov.bensimon@ec.gc.ca gabriel.servranckx@ec.gc.ca
Homepage:		http://meteo.gc.ca/eer/vaac/index_e.html

VAAC Tokyo

Tel:	Operational	+81 (3) 3434 9120
	Administrative	+81 (3) 3434 9119
Fax:	Operational	+81 (3) 3434 9121
AFTN:		RJTDYMYX
E-mail:	Operational	vaac.tokyo@volash.kishou.go.jp vaac.tokyo@jma.go.jp
	Administrative	vaac.tokyo-adm@volash.kishou.go.jp
Homepage:		https://www.data.jma.go.jp/vaac/data/index.html

VAAC Toulouse

Tel:	Operational	+33 (0) 5 61 07 82 30 or +33 (0) 5 61 07 85 10
	Administrative	+33 (0) 5 61 07 82 39 or +33 (0) 5 61 07 82 37
AFTN:		LFPWYMYX or LFPWYMCR
E-mail:	Operational	vaac@meteo.fr
	Administrative	sarah.puginier@meteo.fr
Homepage:		http://vaac.meteo.fr/

VAAC Washington

Tel:	Operational	+1 (301) 683 1401
	Administrative	+1 (301) 683 1400
Fax:		+1 (301) 683 1405
AFTN:		KWBCYMYX
E-mail:	Operational	w-vaac@noaa.gov
	Administrative	jamie.kibler@noaa.gov
Homepage:		https://www.ospo.noaa.gov/Products/atmosphere/vaac/index.html https://www.ospo.noaa.gov/Products/atmosphere/vaac/messages.html

VAAC Wellington

Tel:	Operational	+64 4 470 0808
	Administrative	+64 27 2512 259
AFTN:		NZKLYMYX
E-mail:	Operational	vaac@metservice.com
	Administrative	aviation.manager@metservice.com
Homepage:		http://vaac.metservice.com

Table 4-3. Volcanic ash advisory bulletin headers
(4.6.1 h), Note 2 refers)

VAAC	Back-up VAAC	Bulletin Headers			Remarks
		VAA	VAA (IWXXM)	VAG	
Anchorage		FVAK21 PAWU FVAK22 PAWU FVAK23 PAWU FVAK24 PAWU FVAK25 PAWU	LUAK21 PAWU LUAK22 PAWU LUAK23 PAWU LUAK24 PAWU LUAK25 PAWU	PFXD21 PAWU PFXD22 PAWU PFXD23 PAWU PFXD24 PAWU PFXD25 PAWU	
	Washington	As above	As above	As above	
Buenos Aires		FVAG01 SABM FVAG02 SABM FVAG03 SABM FVAG04 SABM FVAG05 SABM	LUAG01 SABM LUAG02 SABM LUAG03 SABM LUAG04 SABM LUAG05 SABM	PFXD01 SABM PFXD02 SABM PFXD03 SABM PFXD04 SABM PFXD05 SABM	
	Washington	As above	As above	As above	
Darwin		FVAU01 ADRM FVAU02 ADRM FVAU03 ADRM FVAU04 ADRM FVAU05 ADRM FVAU06 ADRM FVAU07 ADRM FVAU08 ADRM FVAU09 ADRM FVAU10 ADRM	LUAU01 ADRM LUAU02 ADRM LUAU03 ADRM LUAU04 ADRM LUAU05 ADRM LUAU06 ADRM LUAU07 ADRM LUAU08 ADRM LUAU09 ADRM LUAU10 ADRM	PFXD01 ADRM PFXD02 ADRM PFXD03 ADRM PFXD04 ADRM PFXD05 ADRM PFXD06 ADRM PFXD07 ADRM PFXD08 ADRM PFXD09 ADRM PFXD10 ADRM	
	Tokyo	As above	As above	As above	
	Wellington	FVAU01 ADRM FVAU02 ADRM FVAU03 ADRM FVAU04 ADRM FVAU05 ADRM FVAU06 ADRM			
London		FVXX01 EGRR FVXX02 EGRR	LUXX01 EGRR LUXX02 EGRR	PFXD01 EGRR PFXD02 EGRR	
	Toulouse	FVXX05 LFPW		PFXD05 LFPW	
Montreal		FVCN01 CWAO FVCN02 CWAO	LUCN01 CWAO LUCN02 CWAO	PFXD01 CWAO PFXD02 CWAO	
	Washington	FVCN03 CWAO FVCN04 CWAO	LUCN03 CWAO LUCN04 CWAO	PFXD03 CWAO PFXD04 CWAO	
Tokyo		FVFE01 RJTD	LUFE01 RJTD	PFXD01 RJTD	
	Darwin	As above	As above		

VAAC	Back-up VAAC	Bulletin Headers			Remarks
		VAA	**VAA (IWXXM)**	**VAG**	
Toulouse		FVXX01 LFPW FVXX02 LFPW FVXX03 LFPW FVXX04 LFPW	LUXX01 LFPW LUXX02 LFPW LUXX03 LFPW LUXX04 LFPW	PFXD01 LFPW PFXD02 LFPW PFXD03 LFPW PFXD04 LFPW PFXD06 LFPW PFXD07 LFPW PFXD08 LFPW PFXD09 LFPW	PFXD[01-04] LFPW : T4 format PFXD[06-09] LFPW : png format Where PFXDnn and PFXDnn+5 are the same VAG in T4 and png.
	London	FVXX05 LFPW	LUXX05 LFPW	PFXD05 LFPW	PFDX05 EGRR : png format
Washington		FVXX20 KNES FVXX21 KNES FVXX22 KNES FVXX23 KNES FVXX24 KNES FVXX25 KNES FVXX26 KNES FVXX27 KNES	LUXX20 KNES LUXX21 KNES LUXX22 KNES LUXX23 KNES LUXX24 KNES LUXX25 KNES LUXX26 KNES LUXX27 KNES	PFXD20 KNES PFXD21 KNES PFXD22 KNES PFXD23 KNES PFXD24 KNES PFXD25 KNES PFXD26 KNES PFXD27 KNES	
	Darwin	As above	As above	As above	The Darwin and Montreal VAACs will share Washington VAAC headers. Coordination will take place during back up on what headers to use for each erupting volcano.
	Montreal	As above	As above	As above	
Wellington		FVPS01 NZKL FVPS02 NZKL FVPS03 NZKL FVPS04 NZKL FVPS05 NZKL	LUPS01 NZKL LUPS02 NZKL LUPS03 NZKL LUPS04 NZKL LUPS05 NZKL	PFXD01 NZKL PFXD02 NZKL PFXD03 NZKL PFXD04 NZKL PFXD05 NZKL	(png format) [relates to the 5 VAG bulletins]
	Darwin	As above	As above	As above	

Table 4-4. Volcano aviation colour codes
(4.2.5 refers)

Level of alert	Status of activity of volcano
GREEN	Volcano is in normal, non-eruptive state. *or, after a change from a higher alert level*: Volcanic activity considered to have ceased, and volcano reverted to its normal, non-eruptive state.
YELLOW	Volcano is experiencing signs of elevated unrest above known background levels. *or, after a change from a higher alert level*: Volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
ORANGE	Volcano is exhibiting heightened unrest with increased likelihood of eruption. *or* Volcanic eruption is underway with no or minor ash emission. *[specify ash-plume height if possible].*
RED	Eruption is forecast to be imminent with significant emission of ash into the atmosphere likely. *or* Eruption is underway with significant emission of ash into the atmosphere *[specify ash-plume height if possible]*.
UNASSIGNED	There is insufficient information available to assess the current status of the volcano or volcanic activity.

Note 1.— The aviation colour code applies only to current volcanic activity associated with a volcano and does not apply to re-suspended volcanic ash.

Note 2.— Due to the varying impacts of volcanic ash emissions on aviation (relating to concentration, altitude, proximity to aviation activities), there is no standardized definition of 'significant ash emissions' for prompting a change to/from aviation colour code RED. Instead, SVOs are encouraged to develop their own criteria to determine what level of activity prompts a change in colour code based on their experience of the volcanic history and related hazards and impacts to aviation.

Table 4-5. Quantitative Volcanic Ash Concentration Information (QVA) Provision
(4.6.1d) and 4.6.2 footnotes refer)

VAAC	QVA Provision	Access Details
Anchorage	TBD	TBD
Buenos Aires	TBD	TBD
Darwin	TBD	TBD
London	Yes, operational 27/11/2025	https://eur-registry.swim.aero/services *or* e-mail: QVA@metoffice.gov.uk
Montreal	TBD	TBD
Tokyo	TBD	TBD
Toulouse	Yes, operational 27/11/2025	e-mail: contact.metgate_mf@meteo.fr
Washington	TBD	TBD
Wellington	TBD	TBD

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APPENDIX A

SAMPLE LETTER OF AGREEMENT BETWEEN THE AIR TRAFFIC SERVICES AUTHORITY, METEOROLOGICAL SERVICE PROVIDER AND STATE VOLCANO OBSERVATORY

Directives for coordination between area control centres (ACCs)/flight information centres (FICs), meteorological watch offices (MWOs) and State volcano observatories and responsibility for the provision/exchange of information relevant to volcanic ash

Effective date: *[DD MMM YYYY]*

1. OBJECTIVE

1.1 The objective of this Letter of Agreement between the [*ATS authority*][1], the [*meteorological service provider*][2] and the [*State volcano observatory*][3] is to establish the directives for the necessary coordination between ATS units, meteorological watch offices (MWOs) and State volcano observatories (SVOs) to ensure the provision of specific information on pre-eruption volcanic activity, volcanic eruptions and volcanic ash cloud required for civil (international and national) air navigation, in accordance with international agreements (see 1.4) and [national air navigation regulatory documents].

1.2 This Letter of Agreement provides guidelines on the responsibilities of ATS units, MWOs and SVOs in relation to the mutual exchange of information related to volcanic ash.

1.3 This Letter of Agreement is in accordance with the Standards and Recommended Practices and Procedures of ICAO, contained in:

- Annex 3 – *Meteorological Service for International Air Navigation*;
- Annex 11 – *Air Traffic Services;*
- Annex 15 – *Aeronautical Information Services;*
- *Procedures for Air Navigation Services – Meteorology* (PANS-MET, Doc 10157)*;*
- *Procedures for Air Navigation Services – Aeronautical Information Management* (PANS-AIM, Doc 10066);
- *Procedures for Air Navigation Services – Air Traffic Management* (PANS-ATM, Doc 4444);

as well as the provisions contained in the relevant regional air navigation plan publications and in the aeronautical information publication of [*State*][4] (AIP-[*State*]). This Letter of Agreement is also based on the guidance material in the *Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services* (Doc 9377), the *Aeronautical Information Services Manual* (Doc 8126) and the *Handbook on the International Airways Volcano Watch* (IAVW) – *Operational Procedures and Contact List* (Doc 9766).

1.4 This Letter of Agreement includes _____[5] appendices, regarding detailed national directives and arrangements pertaining to the use of the volcano aviation colour code, the format of the ASHTAM or NOTAM, abbreviations, list of contact points and means of communication, stations/offices and contact numbers, etc.

1. Name of the ATS authority.
2. Name of the meteorological security provider
3. Name of the State volcano observatory.
4. Name of the State concerned.
5. Number of appendices agreed by the three parties to the Letter of Agreement,

2. REVISIONS

2.1 When, for special or unforeseen reasons, a significant change in the coordination between the three parties involved or the services mentioned in this Agreement becomes necessary, the respective officers-in-charge, through mutual agreement, may effect temporary changes or amendments, provided that these changes are not intended to last more than _____[6] days.

2.2 Permanent revisions to the Letter of Agreement may be made by the authorities who approve and sign this Agreement. This Letter of Agreement is to be reviewed annually. A complete cancellation of this Letter of Agreement may be made, in writing, by the parties to the agreement within a notice period of _____[7] days.

3. GENERAL

3.1 In order to contribute to the efficiency and safety of international air navigation in [*State*] the [*ATS authority*], the [*meteorological service provider*] and the [*State volcano observatory*] will collaborate to ensure fast and efficient coordination to minimize the impact of the presence of volcanic ash in the atmosphere.

3.2 The [*MWOs*][8][*ACCs/FICs*][9][*volcanic ash advisory centres (VAACs) and selected volcano observatories*] concerned shall make suitable arrangements in order to facilitate volcanological briefings as well as inter-agency consultations and to establish reliable communications to undertake an effective coordination.

4. RESPONSIBILITIES

4.1 Responsibilities of the [*meteorological service provider*] and the meteorological watch offices

4.1.1 **General**

4.1.1.1 Table MET 1-1 of the Regional Air Navigation Plane identifies the selected SVOs which are to notify the volcanic ash advisory centres (VAACs), MWOs and ACCs/FICs on volcanic pre-eruption, volcanic eruption and volcanic ash.

4.1.1.2 The [*meteorological service provider*], through the [*MWO*] included in Table MET II-1 of the eANP, is responsible for issuing SIGMET(s) on volcanic ash, that is, providing up-to-date information on existing and forecast volcanic ash clouds, based on the latest information received from the corresponding VAAC, to those ACCs/FICs that need it in order to carry out their functions. The provision of any information related to volcanic activity and the presence of volcanic ash clouds in the atmosphere should be in accordance with the guidelines provided in the attachment to this Letter of Agreement.

4.2 Responsibilities of the [*ATS authority*] and area control centres (ACCs))/flight information centres (FICs)

4.2.1 The [*ATS authority*], through the [*ACC/FIC*] included in Table MET II-1 of the eANP, is responsible to provide up-to-date information on significant pre-eruptive volcanic activity, and existing volcanic ash clouds, to pilots and airline operation centres. This information should be based on the latest information received from:

6. Figure to be agreed locally: six days appears to be a suitable period.
7. Figure to be agreed locally: 180 days appears to be a suitable period.

a) SVOs;

b) the associated VAAC; or

c) the associated MWO;

and passed immediately to aircraft in flight that could be affected by the volcanic ash, and to the adjacent ACCs/FICs.

4.2.2 The ACC/FIC should also issue an ASHTAM or NOTAM through the State International NOTAM Office (NOF) in accordance with the PANS-AIM (Doc 10066), giving details of the pre-eruption activity, volcanic eruption and ash cloud, including the name and geographical coordinates of the volcano, date and time of eruption, flight levels and routes affected and, if necessary, routes to be closed to air traffic. The provision of any information related to volcanic activity and the presence of volcanic ash clouds in the atmosphere should be in accordance with the guidelines provided in the attachment to this Letter of Agreement.

4.3 Responsibility of the State volcano observatory

4.3.1 The [*State volcano observatory*] included in Table MET 1-1 of the eANP is responsible for the provision of up-to-date information on significant volcanic activity, and existing and forecast volcanic ash clouds (based on the latest information received from direct or remote observation sources), to the [*ACC*], the [*MWO*] and the [*VAAC*] concerned. The necessary volcanological information will be supplied in accordance with the guidelines stipulated in the attachment to this Letter of Agreement.

4.3.2 The volcanological information provided will, as far as possible, be in the format described in step 1 of the attachment in order to facilitate easy interpretation by ATS personnel.

5. ATS UNITS, MWOs AND STATE VOLCANO OBSERVATORIES COORDINATION MEETINGS

Regular and/or ad hoc coordination meetings between the chiefs of the ATS units, chiefs of MWOs and chiefs of SVOs, and other interested parties, aimed at improving the services provided to aircraft, will be convened as deemed necessary to ensure the safety of air navigation in accordance with the provisions as identified in 1.3.

6. COURSES FOR METEOROLOGISTS, AIR TRAFFIC CONTROLLERS AND VOLCANOLOGISTS

6.1 Courses or on-the-job training for ATS and meteorological personnel, and volcanologists, will be organized periodically with the objective of familiarizing personnel with the activities performed by the other services.

6.2 Periods and dates for these courses will be agreed by the [*ATS authority*], the [*meteorological service provider*] and the [State *volcano observatory*], taking into account the availability of personnel.

Attachment

GUIDELINES FOR HANDLING VOLCANIC ACTIVITY RELATIVE TO AERONAUTICAL INFORMATION DISSEMINATION

(Complementary to Part 4 of the Handbook on the International Airways Volcano Watch (IAVW) – Operational Procedures and Contact List *(Doc 9766))*

STEP 1

1.1 **Action to be taken by the SVO**

1.1.1 The SVO shall immediately provide information on significant pre-eruption volcanic activity, volcanic eruptions or the presence of volcanic ash clouds to the relevant ACCs/FICs [*list the centres*], [*VAAC*] and the associated MWOs [*list the offices*]. The information provided should be in accordance with the provisions contained within *Procedures for Air Navigation Services – Meteorology* (PANS-MET, Doc 10157), including the message template provided in Table A7-1 – Template for Volcano Observatory Notice for Aviation (VONA).

STEP 2

2.1 **Action to be taken by the ACC/FIC**

2.1.1 The ACC/FIC concerned shall immediately pass the reported information to the aircraft in flight that could be affected by the volcanic ash cloud and to the relevant ACCs/FICs in the adjacent flight information regions (FIRs).

2.1.2 On the reception of special air-reports for volcanic ash by an ACC/FIC, the following action should be taken:

a) the information should be transmitted immediately to all aircraft concerned; and

b) the information should be forwarded to the associated MWO.

The special air-reports for volcanic ash should be disseminated to aircraft for a period of 60 minutes after their issuance or until the issuance of a SIGMET from the associated MWO. The ACC/FIC shall verify that a SIGMET has been issued before discontinuing the transmission of the special air-report.

2.1.3 The ACC/FIC concerned shall ensure that the content of the ASHTAM or NOTAM is consistent with any SIGMET issued for their FIR. Further, the ACC/FIC shall ensure that any ASHTAM or NOTAM issued follows the guidance in the PANS-AIM, Doc 10066.

2.1.4 The ACC/FIC concerned shall activate contingency arrangements, including implementation of alternative routes.

2.1.5 Transmit special air-reports for volcanic ash received by voice communications and those received by data link communication to the associated MWO, and World Area Forecast Centres (WAFCs) London and Washington.

2.2 A**ction to be taken by the MWO**

2.2.1 The MWO shall immediately forward special air-reports for volcanic ash received to its associated VAAC and ROC or IROG.

2.2.2 The MWO shall ensure the reception of information from its associated VAAC on observed and forecast areas of volcanic ash.

2.2.3 The MWO shall immediately inform the ACC whether or not the volcanic ash cloud is identifiable from satellite images based on advice received from the VAAC.

2.2.4 The MWO shall issue SIGMETs in accordance with Annex 3 based on information received from the VAAC and/or SVO and/or ACC. However, during critical conditions where an initial volcanic eruption already poses a danger to aviation, the MWO shall immediately provide to the ACC a forecast of the volcanic ash cloud location based, inter alia, on the forecasts of numerical models used by the aeronautical meteorological service.

STEP 3

3.1 **Action to be taken by the ACC**

3.1.1 The ACC shall submit a request for the promulgation of an ASHTAM/NOTAM for volcanic ash to its associated NOTAM Office (NOF)/Aeronautical Information Service (AIS). The request shall contain the following:

a) date and time of volcanic activity or eruption, or presence of ash clouds;

b) name and number of the volcano (from the Smithsonian Global Volcanism Program);

c) coordinates (latitude/longitude) of the volcano and/or the radial and distance of the volcano from a navigational aid (NAVAID);

d) volcano aviation colour code indicating volcanic activity status, if available (PANS-MET, Table 6.1.7, refers);

e) horizontal and vertical extent of volcanic ash cloud initially based on the special air-report and subsequently based on the MWO or VAAC information;

f) forecast direction of movement of the ash cloud at selected levels based on the advice from the MWO or the VAAC report;

g) air routes or portions of air routes and flight levels affected or expected to become affected; and availability of alternate routes;

h) source of information (air-report and or SVO and/or MWO, aeronautical meteorological service and/or VAAC) indicating whether an eruption has actually occurred or ash cloud reported, or not; and

j) additional information as needed.

Note.— Initially items a), b), c), and d) shall be disseminated immediately pending receipt of additional information from units concerned.

3.2 **Action to be taken by the NOF/AIS**

3.2.1 The NOF shall promulgate an ASHTAM/NOTAM for volcanic activity based on information provided by the SVO or ACC and in accordance with the PANS-AIM (Doc 10066), Appendices 3 and 5, and transmit to other NOFs for which the information is of direct operational significance.

3.2.2 The NOF shall compile a separate message to be transmitted, via AFS, to the [*associated VAAC*] which shall be encapsulated within a dummy WMO abbreviated heading (Doc 9766, Table 4-1 refers). This enables the receiving AFS or meteorological switching centre to forward the ASHTAM/NOTAM for volcanic activity to the VAAC concerned on internal meteorological communications circuits.

Note.— Significant changes in the activity of the volcano shall be reported accordingly.

3.3 The ACC concerned shall, upon receipt of significant information relating to volcanic activity, request the NOF to revise or cancel the ASHTAM.

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APPENDIX B

[REMOVED – London WAFC and SADIS gateways no longer required for each region, EGZZVANW to be used instead.]

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APPENDIX C

OPERATIONAL PROCEDURES FOR THE COORDINATION AND TRANSFER OF RESPONSIBILITY BETWEEN VAACS FOR VOLCANIC ASH EVENTS

Note.— The primary volcanic ash advisory centre (VAAC) is defined as the VAAC with responsibility for coordinating the production of volcanic ash information for a) an ash cloud from a volcanic eruption originating within its designated area of responsibility; or b) an ash cloud, of unknown origin, reported in its area of responsibility (including false alarms).

1. As soon as one of the VAACs learns of an eruption (for a volcano erupting within 300 NM of the VAAC's boundary) or when an ash cloud is expected to come within 300 NM of the VAAC and/or FIR boundary, an information/coordination contact will be made, normally by the primary VAAC. The possibility of a handover will be discussed, if appropriate.

Note.— The VAACs will utilize one or more coordination tools, such as chat rooms, virtual web meetings and/or collaboration websites, supported by established communication templates (where necessary), to coordinate where there may be some language barriers.

2. Handover of operational responsibility shall be discussed/coordinated by the primary VAAC with adjacent affected VAACs when the ash cloud is expected to be not less than 300 NM from a VAAC and/or FIR boundary. The primary VAAC will coordinate with the neighbouring VAACs to produce a coordinated product covering both areas of responsibility. The primary VAAC may produce a single product covering both areas of responsibility or both (all) VAACs may agree to produce seamless products covering their own areas of responsibility. The VAACs will coordinate in a similar manner for the provision of QVA when the VAACs involved in the coordination and transfer of responsibility are operationally issuing QVA.

3. In some situations, there may be agreement that provision of information can best be served by the primary VAAC from "start to finish". In such a case, a message in the remarks section of the volcanic ash advisory would advise users of who has the responsibility (see paragraph 6). However, in situations of large or persistent ash emissions or for other reasons, adjacent responsible VAACs, upon coordination, may agree to divide the operational forecast responsibility and issue their own volcanic ash advisory (see paragraph 8). Examples of this and other situations of coordination and transfer of responsibility between VAACs are given at the end of this appendix.

4. In the case where a handover has been decided, VAACs should insert a note in their "last"/"first" volcanic ash advisory and volcanic ash advisory in graphical format that the handover will take place at that message/graphic number. The last volcanic ash advisory issued by the VAAC before handover will include the following at the end of the message (in the remarks section):

"THE RESPONSIBILITY FOR THIS ASH EVENT IS BEING TRANSFERRED TO VAAC **aaaa** THE NEXT ADVISORY WILL BE ISSUED BY VAAC **aaaa** BY **xxxx** UTC UNDER HEADER **bbbb**."

Where:

aaaa is the name of the VAAC taking over

bbbb is the bulletin header that will be used by the VAAC taking over (FVCN01 CWAO, FVXX21 KNES, FVAK22 PAWU, etc.)

xxxx is the time in UTC

Example:

"THE RESPONSIBILITY FOR THIS ASH EVENT IS BEING TRANSFERRED TO VAAC MONTREAL. THE NEXT ADVISORY WILL BE ISSUED BY VAAC MONTREAL BY 2200 UTC UNDER HEADER FVCN01 CWAO."

5. The first volcanic ash advisory issued by the VAAC that has taken over responsibility will include the following at the end of the message (in the remarks section):

"VAAC **cccc** HAS TRANSFERRED RESPONSIBILITY OF THIS EVENT TO VAAC **dddd**. THIS ADVISORY UPDATES MESSAGE **eeee**."

Where:

cccc is the name of the VAAC issuing the advisories before the handover

dddd is the name of the VAAC that has taken over

eeee is the full bulletin header (such as FVAK22 PAWU 261200) of the last message issued by the VAAC issuing the advisories before the handover

Example:

"VAAC ANCHORAGE HAS TRANSFERRED RESPONSIBILITY OF THIS EVENT TO VAAC MONTREAL. THIS ADVISORY UPDATES MESSAGE FVAK22 PAWU 261200."

6. When a VAAC is issuing messages covering a portion of another volcanic ash advisory centre's area of responsibility, or an ash cloud is approaching (that is, expected within 300 NM) the area of responsibility of another VAAC, that other VAAC should:

a) issue a volcanic ash advisory directing the user to the correct product. The following wording is suggested:

"PLEASE SEE **ffff** ISSUED BY VAAC **gggg** THAT DESCRIBES CONDITIONS OVER OR NEAR THE VAAC **hhhh** AREA OF RESPONSIBILITY."

Where:

ffff is the full bulletin header of the message issued by the first VAAC

gggg is the name of the first VAAC

hhhh is the name of the VAAC re-broadcasting the first volcanic ash advisory centre's message

Example of re-broadcast message issued by VAAC Montreal:

"PLEASE SEE FVAK22 PAWU 121200 ISSUED BY VAAC ANCHORAGE THAT DESCRIBES CONDITIONS OVER OR NEAR THE VAAC MONTREAL AREA OF RESPONSIBILITY"

or

b) send the first volcanic ash advisory as it is by changing only the WMO header in order to address the normal recipients within the other volcanic ash advisory centre's area of responsibility.

Note.— For volcanoes located within 500 km (300 NM) of a VAAC border, it may be that no rebroadcast volcanic ash advisory is required due to the volcanic ash cloud being forecast to move away from the VAAC border for the duration of the forecast period.

7. When two or more distinct ash clouds are present (different eruptions or one eruption for which the ash cloud has divided in two or more distinct parts), the handover only applies to the ash cloud approaching or crossing VAAC boundaries.

8. When adjacent responsible VAACs, upon coordination, have agreed to divide the operational forecast responsibility and issue their own volcanic ash advisory because of large or persistent ash emissions or for other reasons:

a) the primary VAAC will ensure consistency at the border with adjacent VAACs;

b) if the ash cloud is expected to move within 300 NM of the area of responsibility of a third (fourth) VAAC with no common border with the primary VAAC, the second (third) VAAC is responsible for initiating coordination; and

c) the second (third) VAAC is also responsible to ensure consistency at the border with the third (fourth) VAAC.

9. When two or more VAACs are issuing their own volcanic ash advisories for an ash cloud that stretches across their borders (see paragraph 8), the VAACs will coordinate a common issue time for their volcanic ash advisories and will include the following at the end of their message (in the remarks section):

"PLEASE SEE ALSO **ffff** ISSUED BY VAAC **gggg** (and **f'f'f'f'** ISSUED BY VAAC **g'g'g'g'**) THAT DESCRIBE(S) CONDITIONS NEAR THE VAAC **hhhh** AREA OF RESPONSIBILITY."

Where:

ffff, **f'f'f'f'** are the bulletin header of the message issued by neighbouring VAACs

gggg, **g'g'g'g'** are the names of the neighbouring VAACs

hhhh is the name of the VAAC issuing the volcanic ash advisory for its area of responsibility

Example of the remarks section for a message issued by VAAC Toulouse:

"PLEASE SEE ALSO FVAG01 SABM 121200 ISSUED BY VAAC BUENOS AIRES AND FVAU01 121200 ADRM ISSUED BY VAAC DARWIN THAT DESCRIBE CONDITIONS NEAR THE VAAC TOULOUSE AREA OF RESPONSIBILITY"

10. The ending of an advisory for a volcanic ash event shall be performed by the primary VAAC, upon coordination with the adjacent affected VAACs and MWOs. When more than one VAAC is issuing advisories, the ending of advisories will be coordinated between the VAACs involved.

11. VAACs should document in their handover processes as part of their quality management system as a minimum:

a) the contact points at the neighbouring VAACs (telephone, e-mail address, websites);

b) when a call to discuss the handover process will be initiated;

c) from what date/time a handover will take place; and

d) a discussion and agreement of where the volcanic ash cloud is expected to be located at handover time and beyond.

12. VAACs should establish a collaborative mechanism (such as a secure web page) for sharing volcanic ash observational information and dispersion forecast data for evaluation of the handover.

Example 1 of coordination and transfer of responsibility between VAACs:

A single volcanic ash cloud is emitted from a volcano in VAAC A's area of responsibility and becomes "detached" from it following the end of the eruption. It drifts from the area of responsibility of VAAC A to that of VAAC B. When it is within 300 NM of the area of responsibility of VAAC B (or sooner, if one of the VAACs feels it is necessary), VAAC A contacts VAAC B to discuss coordination with respect to this volcanic ash cloud. If it is decided that the volcanic ash cloud will move either completely or partially into VAAC B's area of responsibility, the two VAACs will discuss at what moment VAAC B will become the primary VAAC and take over responsibility for issuance of volcanic ash advisories and volcanic ash advisories in graphical format. Until this handover occurs, VAAC A remains responsible for issuing these products.

Should the volcanic ash cloud in the above scenario be large enough to require coordination with a third VAAC (VAAC C), the same procedure as described between the first two VAACs would apply between the primary VAAC (either A or B in the scenario above, depending on the timing and position of the volcanic ash cloud) and VAAC C.

Example 2 of coordination and transfer of responsibility between VAACs:

A single volcanic ash cloud is emitted from a volcano in VAAC A's area of responsibility and remains "attached" to the volcano during an extended eruption (that is, the eruption continues). The primary VAAC (VAAC A) retains responsibility for issuing volcanic ash advisories and volcanic ash advisories in graphical format for this volcanic ash cloud, but consults the other affected VAACs and accounts for their analysis and forecast positions of the volcanic ash cloud over their area of responsibility. The primary VAAC has the responsibility for coordinating all of this information and contacting the other VAACs. However, if one of the non- primary VAACs feels the need to contact the primary VAAC, it may do so at any time.

Should the volcanic ash cloud described in the preceding paragraph be large enough that having its analysis and forecast position reflected in only one volcanic ash advisory is unwieldy, its advisories shall be issued by multiple VAACs. This would be the case where the volcanic ash cloud covers the areas of responsibility of several VAACs. Each VAAC then has the responsibility of contacting its neighbouring VAACs (as many as required by the position of the volcanic ash cloud) to coordinate the analysed and forecast positions of the volcanic ash cloud along the boundaries between VAACs. In this case, each VAAC is considered to be the primary VAAC for its own products.

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APPENDIX D

BACK-UP PROCEDURES FOR VAACS

The following guidelines on back-up procedures should be followed by VAACs:

a) a back-up site should be established;

b) back-up sites should have the full capability of the primary site, that is, the ability to monitor ash dispersal, run atmospheric dispersion models, produce and distribute the volcanic ash information;

c) the back-up site should be chosen as to maximize efficiency, for example this will normally be at an alternative 24/7 production facility with pre-existing facilities for the VAAC capability;

d) back-up sites should maintain up-to-date contact and distribution (AFS and e-mail) lists as per the VAAC;

e) in the event of the back-up site becoming operational, volcanic ash information issued by the back-up VAAC will contain information in the RMK section of the VAA (and in metadata for IWXXM back-up VAA, and – if provided – in metadata for QVA) giving the origin of the message 'Issued by VAAC nnnnn on behalf of VAAC nnnnn'; and

f) the back-up arrangements should be tested at least annually.

Note.— The nine VAACs have back-up arrangements in place with at least one other VAAC. The back-up information will be disseminated in accordance with the information in Table 4-3.

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APPENDIX E

VOLCANO OBSERVATORY NOTICE FOR AVIATION (VONA) ISSUANCE

This Table expands upon Table A7-1, Template for Volcano Observatory Notice for Aviation, contained in Procedures for Air Navigation Services – Meteorology *(PANS-MET, Doc 10157).*

As outlined in PANS-MET section 6.1.5, English plain language must be used, using approved ICAO abbreviations and numerical values of self-explanatory nature. The template must be used in its entirety (apart from the conditional status indicator), due to the need for globally harmonized information that can be ingested by machine.

Due to character limitations of many AFS connections, text is to be provided in upper-case letters, with no 'special' characters used, as per Annex 10, *Aeronautical Telecommunications, Volume II – Communication Procedures including those with PANS status*, section 4.1.2 *Material permitted in AFS messages*:

Letters: ABCDEFGHIJKLMNOPQRSTUVWXYZ
Figures: 1 2 3 4 5 6 7 8 9 0
Other signs:
- (hyphen)
? (question mark)
: (colon)
((open bracket)
) (close bracket)
. (full stop, period, or decimal point)
, (comma)
' (apostrophe)
= (double hyphen or equal sign)
/ (oblique)
+ (plus sign)

Characters other than those listed above shall not be used in messages unless absolutely necessary for understanding of the text. When used, they shall be spelled out in full.

Key: M = inclusion mandatory, part of every message;
C = inclusion conditional, included whenever applicable;
= = a double line indicates that the text following it should be placed on the subsequent line.

Element Description	Template		Examples and Details
Identification of the type of message (M)	VONA		VONA *The name of the message type is a mandatory inclusion.*
Status indicator (C) *- indicates whether the VONA is test or exercise. There is no status indicator included for operational VONA.*	STATUS:	TEST or EXER	STATUS: TEST or STATUS: EXER *If the VONA is issued as operational then this element is omitted.*
Time of origin (M) *- year, month, day and time in UTC*	DTG:	Nnnnnnnn/nnnnZ	DTG: 20250508/2150Z *This is the time that the VONA is sent. All times must be given in universal coordinated time, denoted by the 'Z'.*
Name of volcano (M)	VOLCANO:	nnnnnnnnnnnnnnnnnnn [nnnnnn]	VOLCANO: KARYMSKY 300130 VOLCANO: UNKNOWN

- The name and IAVCEI number of the volcano.		or UNKNOWN or UNNAMED	VOLCANO: UNNAMED 221251 *The volcano name and IAVCEI number must be that which is in the Smithsonian Global Volcanism Program – this ensures that all aviation messages (such as NOTAM/ASHTAM, VAA, VA SIGMET) are consistent in referring to the same name for the volcano. Differing names, such as the vent name or other local name, can be provided in the remarks section to help avoid any local operator confusion,* *If a volcano is unknown or does not have a name, then UNKNOWN and UNNAMED should be used respectively. UNKNOWN may also be used when issuing test VONA messages, to reduce risk of undue concern around known volcano names being used in the message.* *There is no IAVCEI number or number placeholder required when using the name UNKNOWN.* *When issuing VONA for an UNNAMED volcano, care should be taken to first see if it is included in the Smithsonian list, due to the many UNNAMED volcanoes contained within. If it is not included, then no IAVCEI number or number placeholder is required.*
Location of volcano *or* volcanic ash source (M) *- Location in degrees and minutes of volcano or specific vent (if known) or coordinates in degrees and minutes of field of volcanic ash.*	PSN:	Nnnnn *or* Snnnn Wnnnnn *or* Ennnnn *or* Nnn[nn] *or* Snn[nn] Wnnn[nn] or Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] or Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] or Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] or Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] or Ennn[nn]] *or* UNKNOWN	PSN: N5403 E15927 PSN: UNKNOWN PSN: N5400 E15930 – N5400 E16100 – N5300 E15945 *The Smithsonian GVP contains a position for each volcano, but if the SVO has a more precise position for the vent from which volcanic ash is being emitted, this should be used.* *For SVOs who wish to issue a VONA for a significant volcanic ash deposit being re-suspended (re-mobilised), the coordinates of the field of volcanic ash deposit may be used. When disseminated in abbreviated plain language in accordance with PANS-MET 6.1.5, the number of coordinates is to be kept to a minimum and should not normally exceed seven.*
State *or* Region (M) *- the name of the State the volcano lies within, otherwise the region if the volcano or ash is not located within a State.*	AREA:	nnnnnnnnnnnnnnn	AREA: RUSSIA AREA: NEW ZEALAND TO FIJI *The Smithsonian GVP includes information describing the State or region that each volcano is located within.*
Source elevation (M) *- Source elevation in m (or ft) (elevation of the vent or the average height of volcanic ash field for re-suspended volcanic ash)*	SOURCE ELEV:	nnnnM (*or* nnnnnFT) AMSL (*or* BLW MSL) *or* UNKNOWN	SOURCE ELEV: 1536M AMSL SOURCE ELEV: 50FT BLW MSL SOURCE ELEV UNKNOWN *The source elevation is the height where the volcanic ash is emitted – while an elevation is included in the Smithsonian GVP, it may be adjusted as necessary to reflect the height of the emitting vent. The inclusion 'BLW MSL' is to be used only for submarine volcanoes.* *For VONA issued for re-suspended volcanic ash events, the source elevation is the average height of the volcanic ash field.*
Notice number (M) *- Year in full and message number (separate sequence for each volcano)*	NOTICE NR:	nnnn/[n][n][n]n	NOTICE NR: 2025/9 NOTICE NR: 2025/103 *Each volcano should have its own numbering sequence applied, to be reset at the start of each calendar year.* *For example, an SVO may issue on the same day VONA 2025/15 for volcano 'A' (15th VONA for volcano 'A' issued*

			during 2025), followed by VONA 2025/01 for volcano 'B' (1st VONA for volcano 'B' issued during 2025).
Current colour code (M) *- current aviation colour code*	CURRENT COLOUR CODE:	GREEN *or* YELLOW *or* ORANGE *or* RED *or* UNASSIGNED *or* NIL	CURRENT COLOUR CODE: GREEN CURRENT COLOUR CODE: UNASSIGNED *The aviation colour refers to the current activity status of the volcano itself. For the case of re-suspended volcanic ash, the status of the volcano may be aviation colour code GREEN, as an example.* *The abbreviation NIL may be used in this section for VONA issued with status indicator TEST or EXER, or if a State chooses not to apply the aviation colour code to its volcanoes.*
Previous colour code (M) *- previously assigned aviation colour code*	PREVIOUS COLOUR CODE:	GREEN *or* YELLOW *or* ORANGE *or* RED *or* UNASSIGNED *or* NIL	PREVIOUS COLOUR CODE: YELLOW PREVIOUS COLOUR CODE: RED *The previous colour code issued for the volcano is to be included here. For the case where the VONA is the first ever (in any year) to be issued for the volcano, NIL may be used. NIL may also be used in status indicator TEST or EXER VONA messages, or if a State chooses not to apply the aviation colour code to its volcanoes.*
Name SVO (M) *- name of the SVO issuing the VONA.*	SVO:	Free text up to 256 characters.	SVO: KVERT SVO: ALASKA VOLCANO OBSERVATORY *The 256-character limit is due to some legacy aeronautical fixed service communication systems having limitations to the size of messages transmitted across them.*
Activity status (M) *- Description of current activity status of the volcano*	ACT STS:	ERUPTION OCCURRED *or* ERUPTION ONGOING *or* HEIGHTENED UNREST *or* DECREASED UNREST *or* LAST VA EMISSION nnnnnnnn/nnnnZ *or* RE-SUSPENDED VA *or* UNKNOWN *or* NIL	ACT STS: ERUPTION OCCURRED *To be used at the onset of an eruption. When possible, indicate eruption start time in the RMK section, estimated from geophysical, satellite and/or other observations (visual, PIREP).* ACT STS: ERUPTION ONGOING *To be used to indicate that continued eruptive activity is occurring.* ACT STS: HEIGHTENED UNREST *To be used when no ash eruption occurring and there is an increase in the aviation colour code, OR for increasing unrest (no ash eruption) or significant changes within the current aviation colour code.* ACT STS: DECREASED UNREST *To be used when there is no ash eruption and when decreasing the aviation colour code OR for decreasing unrest (no eruption) within the current aviation colour code.* ACT STS: LAST VA EMISSION nnnnnnnn/nnnnZ *To be used when volcanic ash emissions end. This can be used when decreasing the aviation colour code OR for noting the end of ash emissions within the current aviation colour code.* ACT STS: RE-SUSPENDED VA *To be used when volcanic ash is known to be re-suspended by winds and the volcano is not erupting. Note that the aviation colour code should not be changed unless volcanic activity warrants it.* ACT STS: UNKNOWN ACT STS: NIL *To be used when there is some indication of unrest or activity that warrants VONA issuance (such as a PIREP, visual report or geophysical signal) but for which confirmation of the nature*

			of the activity is not known or observable. May also be used during tests or exercises.
Onset time (M) *- Time of onset (UTC) of eruptive activity or NIL for re-suspended volcanic ash.*	ONSET:	nnnnnnnn/nnnnZ *or* UNKNOWN or NIL	ONSET: 20250508/2150Z ONSET: NIL *This is the time that eruptive activity began. If volcanic ash is emitted, this should be the onset time for the most recent ash emission, which will be used as the start time for ash dispersion modelling.* *If there is no eruptive activity, then use NIL.*
Duration (M) *- Duration of volcanic ash producing eruption (in minutes or hours or days) or indication that eruption is continuing or NIL if no eruption has occurred.*	DUR:	n]n MIN *or* [n]n HR *or* [n][n]n DAY[S] *or* ONGOING EPISODIC *or* ONGOING CONS *or* UNKNOWN *or* NIL	DUR: 45 MIN DUR: 7 HR DUR: 5 DAYS DUR: ONGOING EPISODIC DUR: ONGOING CONS DUR: UNKNOWN DUR: NIL *This section is for describing the duration of volcanic ash being emitted (or re-suspended) from the volcano.* *If the volcanic ash emission has occurred over a discrete period, the length of that time period should be provided.* *If the volcanic ash is emitted (or re-suspended) intermittently, then ONGOING EPISODIC is appropriate.* *If the volcanic ash is continuously being emitted (or re-suspended), then ONGOING CONS is appropriate.* *Otherwise, if the duration of the emission volcanic ash (or re-suspension) is unknown, or there was no volcanic ash emission, then UNKNOWN and NIL, respectively, are appropriate to use.*
Volcanic ash cloud height (M) *- Estimate of volcanic ash cloud height in m, km (or ft) above source/vent or AMSL.*	VA CLD HGT:	[ABV] [n][n]nnnM *or* [ABV][n]nKM (*or* [ABV] [n][n]nnnFT) ABV SOURCE *or* AMSL *or* UNKNOWN *or* NO VA CLD PRODUCED	VA CLD HGT: 15KM AMSL VA CLD HGT: ABV 9000FT AMSL VA CLD HGT: 10000FT ABV SOURCE VA CLD HGT: NO VA CLD PRODUCED *The height estimate is to be given referenced to the height the volcanic cloud reaches above the volcanic ash source (eg the vent), or, the height the volcanic cloud reaches above mean sea level.* *If no volcanic cloud is produced, then the associated NO VA CLD PRODUCED may be used. Alternatively, if due to atmospheric or nighttime conditions, or if the VONA is a test, the term UNKNOWN may be used.*
Height source (M) *- the source of height data (e.g. ground observer, air-report, radar, LIDAR, satellite, webcam, etc.)*	HGT SOURCE:	Free text up to 32 characters *or* NO VA CLD PRODUCED	HGT SOURCE: SATELLITE HGT SOURCE: GND OBSERVER HGT SOURCE: RADAR HGT SOURCE: LIDAR HGT SOURCE: NO VA CLD PRODUCED *Providing the source of the data used in estimating the volcanic cloud height allows VAACs and other users to consider the potential scale of the uncertainty in the height provided. For example, it is expected that a height determined by LIDAR will be more accurate than that from an air-report.*
Movement (M) *- direction of the movement of the observed cloud*	MOV:	N *or* NE *or* E *or* SE *or* S *or* SW *or* W *or* NW *or* VERTICAL *or* OBSCD *or* UNKNOWN *or* NO VA CLD PRODUCED	MOV: NE MOV: VERTICAL MOV: OBSCD MOV: UNKNOWN MOV: NO VA CLD PRODUCED *If possible, a compass direction should be used to indicate in which direction the volcanic plume is moving. If the volcanic cloud is simply moving vertically upwards, then VERTICAL is appropriate. If the volcanic cloud is not visible due to atmospheric or nighttime conditions, or if the VONA is a test, the term UNKNOWN may be used. If no volcanic cloud is produced, then the associated NO VA CLD PRODUCED may be used.*
Contacts (M) *- SVO contact details*	CTC:	Free text up to 128 characters.	CTC: DUTY VOLCANOLOGIST, PTEL +123-456-789

			EMAIL, DUTY.VOLCANOLOGIST[AT]VOLCANO.COM WWW.VOLCANO.COM *This section is for the provision of contact details for the SVO, if a user of the information has follow-up questions. It can also be used to provide a weblink for other information on the volcano.*
Remarks (M) *- further remarks and information, as necessary.*	RMK:	Free text up to 256 characters *or* NIL	RMK: REP FM LOCAL ISLAND RESORT ALSO REP AT 20210223/0100Z THAT THEY CAN OBS W STEAM CLD EXTD VER FM THE METIS SHOAL SITE. PHOTO REP OF THE METIS SHOAL WILL BE SENT IN FM THE LOCAL ISLAND RESORT LATER TODAY. RMK: VOLCANO MONITORING DATA SHOWS AN ESCALATION IN ACTIVITY. ERUPTIVE ACTIVITY LIKELY/POSSIBLE WITHIN HOURS RMK: LAVA ERUPTION CONTINUES. EXTREME THERMAL EMISSIONS EXTEND OVER THE LAVA FLOW AND HIGH LEVELS OF GASES EXIST DOWNWIND. *This section allows for further information to be shared, such as other hazards being observed, or more information on the observations made and/or the potential for change in the activity.*
Next Notice (M) *- indication of the issuance of next VONA*	NXT NOTICE:	A NEW VONA WILL BE ISSUED IF COND CHANGE SIGNIFICANTLY OR IF THE COLOUR CODE CHANGES *or* WILL BE ISSUED BY nnnnnnnn/nnnnZ	NXT NOTICE: WILL BE ISSUED BY 20250223/0730Z *The inclusion of a next issue time informs users when they can expect to see an update on the volcano's activity status. Note, for volcanoes at aviation colour code YELLOW, ORANGE and RED, the update periods defined in PANS-MET, section 6.1.8.* NXT NOTICE: A NEW VONA WILL BE ISSUED IF COND CHANGE SIGNIFICANTLY OR IF THE COLOUR CODE CHANGES *For aviation colour code GREEN or UNASSIGNED, there is no update period defined in PANS-MET. It is expected a new VONA will be issued if there is a change in colour code or if there is a significant change in volcanic activity or conditions related to the volcanic ash field that may be re-suspended.*

Example – VONA

VONA
DTG: 20240216/0130Z
VOLCANO: KARYMSKY 300130
PSN: N5403 E15927
AREA: RUSSIA
SOURCE ELEV: 1536M AMSL
NOTICE NR: 2024/4
CURRENT COLOUR CODE: YELLOW
PREVIOUS COLOUR CODE: ORANGE
SVO: KVERT
ACT STS: DECREASED ACT
ONSET: NIL
DUR: NIL
VA CLD HGT: 15KM AMSL
HGT SOURCE: GND OBSERVER
MOV: SW
CTC: DUTY VOLCANOLOGIST, TEL +123-456-789 EMAIL, DUTY.VOLCANOLOGIST[AT]VOLCANO.COM, WWW.VOLCANO.COM

RMK:	SATELLITE, SEISMIC AND INFRASOUND DATA SHOW NO EVIDENCE OF FURTHER ERUPTIVE ACT. FUTURE EXPLOSIONS AT KARYMSKY ARE LIKELY. THEY OCCUR WO WRNG AND TYPICALLY PRODUCE SMALL VA CLD THAT DISSIPATE QUICKLY; HOWEVER, LARGER ASH EM ARE POSS.
NXT NOTICE:	WILL BE ISSUED BY 20240223/0130Z

Dissemination of VONA via the aeronautical fixed services (AFS)

- To make VONA available to users for planning and operation of flights, there is a need to exchange them in a similar manner to SIGMET – especially when there is an escalating level of volcanic unrest. The VONA may be the first piece of information alerting users to an explosive eruption, available before VAA, SIGMET or NOTAM.

- The World Meteorological Organization (WMO) site https://community.wmo.int/en/activity-areas/wis/iwxxm/ahl-icao-data contains information on the abbreviated heading that should be used when disseminating VONA over the aeronautical fixed services (AFS).

- Abbreviated headings take the form $T_1T_2A_1A_2$ii CCCC where:

    - T_1T_2 is the message type, with WM and LM to be used for the traditional alphanumeric code (TAC) and ICAO Meteorological Exchange (IWXXM) forms of the VONA, respectively.
    - A_1A_2 is the country or territory designators, as included in WMO No. 386.
    - ii is the series number of the bulletin - a two-digit number used to differentiate two or more bulletins with the same $T_1T_2A_1A_2$ issued by an originator
    - CCCC is the location designator of the originator of the message.

- It is recognized that most SVOs do not have direct access to the AFS network, meaning they don't have a 'CCCC' location identifier registered. It is proposed that SVOs can either use the location identifier of their State's National OPMET Centre (NOC)[15] that is disseminating the VONA on their behalf – or they could request a new location identifier to be registered with ICAO.

    Example: a VONA issued for a New Zealand volcano might use the headers WMNZ01 NZKL (TAC) and LMNZ01 NZKL (IWXXM), where NZ is the State designator for New Zealand and NZKL is the location indicator for the New Zealand meteorological service provider, who would distribute the VONA on behalf of the New Zealand SVO.

Note.— If new headers or changes to headers used for VONA are made, METNO or regional data routing notification procedures must be followed.

- Given that some States have many active or potentially active volcanoes, it is recommended that SVOs sequentially use different ii numbers for each erupting volcano, e.g. ii=01 for the VONA relating to erupting volcano A, then ii=02 for the VONA relating to erupting volcano B and so on, prioritizing the most active volcanoes for the very first VONA issues. The number can then be reset when the series of VONA messages for a volcano is completed (back to 'green' or 'unassigned'), or at the beginning of the month to ensure unique headers are used each calendar month.

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[15] Normally, a NOC is associated with the State's national AFTN/AMHS COM centre. The role of the NOC is to collect all OPMET messages generated by the originating stations in the State and to send them to the responsible ROBEX bulletin-compiling centre (ROC).

APPENDIX F

GUIDANCE FOR CONDUCTING VOLCANIC ASH EXERCISES IN ICAO REGIONS

1. OVERVIEW

1.1 Volcanic ash exercises should be conducted by ICAO on a regional basis in order to practice and develop inter-agency response to volcanic activity, in order to maintain safety, regularity and efficiency of aviation in the event of a volcanic eruption. This guidance recognizes that there is significant regional variation in the nature, frequency, observation of and response to volcanic eruptions. The frequency and scope of volcanic ash exercises is the responsibility of the ICAO region concerned. Where frequent volcanic activity results in adequate information about system performance, exercises may be omitted or constrained to infrequent, extraordinary situations or be held only to test revised procedures.

1.2 Volcanic ash exercises should be facilitated via the ICAO Regional Office concerned and support the regular assessment of system performance (in accordance with quality management principles), in particular the assessment of the safety performance which is required by ICAO safety management provisions.

1.3 Reports of the exercises or performance assessments should be reviewed by an appropriate sub-group or sub-groups within the ICAO region concerned. The focus of these reviews should be the development of improved provisions. Recommendations for improvements to global ICAO provisions, based on the regional review of the exercises, should be brought to the attention of the ICAO Planning and Implementation Regional Group (PIRG) concerned and/or to the ICAO Meteorology Panel Working Group - Meteorology Operations Group International Airways Volcano Watch Work Stream.

1.4 A volcanic ash exercises steering group may be established by a PIRG to coordinate all aspects of the organization and conduct of the exercises. The steering group should have representatives from, as a minimum, the volcanic ash advisory centres (VAACs) concerned, air navigation service providers (ANSPs), airspace users and regulators.

2. EXERCISES AND PERFORMANCE ASSESSMENTS

2.1 Volcanic ash exercises should be held at a frequency to be determined by the ICAO region concerned. They should be held at least every three years where the frequency of real eruptions is low and additionally as soon as practicable when significant changes to the procedures have been implemented.

2.2 Volcanic ash exercises should be designed to test volcanic activity alerting, aeronautical information service (AIS) and meteorological (MET) message routing, volcanic ash information, air traffic control procedures, air traffic flow and capacity management and aircraft operator response and the collaborative decision making (CDM) between the various actors in accordance with regional and global procedures.

2.3 Exercises can only simulate a real event, while operation of the aviation system must continue normally and be unaffected by the exercise. The planning of the exercise needs to ensure that detrimental effects on the system performance are avoided, but that nevertheless useful experience and information is generated.

2.4 A complete, system-wide exercise for volcanic ash contamination is an extremely complex undertaking since such an event involves a great number and variety of stakeholders. It might therefore be useful to constrain exercises to specific parts of the whole system, with other parts of the system being subject to testing at subsequent exercises.

3. OBJECTIVES

3.1 The exercises should be designed to:

a) practice the conduct of volcanic activity response in accordance with the regional reference documents;

b) verify existing information, AIS and MET message routing via AFTN addresses, relevant e-mail addresses, telephone and fax numbers, and internet addresses (URLs);

c) maintain appropriate information and message routing between all involved agencies and organizations;

d) provide volcanic activity response training for key personnel involved;

e) allow regulators to assess the preparedness and operational response in terms of planning, process and procedures of operators; and

f) provide, when appropriate, recommendations for amendment of the reference documents, in accordance with the lessons learned and conclusions contained in the final exercise report.

3.2 Exercises may also be designed to test suggested new procedures on a limited scale before regional/global implementation.

3.3 Exercise and system performance assessments should be aimed at a critical review of existing provisions and their further improvement.

4. CONCEPTS

4.1 Each exercise should involve a simulated volcanic contamination (such as eruption of a volcano or a re-suspended cloud of volcanic ash) affecting air navigation. Simulated ash clouds may cross international boundaries, depending on the objectives of the exercise and may affect more than one VAAC area of responsibility. Exercises may utilize real-time meteorological conditions, archived data or a scenario.

4.2 Each exercise may have different objectives, which the scenario will be designed to address. For example, any or all of the activities listed below may be tested depending on the scope of the exercise:

a) AFTN, e-mail addresses, websites, message routing and voice communications;

b) alerting and observation of ash (such as use of VONA and VAR);

c) VAAC response (such as volcanic ash information);

d) ATS response (including air traffic control and AIS for NOTAM issuance);

e) air traffic management (ATM) response;

f) aircraft operator response (including safety risk assessment);

g) meteorological watch office response (that is, SIGMET); and

h) suitability of information, its frequency, format and content.

5. PLANNING AND REPORTING

5.1 Each ICAO region should establish an appropriate structure (such as focal point or steering group) for the conducting of regional volcanic ash exercises and system performance assessments. For each exercise, an exercise leader should be appointed and a planning meeting held approximately three months before the exercise is due to take place.

5.2 An exercise directive should be published prior to the exercise which clearly describes the exercise scenario, participating agencies and any special instructions.

5.3 After the exercise, initial exercise reports should be prepared by all participating agencies. A debrief meeting should be held soon after the exercise to discuss the exercise reports. The exercise leader should then produce a consolidated final exercise report for consideration by the relevant ICAO group.

6. ICAO REFERENCE MATERIAL

Annex 3 – *Meteorological Service for International Air Navigation*

Annex 11 – *Air Traffic Services*

Annex 15 – *Aeronautical Information Services*

Procedures for Air Navigation Services – Meteorology (PANS-MET, Doc 10157)

Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM, Doc 4444)

Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds (Doc 9691)

Global Air Navigation Plan (Doc 9750)

Global ATM Operational Concept (Doc 9854)

Flight Safety and Volcanic Ash (Doc 9974)

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APPENDIX G

COST RECOVERY FOR ISSUANCE OF VONA

1. In accordance with *ICAO's Policies on Charges for Airports and Air Navigation Services* (Doc 9082), the costs of providing all aeronautical information to be charged to users of that information may be recovered.

2. Annex 3 to the Convention on International Civil Aviation, *Meteorological Service for International Air Navigation*, establishes International Standards and Recommended Practices that are necessary or desirable for the safety and regularity of international air navigation, including those that pertain to the responsibilities of Contracting States and their State volcano observatories (where such State volcano observatories exist). In accordance with Article 15 of the Convention on International Civil Aviation (Doc 7300), a Contracting State is entitled to recover from aviation the costs incurred by its State volcano observatory or observatories for the delivery of facilities and services that fulfil the Annex 3 provisions.

3. The volcano observatory notice for aviation (VONA) is integral to the Annex 3 provisions and there is a well-defined template for providing the information contemplated within the VONA to VAACs, MWOs, ACCs/FICs, NORAM offices and, in accordance with regional air navigation agreement, international OPMET databanks.

4. Notwithstanding the Annex 3 provisions, it is at the discretion of each Contracting State to determine whether cost recovery is undertaken – for the State volcano observatory facilities and services and for any other facilities and services that serve international air navigation – and the specific cost allocation and cost recovery methodology used. Typically, a Contracting State's civil aviation authority would recommend to its government what allocation and recovery methodology, if any should be applied.

5. For State volcano observatories seeking to investigate whether cost recovery for the provision of their facilities and services in support of international air navigation is possible, there are two basic initial steps:

a) estimate what State volcano observatory costs are legitimately aviation-related; that is, that are directly associated with the fulfilment of the Annex 3 provisions; and

b) open discussions with the State civil aviation authority and meteorological authority to discuss possible methodologies for the recovery of those identified, legitimate costs, and ensure that all parties act in a coordinated manner.

6. Extensive guidance on cost recovery methodologies for aeronautical meteorological service provision is given in the *Guide to Aeronautical Meteorological Services Cost Recovery: Principles and Guidance* (WMO-No. 904) available via the WMO electronic library (https://library.wmo.int/). This Guide is of use to Contracting States and their State volcano observatories seeking to establish and maintain a cost recovery arrangement.

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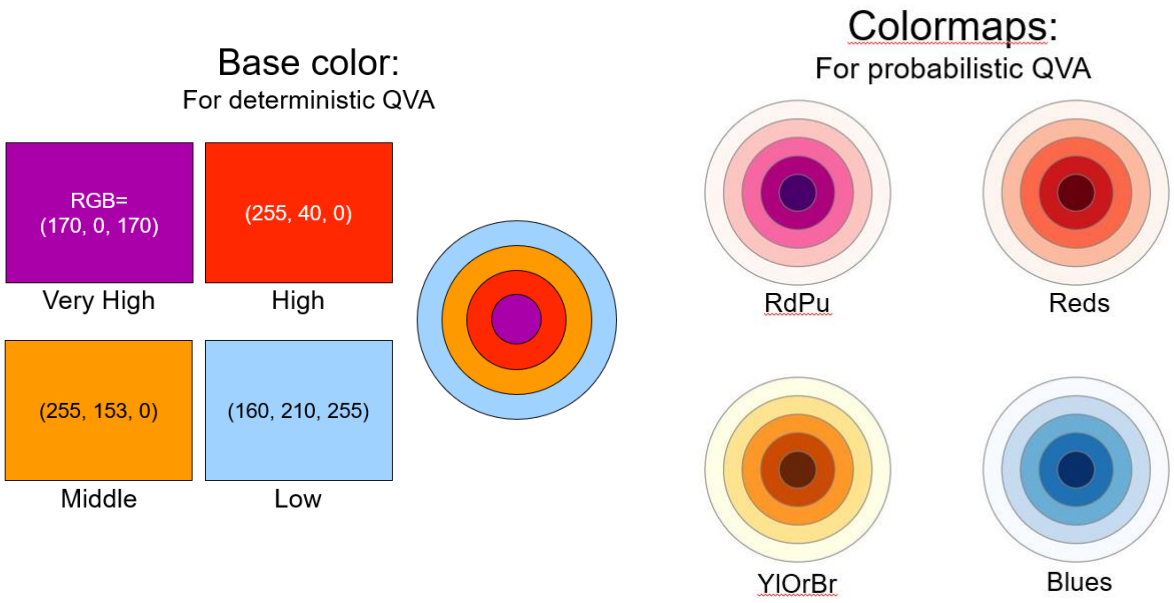
APPENDIX H

GUIDANCE FOR SUPPLEMENTAL QVA CHART PROVISION

1. The host agencies for the volcanic ash advisory centres (VAACs) are encouraged to provide supplemental quantitative volcanic ash concentration information (QVA) graphics, to assist users in developing an understanding of the QVA service provision.

2. The following colour schemes were agreed to in order to comply with accessibility requirements (for example, for individuals with colour blindness) and to ensure uniformity among VAACs. The example on the left applies to supplemental charts from deterministic forecasts, while that on the right is for probabilistic forecasts. In the latter case, the following colours could be used for the specified thresholds:

- Low (greater than 0.2 mg/m^3) – blue
- Medium (greater than 2 mg/m^3) – orange
- High (greater than 5 mg/m^3) – red
- Very high (greater than 10 mg/m^3) – purple



3. Such supplemental charts should be provided at time intervals and vertical levels consistent with those mandated by Annex 3 and PANS-MET and updated according to the same standards.

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APPENDIX I

GUIDANCE FOR USE OF QVA

1. BACKGROUND

1.1. Quantitative volcanic ash concentration information (QVA) provides information on how much volcanic ash is expected in the air, but also a measure of uncertainty in forecasts issued by volcanic ash advisory centres (VAACs)[16].

1.2. QVA information offers operators the opportunity to move away from traditional discernible/visible ash criteria and instead use certified engine susceptibility for flight route planning and inflight replanning.

> Visible ash is what an observer or flight crew member sees with their eyes. The lower limit of visible ash ranges from approximately 0.01 mg/m^3 to 10 mg/m^3, depending on many factors such as time of day, sky background, position of the sun to the observer (pilot) as well as the angle the ash cloud is viewed (for example, viewed from the side).
>
> Discernible ash is what a satellite or other remote sensing instrument detects. Discernible ash from satellites has been used by the VAACs to define the observed area in the volcanic ash advisories (VAA) in both text and graphic form (VAG) over the past two decades. The lower limit of discernible ash from satellites is approximately 0.1 mg/m^3 to 0.2 mg/m^3, depending on the satellite and other factors.

1.3. QVA provides forecasts of ash concentration in two data formats for *significant* eruptions (4.6.2 refers) – as objects, in ICAO's Meteorological Information Exchange Model (IWXXM) format, and in gridded form.

1.4. QVA information consists of the thresholds and ranges shown in Table I-1, which were formulated by ICAO's Meteorology Panel in coordination with the International Coordinating Council of Aerospace Industries Associations (ICCAIA). The units for the ash concentration thresholds and ranges are in milligrams per cubic metre (mg/m^3).

Table I-1. Thresholds and ranges

Descriptor	*Concentration thresholds and ranges*
Very high	$\geq$ 10 mg/m^3
High	$\geq$ 5 and < 10 mg/m^3
Medium	$\geq$ 2 and < 5 mg/m^3
Low	$\geq$ 0.2 and < 2 mg/m^3
Very low	< 0.2 mg/m^3

[16] As indicated in Table 4-5.

1.5. The QVA information in IWXXM form is provided as 'objects' for the very high, high, medium, and low concentration ranges. Illustrated examples of QVA objects are shown in Figures I-1 to I-6, while Figure I-7 is an illustrated example of QVA objects compared to a VAG.

1.6. The QVA in gridded format is provided at a horizontal resolution of at least 0.25 degrees, in 5000-foot (or less) flight levels (FL) from mean sea level to FL600, and in three hourly (or fewer) time steps. QVA information is updated as necessary but at least every six hours until the volcanic ash cloud is no longer considered 'significant'.

1.7. The traditional approach to volcanic ash forecasting is known as deterministic, with only one forecast outcome. The deterministic gridded data set provides modelled volcanic ash concentrations. This data can be plotted as a contour plot as shown in Figure I-8, with the contours chosen to correspond to the levels in Table I-1. However, the data will contain the actual concentrations output by the model and may contain values below, between and above the thresholds given in Table I-1. Thus, this data could be utilized to generate contours at other threshold levels, to meet specific user needs.

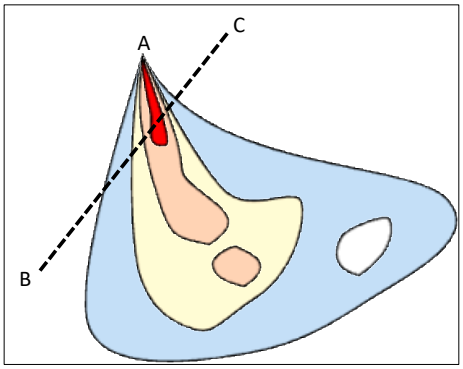
1.8. While deterministic data can provide good advice, it may not provide users with a full understanding of the possible range of outcomes or indicate the risk of encountering specific phenomena. A gridded probabilistic QVA data set provides information from multiple forecasts, as it uses varied atmospheric and/or eruption conditions. QVA in gridded format includes information on the probability of exceeding volcanic ash concentration thresholds of 10, 5, 2 and 0.2 mg/m^3 (also called the 'ensemble relative frequency of exceedance'). This is simply the number of ensemble members with concentration above a threshold divided by the total number of members at each grid point. Figures I-8 and I-9 provide a graphic display of deterministic and probabilistic QVA for a theoretical eruption, using the colour schemes agreed by all VAACs (described in Appendix H).

Note.— QVA objects in IWXXM form do not include probabilistic information.

1.9 Users of QVA information should be aware that it is a separate VAAC product to the traditional VAA and, while similar in the ash observation and dispersion information, will not always align. An example would be that a VAAC may issue a VAA for an ash cloud that is at a 'very low' concentration, meaning the deterministic QVA will have no values above 0.2 mg/m^3. The *probabilistic* QVA data set, however, may contain some information on the likelihood of the volcanic ash exceeding 0.2 mg/m^3. In circumstances when deterministic gridded QVA is issued containing no values above 0.2 mg/m^3, an 'empty' IWXXM form QVA file would also be issued alongside the VAA, and the gridded data sets. The IWXXM QVA file would contain no QVA objects but include other basic elements, such as volcano details, as well as a remark field.

2. QVA OBJECT EXAMPLE VISUALISATION

Colour legend: White = <0.2mg/m^3, Blue = ≥ 0.2mg/m^3, Yellow = ≥ 2mg/m^3, Orange = ≥ 5mg/m^3, Red = ≥ 10mg/m^3. Note that colours were randomly chosen and do not infer any visualization guidelines.



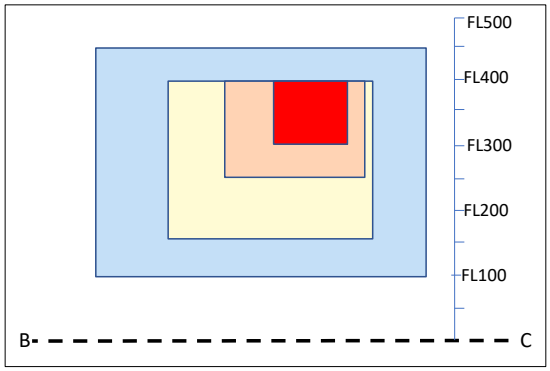


Figure I-1 (left). *IWXXM objects showing all QVA thresholds depicted in the horizontal from a fictitious volcano located at A. The vertical depiction along line B-C is shown in* ***Figure I-2 (right)***.

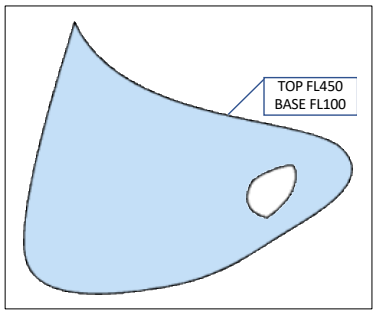


Figure I-3.

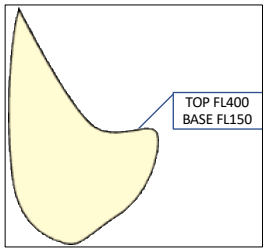


Figure I-4.

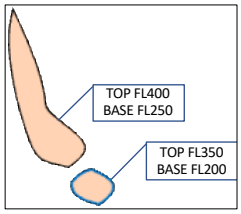


Figure I-5.

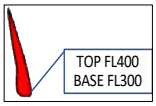


Figure I-6.

Fig. I-3 to I-6 depict the individual IWXXM objects from Fig. I-1. Fig. I-3 is object ≥ 0.2mg/m³ (the "hole" is ash <0.2mg/m³). Fig. I-4 is object ≥ 2mg/m³. Fig. I-5 is object ≥ 5mg/m³. Figure I-6 is object ≥ 10mg/m³.

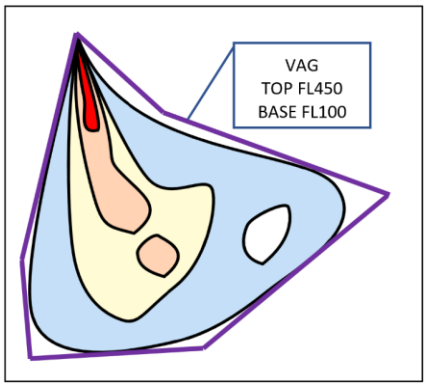


Figure I-7. *Same as Figure I-1 but overlayed with the equivalent volcanic ash advisory graphic (purple polygon).*

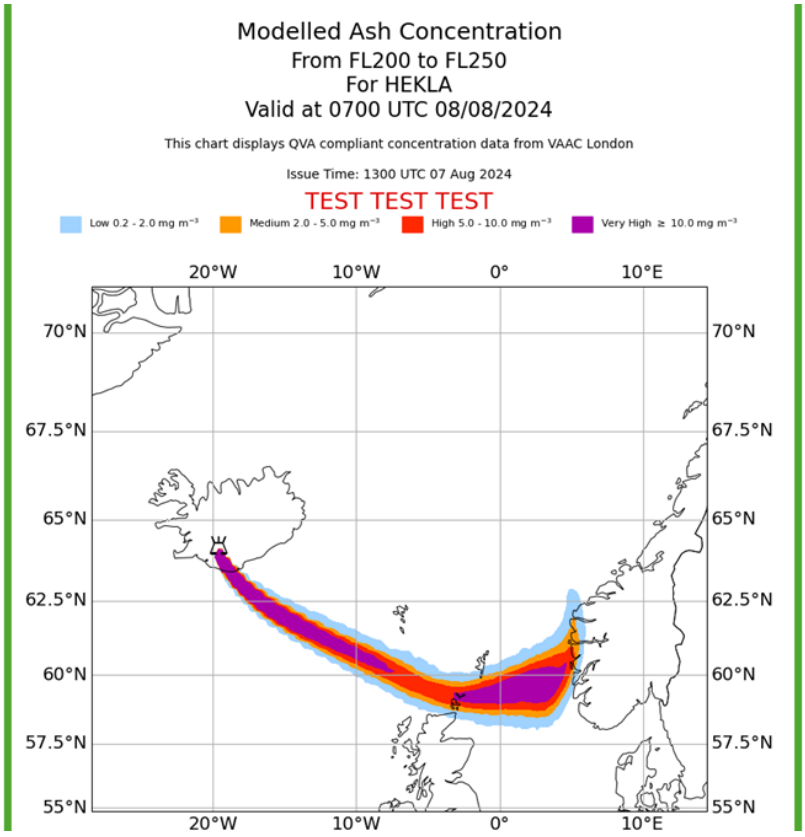


Figure I-8. *Volcanic ash concentrations exceeding 0.2mg/m^3 for a hypothetical eruption of Hekla volcano. Image provided by VAAC London.*

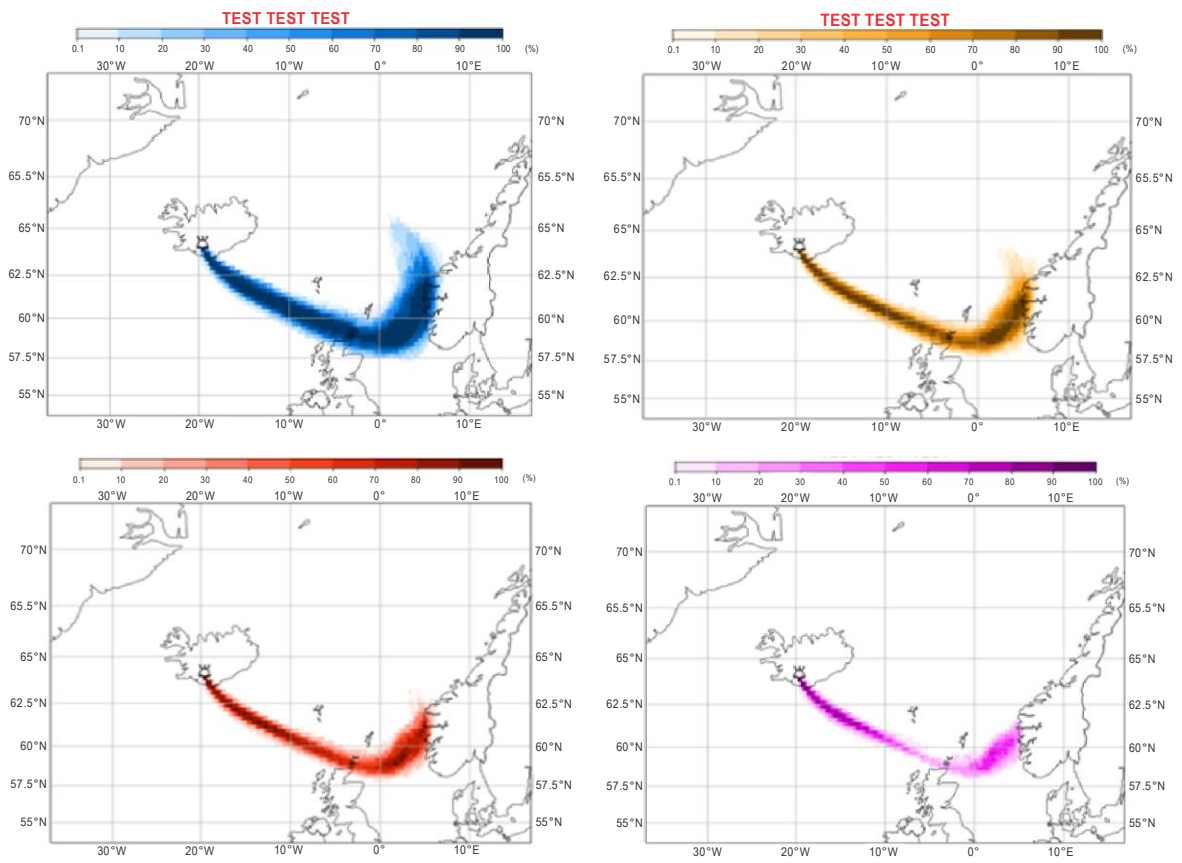


Figure I-9. *Probability of volcanic ash concentrations exceeding 0.2mg/m^3 (top left), 2mg/m^3 (top right), 5mg/m^3 (bottom left), 10mg/m^3 (bottom right), for a hypothetical eruption of Hekla volcano. Images provided by VAAC London.*

3. USING QVA OPERATIONALLY

3.1. QVA provides users with a high-resolution four-dimensional representation of a volcanic ash cloud, providing a more realistic depiction of the ash cloud (compared to the usually < 7-point VAA polygons). The increased temporal resolution of QVA information provides users with more frequent forecast positions of the ash cloud, compared to the 6-hourly timesteps of the VAA/VAG. This reduces the need for operators to interpolate between timesteps and so gives greater confidence in refining the buffer in planning (and flying) around the QVA-described ash cloud areas and so reduces fuel consumption.

Note.— The QVA gridded data will show higher resolution values, however this may not correspond to higher accuracy of the data due to inaccuracies in source terms or impact of meteorological cloud.

3.2. QVA will likely have its greatest utility with ash cloud events that have a widely dispersed ash cloud with mostly lower levels of ash concentration. Operators with approval and procedures/practices, (for example, maintenance for planned flight into select thresholds of ash concentration), will be able to use QVA to fly more efficient routes in accordance with their safety management programme. An example of calculating volcanic ash 'dose' is shown in Figure 1-10, where different engine volcanic ash dosages are calculated based upon the chosen route.

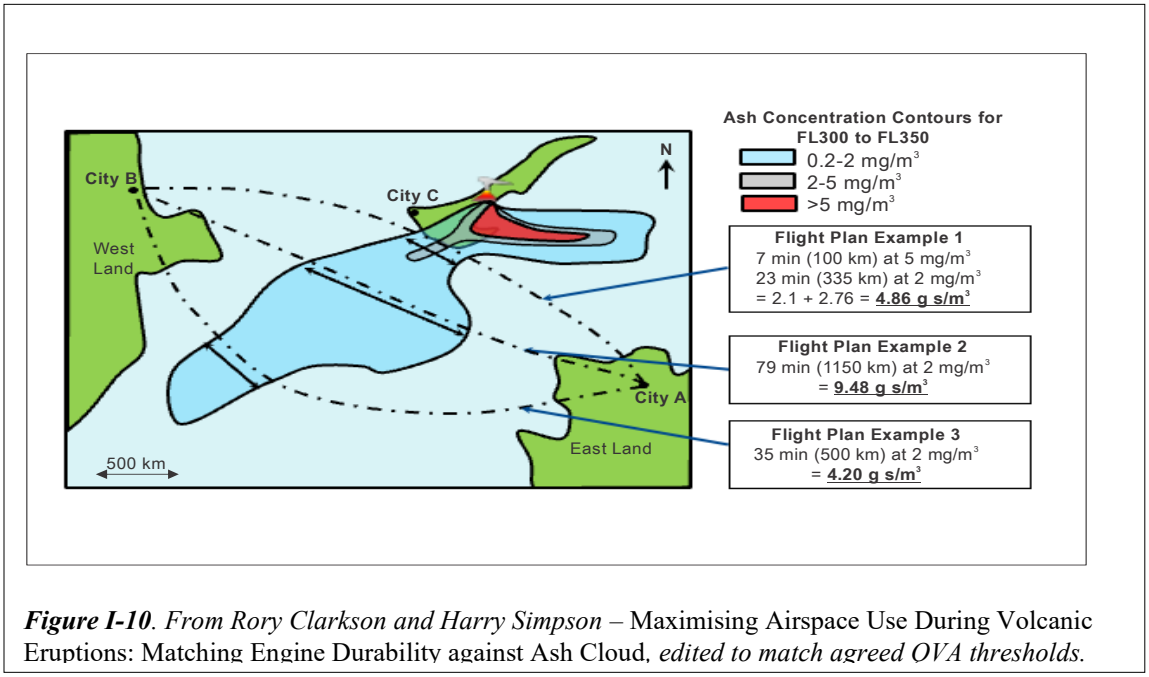


Figure I-10. *From Rory Clarkson and Harry Simpson* – Maximising Airspace Use During Volcanic Eruptions: Matching Engine Durability against Ash Cloud, *edited to match agreed QVA thresholds.*

3.3 Probabilistic QVA is intended for use in operator's flight planning and decision support systems. Operators will use probabilistic QVA to understand the *likelihood* of volcanic ash concentrations exceeding a specific threshold in a given location.

3.4 An ensemble weather model generates multiple forecasts using slight variations of initial conditions or model parameters, offering a range of possible weather outcomes rather than a single, definitive prediction. This approach helps to quantify uncertainty and can improve forecast confidence, especially at longer lead times, by showing how likely different scenarios are and the spread of possibilities at various forecast times. By then running a volcanic ash dispersion model using an ensemble of weather forecasts, the uncertainty in the weather forecast is represented within the ash modelling. Uncertainty in some of the geophysical attributes of a volcanic ash cloud can also be accounted for – such as the height the ash cloud reaches, or the volume of ash contained within the plume.

3.5 Figure I-9 shows an example of the probability of ash exceeding 0.2mg/m^3 (top left) using ensemble meteorology. In this example, a probability of 100 per cent means that every weather scenario is predicting that ash in that location will exceed concentrations of 0.2mg/m^3. A probability of 50 per cent means that half of the weather scenarios are predicting that ash at that location will exceed concentrations of 0.2mg/m^3.

— END —

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