



METEOROLOGY PANEL



New Annex 3 Volcanic Hazard Information Services

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Proposed Amendment 82 to Annex 3 *Meteorological Services for International Air Navigation* and the new *Procedures for Air Navigation Services — Meteorology* (PANS-MET):

- Introduction of the use of the volcano observatory notice to aviation (**VONA**) as a recommended practice for sharing volcanic activity information.
- Introduction of the quantitative volcanic ash (**QVA**) concentration information service as a recommended practice.

Applicable November 2025

VONA introduction





Current Annex 3 requirement

3.6 State volcano observatories

Contracting States with active or potentially active volcanoes shall arrange that State volcano observatories monitor these volcanoes and when observing:

- a) significant pre-eruption volcanic activity, or a cessation thereof;
- b) a volcanic eruption, or a cessation thereof; and/or
- c) volcanic ash in the atmosphere

shall send this information as quickly as practicable to their associated ACC/FIC, MWO and VAAC.

Note 1.— Pre-eruption volcanic activity in this context means unusual and/or increasing volcanic activity which could presage a volcanic eruption.

Note 2.— Doc 9766 contains guidance material about active or potentially active volcanoes.



Handbook on the International Airways Volcano Watch

VOLCANO OBSERVATORY NOTICE FOR AVIATION (VONA)

Item No	Element	Content
1	Message title	VOLCANO OBSERVATORY NOTICE FOR AVIATION
2	Issued:	20190626/0600Z
3	Volcano:	White Island 241040
4	Current Aviation Color Code:	Yellow
5	Previous Aviation Color Code:	Green
6	Source:	GNS Science, New Zealand
7	Notice Number:	NZ VONA 01/19
8	Volcano Location:	3752S17718E
9	Area:	White Island
10	Summit Elevation:	1053FT
11	Volcanic Activity Summary:	Moderate to heightened volcanic unrest with second highest SO ₂ flux of past 20 years
12	Volcanic Cloud Height:	NIL
13	Other Volcanic Cloud information:	NIL
14	Remarks:	ACC changed from Green to Yellow
15	Contacts:	Duty Volcanologist, +6472761784ph,+6473748199fax
16	Next Notice:	Will be issued if there is a change in aviation color code or when a significant volcanic event happens within the current color code.

The Volcano Observatory Notice to Aviation – or VONA – is currently a **suggested** format for the information provided by **designated** State volcano observatories (SVOs) to VAACs, MWOs and ACC/FIC – contained in ICAO Doc 9766 [Handbook on the International Airways Volcano Watch](#).

ICAO COLOUR CODE	STATUS OF ACTIVITY OF VOLCANO
GREEN	Volcano is in normal, non-eruptive state. <i>or, after a change from a higher level:</i> 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. <i>or, after a change from higher alert level :</i> 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. <i>or,</i> Volcanic eruption is underway with no or minor ash emission. <i>[specify ash-plume height if possible].</i>
RED	Eruption is forecasted to be imminent with significant emission of ash into the atmosphere likely. <i>or,</i> Eruption is underway with significant emission of ash into the atmosphere. <i>[specify ash-plume height if possible].</i>



SVO Designation

How do you know your VO is a **designated SVO**?

Need to check the ICAO regional air navigation plan (ANP) – Volume 1, Table MET I-1

APAC ANP:

<https://www.icao.int/APAC/Pages/APAC-eANP.aspx>

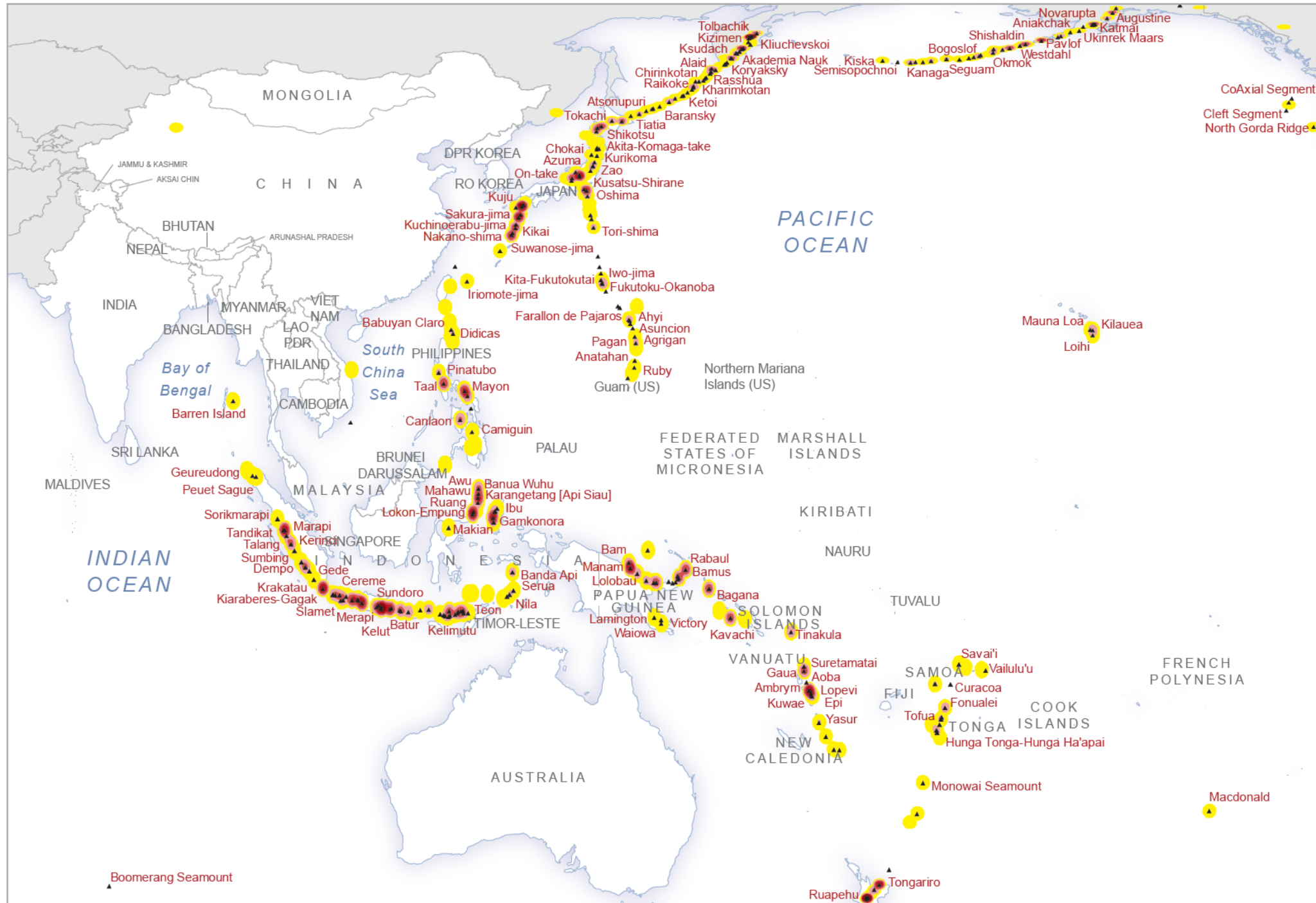
**TABLE MET I-1
STATE VOLCANO OBSERVATORIES**

Explanation of the Table

Column

- 1 Name of the State responsible for the provision of a volcano observatory
- 2 Name of the volcano observatory

State	Volcano observatory
1	2
China	Heilongjiang Wudalianchi Volcano Observatory
China	Jilin Changbai Mountain Tianchi Volcano Observatory
Japan	Fukuoka Volcanic Observation and Information Center, Japan Meteorological Agency
Japan	Kagoshima Local Meteorological Office, Japan Meteorological Agency
Japan	Sapporo Volcanic Observation and Information Center, Japan Meteorological Agency
Japan	Sendai Volcanic Observation and Information Center, Japan Meteorological Agency
Japan	Tokyo Volcanic Observation and Information Center, Japan Meteorological Agency
India	TBD
Indonesia	Directorate of Volcanology and Geological Hazard Mitigation (DVGHM)
New Zealand	Wairakei Research Centre Institute of Geological and Nuclear Sciences
Papua New Guinea	Rabaul

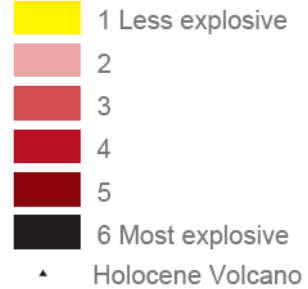


Volcanic Explosivity in Asia-Pacific
 This map shows the density of volcanic eruptions based on the explosivity index for each eruption and the time period of the eruption. Eruption information is spread to 100km beyond point source to indicate areas that could be affected by volcanic emissions or ground shaking.

The original source of the data is a point dataset of worldwide historical volcanic eruptions occurring within approximately the last 11,500 years (to 2002). Adapted from Simkin and Siebert, 1994 "Volcanoes of the World: an Illustrated Catalog of Holocene Volcanoes and their Eruptions" and produced digitally by the Smithsonian Institution's Global Volcanism Program.

The volcanic eruptions were rated using the Volcanic Explosivity Index (VEI). The VEI is a simple 0-to-8 index of increasing explosivity, with each successive integer representing about an order of magnitude increase.

Volcanic Explosivity





Proposed Amendment 82 to Annex 3 + PANS-MET

Using the VONA template becomes a “recommended practice” for designated State volcano observatories. VONA to be provided to operators like any other aviation MET warning.

To be provided in traditional alphanumeric code (TAC) and recommended also in IWXXM format.

VONA	
DTG:	20240216/0130Z
VOLCANO:	KARYMSKY]300130
PSN:	N5403 E15927
AREA:	RUSSIA
SOURCE ELEV:	1536M AMSL
NOTICE NR:	2021/4
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



Proposed Amendment 82 to Annex 3 + PANS-MET

New “unassigned” colour code for poorly monitored volcanoes (e.g., undersea volcanoes, remote volcanoes).

ICAO Colour code	Status of activity of volcano
GREEN	The volcano is in a normal, non-eruptive state; or, volcanic activity is considered to have ceased, and the volcano has reverted to its normal, non-eruptive state.
YELLOW	The volcano is experiencing signs of elevated unrest above known background levels; or, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase;
ORANGE	The volcano is exhibiting heightened unrest with increased likelihood of an eruption; or a volcanic eruption is underway but with no or minor volcanic ash emission.
RED	A volcanic eruption is expected to be imminent with significant emission of volcanic ash into the atmosphere likely; or, a volcanic eruption is underway with significant emission of volcanic ash into the atmosphere.
UNASSIGNED	There is insufficient information available to assess the <u>current status</u> of the volcano or volcanic activity.



How will this work?

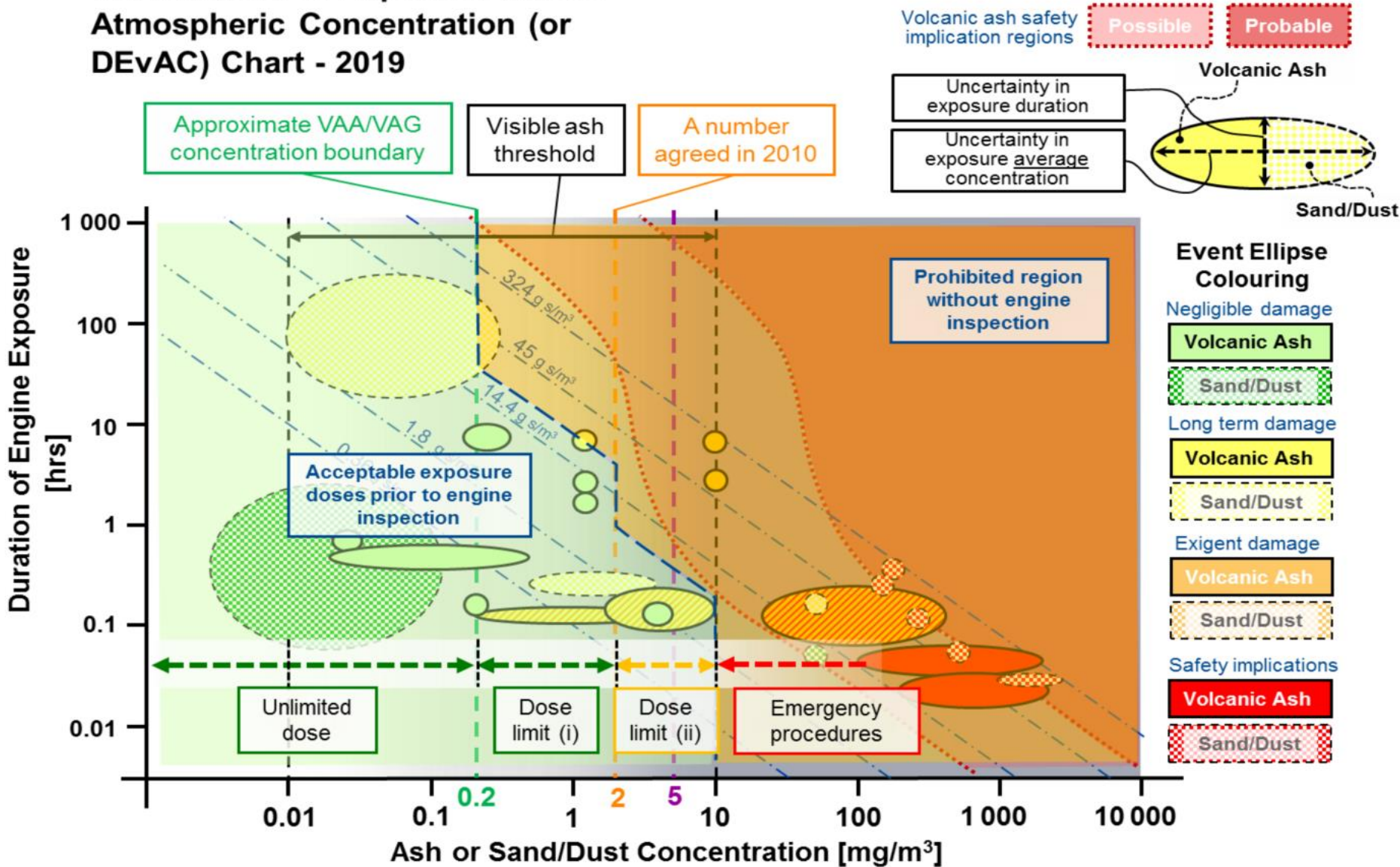
- For States with active or potentially active volcanoes, national aviation authorities (NAAs) should reach out to their SVOs and discuss the current and future requirements.
- Many (most?) SVOs are not likely to have AFS connections – so working with their associated meteorological or air navigation service providers (or VAACs) will be important.
- Guidance is being developed for inclusion in the *Handbook on the International Airways Volcano Watch* (Doc 9766) to assist SVOs.
- Dissemination is being worked on – WMO is providing an IWXXM schema and bulletin headers, MET/IE WG working on a plan for distribution via APAC ROBEX scheme.

QVA introduction





The Duration of Exposure versus Atmospheric Concentration (or DEvAC) Chart - 2019



Dr Rory Clarkson and Harry Simpson –
Maximising Airspace Use During Volcanic Eruptions: Matching Engine Durability against Ash Cloud Occurrence



Rolls-Royce declaration

In 2017, Rolls-Royce issued a world-wide communication WWC11365-1 to operators, applicable to all RB211 and Trent family of engines.

Acceptable operation in dispersed ash of up to a maximum of 4 milligrams per cubic metre (mg/m³) for an hour (equivalent to 2 mg/m³ for 2 hours) – qualified as a dose of 14.4 g s/m³ – should not lead to a significant erosion of engine related flight safety margins.

Rolls-Royce is working with other Original Equipment Manufacturers (OEM) to explore if similar thresholds could be applicable to other engine types.



Visual illustrations of QVA IWXXM objects

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

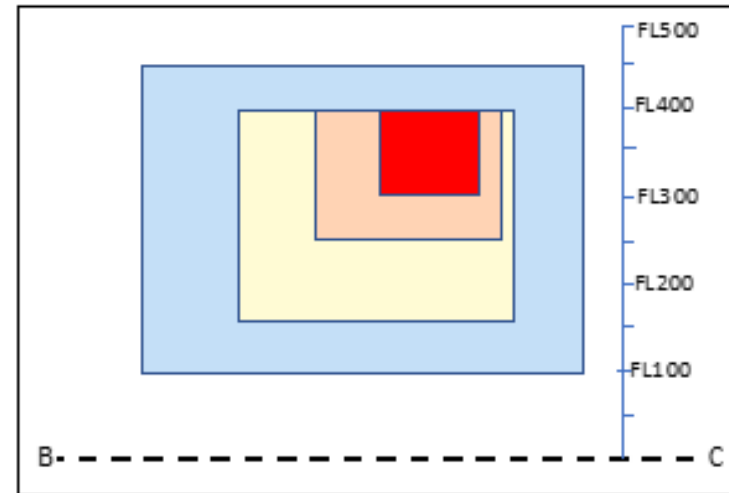
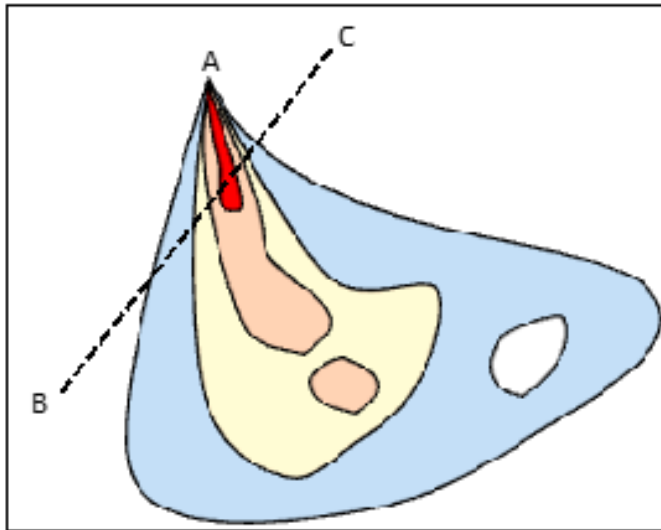


Figure 1 (left). IWXXM objects showing all QVA thresholds depicted in the horizontal from a fictitious volcano located at A. The vertical depiction along line B-C is shown in **Figure 2 (right)**.



Visual illustrations of QVA IWXXM **objects**

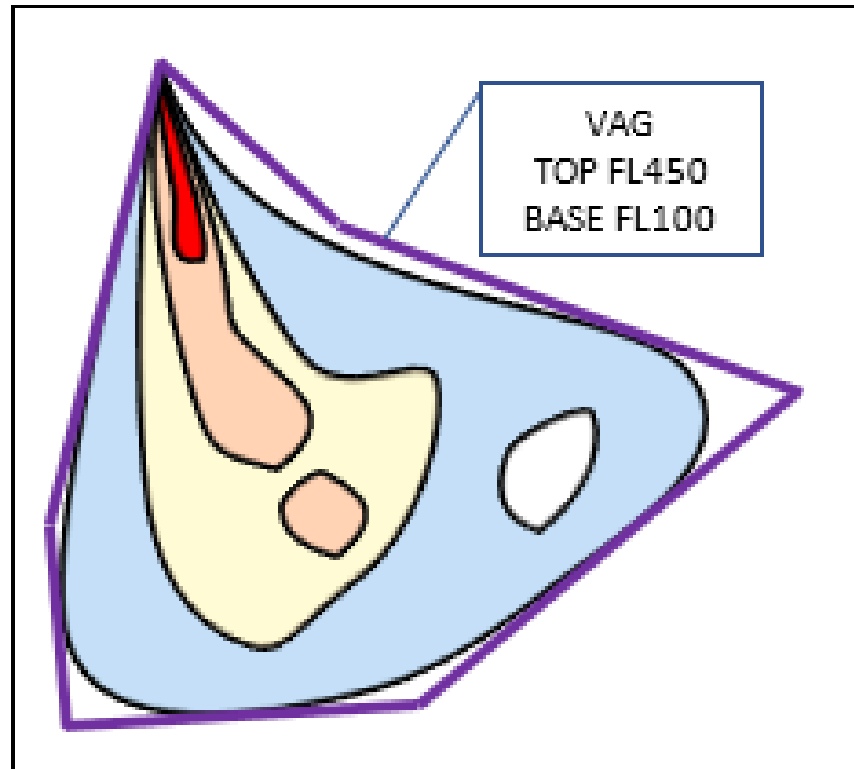
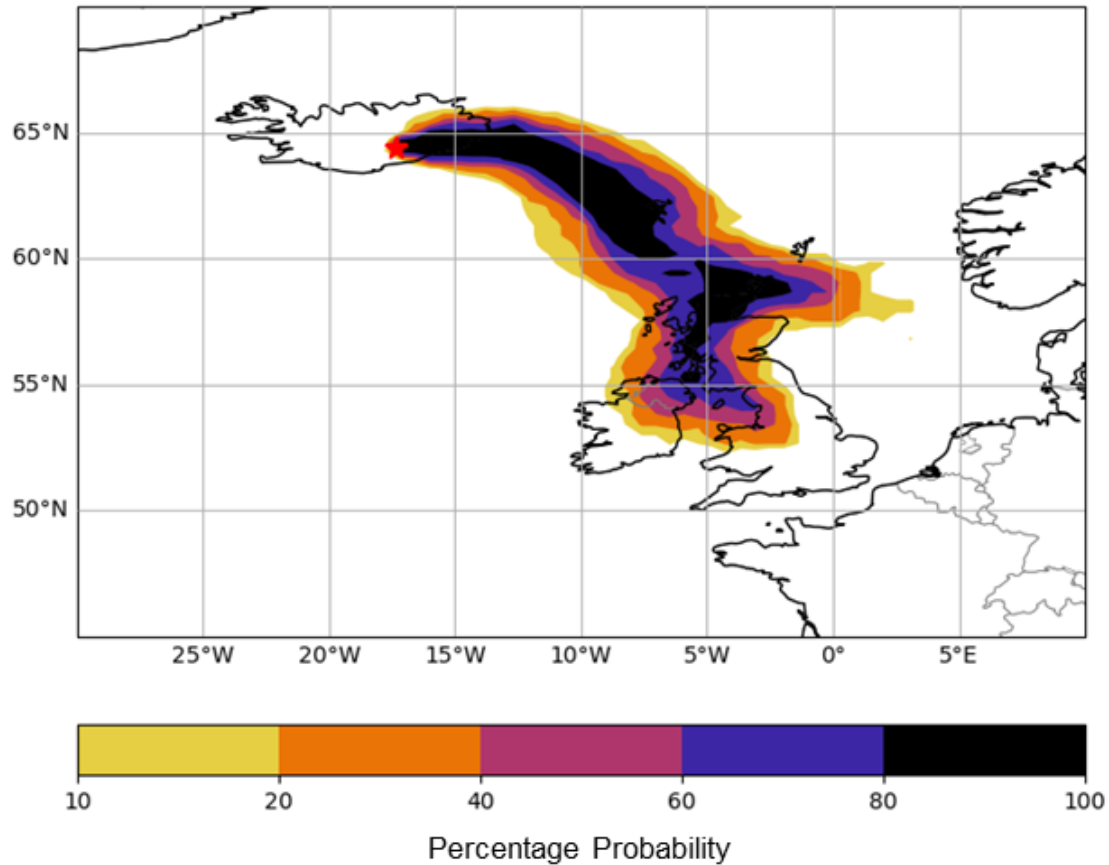


Figure 7. Same as Figure 1 but overlaid with the VAG (purple polygon).

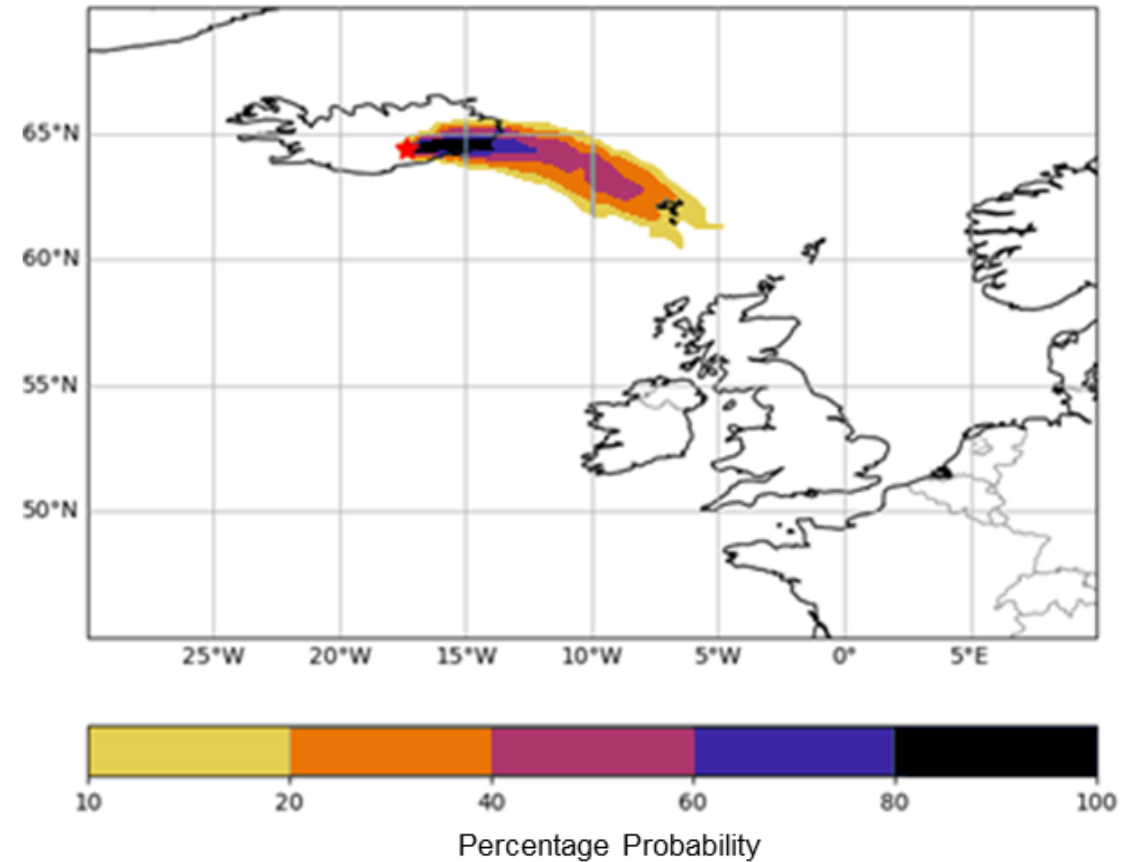


Probability of exceeding 0.2 mg/m^3 (minimum for VAA) and 2.0 mg/m^3 (likely lower limit for damage).

Probability of exceeding 0.2 mg/m^3
From FL250 to FL300
Valid 18:00UTC 05/08/2022

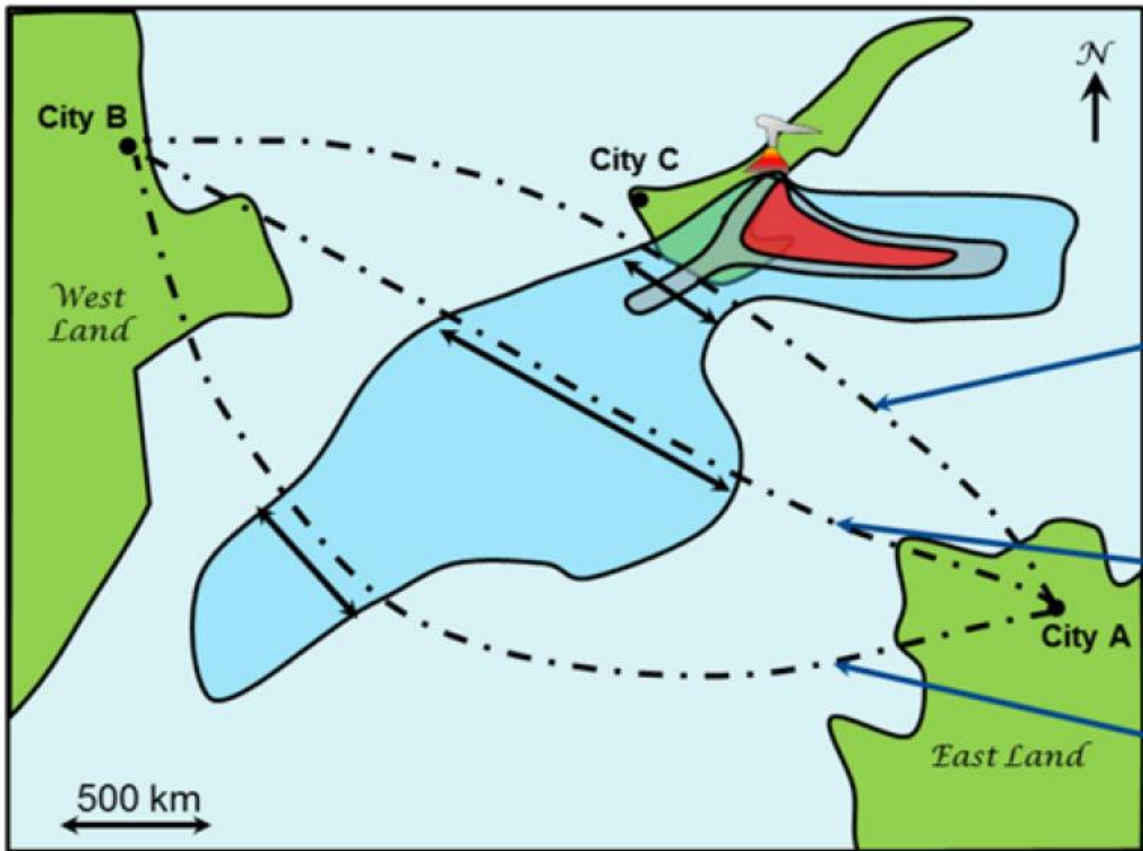


Probability of exceeding 2 mg/m^3
From FL250 to FL300
Valid 18:00UTC 05/08/2022





Volcanic ash dose calculation



Ash Concentration Contours for FL300 to FL350

- 0.2-2 mg/m³
- 2-5 mg/m³
- >5 mg/m³

Flight Plan Example 1
 7 min (100 km) at 5 mg/m³
 23 min (335 km) at 2 mg/m³
 = 2.1 + 2.76 = **4.86 g s/m³**

Flight Plan Example 2
 79 min (1150 km) at 2 mg/m³
 = **9.48 g s/m³**

Flight Plan Example 3
 35 min (500 km) at 2 mg/m³
 = **4.20 g s/m³**



“Significant” volcanic ash clouds

- QVA information will only be provided for “significant” volcanic ash clouds – defined in Annex 3 as *“an ash cloud that poses a widespread impact to aircraft operations and air navigation”*.
- Guidance on what constitutes a ‘widespread impact’ is being coordinated across the VAACs but is expected include:
 - an ash cloud with a certain vertical extent
 - an ash cloud within (or expected to move within) a certain distance of an airport
 - impact of ash on aviation operations
- VAACs may choose to *not* provide QVA if they have no confidence in the output (ie due to MET cloud cover)



Data Distribution

- VAACs will provide a SWIM compliant API to allow access to the data.
- “Publish-subscribe” services (AMQP) suit the irregular nature of volcanic eruptions and it is expected that this will be used.
- Consideration being made of whether local distribution via AFS is required.



QVA timeline

Annex 3	Inclusion
Amd 82 Expected:	RP for VAACs in a position to do so in Nov 2025. RP for all VAACs in Nov 2026.
Amd 83 Planned:	Standard for all VAACs from 2030 (delayed applicability, still just for 'significant' VA events).
Amd 84 Considering:	Extending QVA for all airborne VA. Improved temporal/spatial resolution.
Amd ??	Considerations for VAA and VA SIGMET discontinuation.



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More information...

- QVA Flyer (most up-to-date version)
<https://www.icao.int/airnavigation/METP/MOG%20IAVW%20Reference%20Documents/Forms/AllItems.aspx>
- Relevant ICAO Docs are being updated! (Docs 8896, 9766, 9691, 9744...)
- QVA Users Workshop planning underway for October 2024 in Paris, ICAO EUR Office – presentations to be provided in hybrid format, recorded for later viewing. Talk to Paula or your associated VAAC for information.



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Quantitative Volcanic Ash (QVA) Concentration Information

First edition – 13 September 2022 (corrected 121 June 2024)

1 Introduction

This document describes the quantitative volcanic ash (QVA) concentration information (hereafter referred to as 'QVA information') that is planned to be provided by volcanic ash advisory centres (VAAC) as part of the International Civil Aviation Organization's (ICAO) International Airways Volcano Watch (IAVW). It is the first in a series of information "flyers" on QVA information.

Over the past two decades there were many requests by representatives of the IAVW, through various ICAO and World Meteorological Organization fora, for aircraft and engine manufacturers to provide information on the susceptibility of aircraft and their engines to volcanic ash. The specific desire was for ash concentration thresholds to be identified that did not pose a safety concern but could improve route efficiency. This need has led to the development of QVA information.

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/m³ to 10 mg/m³, 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 (e.g., 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/m³ to 0.2 mg/m³, depending on the satellite and other factors.

QVA information will begin with an initial operating capability (IOC) that is planned to be implemented in three phases in the mid-2020s.

2 Initial operating capability (IOC)

The IOC for QVA will provide forecasts of ash concentration in two data formats for significant eruptions.

2.1 Format

QVA information will be provided in two file formats. Objects will be provided in ICAO's Meteorological Information Exchange Model (IWXXM) format. Gridded data will be provided in a file format which has yet to be determined but will probably be a binary format. The IWXXM format contains a subset of the entire



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Thank you!

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