WEATHER CLIMATE WATER

World Meteorological Organization

EXECUTIVE COUNCIL CAPACITY DEVELOPMENT PANEL (EC-CDP)

Twelfth Meeting (EC-CDP12)
Geneva, Switzerland, 16-17 February 2026

EC-CDP-12/Doc. n.n(n)
(English only)

Submitted by:
WMO Secretariat

19.II.2026

VERSION of 19 February 2026

Proposed new competency framework for volcanic ash forecasters

Note — Upon adoption by WMO, this competency framework might be incorporated into the latest edition of WMO-No. 1209 under Section 2.2, "Competency Standards for Aeronautical Meteorological Personnel," as outlined below.

2.2 COMPETENCY STANDARDS FOR AERONAUTICAL METEOROLOGICAL PERSONNEL

2.2.1 **Aeronautical Meteorological Forecaster**

[…]

2.2.2 **Aeronautical Meteorological Observer**

[…]

2.2.3 **Volcanic Ash Forecaster**

Note: The following competency standards are mostly intended to apply to forecasters at volcanic ash advisory centres (VAACs).

Competency standards

A volcanic ash forecaster should be able to perform the tasks specified in the top-level competency standards for an aeronautical meteorological forecaster (2.2.1 refers). **It is noted that a volcanic ash forecaster at VAACs is not requested to perform tasks related to warning of volcanic ash cloud since VAACs do not issue warnings:**

1. Analyse and continually monitor the meteorological and/or other relevant environmental situations;

2. Forecast meteorological and/or other relevant environmental phenomena and parameters;

~~Warn of hazardous meteorological and/or other relevant environmental phenomena;~~

3. Ensure the quality of meteorological and/or other relevant environmental information and services supplied to users;

4. Communicate meteorological and/or other relevant environmental information to internal and external users.

Note:

Other relevant environmental situations, phenomena, parameters and information in this context are limited to the presence of volcanic ash.

COMPETENCY 1: ANALYSE AND CONTINUALLY MONITOR THE METEOROLOGICAL AND/OR OTHER RELEVANT ENVIRONMENTAL SITUATIONS

Competency description

Monitoring of the area of responsibility and analysis of any volcanic activity[1] to determine the need for issuance, cancellation or amendment/update of volcanic ash advisories according to documented thresholds and guidance.

Performance criteria

1. Monitor the area of responsibility on a day-to-day basis;

2. Analyse and diagnose[2] the volcanic activity situation as required in volcanic ash advisory preparation;

3. Monitor the evolution of the volcanic activity, and validate current volcanic ash advisories based on this activity;

4. Appraise the need for updates of volcanic ash advisories against documented criteria and thresholds.

Background knowledge and skills

- Identification of various meteorological clouds in the troposphere and the mechanism for their formation, movement and dissipation:
  - An understanding of the synoptic or mesoscale processes that contribute to the development of cumulonimbus clouds;
  - Describe the mechanisms contributing to the development of rain or showers and the ability to contrast and compare, and contrast weather radar signatures for these phenomena with those of a volcanic ash cloud;
  - Understanding of the cloud types and precipitation amounts typically associated with synoptic and mesoscale weather systems;
  - Describe the topographic influences on cloud and precipitation.
- An understanding of wind flows induced by thermal contrasts, such as sea breeze or katabatic flows, and how these may impact volcanic ash re-suspension and/or dispersion near the surface;
- Interpretation of:

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[1] Volcanic activity represents activity related to a volcano such as eruptions, volcanic ash cloud emission and associated lightning, re-suspended volcanic ash, thermal anomalies, degassing, sulphur dioxide emission and seismicity.

[2] "Analysis" may be defined as answering the question "what is happening?", and "diagnosis" as answering "why is it happening?"

  - The suite of available weather radar, LIDAR, wind profiler and satellite data to identify volcanic ash clouds and/or volcanic gases in the atmosphere;

  - Numerical weather prediction (NWP) guidance, including deterministic, ensemble and/or atmospheric transport dispersion modelling, and other forms of objective guidance, to be utilized in the preparation of volcanic ash advisories;

  - Differences in observed parameters that may arise because of variations between automatic sensor technologies and manual observing techniques;

  - Information provided by ground observers, including from State volcano observatories, and a basic understanding of pre-eruptive seismic data as well as eruption acoustic (infrasound) data, where available;

  - Video camera (webcam) imagery used to monitor volcanoes in real- or near-real-time, where available;

  - Volcanic processes, with a basic understanding thereof, to assist interpretation of eruption type, size, composition, classification and related hazards;

  - Lightning data with respect to volcanic activity;

  - Sulphur dioxide observations and its relevant effects such as a precursor to potential eruption, volcanic gas emitted during an eruption, separation between sulphur dioxide and volcanic ash, and human health impacts;

- Interpretation of satellite imagery to:

  - Identify volcanic eruptions and volcanic ash cloud compositions compared to normal meteorological clouds;

  - Describe the differences between geostationary and polar-orbit satellite data, and implications for (spatial or temporal) coverage;

  - Understand usages, benefits and limitations of quantitative satellite imagery;

- Understanding of mathematics and physics related to the conceptual model of the atmosphere;

- Knowledge of the geography of the primary area of responsibility to assist in the identification of likely sources of volcanic activity;

- A basic understanding of the geography of the area of backup responsibility to assist in the identification of likely sources of volcanic activity;

- An understanding of the composition and structure of the atmosphere including a comprehension of the radiation balance in the atmosphere;

- Understand the structure of an atmospheric sounding, the International Standard Atmosphere (ISA) and their use to determine the height of a volcanic ash plume;

- Understand streamline and/or synoptic charts across regions and describe any significant features or developments. Volcanic activity monitoring and observing technologies, and forecasting techniques in use at the service provider;

- Basic interpretation of relevant reports, alerts and/or warnings;

  - An understanding of how meteorological observations are made at ground level and how they are displayed on charts and diagrams;
  - An understanding of the volcano observatory notice for aviation (VONA) and how it is generated;
  - An understanding of the aviation colour code and volcano observatory alerts levels, and the difference between them;
- Knowledge of the common terms relevant to aeronautical meteorology, including:
  - (Special) Visual flight rules (VFR) and instrument flight rules (IFR) and their conditions;
  - Flight Information Region (FIR) and, where used, Functional Airspace Block (FAB);
  - NOTAMs/ASHTAMs;
  - Air-reports (AIREP);
  - SIGMET/AIRMET;
- Knowledge of International Civil Aviation Organization (ICAO) location indicators and/or WMO synoptic station numbers, particularly for relevant aerodromes or stations that lay within and near the area of responsibility.

COMPETENCY 2: FORECAST METEOROLOGICAL AND/OR OTHER RELEVANT ENVIRONMENTAL PHENOMENA AND PARAMETERS

Competency description

Forecasts of the extent, movement and dispersal of volcanic ash clouds in the atmosphere including re-suspended volcanic ash, issued in the form of volcanic ash advisories, are prepared and issued in accordance with documented requirements, priorities and deadlines.

Performance criteria

1. All steps involved in the generation and issuance of volcanic ash advisory including:
   - Use of VONA issued by an SVO, aircraft reports, national warnings and other credible information sources to identify an eruption that may produce (or has produced) a volcanic ash cloud;
   - Identification of volcanic ash cloud parameters such as height, base, horizontal and vertical extent, movement, time of origin, continuous and discrete, duration and dissipation on satellite imagery and other credible information sources;
   - Use of NWP to inform stakeholders of the likely shape and distribution of volcanic ash before the dispersion model output is available;
   - Initialization of dispersion model capabilities and interpretation of its outputs including uncertainties and the need to re-run the dispersion model when output doesn't match the current situation or when conditions change;

2. Ensure that the content, accuracy and timeliness of volcanic ash advisories are prepared and issued in accordance with:

    - ICAO Annex 3 to the Convention on International Civil Aviation – *Meteorological Service for International Air Navigation* (ICAO Annex 3), ICAO *Procedures for Air Navigation Services – Meteorology* (ICAO PANS-MET, Doc 10157);

    - ICAO *Handbook on the International Airways Volcano Watch (IAVW) – Operational Procedures and Contact List* (ICAO Doc 9766);

    - ICAO *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds* (ICAO Doc 9691);

    - Regional and national codes or data formats, where applicable;

3. Generation and issuance of quantitative volcanic ash concentration information (QVA) and/or supplemental material, when and where applicable, in accordance with:

    - ICAO Annex 3 and PANS-MET (Doc 10157);

    - ICAO Doc 9766;

4. Ensure, to the extent practicable, that volcanic ash advisories are consistent (spatially and temporally) across boundaries of the VAAC area of responsibility, while maintaining integrity. This will include monitoring advisories and warnings issued for other locations or regions, as well as liaising with VAACs responsible for adjacent locations or regions as required.

Background knowledge and skills

- Knowledge of local topography and its effects on weather; such as meteorological effects of the climate zone or diurnal cycle for convection;

- Understanding of the synoptic-scale weather systems (including wind regimes and cloud formations associated with cold, warm and occluded fronts, and tropical lows) that are likely to impact the area of responsibility;

- Identify the jet stream development and movement, and its impact on volcanic ash cloud movement and dispersal;

- Knowledge of the forecasting guides and techniques of relevance to the area of responsibility pertaining to the development of significant cloud and thunderstorms;

- Access and knowledge of local diagnostic and forecast tools and aeronautical forecast preparation systems, including basic operating system functions, data processing and visualization technologies;

- Knowledge of pre-eruptive volcanic information, volcanic eruptions, volcanic ash displacement, dispersion, and/or re-suspension within the area of responsibility;

- Knowledge of hazards to aviation posed by volcanic eruptions and volcanic ash clouds and gases in the atmosphere;

- Interpret volcanic ash-related aviation products (for example, SIGMET, AIREP, NOTAM/ASHTAM) to ensure consistency with the volcanic ash advisory;

- Monitor for aviation products generated from the volcanic ash advisory and liaise with appropriate agency if product is not issued (e.g. SIGMET);
- Knowledge of international, national and local advisory, alerting, warning and monitoring procedures, directives and instructions of relevance to services for aviation;
- Understanding of the significance of volcanic ash advisories and data thresholds and describe their likely impact on aviation operations;
- Identify volcanic ash through satellite imagery analysis, automated alerts, SVO reports, and aircraft reports;
- Understanding of NWP guidance and output, to determine accuracy, reliability and limitations of data;
- Understanding of dispersion modelling techniques including the initial conditions, NWP inputs, ensembles and output, to determine accuracy, reliability and limitations of data;
- Understanding and monitoring of sulphur dioxide as a precursor to a potential eruption and volcanic gas emitted during eruption as well as potential divergence between clouds of sulphur dioxide and volcanic ash;
- Understanding of the role of persistence and extrapolation forecasting for volcanic ash clouds;
- Combine credible sources of information to prepare a basic wind and volcanic ash cloud forecast for a volcanic eruption and describe the implications of this wind forecast on the displacement of the volcanic ash cloud;
- Knowledge of probabilistic volcanic ash concentration data and associated guidance material;
- Background knowledge and skills in accordance with the relevant ICAO and WMO documents, including:
    - ICAO Annex 3 and PANS-MET (Doc 10157);
    - ICAO *Manual of Aeronautical Meteorological Practice* (Doc 8896);
    - ICAO *Handbook on the International Airways Volcano Watch (IAVW) – Operational Procedures and Contact List* (ICAO Doc 9766);
    - ICAO *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds* (ICAO Doc 9691)
    - WMO *Manual on Codes* (WMO-No. 306);
- Knowledge of regional or national aeronautical meteorological codes and forms of data representation;
- Understanding aviation user requirements, including:
    - The requirements for volcanic ash information for pre-flight planning and in-flight re-planning;

- Impacts of volcanic ash conditions on aviation operations, including air traffic disruption, use of air traffic routes, holding and diversions, aerodrome arrivals and departures, and aerodrome closures or restrictions;

- Effects of volcanic ash deposition on runways and taxiways on aerodrome operations and aircraft performance (for example, braking action);

- Aerodrome operating minima, the need for and availability of alternates and impacts on aircraft operational requirements;

- Effects of volcanic ash on airframe (including windscreen and other leading edges), engines and avionics performance including operating tolerance;

- Volcanic ash aspects of flight planning, relevant definitions required to give explanations to users; procedures for meteorological services for international air navigation; types of meteorological information required for Air Traffic Services, aerodrome control towers, approach and area control, and flight information centres.

~~**COMPETENCY 3: WARN OF HAZARDOUS METEOROLOGICAL AND/OR OTHER RELEVANT ENVIRONMENTAL PHENOMENA**~~

~~**Competency description**~~

~~Not required since VAACs do not issue warnings.~~

~~**Performance criteria**~~

~~Not required since VAACs do not issue warnings.~~

~~**Background knowledge and skills**~~

~~Not required since VAACs do not issue warnings.~~

COMPETENCY 3: ENSURE THE QUALITY OF METEOROLOGICAL AND/OR OTHER RELEVANT ENVIRONMENTAL INFORMATION AND SERVICES SUPPLIED TO USERS

Competency description

The quality of volcanic ash advisories, data and related services is ensured at the required level by the application of documented quality management processes.

Performance criteria

1. Apply the organization’s quality management system and procedures;

2. Maintain business continuity for service delivery according to relevant international, regional or national guidelines;

3. Assess the impact of known NWP and dispersion model uncertainties and observational error characteristics (for example, volcanic ash heights determined from satellite imagery or reports from various sources of credible information) on volcanic ash advisories;

4. Check volcanic activity, information, data, advisories and warnings (timeliness, completeness, authenticity and consistency) in real time;

5. Verify the consistency and accuracy of advisories, where possible;

6. Monitor the functioning of operational systems and take remedial actions when necessary.

Background knowledge and skills

- Knowledge of international, national and local forecast, advisory, alert, and/or warning and monitoring procedures, directives and instructions;

- Understanding of documented business continuity procedures relating to handover/takeover and back-up of services; including:

  - VAAC handover/takeover and volcanic ash approaching boundary of area of responsibility;

  - Actions to be taken in the event of recurrent discrepancies, inconsistencies and malfunctions;

  - Fall-back procedures in the case of computer or other such system failure;

  - Contingency arrangements in case of an evacuation due to emergencies such as fire alarms, bomb alerts or disasters from natural hazards;

- Use local diagnostic and forecast tools and forecast preparation systems, including basic operating system functions, data processing and visualization technologies;

- Interpret volcanic ash-related aviation products (for example, SIGMETs) and monitor the timeliness of products issued after the advisory;

- Knowledge of applicable forecast verification scheme(s) and verification statistics;

- Knowledge of quality management systems;

- Knowledge of aviation safety management systems, as required;

- Knowledge of standards, recommended practices and procedures as defined in ICAO Annex 3 and PANS-MET, guidance as contained in ICAO Doc 9766, and quality management system procedures as defined in ISO 9001 standards and national regulations:

  - Procedures for checking, identifying and correcting errors and omissions;

  - Methods for identifying significant differences between factual and forecast data;

  - Knowing when to ignore information and where to go to resolve points of contention;

  - Desirable accuracy of forecasts as stipulated in ICAO Annex 3 and national regulations;

  - Priorities and schedules.

COMPETENCY 4: COMMUNICATE METEOROLOGICAL AND/OR OTHER RELEVANT ENVIRONMENTAL INFORMATION TO INTERNAL AND EXTERNAL USERS

Competency description

User requirements are fulfilled by communicating concise and complete forecasts, advisories, data and/or other relevant volcanic activity in a manner that can be clearly understood by the users.

Performance criteria

1. Ensure that volcanic ash advisories and dispersion data are disseminated through the authorized communication means and channels to the users concerned;

2. Explain[3] volcanic activity, relevant data and information to users in a clear and concise manner using suitable (where necessary, non-technical) terminology, and provide briefings and consultations that meet specific user needs.

Background knowledge and skills

- Conduct a routine, high-quality self-briefing, which may include a shift handover briefing, of the recent and current volcanic activity situation, and to integrate volcanic ash-related available data to produce a consolidated diagnosis;

- Explain the volcanic activity, meteorological/dispersion model output, and procedural reasons behind a forecast and advisory decision including uncertainties using terminology that will be well-understood by the user;

- Knowledge of the likely impact of forecasts of the volcanic activity parameters and phenomena on aviation operations;

- Knowledge of the means of dissemination of volcanic ash data and information to users;

- Understanding of the use of aeronautical meteorological telecommunications.

REGIONAL VARIATIONS

- Locally agreed and documented procedures, criteria and thresholds;

- Risk assessment and estimation of forecast uncertainties;

- Regional and local regulations;

- Boundaries of forecast areas;

- Extent, scope and (if applicable) exclusions of quality management system implementation;

- Communication language(s);

- Communication technology for advisory transmission and for flight briefing.

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[3] In accordance with any language proficiency requirements stipulated by the national regulator.