U.S. DEPARTMENT OF COMMERCE/ National Oceanic and Atmospheric Administration

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OFFICE OF THE FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

National Volcanic Ash Operations Plan for Aviation

FCM-P35-2007

Washington, DC
August 2007

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National Volcanic Ash Operations Plan for Aviation

and

Support of the ICAO International Airways Volcano Watch

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PREFACE

The *National Aviation Weather Program Strategic Plan* (1997) and the *National Aviation Weather Initiatives* (1999) both identified volcanic ash as a high-priority informational need to aviation services. The risk to aviation from airborne volcanic ash is known and includes degraded engine performance (including flameout), loss of visibility, failure of critical navigational and operational instruments, and, in the worse case, loss of life. The immediate costs for aircraft encountering a dense plume are potentially major—damages up to $80 million have occurred to a single aircraft. Aircraft encountering less dense volcanic ash clouds can incur longer-term costs due to increased maintenance of engines and external surfaces.

The overall goal, as stated in the *Initiatives*, is to eliminate encounters with ash that could degrade the in-flight safety of aircrews and passengers and cause damage to the aircraft. This goal can be accomplished by improving the ability to detect, track, and forecast hazardous ash clouds and to provide adequate warnings to the aviation community on the present and future location of the cloud. To reach this goal, the National Aviation Weather Program established three objectives: (1) prevention of accidental encounters with hazardous clouds; (2) reduction of air traffic delays, diversions, or evasive actions when hazardous clouds are present; and (3) the development of a single, worldwide standard for exchange of information on airborne hazardous materials.

To that end, over the last several years, based on numerous documents (including an OFCM-sponsored comprehensive study on aviation training and an update of Aviation Weather Programs/Projects), user forums, and two International Conferences on Volcanic Ash and Aviation Safety (1992 and 2004), the Working Group for Volcanic Ash (WG/VA), under the OFCM-sponsored Committee for Aviation Services and Research, developed the *National Volcanic Ash Operations Plan for Aviation and Support of the International Civil Aviation Organization's (ICAO) International Airways Volcano Watch*. This plan defines agency responsibilities, provides a comprehensive description of an interagency standard for volcanic ash products and their formats, describes the agency backup procedures for operational products, and outlines the actions to be taken by each agency following an occurrence of a volcanic eruption that subsequently affects and impacts aviation services.

Since our most recent International Conference on Volcanic Ash and Aviation Safety, volcanic ash-related product and service activities have grown considerably along with partnerships and alliances throughout the aviation community. In January 2005, the National Oceanic and Atmospheric Administration's National Centers for Environment Prediction began running the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model in place of the Volcanic Ash Forecast Transport and Dispersion (VAFTAD) model, upgrading support to the volcanic ash advisory community. Today, improvements to the HYSPLIT model are ongoing based on recommendations by the OFCM-sponsored Joint Action Group for the Selection and Evaluation of Atmospheric Transport and Diffusion Models and the Joint Action Group for Atmospheric Transport and Diffusion Modeling (Research and Development Plan).

Two international workshops on volcanic ash have already taken place, noticeable improvements and innovations in education, training, and outreach have been made, and federal and public education and training programs on volcanic ash-related products, services, and procedures

continue to evolve. For example, in partnership with Embry-Riddle Aeronautical University and other academic institutions, volcanic ash hazard and mitigation training has been incorporated into aviation meteorology courses. As an essential next step, our volcanic ash-related efforts in the near term will be centered on the development of an interagency implementation plan to document and address the most critical needs of the volcanic ash advisory community.

This interagency plan, developed as the result of the cooperative efforts of six federal agencies, follows the guidelines in support of the ICAO International Airways Volcano Watch. The signatories on the next page are committed to volcanic ash operations for aviation and will work toward full implementation through agency programs, initiatives, and procedures.

I extend my sincere thanks to all members of the WG/VA, subject-matter experts, and to my staff for their collaborative and cooperative efforts in developing this first-ever national volcanic ash operations plan.

//Signed//

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The National Volcanic Ash Operations Plan for Aviation
and
Support of the ICAO International Airways Volcano Watch

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Chapter 1
Introduction and Background

1.0 Purpose. *The National Volcanic Ash Operations Plan for Aviation (NVAOPA) and Support of the International Civil Aviation Organization International Airways Volcano Watch* supports the observing, tracking, monitoring, forecasting and reporting of volcanic ash in the atmosphere as it affects the safety of flight operations in the United States National Airspace System (NAS) for domestic and U.S. controlled international/oceanic service. This document identifies the federal agencies that implement these actions and describes their responsibilities, procedures/actions, and message formats.

This document also provides information on how the Federal Aviation Administration (FAA), as the U.S. meteorological authority with regard to the International Civil Aviation Organization (ICAO), meets its obligations to the International Airways Volcano Watch (IAVW), which is sponsored by ICAO.

Information on points of contact and useful Web sites are provided in this document. However, readers of this document are encouraged to visit the current Web sites to obtain the most current information on accessing information. Even though this document establishes the framework for operations, each agency has the responsibility to document its internal procedures for implementation of this plan.

1.1 Relation to Other Handbooks, Directives, and Manuals

The NVAOPA is consistent with agreements and publications of the World Meteorological Organization (WMO), ICAO, and civil as well as military weather services:

International:

- ICAO Annex 3, Meteorological Services for International Air Navigation
- ICAO Annex 10, Aeronautical Communication
- ICAO Annex 11, Air Traffic Services
- ICAO Annex 15, Aeronautical Information Services
- ICAO Handbook on the International Airways Volcano Watch (IAVW): Operational Procedures and Contact List (Document 9766)
- ICAO Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds (Document 9691)
- WMO No. 306 – Manual for Codes

Domestic:

- National Oceanic and Atmospheric Administration's National Weather Service Directives, series 10-8 Aviation Weather Services, available at http://www.nws.noaa.gov/directives.
- FMH-12, Federal Meteorological Handbook No. 12 - United States Meteorological Codes and Coding Practices, available at http://www.ofcm.gov/fmh12/frontpage.htm

- FMH-1, Federal Meteorological Handbook No. 1 - Surface Weather Observations and Reports, available at http://www.ofcm.gov/fmh-1/fmh1.htm.
- FAA Order 7110.10: Flight Service
- FAA Order 7110.65: Air Traffic Control
- FAA Order 7930.2: Notices to AIRMEN
- FAA Order 7900.5: Surface Weather Observing
- FAA Aeronautical Information Manual
- FAA Aeronautical Information Publication
- FAA AC-00-45E, Aviation Weather Services
- FAA AC-00-6A, Aviation Weather for Pilots and Flight Operations Personnel
- FAA 8400.10, Handbook for Principal Operating Inspector

1.2 Regional Volcanic Ash Operations Plans. In addition to the *National Volcanic Ash Operations Plan for Aviation*, there are two separate and distinct regional plans which provide operational guidance, supplemental information, and more detail at the regional level for volcanic ash operations in response to volcanic ash episodes and hazards in the Alaskan and Northern Marianas Islands regions.

a. The Interagency Operating Plan for Volcanic Ash Episodes in Alaska

This plan provides an overview of integrated operations among multiple agencies in response to the threat of volcanic ash affecting Alaska, and an agency-by-agency description of roles and responsibilities in such events. The agencies involved in this operating plan are: the Federal Aviation Administration (FAA); the Alaska Volcano Observatory (AVO) operated jointly by the United States Geological Survey (USGS), Alaska Division of Geological and Geophysical Surveys (ADGGS) and the University of Alaska Fairbanks Geophysical Institute (UAFGI); the National Weather Service (NWS); the Department of Defense (DOD); the State Division of Homeland Security and Emergency Management (DHS&EM); and the United States Coast Guard (USCG). It covers the State of Alaska and the adjacent United States airspace Flight Information Regions (FIR). It also includes responsibility for volcanic ash transported by upper winds from erupting volcanoes outside the United States FIRs into the Alaska airspace, such as those in Kamchatka and the Kurile Islands, Russia. To access this plan, please go to http://aawu.arh.noaa.gov/interagency/interagency_plan.pdf or contact NWS Alaska Region Headquarters, ESSD Administration, 907-271-3508.

b. The Interagency Operating Plan for Volcanic Ash Hazards to Aviation in the Pacific Region of the Northern Marianas Islands

This plan provides operational guidelines in support of the detection, observation, tracking, and reporting of airborne volcanic ash as it affects the safety of flight operations in the region of the Northern Mariana Islands airspace. It outlines a framework for interaction among the pertinent federal and local agencies within the context of the International Airways Volcano Watch (IAVW) developed by the International Civil Aviation Organization (ICAO). It also addresses the responsibilities, operational procedures/actions, and information products of each agency that supports the IAVW. This plan refines and codifies the necessary procedures to provide reliable, consistent ash-hazard information to the aviation sector in the Marianas region. To access this plan,

please contact the USGS Volcano Hazard Program, 703-648-6712.

1.3 Format of this plan

Chapter 2 presents an overview of the responsibilities of the cooperating agencies in support of the NVAOPA.

Chapter 3 presents a listing of operational products related to volcanic ash in support of aviation operations.

Chapter 4 discusses general operations and procedures to carry out each agency's mission related to volcanic ash in support of aviation operations.

Chapter 5 provides examples of operational products related to volcanic ash in support of aviation operations.

Appendix A outlines agency backup operational procedures.

Appendix B discusses transport and dispersion models.

Appendix C defines the acronyms and terms used in this plan.

Appendix D is a list of U.S. Volcanoes with associated Air-Route-Traffic Control Centers, Meteorological Watch Offices, and Weather Forecast Offices.

1.4 Changes to The Plan

Changes, additions, deletions, and corrections will be issued, as necessary. These changes shall be issued only by the Office of the Federal Coordinator for Meteorology after consultation and coordination with the Working Group for Volcanic Ash.

1.5 Agency Procedures and Procedural Changes

Individual agencies issue their own manuals and directives defining their procedures which implement the NVAOPA. Such manuals shall complement, not change, the operational procedures contained within this document.

1.6 Questions and Suggestions Regarding the Plan

Questions or suggestions about the content/organization of the Plan should be directed to:

The Office of the Federal Coordinator for Meteorology
8455 Colesville Road, Suite 1500
Silver Spring, MD 20910
Telephone: Commercial (301) 427-2002
FAX (301) 427-2007
DSN 851-1460

Chapter 2
Responsibilities of Cooperating Agencies

2.0 General. There are four principal federal agencies that support the NVAOPA:

- Department of Commerce, National Oceanic and Atmospheric Administration
- Department of Defense, United States Air Force
- Department of Interior, United States Geologic Survey
- Department of Transportation, Federal Aviation Administration

The National Aeronautics and Space Administration and the Smithsonian Institution also provide support to the federal agencies through extending the benefits of earth science research in the areas of volcanic ash observation, tracking, and eruption characteristics. In addition, the Smithsonian Institution archives information on volcanoes, not only in the United States, but globally.

2.1 Responsibilities of Federal Agencies

2.1.1 Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). NOAA is responsible for the operational monitoring of the state of the atmosphere, including the presence of volcanic ash clouds injected into the atmosphere by eruptions. NOAA, through several of its line offices, maintains the observational, analytical, and forecasting capabilities required to estimate the location and movement of volcanic ash clouds throughout its areas of responsibility.

2.1.1.1 National Environmental Satellite, Data, and Information Service (NESDIS). The Satellite Analysis Branch of NESDIS operates the Washington Volcanic Ash Advisory Center (VAAC) in conjunction with the National Weather Service, National Centers for Environmental Prediction (NCEP).

2.1.1.2 National Weather Service (NWS). NOAA's NWS operates the Anchorage VAAC and shares the responsibility of operating the Washington VAAC with NESDIS. The NWS operates:

- The ICAO-stipulated World Area Forecast Center (WAFC)
- Three Meteorological Watch Offices (MWO) located in Anchorage, Honolulu, and Kansas City
- Numerous Weather Forecast Offices (WFO)
- Numerous Center Weather Service Units (CWSU) in support of FAA Air Route Traffic Control Centers (ARTCC).

Through these units, the NWS provides forecasts, advisories, and warnings for volcanic ash.

2.1.1.3 Office of Oceanic and Atmospheric Research. The Office of Oceanic and Atmospheric Research's Air Resources Laboratory conducts supporting research to improve dispersion forecast guidance and is responsible for transferring updated dispersion modeling capabilities to the NWS NCEP. Air Resources Laboratory developed the HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) dispersion model that is used operationally at NCEP.

2.1.2 Department of Defense, United States Air Force (USAF). The USAF through its 2nd Weather Group, Air Force Weather Agency (AFWA), Offutt Air Force Base, Nebraska, is the DOD focal point for volcanic ash advisories and forecasts. AFWA is responsible for issuing advisory text messages and providing imagery analysis and forecast visualization products for U.S. forces worldwide.

2.1.3 Department of Interior, United States Geological Survey (USGS). The USGS has the federal responsibility to issue disaster warnings for earthquakes, volcanic eruptions, landslides, or other geologic catastrophes. The USGS provides eruption warnings and related notifications based on data and observations collected from extensive monitoring networks operated by five U.S. volcano observatories supported primarily by the USGS Volcano Hazards Program.

2.1.4 Department of Transportation, Federal Aviation Administration (FAA). FAA is responsible for issuing and disseminating Notices to Airmen (NOTAM) when notified of precursory volcanic unrest, eruptive activity, or volcanic ash in the NAS. In addition, the FAA, through its communication network, disseminates information on volcanic ash to Airline Operations Centers (AOC), ARTCC, Terminal Radar Approach Control (TRACON), Flight Service Stations (FSS), towers, System Operations, and other users of the NAS.

2.1.5 National Aeronautics and Space Administration (NASA). NASA supports space-based observation and tracking of ash plumes and volcanic gases through the use of earth-observing research satellites. NASA sensors that can characterize volcanic ash include: the Moderate Resolution Imaging Spectroradiometer, the Ozone Monitoring Instrument, and the Tropospheric Emission Spectrometer.

In collaboration with the FAA Aviation Weather Research Program, NASA provides satellite observations for research on volcanic ash detection. NASA's research capabilities are transferred to operational forecasting tools as worked out in agreements with other agencies. Through competitive solicitations, NASA actively seeks to expand its research network for satellite observations of volcanic ash activity.

2.1.6 Smithsonian Institution (SI). The SI Global Volcanism Program (GVP), housed within the Mineral Sciences Department of the Natural History Museum, maintains a database on eruption histories and characteristics of the world's volcanoes. The GVP also publishes books and weekly and monthly reports on volcanoes, collects maps, specimens, photos, and video, and provides handbooks and compilations in support of understanding Earth's 1,500 volcanoes with known or possible eruptions in the past

10,000 years. The Program has a small staff generally in the Washington, D.C., office during normal business hours (9:00 a.m.-5:00 p.m., Monday-Friday, excluding federal holidays).

Chapter 3
Volcanic Ash Related Products

3.0 General. The following is a list of products that may contain volcanic ash or volcanic activity information in support of aviation operations. These products are categorized as: observations, advisories, inflight weather advisories/warnings, notices, forecasts, and model output. Examples of these products in their unique message formats are in Chapter 5.

3.1 Observations

3.1.1 METAR: METeorological Aerodrome Report. *An international code (Aviation Routine Weather Report) used for reporting, recording and transmitting weather observations.*

3.1.1a SPECI: *In the METAR observation program, a surface observation issued on a non-routine basis as dictated by changing meteorological conditions.* Volcanic ash observed at an aerodrome or in the vicinity of an aerodrome is normally reported in this report**.**

3.1.2 PIREP: Pilot Report. *A report of inflight weather by an aircraft pilot or crew member.* Pilots who observe volcanic ash can report the information in an AIREP or PIREP. When volcanic ash information is issued in a PIREP the report is referred to as an Urgent PIREP.

3.1.2a AIREP: Aircraft Report. *A report from an aircraft in flight prepared in conformity with requirements for position, and operational and/or meteorological reporting.* An AIREP is an inflight evaluation usually made over areas where weather information is limited or non-existent (for example, over an ocean).

3.1.3 VAR: Volcanic Activity Report. *A report of volcanic ash similar in format to a PIREP. However, the VAR may include additional information on the physical characteristics of the ash.* It may also be a special AIREP with a supplemental section that describes the ash cloud. Pilots normally provide VAR information immediately upon completion of flight operations or during flight debriefings. (Note: per guidance in the Aeronautical Information Manual, items 1-8 of the VAR are to be transmitted immediately to the ARTCC.)

3.2 Advisories

3.2.1 VAA: Volcanic Ash Advisory. *Information issued by a Volcanic Ash Advisory Center concerning the occurrence or expected occurrence of volcanic ash that may affect the safety of aircraft operations.* A VAA is a text message that identifies the volcano, time of eruption, observed position of the ash cloud, and the forecasted position of the ash. The VAA is not to be used as a warning message.

3.2.2 VAG: Volcanic Ash Graphic. *A graphical depiction of the Volcanic Ash Advisory (VAA).*

3.3 Inflight Weather Advisories/Warnings

3.3.1 CWA: Center Weather Advisory. *The CWA is a 0-2 hour (valid up to 2 hours after issuance) aviation weather warning* primarily used by pilots to anticipate and avoid adverse weather conditions in the en route and terminal environments.

3.3.2 MIS: Meteorological Impact Statement. *An unscheduled flow control and flight operations planning forecast. It is a 2-12 hour (valid up to 12 hours after issuance) briefing and forecast product at ARTCC, Air Traffic Control System Command Center (ATCSCC), TRACON, and the Air Traffic Control Towers (ATCT) responsible for making flow-control type decisions.*

3.3.3 SIGMET: SIGnificant METeorological Information. *SIGMET is a brief description of the occurrence and/or expected occurrence of specified en route weather phenomena that may affect the safety of all aircraft operations (e.g. occurrence or expected occurrence of a volcanic ash cloud).*

3.4 Notices

3.4.1 NOTAM: Notice to Airmen. *A notice containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.* Information related to the pre-eruption or eruptive stage of a volcano can be reported in a NOTAM. Included in a NOTAM is the color code, which is provided by a Volcano Observatory (VO). The NOTAM Office normally issues a NOTAM based on information as provided by the ARTCC.

3.4.2 VONA: Volcano Observatory Notice for Aviation. *A short message in structured format issued by a USGS Volcanic Observatory to describe volcanic activity to the aviation sector, highlighting ash-plume information and including the aviation color code.* The VONA is provided to the appropriate ARTCC, MWO, and VAAC in support of the issuance of NOTAM, VAA, VAG, and SIGMET, as well as to AFWA to support DOD advisories.

3.5 Forecasts

3.5.1 FA: Area Forecast. *Forecast issued by the MWO which describes weather conditions specific to aviation interests.* Each FA contains a synopsis, forecast, and outlook portion. FA issuance times and forecast periods vary somewhat due to customer requirements. The FA will describe, in abbreviated language, specified en route weather phenomena below FL450. FAs are produced for the following areas:

- Six (6) geographical areas in the Continental United States (CONUS) and adjacent coastal waters
- Hawaiian Islands and coastal waters (out to 40 nm from the coastline)
- State of Alaska and coastal waters of Alaska.

3.5.2 TAF: Terminal Aerodrome Forecast. *A forecast of meteorological conditions significant to aviation at an airport location (location within 5 nm of center of the airport's runway complex).* These forecasts are issued by NWS and DOD every 6 hours with amendments issued as needed.

3.6 Model Output

3.6.1 HYSPLIT: The HYbrid Single-Particle Lagrangian Integrated Trajectory model. *HYSPLIT forecast transport and dispersion model output is issued by the NWS as guidance.*

Chapter 4
Operations and Procedures

4.0 General. Every effort has been made to standardize terminology, adopt common definitions, and adjust criteria to a common base; however, each agency has different operational criteria that must be met. Standardization is used wherever possible in advisories, forecasts and warnings; however, each agency retains the right to specify the criteria needed to carry out its mission. Figure 4-1 shows the principal exchange and flow of products and information for volcanic ash.

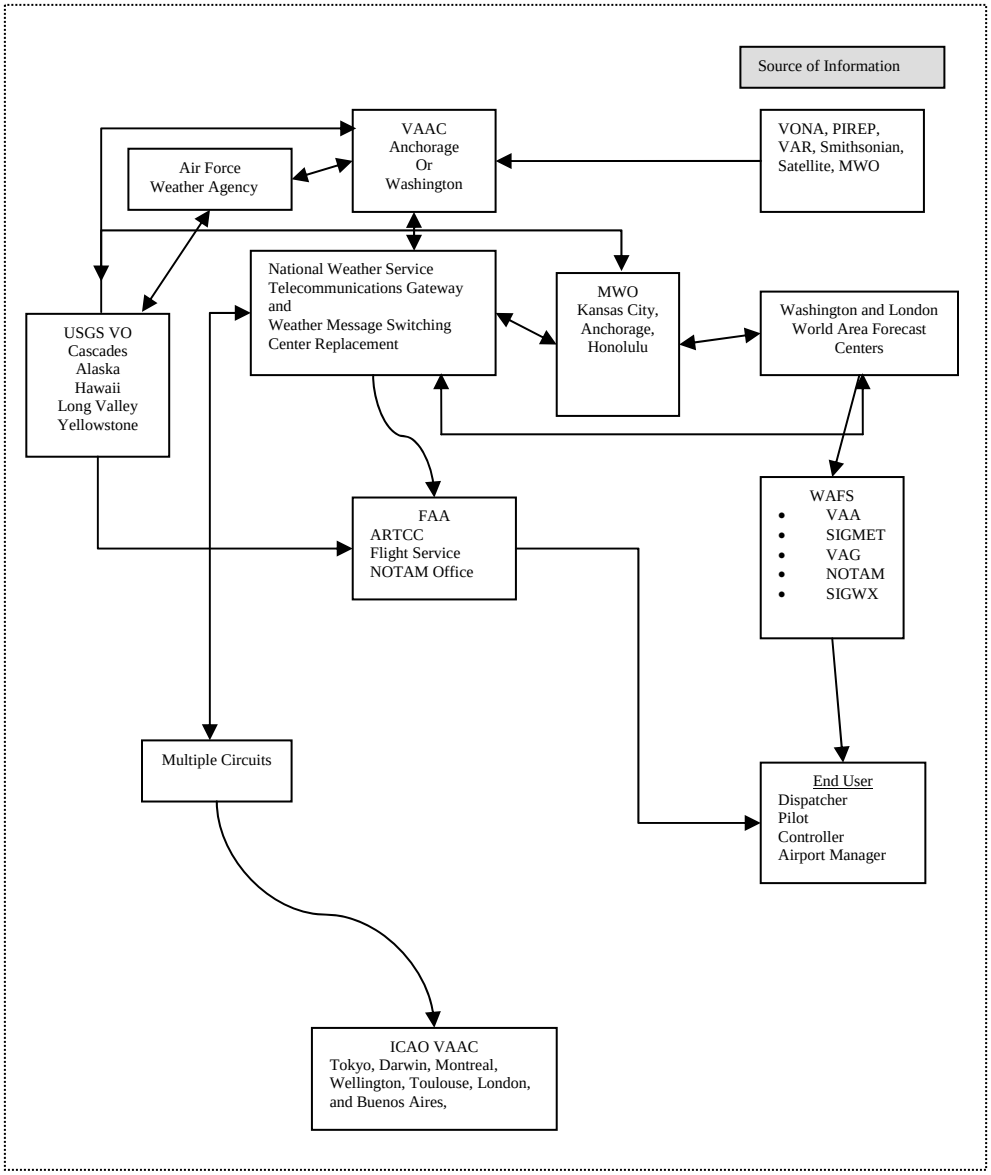


Figure 4-1. Principal Exchange and Flow of Information for Volcanic Ash. This flow diagram shows the principal routes that information will flow between units/offices for the issuance of a VAA, VAG, SIGMET, NOTAM, VONA, PIREP, or VAR. Information can enter at various points on the diagram. It is not to imply that these are the only approved means of routing information but rather to convey who is required to have information available and their primary source for the information.

4.1 National Weather Service and National Environmental Satellite, Data, and Information Service

4.1.1 General. The NWS and NESDIS have the responsibility for providing warnings or advisories for the CONUS, coastal waters, U.S. controlled oceanic flight information regions (FIR), and Alaska. This responsibility is fulfilled by the NCEP/Aviation Weather Center, WFO, CWSU, MWO, and VAAC. The NWS also has responsibility to disseminate reports, warnings and advisories.

4.1.2 Operations and Procedures. The Anchorage and Washington VAAC are staffed 24 hours per day, 7 days per week to provide guidance and support to MWO and the aviation community (Fig. 4-2). Duty meteorologists are tasked to monitor remote sensing data, PIREPs, and reports from the VO and aviation community on a continuous basis. The VAAC are also tasked to run the ash dispersion models, determine current and forecast area extent of the ash, and produce VAA and VAG for its customers. The MWO are responsible for issuing the volcanic ash SIGMET (WV).

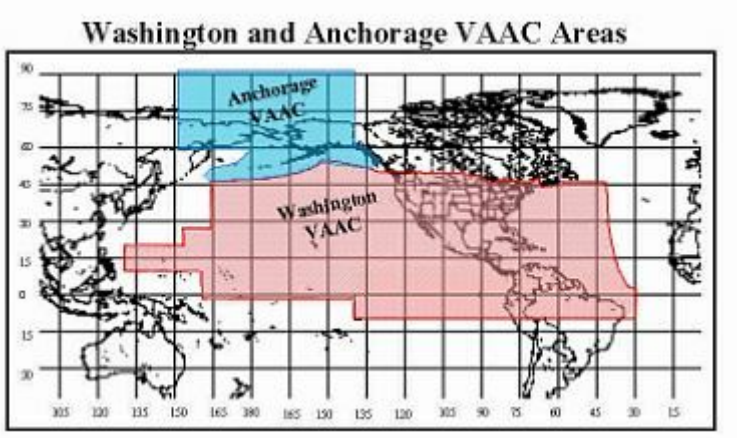


Figure 4-2. The area of responsibility for the Washington, D.C. (red) and Anchorage, AK (blue) VAACs.

4.1.2.1 Volcanic Ash Advisory Centers. The Washington and Anchorage VAAC each issue VAA and VAG as support and guidance to the MWO for issuance of WV.

Upon detection of volcanic ash in satellite imagery or upon receipt of a report of volcanic activity or ash from a bona fide source, the VAAC will:

- Review/analyze satellite images and other data sets of the area for the time of the event to confirm the presence of a volcanic ash cloud and, if possible, its extent.
- Prepare and issue advisory information (VAA/VAG) on the observed and forecasted location of the volcanic ash cloud, in both text and graphical format, for transmission to the MWO and ARTCC.

- As needed, initiate the NOAA volcanic ash dispersion model (HYSPLIT; see appendix B) in order to provide guidance in preparing the VAA/VAG.

The VAAC will monitor subsequent satellite information to assist in tracking the movement of ash clouds, updating of advisory information to the MWO, ARTCC, and AOC at intervals of at least 6 hours, or sooner, until the ash cloud is no longer identifiable from satellite imagery or no further reports of volcanic ash or further eruptions have been received.

4.1.2.2 Meteorological Watch Offices. There are three MWOs in the United States: Anchorage, Alaska; Honolulu, Hawaii; and Kansas City, Missouri. The Kansas City MWO is also known as the Aviation Weather Center and the Anchorage MWO is known as the Alaska Aviation Weather Unit. The MWO is responsible for the issuance of a SIGMET for volcanic ash. Upon receipt of information concerning a volcanic eruption and/or the existence of a volcanic ash cloud, the MWO:

- Issues a SIGMET;
- Amends the FA, if appropriate;
- Notifies the VAAC; and
- Advises the ARTCC/Flight Service Station (FSS) whether or not ash is identifiable on satellite and provide any follow-up information concerning both horizontal and vertical extent of the ash plume.

Alaska only: In addition to the SIGMET, the MWO will amend the Area Forecast if applicable to include reference to the SIGMET.

The Kansas City MWO supports:

- 20 ARTCC in the conterminous United States including coastal waters
- New York, Miami, San Juan Oceanic FIRs
- Oakland Oceanic FIR north of 30 degrees N latitude, and the portion east of 140 degrees west longitude, which is between the equator and 30 degrees north latitude

The Honolulu MWO is responsible for the Oakland Oceanic FIR south of 30 degrees north, and between 140 west and 130 east longitude.

The Anchorage MWO supports the Anchorage FIR.

Current SIGMET information can be found at: http://aviationweather.noaa.gov/

4.1.2.3 Weather Forecast Offices. The WFO are responsible for issuing the TAF for select locations. These forecasts cover a five (5) nautical mile radius around the center point of the runway complex and they are issued every 6 hours with amendments as needed. Under the NWS directive 10-5 series, the WFO also

issue Ashfall Advisories and under the 10-3 series, the WFO issue marine weather statements that include ash information.

4.1.2.4 Center Weather Service Units. The CWSU prepares the Center Weather Advisory (CWA) supporting the ARTCC in the NAS. The CWSU provides advisories of hazardous weather conditions for airborne aircraft. The role of the CWSU during a volcanic eruption will depend somewhat on the situation and flow of information. When an initial report of an eruption is received at the ARTCC, the CWSU meteorologist or designee will enter the report as an URGENT PIREP (UUA). The CWSU meteorologist will then call the MWO to relay the volcano information.

4.2 Department of Defense/United States Air Force

4.2.1 General. The U.S. Air Force through its 2nd Weather Group, Air Force Weather Agency (AFWA), Offutt Air Force Base, Nebraska, is the DOD focal point for volcanic ash advisories and forecasts. AFWA is responsible for issuing a specialized set of advisory text, imagery analysis and forecast visualization graphics products for U.S. Forces worldwide. It also provides a backup for the Washington VAAC in case of disruptions to ensure continuity of operations.

4.2.2 Operations and Procedures.

4.2.2.1 AFWA. The Meteorological Satellite (METSAT) Applications Weather Flight at 2nd Weather Group issues volcanic ash guidance products for the DOD. These products include text advisories incorporating information from NOAA VAA and SIGMET and USGS VONA. These products also include forecast ash trajectory outputs in both animation and static panel format utilizing tailored interactive graphic visualizations of Puff model trajectory forecasts and satellite imagery analysis.

AFWA will notify the appropriate VAAC if it detects an ash plume in imagery surveillance, or other observational data, and has not received a VAA message. AFWA will also notify the VAAC if imagery analysis or other data suggests different conclusions than indicated in the VAA.

When functioning as the backup for the Washington VAAC, AFWA will issue a VAA and produce a Volcanic Ash Forecast Transport and Dispersion model format graphic look-alike based on Puff. The VAG is not provided in backup mode.

4.3 United States Geological Survey

4.3.1 General. The USGS gathers and interprets volcano data from its observatory monitoring networks and any other relevant sources and provides notices of significant precursory unrest and the onset and cessation of eruptive activity. The USGS has five Volcano Observatories (VO) located as follows:

- The Hawaiian Volcano Observatory (HVO) on Hawaii Island monitors volcanoes on the islands of Hawaii and Maui and shares monitoring in the Northern Mariana Islands with other VO.
- The Cascades Volcano Observatory (CVO) in Vancouver, Washington, monitors the Cascade Range volcanoes in Washington, Oregon, and Northern California. CVO partners with the University of Washington to conduct seismic monitoring in the Cascades. CVO also shares monitoring in the Northern Mariana Islands.
- The Alaska Volcano Observatory (AVO) monitors Alaskan volcanoes in partnership with the University of Alaska Fairbanks Geophysical Institute and State of Alaska Division of Geological and Geophysical Surveys. AVO also coordinates monitoring in the Northern Mariana Islands.
- The Long Valley Observatory monitors the Long Valley caldera in California and supports CVO with monitoring of Cascade volcanoes in California.
- The Yellowstone Volcano Observatory, a collaborative effort of the USGS Volcano Hazards Program, the University of Utah, and Yellowstone National Park, monitors the Yellowstone caldera.

4.3.2 Operations and Procedures

Each VO is headed by a Scientist-in-Charge who is responsible for the overall monitoring effort and for determining alert levels for volcanoes monitored by a particular observatory. USGS VO are not staffed 24/7 on a routine basis, although duty scientists carry beepers and phones to receive automatic notification when data levels recorded on key geophysical sensors exceed pre-set thresholds. The VO operate 24/7 watches only during periods of extreme unrest or eruption.

4.3.2.1 Volcano Observatories. The principal role of the VO in support of aviation is to alert ARTCC, MWO, and VAAC of significant precursory volcanic unrest or eruptive activity, including information about ash plumes. Information provided by the VO is used by FAA in the preparation of a NOTAM on the status of the volcano, by MWO in issuance of WV, and by VAAC in issuance of VAA and VAG.

For the aviation sector, in accord with recommended ICAO procedures, VO issue color-coded alert levels – Green, Yellow, Orange, and Red – focused on airborne ash hazards (see Table 4-1). Color codes reflect conditions at the volcano and depend upon monitoring data and interpretation of changing phenomena. A telephone "call down" is implemented when alert levels are raised or lowered and when an ash-producing event occurs, in the following order of priority:

1. The appropriate ARTCC Operations Manager
2. The appropriate MWO
3. Washington or Anchorage VAAC
4. AFWA
5. The appropriate WFO

AVIATION COLOR CODES	
GREEN	Volcano is in normal, non-eruptive state. *or, after a change from a higher level*: Volcanic activity considered to have ceased, and volcano reverted to its normal, non-eruptive state.
YELLOW	Volcano is exhibiting signs of elevated unrest above known background levels. *or, after a change from higher 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]*.

Table 4-1. A description of USGS color-coded alert levels for aviation.

4.3.2.2 Volcano Observatory Notice for Aviation. The aviation color code assigned by the VO is incorporated into the text of a VONA (format in section 5.12). VONA are issued when color codes change (up or down) or within a color code when a significant change, such as an ash-producing event, occurs in volcanic activity. VONA are provided to the appropriate ARTCC, MWO, and VAAC by faxes on commercial communication networks and by emails over the public Internet.

4.3.2.3 Other VO Information. To supplement the VONA, VO also provide information in addition to what is incorporated into a NOTAM as well as information about low-level unrest (color code Yellow) that may not warrant issuance of a NOTAM. This information is available on the publicly accessible Web site http://volcanoes.usgs.gov.

4.4 Federal Aviation Administration

4.4.1 General. The FAA has the responsibility to ensure that all provisions of meteorological services are provided to users of the NAS which includes the dissemination and distribution of observations, forecasts, and warning messages that pertain to volcanic ash. In addition, the FAA is responsible for issuing a NOTAM on the status of a volcano during pre-eruption and eruption phases.

4.4.2 Operations and Procedures

4.4.2.1 Air Route Traffic Control Center. The FAA ARTCC is responsible for all activities within its designated airspace and for determining if a hazard(s) will affect its operations. The Operations Manager, upon receipt of a PIREP or other valid source of volcanic activity, should first verify that information with the respective VO (see appendix D). When an Operations Manager receives volcanic information listed in section 3.1 directly from a VO, the following procedures are recommended *(note: local facility orders may supersede these procedures)*:

A) Notify the following key personnel:
- Center Weather Service Unit Meteorologist, or designee.
- ATCSCC National Operations Manager (NOM).
- Traffic Management Unit Officer/Weather Coordinator.
- FAA Regional Operations Center.
- ARTCC Facility Manager.
- Watch Supervisor of the Automated Flight Service Station (AFSS)/FSS nearest the volcanic activity.
- Watch Supervisors of any affected TRACON and Tower.
- Systems Operations Center Maintenance Control Center.
- Air Traffic Control System Command Center.
- Military Base Operations (if appropriate).

B) Issue a Flight Data Center (FDC) NOTAM, using the information received from the VO, in the prescribed format listed in Chapter 5, Paragraph 5.11. Forward this NOTAM to the U.S. NOTAM Office (USNOF) via the NOTAM Entry System, Fax, or Commercial Phone for national/international dissemination. USNOF will disseminate FDC NOTAM nationally (and internationally if appropriate). NOTAM information is available to the public at: https://pilotweb.nas.faa.gov

C) The Operations Supervisor In Charge (OSIC)/Controller In Charge (CIC) will ensure that:
- PIREPs are solicited by controllers.
- NOTAM and PIREP information is disseminated to controllers on duty in a timely manner.

- Forward Urgent PIREP for volcanic ash to CWSU/Weather Coordinator for dissemination.

D) Traffic Management personnel will:
- Review affected areas for required traffic management initiatives and coordinate with the ATCSCC and all affected facilities.

E) Controllers will:
- Provide to aircraft the most current information available (SIGMET, CWA, MIS, PIREP) concerning the ash cloud position, altitude and movement.
- Suggest headings and re-routes around known ash or possible ash areas.
- Assist Visual Flight Rules aircraft to the extent possible in avoiding ash cloud areas.
- Solicit PIREP and forward to Operations Supervisor.

4.4.2.2 Terminal Radar Approach Control/Tower.

A) The TRACON/Tower Watch Supervisor/CIC, upon receipt of volcanic information from the ARTCC, will:
- Ensure NOTAM and PIREP information is disseminated to controllers on duty in a timely manner.
- Ensure PIREP are solicited by controllers.
- Forward PIREP to ARTCC CWSU/Weather Coordinator or AFSS/FSS for dissemination.

B) TRACON/Tower controllers are to:
- Provide SIGMET, CWA, PIREP concerning the ash cloud position, altitude and movement to flight crews.
- Suggest headings and re-routes around known ash or possible ash areas.
- Assist VFR aircraft to the extent possible in avoiding ash cloud areas.
- Solicit PIREP and forward to Watch Supervisor.

4.4.2.3 Automated Flight Service Station/Flight Service Station

A) The AFSS/FSS Watch Supervisor/Designated Lead Specialist (DLS), upon receipt of volcanic information and PIREPs from an ARTCC or a TRACON/Tower will ensure:
- NOTAM and PIREP information is disseminated to specialists on duty in a timely manner.
- PIREPS are solicited by specialists at the Inflight, Flight Watch, and Pre-flight positions.
- National dissemination of PIREPS (UA and UUA) using existing platforms.

B) The AFSS/FSS Watch Supervisor/DLS, upon receipt of volcanic activity or an ash cloud PIREP from an aircraft will:

- Ensure that the PIREP information is forwarded to the ARTCC Operations Manager.

C) AFSS/FSS specialist will:

- Provide the most current information available (SIGMET, CWA, PIREP, NOTAM) concerning volcanic activity/ash cloud position, altitude and movement in preflight/inflight briefings.
- Solicit PIREPS and input PIREP information into existing platforms for dissemination.
- Broadcast Volcanic Ash SIGMETs, CWAs and PIREPS using the Hazardous Inflight Weather Advisory Service, Tactical Information Broadcast System, and Inflight Broadcast procedures.
- Pass PIREP information received from aircraft on volcanic activity or ash clouds to the AFSS Watch Supervisor.

4.4.2.4 Air Traffic Control System Command Center (ATCSCC).

The ATCSCC is the focal point in the National Airspace System for providing guidance and direction on how best to manage traffic volume and traffic flows that are impacted by constraints. Upon receipt of VAA from the Washington or Anchorage VAAC, the ATCSCC relays the advisory to designated recipients (Traffic Management Units, airline customers, general aviation customers, military coordinators etc.) through e-mail distribution and also displays the advisory on the ATCSCC Web site in the advisories database: http://www.fly.faa.gov/adv/advADB.jsp

Chapter 5
Observation and Message Report Formats

5.0 General. This section provides examples, current as of the date of this plan, of observations, forecasts, and products which contain volcanic ash or volcanic activity information in support of aviation. The basic definitions of these were provided in Chapter 2. Refer to official agency or international documents for further information. Volcanic ash wording is highlighted in gray.

5.1 Area Forecast (FA). FA are issued for the CONUS, Alaska, and Hawaii. FA are issued three times a day in the CONUS and four (4) times a day in Alaska and Hawaii, and amended as necessary. The forecast valid period for the CONUS and Hawaii is 12 hours with an outlook period from 12 to 18 hours. In Alaska, the FA is valid for 12 hours and the outlook is valid from 12 to 30 hours. Example FA are shown for CONUS, Hawaii, and Alaska:

CONUS FA Example

```
FAUS46 KKCI 281804
FA6W
SFOC FA 281804 AMD
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 290500
CLDS/WX VALID UNTIL 282300...OTLK VALID 282300-290500
WA OR CA AND CSTL WTRS
.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.
.
SYNOPSIS...MT ST HELENS ERUPTED AT 1230 UTC.  SEE LATEST SIGMET BRAVO SERIES
FOR DETAILS.  OTRW ALF..11Z RDG OVR GREAT BASIN TO SRN CA. TROF OVR GULF OF
AK. LGT SW FLOW WA THRU NRN CA WITH LGT AND VRBL WNDS SRN CA. BY 05Z TROF
MOVG SEWD TO CSTL WTRS OF WA THRU NRN CA WITH RDG OVR
UT/WRN AZ. MOD SW FLOW WA/OR. SFC..WK TROF CNTRL WA THRU SW ORE
WITH WK TROF INTR CA. HIGH PRES OVR NRN PAC CSTL WTRS. AMS STBL
AND DRY EXC FOR CSTL STRATUS. BY 05Z CDFNT DVLPG NERN WA THRU S
CNTRL ORE WITH GUSTY WLY LOW LVL WNDS OVR WA.
.
WA CASCDS WWD ...UPDT
CASCDS...SKC. SRN PTN VIS 3SM VA.  OTLK...MVFR VA.
CSTLN...BKN-OVC010 TOP 015. VIS 3-5SM BR. 20Z SCT010.
OTLK...MVFR CIG.
INLAND...SCT010. VIS 3-5SM BR. 18Z SKC. OTLK...VFR.
.
WA E OF CASCDS
SKC. NRN PTN OCNL VIS 3-5SM VA. OTLK...VFR.
```

Alaska FA Example

```
FAAK58 PAWU 071953
FA8W
```

```
ANCC FA 071945
AK SRN HLF EXCP SE AK...
.
AIRMETS VALID UNTIL 080200
TS IMPLY PSBL SEV OR GREATER TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HEIGHTS NOTED BY AGL OR CIG.
.
UNIMAK PASS TO ADAK AJ...VALID UNTIL 080800
...CLOUDS/WX...
***SIGMET***INDIA 1 VALID 071813/080013
ANCHORAGE FIR.
VOLCANIC ASH FROM CLEVELAND VOLCANO (N5250 W16957) POSSIBLE ERUPTION OF
CLEVELAND VOLCANO AT 071000 UTC. ASH BOUNDED BY N5400W16500 - N5330W16200 –
N5230W16300 – N5300W16600 – N5400W16500. ASH TOPS AT FL150. ASH MOV ESE 40
KT. ASH VISIBLE IN STLT IMAGERY.
***AIRMET TURB/LLWS***MOD TURB BLW 120. OCNL MOD TURB FL290-FL370.
LLWS POTENTIAL DUE TO STG LOW LVL WINDS. NC...
***AIRMET MT OBSC***MTS OCNL OBSC IN CLOUDS AND PCPN. NC... OTRW
SCT020 BKN-SCT060 BKN-SCT100 TOPS 120. OCNL BKN020. WDLY SCT
VIS 5SM -SHRA. SFC WIND W 20G30 KTS.
OTLK VALID 080800-090200 MVFR CIG SHRA WIND.
...TURB...
***AIRMET TURB***OCNL MOD TURB BLW 040. NC...
...ICE AND FZLVL...
NIL SIG. FZLVL 030.
```

Hawaii FA Example

```
FAHW31 PHFO 281530
FA0HI

HNLC FA 281540
SYNOPSIS AND VFR CLD/WX
SYNOPSIS VALID UNTIL 291000
CLD/WX VALID UNTIL 290400...OUTLOOK VALID 290400-291000
.
SEE AIRMET SIERRA FOR IFR CLD AND MT OBSC.
TS IMPLY SEV OR GREATER TURB SEV ICE LOW LEVEL WS AND IFR COND.
NON MSL HGT DENOTED BY AGL OR CIG.
.
SYNOPSIS...KILAEUA VOLCANO ERUPTED AT 1350 UTC PRODUCING A SMALL AMOUNT OF
ASH.  SEE NOVEMBER SIGMET SERIES FOR DETAILS.  A SURFACE TROUGH HAS MOVED
WEST OF THE ISLANDS...AND TRADE WINDS WILL GRADUALLY STRENGTHEN IN THE
OFFSHORE WATERS THROUGH THE EARLY PART OF THE WEEK.
.
BIG ISLAND MT.
SCT050 TEMPO BKN050 TOPS 120 ISOL BKN030 LCL VIS 6SM VA. 21Z
SCT040 BKN-OVC050 TOPS 150 TEMPO BKN030 -SHRA ISOL VIS 1-2SM -SHRA
BR. OUTLOOK...MVFR CIG SHRA.
.
BIG ISLAND LOWER SLOPES...COAST...AND ADJ WATERS.
SCT050 TEMPO SCT025 BKN040 TOPS 080 -SHRA ISOL BKN030 VIS 5SM -SHRA
BR. 21Z SCT025 SCT-BKN050 TOPS 100 TEMPO BKN020 -SHRA ISOL BKN015
VIS 2-3SM -SHRA BR. OUTLOOK...VFR.
.
```

```
REST OF AREA.
SCT050 ISOL BKN040 TOPS 060 -SHRA. OUTLOOK...VFR.
```

5.2 Aviation Routine Weather Report (METAR) and Aviation Special Weather Report (SPECI).

METAR Example

```
METAR PANC 182150 010006KT 6SM VA FEW040 FEW100 SCT250 02/M09 RMK AO2 SLP 996
T00171089

METAR KPDX 271955Z 31010KT 10SM CLR 30/12 A2990 RMK AO2 SLP124 MT ST
HELENS VOLCANO 50 MILES NNE ERUPTED 271915 SMALL ASH CLOUD EXTENDING
TO APRX 15000 FEET MOVING E T03000122

METAR PGUA 241355Z 29005KT 7SM VA SCT020 SCT100 BKN250 26/26 A2981
      RMK SLP084
```

SPECI Example

```
SPECI KPDX 271926Z 32005KT 10SM CLR 29/13 A2991 RMK AO2 MT ST HELENS
VOLCANO 50 MILES NNE ERUPTED 271915 SMALL ASH CLOUD EXTENDING TO
APRX 15000 FEET MOVING E
```

5.3 Center Weather Advisories (CWA). An aviation weather warning for conditions which either meet or approach national inflight advisory criteria, or will adversely impact the safe flow of air traffic within the ARTCC area of responsibility.

Center Weather Advisory Example

```
ZAN1 UCWA 210025
ZAN UCWA 101 VALID UNTIL 210225
COOK INLET
POSSIBLE ERUPTION OF MT. AUGUSTINE AT 21/0025 UTC.  ASH TOPS ESTIMATED TO
FL350 BASED ON GROUND OBSERVER REPORT.  ASH MOVG NE AT 35 KTS. A SIGMET WILL
BE ISSUED SHORTLY.
JO AUG 05
```

5.4 Meteorological Impact Statement (MIS). A MIS is an unscheduled flow control and flight operations planning forecast. It is a forecast and briefing product produced by the CWSU for personnel at ARTCC, ATCSCC, TRACON, and ATCT responsible for making flow control-type decisions. The MIS is valid up to 12 hours after issuance time, detailing weather conditions expected to adversely impact air traffic flow in the CWSU area of responsibility. This includes being valid immediately for existing conditions when CWSU operations begin, or for rapidly deteriorating conditions, or being valid up to two hours in advance of expected conditions. A MIS may be tailored to meet the unique requirements of the host ARTCC.

MIS Example

ZAN MIS 01 VALID 092200-100900
...FOR ATC PLANNING PURPOSES ONLY...

GUSTY SE WINDS WILL RESUSPEND VA CAUSING VSBY TO LOWER TO BLW 1 MILE. CONDS TO IMPV AFT 06Z.

5.5 Pilot Report (PIREP). Pilots can report the occurrence of volcanic ash in a PIREP as an Urgent PIREP (UAA).

Urgent PIREP Examples

```
PGSN UUA /OV SN355070/TM 2315/FLDURC/TP B757/RM TOP OF ASH CLOUD
    OVER ANATAHAN VOLCANO APPROXIMATELY 15000 FT DRIFTING
    EAST
OLM UUA /OV CLS /TM 1850 /FL 090 /TP BE35 /WV 31005KT /TB NEG /RM
MT ST HELENS PLUME TO SE AT 090
PDX UUA /OV BTG020040/TM 1917/FL085/TP C210/RM ASH CLOUD 115 TO
 SFC
CDB UUA /OV VENIAMINOF VOLCANO (5610N 15923W)/TM 2231/FLUNKN/TP
SF34/RM PUFFS OF SMOKE 1000 FT ABV RIM OR APPROX FL092 (ZAN)
```

5.6 SIGMET (WV). WV are brief descriptions of the occurrence and/or expected occurrence of specified en-route weather phenomena (e.g., volcanic ash) which may affect the safety of all aircraft operations.

SIGMET Example (over land)
(SIGMETs issued for the CONUS use VORs not latitude longitude as prescribed in Annex 3)

```
WVUS06 KKCI 021430
SFON WS 021430
SIGMET NOVEMBER 2 VALID UNTIL 021830
WA OR
FROM 50S SEA TO 40WSW YKM TO 40E PDX TO PDX TO 50S SEA
VA FROM ST HELENS OBS 1040Z AND FCST BLW 140 MOV SE 5KT
CONDS ENDG 1830Z.

WVUS06 KKCI 090350
SFOY WS 090350
SIGMET YANKEE 4 VALID UNTIL 090750
WA
FROM 40WSW GEG TO 30NNE PDT TO 30NNE PDX TO 50S SEA TO 40WSW GEG
VA ERUPTION ST HELENS OBS AT 0350Z AND FCST BLW FL360 MOV ENE 40KT.
CONDS CONTG BYD 0750Z.
```

SIGMET Example (over Oceanic FIR)

```
WVNT13 KKCI 251500
TJZS SIGMET MIKE 5 VALID 251500/252100 KKCI-
SAN JUAN FIR VA FROM SOUFRIERE HILLS LOC N1643 W06211. VA CLD OBS AND
FCST BLW FL090 WI 15 NM EITHER SIDE LINE N1644 W06420 – N1641 W6300 MOV W
20KT. NC OTLK 260300Z VA CLD BLW 090 WI 15 NM EITHER SIDE LN N1657 W06445 -
N1657 W06350 - N1643 W06216.
```

SIGMET Example (from Meteorological Watch Office, Honolulu, HI)

```
WVPA06 PHFO 282046
WSVPAS

KZOA SIGMET SIERRA 452 VALID 282050/290250 PHFO-
OAKLAND OCEANIC FIR. VOLCANIC ASH FROM ANATAHAN VOLCANO OBS BY
SATELLITE AT 282002Z SFC/150 WITHIN AREA BOUNDED BY N1644 E14641 -
N1615 E14644 - N1618 E14544 - N1621 E14543 - N1644 E14641 MOVING E 15
KNOTS. FCST 290200Z VA CLD APRX SFC/150 WITHIN AREA BOUNDED BY N1621
E14543 - N1549 E14645 - N1525 E14637 - N1621 E1454. OTLK 290800Z VA
CLD APRX SFC/FL N1620 E14541 - N1518 E14647 - N1457 E14634 - N1620
E1454. ANATAHAN VOLCANO LOCATED AT N1621 E14540.
```

SIGMET Example (from Meteorological Watch Office, Anchorage, AK)

```
WVANCI WS 071813
PAZA SIGMET INDIA 1 VALID 071813/080013
ANCHORAGE FIR.
VOLCANIC ASH FROM CLEVELAND VOLCANO (N5250 W16957) POSSIBLE ERUPTION    OF
CLEVELAND VOLCANO AT 071000 UTC. ASH BOUNDED BY N5400W16500 - N5330W16200 –
N5230W16300 – N5300W16600 – N5400W16500. ASH TOPS AT FL150. ASH MOV ESE 40
KT. ASH VISIBLE IN STLT IMAGERY.
ERW OCT 05
```

5.7 Terminal Aerodrome Forecasts (TAF). A TAF is the expected meteorological conditions significant to aviation at an airport (terminal) for a specified time period, usually 24 hours. The U.S. definition of a terminal is the area within five (5) statute miles of the center of an airport's runway complex. TAFs are covered in the National Weather Service Instruction (NWSI) 10-813, Terminal Aerodrome Forecasts.

TAF Example

TAF PAHO 171738Z 171818 04006KT P6SM SCT100
FM0000 35003KT 6SM VA SCT100 BKN250
FM1400 00000KT P6SM BKN100

5.8 Volcanic Ash Advisory (VAA). The VAA is a text message that identifies the volcano, time of eruption, and observed and forecast position of the ash and ash cloud. Examples from the Washington and Anchorage VAACs are provided. In addition, a "Quick" VAA is an advisory stating that the VAAC has received information on the possible eruption of a particular volcano. The VAAC will gather further information and a more detailed and full VAA will be provided as soon as possible. An example of the "Quick" VAA is also provided.

VAA Example (Washington VAAC)

```
FVXX21 KNES 251440
VA ADVISORY
DTG: 20070825/1440Z   VAAC: WASHINGTON

VOLCANO: ST. HELENS 1201-05
```

PSN: N4612 W12211   AREA: US-WASHINGTON

SUMMIT ELEV: 8363 FT (2549 M)

ADVISORY NR: 2005/018

INFO SOURCE: GOES-10 USGS JRO CAMERA
AFWA PORTLAND WFO

ERUPTION DETAILS: RESUSPENDED ASH

OBS VA DTG: 25/1415Z

OBS VA CLD: SFC/FL080 10NM WID LINE BTN
N4635 W12310 - N4612 W12211 MOV NW 10KT

FCST VA CLD +6HR: 25/2030Z SFC/FL080 N4632 W12243
- N4619 W12204 - N4613 W12201 - N4610 W12210 -
N4623 W12252 - N4632 W12243

FCST VA CLD +12HR: 26/0230Z SFC/FL080 NO VA EXP

FCST VA CLD +18HR: 26/0830Z NO VA EXP

RMK: MSH CAMERA AND G-10 VISIBLE IMAGERY SHOW
A MODERATELY DENSE PLUME OF VA NW OF THE
VOLCANO ABOUT 30 NM. THIS IS NOT RELATED TO ANY
ERUPTION BUT IS DUE TO WINDS AT THE CRATER
RESUSPENDING ASH AND BLOWING IT NW. PLUME HEIGHT
DOES NOT EXCEED THE CRATER RIM. ...GALLINA

NXT ADVISORY: 20070825/2045Z

VAA Example (Anchorage VAAC)

FVAK21 PAWU 071841
VA ADVISORY
DTG: 20051007/1840Z   VAAC: ANCHORAGE

VOLCANO: CLEVELAND 1101-24
PSN: N5250 W16957   AREA: ALEUTIAN ISLANDS ALASKA

SUMMIT ELEV: 5674 FT (1730 M)

ADVISORY NR: 2005/001

INFO SOURCE: AVO

AVIATION COLOR CODE: ORANGE

ERUPTION DETAILS: BRIEF ERUPTION FROM 07/1000Z TO 07/1100Z

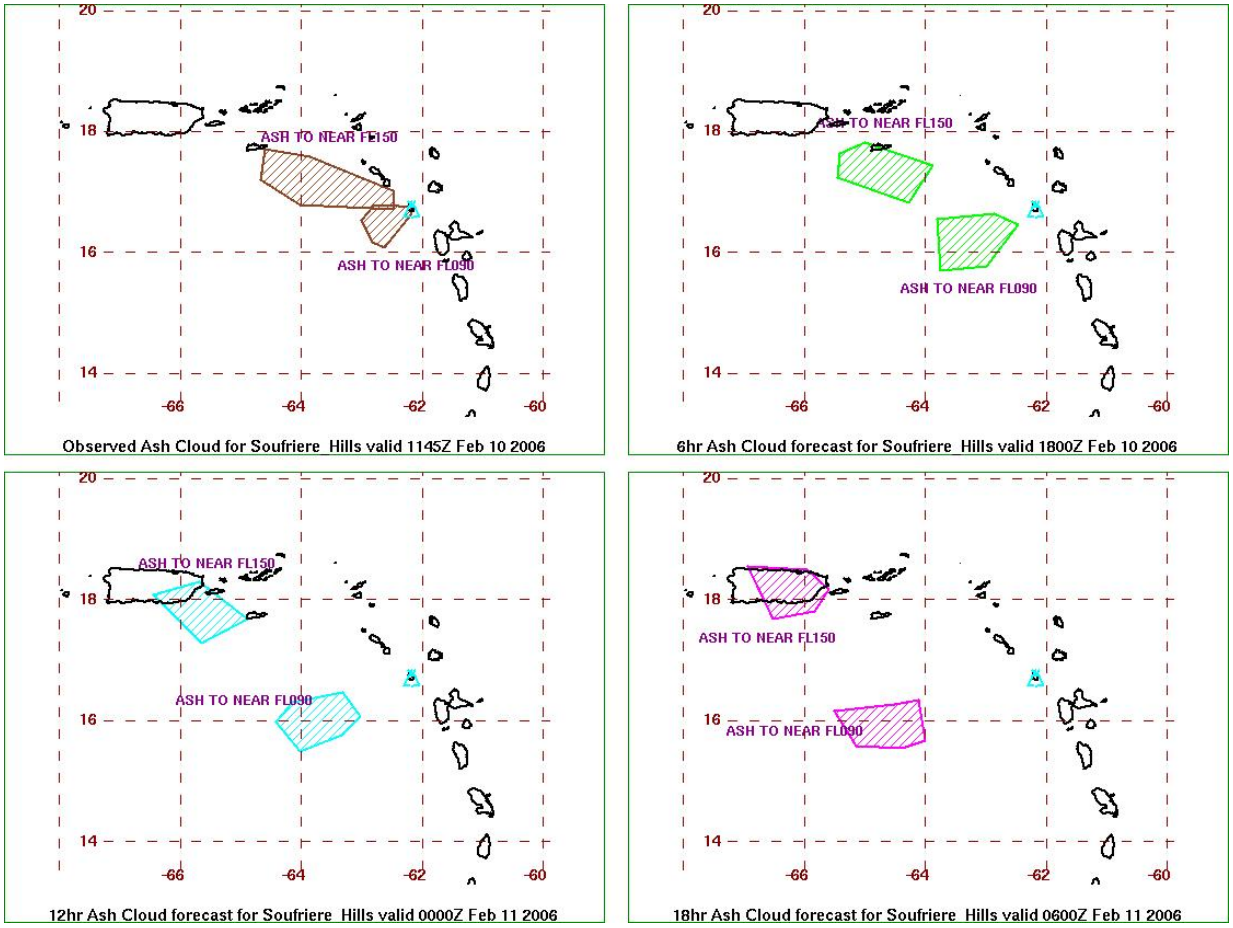
OBS VA DTG: 07/1800Z

```
OBS VA CLD: SFC/FL150 N5400 W16500 - N5530 W16200 - N5230 W16300 - N5300
W16600 - N5400 W16500. MOV SE AT 40KT

FCST VA CLD +6HR: 08/0000Z SFC/FL150 N5330 W15800 - N5300 W15530 - N513000
W15600 - N5200 W15900 - N5330 W15800

FCST VA CLD +12HR: 08/0600Z SFC/FL150 N5300 W15100 - N5200 W14830 - N5030
W15000 - N5130 W15200 - N5300 W15100

FCST VA CLD +18HR: 08/1200Z SFC/FL150 NO ASH EXP

RMK: NONE. ...NAME

NXT ADVISORY: WILL BE ISSUED BY 2005OCT08/0040Z
```

"Quick" VAA Example (Washington VAAC)

```
FVXX20 KNES 161400
VA ADVISORY
DTG: 20060316/1400Z   VAAC: WASHINGTON

VOLCANO: SANTA MARIA
PSN: N1445 W09133   AREA: GUATEMALA

SUMMIT ELEV: 12375 FT (3772 M)

ADVISORY NR: 2006/050

INFORMATION SOURCE: NOT AVBL

ERUPTION DETAILS: NOT AVBL

REMARKS: WE HAVE RECEIVED INFORMATION SUGGESTING A
POSSIBLE VA EMISSION. WE WILL GATHER FURTHER
INFORMATION AND ISSUE A FULL ADVISORY AS SOON AS
POSSIBLE.

NXT ADVISORY: AS SOON AS POSSIBLE
```

5.9 Volcanic Ash Graphic (VAG). The VAG (Figure 5-1) is a graphical description of the text Volcanic Ash Advisory (VAA). The VAG can either by a single panel product or a 4 panel product (separate panel for each time step t+0, t+6, t+12, and t+18 hours). The following is an example of a VAG:



VOLCANIC ASH ADVISORY
ISSUED: 2006FEB10/1230Z
VAAC: WASHINGTON
VOLCANO: SOUFRIERE HILLS 1600-05
LOCATION: N1642 W06210
AREA: W INDIES

SUMMIT ELEVATION: 3002FT /915 M
ADVISORY NUMBER: 2006/025
INFORMATION SOURCE: PIARCO MWO. GOES-12. GFS MODEL WINDS. AWC.
ERUPTION DETAILS: NEW ERUPTION AROUND 10/0900Z WITH ONGOING EMISSION

REMARKS: A NEW ERUPTION AT SOUFRIERE HILLS BEGAN AROUND 10/0900Z WITH ASH ESTIMATED TO FL090 MOVING SOUTHWEST. ONGOING ASH EMISSIONS CONTINUE TO MOVE TOWARDS THE WEST NORTHWEST TO NEAR FL150.
NEXT ADVISORY: WILL BE ISSUED BY 2006FEB10/1830Z

Figure 5-1. Volcanic Ash Graphic

5.10 Notice to Airmen (NOTAM). The NOTAM examples are provided in order to ensure correct formats are followed.

Increased Seismic Activity NOTAM Example

!FDC xx/xxx (ARTCC id) (state code).. SEISMIC ACTIVITY ADVISORY EFFECTIVE IMMEDIATELY UNTIL FURTHER NOTICE FOR (name) VOLCANO, (latitude/longitude), AND THE (name) /id/ VORTAC or VOR/DME (number) DEGREE RADIAL AT (distance) NAUTICAL MILES. (name) VOLCANO OBSERVATORY HAS REPORTED INCREASED SEISMIC ACTIVITY IN THE VICINITY OF (name) VOLCANO WHICH INDICATES THE POSSIBILITY OF A VOLCANIC ERUPTION. AIRCRAFT SHOULD REMAIN ALERT FOR POSSIBLE ERUPTIONS, STEAM, OR ASH CLOUDS AND REPORT ANY SIGHTINGS TO ATC IMMEDIATELY. AVIATION ALERT

COLOR CODE (orange or red) IS IN EFFECT. CONTACT (name) ARTCC, (telephone number), FOR ADDITIONAL INFORMATION.

FDC 4 CFR section 91.137(a)(1) Flight Restriction NOTAM Format

!FDC xx/xxx (ARTCC id) (state code).. FLIGHT RESTRICTIONS (location:town/city) EFFECTIVE (immediately or yyyy-mm-dd-hhhh) UTC UNTIL (further notice or yyyy-mm-dd-hhhh) UTC. PURSUANT TO 14 CFR SECTION 91.137(a)(1) TEMPORARY FLIGHT RESTRICTIONS ARE IN EFFECT FOR VOLCANIC ERUPTION/ACTIVITY. ONLY RELIEF AIRCRAFT OPERATIONS UNDER THE DIRECTION OF (agency in charge) ARE AUTHORIZED IN THE AIRSPACE AT AND BELOW _____ FEET (AGL or MSL) WITHIN A _____ STATUTE/NAUTICAL MILE RADIUS OF (latitude/longitude) AND THE (name of navaid/id) VORTAC (or) VOR/DME _____ DEGREE RADIAL AT _____ NAUTICAL MILES. AVIATION ALERT COLOR CODE (orange or red) IS IN EFFECT. PILOTS ARE ADVISED TO EXERCISE EXTREME CAUTION WHEN OPERATING NEAR THIS RESTRICTED AREA PARTICULARLY WHILE DOWNWIND FROM THE VOLCANO. (Agency name, telephone number, and/or frequency) IS IN CHARGE OF THE OPERATION. (Designated ATC facility, (phone number) or the Air Traffic Organization (ATO) System Operations Control Center (SOSC), 202-267-3333), IS THE FAA COORDINATION FACILITY.

Volcanic Ash NOTAM Format

!FDC xx/xxx (ARTCC id) (state code) VOLCANIC ADVISORY FOR (name) VOLCANO (state code),(latitude/longitude), and the (name) /id/ VORTAC or VOR/DME (number)DEGREE RADIAL AT (distance) NAUTICAL MILES EFFECTIVE IMMEDIATELY UNTIL FURTHER NOTICE. (name) VOLCANO HAS BEEN IN AN ACTIVE STATE. HAZARDOUS EMISSIONS OF VOLCANIC ASH HAVE INTERMITTENTLY COMPLICATED AIR TRAVEL IN THE AREA. ANY IMPACT ON AIRCRAFT OPERATIONS IS DESCRIBED IN CURRENT SIGMET, CWA, OR PIREP INFORMATION. AIRCRAFT SHOULD REMAIN ALERT FOR POSSIBLE ASH CLOUDS AND REPORT ANY SIGHTINGS TO ATC. AIRCRAFT OPERATORS SHOULD CONTINUALLY EVALUATE OPERATIONS IN THE AREA AS DEFINDED BY THE SIGMET. AVIATION ALERT COLOR CODE (orange or red) IS IN EFFECT. FLIGHT INTO VOLCANIC ASH MAY CAUSE ENGINE DAMAGE/FAILURE AND ABRASION DAMAGE TO AIRFRAME AND WINDSHIELD SURFACES. ANY AIR CARRIERS, INCLUDING FOREIGN AIR CARRIERS THAT OBSERVE OR EXPERIENCE ANY DIFFICULTIES RESULTING FROM AN ENCOUNTER WITH VOLCANIC ASH, PLEASE NOTIFY ATC IMMEDIATELY IN ACCORDANCE WITH FAR 121.561 AND ICAO,ANNEX 3, PARAGRAPH 5.4 (SPECIAL AIRCRAFT OPERATIONS), AND ANNEX 6 PARAGRAPH 4.4.3 (HAZARDOUS FLIGHT CONDITIONS). CONTACT (name) ARTCC, (phone number), FOR ADDITIONAL INFORMATION.

5.11 USGS Volcanic Observatory Notice for Aviation (VONA). Suggested format for a VONA, which is issued by a VO when a color code changes (up or down) or within a color-code level when an ash-producing event or other significant change in volcanic behavior occurs.

(1) VOLCANO OBSERVATORY NOTICE FOR AVIATION

(2) Issued: Universal (Z) date and time (YYYYMMDD/HHMMZ).

(3) Volcano: Name and number (per Smithsonian database at

http://www.volcano.si.edu/world/)

(4) Current Aviation Color Code:

(5) Previous Aviation Color Code:

(6) Source: Name of Volcano Observatory (volcanological agency)

(7) Notice Number: Unique number with year

(8) Volcano Location: Latitude, longitude (in NOTAM format)

(9) Area: Regional descriptor (e.g., Cook Inlet, Alaska, USA)

(10) Summit Elevation: nnnn M (nnnn FT)

(11) Volcanic Activity Summary:
Concise statement that describes activity at the volcano.
If known, specify time of onset and duration of eruptive activity.

(12) Volcanic Cloud Height:
Best estimate of ash-cloud top in nnnn M (nnnnn FT) above summit or AMSL (specify which). Give source of height data (ground observer, pilot report, radar, etc.). "NIL" if no ash cloud is produced.

(13) Other Volcanic Cloud information:
Brief summary of relevant cloud characteristics such as color of cloud, shape of cloud, direction of movement, etc. Specify if cloud height is obscured or suspected to be higher than what can be observed clearly. "NIL" if no ash cloud produced.

(14) Remarks: Optional. Brief comments on related topics such as monitoring data, observatory actions, volcano's previous activity, etc.

(15) Contacts: Names, phone numbers (voice and fax), email addresses.

(16) Next Notice: "Will be issued when conditions at the volcano warrant changing the aviation color code or when a significant volcanic event occurs within the current color code." Or, indicate if final notice for an event.

5.12 Volcanic Activity Report (VAR). The VAR form (Figure 5-2) is tentative. It is undergoing international review and is expected to be endorsed by the ICAO Council in the first quarter of 2007 and become applicable in November 2007.

VOLCANIC ACTIVITY REPORT

Air reports are critically important in assessing the hazards which volcanic ash cloud present to aircraft operations.

OPERATOR:		A/C IDENTIFICATION: (as indicated on Flight Plan)			
PILOT-IN-COMMAND:					
DEP FROM:	DATE:	TIME; UTC:	ARR AT:	DATE:	TIME; UTC:
ADDRESSEE		AIREP SPECIAL			

Items 1-8 are to be reported immediately to the ATS unit that you are in contact with.

1) AIRCRAFT IDENTIFICATION	**2)** POSITION
3) TIME	**4)** FLIGHT LEVEL OR ALTITUDE
5) VOLCANIC ACTIVITY OBSERVED AT (position or bearing and distance from aircraft)	
6) AIR TEMPERATURE	**7)** SPOT WIND
8) SUPPLEMENTARY INFO _____	
Brief .description of activity especially vertical and lateral extent of ash cloud . and where possible, horizontal movement, rate of growth, etc) _____	

After landing complete items 9-16 then Fax form to:

9) DENSITY OF ASH CLOUD	☐ (a) Wispy ☐ (b) Moderate dense ☐ (c) Very dense
10) COLOUR OF ASH CLOUD	☐ (a) White ☐ (b) Light Grey ☐ (c) Dark grey ☐ (d) Black (e) other _____
11) ERUPTION	☐ (a) Continuous ☐ (b) Intermittent ☐ (c) Not visible
12) POSITION OF ACTIVITY	☐ (a) Summit ☐ (b) Side ☐ (c) Single ☐ (d) Multiple ☐ e) Not observed
13) OTHER OBSERVED FEATURES OF ERUPTION	☐ (a) Lightning ☐ (b) Glow ☐ (c) Large rocks ☐ (d) Ash fall out ☐ (e) Mushroom cloud ☐ (f) All
14) EFFECT ON AIRCRAFT	☐ (a) Communication ☐ (b) Nav systems ☐ (c) Engines ☐ (d) Pitot static ☐ (e) Windscreen ☐ (f) Windows ☐ (g) All
15) OTHER EFFECTS	☐ (a) Turbulence ☐ (b) St Elmo's Fire ☐ (c) Fumes ☐ (d) Ash deposits
16) OTHER INFORMATION: (Any information considered useful)	

Figure 5-2. Volcanic Activity Report (tentative)

APPENDIX A
BACKUP OPERATIONS

1.0 Backup Operations. Backup operations are implemented during periods of outage at a facility or when significant operational conditions warrant the need to maintain continuity in service during an ongoing event.

1.1 Backup Services. Backup services are provided for products issued by:

National Oceanic and Atmospheric Administration's (NOAA) (National Weather Service (NWS) and National Environmental Satellite, Data, and Information Service (NESDIS)):

- Meteorological Watch Offices (MWO)
- Volcanic Ash Advisory Centers (VAAC)
- World Area Forecast Center (WAFC)

USGS: Volcano Observatories

FAA: U.S. NOTAM Office

2.0 Backup Procedures for NOAA (NWS and NESDIS). The following describes the backup procedures for the MWO, VAAC, and WAFC.

2.1 MWO

The NWS has three MWO: Anchorage, Honolulu and Kansas City. Each has a separate backup procedure as described in the following section.

2.1 1 Anchorage MWO

The Anchorage MWO (Alaska Aviation Weather Unit) SIGMET backup is provided by several offices dependent upon flight level.

High level SIGMETs (FL250 and above) and Volcanic Eruptions/SIGMETS will be issued by the Aviation Weather Center (AWC).

Low level SIGMETs (below FL250) will be issued by the Alaska NWS forecast offices.

If the Anchorage MWO cannot issue SIGMETs, the Juneau Forecast Office will take responsibility for issuing low level SIGMETs in the Juneau FA area.

The Fairbanks Forecast Office will take responsibility for issuing low level SIGMETs in the Fairbanks FA and Anchorage FA areas.

The Alaska FA will not be backed up in a short term (less than 24 hours) unplanned backup scenario. If possible, the AFSSs at Kenai, Juneau and Fairbanks will be notified of the temporary cancellation of the FA production. If notification is not possible, the Juneau Forecast Office will notify the Juneau AFSS and have the Fairbanks Forecast Office notify the Kenai and Fairbanks AFSS. In a longer than 24 hour backup scenario, AAWU forecasters will be sent TDY to the Juneau and Fairbanks FOs as soon as possible to assume AAWU SIGMET, AIRMET and FA production.

2.1.2 Honolulu MWO

When the Honolulu MWO is down and cannot produce or distribute their products, the AWC will provide backup for MWO-related products (SIGMETs, AIRMETs, Area Forecasts) and WFO Monterey will provide backup for WFO related products (TAFs, public advisories).

The Lead Forecaster or MIC at Honolulu will notify AWC and WFO Monterey in the event that backup services are required.

2.1.3 Kansas City MWO/AWC

In the event that Kansas City MWO/AWC is down and unable to produce or distribute products, the following offices will provide backup services.

SIGMETs issued for Oceanic Flight Information Regions

- Atlantic (KZNY FIR) – Tropical Prediction Center (TPC)
- Pacific (KZOA FIR) – WFO Honolulu
- Other (KJZS, KZHU, KZMA FIRs) – TPC

CONUS SIGMETs

- AFWA

Area Forecasts

- Atlantic, Carribean, Gulf of Mexico – TPC
- Pacific – WFO Honolulu

2.2 VAAC

2.2.1 Anchorage VAAC

If the Anchorage VAAC cannot issue a Volcanic Ash Advisory or the associate Volcanic Ash Graphic, responsibility will be transferred to the Washington VAAC.

2.2.2 Washington VAAC

Backup for the Washington VAAC is provided by the Air Force Weather Agency (AFWA) at Offutt Air Force Base in Omaha, Nebraska. AFWA will be notified by the Washington VAAC of the need for backup and requested to initiate any required backup operations. The following actions are taken by AFWA:

- Issues a message under an FVXX## header, stating that the Washington VAAC is out of operation, and that AFWA is assuming the role of the Washington VAAC until further notice.
- Monitors volcanoes by satellite, and receives relevant PIREPs, SIGMETs, etc.
- If the Washington VAAC is down and cannot produce or distribute their products, AFWA will provide backup for products and dissemination. Required products and format are as follows:
  - Volcanic Ash Advisory (VAA) – (FVXX20-27 KNES)
  - Graphical products VAFTAD – 12, 24 hr page 1 (PHBE10 KWBC)
  - Graphical product VAFTAD - 36, 48 hr page 2 (PHBI 10 KWBC)
- Provides information by phone to AWC, ATCSCC, Anchorage VAAC and any other pertinent U.S. agency.
- VAAs are issued on an as-needed basis. Graphical products are issued if ash plume is expected to last at least 24 hrs.
- Timeliness: Products are available as soon as possible after creation.
- Notify responsible MWOs in Washington-VAAC's Area of Responsibility to ensure initiation of SIGMETS advisories; notify government agencies (i.e. FAA, AWC, FEMA, etc) as required, of VAA issuance.

Washington VAAC will notify AFWA as to termination of backup support. The Washington VAAC is responsible for issuing notice of its return to operations, which includes date and time operations are taken over by the Washington VAAC.

The SAB lead analyst is the operational point of contact at the Washington VAAC. The AFWA METSAT Applications Weather Flight duty analyst is the operational point of contact at AFWA.

2.3 WAFC

2.3.1 SIGWX charts provided by the Washington WAFC will be backed up by the London WAFC.

3.0 Backup Procedures for USGS. The backup for all USGS Volcano Observatories is the Alaska Volcano Observatory in Anchorage Alaska. In the event that the Alaska Volcano Observatory cannot serve as a backup, the Cascades Volcano Observatory will provide that function.

4.0 Backup Procedures for FAA. U.S. NOTAM Office. The National Notice to Airman Office is located at the ATCSCC in Herndon, Virginia. In an event requiring backup operations, a contingent of NOTAM staff personnel will relocate to the Washington Air Route Traffic Control Center, located in Leesburg, Virginia and re-establish operations.

APPENDIX B
TRANSPORT AND DISPERSION MODELS

B.1 HYSPLIT

The HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) model is configured to run volcanic ash simulations operationally at NOAA NCEP in support of the Washington and the Anchorage VAAC. Input forecast meteorology can be from either the Global Forecast System (GFS) or the North American Mesoscale (NAM) model. Ash particle sizes range from 0.3 to 30 microns. Particles are assumed to be evenly distributed within the eruption column from the volcano summit to the column top. Since the amount of ash emitted is not known at the time the forecast is run, a unit source is assumed. Graphical model output in "VAFTAD format" (shown below, Volcanic Ash Forecast Transport and Dispersion model) is distributed over the World Area Forecast System and is available at http://weather.noaa.gov/fax/wafsash.shtml. The graphical output depicts forecast areas of "visual ash". The model visual ash boundary is based on a correlation between historical model output and satellite analysis, and further refined when the VAAC chooses, as the visual ash boundary, a model concentration contour that best depicts the forecast based on the observed ash area. The Volcanic Ash Graphic (VAG, see Sec. 4.1.2.1 and 5.10) issued by the VAAC may be based on HYSPLIT model output.

A description of the complete HYSPLIT modeling system is given at http://www.arl.noaa.gov/ready/hysplit4.html. The system is used to compute atmospheric transport from simple air parcel trajectories to complex dispersion and deposition simulations. Input meteorological data is in a format unique to HYSPLIT and programs to convert various meteorological models' output to the HYSPLIT-format are included in the system. The dispersion of a substance is calculated by assuming puff and/or particle dispersion. The transport can occur forward or backward in time. Backward simulations can be used to estimate the source region of observed volcanic ash or other substance. Dispersion ensembles can calculate concentration probability output. Users may specify source starting height(s), source particle size and density, deposition removal constants, output levels, etc. Plotting programs generate postscript files. Dispersion/deposition output can be converted to WMO gridded binary format.

For planning or training, HYSPLIT can be run interactively on the Web or the code executable and meteorological data can be downloaded to a Windows PC at web site: http://www.arl.noaa.gov/ready/hysplit4.html. The HYSPLIT volcanic ash web page is http://www.arl.noaa.gov/ready/ash.html.

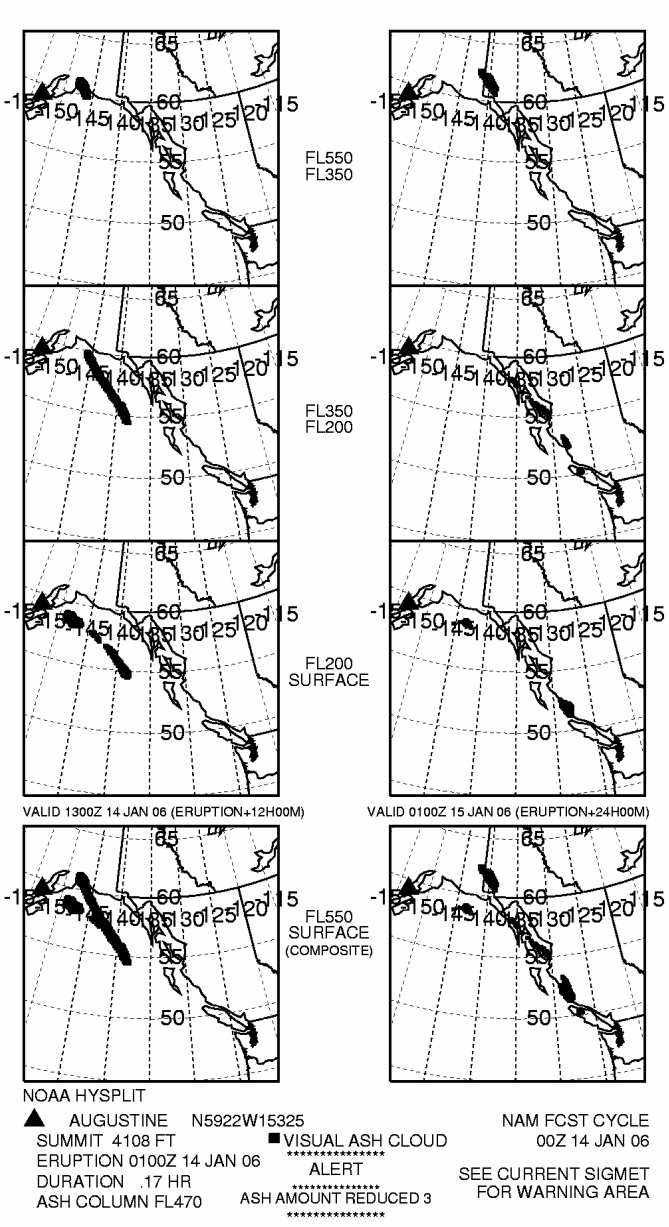


Figure 1. *HYSPLIT model output (VAFTAD format) for an eruption of Mt. Augustine on January 14, 2006. Plots on the left have a valid time of 1300 UTC January 14; plots on the right 0100 UTC January 15. Plots are for the layers surface-FL550 (bottom), surface-FL200, FL200-FL350, and FL350-FL550 (top).*

B.2 Puff

Puff * is a volcanic ash dispersion model that tracks particles through a Lagrangian formulation of advection combined with fallout and turbulent diffusion using a random-walk technique. During the simulation, the model treats the emitted particles as a sequence of packets or puffs over a length of time represented by the eruption duration. The range of particle size, initial plume shape, and fall dynamics can be selected by the user, with both variable and default input parameters available. The default ash particle size range is 1 to 100 microns. Particles are distributed within the eruption column from the volcano summit to the column top, and the number of particles associated with a model run is configured to be directly proportional to the eruption duration set by the analyst. The graphics output depicts ash plumes as tracer particles color-coded by height, or as relative concentration. Output can be displayed in both static and animated graphics. A description of the Puff model is given at http://puff.images.alaska.edu/index.shtml. This site also hosts a web version of the model.

Puff is run operationally at the AFWA in support of DOD operations worldwide. It is also used at the Anchorage and Washington VAAC as well as the Alaska Volcano Observatory for single eruptions. The AFWA version of Puff has the ability to ingest meteorological wind field data from the Global Forecast System. The AFWA Graphical User Interface allows for variations of model capabilities including depicting dispersion of an existing ash cloud, and both continuous and multiple eruptions. In the AFWA version users also have the ability to input an existing ash cloud by outlining a satellite image. A Digital Elevation Model is also used to improve forecasting of low level transport and surface deposition. The Puff graphic visual boundary is verified using satellite analysis, and further refined when necessary. Both static and animated graphical output for global volcanic eruptions as well as hypothetical simulations are available at https://weather.afwa.af.mil/environmental_events.html. During backup of the Washington VAAC, the Puff model graphic output is converted into a VAFTAD format for distribution over the World Area Forecast System.

* Puff (not an acronym) was developed by the University of Alaska, Fairbanks.

APPENDIX C
ACRONYMS and TERMS

AAWU: The Alaska Aviation Weather Unit (also known as the Anchorage MWO).
ACC: Area Control Center. A unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction, also referred to as the Air Route Traffic Control Center (ARTCC).
AFSS: Automated Flight Service Station.
AFWA: Air Force Weather Agency.
AIREP: Aircraft Report. A report from an aircraft in flight prepared in conformity with requirements for position, and operational and/or meteorological reporting.
AIRMET: AIRman's METeorological Information. Information issued by a meteorological watch office (MWO) concerning the occurrence or expected occurrence of specified en route weather phenomena which may affect the safety of aircraft operations.
AOC: Airline Operations Center**.** A facility under control by an air carrier that dispatches aircraft in accordance with existing standards and regulations and monitors and controls aircraft en route.
ARL: Air Resources Laboratory.
ARTCC: Area Route Traffic Control Center. A unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction, also referred to as the Area Control Center (ACC).
ASHTAM: A special series NOTAM advising of volcanic activity, a volcanic eruption and/or a volcanic ash cloud that is of significance to aircraft operations.
ATCSCC: Air Traffic Control System Command Center.
ATCT: Air Traffic Control Tower.
ATO: Air Traffic Organization.
ATS: Air Traffic System.
AWC: Aviation Weather Center.
CIC: Controller in charge.
Color Code: An alert level for aviation use to signify the status of a volcano during periods of quiescence, unrest, or eruption.
CONUS: Continental United States.
CWA: Center Weather Advisory. The CWA is 0-2 hour (valid up to 2 hours after issuance) aviation weather warning for conditions meeting or approaching national in-flight advisory (AIRMET, SIGMET, or SIGMET for convection) criteria.
CWSU: Center Weather Service Unit. Joint FAA/NWS meteorological support units composed of NWS meteorologists and FAA Traffic Management Unit (TMU) specialists directly supporting FAA's 21 Air Route Traffic Control Centers (ARTCC).
DOD: Department of Defense.
EMO: Emergency Management Office (Saipan).
FA: Area Forecast. A text forecast issued by the 3 U.S. Meteorological Watch Offices (MWOs) which describe weather conditions specific to aviation interests.
FAA: Federal Aviation Administration.
FDC: Flight Data Center.

FIR: Flight Information Region. Airspace defined dimensions within which flight information service and alerting service are provided.
FL: Flight level.
FSS: Flight Service Station.
GAMET: An area forecast in abbreviated plain language for low-level flights in a flight information region or sub-area thereof, prepared by a designated meteorological office.
GMT: Greenwich Mean Time.
HYSPLIT: The HYbrid Single-Particle Lagrangian Integrated Trajectory model. The principal model used to forecast the transport and dispersion of the ash cloud.
IAVW: International Airways Volcano Watch. International arrangements for monitoring and providing atmospheric volcanic ash warnings to aircraft.
ICAO: International Civil Aviation Organization.
International NOTAM Office: An office designated by a State for the exchange of NOTAMs internationally.
METAR: METeorological Aerodrome Report. An international code (Aviation Routine Weather Report) used for reporting, recording and transmitting weather observations.
Meteorological Authority: The authority providing or arranging for the provision of meteorological service for international air navigation on behalf of Contracting States and for the provision of meteorological services for national practices.
MIS: Meteorological Impact Statement. An unscheduled flow control and flight operations planning forecast. It is a 2 to 12 hour (valid up to 12 hours after issuance) briefing and forecast product at ARTCC, ATCSCC, TRACON, and ATCTs responsible for making flow-control type decisions.
MWO: Meteorological Watch Office. A meteorological office designated to provide in-flight hazardous weather advisories to AOCs, ATS, and pilots.
NAS: United States National Airspace System.
NASA: National Aeronautics and Space Administration.
NAVAID: Navigational Aid.
NCEP: National Centers for Environmental Prediction.
NESDIS: National Environmental Satellite, Data, and Information Service.
NOAA: National Oceanic and Atmospheric Administration.
NOTAM: Notice to Airmen. A notice containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.
NVAOPA: National Volcanic Ash Operations Plan for Aviation.
NWS: National Weather Service.
PIREP: Pilot Report. A report of in-flight weather by an aircraft pilot or crew member. A complete coded report includes the following mandatory information in this order: location and/or extent of reported weather phenomenon, time, flight level, and type of aircraft.
SAB: Satellite Analysis Branch.
SI: Smithsonian Institution.
SIGMET: SIGnigicant METetorological Advisory. SIGMETs are a brief description of the occurrence and/or expected occurrence of specified en-route weather phenomena which may affect the safety of all aircraft operations.

SIGWX Chart: Mid- and High-Level Significant Weather Chart. A graphical depiction of significant weather for FL100-FL450 (Mid-Level) and FL250-FL630 (High-Level).
SPECI: In the METAR observation program, a surface observation issued on a non-routine basis as dictated by changing meteorological conditions.
TAF: Terminal Aerodrome Forecast. A forecast of meteorological conditions significant to aviation at an airport location (location within 5 nm of center of the airport's runway complex).
TMU: Traffic Management Unit.
TRACON: Terminal Radar Approach Control.
USGS: United States Geological Survey.
USNOF: U.S. NOTAM Office.
UTC: Coordinated Universal Time. An international time standard most commonly used in weather products and observations. Also known as Greenwich Mean Time (GMT).
VAA: Volcanic Ash Advisory. Information issued by a Volcanic Ash Advisory Center concerning the occurrence or expected occurrence of volcanic ash which may affect the safety of aircraft operations.
VAAC: Volcanic Ash Advisory Center. A meteorological office designated to provide Volcanic Ash Advisories and Volcanic Ash Graphics.
VAFTAD: Volcanic Ash Forecast Transport and Dispersion model was used by NCEP from 1992 to 2004. When HYSPLIT became operational in 2005, VAFTAD look-alike output was created for product continuity.
VAG: Volcanic Ash Graphic. A graphical depiction of the Volcanic Ash Advisory (VAA).
VONA: Volcano Observatory Notice for Aviation. A short message in structured format issued by the USGS Volcanic Observatory to describe volcanic activity to the aviation sector, highlighting ash-plume information and including the aviation color-code level.
VAR: Volcanic Ash Report. A report of volcanic ash similar in format to a PIREP. However, the VAR may include additional information on the physical characteristics of the ash.
VO: Volcano Observatory.
Volcanic Ash: Small fragments (generally less than 2 mm in diameter) of rock, mineral, and volcanic glass that are created during explosive eruptions by the shattering of solid rocks and violent separation of magma (molten rock) into tiny pieces. The erupted material – along with gases released from the decompressing magma – is entrained upward in a convecting, columnar mass above the volcano. The larger erupted pieces fall out of the column within minutes to hours and are deposited around the volcano, while the smaller particles (ash) are spread by winds aloft as a diffuse cloud.
Volcanic Eruption: Ejection of magma, gases, and/or old volcanic rock products at the Earth's surface, either explosively as fragmental material or effusively as liquid lava. Not included are energetic but non-ash-bearing steam explosions.
WA: (see AIRMET)
WFO: Weather Forecast Office. One of 122 National Weather Service offices which provide a wide variety of weather forecasts and observations for specific states or portions of states. These forecasts include, but are not limited to, public, aviation, marine, fire weather, and hydrology.
WMO: World Meteorological Organization.

World Area Forecast Center: A meteorological centre designated to prepare and issue significant weather forecasts and upper air forecasts in digital form on a global basis direct to States by appropriate means as part of the aeronautical fixed service.
WV: (see SIGMET)

APPENDIX D
List of U.S. Volcanoes

U.S. volcanoes showing the responsible USGS Volcano Observatory (VO) and primary Air Route Traffic Control Center (ARTCC), Meteorological Watch Office (MWO), and Weather Forecast Office (WFO) to be notified by the VO when the aviation color code is raised or lowered at a volcano or when a significant change in activity occurs within a color-code level. Not all U.S. volcanoes are monitored instrumentally by the USGS. A list of volcanoes taken from the Smithsonian Institution's global volcanism database at http://www.volcano.si.edu/. Volcanoes are listed alphabetically within states; Number refers to unique ID number used in the Smithsonian database. AVO = Alaska Volcano Observatory, CVO = Cascades Volcano Observatory, HVO = Hawaiian Volcano Observatory, LVO = Long Valley Observatory, YVO = Yellowstone Volcano Observatory. Negative value for elevation indicates depth to top of submarine volcano.

Volcano Name	State	Number	Latitude DDMM	Longitude DDDMM	Elev. feet	VO	ARTCC	MWO	WFO
Adagdak	Alaska	1101-112	N 5159	W 17636	2001	AVO	Anchorage	Anchorage	Anchorage
Akutan	Alaska	1101-32-	N 5408	W 16559	4275	AVO	Anchorage	Anchorage	Anchorage
Amak	Alaska	1101-39-	N 5525	W 16309	1601	AVO	Anchorage	Anchorage	Anchorage
Amukta	Alaska	1101-19-	N 5230	W 17115	3498	AVO	Anchorage	Anchorage	Anchorage
Aniakchak	Alaska	1102-09-	N 5653	W 15810	4400	AVO	Anchorage	Anchorage	Anchorage
Atka (Korovin)	Alaska	1101-16-	N 5223	W 17409	5030	AVO	Anchorage	Anchorage	Anchorage
Augustine	Alaska	1103-01-	N 5922	W 15326	4108	AVO	Anchorage	Anchorage	Anchorage
Behm Canal-Rudyerd Bay	Alaska	1105-07-	N 5519	W 13103	1641	AVO	Anchorage	Anchorage	Juneau
Black Peak	Alaska	1102-08-	N 5633	W 15847	3386	AVO	Anchorage	Anchorage	Anchorage
Bobrof	Alaska	1101-10-	N 5155	W 17726	2421	AVO	Anchorage	Anchorage	Anchorage
Bogoslof	Alaska	1101-30-	N 5356	W 16802	492	AVO	Anchorage	Anchorage	Anchorage
Buldir	Alaska	1101-01-	N 5221	E 17555	2152	AVO	Anchorage	Anchorage	Anchorage
Buzzard Creek	Alaska	1105-001	N 6404	W 14825	2723	AVO	Anchorage	Anchorage	Anchorage
Carlisle	Alaska	1101-23-	N 5254	W 17003	5315	AVO	Anchorage	Anchorage	Anchorage
Chagulak	Alaska	1101-20-	N 5235	W 17108	3747	AVO	Anchorage	Anchorage	Anchorage
Chiginagak	Alaska	1102-11-	N 5708	W 15659	7287	AVO	Anchorage	Anchorage	Anchorage
Churchill	Alaska	1105-03-	N 6123	W 14425	16421	AVO	Anchorage	Anchorage	Anchorage

Volcano Name	State	Number	Latitude DDMM	Longitude DDDMM	Elev. feet	VO	ARTCC	MWO	WFO
Cleveland	Alaska	1101-24-	N 5250	W 16957	5676	AVO	Anchorage	Anchorage	Anchorage
Dana	Alaska	1102-05-	N 5538	W 16113	4442	AVO	Anchorage	Anchorage	Anchorage
Davidof	Alaska	1101-04-	N 5158	E 17820	1076	AVO	Anchorage	Anchorage	Anchorage
Denison	Alaska	1102-21-	N 5825	W 15427	7504	AVO	Anchorage	Anchorage	Anchorage
Douglas	Alaska	1102-27-	N 5851	W 15333	7021	AVO	Anchorage	Anchorage	Anchorage
Duncan Canal	Alaska	1105-05-	N 5630	W 13306	49	AVO	Anchorage	Anchorage	Juneau
Dutton	Alaska	1102-011	N 5510	W 16216	4941	AVO	Anchorage	Anchorage	Anchorage
Edgecumbe	Alaska	1105-04-	N 5703	W 13545	3183	AVO	Anchorage	Anchorage	Juneau
Emmons Lake	Alaska	1102-02-	N 5520	W 16205	4712	AVO	Anchorage	Anchorage	Anchorage
Fisher	Alaska	1101-35-	N 5439	W 16426	3648	AVO	Anchorage	Anchorage	Anchorage
Fourpeaked	Alaska	1102-26-	N 5846	W 15340	6907	AVO	Anchorage	Anchorage	Anchorage
Frosty	Alaska	1102-01-	N 5505	W 16249	6601	AVO	Anchorage	Anchorage	Anchorage
Gareloi	Alaska	1101-07-	N 5147	W 17848	5161	AVO	Anchorage	Anchorage	Anchorage
Gordon	Alaska	1105-021	N 6208	W 14305	9039	AVO	Anchorage	Anchorage	Anchorage
Great Sitkin	Alaska	1101-12-	N 5205	W 17608	5709	AVO	Anchorage	Anchorage	Anchorage
Griggs	Alaska	1102-19-	N 5821	W 15506	7602	AVO	Anchorage	Anchorage	Anchorage
Hayes	Alaska	1103-05-	N 6138	W 15225	9955	AVO	Anchorage	Anchorage	Anchorage
Herbert	Alaska	1101-22-	N 5245	W 17007	4200	AVO	Anchorage	Anchorage	Anchorage
Iliamna	Alaska	1103-02-	N 6002	W 15305	10017	AVO	Anchorage	Anchorage	Anchorage
Imuruk Lake	Alaska	1104-06-	N 6536	W 16355	2001	AVO	Anchorage	Anchorage	Fairbanks
Ingakslugwat Hills	Alaska	1104-05-	N 6126	W 16428	623	AVO	Anchorage	Anchorage	Fairbanks
Isanotski	Alaska	1101-37-	N 5446	W 16343	8025	AVO	Anchorage	Anchorage	Anchorage
Kagamil	Alaska	1101-26-	N 5258	W 16943	2930	AVO	Anchorage	Anchorage	Anchorage
Kaguyak	Alaska	1102-25-	N 5836	W 15402	2956	AVO	Anchorage	Anchorage	Anchorage
Kanaga	Alaska	1101-11-	N 5155	W 17710	4288	AVO	Anchorage	Anchorage	Anchorage
Kasatochi	Alaska	1101-13-	N 5211	W 17530	1030	AVO	Anchorage	Anchorage	Anchorage

Volcano Name	State	Number	Latitude DDMM	Longitude DDDMM	Elev. feet	VO	ARTCC	MWO	WFO
Katmai	Alaska	1102-17-	N 5817	W 15458	6716	AVO	Anchorage	Anchorage	Anchorage
Kialagvik	Alaska	1102-12-	N 5712	W 15645	5502	AVO	Anchorage	Anchorage	Anchorage
Kiska	Alaska	1101-02-	N 5206	E 17736	4003	AVO	Anchorage	Anchorage	Anchorage
Koniuji	Alaska	1101-14-	N 5213	W 17508	896	AVO	Anchorage	Anchorage	Anchorage
Kookooligit Mountains	Alaska	1104-03-	N 6336	W 17026	2208	AVO	Anchorage	Anchorage	Fairbanks
Kukak	Alaska	1102-23-	N 5827	W 15421	6703	AVO	Anchorage	Anchorage	Anchorage
Kupreanof	Alaska	1102-06-	N 5601	W 15948	6217	AVO	Anchorage	Anchorage	Anchorage
Little Sitkin	Alaska	1101-05-	N 5157	E 17833	3852	AVO	Anchorage	Anchorage	Anchorage
Mageik	Alaska	1102-15-	N 5812	W 15515	7103	AVO	Anchorage	Anchorage	Anchorage
Makushin	Alaska	1101-31-	N 5353	W 16655	5906	AVO	Anchorage	Anchorage	Anchorage
Martin	Alaska	1102-14-	N 5810	W 15522	6113	AVO	Anchorage	Anchorage	Anchorage
Moffett	Alaska	1101-111	N 5157	W 17645	3924	AVO	Anchorage	Anchorage	Anchorage
Novarupta	Alaska	1102-18-	N 5816	W 15509	2759	AVO	Anchorage	Anchorage	Anchorage
Nunivak Island	Alaska	1104-02-	N 6001	W 16620	1677	AVO	Anchorage	Anchorage	Anchorage
Okmok	Alaska	1101-29-	N 5326	W 16808	3521	AVO	Anchorage	Anchorage	Anchorage
Pavlof	Alaska	1102-03-	N 5525	W 6602	8265	AVO	Anchorage	Anchorage	Anchorage
Pavlof Sister	Alaska	1102-04-	N 5527	W 16151	7028	AVO	Anchorage	Anchorage	Anchorage
Recheschnoi	Alaska	1101-28-	N 5309	W 16832	6510	AVO	Anchorage	Anchorage	Anchorage
Redoubt	Alaska	1103-03-	N 6029	W 15245	10197	AVO	Anchorage	Anchorage	Anchorage
Roundtop	Alaska	1101-38-	N 5448	W 16335	6139	AVO	Anchorage	Anchorage	Anchorage
Sanford	Alaska	1105-01-	N 6213	W 14408	16238	AVO	Anchorage	Anchorage	Anchorage
Seguam	Alaska	1101-18-	N 5219	W 17231	3458	AVO	Anchorage	Anchorage	Anchorage
Segula	Alaska	1101-03-	N 5201	E 17808	3806	AVO	Anchorage	Anchorage	Anchorage
Semisopochnoi	Alaska	1101-06-	N 5156	E 17935	4006	AVO	Anchorage	Anchorage	Anchorage
Sergief	Alaska	1101-15-	N 5202	W 17456	1837	AVO	Anchorage	Anchorage	Anchorage
Shishaldin	Alaska	1101-36-	N 5445	W 16358	9374	AVO	Anchorage	Anchorage	Anchorage

Volcano Name	State	Number	Latitude DDMM	Longitude DDDMM	Elev. feet	VO	ARTCC	MWO	WFO
Snowy Mountain	Alaska	1102-20-	N 5820	W 15441	7094	AVO	Anchorage	Anchorage	Anchorage
Spurr	Alaska	1103-04-	N 6118	W 15215	11070	AVO	Anchorage	Anchorage	Anchorage
St. Michael	Alaska	1104-04-	N 6327	W 16207	2346	AVO	Anchorage	Anchorage	Fairbanks
St. Paul Island	Alaska	1104-01-	N 5711	W 17018	666	AVO	Anchorage	Anchorage	Anchorage
Steller	Alaska	1102-22-	N 5826	W 15424	7454	AVO	Anchorage	Anchorage	Anchorage
Stepovak	Alaska	1102-051	N 5556	W 16000	5102	AVO	Anchorage	Anchorage	Anchorage
Table Top-Wide Bay	Alaska	1101-311	N 5358	W 16641	2599	AVO	Anchorage	Anchorage	Anchorage
Takawangha	Alaska	1101-09-	N 5152	W 17800	4754	AVO	Anchorage	Anchorage	Anchorage
Tanaga	Alaska	1101-08-	N 5153	W 17809	5925	AVO	Anchorage	Anchorage	Anchorage
Tlevak Strait-Suemez Is.	Alaska	1105-06-	N 5515	W 6 1348	164	AVO	Anchorage	Anchorage	Juneau
Trident	Alaska	1102-16-	N 5814	W 15506	6116	AVO	Anchorage	Anchorage	Anchorage
Ugashik-Peulik	Alaska	1102-13-	N 5745	W 15622	4836	AVO	Anchorage	Anchorage	Anchorage
Ukinrek Maars	Alaska	1102-131	N 5750	W 15631	299	AVO	Anchorage	Anchorage	Anchorage
Uliaga	Alaska	1101-25-	N 5304	W 16946	2914	AVO	Anchorage	Anchorage	Anchorage
Unnamed	Alaska	1102-132	N 5752	W 15525	984	AVO	Anchorage	Anchorage	Anchorage
Veniaminof	Alaska	1102-07-	N 5610	W 15923	8225	AVO	Anchorage	Anchorage	Anchorage
Vsevidof	Alaska	1101-27-	N 5308	W 16842	7051	AVO	Anchorage	Anchorage	Anchorage
Westdahl	Alaska	1101-34-	N 5431	W 16439	5427	AVO	Anchorage	Anchorage	Anchorage
Wrangell	Alaska	1105-02-	N 6200	W 14401	14164	AVO	Anchorage	Anchorage	Anchorage
Yantarni	Alaska	1102-10-	N 5701	W 15711	4413	AVO	Anchorage	Anchorage	Anchorage
Yunaska	Alaska	1101-21-	N 5239	W 17038	1805	AVO	Anchorage	Anchorage	Anchorage
Adams	Washington	1201-04-	N 4612	W 12129	12278	CVO	Seattle	Kansas City	Pendleton
Baker	Washington	1201-01=	N 4847	W 12149	10778	CVO	Seattle	Kansas City	Seattle
Glacier Peak	Washington	1201-02-	N 4807	W 12107	10542	CVO	Seattle	Kansas City	Seattle
Indian Heaven	Washington	1201-07-	N 4556	W 12149	5925	CVO	Seattle	Kansas City	Pendleton
Rainier	Washington	1201-03-	N 4652	W 12145	14410	CVO	Seattle	Kansas City	Seattle

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St. Helens	Washington	1201-05-	N 4612	W 12211	8363	CVO	Seattle	Kansas City	Portland
West Crater	Washington	1201-06-	N 4553	W 12205	4360	CVO	Seattle	Kansas City	Portland
Bachelor	Oregon	1202-09-	N 4359	W 12141	9065	CVO	Seattle	Kansas City	Pendleton
Belknap	Oregon	1202-06-	N 4417	W 12150	6874	CVO	Seattle	Kansas City	Portland & Pendleton
Blue Lake Crater	Oregon	1202-03-	N 4425	W 12146	4036	CVO	Seattle	Kansas City	Portland & Pendleton
Cinnamon Butte	Oregon	1202-15-	N 4314	W 12206	6418	CVO	Seattle	Kansas City	Medford
Crater Lake	Oregon	1202-16-	N 4256	W 12207	8160	CVO	Seattle	Kansas City	Medford
Davis Lake	Oregon	1202-10-	N 4334	W 12149	7097	CVO	Seattle	Kansas City	Medford & Pendleton
Devils Garden	Oregon	1202-12-	N 4331	W 12052	5571	CVO	Seattle	Kansas City	Medford
Diamond Craters	Oregon	1202-17-	N 4306	W 11845	4708	CVO	Seattle	Kansas City	Boise
Four Craters Lava Field	Oregon	1202-14-	N 4322	W 12040	4925	CVO	Seattle	Kansas City	Medford
Hood	Oregon	1202-01-	N 4522	W 12142	11241	CVO	Seattle	Kansas City	Portland
Jackies Butte	Oregon	1202-20-	N 4236	W 11735	4652	CVO	Seattle	Kansas City	Boise
Jefferson	Oregon	1202-02-	N 4442	W 12148	10496	CVO	Seattle	Kansas City	Portland & Pendleton
Jordan Craters	Oregon	1202-19-	N 4309	W 11728	4833	CVO	Seattle	Kansas City	Boise
Lava Mountain	Oregon	1202-13-	N 4328	W 12045	5614	CVO	Seattle	Kansas City	Medford
Newberry Volcano	Oregon	1202-11-	N 4343	W 12114	7986	CVO	Seattle	Kansas City	Pendleton
North Sister Field	Oregon	1202-07-	N 4410	W 12146	10086	CVO	Seattle	Kansas City	Portland & Pendleton
Sand Mtn Field	Oregon	1202-04-	N 4423	W 12156	5460	CVO	Seattle	Kansas City	Portland
South Sister	Oregon	1202-08-	N 4406	W 12146	10358	CVO	Seattle	Kansas City	Portland & Pendleton
Washington	Oregon	1202-05-	N 4420	W 12150	7796	CVO	Seattle	Kansas City	Portland & Pendleton
Amboy	California	1203-20-	N 3433	W 11547	945	LVO	Los Angeles	Kansas City	Las Vegas
Big Cave	California	1203-04-	N 4057	W 12122	4131	CVO	Oakland	Kansas City	Sacramento?
Brushy Butte	California	1203-03-	N 4111	W 12127	3852	CVO	Oakland	Kansas City	Medford & Sacramento
Clear Lake	California	1203-10-	N 3858	W 12246	4721	LVO	Oakland	Kansas City	Sacramento
Coso Volc Field	California	1203-18-	N 3602	W 11749	7874	LVO	Los Angeles	Kansas City	Las Vegas

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Eagle Lake Field	California	1203-09-	N 4038	W 12050	5420	CVO	Oakland	Kansas City	Reno
Golden Trout Creek	California	1203-17-	N 3621	W 11819	9469	LVO	Los Angeles	Kansas City	Las Vegas
Inyo Craters	California	1203-13-	N 3742	W 11901	8626	LVO	Oakland	Kansas City	Reno
Lassen Volc Center	California	1203-08-	N 4030	W 12130	10457	CVO	Oakland	Kansas City	Sacramento
Lavic Lake	California	1203-19-	N 3445	W 11638	4905	LVO	Los Angeles	Kansas City	Las Vegas
Long Valley	California	1203-14-	N 3742	W 11852	11123	LVO	Oakland	Kansas City	Reno
Medicine Lake	California	1203-02-	N 4135	W 12134	7914	CVO	Oakland	Kansas City	Medford
Mono Craters	California	1203-12-	N 3753	W 11900	9174	LVO	Oakland	Kansas City	Reno
Mono Lake Volc Field	California	1203-11-	N 3800	W 11902	6959	LVO	Oakland	Kansas City	Reno
Red Cones	California	1203-15-	N 3735	W 11903	9016	LVO	Oakland	Kansas City	Reno
Shasta	California	1203-01-	N 4125	W 12212	14164	CVO	Oakland	Kansas City	Medford
Tumble Buttes	California	1203-06-	N 4041	W 12133	7189	CVO	Oakland	Kansas City	Sacramento
Twin Buttes	California	1203-05-	N 4047	W 12136	5351	CVO	Oakland	Kansas City	Sacramento
Ubehebe Craters	California	1203-16-	N 3701	W 11727	2467	LVO	Los Angeles	Kansas City	Las Vegas
Craters of the Moon	Idaho	1204-02-	N 4325	W 11330	6578	YVO	Salt Lake City	Kansas City	Pocatello
Hell's Half Acre	Idaho	1204-04-	N 4330	W 11227	5351	YVO	Salt Lake City	Kansas City	Pocatello
Shoshone Lava Field	Idaho	1204-01-	N 4311	W 11421	4849	YVO	Salt Lake City	Kansas City	Pocatello
Wapi Lava Field	Idaho	1204-03-	N 4253	W 11313	5263	YVO	Salt Lake City	Kansas City	Pocatello
Yellowstone	Wyoming	1205-01-	N 4426	W 11040	9203	YVO	Salt Lake City	Kansas City	Riverton
Steamboat Springs	Nevada	1206-01-	N 3923	W 11943	4643	LVO	Oakland	Kansas City	Reno
Bald Knoll	Utah	1207-03-	N 3720	W 11224	7005	YVO	Salt Lake City	Kansas City	Salt Lake City
Black Rock Desert	Utah	1207-05-	N 3858	W 11230	5906	YVO	Salt Lake City	Kansas City	Salt Lake City
Markagunt Plateau	Utah	1207-04-	N 3735	W 11240	9318	YVO	Salt Lake City	Kansas City	Salt Lake City
Santa Clara	Utah	1207-01-	N 3715	W 11338	4807	YVO	Salt Lake City	Kansas City	Salt Lake City
Dotsero	Colorado	1208-01-	N 3901	W 10702	7317	YVO	Denver	Kansas City	Grand Junction
Uinkaret Field	Arizona	1209-01-	N 3623	W 11308	5102	YVO	Los Angeles	Kansas City	Las Vegas

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Sunset Crater	Arizona	1209-02-	N 3522	W 11130	8029	YVO	Albuquerque	Kansas City	Flagstaff
Carrizozo	New Mexico	1210-01-	N 3347	W 10556	5679	YVO	Albuquerque	Kansas City	Albuquerque
Valles Caldera	New Mexico	1210-03-	N 3552	W 10634	11254	YVO	Albuquerque	Kansas City	Albuquerque
Zuni-Bandera	New Mexico	1210-02-	N 3448	W 10800	8367	YVO	Albuquerque	Kansas City	Albuquerque
Kilauea	Hawaiian Is	1302-01-	N 1926	W 15518	4009	HVO	Honolulu	Honolulu	Honolulu
Haleakala	Hawaiian Is	1302-06-	N 2042	W 15615	10023	HVO	Honolulu	Honolulu	Honolulu
Hualalai	Hawaiian Is	1302-04-	N 1942	W 15552	8278	HVO	Honolulu	Honolulu	Honolulu
Mauna Kea	Hawaiian Is	1302-03-	N 1949	W 15528	13797	HVO	Honolulu	Honolulu	Honolulu
Mauna Loa	Hawaiian Is	1302-02=	N 1929	W 15536	13682	HVO	Honolulu	Honolulu	Honolulu
Agrigan	Mariana Is	0804-16=	N 1846	E 14540	3166	HVO	Honolulu	Honolulu	Guam
Ahyi	Mariana Is	0804-141	N 2025	E 14502	-449	HVO	Honolulu	Honolulu	Guam
Alamagan	Mariana Is	0804-18=	N 1736	E 14550	2441	HVO	Honolulu	Honolulu	Guam
Anatahan	Mariana Is	0804-20=	N 1621	E 14540	2585	HVO	Honolulu	Honolulu	Guam
Asuncion	Mariana Is	0804-15=	N 1940	E 14524	2812	HVO	Honolulu	Honolulu	Guam
Esmeralda Bank	Mariana Is	0804-21=	N 1500	E 14515	-141	HVO	Honolulu	Honolulu	Guam
Farallon de Pajaros	Mariana Is	0804-14=	N 2032	E 14454	1181	HVO	Honolulu	Honolulu	Guam
Guguan	Mariana Is	0804-19=	N 1719	E 14551	942	HVO	Honolulu	Honolulu	Guam
Maug Islands	Mariana Is	0804-143	N 2001	E 14513	745	HVO	Honolulu	Honolulu	Guam
Pagan	Mariana Is	0804-17=	N 1808	E 14548	1870	HVO	Honolulu	Honolulu	Guam
Ruby	Mariana Is	0804-201	N 1537	E 14534	-755	HVO	Honolulu	Honolulu	Guam
Sarigan	Mariana Is	0804-191	N 1642	E 14547	1765	HVO	Honolulu	Honolulu	Guam
Supply Reef	Mariana Is	0804-142	N 2008	E 14506	-26	HVO	Honolulu	Honolulu	Guam

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