PACIFIC NORTHWEST

FEDERAL INTERAGENCY OPERATING PLAN for VOLCANIC ASH EVENTS

Mount St. Helens March 8, 2005 view from Camas, WA
Photo credit: Elisa Wells

September 2024

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Appendices

I. Introduction

The Pacific Northwest (PNW) has nine volcanoes within its borders that are considered to pose a very high or high threat to society (Ewert, et al., 2018). Additionally, volcanic processes do not follow geo-political boundaries, and thus eruptions can affect the U.S. and its interests across very long distances, through both airborne and ground-based hazards.

Volcanoes create a wide range of hazards, including airborne ash plumes and ashfalls, large landslides, pyroclastic flows, debris flows/lahars, lava flows, toxic gasses, and river flooding. Unlike earthquakes, days to months of unrest will likely precede eruptions of most well-monitored PNW volcanoes. Thus, eruptions can generally be forecast in advance of their occurrence. Advance warning allows for preparation, which often can mitigate effects of an eruption. Also, unlike earthquakes and floods, the durations of volcanic events can last from minutes to months, and volcanoes can erupt intermittently for decades, posing substantial challenges to society.

One of the chief hazards of an explosive eruption is the injection of airborne volcanic ash into the atmosphere. Airborne ash plumes can drift many hundreds of miles downwind, delay or disrupt flight operations nationwide and internationally, damage aircraft, and pose hazards to people and infrastructure in areas blanketed with ashfall. During non-eruptive periods, previously deposited volcanic ash can become resuspended, particularly during periods of strong winds. Resuspended ash rarely poses hazards to aviation in the PNW, but will be considered a “volcanic ash event” for the purposes of this interagency plan.

This plan provides an overview of integrated, multi-agency operations to share information and take coordinated action in response to the threat of volcanic eruptions as they relate to volcanic ash in the PNW. A cohesive, well-coordinated response is essential for ensuring the flow of timely and consistent information to those at risk.

The agencies involved in this operating plan are: the U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), and the Federal Aviation Administration (FAA).

This operating plan is written to cover the States of Washington, Oregon and Idaho and the adjacent airspace Flight Information Regions (FIRs). The plan is an integral part of the NOAA/FAA Volcano Hazards Implementation Plan that

supports the Agreement between NOAA and FAA on volcanic hazards. As such, this PNW plan describes communication links and operational actions necessary to support NOAA/FAA/USGS Volcano Hazards implementation plan. This plan is referenced in the 2024 National Volcanic Ash Operations Plan for Aviation published by the Office of the Federal Coordinator for Meteorological Services (OFCM), now reorganized as the Interagency Council for Advancing Meteorological Services (ICAMS) (see Appendix B).

Importantly, this plan does not address all aspects of a response to an eruption in the PNW. First of all, it does not specifically address the responses to various ground hazards such as landslides, lahars, lava flows, or flooding. It also does not address specific responses to ashfall that affect both nearby and distal communities downwind of volcanoes. Volcanic eruption responses in the PNW from Federal land management agencies and State/Local Emergency Management Agencies are addressed in other "ground-based plans" which are referenced in Appendix C. Except for aviation support, this plan does not describe all the procedures local offices within NOAA and FAA will follow after an eruption. To ensure the integrity of this plan, local NOAA/NWS offices will need to formalize and execute local emergency response plans (i.e., station-duty manuals and standard operating procedures) with the most updated information not included herein. Third, the Department of Defense's (DOD) role in responding to volcanic ash is covered under the National Volcanic Ash Operations Plan for Aviation and its agreements with the FAA. The appropriate primary agencies in this plan (USGS, NOAA, and FAA) will coordinate with their Canadian counterparts regarding ash and ground hazards that may impact Canada according to their own internal procedures and protocols.

II. Information Coordination

Agencies relaying information about volcanic events, ash cloud trajectories, and potential impacts must deliver a consistent message. Close collaboration via telephone and other means during unrest and eruptions is essential.

The USGS Cascades Volcano Observatory (CVO) may be the first agency to receive a report of volcanic unrest in the PNW; however, any participating agency may receive initial reports (for example, the FAA may receive pilot reports of ash in the air before CVO receives any notification). Timely validation, processing, and dissemination of information are crucial steps in a successful multi-agency response. Considering the rarity of volcanic events in the PNW but the high potential for catastrophic loss, all reports should be taken seriously.

III. Plan Management

This is the revised edition of the Pacific Northwest Federal Interagency Operating Plan for Volcanic Ash Events. The previous plan was drafted and implemented in 2011. Ideally, this plan should be reviewed and updated every 5 years, and table top exercises should be conducted between the agencies involved in the plan as part of the plan update cycle.

The 2023-2024 timelines and processes for updating the plan are:

July 2023: Staff from Weather Forecast Offices (WFO) Portland and Seattle visit the USGS CVO and discussions begin on the need to update the plan.

November 2023: National Weather Service (NWS) identifies points of contact for updating their portion of the plan.

November 2023: CVO and NWS Western Region Headquarters (WRH) virtual meeting to discuss plan management, milestones and due dates for updates.

January 2, 2024: NWS representatives from Western Region conduct a virtual meeting to discuss actions and milestones for FY24.

January 10, 2024: NWS delivered a draft update to the first three sections of the plan to the CVO.

February 15, 2024: CVO provided a draft update to the entire plan.

March 26, 2024: Virtual meeting between CVO and NWS WRH to discuss outstanding issues, and plan the April 23rd meeting.

April 23, 2024: Officials from CVO, NWS and the Alaska Volcano Observatory meet at the Cascade Volcano Observatory to discuss the plan and coordination with the Alaska Volcanic Ash Response Plan.

July 2024: Draft completed by all agencies for final circulation and review.

September 2024: Plan is complete.

IV. Roles and Responsibilities of Partnering Agencies

The following sections contain general outlines of each agency's actions in response to an airborne volcanic ash event (though many of these actions by

some agencies are also applicable to hazards posed by volcanic ground-based events).

A. United States Geological Survey (USGS)

The USGS has the federal responsibility to issue notifications for earthquakes, volcanic eruptions, landslides, or other hazardous geologic events. 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 (VHP).

Cascades Volcano Observatory (CVO) – Vancouver WA

The CVO was created on May 18, 1982, in response to continued activity at Mount St. Helens following its 1980 eruptions. Located in Vancouver, Washington, the observatory, in partnership with the University of Washington Pacific Northwest Seismic Network (PNSN), has responsibility for monitoring volcanoes and volcanic regions in Washington, Oregon and Idaho. This responsibility includes providing volcano hazards assessments, detecting unrest, giving timely situational awareness and warnings about volcanic activity, and working with stakeholders to ensure that communities are "volcano ready." Furthermore, CVO provides a three-dimensional Eulerian atmospheric model (Ash3d) for tephra transport, dispersal, and deposition to study and forecast hazards of volcanic ash clouds and tephra fall. During periods of quiescence, CVO monitors volcanoes to watch for signs of unrest, engages in research to refine understanding of eruption histories and volcano hazards, and engages in outreach and coordination with stakeholders and communities surrounding PNW volcanoes. This outreach includes regularly responding to inquiries from public officials and the general public about perceived volcanic activity (for example, reports of ash plumes lofted during hot, dry, windy weather that are related to resuspension of previously deposited ash rather than renewed volcanic activity, or clouds at volcanoes mistaken for eruption plumes) and providing assessment as to whether the perceived activity is real or not. During crises, CVO provides alert notifications as volcanic unrest escalates, sometimes to eruption, and, just as importantly, as eruptive activity declines, eruption stops, and volcanoes return to background levels of activity.

CVO has three primary objectives:

- Monitor volcanoes in the Cascades to provide accurate, timely, and actionable information to public officials and the general public about volcanic activity.

- Conduct basic research, including studies of volcanic processes, eruptive histories, and volcano hazards assessments, in order to interpret monitoring signals, and provide actionable, short-term forecasts during periods of unrest and eruption.
- Engage in public outreach and education to inform public officials and the general public about the hazards associated with volcanic activity and the current state of volcanoes.

All these activities are necessary for a successful response.

Responsibilities During Volcanic Unrest/Eruption

- Operating hours: CVO's normal hours of operation are 8:00a–5:00p, M–F. After hours and on weekends, an on-call Duty Scientist can be reached through a dedicated phone number.

- Call Downs: As a volcano moves from quiescence to unrest, CVO will note increases (and eventually decreases) in activity through call-down procedures and written formal notifications via the Volcano Notification System (VNS) [https://volcanoes.usgs.gov/vns2/]. The VNS is a free subscription-based service through which anyone can select the types of notifications (and from which observatories) they would like to receive.

  Call-downs occur when:
  1. There is a change in the alert level and/or aviation color code;
  2. Eruptive activity has started or ended;
  3. Updates regarding eruptive activity are warranted as new information is obtained regarding style of eruption, plume height (if any), ongoing duration, etc.

  See Appendix D for an example of a call down list for Mount St. Helens.

- Recorded telephone messages: During times of volcanic activity that causes intense public or media interest, CVO will post a message on their front desk phone with guidance as to where individuals can obtain more information about the current activity. CVO will also post information to its observatory website and through social media.

- Structured messaging: CVO coordinates messages regarding alert-level changes with monitoring partners, the land managers for specific volcanoes, and the appropriate State emergency management office. These agencies in turn are responsible for transmitting messages to local, county, and tribal partners and agencies. These responsibilities are described in volcano-specific "ground-based" coordination plans

administered by the relevant State and local emergency management offices (see Appendix C).

Products and Product Dissemination During Volcanic Unrest/Eruption

The USGS Volcano Hazards Program (VHP) issues three styles of information notifications: event-driven, time-driven, and general informational.

Event-driven notifications are urgent, formal notifications of volcanic activity, alert-level changes, and significant changes in activity. People who receive them may need to act quickly. They are consistent in format across volcano observatories. There are three types of event-driven messages:

- Volcanic Activity Notice (VAN): A VAN announces alert- or color-level changes or significant volcanic activity within an alert level. Upon a change of an alert level or recognition of the beginning or cessation of volcanic activity, the observatory will issue a VAN after a call-down procedure is completed. The VAN consists of a formatted text message describing current activity at the volcano and forecast of likely outcomes. The VAN message goes out via e-mail to all entities that subscribe to the USGS Volcano Notification Service (VNS). The message is also immediately posted on the CVO and USGS Volcano Hazards Program (VHP) websites, and additionally on the "USGS Volcanoes" social media accounts. Additional VANs are released as needed depending on changes in volcanic activity, alert level, or hazards.

- Volcano Observatory Notice for Aviation (VONA): A VONA is an International Civil Aviation Organization ICAO) recommended communication format for communication between volcano observatories and aviation interests (ICAO Doc 9766 Handbook on the International Airways Volcano Watch). In the United States, a VONA is a derivative product of the VAN that is aviation-sector specific and focuses only on ash emissions or hazards affecting flight operations. A VONA contains information in a format specifically intended for aviation users of volcano hazard information. A VONA is produced automatically and sent via e-mail to aviation agencies and aviation industry users who have subscribed to the USGS Volcano Notification Service.

- Status Report: A Status Report provides an update about volcano behavior or monitoring activities during ongoing events of unrest or eruption. They are used when it is unnecessary to issue alert-level changes, but it IS necessary to communicate some message about ongoing activity.

CVO collaborates with the National Weather Service (NWS) and other stakeholders via phone calls or other communication platforms on structured messages and information regarding volcanic eruptions and provides information to NWS and FAA on eruption plume heights and locations, potential mass eruption rates, and eruptive activity durations.

Time-driven notifications are periodic reports (daily, weekly, monthly) that summarize a volcano's or volcano group's status. They are for situational awareness and are used for briefing relevant communities. The information is not considered urgent.

- Daily Updates: CVO will issue Daily Updates and/or more frequent Status Reports as situations warrant for any Cascade volcano at an elevated alert level or aviation color code. These reports are sent via e-mail to all entities who have subscribed to the USGS VNS, and they are also posted on the CVO and VHP websites as well as on "USGS Volcanoes" social media accounts.

- Weekly Updates: Regardless of activity levels, CVO routinely issues weekly summaries of volcanic activity in the Cascades each Friday. These reports are sent via email to all agencies and groups who have subscribed to the USGS VNS, are posted to the CVO website, and brief summaries are released through the USGS Volcanoes social media accounts.

Informational Statements cover notable observations for a volcano plus non-urgent yet important technical or operational information.

- Information Statements: CVO may issue a non-scheduled Information Statement that highlights information regarding activity at a volcano that may be noted by the public and which warrants public notification (for example, a minor seismic swarm at a volcano or a non-volcanic event like a debris flow that is the result of a meteorological event). Depending on the nature of activity and/or anticipated degree of media interest, an informal call-down to relevant agency heads may accompany release of an Information Statement. Information Statements are formally released through the VNS.

In addition to formal notifications issued through the VNS, CVO also releases information of interest via its observatory website and social media to reach broader audiences who may or may not subscribe to the VNS.

- Web and social media: Data from many CVO monitoring stations are available online in real-time to the general public. During periods of

unrest and eruption, CVO will also provide timely information and interpretations about ongoing activity through the CVO website [https://www.usgs.gov/cascades-volcano-observatory] and through the "USGS Volcanoes" social media accounts (Facebook, X, Instagram). Other partners may also post information and recommended actions on their social media channels.

Volcanoes of responsibility:

As noted above, CVO is responsible for volcanoes and volcanic fields in Washington, Oregon, and Idaho. The principal volcanoes for which CVO is responsible are:

1. Mount Baker
2. Glacier Peak
3. Mount Rainier
4. Mount St. Helens
5. Mount Adams and surrounding mafic fields
6. Mount Hood
7. Mount Jefferson
8. Three Sisters and surrounding mafic volcanic fields
9. Newberry Volcano
10. Crater Lake
11. Volcanic fields that lie between these volcanoes
12. Volcanic fields in Idaho

A map of Cascades volcanoes is provided in Appendix A.

Volcano Alert Levels, Aviation Color Codes and CVO Protocols:

Specific CVO protocols for how it operates will vary depending on the nature of unrest or eruptive activity. Below are definitions of the USGS VHP alert levels and associated aviation color codes for different levels of unrest and eruption.

USGS Volcano Observatories utilize a dual system of alerts. To address the current overall status of a volcano, observatories issue a Volcano Alert Level. This Alert Level is based on potential ground-based hazards associated with the level of volcanic unrest or eruptive activity (for example, landslide, lava flow, lahar (mudflow), pyroclastic flow). The defined Alert Levels employ the terms NORMAL, ADVISORY, WATCH, and WARNING. Definitions of these terms are shown in Table 1 and the diagram that follows. To address potential aviation hazards, mainly related to volcanic ash, USGS Volcano Observatories use an Aviation

Color Code in tandem with volcano alert levels. Aviation color codes employ the terms GREEN, YELLOW, ORANGE, and RED. Definitions of these terms are shown in Table 2. Changes in Volcano Alert Levels and Aviation Color Codes indicate increasing (or decreasing) severity and likelihood of potential hazards and are similar to notification language used by NWS for severe weather alerts. In rare instances where the CVO monitoring network is insufficient to detect activity, a volcano may be designated as UNASSIGNED. A status of UNASSIGNED indicates that CVO does not have enough information to evaluate whether or not the volcano is at a background (quiet) state of activity.

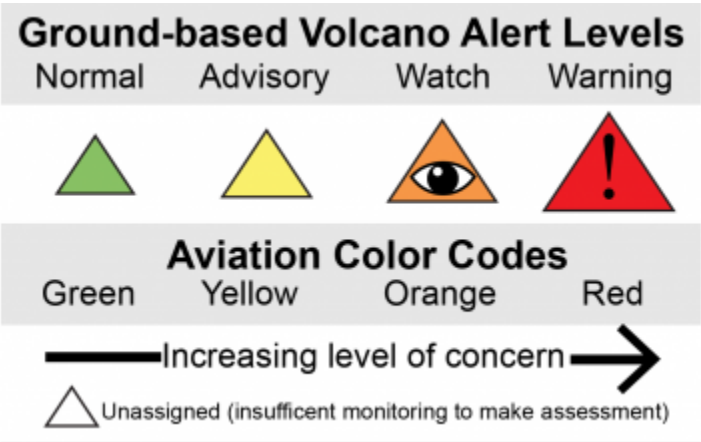
Table 1. Volcano Alert Level Terms

ALERT-LEVEL TERMS. When the volcano alert-level is changed, a Volcano Activity Notice (VAN) is issued.	
NORMAL	Volcano is in typical background, noneruptive state or, *after a change from a higher level,* volcanic activity has ceased and volcano has returned to noneruptive background state.
ADVISORY	Volcano is exhibiting signs of elevated unrest above known background level or, *after a change from a higher level,* volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
WATCH	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, **OR** eruption is underway but poses limited hazards.
WARNING	Hazardous eruption is imminent, underway, or suspected.

Table 2. Aviation Color Codes

GREEN:	Volcano is in typical background, noneruptive state or, *after a change from a higher level*, volcanic activity has ceased and volcano has returned to noneruptive background state.
YELLOW:	Volcano is exhibiting signs of elevated unrest above known background level or, *after a change from a higher level*, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
ORANGE:	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, **OR** eruption is underway with no or minor volcanic-ash emissions [ash-plume height specified, if possible].
RED:	Eruption is imminent with significant emission of volcanic ash into the atmosphere likely **OR** eruption is underway or suspected with significant emission of volcanic ash into the atmosphere [ash-plume height specified, if possible].

Volcano updates include both a Volcano Alert Level and an Aviation Color Code. In most cases, the alert level and aviation-specific color code will move together (e.g., Normal and Green; Advisory and Yellow; Watch and Orange; Warning and Red). However, there may be occasions when the hazards to ground-based communities and the aviation sector differ (for example, during an eruption consisting largely of lava flow where the ground hazard is significant (warning) but the threat to aviation is minimal (orange)). Ground based response plans are listed in Appendix C.



CVO Operational Protocols

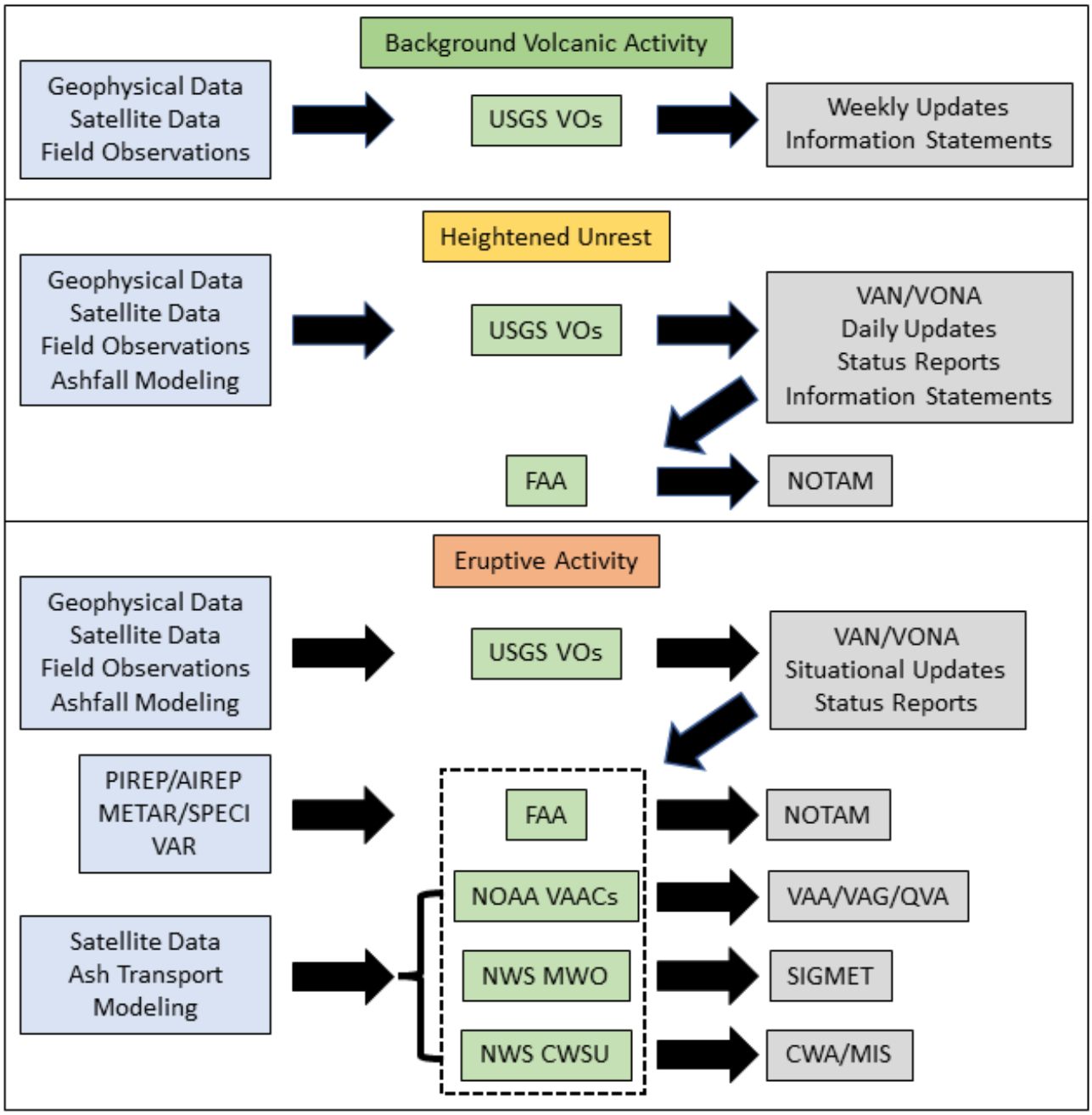
1. Aviation Level **NORMAL**, Aviation Color Code **GREEN**: Weekly Updates and the occasional Information Statement are released. CVO is on normal operating hours. The Duty Scientist and duty seismologists monitor instrumentation data after hours and the Duty Scientist is on-call via a dedicated cell phone, as is the CVO Scientist-in-Charge or their designate.
2. Alert Level **ADVISORY**, Aviation Color Code **YELLOW**: CVO will initiate a call-down to Pacific Northwest Seismic Network (PNSN); FAA Air Route Traffic Control Center (ARTCC) group; NWS WFO; the volcano landowner [US Forest Service or National Park Service]; State Office of Emergency Management; Washington Volcanic Ash Advisory Center (W-VAAC); FAA Command Center and the Air Force 557th Weather Wing before issuing formal alert level and aviation color code changes via VANs and VONAs. Separate call downs to other land management and emergency management agencies are initiated as appropriate. When one or more volcanoes are at elevated alert levels, CVO will issue time-driven updates (daily or weekly) or Status Reports as the situation warrants. CVO's hours of operation will be extended initially

to 12/7 supplemented by overnight checks and/or automated alarms, depending on the uncertainty of situation, intensity of unrest, and/or intensity of media interest. CVO will extend hours of operation to 24/7 if the situation warrants. CVO will work with emergency and land management agencies to establish a Joint Information System (JIS) to answer questions regarding the activity and potential hazards. CVO staff will embed with an Incident Management Team(s) as necessary. CVO will engage in discussions with NWS WFO on structured messaging regarding potential volcanic ash and ground based hazards as appropriate. CVO will discuss with land and emergency managers any requests for a Temporary Flight Restriction (TFR) from the FAA.

3. Alert Level **WATCH**, Aviation Color Code **ORANGE**: CVO issues the alert level and aviation color code changes via formal notification products (VAN and VONA) and initiates a call-down to FAA ARTCC group; NWS WFO; the volcano landowner [US Forest Service or National Park Service]; State Office of Emergency Management; W-VAAC; FAA Command Center; Air Force 557th Weather Wing; Pacific Northwest Seismic Network (PNSN); and British Columbia Provincial Emergency Program (for ash events only) regarding these changes. Separate call downs to other land management and emergency management agencies are initiated as appropriate. When one or more volcanoes are at these elevated alert levels, CVO will issue Daily Updates or Status Reports more frequently as the situation warrants. CVO hours of operation will be 24/7. If the unrest/eruption stabilizes (e.g, settles into a prolonged lava-dome-building eruption), CVO may scale back to 12/7 operations supplemented by overnight checks and/or automated alarms. This decision will depend on the uncertainty of the situation, the intensity of unrest, and/or the intensity of media requests. CVO will work with a JIS to answer questions regarding the activity and potential hazards and give short-term forecasts. CVO staff will embed with an Incident Management Team(s) as necessary. CVO will discuss with land and emergency managers any requests for a TFR from the FAA.
4. Alert Level **WARNING**, Aviation Color Code **RED**: CVO issues the alert level and aviation color code changes via formal products (VAN and VONA) and initiates a call-down to FAA ARTCC group; NWS WFO; the volcano landowner [US Forest Service or National Park Service]; State Office of Emergency Management; Washington Volcanic Ash Advisory Center (W-VAAC); FAA Command Center and Air Force 557th Weather Wing; PNSN, and British Columbia Provincial Emergency Program (for ash events only) regarding these changes. Separate call downs to other land management and emergency management agencies are initiated as appropriate. If an eruption is imminent but not underway,

a call down will be initiated first before a formal release of an alert level/aviation color code change. Once eruption begins, CVO will initiate another call down and continue providing situational awareness and updates via other means (e.g., State EMD facilitated video conference call briefings) at least once per hour as the situation warrants until activity at the volcano diminishes. CVO will also send out additional VANs and VONAs and written updates as warranted. CVO will be in a 24/7 operational mode until the alert level is lowered to WATCH and the aviation color code to ORANGE, and likely for several days to weeks following. CVO will continue to discuss structured messaging with NWS WFO. CVO will work with the JIS to answer questions regarding the activity and potential hazards and give short-term forecasts, and will embed staff with an Incident Management Team(s) as necessary. CVO will discuss with land managers any requests for a TFR from the FAA.

USGS Volcano Observatory Response Flow Chart



B. National Oceanic Atmospheric Administration (NOAA)

NOAA is responsible for the operational forecasting and monitoring of the state of the atmosphere, including the presence of volcanic ash clouds injected into the atmosphere by eruptions or resuspended by strong winds. 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. National Environmental Satellite, Data and Information Service (NESDIS) and the NWS are the primary line offices for volcanic ash decision support.

- **National Weather Service (NWS)**

NOAA's NWS shares the responsibility of operating the W-VAAC with NESDIS. The NWS operates:

- The International Civil Aviation Organization (ICAO) stipulated World Area Forecast Center (WAFC)
- Three Meteorological Watch Offices (MWO) are located in Anchorage, Honolulu, and Kansas City, and the Alaska VAAC in Anchorage.
- Numerous WFOs and River Forecast Centers (RFC).
- Twenty-one Center Weather Service Units (CWSU) in support of FAA ARTCCs.

Through these units, the NWS provides forecasts and warnings for volcanic ash and river-based hazards. NWS policy and procedures for volcano hazards are covered in NWS Directives 10-5, Public Weather Services; 10-9, Water Resources Services Program; and 10-15, Volcanic Ash Services.

- **National Environmental Satellite, Data and Information Service (NESDIS)**

The Satellite Analysis Branch of NESDIS operates the W-VAAC located in College Park, Maryland in conjunction with the NWS National Centers for Environmental Prediction (NCEP).

- **Washington Volcanic Ash Advisory Center (W-VAAC)**

The W-VAAC is a collaborative effort between the Office of Satellite Data Processing and Distribution (OSPO) of NESDIS and the NCEP of the NWS. The Satellite Analysis Branch (SAB), within NESDIS, is the operational portion of the W-VAAC and issues all advisories. The VAAC uses satellite imagery and data retrieval techniques to locate, confirm and track the presence of volcanic ash clouds following an eruption. The W-VAAC receives alerts and uses the NOAA/Cooperative Institute for Meteorological Satellite Studies (CIMSS) Volcanic Cloud Monitoring tool for help in the location, height, aerosol speciation, and

other vital information during a volcanic eruption. The W-VAAC also receives information from the USGS and NWS WFOs in the Pacific Northwest. The VAAC will issue Volcanic Ash Advisories (VAA) that provide current locations and forecasted movements of an ash cloud through T+18 hrs. The VAA is accompanied by the Volcanic Ash Graphic (VAG - graphical depiction of the VAA).

The NCEP portion of the VAAC is co-located with the W-VAAC, and will run and disseminate NOAA Air Resource Laboratory (ARL) Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model to provide forecast and dispersion guidance of volcanic-ash clouds. The W-VAAC also has the ability to run the HYSPLIT online on the ARL webpage, run other models such as USGS Ash3d (Eulerian model), and look at other vital forecast information during a volcanic ash event.

- **Aviation Weather Center (AWC)**

Located in Kansas City, Missouri, the AWC serves as the ICAO Meteorological Watch Office (MWO) for the continental United States (CONUS), surrounding waters, and international flight information regional airspace. AWC's mission is to deliver consistent, timely and accurate weather information for the world airspace system and to enhance safe and efficient flight. The role of AWC during volcanic eruptions is to provide Volcanic Ash Significant Meteorological Information (SIGMETs).

- **Center Weather Service Units (CWSU)**

NWS meteorologists in CWSUs are components of the FAA's 21 ARTCCs. NWS personnel work as a team with FAA Air Traffic Control (ATC) specialists. They provide weather information critical to the safe and efficient flow of air traffic and serve the National Airspace System (NAS) directly. The CWSU is also the liaison between FAA facilities and other NWS offices in its area. Complete details of the relationship between the FAA and the CWSU are contained in an interagency agreement.

Weather support is accomplished through various products and verbal briefings describing weather conditions (forecasts or observations) which may affect air traffic flow or operational safety in the ARTCC's portion of the NAS (the CWSU area of responsibility), and in other locally defined, special operations areas (e.g., offshore helicopter operations areas). Normal CWSU operational hours in the ARTCC are sixteen hours a day, seven days a week. CWSU meteorologists are available to work outside normal business hours (e.g. overtime) during high impact weather events such as volcanic ash events.

- **NWS Weather Forecast Offices (WFOs)**

NWS WFOs mission is to provide weather, water and climate data, forecasts, warnings, and impact-based decision support services for the protection of life and property and enhancement of the national economy. There are six WFOs with forecast and warning responsibility in the PNW.

WFOs in the PNW participate in volcanic hazard response by issuing volcanic ashfall statements, forecasts, advisories, and warnings to the public, aviation and marine community. Furthermore, WFOs are responsible for public warnings of lahars via the flash flood program. NWS roles and responsibilities for lahars and ash on the ground are addressed in the local "ground based" volcano-specific response plans (Appendix D).

WFOs provide support for all the parties in this operating plan by soliciting spotter and/or pilot reports, monitoring radar and satellite observations, and forwarding all pertinent information to CVO, AWC, W-VAAC and appropriate CWSU.

WFOs also share observations of eruptions and the resulting volcanic threat with USGS and other agencies as needed.

- **Northwest River Forecast Center (NWRFC)**

The Northwest River Forecast Center (NWRFC) provides river and water supply forecast services at approximately 400 locations throughout the Pacific Northwest. Forecasts are utilized by a variety of stakeholders and are vital for public safety and for supporting the NWS Flood Warning program. Downstream forecasts are provided for most of the major rivers originating from the active volcanoes covered in this plan. For short-fused events including flash floods, dam failures, or lahars the NWRFC will assist local NWS WFOs by providing guidance and expertise.

- **Western Region Operations Center (WR ROC)**

The WR ROC serves as the NWS's primary point of contact for most federal agencies, such as FEMA Region X, Environmental Protection Agency and the Department of Homeland Security.

The WR ROC Duty Officer (DO) provides briefings to regional and national leadership to summarize impacts, weather products and staffing situations at the affected NWS offices.

Responsibilities During Volcanic Unrest/Eruption and the Warning Process

- Following a change in volcano alert level and aviation color code, but before onset of an eruption, planning discussions begin with USGS CVO and NWS/NCEP offices.
    1. The WR ROC will schedule and facilitate a planning conference call with USGS, appropriate NOAA offices and the FAA.
    2. Plans, procedures and staffing will be reviewed.
- Volcanic Eruption in the PNW:

  The NWS may receive notification of a volcanic eruption in the PNW through many different channels such as satellite detection, pilot reports (PIREPS), radar observations and/or phone calls from the USGS and VAAC. After an initial report of an eruption, NWS forecasters take the following steps:
    1. If a NWS forecaster detects an eruption or receives notice from a source other than USGS and/or W-VAAC, their first priority is to notify CVO.
    2. The W-VAAC and CVO will confirm whether an eruption has occurred and if so, coordinate initial eruption details.
    3. If an eruption is confirmed or suspected, W-VAAC will call via commercial phone lines: AWC and the Montreal VAAC if ash is likely to enter into their region.
    4. The VAAC will issue the VAA and the VAG. In addition, NCEP Senior Duty Meteorologist (SDM) will initiate the HYSPLIT model by request of W-VAAC for NWS guidance of volcanic ash transport and dispersion.
    5. AWC will issue a Volcanic Ash SIGMET. AWC will also include the active volcano on the World Area Forecast System (WAFS) forecast, and follow up with collaboration calls with the adjacent MWO, affected CWSU and WAFC London.
    6. The CWSU forecaster distributes the SIGMET, shares preliminary information with the ARTCC Operations Manager (OM) and Traffic Management Unit (TMU) and asks the air traffic controllers to solicit PIREPS for volcanic ash plume height and wind vectors.
        a. CVO and AWC will notify the ARTCC OM of the eruption and SIGMET if the eruption occurs when the CWSU is closed.
    7. The CWSU will coordinate with W-VAAC, AWC and appropriate WFOs to help ensure all products and warnings contain consistent information.
    8. Coordination with neighboring CWSUs: Seattle CWSU forecasters share information with surrounding CWSUs when volcanic ash is forecasted to impact their airspace within two hours.

9. WFO and RFC forecasters will monitor observation platforms and issue forecasts and warnings as necessary. NWS responsibilities for ground-based hazards are provided in the local "ground-based" volcano response plans (Appendix C). WFOs will notify the WR ROC of the eruption.
10. The WR ROC will notify WR management and the National Operations Center (NOC), and implement 24/7 operations. The WR ROC will assume the leadership role of coordination within NWS units and staffing assistance for all the necessary command centers and offices.
11. WFO forecasters monitor observation platforms and update Terminal Aerodrome Forecasts (TAFs) as necessary.

- Eruption in Alaska or other distant volcanoes

  When ash plumes from an eruption in Alaska, Russia or surrounding regions are threatening the PNW airspace, NWS forecasters take the following steps:

  1. The W-VAAC, the AK VAAC and when necessary, the Montreal VAAC will coordinate on the ash cloud movement. The W-VAAC will issue the VAA and VAG when the ash has moved into their area of responsibility.
  2. AWC will issue a SIGMET and conduct follow up with collaboration calls with the adjacent MWO, affected CWSU and WAFC London
  3. The CWSU forecaster distributes the SIGMET, shares preliminary information with the ARTCC OM and TMU and asks the air traffic controllers to solicit PIREPS.
     a. AWC will notify the ARTCC OM of the ash and SIGMET if the CWSU is closed.
  4. WFO forecasters monitor observation platforms and update TAFs as necessary.

Specific Office Procedures Beyond the Initial Collaboration and Warning Process

- **W-VAAC and AWC**

  During an ongoing eruption, VAAs, VAGs and SIGMETs are updated at least every six hours. Products are updated for all new eruptions any time observations or other data sources indicate changes to existing products as necessary. The NCEP SDM may also declare a Critical Weather Day after a volcanic eruption. Critical Weather Days will ensure that the computer, communications, and personnel resources of the NCEP are directed toward production and delivery of essential forecast products. The Montreal VAAC and Darwin VAAC provide backup for the W-VAAC in case of disruptions to ensure continuity of operations.

Once ash is no longer identifiable on satellite, no further reports of ash are received from the impacted area, and explosive eruptions have ceased, the W-VAAC will coordinate with CVO and AWC to determine the end of the event, any needed changes in alert level and aviation color code, and issue a final advisory.

- **Seattle CWSU**

  CWSU forecasters continuously monitor satellite and radar imagery to detect and track volcanic ash in the atmosphere. Eruption and ash cloud details are coordinated with key partners as appropriate.

  1. The CWSU's primary mission is to support Air Traffic Management decisions (i.e. Decision Support Services to the FAA). The CWSU provides on-demand briefings during volcanic ash eruptions and distributes AWC warning products (i.e. SIGMET), and CWSU products to the appropriate Air Traffic Manager(s), controllers and/or FAA facilities.
  2. Coordination with the National Aviation Meteorologists (NAMs) at the FAA Air Traffic Control System Command Center (ATCSCC): CWSU forecasters communicate volcanic ash information to the NAMs in the ATCSCC when a volcanic eruption may affect the National Airspace System.

  If the CWSU is closed for the night, the AWC will assume primary CWSU responsibility as the backup weather office for air traffic management support.

  A map of CWSU ZSE's forecast and warning area is available in Appendix A.

- **WFOs**

  The appropriate WFO will continually coordinate with the USGS CVO after an initial report of an eruption, and will provide situational awareness to all appropriate NWS offices.

- **NWRFC**

  NWRFC, with the help of local WFO staff, continuously monitors river levels and conditions to detect and forecast river flooding. Flood potential and forecasts are coordinated with WFOs and key partners as appropriate.

  When unscheduled after-hours RFC support is required, the Portland WFO will notify NWRFC staff using an established call-back procedure.

A map of the NW RFC's hydrologic service area is available in Appendix A.

- **Western Region ROC**

  The WR ROC Duty Officer (DO) will schedule and facilitate conference calls with impacted offices throughout the event. The WR ROC will also lead and coordinate any requests for onsite support, and provide logistical support (funding, travel, equipment, etc) for onsite meteorologists. Lastly, the WR ROC DO will serve as the NWS point of contact for most inquiries from the media.

Information and Services During Volcanic Unrest/ Eruption

- **Washington VAAC**

  Volcanic Ash Advisory (VAA): Advisory issued by the W-VAAC concerning the occurrence of volcanic ash (or resuspended ash) that may affect the safety of aircraft operations. A VAA is an advisory that identifies the volcano, time of eruption, observed position of the ash cloud, the forecasted position of the ash and forecaster remarks. The VAA is distributed in TAC and XML formats through several global networks, and is placed on the internet. The VAA is not to be used as a warning message.

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

  The W-VAAC will notify by phone the NWS offices (AWC and appropriate WFO) responsible for issuing official watches and warnings. During an event, the VAAC will continue to monitor and issue updates at least every 6 hours or for any major changes in height or movement, and will coordinate with USGS and AWC to determine the end of the event and issue final messages.

- **AWC**

  SIGMETs for Volcanic Ash Cloud (VA SIGMET): A SIGMET for a volcanic ash cloud will be issued for volcanic eruptions that eject ash into the atmosphere, or if there is significant resuspended ash lofting into the atmosphere. The SIGMET enhances tactical decision-making for en-route air traffic. The SIGMET represents a snapshot of the observed ash cloud position and includes a six-hour forecast position. VA SIGMETs are issued for all volcanic ash eruptions or remote ash clouds within the AWC area of responsibility, regardless of the eruption's magnitude or the size of the ash cloud. When AWC receives information that a volcanic eruption has occurred, a VA SIGMET is issued immediately. If the notification came from a VAAC, the SIGMET is based on forecast information from a VAA. If the notification came from a source other than a VAAC, then an initial VA SIGMET is issued based on satellite observations, aviation surface

observations (METARs), and/or credible pilot reports. The SIGMET is updated as soon as a VAA statement becomes available. VA SIGMETs are re-issued and updated until the ash cloud is no longer a threat to aviation.

World Area Forecast System (WAFS) global forecasts: AWC will also include the active volcano in the World Area Forecast System (WAFS) global forecasts. The active volcano will be added to the forecasts until notified by the VAAC that activity has ceased. This information aids in flight planning efficiency of medium and long-haul flights by notifying flight dispatchers and flight crews that volcanic activity is possible near the volcano.

- **CWSU ZSE**

  During eruptions, it may be necessary for the CWSU to issue Center Weather Advisories (CWA) or Meteorology Impact Statements (MIS) to cover areas that develop outside of existing ash advisories. The CWA contains information about eruptions and location of volcanic ash for a 0–2-hour period. The CWA is an in-flight aviation weather warning for pilots, air traffic controllers, and ARTCC operational staff. The MIS is an information product for eruptions and the location of volcanic ash that are less significant and is issued for a 2–48-hour period. The MIS is an "in-flight" aviation weather statement for Air Traffic Operations Managers and pilots.

- **WFOs**

  Ashfall Advisories and Warnings: WFOs located in the PNW are responsible for issuing ashfall advisories and warnings.

  A WFO will update the Terminal Aerodrome Forecast (TAF) if ash will impact an airport. TAFs are used by a variety of aviation users, including domestic and international commercial airlines, general aviation (GA), civilian, and military operators. TAFs are prepared, issued, and distributed on a timely basis to meet FAA and ICAO requirements, and using a code format designed by the World Meteorological Organization (WMO) for both domestic and international use. TAFs will include volcanic ash when ash is present or expected at ground level or any level over the terminal area (5 mi radius from center of runway).

  WFOs are responsible for issuing and disseminating Flash Flood Warnings for areas where lahars are expected. The USGS will alert WFOs when lahars are anticipated or in progress and will coordinate with WFOs on structured messaging.

- Web and social media: Information from the NWS offices is available online in real-time to the general public. During periods of unrest and eruption, the NWS will coordinate with USGS on structured messaging and provide information concerning ongoing activity on office web sites, and social media platforms.

  Volcano and Responsible WFO (listed geographically from north to south):

  - Mount Baker: WFO Seattle
  - Glacier Peak: WFO Seattle
  - Mount Rainier: WFO Seattle
  - Mount Adams: WFO Pendleton
  - Mount St Helens: WFO Portland
  - Mount Hood: WFO Portland
  - Three Sisters: WFO Pendleton
  - Newberry Crater: WFO Pendleton
  - Crater Lake: WFO Medford

A map of the WFOs forecast and warning areas and maps, of weather radar coverage and PNW volcanoes are available in Appendix A.

C. Federal Aviation Administration

The FAA disseminates information on volcanic ash to Airline Operations Centers, Air Traffic Facilities, Flight Service Stations (FSS), System Operations, and other users of the National Airspace System (NAS).

- **Air Traffic Control System Command Center (ATCSCC)**
  Located in Warrenton, Virginia the ATCSCC balances air traffic demand with system capacity in the NAS. The “Command Center”, as it is commonly known, is committed to managing the NAS in a safe, efficient, and cohesive manner. The ATCSCC is staffed 24 hours a day, 365 days a year.

- **Western Regions Operations Center (W-ROC)**

  The Northwest Mountain Regional Office along with the FAA's Western Regions Operations Center (W-ROC), reside in Des Moines, WA. The W-ROC is staffed 24 hours a day, 365 days a year and is the communications hub for the Northwest Mountain Region, Alaskan Region, and Western Pacific Region. The Northwest Mountain Region encompasses Washington, Oregon, Idaho, Montana, Utah, and Colorado. The W-ROC disseminates emergency information to FAA leadership, FAA regional lines of business employees, and FAA emergency planners. Disseminated information includes anything that impacts the NAS and/or FAA employees within the regions.

- **Air Route Traffic Control Center (ARTCC) - Seattle**

  Located in Auburn, Washington, Seattle ARTCC's airspace encompasses approximately 300,000 square miles including all of Washington, most of Oregon and portions of Montana, Idaho, Nevada and California. The center's boundaries extend from the Canadian border to Northern California and from western Montana to 150 miles off the Pacific Coast.

  The FAA defines an ARTCC as a facility established to provide air traffic control service to aircraft operating on Instrument Flight Rules (IFR) flight plans within controlled airspace, principally during the en route phase of flight. When equipment capabilities and controller workload permit, certain advisory/assistance services may be provided to Visual Flight Rules (VFR) aircraft.

  Air traffic controllers working within a Center communicate via radio with pilots of IFR aircraft passing through the Center's airspace. ARTCCs are electronically linked through the NAS, which allows nationwide coordination of traffic flow to manage congestion. Controllers use radar to monitor the progress of flights and instruct aircraft to perform course adjustments as needed to maintain separation from other aircraft. Pilots may request altitude adjustments or course changes for reasons including avoidance of severe weather or volcanic ash.

Responsibilities During Volcanic Unrest/Eruption

The FAA Seattle ARTCC and ATCSCC collect and disseminate volcanic information received from various sources, including USGS Volcano Observatories, VAACs, airline operators, or other FAA facilities.

The FAA does not generate primary information pertaining to volcanic ash episodes, nor track or predict volcanic ash cloud movement. The FAA relies on

information provided by the NWS, CVO, NESDIS/W-VAAC and pilot reports for current and forecast conditions.

- **Air Route Traffic Control Center (ARTCC) – Seattle WA**

  Upon receiving notification of an eruption or possible eruption, the Watch Supervisor will:

  1. Verify the occurrence of volcanic activity with USGS or the CWSU. If USGS advises that there is increased seismic or other precursory activity of PNW volcanoes, but an eruption event has not occurred, the Operations Manager In Charge (OMIC) will notify ARTCC personnel and appropriate FAA facilities. If the Aviation color code has been elevated to “Orange” or “Red”, the OMIC will notify ARTCC personnel and appropriate FAA facilities as well.

     If a volcanic eruption is verified by USGS or W-VAAC, the OMIC will notify the CWSU and the W-ROC. If an eruption occurs when the CWSU is closed, the Weather Coordinator will contact the AWC, and the CWSU Meteorologist in Charge to staff the CWSU immediately.

  The Traffic Management Unit will:

  Provide assistance to the Area Supervisor as needed. Evaluate the areas impacted to determine if any Traffic Management Initiatives (TMI) are required. Coordinate TMIs with affected areas and ATCSCC, and request to participate in any telcons to gather the latest information on the volcanic activity and ash.

  Air Traffic Controllers will:

  Ensure that all aircraft in the affected area are aware of the most current information available concerning the volcanic eruption and any resultant ash dispersal. Suggest headings or reroutes around known ash or possible ash cloud locations. Assist VFR aircraft to the extent possible in avoiding known ash clouds.

Products and Product Dissemination during Volcanic Unrest/ Eruption

The FAA does not generate primary information pertaining to volcanic ash episodes, nor track or predict volcanic ash cloud movement. The FAA relies on information provided by the NWS, USGS, NESDIS/W-VAAC and pilot reports for current and forecast conditions.

- **Notice to Airmen (NOTAM):** During increased volcanic activity, a NOTAM is issued by the ARTCC Watch Supervisor when USGS has advised that there is increased seismic or other precursory activity of any PNW volcano, but an

eruptive event has not occurred. NOTAMs are disseminated to controllers by the Front-Line Manager and passed on to operators in the affected area.

- **Urgent Pilot Reports (UUA):** UUAs are issued by the Weather Coordinator when an eruption occurs. UUAs may be passed to controllers by the OMIC, or relayed from pilots in the affected area. Controllers will solicit PIREP information from pilots if needed.
- **Temporary Flight Restriction NOTAM (TFR):** A TFR is issued by the ARTCC Watch Supervisor if it is determined that a volcanic event could endanger airborne aircraft and occupants. TFR's are disseminated to controllers by the OMIC and passed on to operators in the affected area.
- Controller's will broadcast information received relating to volcanic eruptions and ashfall hazards.

V. After-Action Reviews (Service Assessments)

An after-action review is a structured review process for analyzing the response to an event, and how the response can be handled better. After action reviews will be conducted for all volcanic ash table top exercises related to this plan, and any real (actual) volcanic ash events impacting the PNW.

VI. List of Acronyms

ARL	Air Resource Laboratory
ARTCC	Air Route Traffic Control Center
Ash3D	Three-dimensional Eulerian Atmospheric Model
ATC	Air Traffic Control
ATCSCC	Air Traffic Control System Command Center
AWC	Aviation Weather Center
CIMSS	Cooperative Institute for Meteorological Satellite Studies
CONUS	Continental United States
CVO	Cascades Volcano Observatory
CWA	Center Weather Advisory
CWSU	Center Weather Service Unit
DO	Duty Officer
DOD	Department of Defense
EMD	Emergency Management Division
FAA	Federal Aviation Administration
FIR	Flight Information Region
FSS	Flight Service Station
GA	General Aviation
HYSPLIT	HYbrid Single-Particle Lagrangian Integrated Trajectory
ICAO	International Civil Aviation Organization

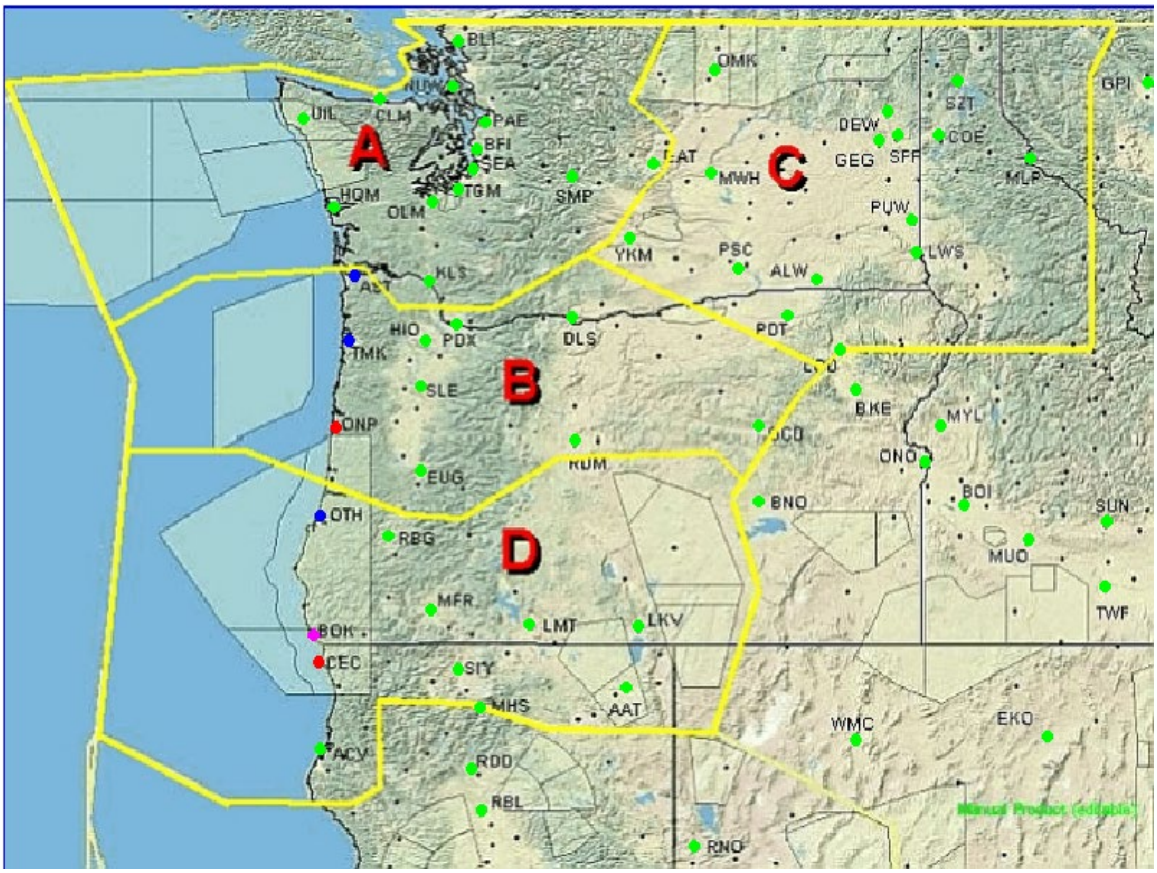
ICAMS	Interagency Council for Advancing Meteorological Services
IFR	Instrument Flight Rules
JIS	Joint Information System
METAR	Aviation Routine Weather Observation Message
MIS	Meteorological Impact Statement
MWO	Meteorological Watch Office
NAM	National Aviation Meteorologist
NAS	National Airspace System
NCEP	National Center for Environmental Prediction
NESDIS	National Environmental Satellite Data Information Service
NOAA	National Oceanic and Atmospheric Administration
NOC	National Operations Center
NOTAM	NOTice to AirMen
NWRFC	Northwest River Forecast Center
NWS	National Weather Service
OFCM	Office of the Federal Coordinator for Meteorology
OM	Operations Manager
OMIC	Operations Manager In Charge
OSPO	Office of Satellite and Product Operations
PIREP	Pilot Weather Report
PNSN	Pacific Northwest Seismic Network
PNW	Pacific Northwest
RFC	River Forecast Center
ROC	Regional Operations Center
SAB	Satellite Analysis Branch
SDM	Senior Duty Meteorologist
SIGMET	SIGnificant METeorological Information
TAF	Terminal Aerodrome Forecast
TMI	Traffic Management Initiative
TRACON	Terminal Radar Approach Control
TFR	Temporary Flight Restriction
TMU	Traffic Management Unit
USGS	United States Geological Survey
UUA	Urgent Pilot Report
VA	Volcanic Ash
VAAC	Volcanic Ash Advisory Center
VAA	Volcanic Ash Advisory
VAG	Volcanic Ash Graphic
VAN	Volcanic Activity Notice
VFR	Visual Flight Rules
VHP	Volcano Hazards Program
VNP	Volcano Notification Service
VONA	Volcano Observatory Notice for Aviation
W-ROC	FAA Western Regions Operations Center

W-VAAC	Washington Volcanic Ash Advisory Center
WAFC	World Area Forecast Center
WAFS	World Area Forecast System
WFO	Weather Forecast Office
WMO	World Meteorological Organization
WRH	Western Region Headquarters
WR ROC	NWS Western Region Regional Operations Center
ZSE	Seattle CWSU and ARTCC

Appendices

Appendix A
Map of Cascades Volcanoes and PNW NWS forecast areas

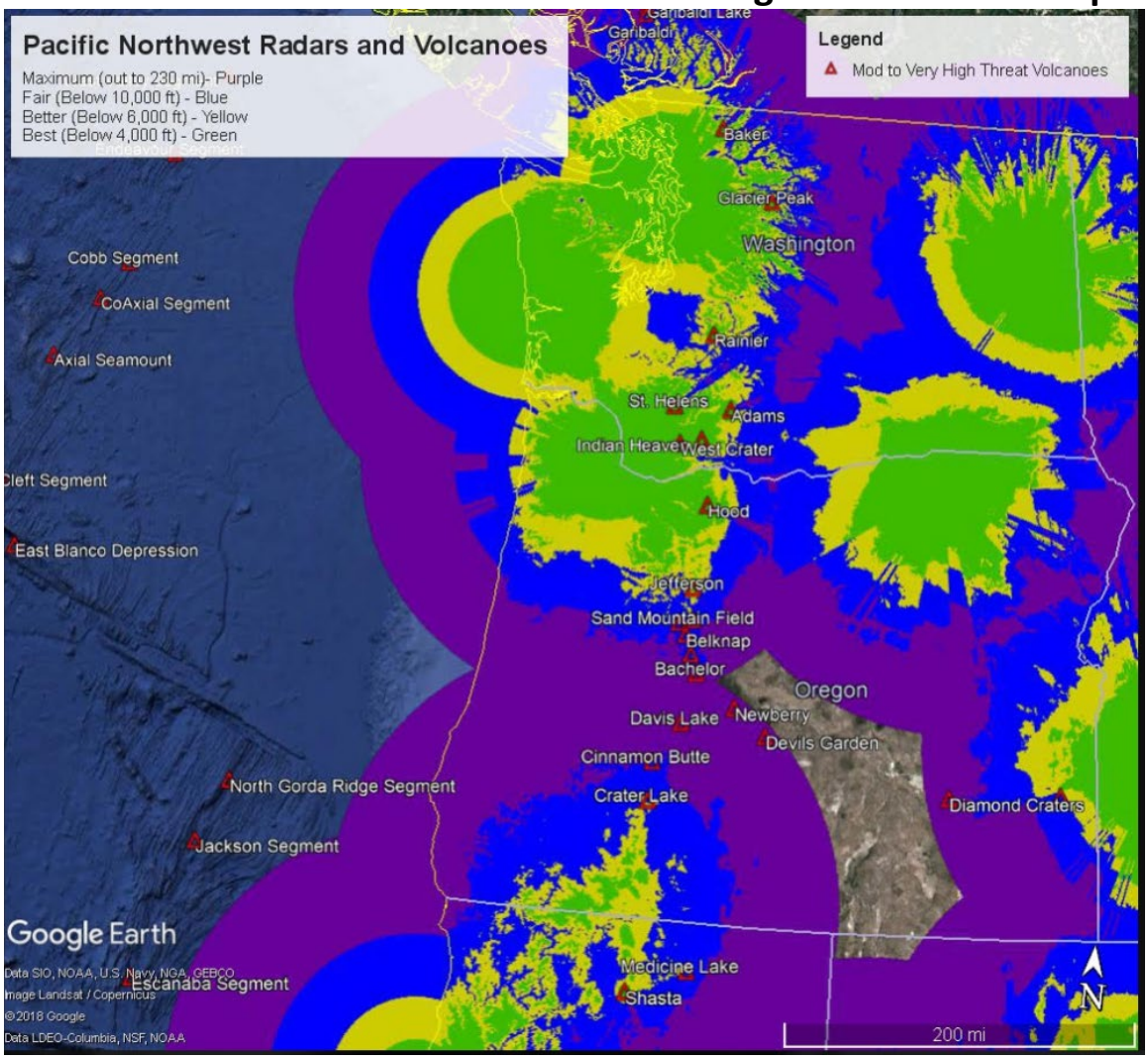
Appendix A
CWSU Seattle (ZSE's) forecast area and sectors



Pacific Northwest Forecast Offices

Appendix A

Pacific Northwest Weather Radar Coverage and Volcano Map



Appendix A
Northwest River Forecast Center Domain Map

Appendix B

Office of the Federal Coordinator for Meteorological Services and Supporting Research, National Volcanic Ash Operations Plan for Aviation

https://www.ofcm.gov/publications/volcanicash/FCM-P35-2007-NVAOPA.pdf

Note: As of September 10, 2024, the National Plan is currently in draft review

Appendix C

Ground Based Volcano Response Plans in Washington and Oregon

- **Mount Baker – Glacier Peak Coordination Plan:**

  https://volcanoes.usgs.gov/vsc/file_mngr/file-129/mount%20baker%20glacier%20peak%20coordination%20plan.pdf

- **Mount Rainier Volcanic Hazards Response Plan**

  https://www.piercecountywa.gov/DocumentCenter/View/3499/ISA-8Volcanic-Incident-minus-external-attachments?bidId=

- **Mount St. Helens – Mount Adams Volcanic Region Coordination Plan**

  https://volcanoes.usgs.gov/vsc/file_mngr/file-132/mount-st.-helens---mount-adams-volcanic-region-coordination-plan-october-2014.pdf

- **Mount Hood Coordination Plan:**

  https://www.oregon.gov/OEM/Documents/Mount_Hood_Volcano_Coordination_Plan.pdf

- **Central Cascades Volcano Coordination Plan**

  https://www.oregon.gov/OEM/Documents/Central_Cascades_Coordination_Plan.pdf

Appendix D

EXAMPLE Cascade Volcano Observatory Event Call-Down Protocol
Mount St. Helens "Call Down" Protocol (February 2024)

CONFIRMED EVENT

Make calls as brief as possible!

OPS Person	
Or person #1	**And person #2**
1. SIC (cell) **Duty Scientist (cell)** **(this person will call USGS Volcano Science Director (cell)** **Proceed to #3**	**2. Seismic Person (will call one)** **CVO Seismologist** **PNSN** **UW Hot Line** **EW Support (cell)** **Proceed to #4**
3. Seattle FAA (ARTCC) **Ask for PIREPs, have them call back on hotline** **Proceed to #5**	**4. National Weather Service (WFO Portland)** **Ask them to check for plume with NEXRAD, have them call back (this could take 6-10 minutes)** **Proceed to #6**
5. Forest Service (Gifford Pinchot) **Proceed to #7**	**6. WA State EMD** **Proceed to #8**
7. Washington VAAC **Proceed to #9**	**8. National Weather Service – hydrology** **Could the event generate lahars? Notify NWS and also check channel flow monitors** **Proceed to #10**
9. FAA Command Center **Proceed to #11**	**10. 557th Weather Wing (557WW) (primary or secondary)**
11. BC Provincial Emergency Program (PEP) (covers all Canada)	

Remember to call back and keep each group informed of event's progress every 15-20 minutes and when there are significant changes (including termination)

SUSPECTED EVENT

CALL 1-6 with "heads-up" and ask for feedback. IF event is confirmed or IF signal is continuing and you still suspect an event, initiate full call down.

Appendix E

Glossary of Volcanological Terms

Volcanic Ash: Particles of rock, glass and minerals less than 2 millimeters in diameter produced by explosive volcanic eruption. Ash is a type of **tephra**.

Ash3d: An atmospheric volcanic-ash model for tephra transport, dispersal, and deposition developed by the USGS. The model tracks particles through Eulerian formulation of advection, fallout and turbulent diffusion, providing forecasts of ash clouds and ashfall

Ash cloud: An airborne cloud of volcanic particles, often with gases and aerosols of volcanic origin, formed by volcanic explosion that is carried by winds away from an eruption column. Ash clouds may drift for hundreds to thousands of kilometers from their volcanic source.

Ash fall: Volcanic particles that fall from an eruptive cloud and are deposited on the ground surface.

Eruption: The arrival of volcanic material at the Earth's surface, including explosive ejection of volcanic particles and/or effusion of molten lava.

Eruption column or plume: The (sub) vertical pillar of ash and gas that forms above an explosively erupting volcano. Columns from energetic eruptions may rise to more than 100,000 ft (30 km).

Lahars: Volcanic mud (debris) flow.

Magma: Molten rock below the earth's surface. Termed lava or tephra once erupted at the surface.

Magmatic eruption: Eruption of fresh ('juvenile') volcanic particles, originating from new molten rock reaching the surface (in contrast to phreatic explosions). Involvement of fresh magma can suggest more vigorous and/or longer duration activity.

Phreatic explosion: Steam-driven explosion that occurs from heated groundwater. May eject particles from the older surrounding rock, but does not contain fresh ('juvenile') particles from new magma reaching the surface.

Pyroclastic Flow: A hot, dry flowing chaotic mixture of pumice, ash, and gas that travels rapidly (as fast as tens of meters per second) away from a volcanic vent during an explosive eruption or from dome collapse.

Tephra: The collective term for particles of all sizes (microns to meters) explosively ejected during volcanic eruptions.

Vog: Short for "volcanic smog"; is a form of air pollution (haze) caused by the reaction of volcanic gases (especially sulfur dioxide) with sunlight, oxygen, dust particles, and water.

Volcano: A vent or opening at the surface of the Earth through which magma erupts; also the landform that is produced by the erupted material accumulated around the vent.

Volcanic gas: Volatile material released during a volcanic eruption that previously was dissolved in the magma. The principal volcanic gases include water vapor, carbon dioxide, and sulfur dioxide.

Sources

John W. Ewert, Angela K. Diefenbach, and David W. Ramsey, 2018 update to the U.S. Geological Survey national volcanic threat assessment, Scientific Investigations Report 2018-5140 U.S. Department of the Interior U.S. Geological Survey, page 5