

# **INTERAGENCY OPERATING PLAN FOR VOLCANIC-ASH HAZARDS TO AVIATION IN THE PACIFIC REGION OF THE NORTHERN MARIANA ISLANDS**



- **Commonwealth of the Northern Mariana Islands/Emergency Management Office**
- **Department of Interior/U.S. Geological Survey**
- **Department of Commerce/National Oceanic and Atmospheric Administration**
- **Department of Transportation/Federal Aviation Administration**
- **Department of Defense/U.S. Air Force**

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# Draft Framework

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# INTERAGENCY OPERATING PLAN FOR VOLCANIC-ASH HAZARDS TO AVIATION IN THE PACIFIC REGION OF THE NORTHERN MARIANA ISLANDS

## 1. INTRODUCTION

The purpose of this document is to provide 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. The document 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). This plan addresses the responsibilities, operational procedures/actions, and information products of each agency that supports the IAVW.

The overall exposure of aviation to potential volcanic-ash hazards from volcanoes in the Northern Mariana Islands is significant. The nine active sub-aerial volcanoes in the region are upwind of frequently used commercial and military air routes that link Saipan and Guam to Asia and the rest of the Pacific Rim. Air routes connecting northeast Asia to Australia, Indonesia, Philippines and New Zealand also are vulnerable to ash hazards from eruptions of Northern Mariana volcanoes.

Since 1900, Northern Marianas volcanoes have erupted every 3-5 years on average (Simkin and Siebert, 1994; Appendix 3), and eruptions can be large. On 15 May 1981, Mount Pagan produced a large eruption with an ash column to more than 52,000 ft (~16 km). Ash fall was reported on Saipan and Guam up to 310 miles (~500 km) south of the volcano on the following day, and the ash cloud was track able for 600 miles (~1000 km) using infrared satellite images (Banks and others, 1984). Anatahan volcano unexpectedly erupted on 10 May 2003, its first eruption in historical times. Occurring at a little known, uninhabited volcanic island with no *in-situ* real-time seismic monitoring and no forecast of imminent activity, the eruptive activity forced an operational response by various meteorological and aviation-related groups that largely had been unaware Anatahan was a potentially active volcano. During 2005, Anatahan erupted well over one million cubic meters of ash during a nearly continuous eruption lasting five months and on several occasions expelled ash to heights of 7.5 miles (12 km). This plan is intended to refine and codify the necessary procedures to provide reliable, consistent ash-hazard information to the commercial and military aviation sectors in the Marianas region.

## 2. RESPONSIBILITIES OF THE PARTIES

**2.1 Commonwealth of the Northern Mariana Islands (CNMI)/Emergency Management Office (EMO):** The EMO is the local agency responsible for informing other CNMI agencies and the public of potential hazards from volcanic activity, tsunami, typhoons, and other natural phenomena.

**2.1.1** The EMO is responsible for providing a facility on Saipan with an internet connection and the capability to receive data via radio transmission from geophysical

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instruments on other islands. The EMO also is responsible for providing staff for technical and logistical support for volcano-monitoring activities in the Marianas region.

**2.2 Department of Interior/U.S. Geological Survey (USGS):** The USGS has the Federal responsibility to issue disaster warnings for earthquakes, volcanic eruptions, landslides, or other geologic catastrophes. The capability of the USGS to provide eruption warnings and related notifications is based on data and observations collected from monitoring networks operated by five U.S. volcano observatories supported by the USGS. The Volcano Observatories provide information on the status of volcanoes on a regular basis to local, state, and Federal officials and the public.

**2.2.1** In the Northern Mariana Islands, the USGS operates and maintains a small seismic and microphone array on Anatahan, one seismic station on Sarigan, and one on Saipan under the USGS's Northern Mariana Islands Volcano Hazards Project. Data from these instruments are radio-telemetered to a data acquisition and analysis system at the EMO on Saipan. Data are displayed locally at the EMO and exported in real time to computer systems at other USGS volcano observatories for analysis by USGS scientists located at CVO, HVO, AVO, and the USGS facility in Menlo Park, California. The USGS and EMO also monitor the air at the EMO for volcanic gases (sulfur dioxide and hydrogen sulfide) that can be carried by the winds south from the volcanoes to Saipan.

**2.2.2** The USGS Northern Mariana Islands Volcano Hazards Project is head by a Project Chief who typically is the Scientist-in-Charge of one of the five USGS volcano observatories. Under the Project Chief is the Northern Mariana Islands (NMI) Duty Scientist who serves as the contact person for phone calls from other groups concerning volcanic activity in the Marianas, conducts call-downs and information releases, and engages other USGS scientists as needed to respond to activity. The position of NMI Duty Scientist rotates weekly among a group of USGS staff. The Duty Scientist is reached by calling a phone number established at HVO that forwards all calls to the cell phone carried by the Duty Scientist.

**2.3 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 organizations, maintains the observational, analytical, and forecasting capabilities required to estimate the location and movement of volcanic ash clouds throughout its areas of responsibility.

**2.3.1** The Washington Volcanic Ash Advisory Center (W-VAAC) is a collaborative effort between the Office of Satellite Data Processing and Distribution of the National Environmental Satellite Data and Information Service (NESDIS) and the National Centers for Environmental Prediction (NCEP) of the National Weather Service (NWS). The Satellite Analysis Branch (SAB), within NESDIS, is the operational portion of the Washington VAAC. The VAAC uses a variety of satellite imagery and techniques to confirm the presence of volcanic ash clouds and track their movement during and following eruptions. The VAAC issues Volcanic Ash Advisories (VAA) that provide

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current locations and forecasted movements of an ash cloud. A VAA is accompanied by a graphical depiction (Volcanic Ash Graphic - VAG) of an ash cloud if such is detectable in satellite imagery. The NCEP portion of the W-VAAC is co-located with the W-VAAC in Camp Springs, Maryland, and runs and issues the HYSPLIT model to provide forecast guidance of the dispersion of volcanic-ash clouds.

**2.3.2** The Honolulu Meteorological Watch Office (MWO) is a Weather Forecast Office within the National Weather Service (NWS). Honolulu MWO serves that portion of the Oakland Oceanic Flight Information Region (FIR) south of 30 degrees North latitude (see graphic in Appendix 4) and issues volcanic eruption and volcanic ash SIGNificant METeorological Information (SIGMET). The SIGMET is the official warning product to the aviation community regarding the volcanic-ash hazard.

**2.3.3.** Weather Forecast Office (WFO) Guam is the National Weather Service office responsible for issuing local weather advisories and short-term forecasts and also serves as a point of contact for EMO officials to coordinate statements about public hazards. For volcanic ash, WFO Guam issues public ash fall and vog advisories, aviation forecasts, and forecasts of conditions that may affect local airports and airfields. WFO Guam operates a ground-based radar WSR-88D (NEXRAD) that can detect ash erupted from Anatahan volcano at altitudes greater than 30,000 ft (9 km). The area of responsibility of WFO Guam is from the equator to 25 Degrees North latitude and between 130 to 180 Degrees East longitude.

**2.4 Department of Transportation/Federal Aviation Administration (FAA):** The FAA is responsible for issuing and disseminating Notices to Airmen (NOTAM) when notified of precursory volcanic unrest, eruptive activity, and volcanic ash in the National Airspace. In addition, FAA serves as the principal agency to coordinate information to Airline Operations Centers and all other users of the NAS through FAA's Air Traffic Services (ATS).

**2.4.1** The Guam Air Route Traffic Control Center (ARTCC) is the sole provider of Instrument Flight Rules (IFR) air traffic control services within a 250 nautical mile radius of the island of Guam, including the Northern Mariana Islands. The ARTCC is responsible for the safe, orderly, and expeditious flow of air traffic within the Guam Control Area, primarily through the use of radar monitoring and flight following. The majority of the Marianas volcanoes exist within the Guam Control Area airspace which includes nearly 200,000 square miles of airspace.

**2.5 Department of Defense (DOD)/U.S. Air Force (USAF):** The USAF through its 2<sup>nd</sup> Weather Group, Air Force Weather Agency (AFWA), Offutt Air Force Base, Nebraska, is the DOD center for volcanic-ash advisories and forecasts for U.S. Forces worldwide.

**2.5.1** AFWA's 2<sup>nd</sup> Weather Group monitors volcanic-ash activity globally using NOAA, NASA, Foreign, and DMSP satellite sensors and issues a standardized set of advisory products tailored for support of activities within DOD units, including those operating in the Marianas region. In U.S. FIR, these products include text advisories incorporating information from NOAA VAA and SIGMET, satellite imagery analysis, and forecast ash

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trajectory outputs in both animation and static panel format utilizing tailored graphic visualizations of the PUFF model.

**2.5.2** AFWA also functions as the backup for the W-VAAC to assure continuity of operations by providing text and graphical forecast products to civilian users during W-VAAC outage periods.

**2.5.3** The Weather Flight of the 36<sup>th</sup> Operations Support Squadron (OSS) at Andersen Air Force Base (AFB), Guam, provides support to the 36<sup>th</sup> Wing (WG) including local airfield weather observations and reporting, produces tailored sortie/mission execution forecasts, and conducts aircrew briefings and mission watch. The 36<sup>th</sup> Weather Flight is responsible for informing key 36<sup>th</sup> WG personnel in event of volcanic activities especially affecting Andersen AFB and military pilots flying routes near the Marianas.

### **3. PROCEDURES FOR ASH-CLOUD EPISODES IN THE MARIANAS REGION**

#### **3.1 EMO**

**3.1.1** EMO will confirm eruption reports received locally by contacting the USGS duty scientist and Washington VAAC. Upon receiving a confirmed eruption report from the USGS, the EMO will call Commonwealth Ports Authority (Airport Manager) and other appropriate CNMI agencies.

**3.1.2** If EMO needs other information about ongoing or suspected volcanic activity (e.g., ash-fall estimates, status of instruments), such requests will be directed to the USGS duty scientist.

#### **3.2 USGS**

**3.2.1** USGS gathers and interprets operational data from its geophysical monitoring networks and any other relevant sources and provides notifications of significant precursory unrest and the onset and cessation of eruptive activity. The call-down (via commercial phone line) by the USGS for such notifications is as follows:

1. Guam ARTCC
2. Honolulu MWO
3. AFWA
4. W-VAAC
5. EMO
6. Guam WFO
7. 36th OSS CWT

**3.2.2** For the aviation sector, the USGS issues a color-coded alert level (Green, Yellow, Orange, or Red) pertinent to ash hazards (Table 1). Color codes reflect the activity at the volcano and expected or ongoing hazardous volcanic phenomena. Color-code assignment is based upon monitoring data and interpretation of changing phenomena. The color code

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is incorporated into the text of a Volcano Observatory Notice for Aviation, (VONA, suggested format given in Appendix 5). A VONA is issued when a color code changes (up or down) or within a color code when significant change in volcanic behavior occurs.

**3.2.3** The USGS will email the text of VONA and other activity reports to staff at AFWA, W-VAAC, EMO, Honolulu MWO, and Guam WFO. In addition to VONA issued for major changes, the USGS prepares other activity reports such as monthly or weekly status reports. Text reports and graphical displays of the status of activity at CNMI volcanoes are available through the USGS Volcano Hazards Program web site <http://volcanoes.usgs.gov/>. An activity report will be posted at least monthly during periods of volcanic quiescence and more frequently as warranted during periods of increased volcanic activity.

<b>Table 1. Aviation Color Codes for Volcanic Activity</b>	
<b>GREEN</b>	Volcano is in normal, non-eruptive state. <i>or, after a change from a higher alert level:</i> Volcanic activity considered to have ceased, and volcano reverted to its normal, non-eruptive state.
<b>YELLOW</b>	Volcano is exhibiting signs of elevated unrest above known background levels. <i>or, after a change from higher alert level:</i> Volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
<b>ORANGE</b>	Volcano is exhibiting heightened unrest with increased likelihood of eruption. <i>or,</i> Volcanic eruption is underway with no or minor ash emission [specify ash-plume height if possible].
<b>RED</b>	Eruption is forecast to be imminent with significant emission of ash into the atmosphere likely. <i>or,</i> Eruption is underway with significant emission of ash into the atmosphere [ <i>specify ash-plume height if possible</i> ].

**3.3 NOAA:** NOAA procedures are in accordance with ICAO standards and recommended practices set forth in Annex 3 to the Convention on International Civil Aviation, Meteorological Services for International Air Navigation.

**3.3.1** Upon detection of volcanic ash in satellite imagery or upon receipt of report of volcanic ash from a bonafide source, W-VAAC will call via commercial phone lines:

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1. Honolulu MWO
2. AFWA
3. FAA Guam ARTCC
4. Aviation Weather Center in Kansas City
5. USGS

### **3.3.2** W-VAAC shall take these additional actions:

1. Issue a “Quick VAA” if appropriate (example in Appendix 5).
2. Run the HYSPLIT model if appropriate.
3. Gather/determine additional information about an ash cloud and issue a complete VAA and VAG.
4. Continue to monitor and issue updates at least every 6 hours or for any major changes in height or movement.
5. Coordinate with USGS and Honolulu MWO to determine the end of the event and issue final messages.
6. Coordinate with the Darwin VAAC and Tokyo VAAC if ash is likely to enter into their regions.
7. Post and archive VAA and accompanying VAG, if any, on the website of the Satellite Services Division of NESDIS (see section 6.3.1 for URL).

**3.3.3** Honolulu MWO, upon detection or receipt of a reliable notification of an eruption or presence of volcanic ash in the atmosphere that affects the Oakland Oceanic FIR, will issue a SIGMET as soon as possible within ten minutes from the time of notification. A SIGMET should be quickly issued that an eruption has occurred, even with only limited information and before the presence of an accompanying ash cloud has been confirmed. If it is determined that volcanic ash is present and as additional information becomes available through satellite, PIREPS, radar, Volcanic Ash Advisories (VAA), volcano observatory reports, etc., the SIGMET will be updated to further describe the vertical and spatial extent of the volcanic ash cloud for a six-hour period. Examples of VA SIGMET are given in Appendix 5.

### **3.3.4** Honolulu MWO as soon as possible also will call:

1. FAA Guam ARTCC
2. CWSU or FAA Supervisor (during times of CWSU non-duty hours) at the Oakland Air Route Traffic Control Center (ARTCC)
3. W-VAAC
4. WFO Guam
5. USGS

### **3.3.5** WFO Guam, upon detection or receipt of a reliable report of volcanic ash in the vicinity shall, as needed, call:

1. FAA Guam ARTCC
2. W-VAAC
3. Call 36 OSS CWT
4. Honolulu MWO
5. Saipan EMO



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6. Guam Civil Defense
7. USGS Duty Scientist for NMI

### **3.3.6** WFO Guam shall take these additional actions, as needed:

1. Coordinate with the CNMI Ports Authority to issue Terminal Airfield Forecast (TAF) and Aviation Weather Warnings (AWW) for CNMI airports
2. Issue a Marine Weather Statement
3. Issue Volcanic Ash Fall Advisories to the general public.

## **3.4 FAA**

### **3.4.1** Upon receipt of a PIREP or other bona fide information indicating a volcanic ash cloud is known or forecast to be present in the Northern Mariana Islands, Guam ARTCC shall:

1. Relay all information available to pilots to ensure that they are aware of the ash cloud's position and altitude(s).
2. Suggest appropriate reroutes to avoid the area of known or forecast ash clouds.
3. Forward relevant PIREP information to the Honolulu Flight Service Station for long-line dissemination.
4. Initiate an International Notice to Airmen (NOTAM) on the status of the volcanic activity.
5. To the extent possible, continually solicit PIREP from other operators in the affected area to determine the status of the volcanic activity.

## **3.5 USAF**

### **3.5.1** Upon detection or report of a volcanic-ash eruption in the Northern Mariana Islands, the Space Weather/Meteorological Satellite Flight at AFWA's 2<sup>nd</sup> Weather Group shall:

1. Notify Andersen AFB 36<sup>th</sup> OSS, the Pacific Air Force Operational Weather Squadron at Hickam AFB, and the U.S. Navy 7<sup>th</sup> Fleet Meteorological and Oceanographic units that support aviation operations in the Marianas vicinity.
2. Call the W-VAAC and USGS duty scientist if AFWA detects an ash plume in imagery surveillance, or other observational data, and has not received a VAA message. AFWA will also notify the W-VAAC if imagery analysis or other data suggests different conclusions than indicated in the VAA.

### **3.5.2** AFWA will provide continuity of operations for the W-VAAC in case of disruptions, including distribution of products via communication channels of the National Weather Service. Appendix 6 specifies the volcanic-ash products that AFWA will produce when required to backup the Washington VAAC.

### **3.5.3** The 36th OSS CWT, upon detection or notification of an ash-producing eruption in the Northern Mariana Islands, shall:

1. Notify key personnel at the 36<sup>th</sup> WG Command Center of expected impact to Andersen AFB and flight routes near the Marianas

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2. Ensure aircrews are made aware of the horizontal and vertical extent of the ash cloud during weather briefings.
3. Transmit to AFWA any PIREP received containing volcanic ash activity information and encode them as Urgent PIREPs (UUA).
4. Notify AFWA, USGS, and WFO Guam

### 4. SHARING OF OBSERVATIONAL DATA

**4.1:** Observational data includes PIREPS, satellite images, seismic and other geophysical data, and ground-based radar images. As soon as anomalous volcanic unrest or activity is detected and throughout the episode of volcanic activity, frequent contact by telephone or email will be maintained among the USGS, W-VAAC, AFWA, FAA, Honolulu MWO, WFO Guam, 36<sup>th</sup> OSS CWT, and EMO to ensure effective sharing of observational data and consistent interpretations of volcanic activity and potential hazards, with the goal of disseminating uniform guidance via the agencies' various hazard messages.

### 5. COMMUNICATION LINKS

**5.1** EMO uses commercial telephone lines (land and cell) and the public internet.

**5.1.1** EMO points of contact in Saipan:

Operations Section: 670-322-9528 (Alternate: 670-322-9528)

Seismic Supervisor: 670-287-8072 (Cell)

Office of Homeland Security: 670-483-4522 (Alternate: 670-483-0151)

Fax: 670-322-7743

**5.2** USGS uses commercial telephone lines (land and cell) and the public internet.

**5.2.1** USGS points of contact for monitoring status:

NMI Duty Scientist (on call 24/7): 808-967-8815

Backup: 907-786-7497 (AVO main number, follow directions for reporting a volcanic eruption in order to get to answering service)

For other information:

Northern Mariana Islands Volcano Hazards Project Chief

Office: 907-786-7443

Cell: 907-632-2276

Fax: 907-786-7425

Email: [tlmurray@usgs.gov](mailto:tlmurray@usgs.gov)

**5.3** NOAA maintains a connection to Global Telecommunications System which connects to the FAA's Aeronautical Fixed Telecommunication Network. Satellite broadcast is via the World Area Forecast System.

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- 5.3.1** Washington VAAC point of contact (24/7):  
Voice: 301-763-8444  
Fax: 301-763-8333  
Email (alarms upon receipt): [w-vaac@noaa.gov](mailto:w-vaac@noaa.gov)

VAA Headers are FVXX20 KNES to FVXX27 KNES

HYSPLIT Headers (only available on WAFS or Internet) are PHBE10KWBC (12/24 hr) and PHBI10KWBC (36/48 hr)

- 5.3.2** Honolulu MWO point of contact (24/7):  
Primary: 808-973-5282  
Alternates: 808-973-5280/5285  
Fax: 808-973-5281

- 5.3.3** WFO Guam contact (24/7):  
Office: 671-472-0950/0951/0952  
Fax: 671-472-7405 (Alternate: 671-472-0980)

### 5.4 FAA

- 5.4.1** FAA Guam ARTCC point of contact (24/7):  
Front Line Manager/Controller-in-Charge: 671-473-1210

### 5.5 USAF

- 5.5.1** AFWA point of contact (24/7):  
AFWA Space Weather/Meteorological Satellite Flight (WXZ)  
Operations Floor: Commercial 402-294-7264/402-232-5321  
Fax: 402-294-6557  
DSN 271-7264/272-5321  
Email: [volcano@afwa.af.mil](mailto:volcano@afwa.af.mil)

- 5.5.2** 36<sup>th</sup> OSS point of contact(24/7):  
Weather Flight - Andersen AFB, Guam  
Commercial 671-366-5230/1407/3176  
DSN 315-366-5230/1407/3176  
Fax (commercial): 671-366-6217  
Email: [36OSS.OSW1@andersen.af.mil](mailto:36OSS.OSW1@andersen.af.mil)

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### 6. INFORMATIONAL WEB PAGES AND OTHER SOURCES OF SUPPORTING DATA

#### 6.1 EMO

**6.1.1** EMO coordinates with USGS to post joint information on a USGS website (see 6.2.1)

#### 6.2 USGS

**6.2.1** For the Northern Mariana Islands, USGS VONA and other volcanic activity reports, with input from the EMO, are available through the USGS Volcano Hazards Program web site <http://volcanoes.usgs.gov/>.

#### 6.3 NOAA

**6.3.1** W-VAAC web site for VAA and VAG is [www.ssd.noaa.gov/VAAC/](http://www.ssd.noaa.gov/VAAC/)

Web site for satellite imagery over particular areas is <http://www.ssd.noaa.gov/VAAC/anat-img.html/>

HYSPLIT model outputs issued for actual ash clouds posted at <http://www.arl.noaa.gov/ready-bin/ashcurrent.pl/>

Website for hypothetical HYSPLIT model outputs (4 times daily) for possible eruptions is <http://www.arl.noaa.gov/ready-bin/ashhypo.pl/>

**6.3.2** The National Weather Service website for SIGMET is <http://www.prh.noaa.gov/hnl/pages/sigmet.php/> The WFO Honolulu website is <http://www.prh.noaa.gov/hnl/>

**6.3.3** WFO Guam website is <http://www.prh.noaa.gov/guam/>

#### 6.4 FAA

**6.4.1** NOTAM information is available to the public at <https://pilotweb.nas.faa.gov/>

#### 6.5 USAF

**6.5.1** AFWA's Joint Air Force and Army Weather Information Network (JAAWIN) provides access to volcanic-ash advisory products (text advisory, annotated satellite imagery and/or web cam imagery, animated and static panel dispersion PUFF graphics) via the Internet: <https://weather.afwa.af.mil/> for any user at a military computer. Non-military computer users must first request an account and be issued a password.

**6.5.2** The 36<sup>th</sup> OSS CWT website is <https://wwwmil/36ossroot/osw/index.htm/>

**7. UPDATING THE PLAN**

7.1 This plan shall be updated every two years, or more frequently if conditions warrant.

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### **References Cited**

Banks, N.G., Koyanagi, R.Y., Sinton, J.M., and Honma, K.T., 1984. The eruption of Mount Pagan Volcano, Mariana Islands, 15 May 1981. *Journal of Volcanology and Geothermal Research*, v. 22, p. 225-269.

Simkin, T. and Siebert, Lee, 1994. *Volcanoes of the World*. Geoscience Press, Tucson, Arizona, 349 pages.

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## Appendix 1

### ACRONYMS

AFB	Air Force Base
AFWA	Air Force Weather Agency
ARTCC	Air Route Traffic Control Center
AVO	Alaska Volcano Observatory
AWC	Aviation Weather Center
AWW	Aviation Weather Warning
CCF	Combined Control Facility
CNMI	Commonwealth of the Northern Mariana Islands
CVO	Cascades Volcano Observatory
CWSU	Center Weather Service Unit
CWT	Combat Weather Team
DOD	Department of Defense
DMSP	Defense Meteorological Satellite Program
DSN	Defense Switching Network
EMO	Emergency Management Office
FAA	Federal Aviation Administration
FIR	Flight Information Region
HVO	Hawaiian Volcano Observatory
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory
IAVW	International Airways Volcano Watch
ICAO	International Civil Aviation Organization
JAAWIN	Joint Air Force and Army Weather Information Network
KKCI	Aviation Weather Center in Kansas City
MWO	Meteorological Watch Office
NASA	National Atmospheric and Space Administration
NCEP	National Centers of Environmental Prediction
NESDIS	National Environmental Satellite Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
NOTAM	NOTice to AirMen
NPW	Non-Precipitation Warning
NWS	National Weather Service
OSS	Operation Support Squadron
PHFO	Meteorological Watch Office in Honolulu
PIREP	Pilot REPort
SAB	Satellite Analysis Branch
SIGMET	SIGNificant METeorological Information
TAF	Terminal Aerodrome Forecast
UUA	Urgent Pilot Report (PIREP)
USGS	United States Geological Survey
VA	Volcanic Ash
VAA	Volcanic Ash Advisory
VAAC	Volcanic Ash Advisory Center
VAG	Volcanic Ash Graphic
VONA	Volcano Observatory Notice for Aviation
VANA	Volcanic Activity Notice for Aviation
WFO	Weather Forecast Office

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WG	Wing
W-VAAC	Washington Volcanic Ash Advisory Center
USAF	United States Air Force



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### Appendix 2

#### GLOSSARY OF VOLCANOLOGICAL TERMS

**Ash:** Finely fragmented particles of rocks and minerals less than 2 millimeters in diameter produced by explosive volcanic eruption. Ash is a type of **tephra**.

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

**Ash fall:** Fragmental material (tephra) that falls from an **eruptive plume, eruption cloud, or ash cloud** and is deposited on the ground surface.

**Eruption:** The arrival of volcanic material at the Earth's surface, including explosive ejection of fragmental material and/or the effusion of liquid lava. Includes **phreatic eruptions**.

**Eruptive plume:** The elongated, downwind dispersed portion of an **eruption column cloud or ash cloud**.

**Eruption column:** The 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).

**Magma:** Naturally occurring molten rock that is generated within the Earth and can erupt at the surface at volcanic vents.

**Phreatic eruption:** Steam-driven explosion that occurs when water beneath the ground or on the surface is heated by a magmatic source and produces **ash** by pulverizing existing volcanic rocks.

**PUFF:** A volcanic-ash trajectory and dispersion model developed by the University of Alaska. The model tracks particles through a Lagrangian formulation of advection, fallout and turbulent diffusion using a random-walk technique.

**Tephra:** The collective term for fragmental materials ejected from craters or vents during volcanic eruptions.

**Vog:** A natural smog-like phenomenon caused by the reaction of **volcanic gases** (especially sulfur dioxide) with sunlight, oxygen, dust particles, and water.

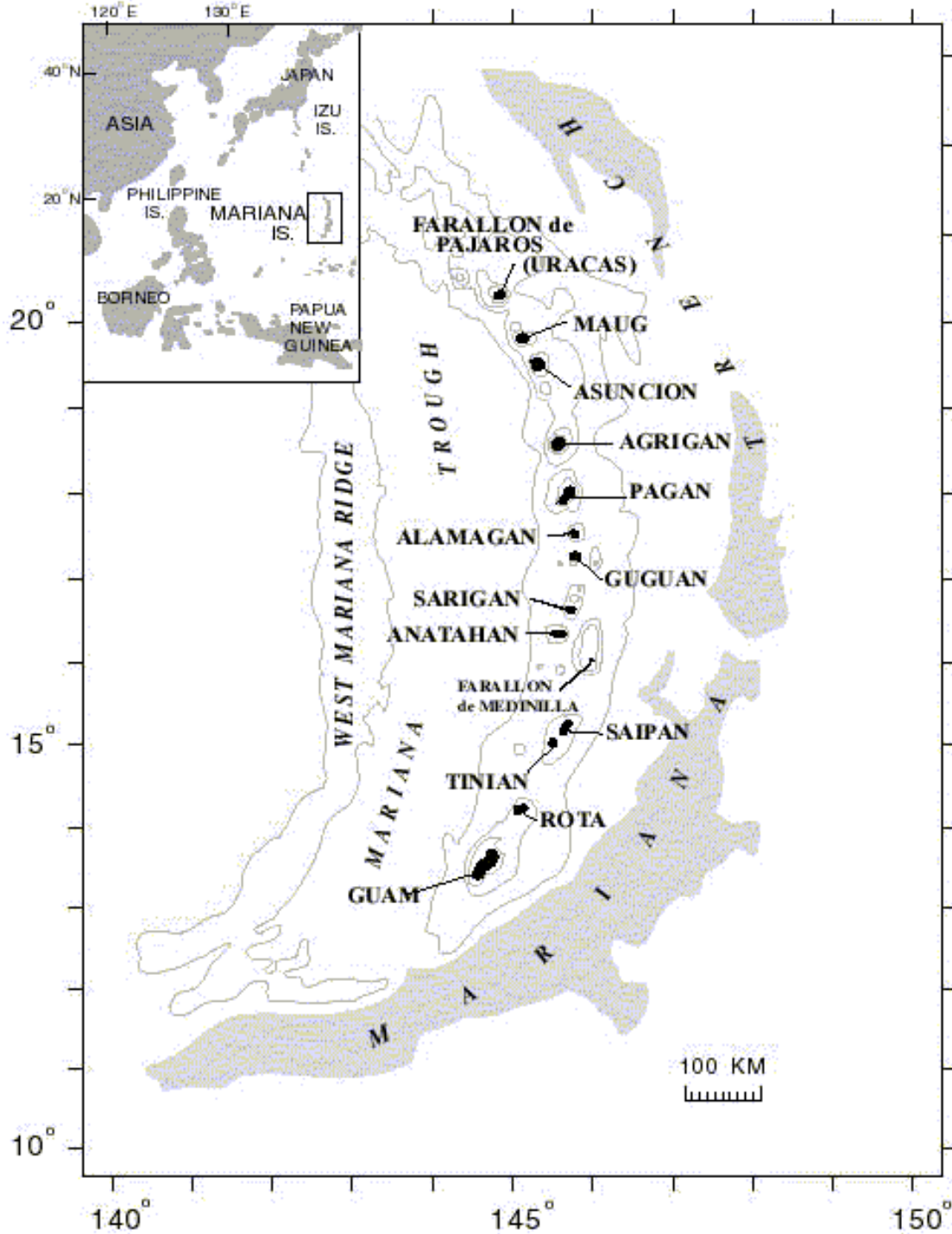
**Volcano:** A vent or opening at the surface of the Earth through which magma erupts; also the landform that is produced by the erupted material accumulated around the vent.

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

Appendix 3

**VOLCANIC DATA FOR THE NORTHERN MARIANA ISLANDS**

Map showing locations of active volcanoes of the Northern Mariana Islands; inset map depicts regional setting.

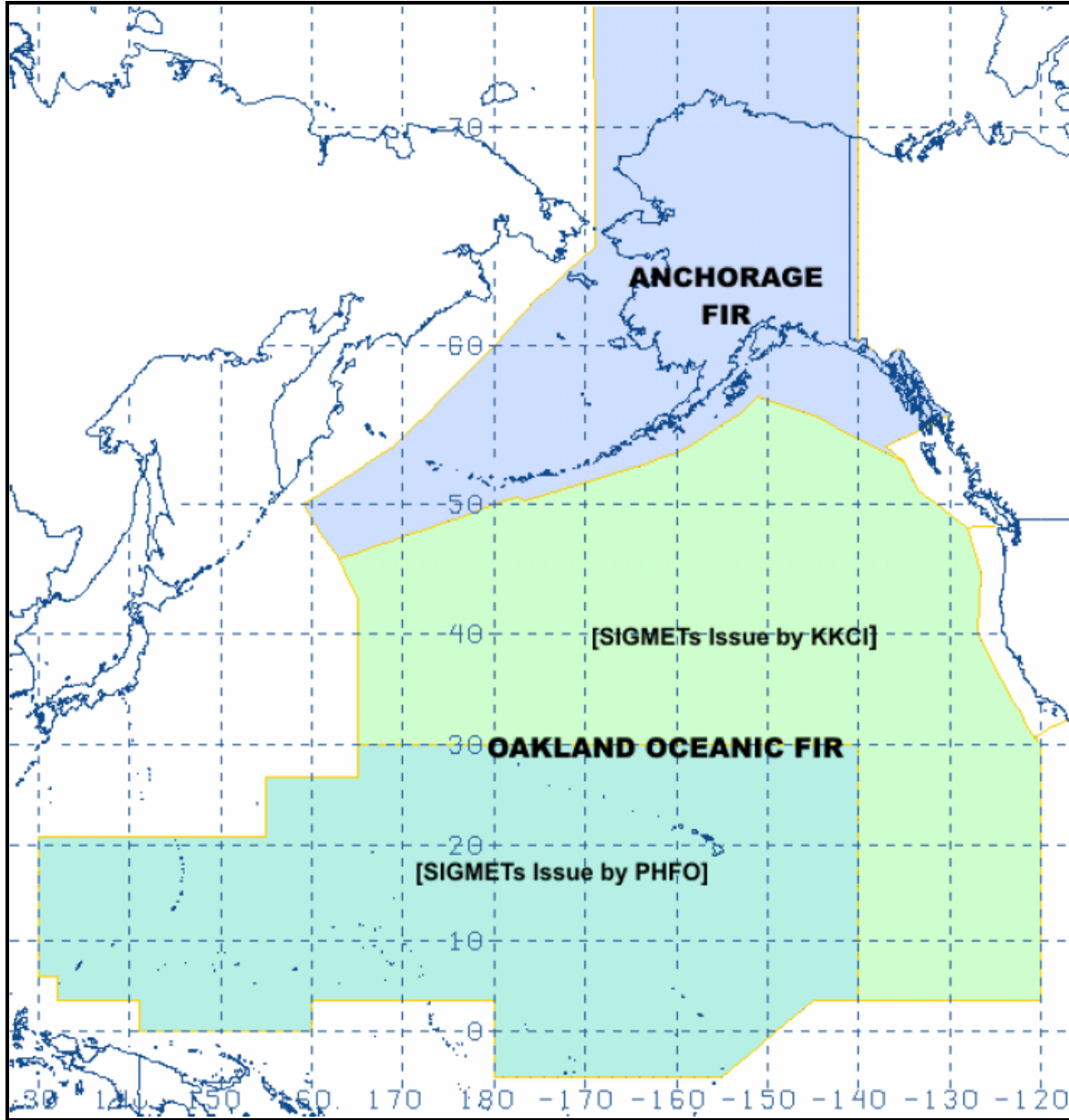


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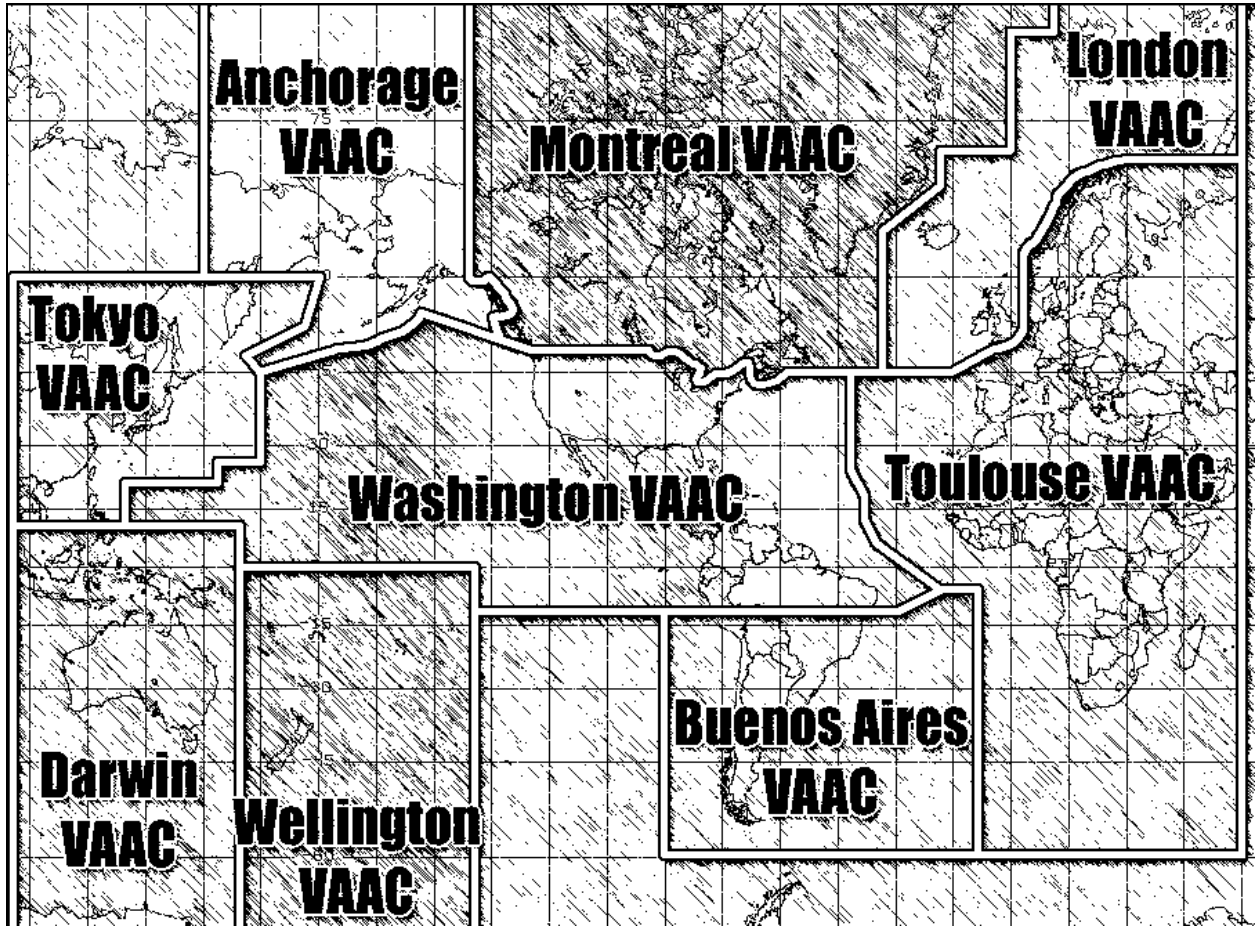
<b>Table of recent eruptive activity at Northern Mariana volcanoes.</b> Data from Smithsonian Institution's database of global volcanism.					
Volcano	Elevation in feet	Latitude, north DDMM	Longitude, east DDMM	Eruptions Since 1900	All Known Eruptions
Farallon de Pajaros*	1182	N2032	E14454	14	16
Maug Islands*	?	N2001	E14513	0	0
Asuncion	2812	N1940	E14524	2	3
Agrigan*	3167	N1846	E14540	1	1
Pagan*	1870	N1808	E14548	10	17
Alamagan	2441	N1736	E14550	0	2
Guguan*	942	N1719	E14551	0	1
Sarigan	1765	N1643	E14547	0	0
Anatahan*	2585	N1621	E14540	4	4
<i>* Indicates caldera structure</i>					

Appendix 4

A. U.S. FLIGHT INFORMATION REGIONS FOR THE NORTH PACIFIC



**B. VAAC BOUNDARIES**



## Appendix 5

### SAMPLE MESSAGE FORMATS

#### I. USGS

Suggested format of a Volcano Observatory Notice for Aviation (VONA) issued by a USGS volcano observatory. A VONA is issued when a color code changes (up or down) or within a color-code level when significant change in volcanic behavior occurs.

- (1) **VOLCANO OBSERVATORY NOTICE FOR AVIATION (VONA)**
- (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:** *In capital letters*
- (5) **Previous Aviation Color Code:** *In lower case letters*
- (6) **Source:** *Name of volcanological agency*
- (7) **Notice Number:** *Year/sequential number (YYYY/xxx)*
- (8) **Volcano Location:** *Latitude and longitude in degrees and minutes (e.g., N1621E14540)*
- (9) **Area:** *Regional descriptor (e.g., Northern Mariana Islands)*
- (10) **Summit Elevation:** *nnnn M (nnnn FT)*
- (11) **Volcanic Activity Summary:** *Brief summary in free text. If known, specify time and duration of eruptive activity.*
- (12) **Volcanic Cloud Height:** *nnnnn M (nnnnn FT) above summit or AMSL (specify which). Give source of height data (pilot or ground observer, radar, webcam etc.). "NIL" if no ash cloud produced. "Unknown" if no data or observations.*
- (13) **Other Volcanic Cloud information:** *Free text. Brief comments on cloud characteristics (ash content, 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. "Unknown" if no data or observations.*
- (14) **Remarks:** *Free text. Brief comments on seismic and other monitoring data, observatory actions, etc.*
- (15) **Contacts:** *Names, phone numbers (voice and fax), email addresses*
- (16) **Next Notice:** *Suggested text: "A new VONA will be issued if volcanic activity changes significantly and/or the aviation color code is changed."*

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### II. FAA

#### **SAMPLE NOTICES TO AIRMEN FOR VOLCANIC ACTIVITY**

!PGZU \_\_\_\_ SEISMIC ACTIVITY ADVISORY FOR (name) VOLCANO (latitude/longitude of volcano) THE WASHINGTON 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. CONTACT GUAM CENTER AT US 671-366-5151 FOR ADDITIONAL INFORMATION.

!PGZU \_\_\_\_ ACTIVE VOLCANO ADVISORY FOR (name) VOLCANO (latitude/longitude of volcano). (name) VOLCANO IS 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 AND PIREP INFORMATION. AIRCRAFT SHOULD REMAIN ALERT FOR POSSIBLE ASH CLOUDS AND REPORT ANY SIGHTINGS TO ATC IMMEDIATELY. AIRCRAFT OPERATORS SHOULD CONTINUALLY EVALUATE OPERATIONS TO AND FROM LOCATIONS IN THE MARIANAS ISLANDS. FLIGHT INTO VOLCANIC ASH MAY CAUSE ENGINE DAMAGE OR FAILURE AND ABRASION DAMAGE TO AIRFRAME AND WINDSHIELD SURFACES. ANY AIRCRAFT THAT OBSERVE OR EXPERIENCE ANY DIFFICULTIES RESULTING FROM AN ENCOUNTER WITH VOLCANIC ASH, PLEASE NOTIFY ATC IMMEDIATELY. CONTACT GUAM CENTER AT US 671-473-1210 FOR ADDITIONAL INFORMATION.

#### **SAMPLE PIREP with VA**

UBUS35 KWBC 282321

PIRUS

PGSN UUA /OV SN355070/TM 2315/FLDURC/TP B757/RM TOP OF ASH CLOUD  
OVER ANATAHAN VOLCANO APPROXIMATELY 15 000 FEET DRIFTING  
EAST=

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## III. NOAA

### SAMPLE VA SIGMET

#### *Initial report of eruption or ash cloud:*

KZOA SIGMET NOVEMBER 1 VALID 120145/120745 PHFO-OAKLAND OCEANIC FIR. THE SAIPAN EMERGENCY MANAGEMENT OFFICE REPORTS THAT ANATAHAN VOLCANO HAS ERUPTED AND A VOLCANIC ASH COLUMN IS VISIBLE. THE ASH CLOUD EXTENDS TO FL450 AS ESTIMATED WITH GUAM RADAR. ANY ASH WOULD MOVE TO THE W AT ABOUT 20 KT. THIS SIGMET WILL BE UPDATED AS MORE INFORMATION BECOMES AVAILABLE. ANATAHAN VOLCANO LOCATED AT N1621 E14540.

#### *Ongoing Eruption:*

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. ANATAHAN VOLCANO LOCATED AT N1621 E14540

### SAMPLE VAA

FVXX20 KNES 060009  
VA ADVISORY  
DTG: 20090406/0009Z

VAAC: WASHINGTON

VOLCANO: ANATAHAN 0804-20  
PSN: N1621 E14540

AREA: MARIANA.ISLANDS

SUMMIT ELEV: 2585 FT (788 M)

ADVISORY NR: 2009/001

INFO SOURCE: GUAM MWO. MTSAT. GFS WINDS. PILOT REPORT. USGS.

ERUPTION DETAILS: BRIEF ERUPTION AT 05/2245

OBS VA DTG: 05/2313Z

OBS VA CLD: SFC/FL100 25NM WID LINE BTN N1622 E14425 - N1619 E14540. MOV W 20KT SFC/FL300 N1710



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E14558 - N1659 E14707 - N1557 E14630 - N1622  
E14541 - N1710 E14558 MOV NE 30KT

FCST VA CLD +6HR: 06/0500Z SFC/FL100 35NM WID  
LINE BTN N1618 E14540 - N1602 E13734. SFC/FL300  
N2258 E15240 - N2120 E15329 - N1958 E15147 -  
N2155 E15041 - N2258 E15240

FCST VA CLD +12HR: 06/1100Z SFC/FL100 35NM WID  
LINE BTN N1617 E14540 - N1453 E13737. SFC/FL300  
NO ASH EXP

FCST VA CLD +18HR: 06/1700Z SFC/FL100 35NM WID  
LINE BTN N1617 E14541 - N1419 E13744.

RMK: ERUPTION SEEN MOVG IN TWO DIRECTIONS. HIGH  
LEVEL AREA EXPECTED TO DISSIPATE AFTER 6HRS WITH  
LOW LEVEL PLUME CONTG. ...SWANSON

NXT ADVISORY: WILL BE ISSUED BY 20090406/0615Z

NNNN

### SAMPLE QUICK VAA

FVXX23 KNES 190412  
VOLCANIC ASH ADVISORY  
ISSUED: 2006MAR19/0412Z VAAC: WASHINGTON

VOLCANO: ANATAHAN  
LOCATION: N1621 E14539 AREA: MARIANA.ISLANDS

SUMMIT ELEVATION: 2585 FT (788 M)

ADVISORY NUMBER: 2006/001

INFORMATION SOURCE: NOT AVBL

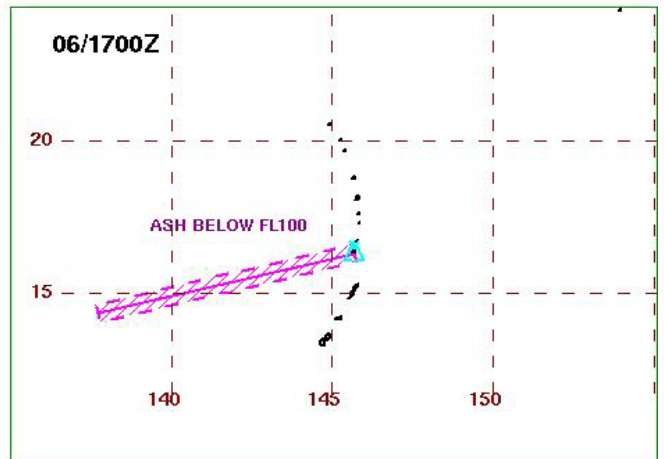
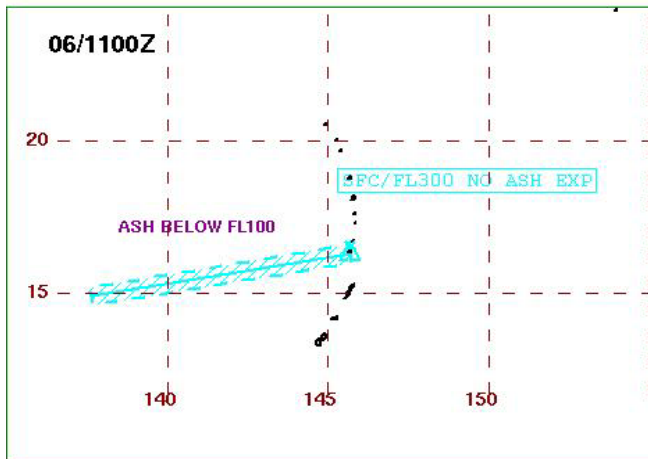
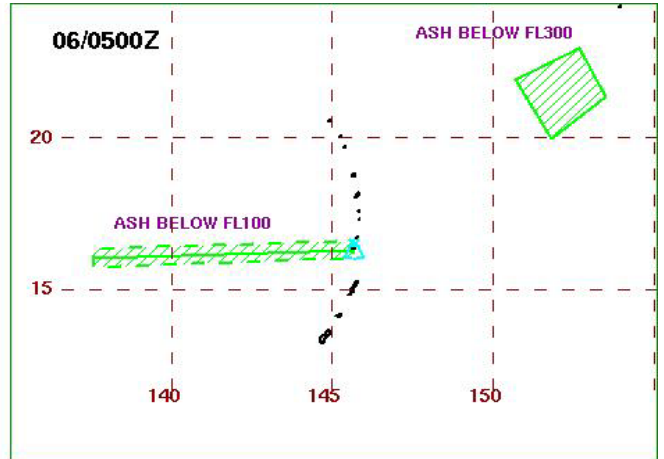
ERUPTION DETAILS: NOT AVBL

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

NEXT ADVISORY: AS SOON AS POSSIBLE

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**SAMPLE VAA VOLCANIC ASH GRAPHIC (VAG)**

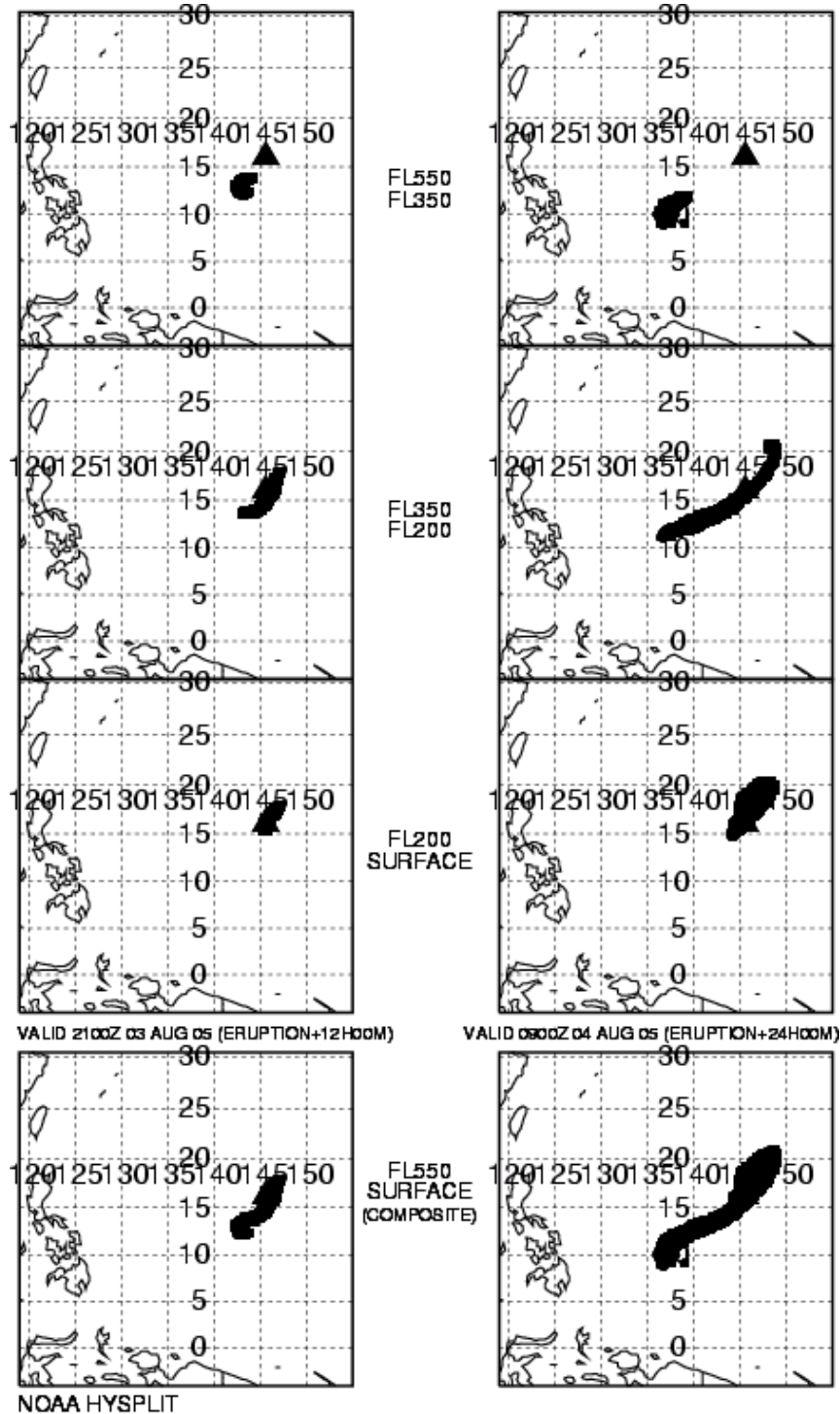


VOLCANIC ASH ADVISORY  
 DTG: 20090406/0009Z  
 VAAC: WASHINGTON  
 VOLCANO: ANATAHAN 0804-20  
 AREA: MARIANA ISLANDS  
 SUMMIT ELEV: 2585 FT (788 M)  
 ADVISORY NR: 2009/001

INFO SOURCE: GUAM MWO. MTSAT. GFS WINDS. PILOT REPORT.  
 USGS  
 ERUPTION DETAILS: BRIEF ERUPTION AT 05/2245  
 RMK: ERUPTION SEEN MOVG IN TWO DIRECTIONS. HIGH LEVEL AREA  
 EXPECTED TO DISSIPATE AFTER 6HRS WITH LOW LEVEL PLUME  
 CONTG. ... SWANSON  
 NXT ADVISORY: WILL BE ISSUED BY 20090406/0615Z

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SAMPLE HYSPLIT



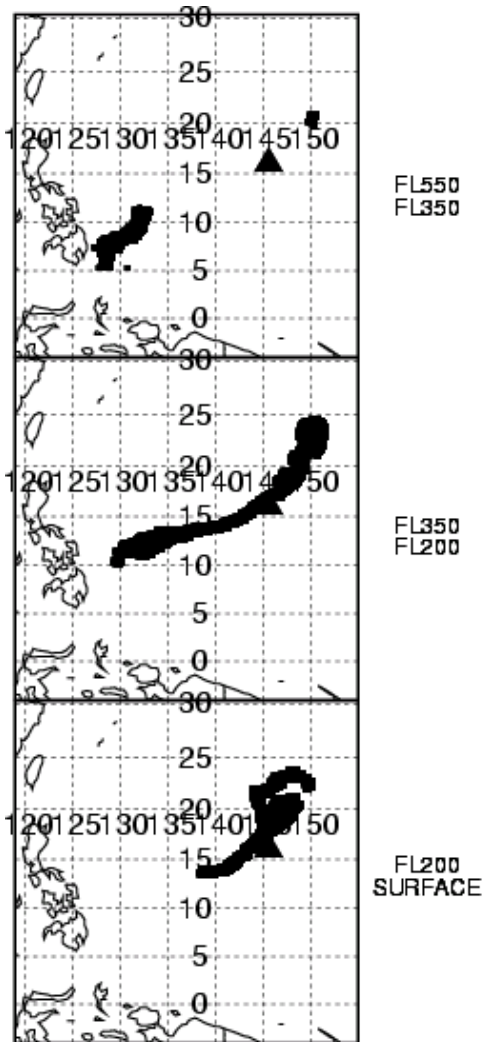
VALID 2100Z 03 AUG 05 (ERUPTION+12H00M)

VALID 0600Z 04 AUG 05 (ERUPTION+24H00M)

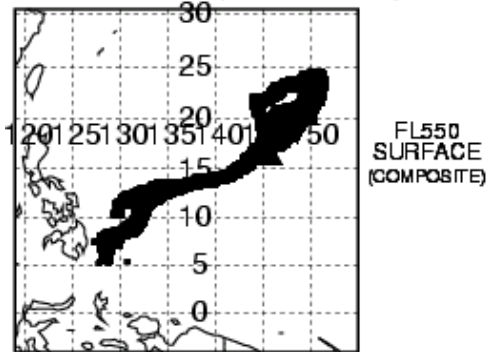
NOAA HYSPLIT

▲ ANATAHAN N1621E14540	■ VISUAL ASH CLOUD	GFSG FCST CYCLE
SUMMIT 2585 FT	*****	06Z 03 AUG 05
ERUPTION 0900Z 03 AUG 05	ALERT	SEE CURRENT SIGMET
DURATION 1.0 HR	*****	FOR WARNING AREA
ASH COLUMN FL420	ASH AMOUNT REDUCED 1	
	*****	

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VALID 2100Z 04 AUG 05 (ERUPTION+36H00M)



NOAA HYSPLIT

▲ ANATAHAN N1621E14540  
 SUMMIT 2585 FT  
 ERUPTION 0900Z 03 AUG 05  
 DURATION 1.0 HR  
 ASH COLUMN FL420

■ VISUAL ASH CLOUD  
 \*\*\*\*\*  
 ALERT  
 \*\*\*\*\*  
 ASH AMOUNT REDUCED 1  
 \*\*\*\*\*

GFSG FCST CYCLE  
 06Z 03 AUG 05  
 SEE CURRENT SIGMET  
 FOR WARNING AREA

## Draft Framework

### Appendix 6

#### CONTINGENCY BACKUP OPERATIONS FOR AFWA AND W-VAAC

1. If the Washington VAAC is down and cannot produce or distribute their products, Air Force Weather Agency (AFWA) at Offutt AFB in Omaha, Nebraska, will provide backup for products and dissemination.
2. Required products and format:
  - Volcanic Ash Advisory (VAA) – (FVXX20-27 KNES)
  - Graphical products, 12, 24 hr page 1 (PHBE10 KWBC)
  - Graphical product, 36, 48 hr page 2 (PHBI 10 KWBC)
3. VAA are issued on an as needed basis. Graphical products are issued if ash plume is expected to last at least 24 hrs.
4. Timeliness: Products should be available as soon as possible after creation.
5. AFWA will be notified by the Washington VAAC of the need for backup and requested to initiate any required backup operations. AFWA is responsible for issuing a statement that it is performing backup operations on behalf of the Washington VAAC.
6. AFWA will notify responsible MWO in the Washington-VAAC's area of responsibility to ensure initiation of SIGMET advisories. AFWA will also notify government agencies as required (including FAA, AWC, FEMA, USGS) of VAA issuance.
7. Washington VAAC will notify AFWA regarding termination of backup support. The Washington VAAC is responsible for issuing a notice of its return to operations.
8. At the Washington VAAC, the lead analyst in the Satellite Analysis Branch is the operational point of contact. At AFWA, the duty analyst in the Satellite Applications Branch is the operational point of contact.
9. Backup capabilities and procedures will be exercised quarterly.