



Republic of the Philippines
CIVIL AVIATION AUTHORITY OF THE PHILIPPINES

Advisory Circular

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Volcanic Ash Cloud Awareness & Guidance Procedures for Volcanic Ash Events

Aerodrome & Air Navigation Safety Oversight Office (AANSOO)
Office of the Director General
Civil Aviation Authority of the Philippines
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VOLCANIC ASH CLOUD AWARENESS & GUIDANCE PROCEDURES FOR VOLCANIC ASH EVENTS

General

Civil Aviation Authority Advisory Circulars contain information about standards, practices, and procedures that the Director-General has found to be an acceptable means of compliance. An advisory circular is not intended to be the only means of compliance with a rule/regulation or requirement, and consideration will be given to other methods of compliance that may be presented to the Director-General. When new standards, practices or procedures are found to be acceptable, they will be added to the appropriate Advisory Circular.

Purpose

- A. This advisory circular provides guidance to all aviation organizations, meteorological offices, volcano observatories and ATM community regarding the hazards posed by volcanic ash cloud.
- B. It also provides information concerning the requirements for the provision of warnings to aircraft of volcanic ash clouds and guidance regarding how these requirements may be satisfied. (ICAO Doc 9974 – Fit Safety-Volcanic Ash, 1st Edition 2012).

Applicability

The guidance provided in this advisory circular is applicable to all Aviation Organizations (Domestic and International), Pilots, Airline Operations Center, Air Traffic Service Units, Meteorological Offices, Volcano Observatories, Airport Authorities (Aerodrome Operators), and ATM Users.

Status of This Advisory Circular (AC)

This AC is an original issuance.

Copy of this AC

The Regulatory Safety Standards Division of AANSOO makes ACs available to the public through the Internet. This AC on Volcanic Ash Cloud Awareness and Guidance Procedures for Volcanic Ash Events may be accessed through the CAAP home page (www.caap.gov.ph). A printed copy of this and other ACs can also be requested from the Aerodrome and Air Navigation Safety Oversight Office (AANSOO), Civil Aviation Authority of the Philippines, MIA Road, Pasay City 1301, Telefax: (632) 8-799-2286.


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Section 1 – POLICY AND GENERAL INFORMATION

1.1 Introduction

- 1.1.1 Volcanic Ash in the atmosphere has a direct safety concern to aviation. Therefore, it is incumbent on the aviation community to take the lead in establishing and maintaining the essential channels of communication between volcano-observing sources and the relevant ACCs and MWOs, and maintaining the currency of the local staff instructions and procedures.
- 1.1.2 Flying through an ash cloud should be avoided by all means due to the extreme hazard for the aircraft. Experience has shown that damage can occur to aircraft surfaces, windshields and power plants. Aircraft ventilation, hydraulic, electronic and air data systems can also be contaminated.
- 1.1.3 Partial or total engine power loss events caused by volcanic ash ingestion, while not frequent, are major safety concerns. Simultaneous power loss in all engines has occurred, where the crew succeeded in restarting the engines, after application of operational procedures.
- 1.1.4 As weather radar is not effective in detecting volcanic ash clouds, crews must be informed by other means of the potential or effective presence of ash clouds on air routes.
- 1.1.5 The aim of this Advisory Circular is to provide information about volcanic ash effects on aircraft and the aviation community, and to give operational guidelines to help prevent volcanic ash cloud encounter.

1.2 Background

- 1.2.1 Since the eruptions of Mt. Galunggung in Indonesia in 1982, Mt. Redoubt in Alaska in 1989 and Mt. Pinatubo in the Philippines in 1991, there have been numerous explosive volcanic eruptions around the world, many of which have affected aircraft operations. With the occurrence of each new eruption, the opportunity has been taken to focus on and review the local and international arrangements for the issuance of information to pilots and, where necessary, fine-tune these arrangements based on actual operational experience gained in dealing with the impact of the eruptions on aircraft operation.
- 1.2.2 If an explosive eruption is observed or if the analysis of the monitoring data indicates that such an eruption is imminent, this information has to be sent quickly through pre-arranged channels of communication to an agreed list of recipients, including the civil aviation and meteorological authorities, and then to pilots of aircraft which could be affected.
- 1.2.3 This is the basis for the establishment of the ICAO International Airways Volcano Watch Handbook (IAVW- ICAO Doc 9766). Moreover, explosive eruptions have a tendency to occur with little or no warning from dormant volcanoes which have not erupted for hundreds of years.
- 1.2.4 Pilots themselves are also an important source of information on volcanic activity and volcanic ash cloud. In this regard, ICAO has developed a format for a special air-report of volcanic activity which pilots are encouraged to use when reporting volcanic activity to air

traffic service units.

1.3 Statistical Data

- 1.3.1 The Asia and the Pacific region represent one of the biggest concentrations of volcanoes in the world, with over 100 active volcanoes (See Appendix F). Active volcanoes are capable of sending volcanic ash up to altitudes greater than FL300 after explosive eruptions. Encounters affecting aircraft performance have occurred 2 400 NM from the ash source and up to 72 hours duration after the eruption.
- 1.3.2 Over a hundred aircraft have reported to have flown into volcanic ash cloud from 1980 up to the present, with consequences ranging from increased wear of engines to simultaneous power loss in all engines.
- 1.3.3 Alert messages (volcanic ash SIGMET) are issued by a Meteorological Watch Office (MWO) for its area of responsibility. Nine (9) Volcanic Ash Advisory Centers (VAAC) have been designated by international organizations to provide expert advice to MWO/VOLCANO OBSERVATORY regarding the location and expected movement of volcanic ash cloud.
- 1.3.4 In the Philippines, the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) is the national weather bureau and the Philippine Institute of Volcanology and Seismology (PhiVolcS) is in charge of volcanic events and earthquakes.

1.4 Related Regulations

- CAR-ANS Part 3 – Chapter 3
- CAR-ANS Part 11 – Chapter 2 & Chapter 7
- CAR-ANS Part 15 Issue 4, Amendment No. 7 – Governing Aeronautical Information Services

1.5 Related Publications

- ICAO Doc 9376 – *Preparation of an Operations Manual* Chapter 8 and Attachment K
- ICAO Doc 9691 Third Edition 2015 – *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds*
- ICAO Doc 9974 – *Flight Safety-Volcanic Ash*, 1st Edition 2012
- Glossary of Volcanological Terms – PHIVOLCS
- ICAO Doc 9766 – *Handbook on the International Airways Volcano Watch (IAVW) Operational Procedures and Contact List* (2nd Edition).
- ICAO PANS ATM (Doc 4444) Appendix 1, 16th Edition 2016 – ICAO Special Air-report of Volcanic Activity Form (model VAR).

1.6 Definition of Terms & Acronyms

1.6.1 Definition of Terms

The following definitions are used in this document:

AIRMET information– Information concerning en-route weather phenomena which may affect the safety of low- level aircraft operations.

ASHTAM – Information issued by a meteorological watch office concerning the occurrence or expected occurrence of specified en-route weather phenomena which may affect the safety of low-level aircraft operations and which was not already included in the forecast issued for low-level flights in the flight information region concerned or sub-area thereof.

Ash cloud — A cloud of volcanic ash and pyroclastic fragments, often with gases and aerosols of volcanic origin, formed by volcanic explosion that is carried by winds away from an eruption column. Ash clouds are often dark-colored brown to gray. Ash clouds may drift for hundreds to thousands of kilometers from their volcanic source.

NOTAM – A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

SIGMET information – information issued by a meteorological watch office concerning the occurrence or expected occurrence of specified en-route weather phenomena which may affect the safety of aircraft operations.

Volcano — vent, hill or mountain from which molten or hot rocks with gaseous material have been ejected

Vulcanian eruption — A type of volcanic eruption characterized by the short duration, violent explosive ejection of fragments of lava. Vulcanian eruption columns may attain heights of 45 000 ft (14 km) or more.

VAAC – a group of experts responsible for coordinating and disseminating information on atmospheric volcanic ash clouds that may endanger aviation. The VAAC was set up by ICAO and there are nine (9) VAACs worldwide. The individual VAACs are run as part of the national weather forecasting organizations of the country where they are based.

Volcanic Ash – consists of small tephra, which are bits of pulverized rock and glass created by volcanic eruption less than 2mm in diameter.

Volcanic Ash Advisory – An alert message issued to aviation and meteorological offices when an ash cloud is detected in the atmosphere. It provides information on: name of volcano, country, location, crater elevation of volcano, source of information, details of ash cloud including flight level, size, current movement, forecast movement for 6, 12, & 18 hours.

1.6.2 Acronyms & Abbreviations

ACC	– Area Control Center
AIREP	– Air-report
AIS	– Aeronautical Information Service
ANSP	– Air Navigation Service Provider
APU	– Auxiliary Power Unit
ATM	– Air Traffic Management
ATS	– Air Traffic Services
EGT	– Exhaust-gas temperature

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EPR	– Engine pressure ratio
FIR	– Flight Information Region
HF	– High frequency
IATA	– International Air Transport Association
IAVW	– International Airways Volcano Watch
IFALPA	– International Federation of Air Line Pilots' Association
ISCS	– International Satellite Communications System
MWO	– Meteorological Watch Office
NASA	– National Aeronautics and Space Administration
NOTAM	– Notice to Airmen
PAGASA	– Philippine Atmospheric, Geophysical and Astronomical Services Administration
PANS	– Procedures for Air Navigation Services
PhiVolcs	– Philippine Institute of Volcanology and Seismology
PIREP	– Pilot Report
SADIS	– Satellite Distribution system for information relating to air navigation
SIGWX	– Significant Weather
SITA	– International Society for Aeronautical Telecommunications
TAF	– Terminal aerodrome forecast
VAAC	– Volcanic Ash Advisory Center
VAR	– Volcanic Activity Reporting
VEI	– Volcanic Explosivity Index
VFR	– Visual Flight Rules
WAFC	– World Area Forecast Center
WMO	– World Meteorological Organization

SECTION 2 - INFORMATION & GUIDANCE

2.1 Volcanic Ash Effects on Aircraft (Refer to ICAO Doc 9974)

2.1.1 Components Abrasion

2.1.1.1 Volcanic ash is a highly abrasive particle that may damage aircraft components, particularly the forward facing surface of external parts and engine components. They are made of sharp rock fragments that will easily erode plastic, metal and even glass pieces.

2.1.1.2 In-service events show that aircraft may suffer from extensive damage after volcanic ash encounter. In some cases, all the following parts were removed and replaced, after they were sand blasted:

- a) Windshields;
- b) Forward cabin windows;
- c) Navigation and landing lights cover;
- d) Wing, stabilizer and fin leading edges;
- e) Engine nose cowl and thrust reversers; and
- f) All pitot and static probes.

2.1.2 Engine Performance Deterioration

2.1.2.1 Ingestion of volcanic ash by engines may cause serious deterioration of engine performance due to erosion of moving parts and/or partial or complete blocking of fuel nozzles.

2.1.2.2 Volcanic ash contains particles whose melting point is below engine internal temperature. In flight, these particles will immediately melt if they go through an engine. Going through the turbine, the melted materials are rapidly cooled down, stick on the turbine vanes, and disturb the flow of high-pressure combustion gases. This disorder of the flow may stall the engine, in worst cases.

2.1.3 Bleed, Air Data and Electronic Systems Contamination

2.1.3.1 Volcanic ash is made of very fine particles (down to 1 micron) that can easily penetrate all but the most tightly sealed enclosures. It may carry high static charge that makes it difficult to remove from electronic components.

2.1.3.2 Ash deposit easily absorbs water and can cause arcing, short circuits and intermittent failures of electronic components.

2.1.3.3 Dense ash deposit can clog bleed system filters and may lead to total bleed loss, with associated loss of cabin pressurization. Pitot and static systems may also become

obstructed by the dust.

2.2 Impact of Volcanic Ash on Aviation Operational and Support Services

2.2.1 Aerodromes

The effect of volcanic ash on an aircraft is similar to aerodromes, its facilities and equipment. Aerodrome operators should be aware that:

- a) Cooling, lubrication and filter systems could be contaminated and become clogged.
- b) Ash which has been dampened by rain can cause short circuits, arcing and flashovers resulting in fires on electrical distribution system components.
- c) Wet ash has the consistency of wet cement and, when deposited on top of hangars, can cause buildings to collapse.
- d) Wet ash on parked aircraft can shift the Center of Gravity (CG) and cause the aircraft to tip over if not secured by a tail stick.
- e) In heavy ash falls with very dry and windy conditions, broncho-pulmonary, ophthalmic and skin medical problems can occur to aerodrome personnel.

2.2.2 Air Traffic Management

2.2.2.1 General

Volcanic eruptions and the resulting ash cloud can cause major disruptions in air traffic operations and in some instances result in life-threatening situations for aircraft en-route.

2.2.2.2. Detection and Reporting

In order to avoid the risk of a major accident and the economic costs associated with aircraft re-routing, flight delays etc., the following worldwide standard message formats for the notification of volcanic eruptions and ash cloud have been developed:

- a) AIS- NOTAM or ASHTAM;
- b) MET- METAR/ SPECI, VAR, SIGMET, AERODROME WARNING;
- c) VULCANOLOGICAL AGENCY- VONA/ VAR (may include alert status color code);
- d) PILOTS- Special PIREP, Urgent PIREP; and
- e) VAAC - VAAI in abbreviated plain language message.

2.2.3 Air Traffic Services Procedures for an Area Control Center (ACC)

If a volcanic ash cloud is reported or forecasted in the FIR for which the ACC is responsible from any of the approved sources or VAACs, the following procedures should be followed:

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- a) Relay all information available immediately to pilots whose aircraft could be affected to ensure that they are aware of the ash cloud's position and the flight levels affected
- b) Suggest appropriate re-routing to avoid area of known or forecast ash clouds
- c) Remind pilots that volcanic ash clouds are not detected by airborne radar or traffic radar systems. The pilot should assume that radar will not give them advance warning or location of the ash cloud
- d) If the ACC has been advised by an aircraft that it has entered a volcanic ash cloud and indicates that a distress situation exists:
 - i. The ACC should consider the aircraft to be in an emergency situation;
 - ii. The ACC should not initiate any climb clearances to turbine-powered aircraft until the aircraft has exited the ash cloud;
 - iii. The ACC should not attempt to provide escape vectors without pilot concurrence.

Note: Experience has shown that the recommended escape maneuver for an aircraft which has encountered an ash cloud is to reverse its course and begin a descent if terrain permits. The final decision, however, rests with the pilot.

Air Traffic Controllers need to be informed that aircraft which encounters ash cloud may suffer serious consequences which can include complete loss of power to the turbine engines. **ATCOs therefore need to be trained to handle such situations and each ATS Unit must develop contingency plans which meet its circumstances.**

Note: ACC contingency procedures in conjunction with other relevant units/organizations during this event are activated.

2.2.4 Radio and Ground Notification

The Area Control Center (ACC) is the communication link between the Pilot, PAGASA and/or PhiVolcS, and ATFM Office (handling flight dispatchers) during episodes of volcanic ash clouds within the Manila FIR.

The responsibility of ACC is as follows:

- a) To provide the pilots with information on the flight levels that is affected by the ash cloud;
- b) To provide the pilots with the projected trajectory and drift of the ash cloud;
- c) To coordinate the pilot's alternative route to avoid the cloud based on the information provided in the volcanic ash SIGMET, the Volcanic Ash Advisory Message and the MWO Advice;
- d) To initiate the promulgation of ASHTAM/NOTAM;

- e) To provide ATFM Office relevant information during this event for flight dispatchers with NOTAM, ASHTAM, SIGMET, and special PIREPS for flight planning.

2.2.5 Meteorological (PAGASA) Services

With the onset of a volcanic eruption resulting in ash cloud, Volcanic Ash Advisory Messages are required to be made available via the following ICAO Satellite communication channels:

- a) ISCS;
- b) SADIS;
- c) SITA;
- d) VAACs Websites;
- e) SIGMET & NOTAM; and
- f) SIGWX.

Procedures:

- a) MWO should immediately inform its associated ACC/ FIS so that aircraft which could be affected may be warned and diverted.
- b) MWO should notify its associated VAAC by telephone, fax or any means available and;
 - i. Seek confirmation of the ash clouds from satellite data;
 - ii. Request trajectory forecasts based on initial information; and
 - iii. Confirm height of the ash cloud

Note: PAGASA (MWO) procedures in conjunction with other relevant organizations during this event are activated.

2.2.6 Flight Planning, Dispatch and Operational Control

2.2.6.1 Flight dispatchers and Operational Control Centers must always consider the safety of the aircraft and its occupants when information on volcanic eruption or ash cloud is received.

2.2.6.2 The following factors must be considered during the flight planning:

- a) carriage of additional fuel;
- b) off-loading of passenger or cargo; and
- c) flight crew duty time limitation due to technical stops.

2.2.7 Arrangement for Provision of Meteorological Services

2.2.7.1 Please refer to Attachment A regarding Directives for the Coordination Between CAAP and PAGASA on the Responsibilities for the Provision of Meteorological Services for International and National Civil Air Navigation.

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SECTION 3 - FACTORS INVOLVED IN VOLCANIC ASH CLOUD ENCOUNTER

The following factors have an influence on volcanic ash detection in flight and on the consequences of volcanic ash encounter.

3.1 Detection

3.1.1 Night and IMC flights are more vulnerable to ash cloud encounter, as dust clouds cannot be detected by airborne weather radars. Low concentration of volcanic ash may not be detected by the crew.

3.3.2 Presence of the following elements can help recognize a volcanic ash cloud encounter:

- a) Acrid odor similar to electrical smoke;
- b) Rapid onset of engine problems;
- c) St. Elmo's fire – (electrical discharge): a luminous region of electrical discharge that appears during stormy weather around a narrow pointed object such as a church spire or the mast of a ship;
- d) Bright white/orange glow appearing in the engine inlets;
- e) Dust and foul smell in the cockpit;
- f) Outside darkness;
- g) Airspeed fluctuation; and
- h) Landing lights casting sharp, distinct, shadows.

3.2 Consequences

- a) Recent (within hours of eruption) volcanic clouds contain concentration of ash that can cause complete loss of engine power within one minute.
- b) Engines operating at high thrust setting are more prone to suffer from ash deposit buildup in the turbine chamber, as internal engine temperature may exceed volcanic-glass material melting point.
- c) In service events show that even low concentration of volcanic ash can cause expensive damage.

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SECTION 4 - PREVENTION STRATEGIES AND OPERATIONAL RECOMMENDATIONS

Prevention strategies and lines-of-defense should be developed to address the risk of volcanic ash encounter. The following communication links can be used to obtain timely updated information on volcano eruptive activity:

4.1 PhiVolcS Function

4.1.1 The Volcanic Observatory function consists of collecting, compiling, processing and updating detailed information regarding the active and pre-eruptive volcanoes likely to affect the area of operation.

4.1.2 This function can be assigned to the following departments, as applicable:

- a) Flight Operations
- b) Flight Safety Office.

4.1.3 To assess the volcanic threat for the affected airways or air routes, the following information sources and communication links can be used:

- a) Aeronautical Information Service (AIS), for active NOTAM/ASHTAM;
- b) Meteorological Watch Offices, Airport Offices and Regional Area Forecast Centers for active SIGMETs;
- c) On-site Aviation Authorities for additional information, such as data and maps related to the ash cloud observed and forecasted extension; and
- d) International organizations such as ICAO, IATA, IFALPA.

Note: PhiVolcS procedures in conjunction with other relevant organizations during this event are activated.

4.2 Flight Crews Pre-flight Briefing and Documentation

4.2.1 All flight crews, operating a flight to/from/through an area likely to be affected by volcanic activity, should be provided with the following information and documents:

- a) On a systematic basis:
 - i. Map(s) of active volcanoes and hazards area
 - ii. ICAO special air-report of volcanic activity form (model VAR - See Appendix C).
- b) As dictated by current volcanic eruptive activity:
 - i. Last active NOTAM/ASHTAM;

- ii. Last active SIGMETs;
- iii. Data or map(s) reflecting the observed ash cloud location, extension and/or trajectory forecast;
- iv. Upper Wind analysis and forecast at selected flight levels; and
- v. Satellite Images.

4.3 En-Route Information Updating

4.3.1 The activity of an erupting volcano usually features series of eruptions sometimes separated by only a few hours. En-route updating of the pre-flight briefing information is therefore of paramount importance to minimize the potential for volcanic ash cloud encounter.

4.3.2 The following communication links can be used to obtain timely updated information on the volcano eruptive activity:

- a) Company FLIGHT WATCH frequency;
- b) ACARS;
- c) VOLMET broadcasts (SIGMETs); and
- d) Flight Information Service (SIGMETs).

4.3.3 Detailed update should be solicited and obtained regarding the following aspects:

- a) Notification of new eruption(s);
- b) Location, height, extension and forecasted trajectory of volcanic ash cloud; and
- c) Notification of airspace restrictions (closure of air routes, activation of contingency routes).

4.4 Flight Crew Training

So as to build-up a flight crew mind-set regarding the volcanic ash threat, volcanic ash awareness should be addressed as part of the flight crew initial and recurrent training, as follows:

- a) Understanding volcanic ash and volcanic ash clouds, as any other weather systems, and their threat to jet aircraft operation
- b) Highlighting the published procedures related to volcanic ash cloud avoidance, recognition of encounter and encounter recovery
- c) Placing a particular attention, during the simulator session related to the ALL ENGINE FLAME OUT procedure, to the slow engine acceleration characteristics to be expected upon engine restart after volcanic ash ingestion
- d) Stressing the instrumental contribution of flight crew air reports and the use of the ICAO special air-report of volcanic activity form (model VAR - See Appendix C).

4.5 Operational Recommendation

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Flight crew operational procedures are published in respective aircraft manufacturers' documentation. Nevertheless, the following actions have been identified as being typical recommendations in case of volcanic ash encounter.

4.5.1 On The Ground

Operation to or from airports contaminated with volcanic ash should be avoided, if possible. Should volcanic ash exposure be unavoidable, the following recommendations and procedures should be applied:

- a) Whenever an aircraft is planned to stay over at an airport contaminated with volcanic ash;
 - i. Engine inlet covers as well as other protective covers and plugs should be installed.
 - ii. Have the aircraft cleaned before departure.
- b) Ash layer may contaminate the lubricated parts, penetrate the seals or enter the engine's gas path, air conditioning system, air data probes and other aircraft orifices.
 - i. Dry crank the engines.
- c) Before starting the engines, ventilate them by dry cranking at maximum motoring speed for two minutes.
 - i. Do not use windshield wipers for ash dust removal.
 - ii. Restrict ground use of APU to engine starts.
- d) Do not use APU for air conditioning and electrical power supply. Use external pneumatic supply for starting the engines, if it is available.
 - i. Keep bleed valves closed for taxiing
 - ii. Taxi with minimum thrust
- e) Advance the levers smoothly to the minimum required for breakaway. Avoid making sharp or high-speed turns. All engines taxi should be preferred, to minimize thrust level on each engine.
 - i. Allow ash and dust (if present) to settle on runway before starting the takeoff roll
 - ii. Use the rolling takeoff technique if possible
 - iii. Consider the runway as wet (for dry ash) or contaminated with slush (wet ash) for takeoff/landing performance calculation
- f) Braking efficiency may be degraded by the layer of ash on the runway.

4.5.2 In Flight

If a volcanic eruption is reported while in flight, the flight should remain well clear of the affected area and, if possible, stay on the upwind side of the volcanic dust (typically 20 NM upwind of the erupting volcano).

- a) Should the volcanic ash encounter be unavoidable, the following general recommendations apply:
 - i. Make a 180° turn
- b) Pilots should exit the cloud as quick as possible. Generally, a 180° turn will result in the fastest cloud exit, due to the possible extension of such clouds over hundreds of nautical miles
 - i. Decrease the thrust
- c) High thrust settings increase the risk of glass particles melting and associated ash deposit buildup in the turbine chamber. Thrust should therefore be decreased, if conditions permit.
 - i. Wear oxygen masks (100%)
 - ii. Report to the ATC
- d) Any observation of volcanic activity or any encounter with a volcanic ash cloud should be reported by immediate radio transmission and/or by filling the ICAO special air-report of volcanic activity form (model VAR - See Appendix C).
 - i. Increase bleed demand (wing and engine anti-ice ON)
- e) Increasing the bleed demand aims at increasing the fuel/air ratio in the engine combustor to limit the possibility of an engine surge and/or flameout.
 - i. Start the APU
- f) The APU GEN will be available to supply the electrical network in case of engine flameout.
 - i. Monitor engine parameters and airspeed indications
- g) The crew should be aware that volcanic ash may render airspeed indications unreliable.

SECTION 5 - SUMMARY OF KEY POINTS

It is important to note the following key points:

- a) Airlines should provide exhaustive and updated information to crews flying in regions likely to be affected by volcano activity.

Note 1: Flight crews should solicit updating of the preflight information when en-route.

Note 2: Flight Crews should report to the ATC any observation of volcanic activity or any encounter with a volcanic ash cloud.

- b) If encounter with volcanic ash cannot be avoided, the flight crew should immediately apply the procedure recommended by the aircraft manufacturers' documentation.

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APPENDIX A

RECOMMENDED PROCEDURES FOR THE MITIGATION OF THE EFFECT OF VOLCANIC ASH ON AIRPORTS AND AIR TRAFFIC CONTROL (ATC) FACILITIES

1. Introduction

1.1 Techniques for reducing the effects of volcanic ash can be grouped into three broad categories:

- a) Keeping the ash out,
- b) Controlling what gets in, and
- c) Disposing of the ash.

1.2 These categories are more illustrative than discrete, and some mitigation techniques will apply in all three cases. Mitigation actions will be required on a continuous basis as long as ash is present. Settled ash is easily re-entrained into the atmosphere, and a 2-mm layer can be as troublesome as a 50-mm layer.

1.3 The most effective technique for reducing ash-related damage or upset to equipment is to avoid using the equipment: shut down, close up, keep inside, or seal the area until the ash can be removed. This tactic is acceptable only for short periods of time because operations must be resumed at some point. In any case, disposal techniques will not eliminate all of the ash. A residue will remain on the ground and will be blown into the air by wind, passing vehicles and aircraft take-offs. Thus, an accelerated and intensive program of inspection, maintenance, cleaning and monitoring will be necessary during and after the main part of ash deposition.

1.4 Cleaning the ambient air — and keeping it clean — is the key to reducing operation and maintenance problems. Blowing ash off of a circuit board is useless if the ash is fine enough to remain suspended for several minutes. The difficulty of attempting to perform maintenance tasks in an already ash-contaminated atmosphere is obvious. Clean-room procedures can be used to isolate an area and keep it free of ash, but only under ideal circumstances. Some equipment — aircraft engines, for example — are too large for such treatment. Tents or tarps can be used to reduce gross contamination. However, the fine particles of volcanic ash can penetrate very small openings and seams; it is this property that makes volcanic ash so damaging to critical equipment.

1.5 Some mitigation procedures may cause additional problems or may actually be counterproductive, depending on the circumstances. For example, adding filtration to a computer system will reduce the amount of ash contamination, but it will also decrease the air flow. The resulting rise in temperature may change the operating characteristics of sensitive components or even cause damage. Adding a larger fan would increase the air flow, but not all computers, especially smaller units, can be easily modified. Another example is the use of moisture to control ash. Wetting carpets will increase relative humidity and help to keep the ash down; however, wet or even damp volcanic ash is conductive.

1.6 No single technique will be absolutely effective; a combination of techniques has been found

to provide the best results for managing volcanic ash. Constant monitoring and reassessment of ash effects and the mitigation process will be required to achieve the most effective balance between operational requirements and the desired level of damage limitation. The following sections summarize ash mitigation techniques for selected aircraft and support systems.

2. Aircraft Systems

2.1 The basic mitigation tactic to protect aircraft systems is avoidance of exposure to ash. The airports and airfields surveyed after the Mt. St. Helens eruption simply shut down for the duration of the ash problem or until the ash had been removed. Airlines rerouted traffic away from ash-impacted airports.

2.2 Sealing aircraft seams, ports, vents and other openings with duct tape will keep out the bulk of the ash, especially if the aircraft is under cover. Maintaining positive pressure within aircraft components would help to keep ash out, but it is difficult, if not impossible, to pressurize an aircraft on the ground without damaging ground equipment.

2.3 Techniques include:

- a) Blow or vacuum ash before washing, otherwise, ash tends to flow into ports, vents or control surfaces;
- b) Flush or wash residue, do not scrub or sweep;
- c) Wash gear, underside, air-conditioning intakes and engines;
- d) Check pH of aircraft/engine surfaces for acidity; and
- e) Neutralize acidic residue by adding petroleum-based solvent to the wash water.

2.4 All of the above techniques require large amounts of time, manpower and equipment. All have significant effects on the level and scope of continued operations. These techniques were tried under conditions of greatly reduced operating levels; however, there is some question as to their effectiveness during normal (or near-normal) operations.

For example:

- a) Sealing an aircraft would take 4-5 hours, and removing all seals and tape would take 1-2 hours. It is very hard to seal an aircraft completely because of numerous ports, vents, seams and joints;
- b) Ash buildup in or around hatch seals could cause pressurization problems; and
- c) Fuel tank vents must be open during loading, unloading and transfer of fuel. If vents are plugged with ash, or if sealed, the tank could collapse. A 4-5 psi vacuum is sufficient to cause collapse.

3. Runways

- 3.1 If aircraft operations are not suspended, runways must be continually cleaned as ash is re-suspended by wind, aircraft take-off and ground vehicle movement. There is some disagreement on the proper use of water in cleaning runways. Some sources felt that water turns the ash to sludge (or causes it to harden), whereas others found it impossible to control the ash without wetting it first. Open-graded (popcorn surface) runways are to some extent self-cleaning because the engine blast on take-off will blow ash out of crevices.

Basic techniques include:

- a) Wet ash with water trucks;
- b) Blade into windrows;
- c) Pick up with belt or front-end loaders;
- d) Haul to dump areas;
- e) Sweep and flush residue;
- f) Sweep/vacuum ash first, then flush with water (best for ramps, etc.);
- g) Push ash to runway edge and plow under or cover with binder such as Coherex or liquid lignin;
- h) Install sprinklers along edges of runway to control re-suspension of ash from aircraft engine blast or wing-tip vortices; and
- i) Keep residue wet on taxiways and ramps.

Note: *The slippery nature of wet ash should be taken into account by pilots maneuvering aircraft on the ground and during landing and take-off.*

4. Landing Aids and Air Traffic Control Systems

- 4.1 Protection of landing aids and air traffic control systems will require periodic cleaning, maintenance and monitoring. Also, turning off unnecessary equipment will reduce exposure from ash contamination suspended in the moving air. Exposed light and indicator systems, radar antennas and any equipment that requires cooling air are especially vulnerable to ash contamination and damage. Interruption of commercial power supplies will require backup generators, which are also vulnerable to ash damage.

Techniques include:

- a) Replace antennas that have Teflon insulators because ash is hard to remove and will cause shorting, ceramic insulators should be used;
- b) Seal relay boxes and remove indicator units and light systems to prevent ash entry;
- c) Increase cleaning and maintenance of systems that cannot be sealed or that require cooling air;

- d) Vacuum or blow ash out and clean relays with contact cleaner;
- e) Use high-pressure water wash on exposed antenna rotor bearings and then re-lubricate;
- f) Cover exposed joints, seams and bearings;
- g) Seal buildings, control access, vacuum shoes and clothes; and
- h) Reduce operating levels: shut down unused equipment, reduce broadband displays to a minimum, and reduce cooling and power consumption.

5. Ground Support Equipment

5.1 The consensus is that ground support equipment is the key to flight operations. If ground support equipment is unserviceable because of ash, aircraft cannot be operated. Unfortunately, there are more problems than solutions in the ash contamination of ground equipment.

5.2 Gas turbines, air compressors and air conditioners operate by ingesting large volumes of air. This equipment has only coarse filtration (or none at all), and extra filtration cannot be added without affecting operation. Using air conditioners to pressurize aircraft compartments would only blow ash into the aircraft and ruin the air conditioners in the process.

Techniques include:

- a) Constant cleaning and maintenance;
- b) Do not wash equipment, because water turns ash to sludge and washes it into the equipment;
- c) Vacuum equipment;
- d) Change oil and filters more often; and
- e) Change design to include better filtration.

6. Computer Systems

6.1 The most widely advised damage-prevention tactic is to shut down all computer and electronic systems until the ash has been completely removed from the area and from the equipment. Computer heads and disks, and any high-voltage circuits, are especially vulnerable to ash upset and damage. Ash on digital circuits will not cause much of a problem because of the low voltages involved. High-voltage or high-impedance circuits are very vulnerable to leakage caused by semi-conductive ash. Ash that is acidic is conductive as well as corrosive. Continual cleaning and aggressive protection of computer systems should allow for continued operation in all but the heaviest ash fallout.

Techniques include:

- a) Clean and condition surrounding air to keep ash out of equipment;
- b) Cotton mat filters used in clean rooms were found to be best for filtering particles, but they reduce air flow. A solution is to use larger fans to maintain required air flow. Rack-mounted equipment can be modified to add a larger fan, but smaller instruments or components with a built-in fan would require a design change to increase fan capacity;
- c) Use fluted filters as a compromise; this increases surface area but reduces air flow by only about 20 per cent;
- d) Humidifying ambient air (e.g. wetting carpets) will help to control ash re-entrainment;
- e) Ash on equipment can be blown out with compressed air. If the air is too dry, static discharge could damage sensitive components (e.g. integrated circuits). If the air is too damp, the ash will stick. Relative humidity of 25-30 per cent is best for compressed air;
- f) Cleaning with a pressurized mixture of water and detergent and using a hot-water rinse is quite effective, however, this process requires at least partial disassembly;
- g) Ash may have a high static charge and be hard to dislodge, thus requiring brushing to dislodge particles;
- h) Accelerate filter change, use pre-filters;
- i) Change to absolute filters, these will keep out particles down to 1 μm and smaller;
- j) Keep computer power on for filtration, but do not operate, especially disk drives;
- k) Maintain room-within-a-room configuration, restrict access, re-circulate air and accelerate cleaning of the critical area.

7. Radar and Optical Systems

7.1 Most radar equipment in the heaviest ash-fall areas has to be shut down for the duration of severe ash contamination. Thus, few problems are likely aside from clean-up and control of residual ash. The simplest mitigation tactic is to cease operations.

Clean-up techniques include:

- a) Repair and clean high-voltage circuits;
- b) Wash antenna rotor bearings, re-lubricate, and cover exposed bearings;
- c) Ash on optical components should be blown away or washed with copious amounts of water. Do not wipe, brush or nib, as this will abrade the optics;
- d) Take care not to wash ash into optical-instrument mounts on aircraft (e.g. sextant);
- e) Turn off non-essential radar equipment to reduce cooling load and power requirements;

- f) Transfer radar coverage to other facilities, combine sectors;
- g) Remove and replace camera bearings and clean gear drives; and
- h) Protect video tape from ash because it will cause —drop-outs and scratches.

8. Planning for Ash Mitigation

8.1 Techniques for reducing the impacts of volcanic ash are basically — low tech and depend more on procedural approaches than on technical fixes. Also, they are quite labour and resource intensive. Normal stock of daily-use items such as filters, lubricants, spare parts, cleaning supplies, etc., may be expended faster than they can be replaced through the normal reordering process. Prior planning is necessary to reduce the severity of ash effects.

Planning actions include:

- a) Conduct a vulnerability analysis of equipment and facilities to determine which would be most impacted by ash, which are adequately protected, and which need long-term or expedient modification;
- b) Develop a priority list of facilities that must be kept in operation versus those that can be closed or shut down for the duration of ash fall;
- c) Ensure hazard-alert and information channels are properly maintained with the volcanological/geological agencies, and the meteorological service, local news media, and national and local governments;
- d) Establish plans and procedures for alerting and notification, reduced operations, accelerated maintenance, protection of critical facilities, and clean-up and disposal;
- e) Alert air traffic controllers and airport operations personnel to notify aircraft as soon as volcano watch and warning notices are received. Normal air traffic and weather radars cannot detect volcanic ash; therefore, relatively large — keep-out zones should be established at night or during bad weather once the warning notice is issued. Personnel should also be alerted to the existence of fall-out beneath the clouds and lightning conditions, etc.;
- f) Stockpile spare parts for critical equipment, filters, sealing, cleaning and disposal equipment;
- g) Plan for extended clean-up and maintenance activities including 24-hour operations, augmentation of the work force, and training of clean-up crews; and
- h) Ensure that sufficient water and back-up power is available to support clean-up operations, should normal supply sources fail.

8.2 Ash clean-up operations may continue for weeks or months if multiple eruptions occur. Effective mitigation of volcanic ash effects depends on prior planning and preparation, mobilization of resources, and persistence.

APPENDIX B

RECOMMENDED GENERAL PROCEDURES TO MITIGATE THE EFFECT OF VOLCANIC ASH ON AIRCRAFT

Volcanic eruptions and subsequent ash drift/fallout have previously caused delays and damage to aircraft and equipment. (Cross-reference with Attachment – ICAO Doc 9974)

The following general procedures have been recommended for use by pilots whose aircraft inadvertently encounter a volcanic ash cloud:

- a) Immediately reduce thrust to idle. This will lower the exhaust-gas temperature (EGT), which in turn will reduce the fused ash build-up on the turbine blades and hot-section components. Volcanic ash can also cause rapid erosion and damage to the internal components of the engines;
- b) Turn auto throttles off (if engaged). The auto throttles should be turned off to prevent the system from increasing thrust above idle. Due to the reduced surge margins, limit the number of thrust adjustments and make changes with slow and smooth thrust-lever movements;
- c) Exit volcanic ash cloud as quickly as possible. Volcanic ash may extend for several hundred miles. The shortest distance/time out of the ash may require an immediate, descending 180° degree turn, terrain permitting. Setting climb thrust and attempting to climb above the volcanic ash cloud is not recommended due to accelerated engine damage/flame-out at high thrust settings;
- d) Turn engine and wing anti-ice ON. All air conditioning packs ON. Turn ON the engine and wing anti-ice systems and place all air conditioning packs to ON, in order to further improve the engine stall margin by increasing the bleed-air flow. It may be possible to stabilize one or more engines at the idle thrust setting where the EGT will remain within limits. An attempt should be made to keep at least one engine operating at idle and within limits to provide electrical power and bleed air for cabin pressurization until clear of the volcanic ash;
- e) Start the auxiliary power unit (APU), if available. The APU can be used to power the electrical system in the event of a multiple-engine power loss. The APU may also provide a pneumatic air source for improved engine starting, depending on the aircraft model; and
- f) Put oxygen mask on at 100 % percent, if required. If a significant amount of volcanic ash fills the cockpit or if there is a strong smell of sulphur, don an oxygen mask and select 100 per cent. Manual deployment of passenger oxygen masks is not recommended if cabin pressure is normal because the passenger oxygen supply will be diluted with volcanic ash-filled cabin air. If the cabin altitude exceeds 4 250 m (14 000 ft), the passenger oxygen masks will deploy automatically.

In the event of engine flame-out:

- a) Turn ignition ON. Place ignition switches to ON as appropriate for the engine model (position normally used for in-flight engine start). Cycling of fuel levers (switches) is not required. For aircraft equipped with auto start systems, the auto start select or should be in the ON position. The auto start system as designed and certified with a — hands-off philosophy for emergency air starts in recognition of crew workload during this type of event;
- b) Monitor EGT. If necessary, shut down and then restart engines to keep from exceeding EGT limits;
- c) Close the outflow valves, if not already closed;
- d) Do not pull the fire switches;
- e) Leave fuel boost pump switches — ON and open crossfeed valves;
- f) Do not use fuel heat — this would be undesirable if on suction fuel feed;
- g) Restart engine. If an engine fails to start, try again immediately. Successful engine start may not be possible until airspeed and altitude are within the air-start envelope, monitor EGT carefully. If a hung start occurs, the EGT will increase rapidly. If the engine is just slow in accelerating, the EGT will increase slowly. Engines are very slow to accelerate to idle at high altitude, especially in volcanic ash—this may be interpreted as a failure to start or as a failure of the engine to accelerate to idle or as an engine malfunction;
- h) Monitor airspeed and pitch attitude. If unreliable, or if a complete loss of airspeed indication occurs (volcanic ash may block the pitot system), establish the appropriate pitch attitude dictated by the operations manual for —flight with unreliable airspeed. If airspeed indicators are unreliable, or if loss of airspeed indication occurs simultaneously with an all-engine thrust loss, shutdown or flame-out, use the attitude indicator to establish a minus-one degree pitch attitude. Inertial ground speed may be used for reference if the indicated airspeed is unreliable or lost. Ground speed may also be available from approach control during landing;
- i) Land at the nearest suitable airport. A precautionary landing should be made at the nearest suitable airport if aircraft damage or abnormal engine operation occurs due to volcanic ash penetration; and
- j) Because of the abrasive effects of volcanic ash on windshields and landing lights, visibility for approach and landing may be markedly reduced. Forward visibility may be limited to that which is available through the side windows. Should this condition occur, and if the autopilot system is operating satisfactorily, a diversion to an airport where an auto landing can be accomplished should be considered. After landing, if forward visibility is restricted, consider having the aircraft towed to the parking gate.

NOTE: *The foregoing general procedures should be supplemented by specific procedures in the aircraft operations manual—developed by aircraft operators for each*

aircraft type in their fleet—dealing with the particular aircraft engine combination concerned. Guidance on this is provided in the ICAO document Preparation of an Operations Manual (Doc 9376), Chapter 8 and Attachment K, and in aircraft manufacturers' flight manual procedures for each of their aircraft types.

Guidance should also be included in aircraft maintenance manuals regarding the necessary maintenance and/or inspections to be undertaken on an aircraft following an encounter with volcanic ash. Mention has already been made in Chapter 2 that for those airlines which operate aircraft regularly through regions of the world subject to frequent volcanic eruptions, the long-term consequences of frequent flights through even very low concentrations of volcanic ash may be increased maintenance costs. Certainly a number of airlines have found that cockpit and passenger windows needed to be re-polished or replaced rather more frequently than expected for the flight hours involved. At this stage it is not clear, however, if this is due more to newer types of plastic window materials used for passenger outer windows or if low concentrations of volcanic ash/acid droplets in the atmosphere are contributing to the problem.

Given that the most serious threat to an aircraft from volcanic ash is the risk of multiple-engine flame-out, it is extremely important to consider the ways and means of improving the success of engine restarts in air contaminated by volcanic ash.

To this end, it is recommended that:

- a) Aircraft manufacturers, with assistance from the engine manufacturers, should define maximum engine power levels (expressed in engine pressure ratio (EPR), fanspeed (N1), and (or) exhaust-gas temperature (EGT) levels) that will minimize buildup of melted and re-solidified ash on HPT nozzle guide vanes. These values should be added to flight-manual procedures and should be used only when the recommended flight idle power will not assure adequate terrain clearance.
- b) Aircraft manufacturers, with assistance from engine manufacturers, should consider addition of a time- delay circuit to allow an air-started engine to reach stabilized idle speed before the electrical or generator load is applied. This would facilitate engine restarts under less-than-ideal conditions.
- c) States should require that air crews practice engine air-restart procedures in a simulator on recurring basis. Normal and deteriorated engine start characteristics should be simulated.

The prime importance of the last recommendation cannot be overestimated. Engine shut-downs or flame-outs in flight are rare events which many pilots will never be called upon to deal with in their whole careers. This is further complicated by the different procedures used for air-start as compared to normal ground-start. The only solution is for pilots to be provided with a set of air-start procedures which also cover procedures in volcanic ash contaminated air and for simulator air-starts to be part of basic and recurrent pilot training.

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APPENDIX C

Special Air-Report of Volcanic Activity Form (Model VAR)
(to be used for post-flight reporting)

VOLCANIC ACTIVITY REPORT

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

OPERATOR:			A/C IDENTIFICATION:(as indicated on flight plan)		
PILOT-IN-COMMAND:					
DEP FROM:	DATE:	TIME; UTC:	ARR AT:	DATE:	TIME; UTC:
ADDRESSEE			AIREP SPECIAL		
Items 1–8 are to be reported immediately to the ATS unit that you are in contact with.					
1) AIRCRAFT IDENTIFICATION			2) POSITION		
3) TIME			4) FLIGHT LEVEL OR ALTITUDE		
5) VOLCANIC ACTIVITY OBSERVED AT					
(position or bearing and distance from aircraft)					
6) AIR TEMPERATURE			7) SPOT WIND		
8) SUPPLEMENTARY INFORMATION					
<div style="text-align: right;">_____</div> (Brief description of activity especially vertical and lateral extent of ash cloud and, where possible, horizontal movement, rate of growth, etc.) <div style="text-align: right;">_____</div>					
After landing complete items 9–16 then fax form to:					
9) DENSITY OF ASH CLOUD <input type="checkbox"/> (a) Wispy <input type="checkbox"/> (b) Moderate dense <input type="checkbox"/> (c) Very dense					
10) COLOUR OF ASH CLOUD <input type="checkbox"/> (a) White <input type="checkbox"/> (b) Light grey <input type="checkbox"/> (c) Dark grey					
<input type="checkbox"/> (d) Black <input type="checkbox"/> (e) Other _____					
11) ERUPTION <input type="checkbox"/> (a) Continuous <input type="checkbox"/> (b) Intermittent <input type="checkbox"/> (c) Not visible					
12) POSITION OF ACTIVITY <input type="checkbox"/> (a) Summit <input type="checkbox"/> (b) Side <input type="checkbox"/> (c) Single <input type="checkbox"/> (d) Multiple <input type="checkbox"/> (e) Not observed					
13) OTHER OBSERVED <input type="checkbox"/> (a) Lightning <input type="checkbox"/> (b) Glow <input type="checkbox"/> (c) Large rocks					
FEATURES OF ERUPTION <input type="checkbox"/> (d) Ash fallout <input type="checkbox"/> (e) Mushroom cloud <input type="checkbox"/> (f) All					

VOLCANIC ASH CLOUD AWARENESS & GUIDANCE PROCEDURES FOR VOLCANIC ASH EVENTS

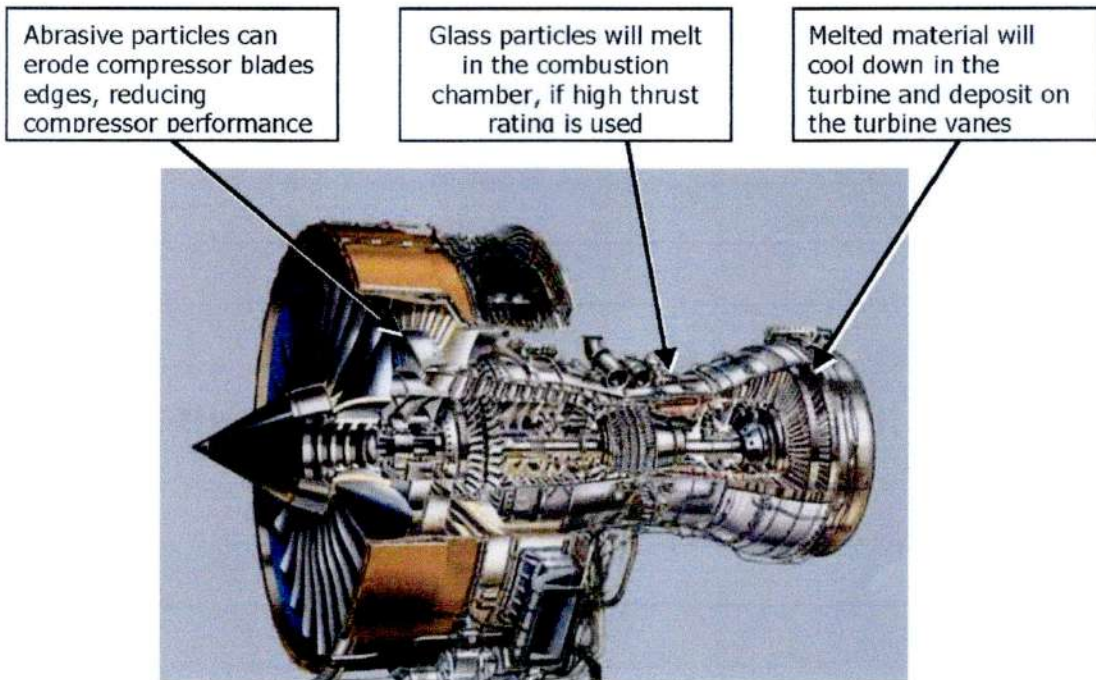
14) EFFECT ON AIRCRAFT <input type="checkbox"/> (a) Communication <input type="checkbox"/> (b) Navigation systems <input type="checkbox"/> (c) Engines <input type="checkbox"/> (d) Pitot static <input type="checkbox"/> (e) Windscreen <input type="checkbox"/> (f) Windows <input type="checkbox"/> (g) All
15) OTHER EFFECTS <input type="checkbox"/> (a) Turbulence <input type="checkbox"/> (b) St. Elmo's Fire <input type="checkbox"/> (c) Fumes <input type="checkbox"/> (d) Ash deposits
16) OTHER INFORMATION (Any information considered useful.)

An example of such a SIGMET is as follows:

SIGMET FOR VA YUDD SIGMET 2 VALID 211100/211700 YUSO-
YUDD SHANLON FIR/UIR VA ERUPTION MT ASHVAL LOC S1500 E07348 VA CLD OBS AT
1100Z
FL310/450 APRX 220KM BY 35KM S1500 E07348 – S1530 E07642 MOV SE 65KMH FCST
1700Z VA CLD APRX S1506 E07500 – S1518 E08112 – S1712 E08330 – S1824 E07836

APPENDIX D

EFFECT OF VOLCANIC ASH ON ENGINE



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APPENDIX E

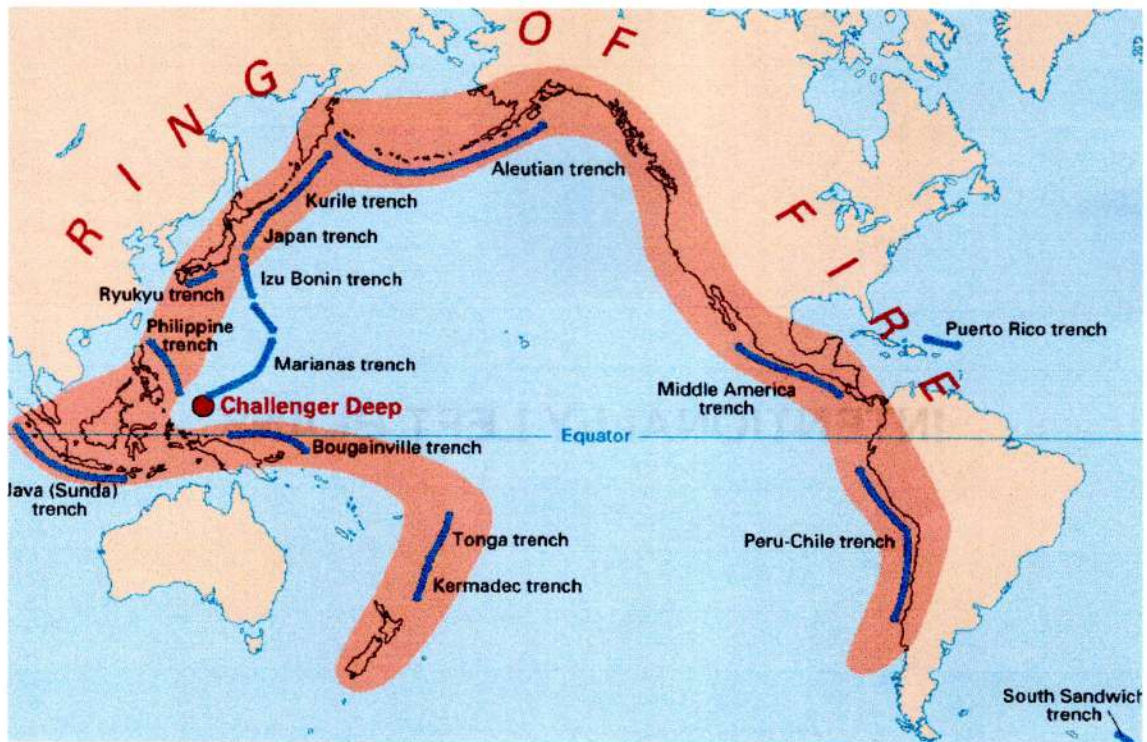
9 VOLCANIC ASH ADVISORY CENTERS AREA OF RESPONSIBILITY



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APPENDIX F

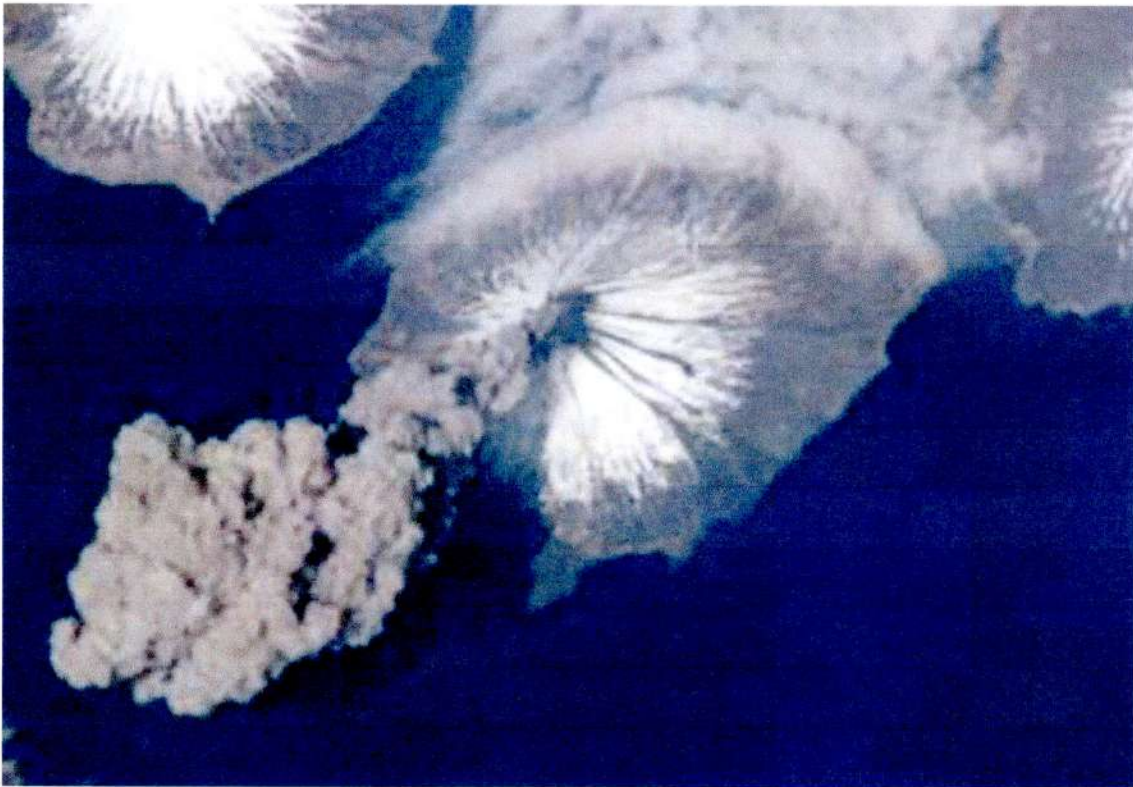
ACTIVE VOLCANOES IN ASIA AND THE PACIFIC AREA



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APPENDIX G

CLEVELAND VOLCANO, ALASKA 23 MAY 2006 (PHOTO: COURTESY NASA)



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ATTACHMENT A

LETTER OF AGREEMENT

BETWEEN

The Civil Aviation Authority of the Philippines (CAAP)

and the

**Philippine Atmospheric, Geophysical and Astronomical Services Administration
(PAGASA)**

LETTER OF AGREEMENT

BETWEEN

The Civil Aviation Authority of the Philippines (CAAP)

and the

**Philippine Atmospheric, Geophysical and Astronomical Services
Administration (PAGASA)**

Directives for the Coordination between CAAP and the PAGASA on the Responsibilities for the
Provision of Meteorological Services for International and National Civil Air Navigation

1. OBJECTIVE

- 1.1 The objective of this Letter of Agreement between the Civil Aviation Authority of the Philippines (CAAP) and the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) is to establish the directives for the necessary coordination between CAAP units and PAGASA's meteorological watch office and aeronautical meteorological offices/stations to ensure the provision of the meteorological service required for international and national civil air navigation, in accordance with international agreements and relevant Philippine civil air regulations.
- 1.2 The CAAP, in accordance with relevant provisions of CAAP CAR-ANS Part 3 and WMO (No. 49) Technical Regulations, Vol. II – Meteorological Service for International Air Navigation, recognizes PAGASA as the state-designated authority for the provision of aeronautical meteorological services for air navigation.
- 1.3 This Letter of Agreement specifies the responsibility of CAAP to transmit air-reports and other meteorological information obtained from aircraft in flight to PAGASA meteorological offices and stations.
- 1.4 This Letter of Agreement also specifies the responsibility of PAGASA to grant CAAP access to PAGASA specific specialized information or data, such as meteorological satellite and/or radar imageries and upper air multi-level wind prognostic charts in support of CAAP operations.
- 1.5 PAGASA is the national meteorological authority mandated to provide or to arrange for the provision of meteorological service for air navigation, pursuant to relevant provisions of ICAO Doc. 8896 – Manual of Aeronautical Meteorological Practice.
- 1.6 This Letter of Agreement also includes the responsibilities of CAAP and PAGASA for the mutual exchange of information with the Philippine Volcanology and Seismology (PHIVOLCS) (as detailed in the tripartite agreement and responsibilities) on pre-eruption volcanic activity, volcanic eruptions and volcanic ash cloud, and information on the release into the atmosphere of radioactive materials and toxic chemicals.

Channel of communications between agencies: 24 hours

CAAP: 9442028 / 9442029 / 9442235 (Manila ACC Operations)

PAGASA: 8522927 / 8795269 / 8323023 (NAIA Synoptic Station)

PHIVOLCS: 9271095 / 4261469 / 4261468 loc 127 (Operations Center)

- 1.7 The directives detailed in this document are in accordance with the regulations of CAR-ANS, Standards and Recommended Practices and Procedures (SARPs) of ICAO Annexes and related documents, WMO Technical Regulations, PAGASA Manual of Surface Synoptic Observation (MASSO) and other related documents.

2. BACKGROUND

2.1 The CAAP is mandated to implement policies on civil aviation to ensure safe, economic, orderly flow of traffic and efficient air travel.

2.1.1 Pursuant to R. A. 9497, the CAAP is tasked to:

- The development and utilization of the air potential of the Philippines;
- The encouragement and development of an air transportation system properly adapted to the present and future foreign and domestic commerce of the Philippines;
- The regulation of air transportation in such manner as to support sound economic condition in such transportation and to improve the relations between air carriers;
 - Establish and prescribe the corresponding rules and regulations for enforcement of laws governing air transportation;
 - Establish and prescribe rules and regulations for the inspection and registration of all aircraft owned and operated in the Philippines and other facilities;
 - Accredite foreign aircraft manufacturers and/or international organizations for aircraft certificates in accordance with established procedures and standards;
- Ensuring the safety, quality, reliability and affordability of air transport services for the riding public;
- The encouragement and development of a viable and globally competitive Philippine aviation industry;
 - Operate and maintain national airports, air navigation and other similar facilities in compliance to ICAO SARPs;
- Determine, fix and/or prescribe charges and/or rates pertinent to the operation of public air utility facilities and services;
- Administer and operate the Civil Aviation Training Center; and
- Perform other functions as maybe provided by law.

2.2 The PAGASA is mandated to provide protection against natural calamities and utilize scientific knowledge as an effective instrument to insure the safety, well-being and economic security of all the people, and for promotion of national progress.

2.2.1 Pursuant to Executive Order No. 128, PAGASA has been mandated to perform the following functions:

- Maintain a nationwide network pertaining to observation and forecasting of weather and other climatological conditions affecting national safety, welfare and economy;
- Undertake activities relative to observation, collection, assessment and processing of atmospheric and allied data for the benefit of agriculture, commerce and industry;
- Engage in studies of geophysical and astronomical phenomena essential to the safety and welfare of the people;
- Undertake research on the structure, development and motion of typhoons and formulate measures for their moderation; and
- Maintain effective linkages with scientific organizations here and abroad and promote exchange of scientific information and cooperation among personnel engaged in atmospheric, geophysical and astronomical studies.

2.2.2 Function of PAGASA Weather Division:

- Undertake continuous monitoring, analysis and prediction of atmospheric conditions and issue forecasts daily for general public, shipping and *civil aviation*.

- Issue warnings and bulletins on tropical cyclones and other potential dangerous meteorological telecommunication system for effective collection/reception of data, local and international exchange of data and warning bulletins, weather forecasts and other relevant information; and
- Conduct operational studies and investigations for the continuing development/improvement of weather analysis and prediction techniques.

2.3 The objectives of the Air Traffic Service (ATS) under CAAP are to:

- a) Prevent collision between aircraft in the air or on the maneuvering area of an aerodrome;
- b) Prevent collision between aircraft on the maneuvering area and obstructions on that area;
- c) Expedite and maintain an orderly flow of traffic;
- d) Provide advice and information useful for the safe and efficient conduct of flights; and,
- e) Notify appropriate organizations regarding aircraft in need of search and rescue aid and assist such organizations as required.

2.3.1 CAAP-ATS comprises the following four (4) services:

- a) Air Traffic Control Service (ATC);
- b) Flight Information Service (FIS);
- c) Alerting Service (AS); and
- d) Aeronautical Information Service (AIS).

2.3.2 The ATC includes the provision of:

- a) Area control service for controlled flights, except for those parts of such flights provided within the approach control service and the aerodrome control service;
- b) Approach control service to that portion of controlled flights associated with the arrival of an aircraft at, or its departure from, the various controlled aerodromes; and
- c) Aerodrome control service for aerodrome traffic, except for those parts of flights provided within approach control service.

2.3.3 The FIS provides advice and information essential for the safe and efficient conduct of flights.

2.3.4 The AS is a service provided to notify appropriate organizations regarding aircraft in need of search and rescue aid and assists such organizations as required.



2.3.5 The AIS is a service established within the Manila FIR responsible for the provision of aeronautical information of a lasting character essential to air navigation.

2.4 The objective of PAGASA is to execute and coordinate activities to meet the aeronautical meteorological requirements necessary for civil air navigation in the Philippines.

2.4.1 To pursue the above cited objective, PAGASA maintains and establishes an adequate number of meteorological offices and stations to meet the relevant requirements for the provision of meteorological service for civil air navigation.

2.4.2 The following aeronautical meteorological services are provided to CAAP:

- a) Aeronautical Meteorological Stations (AMSs) make routine and special observations and issue local and special reports (METAR and SPECI) for the respective aerodrome. In addition, these stations make non-routine observations and prepare volcanic activity reports when applicable;






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- b) Aeronautical Meteorological Offices (AMOs) and/or aerodrome meteorological offices provide forecasts for aerodromes such as Terminal Aerodrome Forecast (TAF) and trend forecasts, relevant warnings for aerodromes and their vicinity, as well as forecasts of en-route weather conditions, meteorological consultation, flight briefings and documentation; and;
 - c) Meteorological Watch Office (MWO) provide meteorological watch for the Manila Flight Information Region (FIR)/Upper Information Region (UIR) established in the Philippines, including the preparation, issuance and dissemination of all types of SIGMET and AIRMET information concerning specified en-route weather phenomena which may affect the safety of aircraft operations.

3. RESPONSIBILITIES

3.1 General

- 3.1.1 In order to provide an efficient air traffic service and in view of the fact that the CAAP Units are an important factor in the linkage between aircraft in flight and the meteorological offices and stations, the CAAP and the PAGASA will collaborate to ensure a fast and efficient coordination.

3.2 Responsibilities of CAAP and CAAP units

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- 3.2.1 The CAAP makes the necessary arrangements for CAAP-ATS units to transmit, without delay, routine and non-routine (special) air-reports received from aircraft in flight to PAGASA meteorological watch office (CAR-ANS Part 3, 5.6 refers) and meteorological offices and stations concerned. (CAR-ANS 11, 2.20.1 a) and b) refer.)
 - 3.2.2 ATS units shall also transmit, without delay, reports received from aircraft information on turbulence, pre-eruption volcanic activity, volcanic eruptions and volcanic ash cloud for which SIGMET information has not been issued (CAR-ANS 11, 2.20.1 c) refers) to the associated meteorological offices and to the meteorological watch office or to the associated Volcanic Ash Advisory Center (VAAC - Darwin and Tokyo), as appropriate.
 - 3.2.3 Provide PAGASA the access to CAAP-owned Automated Weather Observing System (AWOS) data and other supplementary information necessary for the aeronautical meteorology operation. 
 - 3.2.4 Within the frame of the FIS, relevant ATS units will transmit to aircraft pertinent:
 - a) SIGMET information up to a distance normally corresponding to two hours' flying time and appropriate special air-reports for which SIGMET information has not been issued. The transmission to aircraft of such air-reports will continue for two hours from the time of issuance of the respective air-reports;
 - b) AIRMET information up to a distance of two (2) hours' flying time;
 - c) Information concerning pre-eruption volcanic activity, volcanic eruptions and volcanic ash clouds received from the sources specified in arrangements developed by the CAAP-ATS, PHIVOLCS and PAGASA until the respective SIGMET and/or ASHTAM or NOTAM are issued; 
 - d) Information received from WAFCS London and Washington concerning the release into the atmosphere of radioactive materials or toxic chemicals, in accordance with arrangements developed by the ATS authorities in coordination with the meteorological authority; and
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- e) As necessary, weather conditions at departure, destination and alternate aerodromes reported in relevant METAR and SPECI, with TREND forecasts and TAF.

3.2.5 In order for PAGASA to perform its mandate in respect of provision of meteorological services in civil aviation, CAAP shall arrange to provide PAGASA an office space with a total view of the aerodrome, in airports that are owned and operated by CAAP, for the continuous monitoring of atmospheric condition or station building within the airport complexes established in the Philippines including the following among others:

- 1) Instrument garden for the basic outdoor meteorological instruments without obstruction;
- 2) Office tables/chairs;
- 3) Communication facilities; and
- 4) Power and water supplies.

If an office space or station building cannot be provided by CAAP, a suitable lot area of approximately 1000 sqm (subject to availability) for PAGASA Airport-Synoptic Station should be allocated, sufficient to accommodate an instrument garden and the building structure and to include only items 3 and 4 of the above.

The meteorological station should be located such that it could cater also to the requirements of the general public, e.g., space to accommodate visitors and researchers without disturbing the airport operation.

3.2.6 In line with the CNS-ATM implementation, CAAP should endeavor to install Automated Weather Observing System (AWOS) in eight (8) selected airports, to upgrade and enhance the meteorological information provided by PAGASA to aviation operations. For CAAP airports equipped with AWOS, item 3.2.5 may not apply. Instead, a suitable lot area of 500 sqm may be provided (subject to availability) and to include only items 3 and 4 of item 3.2.5.

3.3 Responsibilities of PAGASA and its service units

3.3.1 PAGASA shall establish, within the Manila FIR, aerodrome/aeronautical meteorological offices/stations and meteorological watch office which shall be adequate for the provision of the meteorological services required to satisfy the needs of international and/or national air navigation.

3.3.2 PAGASA aerodrome/aeronautical meteorological service units shall continuously transmit, without delay, relevant data to local CAAP-ATS units to ensure that aircraft receive the most up-to-date meteorological information for aircraft operations.

3.3.3 PAGASA aerodrome/aeronautical meteorological service units are the following:

- a) The Meteorological Watch Office (MWO). PAGASA designates a MWO to:
 - i. Maintain a continuous watch over meteorological conditions affecting the flight operations within the Manila FIR;
 - ii. Issue information on the occurrence or expected occurrence of specified hazardous en-route weather conditions which may affect the safety of aircraft and low-level aircraft operations in the form of SIGMET and AIRMET information, respectively and supply these and other weather information to the associated ATS units or an area control center (ACC).
 - iii. Exchange SIGMET information issued by other MWO as required by regional air navigation agreement.

- b) Aerodrome/Aeronautical Meteorological Office (AMO) and Aeronautical Meteorological Stations (AMS).

PAGASA maintains four **(4) AMOs**: Ninoy Aquino International Airport (NAIA), Mactan-Cebu International Airport (MCIA), Subic Bay International Airport (SBIA) and Diosdado Macapagal International Airport (DMIA); and **Six (6) AMSs**: Laoag International Airport, Zamboanga International Airport, Francisco Bangoy (Davao) International Airport, General Santos (Tambler) Airport, Puerto Princesa Airport and Dumaguete Airport. Depending mainly on the airport individual time of operation, the AMSs will provide aviation routine weather report and/or special routine weather report in the form of METAR and SPECI METAR as stated in 2.4.2 (a) while the AMOs will provide the services as stated in 2.4.2 (b) above.

4. SUPPLEMENTARY PROVISIONS

- 4.1 Coordination meetings between heads of the concerned service units of PAGASA and CAAP will be convened annually or as appropriate.
- 4.2 Relevant Specialized Trainings will be conducted by CATC-CAAP in collaboration with PAGASA to equip concerned ATS personnel of CAAP the knowledge and skills in weather observation. CAAP shall bear the cost of trainings.

Qualified CAAP personnel may attend the BIP-MT competency training for weather observer in the WMO-PAGASA Regional Training Center in RA V (Southwest Pacific), PAGASA Office, Quezon City.

- 4.3 For CAAP airports that are not connected to the AMHS, all possible means of communication, such as telephone/mobile phone/facsimile/HF/email/social media – in that order of priority, but not limited to, shall be exhausted to ensure prompt reception/transmission of Operational Meteorology (OPMET) information.

- 4.4 A joint CAAP/PAGASA Technical Team shall be formed to conduct:

- a) Periodic annual inspection and calibration of CAAP meteorological instruments.
- b) Post-corrective maintenance calibration of CAAP meteorological instruments.
- c) Siting and Relocation of CAAP meteorological instruments.

Repair and maintenance of the CAAP Meteorological Instruments shall be CAAP's responsibility.

- 4.4.1 The Joint Team will conduct annual inspection/check-up of CAAP meteorological instruments installed in both CAAP-owned and Airport Authority-operated airports, in accordance to the timetable as agreed upon by the Joint Team.

- 4.4.2 CAAP will provide for the transportation and other related expenses for the members of the Joint Team in the inspection of CAAP-owned meteorological instruments.

- 4.4.3 The CAAP/PAGASA Joint Team shall pull-out meteorological instruments from CAAP stations/facilities to be calibrated at PAGASA Science Garden. No person or unit, other than the Joint Team, shall be authorized to pull-out weather instruments for off-site calibration.

- 4.5 CAAP, in coordination with PAGASA, shall explore possible means for the cost recovery relative to the provision of MET services to air navigation, including but not limited to charging an aeronautical MET service fee as may be necessary.

5. PROVISIONS FOR REVISIONS/TERMINATION


5.1 When, for special or unforeseen reasons, a significant change in the coordination between the two parties involved or the services mentioned in this Letter of Agreement becomes necessary, the respective officers-in-charge, through mutual agreement, may effect temporary changes or amendments, provided that these changes are not intended to last more than seven (7) days.


5.2 Permanent revisions to this Letter of Agreement may be made by the approving and signing authorities, and shall ensure that the details of any changes be communicated six (6) months prior to any implementation.

5.3 A complete cancellation/revocation of this Letter of Agreement may be made, in writing, by either parties to this agreement provided that the other party is notified for a period of at least six (6) months before the effectivity of its cancellation or revocation.


6. EFFECTIVITY: 15 DEC, 2016

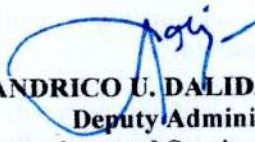
This Agreement shall take effect upon signing thereof.



CAPT. JIM C. SYBIONGCO
Director General
Civil Aviation Authority
of the Philippines (CAAP)



VICENTE B. MALANO, PhD
Administrator
Philippine Atmospheric, Geophysical
and Astronomical Services
Administration (PAGASA)

WITNESSED BY:



CAPT. MANUEL ANTONIO L. TAMAYO
Deputy Director General
for Operations, CAAP



LANDRICO U. DALIDA, JR., PhD
Deputy Administrator for
Operations and Services, PAGASA


ATTY. ANTONIO G. GONZALES
Acting Chief
Air Traffic Services, CAAP



CATALINO L. DAVIS, MPA
Deputy Administrator for
Administration and Engineering
Services, PAGASA

SUBSCRIBED AND SWORN TO BEFORE ME THIS ____ DAY ____ AT ____
COUNTY OF _____ CITY OF _____


ARNOLD R. BALUCATING
Assistant Director General
Air Navigation Service, CAAP


ESPERANZA O. CAYANAN, PhD
Chief, Weather Division
PAGASA

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