

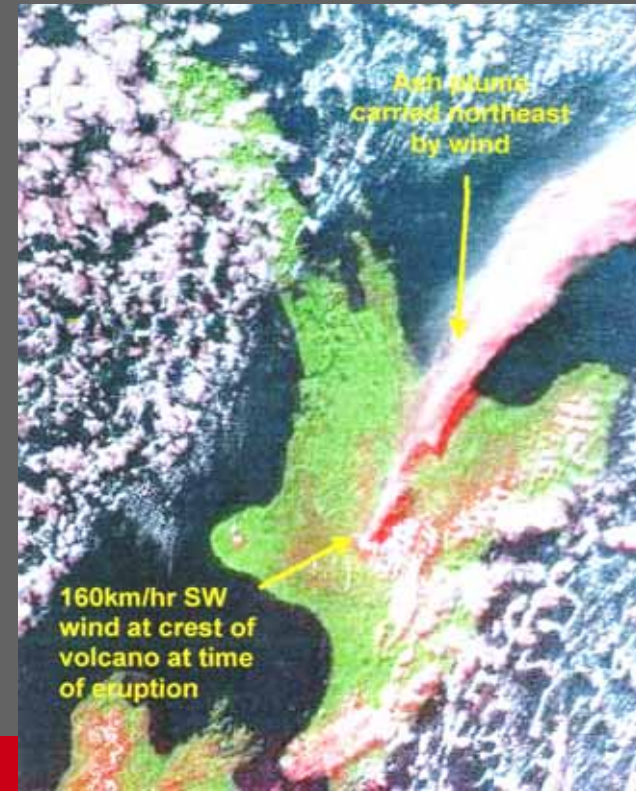
Volcanic Impacts Study Group



**Dr David Johnston,
GNS Science / Massey University**

Objectives

- To facilitate improved knowledge about the impacts of volcanic hazards on, and mitigation measures for, lifeline infrastructure.
- To facilitate and support research on the impacts of volcanic hazards on lifelines and development of appropriate mitigation measures,
- To provide input into the applicability for lifelines of any research being undertaken.
- To facilitate reconnaissance investigations to active volcanic areas where this would add to our knowledge about volcanic impacts on infrastructure.
- To provide a national focal point for volcanic impacts work on lifelines (as Wellington currently is for earthquakes).



Sector Analysis: AIRPORTS



VOLCANIC ERUPTION

Recommended Actions for Airports










Reduction

- Develop a Volcanic Hazard Management Plan. Ensure this includes:
 - designated ash disposal sites
- Maintain Volcanic Hazard Management Plan. Regularly review plan to ensure it is up to date.
- Conduct regular exercises and training.

Readiness

If warning is given that an eruption may occur, ensure stocks of the following equipment are available:

- Tarpaulins / Plastic sheeting**
Sufficient quantities to cover vulnerable parts of aircraft grounded during the eruption, i.e. windshields, nose cones, engine intakes, wheel assemblies. Further quantities to cover any machinery left outside.
- Adhesive tape (duct tape)**
Sufficient quantities to secure plastic sheeting to aircraft/machinery, sealing all edges.
- Spare parts for essential vehicles & machinery**
Air filters, oil filters, fuel filters, hydraulic fluids, seals, lubricants.
- Cleaning supplies**
Additional brooms, vacuum cleaner bags, cleaning fluids.
- Filtration/dust masks & goggles**
Sufficient masks for all involved staff for at least one week.
Sufficient goggles for workers cleaning up ash.
- Adequate harnesses to secure workers to slippery roofs.
- Prior to ashfall establish a tip site where ash may be dumped.

Further information on dealing with volcanic ash may be found in the following resources:
<http://www.caa.govt.nz>
<http://www.aucklandairport.co.nz>
<http://www.gns.govt.nz>
<http://www.aucklandairport.co.nz>

Response

Should an ash plume be generated that is likely to impact the airport, the following steps should be taken:

Activate: Emergency teams, Business Continuity Plan and ensure health & safety issues are identified for all personnel.

Decide: If aircraft out, cover aircraft.

Grounded Aircraft

Need to have vulnerable parts covered. Immediately confirm which aircraft are to remain grounded.

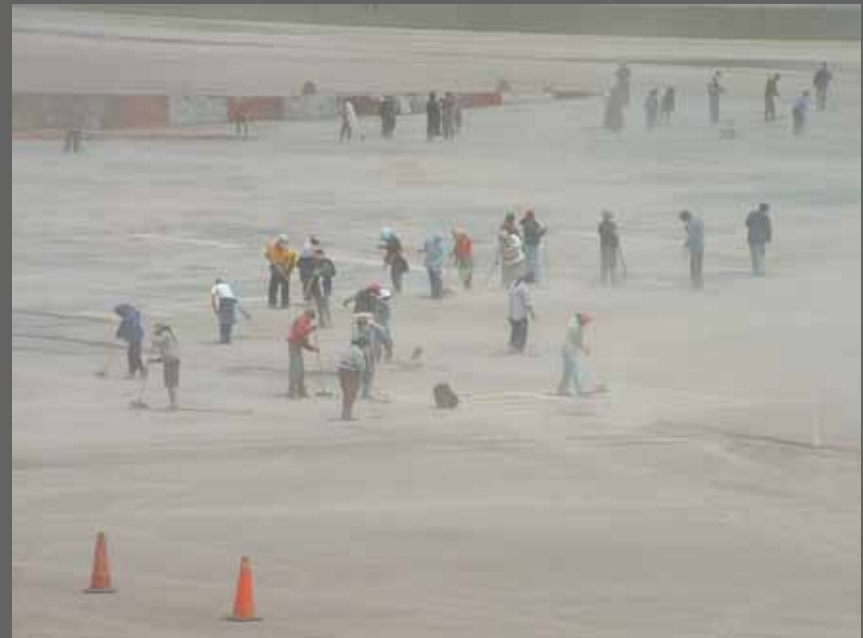
- Vulnerable parts include: windshields, pitot tubes, nose cones, engine intakes, wheel assemblies.
- Use plastic sheeting/tarpaulins and adhesive (duct) tape.
- All flap, spoiler etc. should be fully closed.
- If a significant ashfall is expected (> 5cm), **evacuate any aircraft to the ground at the ropes that have:**
 - engine at the tail
 - large surface areas (i.e. horizontal stabilisers) at rear of aircraft.

Infrastructure

- Use as few wetbrake's as possible for buildings (include ash entrainment from outside).
- Cover electronic equipment inside buildings as fine ash may penetrate even closed buildings.
- Close buildings not essential for running the airport.
- Cover (where possible) intake fans or heat pump units on building exteriors.
- Do not use air-conditioning systems that pump in outside air.
- Damp windows will may induce feather on electrical components (causing failure and fire risk).
- Some use of systems that re-structure interior air may be possible during ashfall (except attraction to fan blades, bearings etc).
- Clean roofs frequently during a long-term eruption to prevent ash accumulating (especially wind-torn hangar-type roofs).
- Take extreme care due to slipperiness of ash.

Recovery

- Volcanic ash is highly abrasive and can be extremely corrosive
 - take this into account when cleaning (especially aircraft)
 - clean airport as quickly as possible to mitigate corrosion.
- Conduct volcanic ash response plan (where present) before beginning aircraft and airport clean-up
 - ensure correct procedures are followed.
- Ensure ash is disposed in appropriate manner.



Sector Analysis: WATER




VOLCANIC ERUPTION

ADVICE FOR WATER SUPPLY MANAGERS

IMPACTS ON WATER SUPPLIES

Volcanic ash is highly abrasive, mildly corrosive, conductive. Freshly-fallen volcanic ash may result in: short term physical and chemical changes in water quality; increased wear on water delivery and treatment systems; disruption of electrical power supplies; and high demand for water during clean-up.



RECOMMENDED ACTIONS

Anticipate increased water demand for clean-up operations

- where possible use alternative, non-potable sources of water for clean-up and fire-fighting, and encourage clean-up with brooms and shovels rather than hoses

Monitor potentially hazardous components of water (pH, turbidity, fluoride)


Review stocks of essential items such as spare filters and treatment chemicals

Ensure access to back-up power generation

Take precautions to keep ash out of water supply equipment/land

- close water supply intakes before turbidity levels become excessive
- consider adding coagulation/flocculation agent to reduce turbidity
- cover filter-beds and clarifiers
- protect other exposed equipment such as electrical control panels
- maintain clean site to reduce contamination

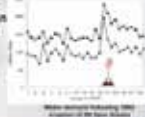
RECENTLY ACTIVE VOLCANIC CENTRES IN NEW ZEALAND



WATER DEMAND

High demand for water typically occurs after an ashfall and can lead to temporary water shortages.

This may compromise key services, such as fire-fighting capacity.



EFFECTS ON EQUIPMENT

Suspended ash in water can:

- block intake structures
- cause mechanical damage and increased wear of equipment
- block filters and clarifiers and generate increased waste
- decrease pH which can in turn increase plumbosolvency

Airborne ash particles can:

- plug air filtration systems, causing overheating and engine failure before
- abrade and scratch moving parts of equipment and intakes
- cause arcing and flash-over damage to electrical equipment

PUBLIC HEALTH IMPACTS

Public anxiety about contamination of water supplies is common after a volcanic ashfall. Timely and transparent communication of risks to the public is advised.

The main public health issues are:


- 1) Hygiene and sanitation problems can arise if water supplies are disrupted following volcanic activity.
- 2) High levels of suspended ash (turbidity) can inhibit disinfection of drinking water, which may lead to outbreaks of infectious disease if treatment (e.g. chlorination) is not adjusted accordingly.
- 3) Elevated fluoride concentrations may be a problem following some types of volcanic eruptions.

Drinking water Standards for New Zealand 2008 (Revised 2009), Ministry of Health

Parameter	Standard
Turbidity	5 NTU
Fluoride	1.5 mg/L

Authorities will analyse volcanic ash composition and advise on the presence of any toxic elements that may pose a health hazard.

In general ashfall is likely to make water undrinkable (metallic-tasting and discoloured) before it presents health risks.




RECOMMENDED ACTIONS

The following resources provide further information on volcanic hazards:

- <http://www.gns.govt.nz>
- <http://www.doh.govt.nz>
- <http://www.epa.govt.nz>
- <http://www.mfem.govt.nz>

Studied by Carol Brown, Tony Wilson, & David Johnston, 27 January 2010



Sector Analysis: ROADING



VOLCANIC ERUPTION

RECOMMENDED ACTIONS FOR ROADING MANAGERS



Volcanic centres in New Zealand

VOLCANIC ASH

Ash dispersal is dependant on prevailing wind direction

Silt to sand size, highly Abrasive, mildly Corrosive, potentially Conductive

May be ingested into engines, blocking filters and abrading the engine and other mechanical parts

Ash may contaminate areas for extended periods of time (doesn't melt like snow), and its fine grain size can make it difficult to handle compared to sand

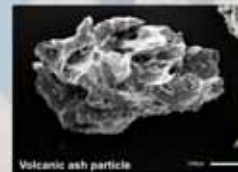
Thick ashfalls may create extra loadings on bridges (wet ash is very heavy)

Driving Hazards

Easily re-mobilised by wind, water, and fast moving vehicles

Driving Hazards - slippery surfaces, covers road markings, poor visibility during ashfall

Respiratory hazard (easily ingested by humans and animals)



Volcanic ash particle

REDUCTION

Volcanic eruptions may have a rapid onset, so emergency planning needs to be done well in advance

Develop a Volcanic Hazard Management Plan

Identify a hierarchy of roads for priority of clean-up. Ensure this includes designated ash disposal sites and considers road closures.

Ensure road maintenance equipment is undercover.

Maintain Volcanic Hazard Management Plan

Regularly review plan to ensure it is up to date.

READINESS

Prior to an eruption (i.e. periods of volcanic unrest), ensure that there are stocks of the following equipment:

Spare parts for essential road maintenance vehicles (*air filters, oil filters, fuel filters, lubricants hydraulic fluids, seals, etc.*)

Safety plan & equipment for personal (*masks, goggles - sufficient for all staff*)

Adequate water supply for damping down ash to reduce re-mobilisation (ideally not domestic water supply)

Facilities for cleaning maintenance vehicles

Establish ash disposal site (in consultation with Territorial Local Authority)



Clearing roads following ashfall in Catania, Italy during the 2002 Etna eruption (S. Barnard)

RESPONSE

ACTIVATE:

emergency plan

health and safety plan

identify priority roads for clearance

monitor eruption information (www.geonet.org.nz)

monitor weather conditions (determines where ash will be deposited)

Ensure staff are well briefed on ash removal and safety aspects

Be prepared to distribute information to other road users on best practices

Closely monitor performance maintenance vehicles and health of staff



Collecting ash from roads in Yakima, Washington, United States following the 1982 Mt St Helens eruption

RECOVERY

Equipment should be cleaned as often as possible to mitigate damage

Ensure ash is disposed of in an appropriate manner

An on-going eruption & re-mobilised ash may continue to re-contaminate roads long after the eruption

plan for long term management of ash clearance and disposal from sediment capture devices

long term supply arrangements of protective and spare parts may be required



Further information on dealing with volcanic ash may be found in the following locations:

<http://www.geonet.org.nz>

<http://www.gns.cri.nz/ce/here/whats/whats/volcanoes>

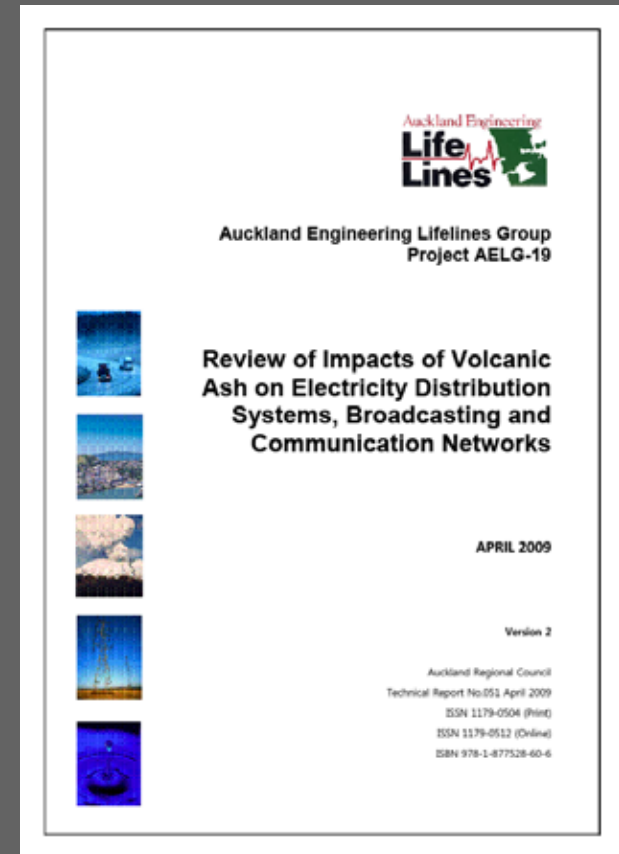
<http://volcanoes.usgs.gov/ash/index.html>

<http://www.vfhn.org>

AELG – 19

Electricity, telecommunications & broadcasting

1. To summarise the information and research undertaken (nationally and internationally) on the impacts of volcanic ash on **electricity distribution systems, broadcasting and communication networks**.
2. To identify **vulnerable components** of electricity, broadcasting, radio transmission and communications networks to ash.
3. To identify **mitigation measures** to reduce vulnerability prior to a volcanic event, and measures to reduce damage during and post event.



VOLCANIC ERUPTION

ADVICE FOR ELECTRICITY NETWORK MANAGERS



ASH IMPACTS ON ELECTRICITY DISTRIBUTION

Volcanic ash is: hard, highly abrasive, mildly corrosive and conductive.

Volcanic ashfalls can cause disruption to electricity supplies in the following ways:

- Ashfall buildup on insulators can lead to flashover (the unintended disruptive electric discharge over or around the insulator), causing disruption to distribution networks.
- Line breakages and damage to towers and poles due to ash loading, both directly onto the structures and by causing treefall onto lines, particularly in heavy, fine ashfall events. Snow and ice accumulation on lines and vegetation will exacerbate the risk.
- Breakdown of substation and control equipment such as air conditioning/cooling systems due to ash penetration which can block air intakes and cause corrosion.
- Controlled outages during cleaning.

Of these, the main hazard is insulator flashover. Volcanic ashfall may also increase electrocution risks (by increasing touch potentials) to workers in substations.



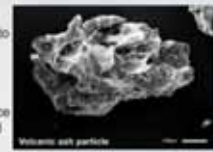
INSULATOR FLASHOVER

Factors contributing to risk of flashover include:

- Light wet weather conditions (dew, fog, drizzle or light rain) wets the ash and leads to a conductive layer forming on the surface which initiates leakage current and leads to arcing and flashover. Heavier rain will wash off contaminants.
- Ash grain size (fine ash adheres to insulators more strongly).
- Presence of other contaminants e.g. sea salt, dust, agricultural sprays, smoke.
- Elapsed time since last maintenance.
- Insulator design and construction (ability to shed ash and resist acidic corrosion).



Insulator covered in 132kV insulator following the May 2008 Clarendon eruption, UK.



Volcanic ash particle

ELECTROCUTION RISK



Resistivity of ground gravel cover may reduce following ashfall, reducing step potential and possibly increasing touch potentials.

RISK OF LINE AND SUBSTATION INSULATOR FLASHOVER

Risk factors	Ash moisture content	Probability of failure			
		Ash thickness <5 mm		Ash thickness >5 mm	
Line voltage (kV)		Fine ash	Coarse ash	Fine ash	Coarse ash
<11 kV (domestic)	Wet	High	Low	High	Medium
	Dry	Low	Low	Low	Low
>11 kV (regional-national)	Wet	Medium	Low	High	Medium
	Dry	Low	Low	Low	Low

RISK OF DAMAGE TO TOWERS, POLES AND LINES

Weather conditions	Ash thickness <100 mm		Ash thickness >100 mm	
	Fine ash	Coarse ash	Fine ash	Coarse ash
Towers and poles	Wet	Low-medium	Low	Medium-high
	Dry	Low	Low	Medium
Lines	Wet	Low-medium	Low	High-medium
	Dry	Low	Low	Medium

RECOMMENDED ACTIONS

Substations

- Prior to an ashfall, maintain insulators in a clean condition, especially in coastal areas.
- During an ashfall, monitor buildup of ash on insulators. If conditions are wet, consider controlled outages to allow cleaning.
- Immediately after an ashfall, dispatch personnel to substations to dust, sweep and blow ash from electrical equipment, and clean roofs and gutters.
- Be aware of increased electrocution hazard if ashfall covers the ground. Isolate substations or electrical equipment before entering site.

Line insulators

- Maintain line insulators in a clean condition, especially in coastal areas.
- During an eruption, monitor buildup of ash on insulators.
- Make controlled cuts if necessary to clean insulators, or replace damaged insulators. Ensure all surfaces are cleaned, including underneath. Cost benefit analysis will dictate whether cleaning or total replacement is appropriate.

Towers, poles and lines

- Maintain in a good state of repair, in particular ensure that lines are kept free of overhanging branches.
- During an eruption, continuously monitor the network for ash accumulation on towers, lines, poles and overhanging branches.
- Replace or repair damaged components as appropriate.

General notes on cleanup of ash

- Remove dry ash from the most sensitive systems by blowing it off using air pressure of 30 psi or less, to avoid a sandblasting effect.
- Avoid rubbing or brushing equipment. Remove ash by vacuuming if possible.
- Regularly clean and/or replace vehicle and air-conditioning filters (stock spares).
- To avoid eye and respiratory irritation wear face masks and goggles.
- Consider acquiring cleanup equipment (water blasters, air compressors)



The removal of a 132kV insulator covered in ash which led to a regional blacking out during the 2008 Clarendon eruption, UK.



Ash is removed from a 110 kV insulator tower using pressurized water following the 2003 Taupo eruption, New Zealand (Teapouran, New Zealand).

The following resources provide further information on volcanic hazards:

- <http://www.geonet.org.nz>
- <http://volcanoes.usgs.gov/info/index.html>
- <http://www.aftco.org>
- <http://www.aesg.org>

Drafted by Tom Wilson, Carol Stewart & David Johnston. 26 August 2009

