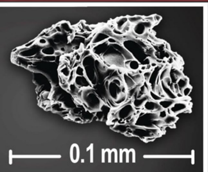


Volcanic ash is: <2mm (0.1 in) diameter, hard, abrasive and corrosive, and conductive if wet

VOLCANIC ASHFALL

ADVICE FOR: **POWER PLANT OPERATORS**

ASH IMPACTS ON POWER GENERATION FACILITIES

- ***FLASHOVER:*** Ash contamination of station and line insulators leading to flashover is the most common impact at power plants.
- ***MECHANICAL BLOCKAGE:*** Ash accumulation on mechanical systems can block or disrupt operation.
- ***STAFF ACCESS AND HEALTH HAZARD:*** Visibility reduction, disruption of transport networks and health hazards can inhibit staff accessing sites.
- ***STEP/TOUCH POTENTIAL:*** Ash may reduce the resistivity of ground gravel cover, reducing tolerable step and touch voltages.
- ***DISRUPTION TO CONTROL SYSTEMS:*** Ash ingress into heating, ventilation and air-conditioning (HVAC) systems can block intakes leading to reduced performance, and affect dependent systems.
- ***STRUCTURAL DAMAGE:*** Very thick ash deposits (>100 mm/4 in) may create excessive loads on structures.
    - » Long span, low pitched roofs are typically the most vulnerable.
    - » When ash is wet, static loads may increase by up to 100%.
- ***INTERNAL GUTTERS:*** May block with ash, potentially leading to water ingress to indoor electrical equipment.

ℹ *See companion HVAC poster for examples of ash impacts on other systems.*

ℹ *See companion Power Transmission and Distribution Systems poster.*

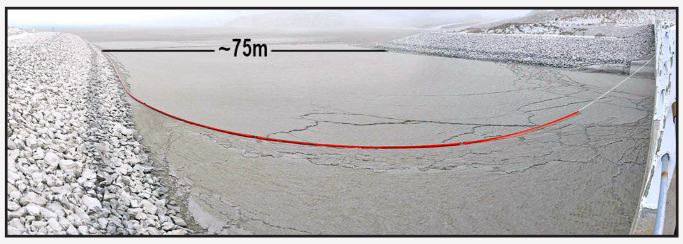
HYDROELECTRIC POWER (HEP) STATION IMPACTS

- Lahars (volcanic mud flows) can occur in catchments following ashfall.
- Ash suspended in intake water, including pumice rafts, can cause accelerated wear of hydroelectric turbines (e.g. runner blades, labyrinth seals, cheek plates and wicket gates). See case study below.
- Potential impacts depend on volume of ash deposited in catchment, reservoir size, settling rate of ash, abrasiveness of ash.
- Rain gauges can fill with ash, disrupting data collection and requiring cleaning.
- There are few case studies to guide possible impacts or advice.

THERMAL POWER STATION IMPACTS

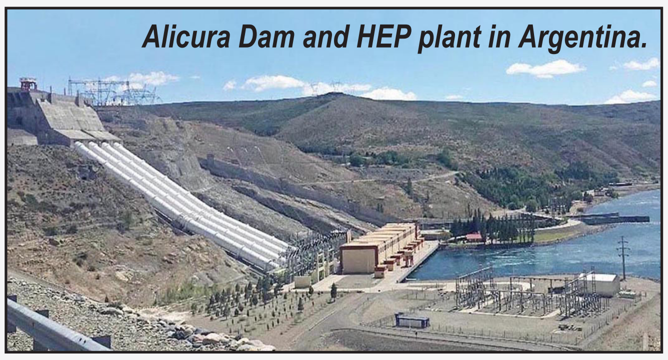
- Ash infiltration via air intakes for gas turbines and boilers, or sub-aerial condenser systems causing blockages, abrasion and creating cleaning difficulties.
- Mechanical seals may be vulnerable to abrasion and corrosion by ash.
- If ash is ingested and makes it past filtration systems, it may contaminate exposed surface water cooling reservoirs, potentially blocking heat-exchange systems.
- Fine ash particles (<0.5 mm/0.02 in diameter) ingested into gas turbines may cause accelerated wear or melt on turbine surfaces (similar to aircraft turbines).

CASE STUDY

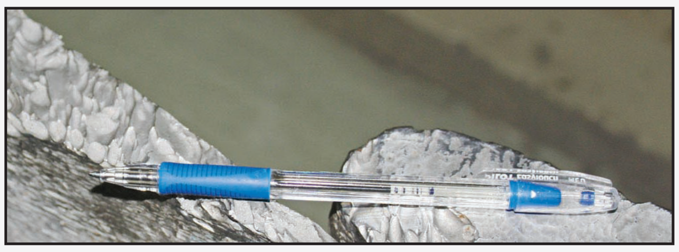


Pumice raft from the June 2011 eruption of Cordón Caulle volcano, Chile, on the Alicura HEP reservoir. Dam staff had advance warning of the arrival of the pumice raft (of 6 million m³ volume) and used oil spill booms to attempt to direct the pumice away from intakes. Photo by AES Argentina.

While the HEP plant maintained power generation at full capacity, a range of problems was experienced. Staff access to the dam site was disrupted by extensive ashfall across road networks, and reduced visibility during wind remobilization events. Cleaning of the site took around four months and had a high labor demand. Air intake filters were clogged with ash and had to be replaced much more frequently. Floodgates clogged by ash could not open. Corrosion was also an issue; every unpainted/ungalvanised metal surface was affected which shortened the working life of components. Photo by Gustavo Villarosa.



Alicura Dam and HEP plant in Argentina.



Accelerated abrasion damage to wicket gates from Agoyan HEP, Ecuador. Normal design life of turbines at this plant is 6–7 years, but this has been reduced to 5 years due to ashfalls from nearby Tungurahua volcano contaminating reservoir water. Photo by Johnny Wardman.

• FURTHER RESOURCES •

https://volcanoes.usgs.gov/volcanic_ash/power_generation.html

www.ivhhn.org (volcanic health hazards information)

Content by Tom Wilson, Johnny Wardman, Carol Stewart and Daniel Blake. Layout by Lisa M. Faust. Version 1 of International Volcanic Ash Impacts Posters, November 2020.

RECOMMENDED ACTIONS

WHERE TO FIND HAZARD & WARNING INFORMATION

Refer to the website of your local volcano observatory, national weather service and/or disaster management agency for warnings of ashfall.

HOW TO PREPARE

Operational plans should be developed well in advance for infrastructure at risk from volcanic ashfall.

- Coordinate plans with emergency management groups, scientists and infrastructure providers.

For plants which rely on river catchments or lakes (e.g. HEP and thermal):

Install/check turbidity monitoring instrumentation at intakes and identify thresholds for intake closures.

- » Consider hardening turbines during design and maintenance programs.

- Develop priority schedules for inspecting/cleaning essential sites and components.
- Site clean up may be required following an ashfall and plans should include:
    - » Ashfall clean-up procedures, suitable to your local conditions and site.
    - » Availability of sufficient supplies and equipment for cleaning.
    - » Availability of staff and other resources for repairs and additional maintenance (increased demand can be significant during clean up).
- Insulator cleaning requirements:

ℹ *See IEEE Standard 957–Guide for Cleaning Insulators.*

- Transmission and distribution circuits feeding into or transmitting from the generation site may be disrupted and require additional planning.

ℹ *See companion Power Transmission and Distribution Systems poster.*

HOW TO RESPOND

- Seal key facilities to limit ash ingress.

ℹ *See companion Buildings poster.*

- Clean up site to reduce remobilization of ash and thus recontamination of energized components. Use dry methods where possible.
- Remove ash from gutters to avoid localized flooding.
- Internal gutters may require suction cleaning.
- Be aware of increased electrocution hazard if ash covers the ground. Isolate and earth energized equipment before entering site.
- ***HYDROELECTRIC POWER PLANTS:*** Monitor the turbidity in water intakes. Be mindful of lahars (volcanic mud flows). Consider bypassing turbines if necessary.
- ***GEOTHERMAL/THERMAL:*** Assess ash hazard and consider shut down if necessary.
- Ensure staff have adequate personal protective equipment (long-sleeved clothing, heavy footwear, fitted goggles and a properly-fitted P2, N95 or FFP2 dust mask). Masks should be changed when clogged.
- If industry-certified masks are not available, other masks may provide partial protection. For more information: **www.ivhhn.org/ash-protection**

Auckland Lifelines · DEVORA · USAID FROM THE AMERICAN PEOPLE · VDAP Volcano Disaster Assistance Program · VISG · USGS science for a changing world