

Beware the Zinc Whiskers

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What have the Australian Tax office data centre, NASA, a handful of nuclear power stations and a Patriot missile battery all got in common? Computers, certainly, but one other binding factor is that they have all suffered computer malfunction due to zinc and tin whisker deposition onto printed circuit boards.

Zinc Whiskers were first noticed in the 1940s by telephone companies in the USA when tracking down equipment failures. Zinc Whiskers originate from zinc electroplated products commonly used in computer rooms. Zinc is an element used to prevent rusting or oxidation of steel. Steel items are coated or passivated, with zinc. This coating can either be zinc Hot Dipped Galvanized (HDG) or electroplated. The HDG coating is not associated with zinc whisker contamination and can be easily recognized by the irregular triangular or spangled pattern on the metal surface.

Electroplating provides a uniform gray surface but in some cases brighteners may have been added to the zinc plating process, creating a bright shiny appearance.

Zinc whiskers grow from the electroplated surface without any external stimuli and have even been observed to grow in vacuum. This is known as "spontaneous" growth and differs from the whisker growth known as "compression" where whiskers are formed by applying an external compressive stress to the electroplated film.

Whiskers have been observed on electroplating of tin, zinc and cadmium and all appear similar. Tin whiskers have been a major source of failure at component level, whereas zinc whiskers have become associated with old floor tiles in computer rooms.

It is not clearly understood why the zinc atom structure begins to separate from the steel and pushes the zinc coating away from the steel surface. The whisker growth occurs from the base and the result of this separation is tiny zinc columns that are pushed or grow away from the surface.

The whiskers grow at a rate of about 250 microns per year and have a uniform diameter of about 2 microns. The whiskers can reach lengths of up to 1 cm and can become potential problem to electronics when they reach a length of 500 microns or half a millimetre.

Zinc whiskers can grow on any electroplated metal which in turn may be found in equipment racks and cabinets, inner door skins, mounting rails and cable containment. However the biggest source is old floor tiles.

The underside of computer room floor tiles are traditionally made of mild steel coated with zinc to act as the corrosion-resistant layer. This represents a huge surface area, with computer rooms ranging from 60 to 900 square metres. Computer rooms that use a raised floor as pressurised plenum for distributing chilled air to the equipment racks present the ideal distribution method for the zinc whiskers. It is easy to imagine how the airflow can pick up the zinc particles, carry them through the floor vents and deposit them across the printed circuit boards of servers and other electronic equipment.

Data centre managers have noticed that multiple failures often occur some hours after the floor tiles have been lifted for some reason and then replaced. A NASA data centre reported no less than 18 separate equipment failures.

The shock of dropping a floor tile back in place will easily knock off hundreds or thousands of the metallic filaments. If the airflow is sufficient some of these will find their way into the front of electronic equipment and will be trapped against the legs of microchips attached to printed circuit boards. The resulting short circuit is enough to finish off the whole assembly. Often it is power supplies that fail, as it is they that have the biggest fans and thus draw in the most, potentially contaminated, air.

The likes of IBM and HP have been writing about this phenomenon since 2000 at least and competent floor manufacturers now only produce the safer Hot Dipped Galvanised version of the zinc coated floor tiles. However there are plenty of computer rooms still around that predate the 21st century! The Uptime Institute, an American 'think tank' dedicated to developing the philosophy of high-availability data centres, estimates that 'only' about 1% of computer rooms will be affected in any one year. Even in the UK this could amount to over a hundred computer room malfunctions in a year.

Zinc whiskers may be the cause of failures in your computer room, especially if multiple equipment failures occur after movement and replacement of floor tiles of a pre-millennium vintage. The underside of floor tile can be visually inspected for the build-up signs of zinc whiskers and the dull uniform grey surface associated with the electroplating process.

Some cabinets can be fitted with particle detectors to give an early warning, but the only final solution is a complete replacement of the floor tiles. This is obviously a traumatic step and also one guaranteed to kick up as much dust as possible. If the computer room cannot be completely turned off during this process then it could only be achieved by a well planned and managed partial replacement programme, with dust minimisation, old tiles sealed in bags and a massive post-operation cleanup programme.

At the very least, when specifying for new projects, ensure that hot dipped galvanised floor tiles are used. If your supplier or installer doesn't know what you are talking about, then you are talking to the wrong supplier.

NASA maintains a web site discuss the issue and gather data from around the world. <http://nepp.nasa.gov/whisker/>

Photo: Zinc whiskers, approximately 1 mm long. Courtesy NASA

