WORLDWIDE Environmental Services

Metallic Whisker Sources

Access Floor Tiles Are Not The Only Source In the Mission Critical Environment.

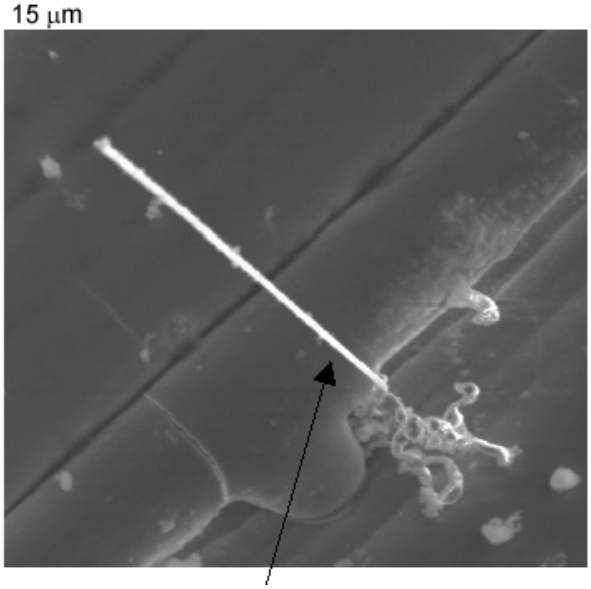
By Worldwide Environmental Services

This document is intended to provide background and information on metallic whisker growth. For over 50 years, the electronics industry has been aware of the threat posed by metallic whisker formation. These conductive filaments that can form on metal coatings have been known to bridge gaps in electronic circuitry, causing voltage aberrations and shorts. During recent years, a growing concern has developed in the data processing industry where these conductive contaminants have been found to form on the metal surfaces of some types of computer room access floor tiles, and distributed to hardware within the room where they have caused failures and operational interruptions. More recently, extensive research and testing by WES has uncovered other metallic whisker formation sources present in the mission critical environment that could potentially impact availability.

Metallic Whiskers Are Not New: For over 50 years, the electronics industry has been aware of the threat posed by metallic whisker formation. Metallic whiskers are small conductive filament like structures found to form on some metals used in coating processes. Tin, zinc and cadmium have been shown to be capable of producing these metallic whiskers. The whiskers are typically a few thousandths of a millimeter wide and may reach lengths of several millimeters. When examined using Electron Microscopy (right), the filament like structure can readily be identified. This, combined with the phenomenon that they "grow" from the surfaces, has resulted in them being termed as whiskers. Many metallurgists agree that the phenomenon is related to compressive stresses incurred during the actual plating process; however, not all metal coatings show evidence of metallic whisker growth. The exact causes of the selective nature associated with the phenomenon remains in question and the subject of ongoing research.

It has been suggested that the growth rate and concentration of the metallic whiskers varies upon the prevailing conditions during the coating process and possibly the environment in which the coated materials are used as a final product.

Regardless of their growth rate, the factors that make this particular contaminant harmful to data processing equipment are its conductivity and its potential to become airborne and be introduced into mission critical equipment. When introduced into electronic equipment metallic whiskers can cause short circuits between conductors on printed circuit boards and leads of microchips. Metallic whisker growth can occur on surfaces within electronic hardware, or can be carried to the hardware from outside sources.



Zinc Whisker Forming On Hardware Surface

Zinc Whiskers On Access Floor Tiles. Of known metallic whisker formations, zinc whiskers on access floor tiles have already proven to be of particular concern. Zinc whiskers can form on the bottoms of certain types of flat-bottom access floor tiles. The zinc whiskers released from these floor tiles have been well documented as causing numerous failures in data processing hardware.

Pictured above are examples of three tile finishes. The spangled surface (left) and the light gray, streaked surface (middle) are both hot-dipped. The uniform dull gray surface (right) of the electroplate tile is also apparent.

Wood core tiles typically have a flat, sheet metal bottom surface. Some concrete core tiles are manufactured with flat, sheet metal bottom surfaces as well but these are far less prevalent. This sheet metal is often coated with zinc as an anti-corrosive agent. There are two coating processes commonly used in this type of application. Only one of these has currently been identified to be subject to zinc whisker formation.

Hot-dip coating is one of the processes used. It involves passing metal though a molten zinc bath. The resultant hot-dip coating is comprised of several metallurgical bonded layers. There are variations within this process that may or may not readily lend themselves to field identification to the casual observer. However, none of the variations of the hot-dip process used in access floor tile manufacture have been identified to be subject to zinc whisker formation at this point.

The other common zinc coating process used in floor tile manufacture, known as electroplating, involves connecting the metal substrate to a negative terminal of a direct current source and another piece of metal to the positive pole, and immersing both metals in a solution containing ions of the metal to be deposited, in this case zinc. Tiles manufactured with this type of coating have been identified to be subject to zinc whisker formation.

There is a difference in the appearance of the various coatings used in floor tile manufacture. There are at least two variations of the hot-dipped process used in access floor tile manufacture. One produces a shiny surface with visible zinc crystals or spangles. This shiny, spangled appearance is often referred to within the industry as a “full G90 hot-dipped finish” and makes it easily identifiable. A second hot-dipped variation produces a streaked, less shiny, light gray surface and is often called a satin finish. The electroplated process used in floor tile manufacture produces a more uniform and dull surface but scratches can cause shiny streaks as well. The satin finish hot-dipped tiles are often mistaken for electroplated tiles, which are the known threat. The reverse is also true with the electroplate tiles being mistaken for the satin finish hot-dipped tiles. An example of each type is pictured below.

Typically, data centers are designed to utilize the subfloor void for air distribution. The bottom surfaces of the access floor tiles are located in the air distribution plenum. The metal surface of the floor tiles that produces the zinc whiskers are; therefore, located in the air distribution system. Further, they exist in mass quantities as the entire floor is often affected. Because the subfloor void is often used for distributing the piping, power cables, inter-hardware communication wiring and a number of other systems, significant activity occurs in this area. During activity in the subfloor void the whiskers can easily be broken from the surface and carried by the airflow directly to the mission critical hardware, significantly impacting the reliability of the systems. Multiple manufactures of data processing equipment including IBM and HP/Compaq warn against the threat caused by zinc whisker formations in Site Planning Guides for their hardware.

Other Metallic Whisker Sources: More recently, metallic whisker formation has also been identified on data processing hardware and cabinets. Currently available information suggests this is a multi-vendor/manufacturer issue. To date, at least ten manufacturers of data processing hardware, or cabinets, have been identified with metallic whisker growth. The identified manufacturers include some of the largest vendors in the industry as well as smaller vendors, cabinet manufacturers, and OEM suppliers. Areas of hardware and cabinets where whiskers have been identified include horizontal and vertical support structures, power distribution modules, mounting rails, inner door skins, cabinet ceiling and floor structures, and device cases among many other identified and potential surfaces. Most of the equipment that has been identified with metallic whisker growth did not have the same level of whisker formation density as that typically seen on affected access floor tiles. Also, while many of the locations where metallic whisker formation has been discovered appear to be areas where the risk of the whisker being broken off during routine activity is reduced, this is not always the case. Wherever they are forming, once identified within the mission-critical environment, metallic whiskers become a known failure threat to electronic and computer equipment within that facility.

Research by WES on this concerning discovery is ongoing and thus, the level of threat posed to the mission-critical environment by metallic whisker formation on hardware has not yet been quantified.

Facilities where cabinets and hardware have been identified with metallic whisker formation are currently unable to correlate hardware failures to metallic whiskers. Due to the apparent lower levels of activity, accessibility and airflow inside cabinets, as well as a more limited surface area for growth as compared to a floor, the level of migration is much more difficult to quantify. A more accurate determination of the risk associated with metallic whiskers growth sources other than floor tiles will be developed as research progresses.

Field Identification Of Metallic Whisker Formation. As is well known throughout the industry, experienced personnel can often visually identify the type of coating process used on a particular floor tile, as well as zinc whisker formation if present. If a suspected floor tile is lifted and examined from the edge (looking at the plane of the bottom surface) with sufficient and properly directed light, whiskers will often be identified. The flash of a camera has been used to illuminate the particularly serious zinc whisker growth seen in the photograph at the top of the next column.

The problem with this method of identification is that the mature growth necessary to utilize this method has already exposed the data center to tremendous risk and has likely compromised hardware reliability. Furthermore, affected data processing hardware may not exhibit the level of mature growth and formation density necessary to be identified using this means.

WES has developed a field identification process, utilizing digital field microscope technology that, when used in conjunction with currently accepted methods, can identify metallic whisker presence at the very early stages of formation.

Conclusions: An inspection of your site by a qualified WES representative can identify the source and degree of any conductive contaminant problems. If zinc whisker formation is identified within the room, extreme caution must be used in dealing with this issue. Incorrect actions can spread this potentially harmful contaminant throughout the room.

If floor tiles are affected, the most appropriate action in most cases involves the replacement of all access floor tiles. This is an extremely delicate and labor-intensive procedure involving specialized, high efficiency decontamination and encapsulation of appropriate air plenum surfaces to trap residual

contaminants. The project must employ appropriate monitoring and must be planned with proper regard to contaminant isolation and conditioned air distribution to minimize the possibility of impacting hardware reliability. Consultation with experienced WES specialists is strongly recommended.

The failures caused by this contaminant, when identified on the access floor, are often obvious and correlate directly; and the recommendation is clear. However, with whisker growth now identified in other areas such as cabinets and hardware, the recommendation is not as straightforward. Worldwide Environmental Services can identify metallic whisker sources in your mission critical facility. WES can also recommend actions for remediation and through consultation, the mission-critical facility owner can establish if the cost of remediation of any potential threat to availability is justified.

Worldwide Environmental Services can help determine the solutions that are right for your site. Please contact a WES representative if you have any questions.

Worldwide Environmental Services has assessment, support, remediation and training programs available to address all high availability data center needs.

For more information on WES services, please visit our website or contact a WES representative.

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