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Data Centre Design and Training

Static electricity – The data centre's hidden failure mechanism

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Everybody accepts that static electricity can and does destroy sensitive electronic components and microchips. Exactly what the impact is upon equipment within data centres is difficult to determine as few, if any, statistic seem to be published on the matter.

Equipment does fail however and static is known failure mechanism and there are at least three known mechanisms for static build-up and discharge within a data centre. This makes the optimisation of the design to minimise this risk an obvious choice.

The three 'known' mechanisms are;

1. Static build up on people due to walking about the computer room and then touching equipment. This is dependent upon the materials in question, i.e. clothes, shoes and floor surface, and also humidity
2. Static build-up within equipment, especially power supplies, caused by very low humidity air blowing over the equipment. At some point an instantaneous discharge will occur from the 'charged-up' items to the nearest grounded point
3. Static build up on disconnected cables caused by low humidity air blowing over them. Discharge will occur when the cables are plugged into equipment

We can see that in all three failure mechanisms humidity is a key component.

Antistatic floors

An antistatic floor must be slightly conductive to allow the static electricity to bleed away. To do this the floor must be connected to an earthing system which itself must be effectively connected to the main building ground.

To ensure a good connection to ground the American data centre standard TIA 942 *telecommunications infrastructure standard for data centers* calls for every 6th pedestal of a raised floor to be connected back to the grounding system with a 6 AWG wire (4 mm diameter).

EN 50174-2 is a bit vague on the subject suggesting that every second or third leg should be connected back to the ground.

The anti static floor tile itself can be composed of several materials. Conductive PVC is the most common but not necessarily the best. There is also solid aluminium, conductive carpet tiles and solid rubber or epoxy tiles. PVC floor tiles are certainly the most often used and if we look again at TIA 942 it calls for "Floors shall have anti-static properties in accordance with IEC 61000-4-2." This is quite a general standard and if we look it up it is *Electromagnetic compatibility (EMC)- Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test.*

A more relevant test would be IEC 61340-4-1 Ed. 2.0 b:*2003 Electrostatics - Part 4-1: Standard test methods for specific applications - Electrical resistance of floor coverings and installed floors.*

In Europe we have a standard for raised floors called EN 12825 *Raised access floors*. Under Electrostatic Conductivity it states *The element shall comply with EN 1081, EN 1815 and HD 384.6.61, where relevant.*

Once again if we look these up.

EN 1081 *Resilient floor coverings - Determination of electrical resistance*
EN 1815 *Resilient and textile floor coverings – Assessment of static electrical propensity*

However in all of the above they only talk about tests and none of them describes what a suitable pass result would be.

IBM have published some more substantive figures

> *Ensure the maximum resistance for the flooring system is 2 x 10^{10} ohms, measured between the floor surface and the building (or an applicable ground reference). Flooring material with a lower resistance will further decrease static buildup and discharge. For safety, the floor covering and flooring system should provide a resistance of no less than 150 kilohms when measured between any two points on the floor space 1 m (3 ft.) apart.*

If we look at a typical manufacturer's specification then it calls for a resistance of between 10^6 and 10^9 ohms when measured according to the test standards already discussed. One point raised in most manufacturers' data sheets is that anti static performance is dependent upon relative humidity levels remaining above 40%. This brings us on then to the importance of humidity.

TIA 942 takes its lead on environmental performance from ASHRAE, the American Society of Heating Refigeration and Air conditioning Engineers. ASHRAE has published many influential documents such *Thermal Guidelines for Data Processing Environments*, which call for humidity levels to be kept between 40 and 55%. "Low humidity is known to cause problems with static build up……."

ANSI/ESD S20.20-1999 recommends a target RH between 30% - 70%. *"Below 30% RH, materials have a greater tendency to charge."*

According to Department of Defense Handbook 263 a person walking across a vinyl floor at 65% Relative Humidity, RH, is likely to pick up 250 volts static electricity. Walking across the same floor at 20% RH is likely to result in a 12000 volt static charge!

ANSI/TIA/EIA-569 recommends that the humidity in telecommunications spaces housing equipment be maintained between 30 and 55 percent and IBM system engineering recommends limits of 35 to 60%.

Maintaining a tight humidity control can take a lot of energy. Keeping within a band of 45 to 55% can take twice as much energy as maintaining a band of 40 to 60% RH. To keep within the current trend for trying to minimise energy consumption for data centres ASHRAE, at the end of 2008, published a more relaxed tolerance band for humidity and temperature control.

In their publication *2008 ASHRAE Environmental Guidelines for Datacom Equipment -Expanding the Recommended Environmental Envelope*- ASHRAE make the interesting observation that the mechanism of the static discharge and the impact of moisture in the air are not widely understood.

> *The dryer the air, the greater the risk of electrostatic discharge (ESD). The main concern with decreased humidity is that the intensity of static electricity discharges increases. These higher voltage discharges tend to have a more severe impact on the operation of electronic devices, causing error conditions requiring service calls and, in some cases, physical damage. Static charges of thousands of volts can build up on surfaces in very dry environments. When a discharge path is offered, such as a maintenance activity the electric shock of this magnitude*

can damage sensitive electronics. If the humidity level is reduced too far, static dissipative materials can lose their ability to dissipate charge and then become insulators.

In addition to ESD, low moisture levels can result in drying out of lubricants which can adversely affect some components. Possible examples include motors, disk drives, and tape drives. While manufacturers have indicated acceptance of the environmental extensions documented here, some have expressed concerns about further extensions. Another concern for tape drives at low moisture content is the increased tendency to collect debris on the tape, around the head, and tape transport mechanism due to static buildup.

The new ASHRAE table is shown below

	2004 Version	2008 Version
Low End Temperature	20°C	18°C
High End Temperature	25°C	27°C
Low End Moisture	40% RH	5.5°C DP
High End Moisture	55% RH	60% RH & 15°C DP

In line with their comment that the relationship between Relative Humidity and ESD is poorly understood ASHRAE has replaced a lower humidity limit with a Dew Point figure of 5.5^0 C rather than a RH percentage figure. It is believed that practically this equates to something in the order of 35% RH.

Another Standard deals with the reported impact of electrostatic discharge from cables. This effect came to light some years ago and has been blamed on very dry air blowing over bundles of disconnected cables, presumably lying under the raised plenum floor. A cable is essentially a long capacitor and with dry air blowing over the surface for long periods of time it will start to charge up. The static charge will stay there until somebody plugs that cable into something at which point the charge on the cable sheath will discharge through the equipment. This led to standard TSB 153 *Static discharge between LAN cabling and Data Terminal Equipment*. TSB 155 calls for a humidity range of between 30 and 55%. It also recommends discharging cables onto an earthed surface before bringing them into contact with LAN equipment or keeping cables permanently connected into something – also earthed.

To be fair, in our western and northern European climate, very low humidity is not a common problem, although in other parts of the world humidity levels of 10 to 20% are not uncommon. Uncontrolled air conditioning however can drive the humidity down and so the humidity of most computer rooms is below the outside level where uncontrolled or poorly controlled air conditioning is in place.

Conclusions

Static, causing electrostatic discharge, ESD, is a known failure mechanism for electronic equipment although there is not much data to quantify that effect in data centres. Failure rates will be improved by controlling static problems and these can be summarised as;

- Use a floor with an antistatic finish and ask any supplier to define exactly what that means as it is an easy thing to just say in a brochure

- Connect every sixth leg of a raised floor system to an earth point
- Supply your data centre with a good quality telecommunications grade earth system
- Control humidity to prevent it from falling below 35% RH