datacentrealliance
The Data Centre Industry Association

DCA Data Centre Anti-Contamination Guide V1.4

Contents

1. Change Control

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V1.0	Initial DCA Group level circulation and Draft	12/03/2013
V1.1	Added Mark Knight to Credits, added paragraph on ISO standard 14644-1 (5.1), minor grammatical changes throughout.	26/3/2013
V1.2	Further white rust explanation, minor amends, and public release	3/4/2013
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2. Introduction

The demands and growth of digital services has driven radical changes to ICT equipment and this in turn has driven equally radical changes to data centre designs. This has been caused by wider and greater ranges in temperature and humidity in the data centre together with new technological schemes and upgrades to meet these changes, which in many cases requires a new approach to anti-contamination strategy to ensure the desired reliability and energy efficiency goal of the data centre remains intact.

This document examines the risks posed to data centre facilities of contamination from dust, dirt, airborne particulates and other foreign flora and fauna that enter the data centre.

The information provided is the result of a collaborative approach by members of the Data Centre Alliance, an independent industry association. This involved a range of data centre M&E and design experts and a number of data centre technical cleaning specialists. The objective is to provide an independently written guideline for owners and operators to benefit from the collective experience of the industry with the trusted peer review of the DCA.

3. The risks posed to data centres by contamination and dirt

Data Centre owner/operators can benefit from attractive cost savings by implementing modern data centre operating temperatures and humidity guidelines, improved cooling and ventilation methods and technologies. However, these improvements demand a re-think of the anti-contamination strategy in order to enable these cost savings without compromising the data centres design goal.

3.1 Reliability of the data centre

Preventing dust and contaminants from infiltrating your IT equipment can reduce the risk of overheating, improve filter life and guard against unnecessary wear to components. Manufacturers such as HP, CISCO and IBM require that their equipment should be situated in a properly maintained area to ensure their hardware warranties remain intact. The relatively low cost of conducting an appropriate cleaning and anti-contamination regime can prevent service outage by minimising the risk of various, often hidden, threats to equipment and infrastructure damage.

3.2 Energy Efficiency

Contaminant build up can reduce the effectiveness of heat dissipating units on servers such as heat sinks, and fans. In addition, data centre air plenums can be obstructed by various material either contaminants or equipment discarded by contractors and engineers over time.

Air filters deployed within air handling and air conditioning units to control particulates can become blocked over time negating the efficiency realised when first installed.

3.3 Fire Risk

Dust and other contaminants if allowed to build up can increase the risk of fire. Floor tiles are designed to dissipate electricity by providing a conductive path to ground. Ground in dirt greatly reduces the floors ability to dissipate static. Dirt build up in floor voids and air plenums can block airflow and increase the risk of fire or the risk of fire suppression alarms being activated.

3.4 Chemical Corrosion

Gaseous contaminants that are too small to be caught by traditional HEPA filtration are present in every environment. In high concentrations these contaminants can have a negative performance impact on both IT equipment and human beings.

Most of the gaseous contaminants found in data centres are by-products of the combustion of fossil fuels and these can cause corrosion across printed circuit boards (PCBs). This will be evidenced within the PCB through corrosive shorting across conductive points and pathways and contaminated solder joints. All of these result in a decrease in the useful life of the equipment.

This form of corrosion has become more prevalent since the Restrictions on Hazardous Substances (RoHS), or lead-free, manufacturing regulations for electronic equipment were introduced in 2006.

Data Centre operators should include an environmental contamination monitoring and control section as part of an overall site planning, risk management, mitigation and improvement plan.

ISA Standard 71.04-1985 specifies the following levels of Indoor Air Quality (IAQ)as it specifically relates to its impact on the life expectancy of electronic equipment. The four levels defined within the standard are G1, G2, G3 and GX with G1 being the best or least contaminated. A brief description of each category is as follows:

G1. Severity Level MILD – an environment sufficiently well controlled such that corrosion is not a factor in determining equipment reliability.

G2. Severity Level MODERATE – an environment in which the effects of corrosion are measurable and corrosion may be a factor in determining equipment reliability.

G3. Severity Level HARSH – an environment in which there is a high probability that corrosive attack will occur. These harsh levels should prompt further evaluation resulting in environmental controls or specifically designed and packaged equipment.

G4. Severity Level SEVERE – an environment in which only specially designed and packaged equipment would be expected to survive. Specifications for equipment in this class are a matter of negotiation between user and supplier.

The IAQ level can be established by the use of “Corrosivity Coupon Analysis” to measure the effect of the air on exposed copper and silver over a 30 day period. After the 30 day period the coupon is sent to a laboratory to measure the depth of rate of coupon corrosion due to contamination that has occurred. A chemical analysis can then be performed to determine which gas contaminants are present and then a molecular gas

filtration strategy can be formed to extend the life of the electronics and make a safer working environment for Data Centre staff.

There are also devices using coupon technology that allow real time monitoring and data storage. This allows characterization of gas contaminant concentrations over time. If there are regular peaks of contamination then a control strategy can also be used to mitigate exposure.

3.5 "Tin" or "zinc" whiskers and "white rust"

Tin or Zinc whiskers are minute electrically conductive pure-metal crystalline structures that grow on components and products having electroplated tin as a surface finish. Zinc whiskers can grow in abundance within data centres, causing bridging and shorting between electrical conductors and component terminations. While zinc whiskers remain attached to their source i.e. floor panels, pedestals, etc they are basically dormant, however when the whiskers are disturbed and dislodged they become airborne and circulate freely throughout the environment. Disturbance is likely to be caused by routine maintenance activities in the Data Centre, including for example, lifting, sliding, reinstalling of access floor tiles or overhead trays and installing of network cables.

Once inside IT equipment, zinc whiskers as electrically conductive structures, can cause various electrical failures, ranging from intermittent to permanent short circuits. Zinc whiskers can also become a physical impediment to moving parts or obscure optical surfaces and sensors within some equipment

White rust

Atmospheric moisture contains a small amount of contaminates (salt or minerals) and zinc will react quickly with it to form zinc hydroxide, a chalky white and relatively unstable oxide of zinc. Where freshly galvanized steel is exposed to this type of moisture (rain, dew, condensation) in oxygen deficient environment, the moisture will continue to react with the zinc and aggressively consume the coating.

The most common condition in which white rust occurs is with galvanized products that are nested together, tightly packed, or when water can penetrate between the items and remain for extended periods such as construction sites where materials are stored outside through poor weather conditions. White rust can cause particulate contamination of the data centre as a result of the white chalky matter becoming loose and airborne within the facility.

Severe white rusting

This is characterised by a noticeable darkening and apparent etching of the galvanized coating under the affected area, with the white rust formation appearing bulky. The galvanized coating thickness should be checked to determine the extent of attack on the coating.

3.6 Health and safety in the data centre

Safety issues to the eyes regarding airborne dust and grit can be created when technicians maintain floor tiles or overhead venting equipment, especially after long periods where particulates have been allowed to accumulate. The effects on humans of long-term exposure to increased levels of chemicals and zinc whiskers are not fully understood but should be considered a risk.

3.7 Flora & Fauna

Floor voids and hidden areas within the data centre can be havens for mice and rats, these chew through cabling causing outage. They can also build nests using shredded paper and debris that can raise the risk of fire. Rodent droppings if left in the void will become extremely poisonous.

4. Advice on data centre design to minimise contamination

4.1 Geographic Location

Consideration should be given to the location of a data centre in order to minimize the risk of contamination issues. Situating a data centre in an area that is high in contaminants whether natural (ie close proximity to the sea giving rise to increased levels of sodium chloride in the air) or man-made (ie close proximity to a transportation hub such as an airport or bus station) will increase the risk of contamination penetrating the structure and the IT kit.

4.2 Floors, ceilings, walkways and layout

All unsealed concrete should be painted and/or sealed, concrete materials and exposed concrete surfaces continually oxidise and breakdown, this releases loose sand and lime. Lime dust is particularly corrosive when combined with water or is humidified. The oxidisation is amplified if the unsealed concrete is found in the sub-floor, due to the constant air-flow being moved over the surface.

Data centres should ensure all unused drill holes are sealed & painted within the technical area of the facility.

Ideally, only one entrance should be used to gain access to the Data Centre, this improves the restriction of contamination entering the data centre. People entering the data centre are a source of contamination for many reasons, hair and fibres from clothes, mud and dirt on footwear all contribute directly to the contamination levels. Therefore careful consideration of minimising the entrances to the data centre and the management of control measures on each entrance is recommended.

Simply walking across the data centre floor can agitate settled contamination, making it airborne for induction into equipment. Restricting the access for unnecessary entry onto the live technical floor is also extremely important.

Compressed fibre ceiling tiles are not recommended for use within the data centre; the compressed fibre tiles are cellulose which shed contamination when touched by maintenance teams. Ceiling panels with smooth surfaces or encapsulated edges are recommended within the technical area.

All potential exposure points in the data centre should be addressed to minimise potential influences from outside the controlled environment.

The positive pressurization of the data centre will help limit contamination infiltration. Areas to be inspected in the data centre should encompass;

1. Breaches within the sub-wall

2. Breaches within the ceiling void

3. All door-sweeps are correctly in position and are not damaged in any way

4. All entrance doors should fit correctly in the frame

5. Walkways and pathways should be protected with material that removes contamination from shoes and soles.

Contamination generating activities and equipment within the data centres building include toner dust from copiers and printers (and the paper used) should be segregated and the relevant doors/air-locks installed.

5. Advice for operational data centres

5.1 Measurement and standards

It is recommended that all controlled environments are measured for air borne particulates to ensure contamination controls in place are effective. ISO 14644-1 International Standard for Clean Rooms and Associated Controlled Environments is an industry recognised body for air quality testing
and controlled environment classification and was updated to reflect current methods of operation in 2015. Although the standard is not specifically designed for only data centre facilities, it is accepted that without measurement there is no control and it can be a valuable measure if used within the context of this overall guide. This is because the standard is concerned only with the amount of airborne particulates within a volume of air, and therefore cannot measure settled or trapped particulates and the overall status of a data centre's anti-contamination performance or risk profile. Therefore in summary, compliance against the standard cannot be relied upon if taken in isolation; however the DCA recommend compliance as part of the overall recommendations and advice contained within this document.

The DCA Certification Scheme which audits against all the best practice standards for operating a data centre includes testing against the ISO14644 standard as part of the certification criteria.

5.2 Waste management: packaging and cardboard

Cardboard should not be stored or taken into the live technical facility, as cardboard releases compressed fibres. Any new equipment delivered into the facility must be unpacked in a staging area immediately outside the data centre. Cardboard packing material can itself be a source of contamination, fibres as well as being subject to dust and dirt contamination via transportation & intermediate storage and handling prior to arrival. Fibrous dust from paper, cardboard or textiles can foul heat sinks and disrupt equipment cooling. The plastic inner wrapping can also become a source of contamination, although the problem is less severe if the plastic is manufactured from antistatic material.

The use of 'dirty pallet trucks/trolleys' in the technical facility is not recommended, all manual handling aids should be clean and free from contamination. It is recommended that loading bays and storage areas connected to the data centre where trucks/trolleys are used are sealed or protected with anti-contamination flooring material especially at egress/ingress points between the outside and the technical areas.

5.3 Air filters and air conditioning & handling units

Data Centre reliability is a top priority and so must be ensured. Air filters must be best positioned to deal with the source of airborne contamination. High concentrations of airborne contaminants combined with higher humidity levels will usually show increased rates of equipment failure in Data Centres.

Air filters used to clean incoming supply air from outside and recirculated inside air must be capable of removing airborne particles and also corrosive gases when present. Tin or Zinc whiskers can be an internal source of airborne contamination as well as White rust particles.

There is an increasing use of free cooling to reduce energy consumption in Data Centres. Use of outside air at lower temperature introduced directly into the Data Centre server hall can offer large reductions in Power Usage Effectiveness (PUE).

The current recommended filter class for Data Centre supply air systems is M6 or F7 and for recirculated air systems is G4 as classified by EN779:2012 as recommended by ASHRAE in “2011 Gaseous and Particulate Contamination Guidelines for Data Centres”. Air monitoring can be used to determine the concentrations of Particles and Corrosive gases present.

It is recommended that particle concentrations in Data Centre operational equipment areas meet the requirements of ISO Standard 14644-1 Class 8.

For Corrosive gases it is recommended that monitored levels of corrosion meet the requirements of ISA Standard 71.04-1985 to meet class G1 Mild. Where monitored levels of corrosion exceed this then gas phase filtration needs to be used. Molecular gas filtration can be fitted to the main supply ventilation system or applied by use of standalone recirculation units.

Air filters consume significant amounts of electrical energy through the fan motor so selection of low energy air filters is recommended. These filter classes have the lowest operating pressure drop for their rated airflow. The Eurovent energy rating for air filters gives an A+ rating for the most energy efficient air filters.

For particle filters best economic filter change can be made when the initial operating pressure drop of the air filter doubles at the given reference fan speed. Air filter pressure drop monitoring is recommended.

Ensure all contaminated air-conditioning filters are correctly removed from the live environment before cleaning; the filters should be placed into bags and sealed to prevent any particulate matter becoming air borne. The removing of contaminated filters inside the live data centre should be performed in a controlled & professional manner.

Regular maintenance checks for ‘belt degradation’ within the air conditioning units (if belt driven) the visual sign is a fine black soot-like contamination, the contamination

caused by the degrading of the AC belt will become air-borne throughout the data centre.

5.4 Cleaning processes

The following provides advice and recommendations for data centre managers to follow to ensure anti-contamination practice is maintained during the day to day operations of a data centre:

1. Ensure no sweeping brushes are used in any live technical facility; all contamination should be extracted and contained within 3 stage HEPA filtered vacuum cleaners. Sweeping brushes create air-borne particulate matter.
2. Ensure all contractors performing tasks within the technical facility use HEPA filtered vacuums to remove contamination/dust/debris. A traditional vacuum cleaner fitted with a standard textile dust bag can filter down to a 30 micron particle size. A normal two ply paper dust bag will usually filter down to a particle size of 15 microns (twice as small). To eliminate biological/particulate matter contamination the level of filtration must be many times better than this since bacteria are between 1 and 10 Microns in size. Specifying 'HEPA' rated vacuum cleaners will ensure that the exhaust air is 'biologically' clean and filtered down to 0.3 Microns (100 times as small).
3. It is recommended that all contractors submit a 'works contamination' plan before commencement of 'dirty works' in the Data Centre, this plan should be approved by the Data Centre Manager for approval.
4. Ensure no cutting or filing of cable trays/cable baskets take place within the data centre, this action will create a small conductive particle which will be drawn into the air recirculation of the room.
5. Ensure all contaminated tak-mat sheets are regularly changed or if using polymeric mats, are regularly cleaned - approximately 70% of the contamination enters the data centre through the main access point (door), therefore these should be checked regularly.
6. Facilities management team should ensure all contractors have removed contamination following maintenance works in the technical facility.
7. A 'contamination action plan' should be implemented if refurbishment works are to be undertaken in the building (not necessarily the Data Centre) but if the data centre is housed within the same building as the construction work.
8. Take steps for avoiding White Rust formation by ensuring packed material remains dry. Provide/permit air circulation between the surfaces. Allow for adequate drainage on stacked items. In extreme situations you may apply water repellent or barrier coatings to prevent moisture.

5.5 Floor & Ceiling voids

All data center's housing 'air return' ceiling voids/plenums should be professionally decontaminated. The contamination present within the ceiling void is subject to a constant circulated airflow. Maintenance checks should be performed on the infill bags within the ceiling void (if applicable). The infill bags contain a fibrous installation

material which if the infill bag is damaged/torn in any way, the fibres will be exposed to the air flow within the ceiling plenum. Within the ceiling void plenum, a visual inspection is required to identify if any 'spray-on fire insulation' has been applied to the structural steel, if this is the case, it must be sealed as it is a source of particulate matter.

5.6 Monitoring the data centre for signs of contamination

Regular testing for Tin Whiskers should be performed as part of controlling contamination in the data centre. Should tin whiskers be identified, a remediation plan will need to be implemented as a matter of urgency.

Regular testing for Zinc Whiskers should be performed as part of controlling contamination in data centers, the whiskers are zinc crystals formed by the degradation (corrosion) of the galvanized metal surface.

5.7 Choosing the correct cleaning contractor

Avoid using office or "IT" cleaning contractors who cannot demonstrate specialist data centre knowledge and experience. In-house cleaners are often not insured to work in data centres.

Ensure specific tools are used, such as hepa filtered vacuums, specialist cleaning agents, tak cloth etc

Do not use cleaning contractors that advocate the use of brooms, feather dusters, non specialist vacuum cleaners.

Ensure contractors have knowledge of using the correct power points, the fire protection and warning system(s) needing to be isolated, the correct lifting of data centre floor tiles and a general good understanding of the data centre environment and awareness of its functions.

When considering a cleaning provider, assess:

- Experience Profile
- References
- Training – documentation and proof
- Dedicated data delivery preferable
- Accreditations
- UK Geographical cover
- Manpower and sufficiency of cover
- Security Clearances of cleaning technicians
- Back-up, reporting and supporting systems

- Ability to carry out site survey to properly assess
- Health & Safety record
- Sufficient insurance cover

6. Summary

Recommended ways to Avoid Contamination and Reduce Risk and avoid problems

1. Ensure all bare construction materials such as, concrete, plasterboard, masonry, brickwork are sealed with the relevant none water based paint/sealer. This is to stop surface particles being drawn into the air flow and subsequently deposited into critical equipment.
2. All equipment is to be de-boxed in a dedicated staging/de-box area, fibres in cardboard and paper and related products are released when handling and distributed into the airflow
3. Facility staff and contractors should remove all debris from their work site after completion of project, tie wraps, nuts bolts; screws etc. whilst these items will not be picked up in the air flow they do obstruct airflow.
4. Facility staff and contractors should have to hand a HEPA vacuum or equivalent and extract and contain any dust particles whilst drilling, knocking through wall etc.
5. All construction/dirty works within a DC should be completed under a “Permit to Work” scheme and checked off after completion to ensure all debris/contamination has been removed
6. Carpet tiles within a DC should be removed and replaced with vinyl or laminated RAF tiles to eliminate the distribution of carpet fibres.
7. Foot traffic through a critical facility should be kept to a minimum to avoid the distribution of clothing, hair, skin and foot borne contamination ensure that short cuts are not used through a critical facility.
8. ACU drive belts to be regularly inspected and the drive bully is inline an out of line pulley will cause the drive belt to wear quicker distributing rubber particles into the environment
9. Tak mats to be placed at all entry points, or other control systems.
10. Overshoes to be compulsory for anyone entering a critical environment
11. Rooms to be held at positive pressure to ensure particles are not drawn into the room when entering or exiting
12. Ensure all entry point door have the correct door seals fitted to ensure an airtight seal when the door is closed
13. All cable containment runs/services running through internal/external walls are to be correctly firewalled/ sealed to avoid contamination entering and also the construction powder from bare brickwork/plaster board being drawn into the facility
14. Ensure a pest control management system is installed
15. Soft compound ceiling tiles should be replaced with enameled metal tiles as soft compound tile will distribute fibres into the air flow.
16. Water ingress will cause concrete/brick work etc. to deteriorate and crumble over time releasing construction powders into the facility
17. Ensure all lagging is of the correct specification on chilled water lines to avoid condensate build up
18. Ensure ACU are maintained on a regular frequency and the correct filters are fitted and changed as the manufactures recommendation
19. The use of fibrous based fire retardant coatings should be avoided

20. All contractors' tools and equipment such as steps, trolleys etc. should be of suitable state of cleanliness to enter a critical environment
21. If windows are present within the access corridors, service corridors and or DC itself, under no circumstance should these be opened unless in an emergency.
22. Soft furnishings such as curtains, chairs etc. should be removed and replaced with a none fibrous equivalent
23. Where major construction/dirty works have to be completed within any part of a DC facility it is recommended that the area be enclosed (polythene tenting or equivalent) to avoid the spread of contamination particulates
24. Any major works/construction should be carried out in conjunction with a reputable DC cleaning organisation to enable the correct preventative measures and best practice are adhered too.
25. No food or drink to be permitted, discarded food stuffs can invite a pest infestation.
26. All related metal surfaces to be checked for Zink Whiskers and the relevant management plan put in place
27. All signage around the data centre should be of a solid substance (plastic) or of a laminated finish, loose paper signs are not recommended and should be avoided.
28. If non-data centre specific wall mounted AC units are utilised, as is common practice within small server, comms rooms and UPS/battery rooms, it is recommended that the primary filters are removed every 4 weeks and vacuumed with a HEPA filtered machine.
29. Data centre compliant foam or a suitable material is recommended for sealing redundant holes/cuts that have been made in raised access floor panels if fitted and any other sealable air plenum. Recommended foam Data Centre compliant foam is a fire retardant, impregnated polyurethane substance, which is not affected by bacteria and does not shelter or shed any particulates when cut or handled.

7. Credits

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