VFD Protection Program

Project Suggestion from:
Magna International Pte Ltd., Singapore
&
Business Plus, Mumbai

PROTECT: VFD, DELL Server PCs/ Work station PC, Normal PCs used for HMI, Baler electronics, Chillers Electronics, And Other electronic instruments used in plant

With 3rd Generation corrosion protection system in Highly corrosive atmosphere

Background

- Our project aim is to provide non-corrosive or corrosion resistant atmosphere for VFD, (Variable frequency drive, DELL Server PCs/ Work station PC, normal PCs used for HMI, Baler electronics, Chillers Electronics, And Other electronic instruments used in plant), VFDs, will be mentioned in short, for Min. 10+ years protection.

- VFDs need protection from major corrosive gasses involved in production. Major problem comes from H_2SO_4, & Carbon Di Sulfide (CS_2). Acetic Acid, Caustic Lye, Caustic etc are major corrosive gases used in the plant, which affect the PCBs various metal components, viz. Copper, Silver, etc.

Present scenario

- Cocktail of corrosive gases from plant environment leads to frequent PCBs failure.
- Corrosion hastens due to VFD's/server's internal fans, which scrubs the corrosive gas continuously on PCBs. In this situation 1X corrosion turns to 'nX' times.
- Zinc, Metal, corrodes and emit micron size 'whiskers' in environment, which carried by air, lands on PCBs, short circuits them.

Two major issues for VFD failures

- **Corrosive gases** attacking PCBs directly, contacts become oxidized, leading to failure of PCBs.

- Corrosive gases attacking metal structure inside the AC rooms, Such metal releases metal **'whiskers',** in the air. Whiskers are visible under Electron microscope and can be carried by any Medium, Air, movement, etc can fall on the PCBs and short circuit them leading to failure of VFD. Being not visible by naked eye, they might just fall away, when PCBs are removed. Whiskers involvement is shown in following **figure-1,2 & 3**.

What is Zinc Whiskers

Zinc Whiskers are NOT a newly discovered phenomenon
They were first reported in the 1940s!!!

Physical Attributes (typical)

- ***Length:*** a few millimeters or less
- ***Diameter:*** a few microns (thousandths of a millimeter)
- ***Shapes:*** straight or kinked filaments, nodules
- ***Texture:*** fluted and/or striated along axis of growth
- ***Conductive:*** can carry tens of milliamperes before melting

Growth Behavior

- ***Mechanism of Growth:*** UNCONFIRMED, as is also the case for tin whiskers. However, the most plausible mechanism for tin whiskers is that they grow to relieve compressive stress within the film, and that may be the case also for zinc whiskers
- ***Incubation:*** ranges from days to ***years***
- ***Growth rate:*** typically less than 1 mm/year

Failure Modes:

- ***Intermittent Shorts*** if available current > tens of milliamperes
- ***Permanent Shorts*** if available current < tens of milliamperes
- ***Metal Vapor Arcs*** initiated in vacuum when V > dozens of volts and I > tens of Amperes. Such arcs are capable of sustaining ***HUNDREDS of AMPERES***

Why Zinc Whisker Concerns Now?

FACT: *Zinc Whiskers were first reported in the 1940s!*

QUESTION: *Why are we "Rediscovering" Zinc Whiskers in the 21st Century?*

ANSWER: *Many Factors Combine to INCREASE Risk of Whisker Problems*

- ***Miniaturization of Electronic Circuits***
  - Reduction in spacing between conductors NOW makes the same old whiskers a hazard.
  - Former electronics used distinctly wider spacing which these whiskers could not bridge
- ***Reduction of Circuit Voltages and Currents in Many of Today's Electronics***
  - Available circuit voltage may be insufficient to melt whiskers --> PERMANENT short circuits
- ***TIME!!!***
  - Many Computer Room Floors and Equipment Racks are now 10, 20, 30 YEARS Old... Thus where zinc-plated hardware is in use, whiskers have had sufficient time to grow in potentially hazardous quantities and lengths
- ***More Frequent System Upgrades***
  - Replacement of "older" computer servers, routers etc. involves construction in the computer room which may lead to generation of conductive whisker debris

Figure1: In Recent Years “Zinc Whisker” Induced Electrical Short Circuits Have Been Cited as the Root Cause of Costly Computer System Failures World-Wide. Zinc whiskers are tiny conductive filaments of zinc typically less than a few millimeters(mm) long and only a few thousandths of a millimeter in diameter. Zinc whiskers are conductive and therefore they will cause electrical shorts

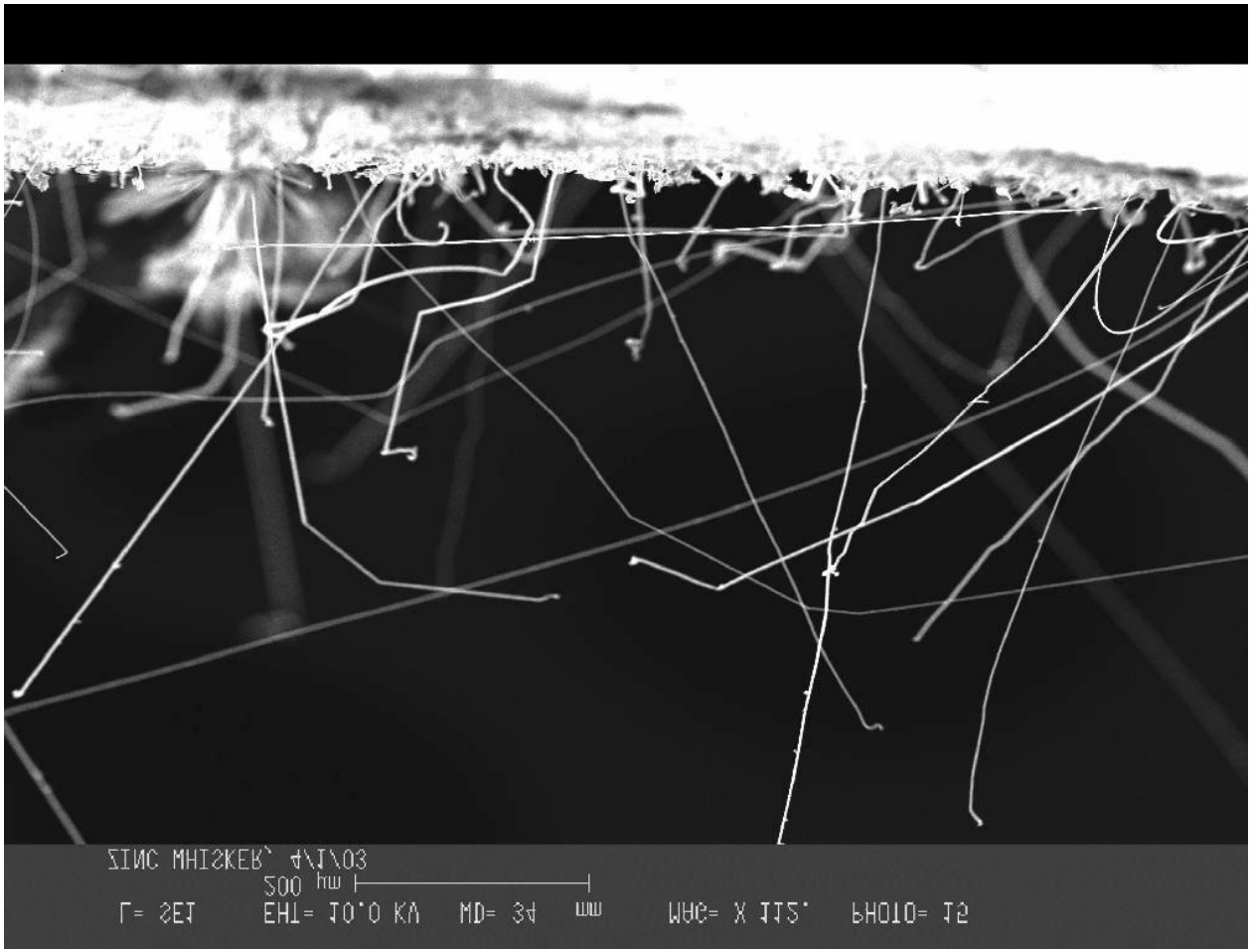
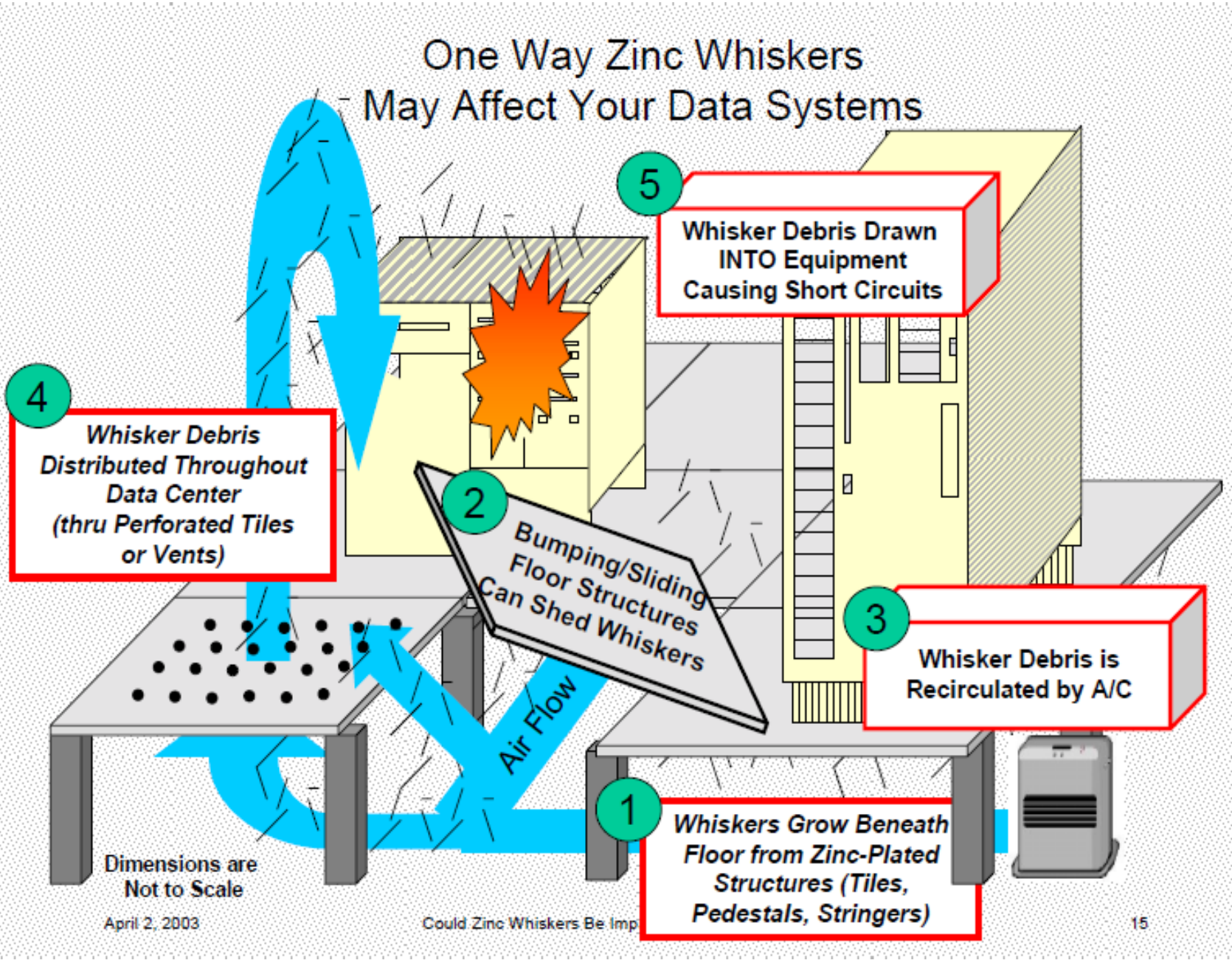


Figure2: Some Sources of Zinc Whiskers
Metals Electroplated with Zinc

One Way Zinc Whiskers May Affect Your Data Systems



Various Protection alternatives

- **Wet Protection system:** We apply coating and insulate the area from gases damaging PCBs. Such passive coating does not surround nearby area, difficult to remove, just insulate n protects. Removal of coating for repair etc is most difficult.

- **Dry Corrosion Protection system**: Vapor based protection system, where VCI 'emitters' releases vapor in enclosed area, molecular film formed on PCBs will protect PCBs from corrosion. Active coating protects adjacent areas to , cracks, cervices etc. Such coating are Active film.

HOW VCI Works

- FEATURES:
- • Provides a minimum of 12-24 months of continuous protection
- • VCI layer does not interfere with operation of mechanical components
- • Does not contain nitrites, silicones, phosphates or heavy metals.
- • VCI's are self-repleneshing to provide continuous protection if package or container is disturbed by opening and closing.
- • No spraying, wiping, dipping or surface preparation required.
- • Available in multiple forms for each unique application.
- • No need to remove VCI protection before using the protected material.
- • Efficient delivery system makes it economical to protect hard-to-reach areas.
- • Easy to apply, Extends equipment life, Multi-metal protection
- VAPPRO Products conforms to RoHS, US MIL and has NATO codification.

PROTECTION FOR MULTI-METALS

Copper
Cast Iron
Aluminium Alloys
Zinc
Magnesium Alloys
Brass
Cadmium
Silver
Copper-Nickel Alloys
Stainless Steel
Carbon Steel
Galvanzied Steel
Aluminized Steel

VAPPRO®: VCI Technology

- **What is VCI Technology?**

- **VAPPRO®** VCI (VCI stands for Vapor-based Corrosion Inhibitor) works by emitting VCI molecules into the surrounding area in an enclosure until it is completely saturated. These VCI molecules are safe, invisible and odorless.
- When the VCI molecules come in contact with the air in the enclosure, ionic reaction takes place between the VCI molecules and the water molecules in the air.
- The VCI molecules in the surrounding enclosure are hydrolyzed into VCI ions, which form a molecular corrosion protective barrier on the metal surface through polarization and thus passivate the substrate from atmospheric corrosion. It normally takes approximately 24 hours for the VCI ions to be absorbed on the metal surface

Dry Corrosion Protection features

- Molecular film forms does not affect by Electrical or Magnetic field.
- Vapors cannot be seen or smell.
- Film form will not be effected by opening few times of protected control panel for short duration.
- Vapor protects cervices, unreachable parts etc
- Generally provides protection for 12-24 months
- Wide range of products such as Paper, Plastic, Aerosol, Emitter etc
- Life effected due to Temperature, Fans, etc

VAPPRO
Your Partner In Corrosion Control

VAPPRO VCI TECHNOLOGY

A new concept
on corrosion protection
utilizing the latest technology
(ACCI)
Amine Carboxylate Corrosion Inhibitors

100% Nitrite Free

100% Nitrite Free

Why is nitrite based products no good?

Answer: Because it will react with amino acids in our bodies to form Nitrosamine, which is highly carcinogenic.

Nitrite + Amino Acids = Nitrosamine.

Nitrosamine are powerful Carcinogens

Carcinogen = **Cause Cancer**

VAPPRO VCI 100% Nitrite Free

HOW VAPPRO VCI WORKS

Stage 1

At ambient temperature VAPPRO VCI molecules are released into the surrounding enclosure. These VCI molecules are invisible and odorless.

Stage 2

When the VCI molecules come into contact with the surrounding moisture ionic reaction takes place between the VCI molecules and the moisture.

Stage 3

Upon contact with moisture, the VCI molecules hydrolyzed into VCI ions.

Stage 4

The hydrolyzed VCI ions polarized the metal surfaces and passivates the metal from corrosion.

VAPPRO
Your Partner In Corrosion Control

VAPPRO VCI TECHNOLOGY

INTRODUCTION:

- Vappro VCI 100% nitrite free vapour corrosion inhibitor specially developed to combat the problem caused by moisture, humidity and condensation in confined spaces.
- At ambient temperature Vappro VCI molecules are released into the enclosed area and VCI molecules began to saturate in the enclosed area.
- In the presence of moisture, ionic reaction takes place between VCI molecules and water molecules in the enclosed area. *(breakdown in the presence of water)* into VCI ions.

VAPPRO VCI TECHNOLOGY

INTRODUCTION:

- The hydrolized VCI ions *(VCI molecules and Water molecules break down in the presence of water)* polarized the surface of the metal and form a thin barrier and passivate on all metal surface in the enclosed area from corrosion.

- The higher the moisture contents the faster the rate of hydrolyzation of VCI molecules.

- Corrosion protection is typically up to 2 years, depending upon conditions, applied rate and degree of air exchange of the vessel.

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VAPPRO VCI APPLICATION

APPLICATION:

- Easy application and removal
- Long term protection (6 – 12 months outdoors and 24 months indoors)
- Little or no surface preparation required
- Versatile – applicable to multiple metal protection
- Suitable for all metals including cast iron
- A final rinse additive for corrosion control in production lines cleaning and protecting metal parts

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VAPPRO VCI APPLICATION

- Protected products can be shipped to customer without removing of water or powder for dry corrosion protection of metals
- Ideal for hard to reach areas and effective corrosion protection of:
- Tanks, pipes, casings
- Lay Up of Plant & Equipment
- Lay up of cooling towers
- Preservation of boilers, tubes and condensers
- Protection of metal parts and equipment inside any enclosed container

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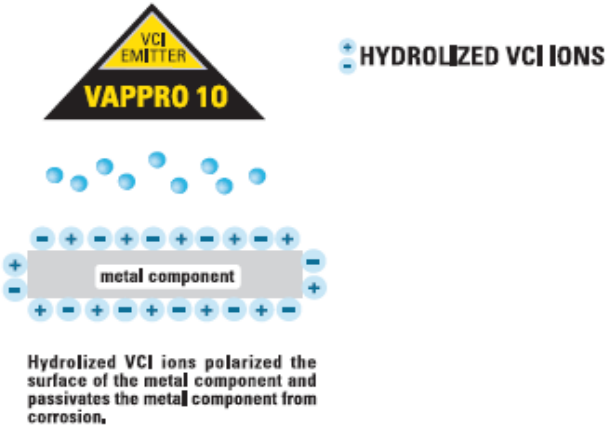
VCI APPLICATION

- Provides a component that is attracted to all metal surfaces and forms a molecular barrier that provides protection from rust and corrosion
- Does not contain nitrites, silica, chromates, heavy metals and ozone depleting systems (ODS)
- Bio-friendly, organic chemistry, free of hazardous amines, phosphate ester
- Non-hazardous /environmentally friendly/biodegradable
- Economical & requires low dosage

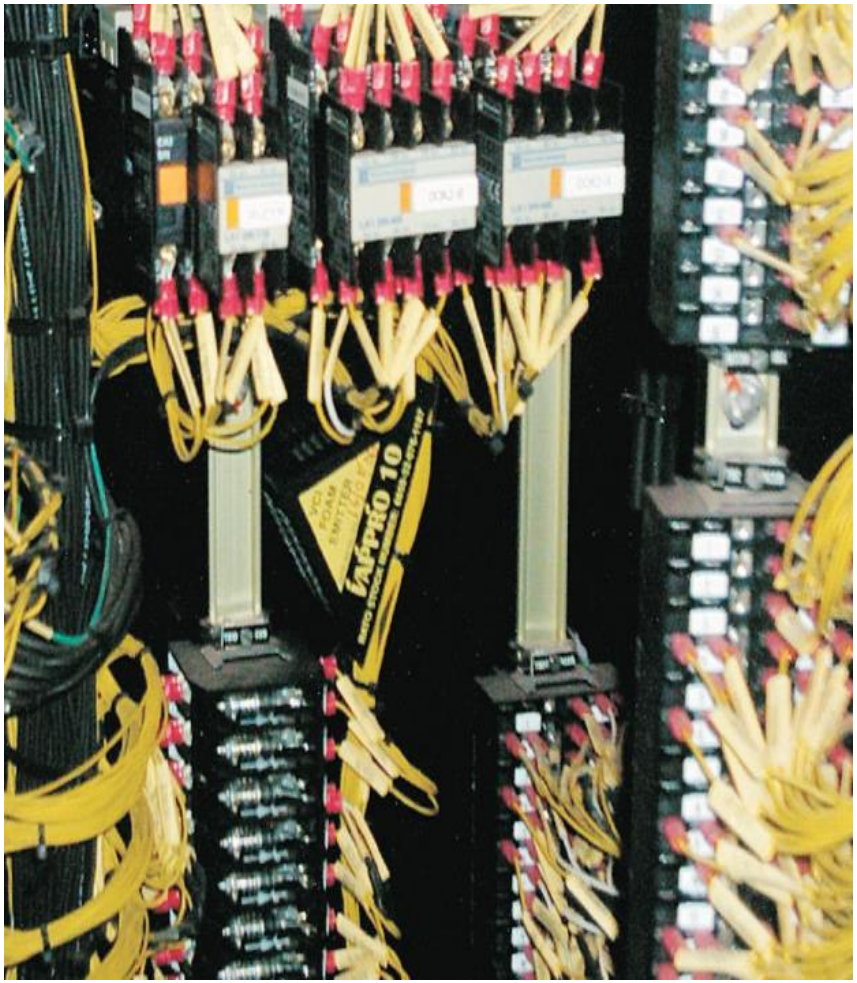
RELIABLE, COST EFFECTIVE SOLUTION

TOTAL PROTECTION

Vappro VCI protects all recessed areas and cavities and works on all metal surfaces in an enclosed atmosphere. In an enclosure, VCI emits molecules to a point of saturation within 12-24 hours. In the presence of moisture, these VCI molecules hydrolise to form VCI ions. The Vappro VCI ions are attracted to metal surfaces to form a thin mono-molecular protective layer over the metal surface. These ions passivate the metal and cause it to be inert to corrosion. The vapour covers all surfaces including crevices, cavities and all inaccessible areas sealing them to provide total protection.



Hydrolized VCI ions polarized the surface of the metal component and passivates the metal component from corrosion.



Suggestions

- We suggest 7 stage protection ring as follows

1) **Location:** Safe environment in plant or nearby is suggested, where VFD can be housed.

2) **Doors & Floorings:**

a) Dual doors entry, doors n windows should be double insulation UPVC or similar style for extreme weather protective seal type, which does not permit Air-water, insects to pass thro'

b) Rigid entry system, Entry through Biometrics system type permitting only official staff inside, to remove their footwear outside of room, so corrosive dust stays outside. 24 x 7 video recording of room to check for un-wanted entry, specially for night. Foods n Liquid not allowed inside room.

c) Air curtain, both inside n outside entry covered, Outside & Inside door should have dual air curtains. Air curtains should be kept in spare so, in case of failure, spare one can be installed. If possible such curtain motors should be VCI protected system, so motors working is longer.

Suggestions

d) Entire room should be air proof, i.e. all cables, piping's, duct etc openings should not have any leaks in wall of their entry/exit. Positive air pressure to be maintain inside the room, so inside air will flow out, not in reverse. Since room air is highly purified + VCI fortfied, such air should not have any leaks etc.

e) False Floorings supports should be **DIP coated** in anti corrosion coating, so whiskers are avoided.All exposed metals use avoided, or if used should be **DIP coated**, especially as shown in Fig.1-3, for false flooring, metal parts.

f) Doors & windows should be perfect fit, not allowing air flow from either side, i.e. perfect seal.

Suggestion-2

Isolated Room

* Battery Room & AC room should be separated, Spare & VFD Repair- Service room can be kept in same room. Presently repair units are lying open in Instrument room, they are open to corrosion attack. VFD New / Old or for repair should be kept in VCI protected bag + VCI protected cartoon having V-5/10. Even New VFD should be send from supplier in VCI packed plastic bags. Such VCI bags are re-useable, and VFD should be kept in such bag immediately, even for internal transfer

* Try to keep VFD room isolated from HVAC or Battery room, to avoid gases, moisture/water (2^{nd} source for corrosion, 1^{st} is corrosive gases)

Suggestion-2

AC, Air Purifier:

* They should be of Min. 30% over capacity, so in case of any corrosive attack, or High summer temperature, the system is able to take the load, plus there is positive air pressure in room.

* Fresh air In take should be planned carefully so that the air corrosiveness is removed thro' scrubbing system etc

* AC system all copper+ Fins + brazing joints + Metal parts used incl. frame, tray etc should be coated, for preventing leaks, and whiskers growth. Zinc is used in various AC parts, stands & systems, special care should be taken here, for DIP coating.

* AC, Air Purifiers system etc strengthening and interference of outside air to be minimized. Nor inside air should leak out. Return air loss should be avoided at all cost.

* Better AC system, with stand by units, so as to avoid high temperature in case of failure of 1st unit. High temp. should be avoided at any cost.

* AAA air purifiers with adequate extra capacity, so in case of air leaks, working is not affected. Such units discarded filters can be re-used inside the rooms in server / work station for gas trapping **or** as fiber filter / stopper etc.

* AC air should be re-circulated inside, so it does not get mix with corrosive gases, thus load on all VCI installations are minimum. Corrosion Coupon in AC inlet / outlet path + regular reading.

* AC coil to be clean with ***Magna 500, Alkaline coil cleaner***, so corrosive Acid dust is neutralized.

Suggestions: 3

Housekeeping: (HK)

HK should be extreme professional with special equipments to trap whiskers, we know some makers who have world patented system products, plus HEPA filters.

HK without chemical at all cost. Chemical with VOC can make cocktail of unwanted harmful gases.

Better Housekeeping with special equipments to trap ‘whiskers’ is must.

Very Special Vacuum cleaning to trap whiskers inside the rooms, under flooring etc. Under flooring cleaning to be done at regular intervals.

Suggestions: 3

VFD Storage Enclosures:

* Made of Special Industrial plastic, Min. use of metal, should be 100% airtight, No leak, all cable opening should have capping, of PP / HDPE material, being better acid resistance, extra supplies, so broken or lost one can be replaced. If possible door partition to be made VCI additive at time of extrusion.
- Should have internal linings of **VCI plastic sheet** on all wall, flooring + ceiling + corner covered. Replaced every 12 months, If possible **V-870 sprayed** on walls. Replenish protective linings, if corrosion found.
- Opening of enclosures should be minimum, readings to be thro' glass.
- Cable lining should be systematic, not dumped on the floor, so HK is effective
- Fans opening should have Fiber trapping system with thick Non-woven wadding type material(e.g. 3M Utensil cleaner). Weekly cleaning of filters. Fans to be connected to system, with failure reporting system, spare fans replacement immediate, so the inside temp does not increase. Use V**-870** on Fiber traps
- Indoor temperature indicator to IT system, so temp is maintained. All openings for regular Air leak check with CFM reader.
- Enclosures should have corrosion coupons installed with regular reading checks, 1 coupon kept near fan air path, to check air quality.

VFD Protection points

- Individual VFD kept in special protective enclosure made of Air tight plastic, should be 100% Air tight, all openings should be blocked. No openings of any type to be left open. Fans if required must have Viscose fiber trap similar to 3M scrubber pad used in kitchen. Cable openings cap for closing it with VCI film backing, than it will avoid corrosive fumes defense.
- Cables, should be covered with VCI film, so it's brittleness can be avoided. Cables should be nicely fixed to bottom or sides, useful for repair, house keeping(HK), fiber + corrosive dust cleaning by HK staff. Avoid accumulation of fiber + dust, it hastens corrosion.
- Individual VFD door panels, corners, bottom n top ceilings should be coated with VCI film sheets, so leaks are protected. All Joints to be sealed with VCI tapes.
- Inside area wise **Vappro-10** or **Vappr Pouch** to be used, should be replaced yearly, or when if coupon indicates.

VFD Protection points

- Metals inside the room area, should be coated with **V-886** DIP coating, to avoid whiskers growth.
- Junction box should not be open, but enclosed with plastic made with VCI additive, or covered with VCI plastic film, from both inside n outside.
- VFD should be packed sealed with VCI Film / paper, all joints /opening to be sealed with VCI tapes/film, inside walls to be sealed with VCI film / paper + Aerosol spraying every quarterly, if copper coupon shows corrosion signs, then frequency should be increased.
- **V-5/10** to be placed inside VFD, away from fan, near air entrance place preferred.
- **V-900** spraying on PCB, final source of protection, being permanent active film is useful, or else **V-870** for evaporative type coating, **V-900** coating - check it for repair + PCB backside usefulness.

Magna's suggestive products 1 of 3

- **Preservation of Electrical Control Panels, Switchboards, Transformers, Junction Box and Electrical Parts to be cleaned and preserved with:**
- Vappro 01 – VCI Foam Emitter (Coverage Area: 1 Cubic ft)
- Vappro 05 – VCI Foam Emitter (Coverage Area: 5 Cubic ft)
- Vappro 10 – VCI Foam Emitter (Coverage Area: 10 Cubic ft)
- Vappro 820 – VCI Pak (Coverage Area: 1 Cubic ft)
- Vappro 823 – VCI Pouch (Coverage Area: 50 Cubic ft)
- Vappro 825 – VCI Stretch Film
- Vappro 826 – VCI P.E. Film
- Vappro 870 – Electro-Spray (500ml/Spray Bottle)
- Vappro 900 – Permanent coating for PCB

Separate VFD Observation team

- Special team of Engineers having expert in corrosion + IT + Repair, HVAC or as suggest to man such enclosures 24x7.
- Team should take all the responsible duties as being suggested in this report & follow Corrosion coupon data maintenance, as per Management final decision.
- If needed photos should be taken for timely comparison, with soft storage data.
- Any failure report or corrosion signs should be deeply analyzed and preventive action to be taken accordingly.
- This team should also observe VFD repair, transfer, spares, Air Scrubbers, IT systems etc.
- One of the most important work is, when VCI products are installed, proper marking of installation should be done on product and register, so we know it's life, performance, progress

Separate VFD Observation team

- Corrosion signs observations on all coupons are very much important for long term performance, and it's comparison with past signs.
- Second Imp function is to check for Fan working, Temperature details of VFD cupboards, air path choking, Leak detection starting from outside walls to windows, doors, cupboards etc
- Replacement of VCI products or installing over same old products will be economical.

Separate VFD Observation team

- Installing such systems inside CPU/Server etc, same guideline as VFD should be used. **V-870** spray on side walls etc. Adequate VCI protection inside CPU + VCI wall linings + FAN working, with other system also they can work with supplier, HK, Cos. Management etc.
- Selection of **BEST** Door, Windows, Air curtains, Coating work final check, dirt-corrosion-contamination-misuses report etc should be there responsibilities Plus other similar duties given by Management.
- This team should be having great observation + memory sharpness to find out minute variation.

Magna's suggestive products 2 of 3

- **Preservation of Piping Systems, Tanks, Flanges Valves, Pumps, Spindles, Bolts, Nuts, Vessels, Compressors, Coolers, Heat Exchangers and Equipment, etc. Fogging with Vappro VCI Powder / or treat with the followings:**
- Vappro 849 – Water Soluble VCI Powder
- Vappro 868 – VCI Wax Coating
- Vappro 869 – VCI Grease
- Vappro 838 – VCI Coolant
- Vappro 850 – Engine Guard
- Vappro 852 – Hydraulic Oil and Additive
- Vappro 855 – VCI Anti- Corrosion Oil
- Vappro 868 – Vappro VCI Wax Coating (Aerosol Can 400ml/Can)

Magna's suggestive products 3 of 3

Treatment of Inherence Rust Exposed on Piping Systems, Flanges Valves, Spindles, Bolts, Nuts, Vessels and Equipment, etc.

- Vappro 800 – Multi-Purpose Cleaner/Degreaser
- Vappro 887 – Rust Converter (MRST)
- Vappro Corro Tape – VCI Anti-Corrosion Tape

VFD Protection Report made with Technical Inputs from Magna Technical Team, Singapore

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