Corrosion Issues Associated with RoHS Can Be Fatal to Electronic Control Equipment

CORROSION 2010

March 14 to 18, 2010

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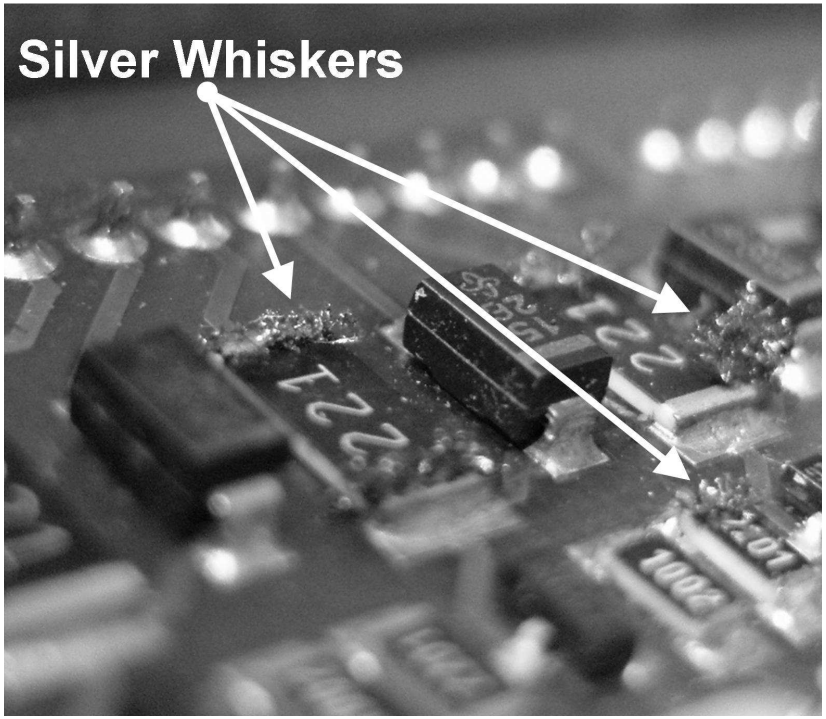
AAF® INTERNATIONAL

Outline

- Historical Corrosion
- RoHS
- How to Monitor Corrosion
- ASHRAE Environmental Classification
- Conclusions

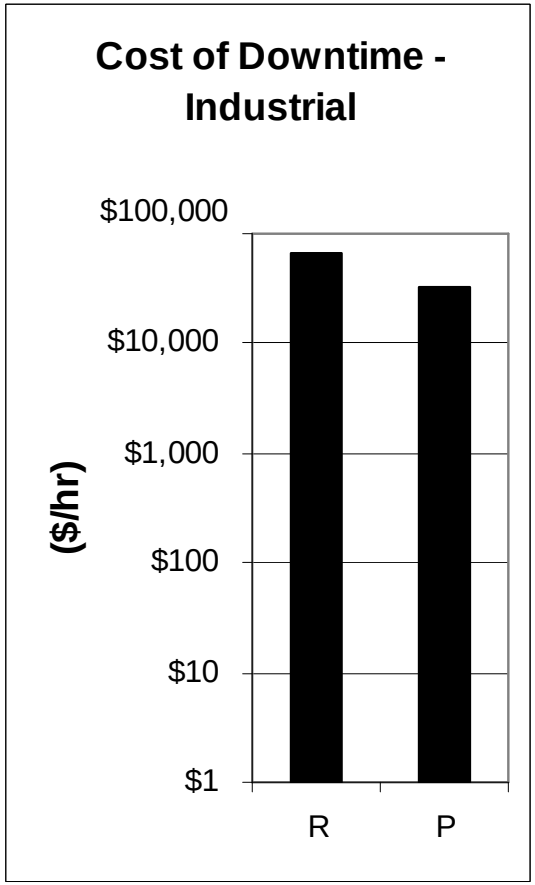
Historical Corrosion

- Industrial Plants
  - Geothermal Plants
  - Petrochemical Refineries
  - Pulp & Paper Mills
- Ambient Air Pollution
  - Sulfur Compounds
    - hydrogen sulfide
    - sulfur dioxide
    - mercaptans
    - sulfur laden particulates
  - Other Compounds
    - chlorine
    - nitrogen oxides
- Circuit Board Corrosion



Historical Downtime

- Corrosion
  - whisker growth, creep corrosion, others
  - cause failure by either impeding the flow of electricity or forming unintended circuit paths
- Downtime
  - corrosion of electronic control equipment can lead to process shutdown
    - lost production time.



R = Refinery;
P = Pulp and Paper Mill
*Assumptions clarified in paper

RoHS

- Restriction of Hazardous Substances (RoHS)
  - restricts six substances including lead
- Circuit board manufacturers removed lead based solder to comply
  - ImAg chosen by many manufacturers
  - Manufacturers found environments containing sulfur could cause failures in as little as 4 weeks
  - Locations which did not have corrosion issues previously, now showed problems quickly

RoHS - Failures

Before RoHS

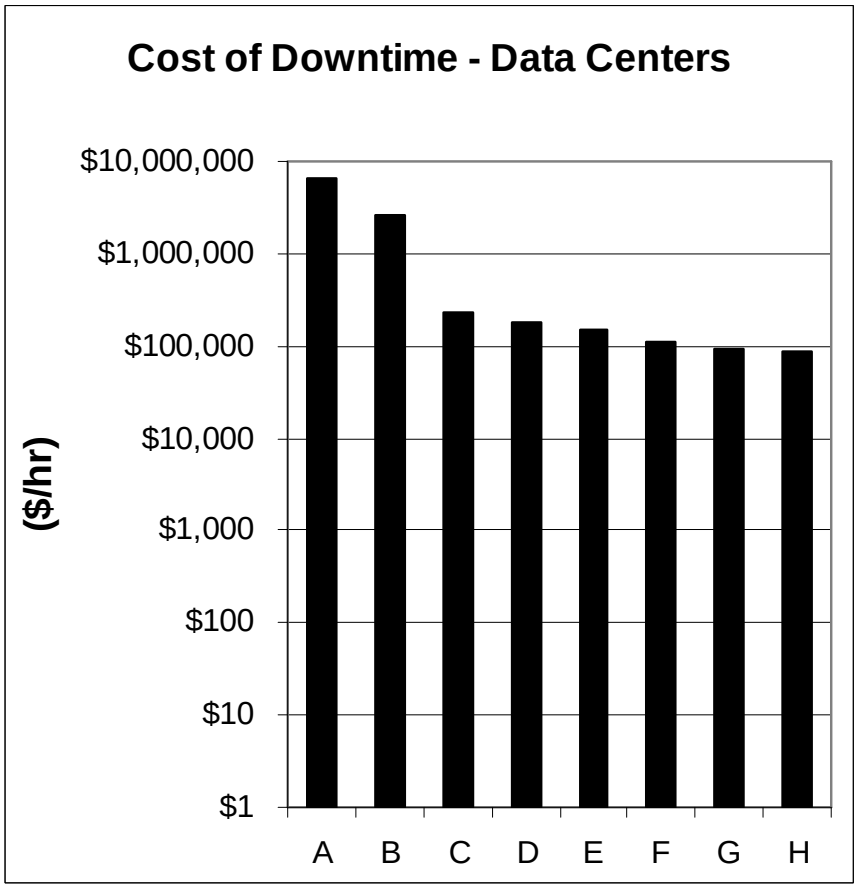
ISA Severity Level	Time to Failure
G1 – Mild	4-5 years
GX – Severe	4-6 months

After RoHS

Environment	Time to Failure
Rubber Manufacturer	2-4 months
High Sulfur Areas	4 weeks

RoHS Downtime

- RoHS Corrosion
  - Less industrial areas housing data centers begin having problems
- Downtime
  - corrosion of server components means data center downtime
    - transactions must stop
    - data can't be stored
    - logistics can't run



A = Brokerage operations;
B = Credit card authorization;
C = On-line Auction;
D = On-line Retail;
E = Package shipping services;
F = Home shopping channel;
G = Catalog sales center;
H = Airline reservation center

*R. Kembel, "Fibre Channel: A Comprehensive Introduction", Internet Week, (April, 2000)

How to Monitor Corrosion

- "Reactivity Monitoring"
  - Exposing copper and silver coupons to the controlled environment
  - Analyze after ~30 days for corrosion thickness → Angstroms corrosion /30 days

New Copper Coupon

Exposed Copper Coupon (38 Days)

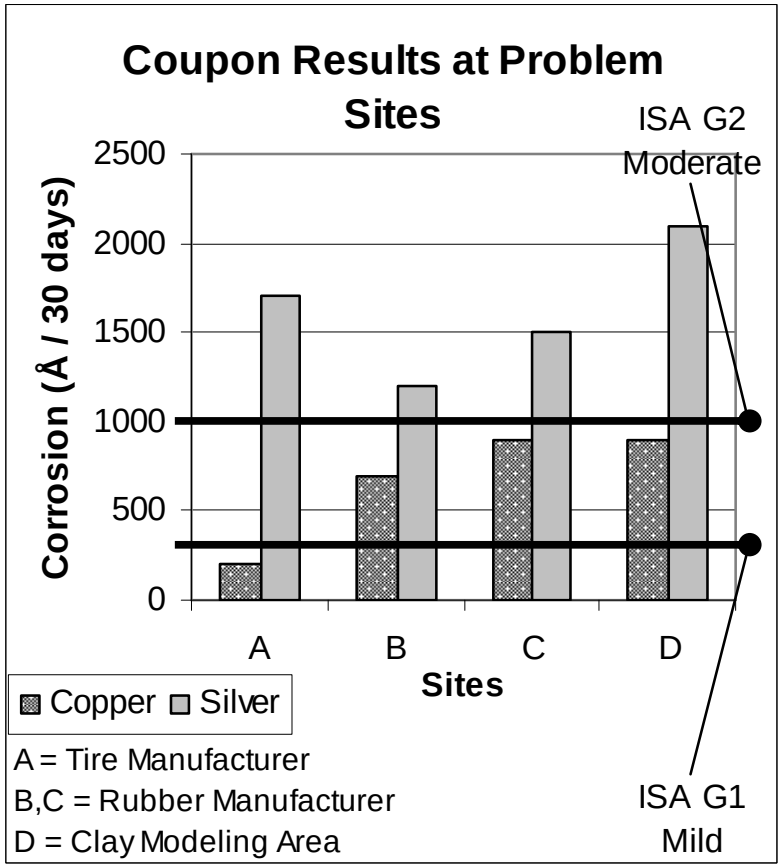
ISA 71.04 Classification Scheme

- Reactivity Classification Scheme of ISA 71.04 is based solely on copper corrosion

Classification	**Copper Angstroms /30 days**	**Reliability Statement**
G1-Mild	< 300	. . .sufficiently well controlled . . . corrosion is not a factor . . .
G2-Moderate	< 1000	. . .effects of corrosion are measurable and may be a factor . . .
G3-Harsh	< 2000	. . .high probability that corrosive attack will occur . . . .
GX-Severe	≥ 2000	. . .only specially designed and packaged equipment would be expected to survive . . . .

Need Both Copper & Silver (1)

- Results of reactivity monitoring at sites housing RoHS compliant circuit boards have shown that copper alone is a poor indicator of corrosion.

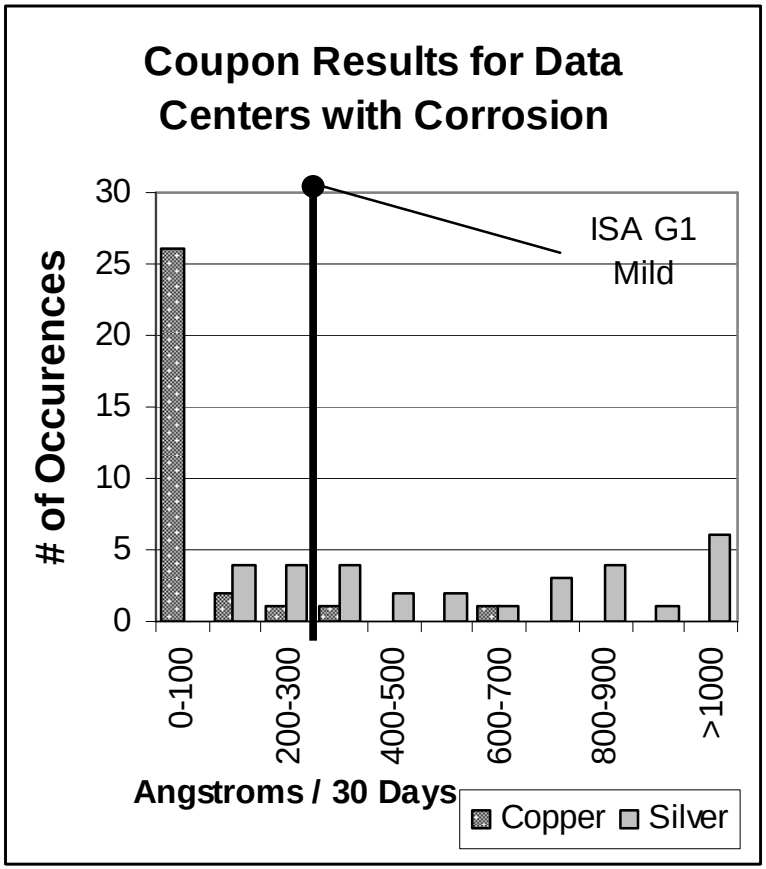


Coupon Results for Sites which Housed RoHS Compliant Boards with Quick Failure Times*,**

*R. Schueller, "Creep Corrosion on Lead-Free Printed Circuit Boards in High Sulfur Environments", SMTA Journal, (January 2008).
**Internal Results. Air Quality Analysis Results from Field Tests. (2008)

Need Both Copper & Silver (2)

- Further work indicates that silver coupons can indicate atmospheric aggressiveness when copper coupons do not.



Coupon Results for Data Centers with Copper Creep Corrosion or Silver Corrosion or Both*

*ASHRAE, Gaseous and Particulate Contamination Guidelines for Data Centers, (Atlanta, GA: ASHRAE, 2009)

ASHRAE Classification (1)

- The best data to date point toward using an environmental classification scheme based on both copper and silver coupons.
- ASHRAE TC 9.9 “Mission Critical Facilities” has developed a classification scheme for areas that use RoHS compliant boards (data centers)
- Reactivity Monitoring should be judged against this standard for all areas using RoHS compliant circuitry.

ASHRAE Classification (2)

Description	Angstroms / 30 days	
	Copper	Silver
ASHRAE Recommendations	< 300	< 300

Conclusions

- RoHS compliant electronic control equipment fail quickly in industrial or mildly industrial environments due to gaseous corrosion.
- Industrial plants should monitor the air quality in control rooms and spaces.
- Control areas producing 300 angstroms or more per month on copper or silver coupons (or sensors) may incur costly failures and downtime if not protected from gaseous corrosion through methods such as gas-phase filtration.