



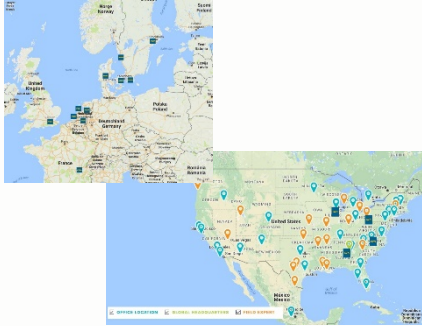
CONTAMINATION ONBOARD VESSELS AFTER FIRES

Presented by:

Torben Vad, AREPA

Gini Mattson, ENVISTA FORENSICS

Just a bit about AREPA



The AREPA Group is represented in 10 countries

- Denmark, The Netherlands, Sweden, England, France, US, Canada and Singapore.

Our core business is the restoration of industrial equipment and installations onshore and offshore.

- In industrial facilities in general, onboard ships, on off-shore installations and in wind turbines all over the world.

Our key assets are our experience, knowledge, first response and mobility.

- We assist our customers with interventions globally, whenever needed. We hold the required certificates, licenses and we are available 24H/7.



What AREPA do is...

SCOPE OF WORK ON VESSELS



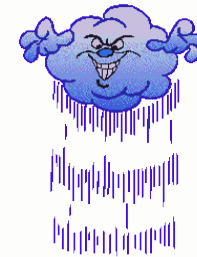
Core service

- Corrosion risk assessment by chemical measurement
- Preservation against corrosion on equipment and installations
- Removal of debris and direct damaged equipment
- Cleaning of structures
- Dismantling of equipment for restoration (electro/mechanics/electronics)
- Cleaning and decontamination of dismantled equipment
- Reassembling of equipment after drying process
- Re-installation and test
- Chemical test for clean surfaces

Contamination after fire

Hydrochloric gas + humidity =
+ carbon

1,2 L Hydrochloric acid



PVC



1 kg

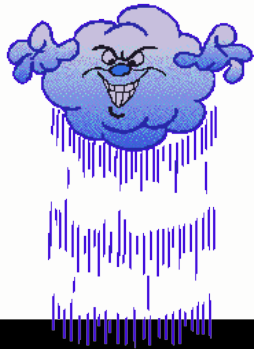


Condensation



Corrosion after contamination

Hydro Chloric Acid



1. Etching

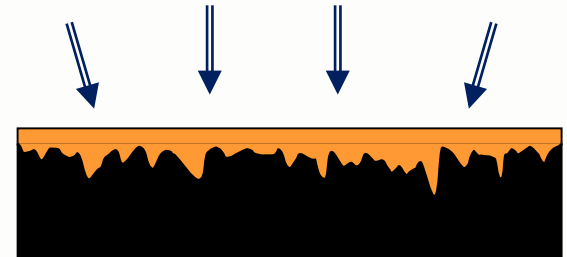
Iron Chloride



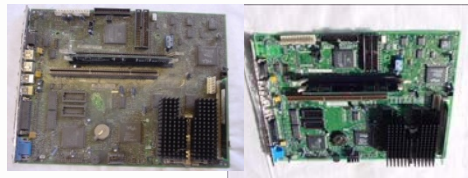
2. Development of salt

Moisture

Hydroscopic effect



3. Corrosion



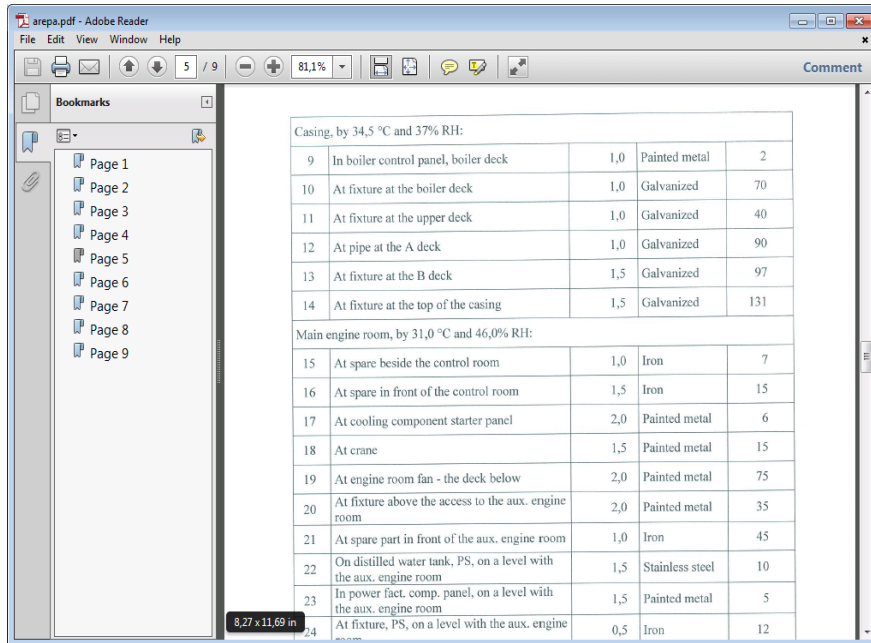
Measurements to get facts right...

On Site measurement

- Titration - Chloride analyses
- ISE – Ion Selective Electrode
- Conductivity Metering

Lab analysis

- IC – Ion Chromatography
- Ad hoc analysis



arepa.pdf - Adobe Reader

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81,1%

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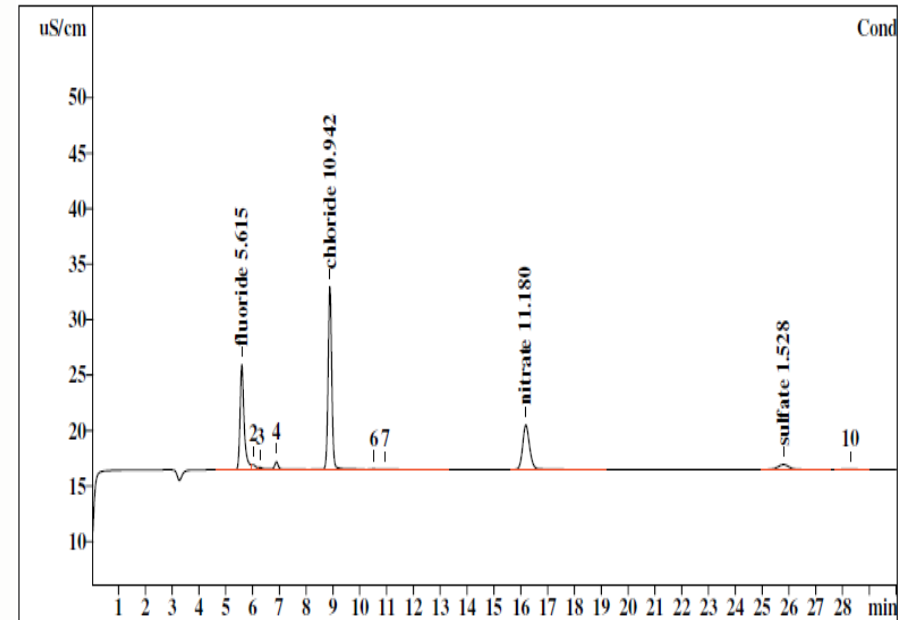
Casing, by 34,5 °C and 37% RH:

9	In boiler control panel, boiler deck	1,0	Painted metal	2
10	At fixture at the boiler deck	1,0	Galvanized	70
11	At fixture at the upper deck	1,0	Galvanized	40
12	At pipe at the A deck	1,0	Galvanized	90
13	At fixture at the B deck	1,5	Galvanized	97
14	At fixture at the top of the casing	1,5	Galvanized	131

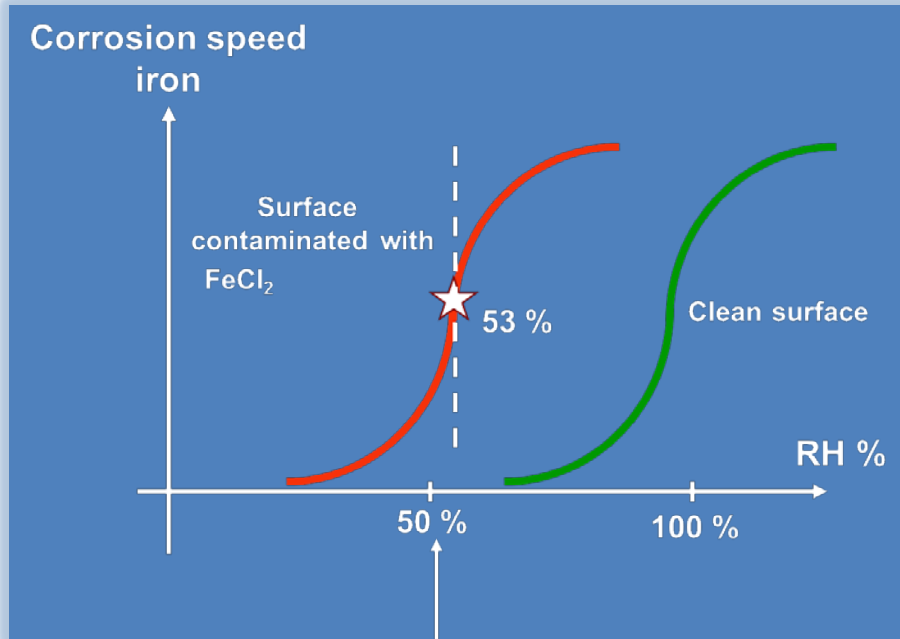
Main engine room, by 31,0 °C and 46,0% RH:


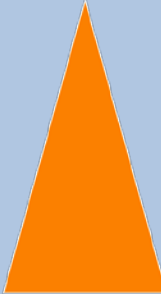

15	At spare beside the control room	1,0	Iron	7
16	At spare in front of the control room	1,5	Iron	15
17	At cooling component starter panel	2,0	Painted metal	6
18	At crane	1,5	Painted metal	15
19	At engine room fan - the deck below	2,0	Painted metal	75
20	At fixture above the access to the aux. engine room	2,0	Painted metal	35
21	At spare part in front of the aux. engine room	1,0	Iron	45
22	On distilled water tank, PS, on a level with the aux. engine room	1,5	Stainless steel	10
23	In power fact. comp. panel, on a level with the aux. engine room	1,5	Painted metal	5
24	At fixture, PS, on a level with the aux. engine room	0,5	Iron	12

8,27 x 11,69 in



Accelerators: Salt and humidity



Very sensitive		Cloride level 5 micro gram
	Semi-manufactures Fine mechanics Machines Computer equipment Switch gears Industrial electronics Protected machinery Maritime equipment	
Less sensitive		20 micro gram

Other contaminations from fire

- **Corrosive Ions in Smoke**

- Sulfates

- From burning wood, cardboard, paper, lead batteries etc. Sulfates is salts of sulfuric acid

- Nitrates

- From burning nylon carpets, drapes, and certain plastics. Nitrate is a short term for nitrogenous fertilizers, which are salts of nitric acid

- Chlorides

- From burning plastics, such as PVC and electrical wiring

- **Carbon and other conductive materials**

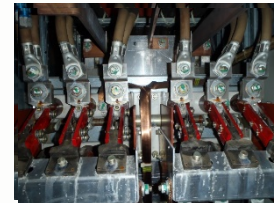
- **+1000 other residuals**



Extinguish agents and contamination

Be aware of added corrosion risks from extinguishing agents

- Water (mist, sea water or fresh water)
- Foam
- Carbonic acid (CO₂)
- Halon
- Powder
- Sand



Preservation after fire

Preservation methods

- Ventilation
- Water/humidity removal
- Cleaning of critical surfaces
- Dehumidification
- Heating or spot heating
- Humidity penetrating oil
- Removal of critical equipment

Result should be a stabilized situation, where we

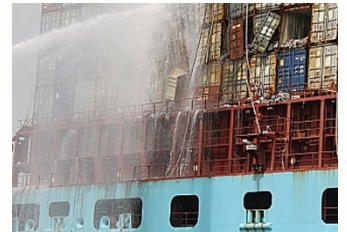
- have preserved your repair options
- gained time to make the right and intelligent decisions



Flooding of engine room

Damage control process - Preparations

- Eliminate the damaged area
- Get an overview of equipment involved
- Make resources available
 - Site coordination
 - Specialized damage control company
 - Project manager
 - Engineers and technicians
 - Pumping equipment
 - Dehumidifiers
 - Anti-corrosion materials
 - Fresh water and rinsing equipment



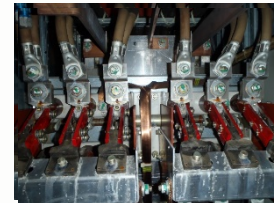
Preservation process

Damage control process – Dewatering and protection

- Start pumping
- Rinse with fresh water
- If possible rinse same time as pumping
- Open switchgears, motors and equipment and rinse
- Protect with penetrating oil
- Dehumidification if possible
- Heat up critical equipment

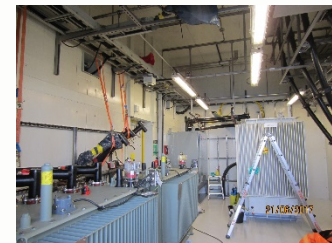
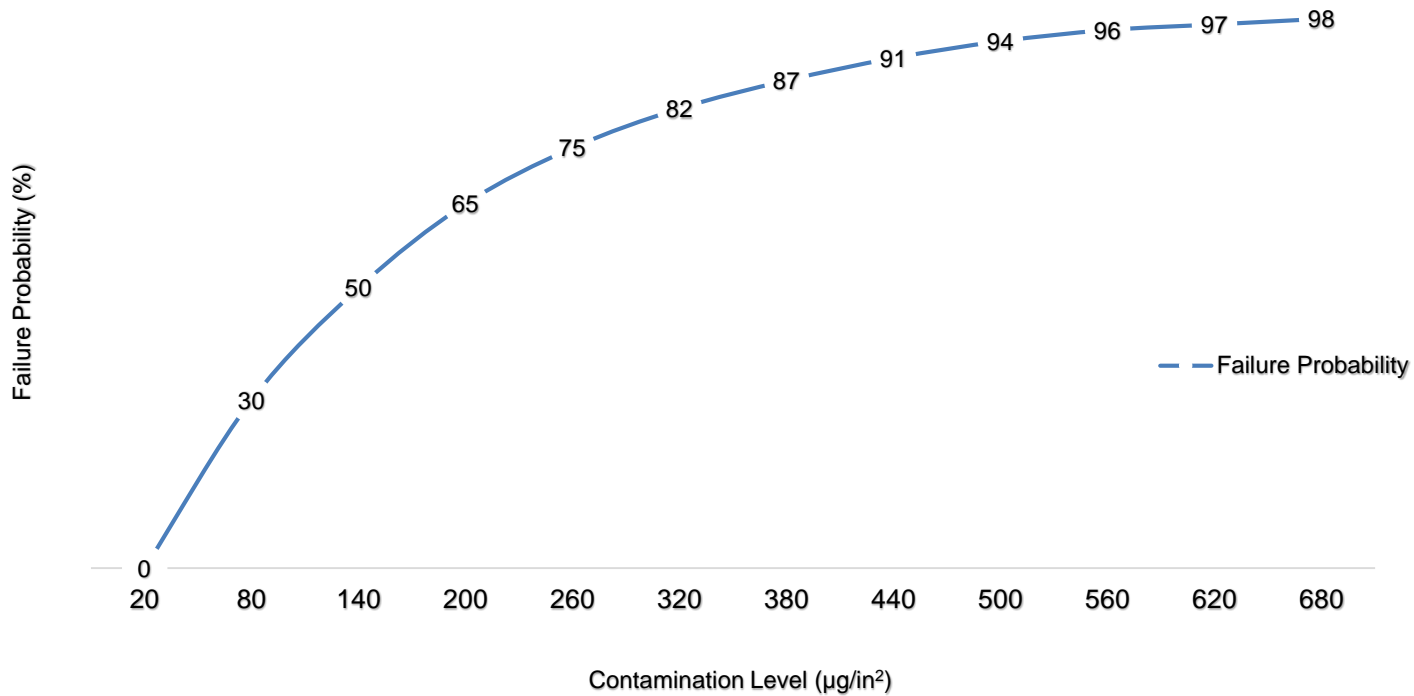
Result should be a stabilized situation, where we

- have preserved repair options
- gained time to make intelligent decisions to proceed



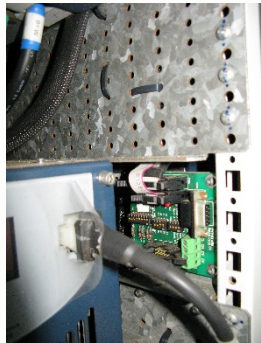
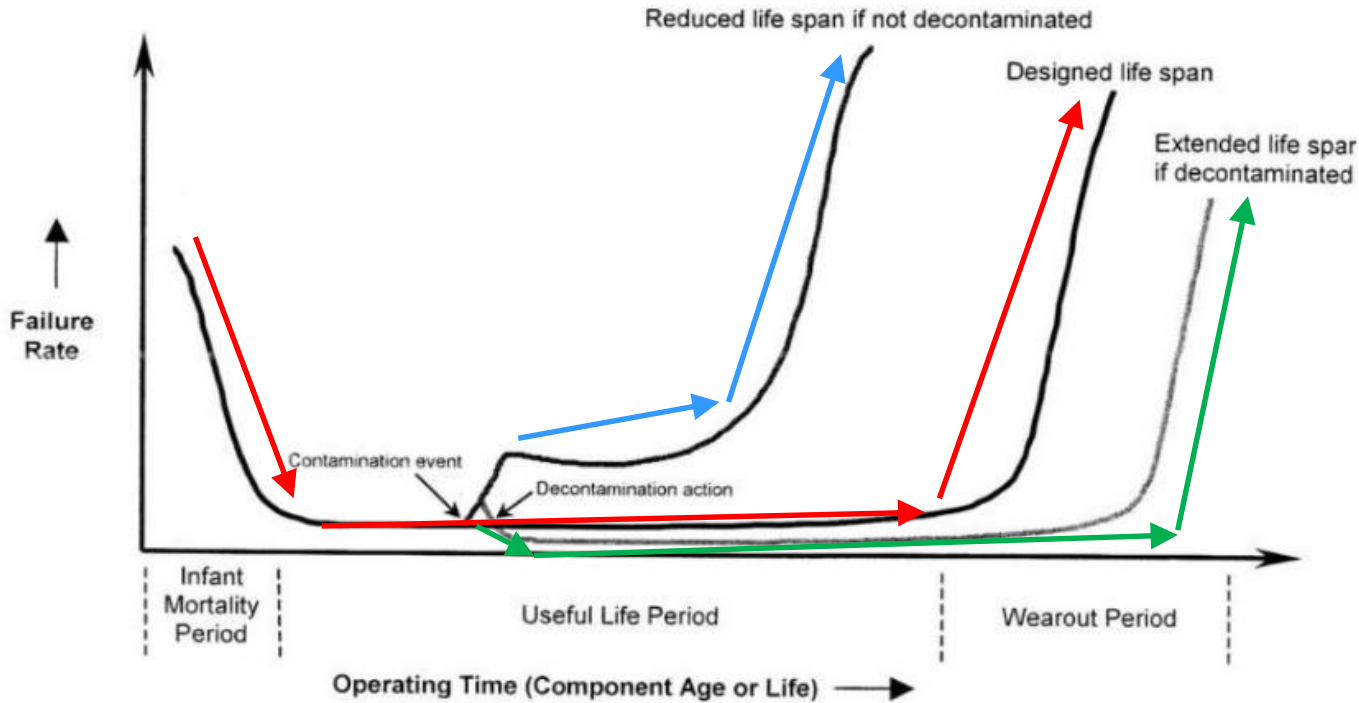
Failure Probability

Device Failure Probability after Smoke Exposure



Hughes Associates, "DOE Fire Protection Handbook Volume II, Fire Effects and Electrical and Electronic Equipment," US Department of Commerce, 1996, pp. 41, 43.

Reliability and Life Expectancy of Restored Equipment



Success Factors

TIME AND SPEED IS CRITICAL

- Preparation and contingency
- Actions by the crew immediately after the incident
- Actions on the way to port
- Actions at port



AVAILABILITY AT AREPA

- 24/7 response
- Direct advise on call (hotline)
- On line evaluation
- Project Managers on standby
- Mobilization within 24 hours
- Availability in Europe, US and Asia

COMPETENCE IS CRITICAL

- Technical
- Chemical
- Process

Additional information

- German Lloyds:
 - Guidelines for restoration of electrical systems caused by Fire, Water and Extinguishing agents
- Danish Marine Association (Insurance committee):
 - Guidelines in case of average
- Department of Energy:
 - Fire Protection Handbook Volume II, Fire Effects and Electrical and Electronic Equipment," US Department of Commerce