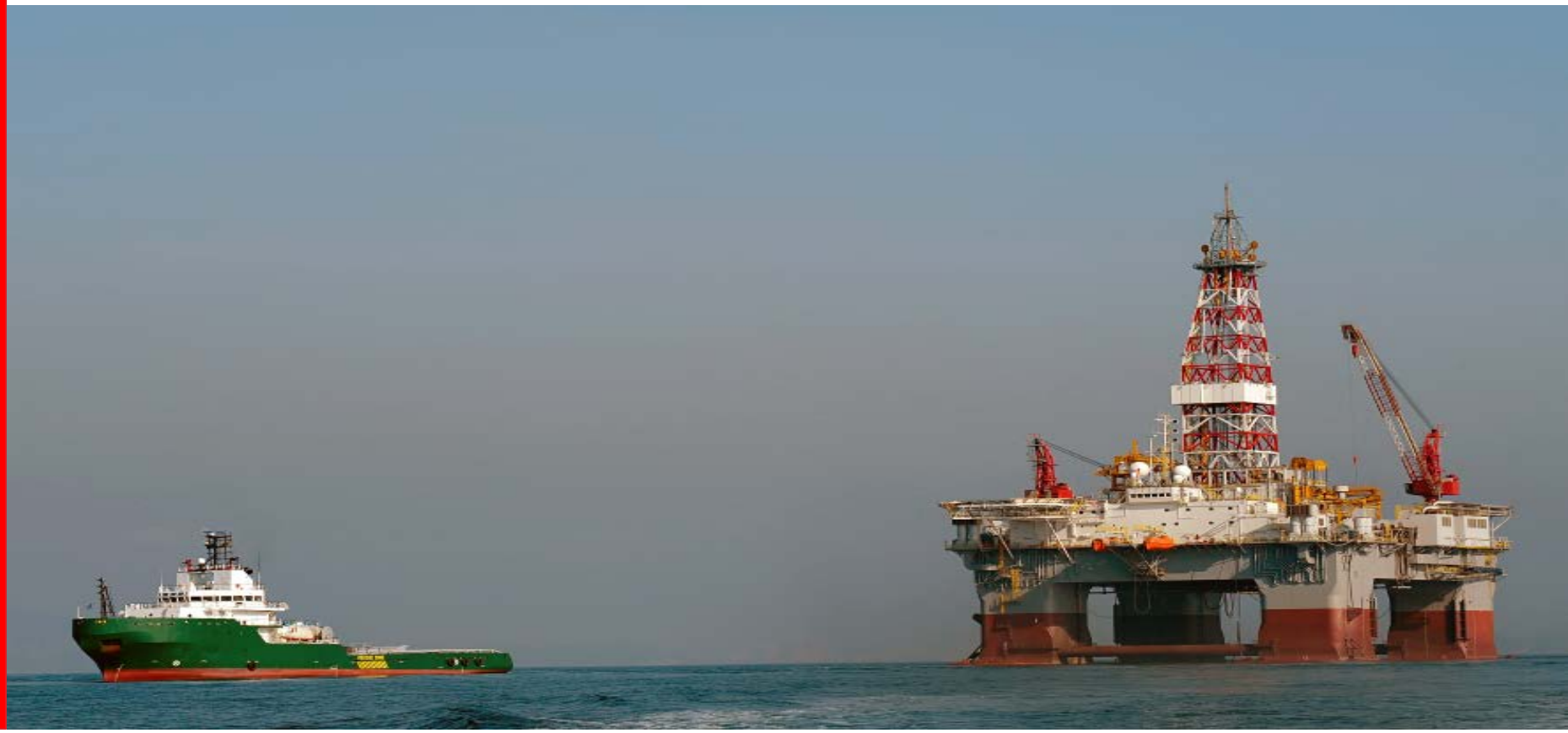
IMCC INTERNATIONAL MARINE CLAIMS CONFERENCE

BELFOR

Condition based Maintenance - Prevention



Condition based Maintenance - Prevention

Ton van den Broek

- Nautical College Flushing
- Shell Tankers -Engineer
- Shell Chemicals Refinery -“Senior” process operator
- Corocor -Project manager
- Recontec NL/B -Branch manager / Technical Manager
- BELFOR Technology NL/B/D/ES/UK -Technical Sales Consultant

Condition based Maintenance - Prevention

Subjects

- Evolution of ship propulsion
- Introduction of maintenance
- Contamination related risks
- Condition Monitoring / Assessment
- Condition Based Maintenance
- Resume

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A small impression of fire & flooding!

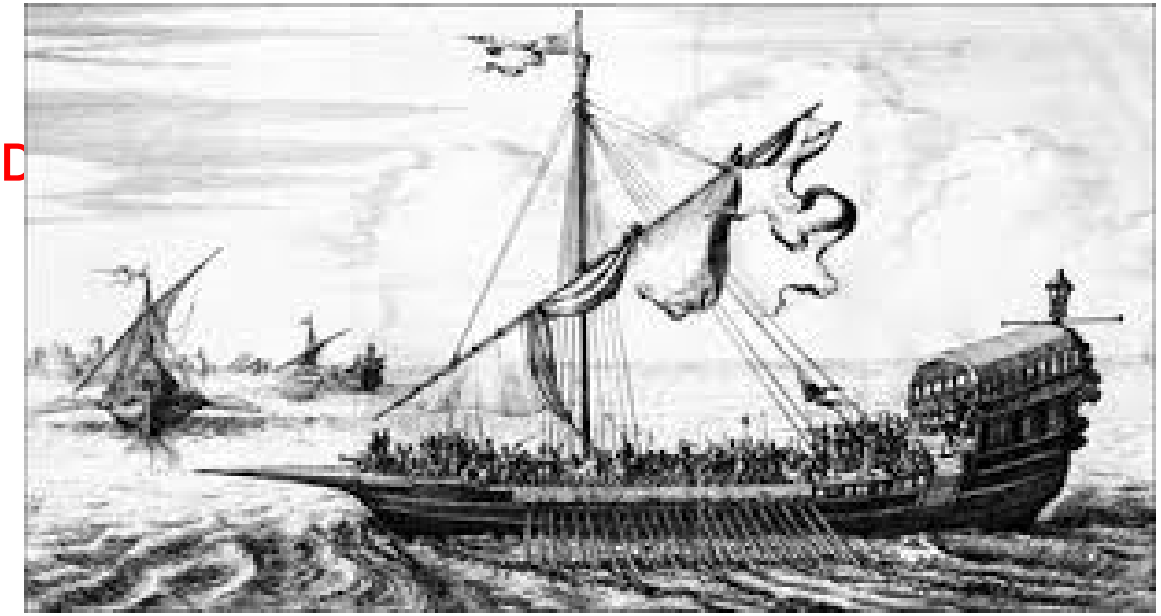
Condition based Maintenance - Prevention

QUESTION 1: What percentage of damages in general is considered to be caused by human involvement or failure?

QUESTION 2: By the way, who's the performer of the song?

Evolution of ship propulsion

- Propulsion of a ship was manpower & sailing
- INVENTOR, D



Evolution of ship propulsion

- Sailing
- Boilers, ste
- Combustio
- INVENTOR,

Evolution of maintenance

- Tools & machinery → defects, breakdown
- Renewal or repair → breakdown maintenance
- Maintenance prior to defects → based on human senses
- Human senses & interpretation defer per person

- Slow speed engines: over-dimensioned, solid, maintainable & repairable

Evolution of maintenance

- Periodical maintenance: → safety margin
  → commercial margin

  Too often & early, unnecessary, expensive

- Potential cause of malfunctioning, breakdown or damages

Evolution of maintenance

QUESTION 3: What percentage of H&M claims is annually accounted for by machinery claims?

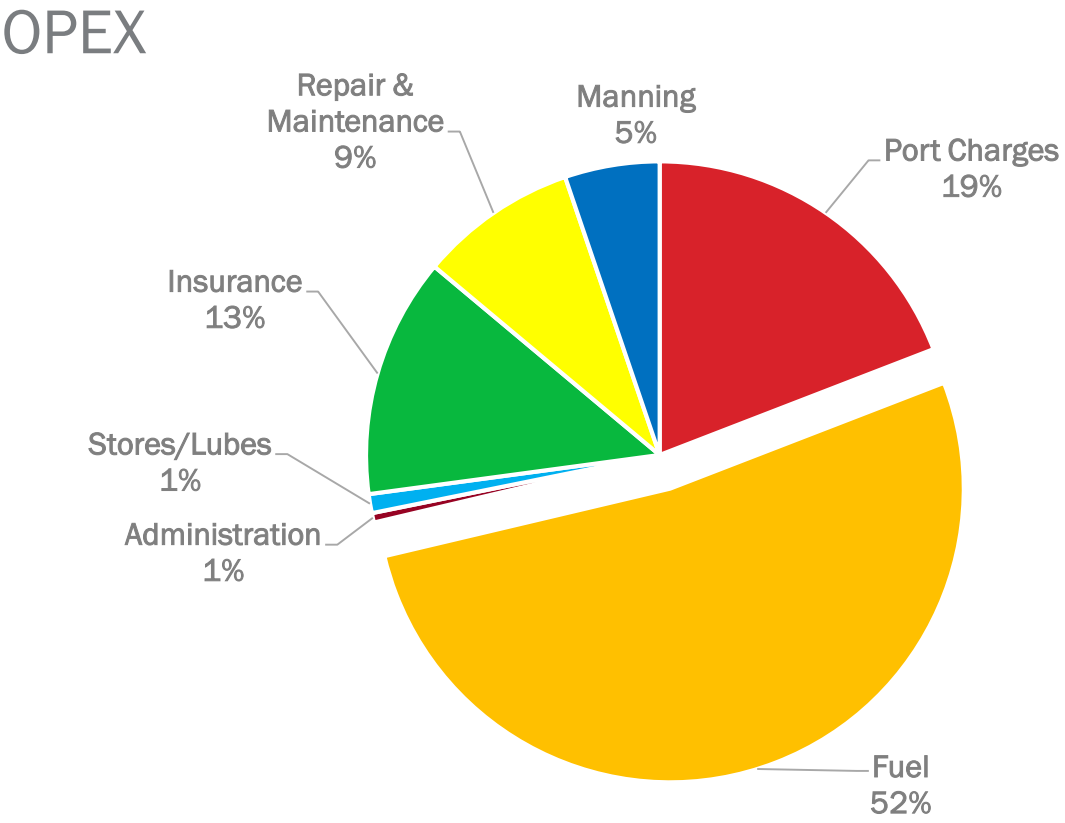
Evolution of maintenance

- Machinery damages are estimated to account for up to 60% of the H&M claims!
- What is the influence of reduction of technically educated & trained crew up to the requirements of the “Minimum Safe Manning” on machinery claims?
- Is reduction of technically educated crew cost saving?

Evolution of maintenance

QUESTION 4: What percentage of the OPEX of e.g. a container ship is accounted for by costs of manning?

Evolution of maintenance



Evolution of maintenance

- Why reduce the levels of education, thus competency?
- Knowing that technically competence of the crew is the biggest defence against machinery damages

- Why reducing costs of manning as the positive influence on OPEX is marginal?

Evolution of maintenance

- What can be the real reason?

  Knowing that:

  - savings in costs of fuel (52% of OPEX) can be achieved by automation & advanced software
  - savings in costs of maintenance & repairs by maintenance teams in port based on “condition monitoring & assessment”

  Reduction of the influence on board of “the weakest link”?

Future of maintenance

- Future → ship consists of “hardware & software”
- Hardware structure, machinery, electrics & electronics
- Software navigation programs, engine control systems, condition monitoring systems, alarm systems, etc.

Condition based Maintenance

Condition based Maintenance - Prevention

Condition based Maintenance - Prevention

Electronic devices

Past:

goal of automation → reduction of crew

Now & in future:

Brain & Nerves of Machinery

- Alarms, Operational & Detection systems
- Combustion / Green Ship
- Remote Machinery Control
- Navigation

Contamination related Risks:

Production of printed circuit board

- contamination → flux
  → dust (composition?)
- relative humidity (momentarily)

→ electrolyte
x µS/cm

Contamination related Risks:

Transport to receiver of printed circuit board

- extra contamination (composition?)
- relative humidity (momentarily)

→ electrolyte (x+y) µS/cm

Storage at receiver of printed circuit board

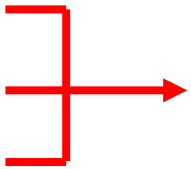
- extra contamination (composition?)
- relative humidity (momentarily)

→ electrolyte (x+y+z) µS/cm

Contamination related Risks:

Assembly of equipment

- process time?
- contamination during assembly?
- relative humidity during assembly?



electrolyte
>(x+y+z) µS/cm

Important factors

- composition of contamination (an-ions)
- electrolytic conductibility contamination (µS/cm)
- relative humidity
- ΔT in the equipment (development of condensate)

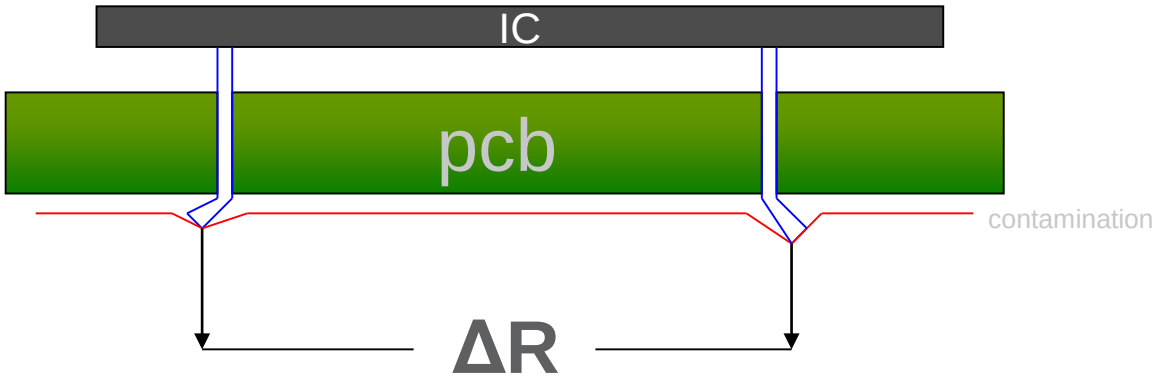
Contamination related Risks:

Equipment & contamination

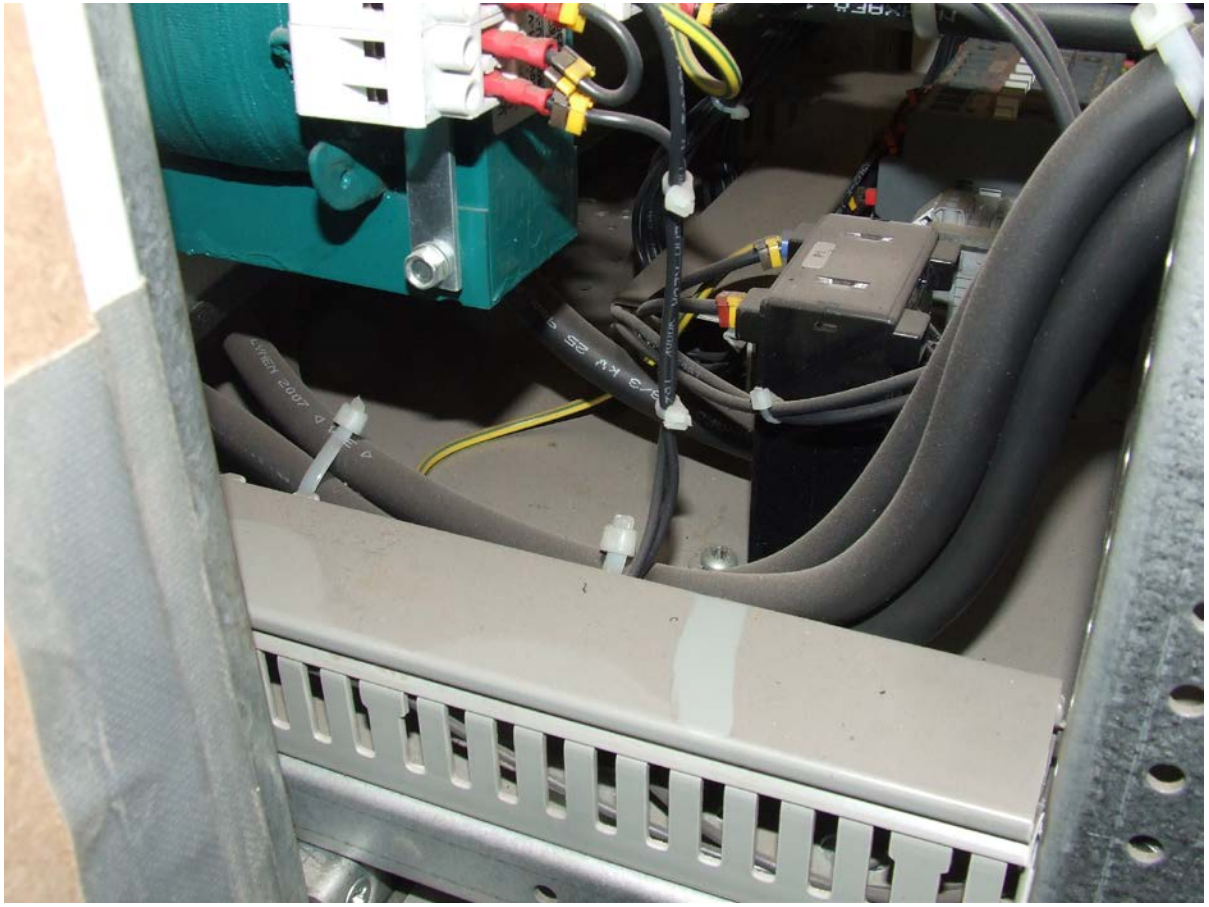
→ attack of lacquer

→ development of corrosion

→ conductivity (r.h. & contamination)



Contamination related Risks:



Contamination related Risks:

Contamination related Risks:

Printed circuit board & contamination → attack of lacquer

→ development of corrosion

→ conductivity (r.h. & contamination)

→ increase of ΔT in components

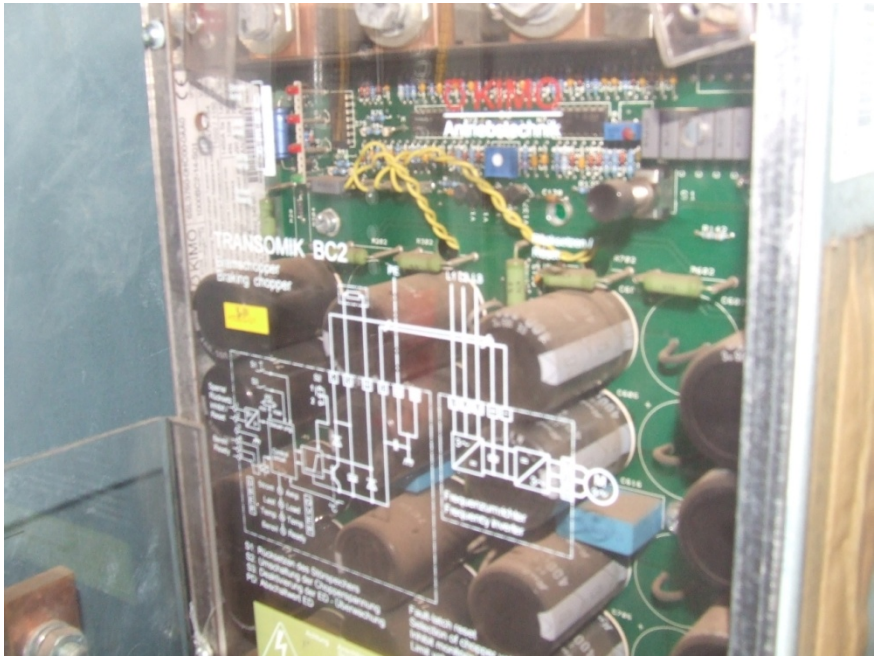
Contamination related Risks:

Components process larger electric power

Drives become smaller, more compact

- CONSEQUENCES:

- ➔ *increase* heat development
- ➔ *decrease* air circulation
- ➔ *increase* ventilation demand
- ➔ *increase* internal contamination



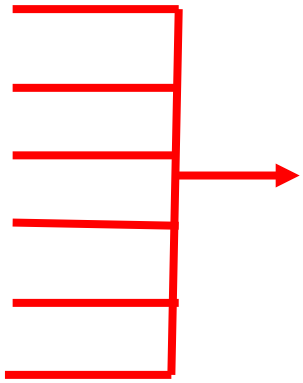
Contamination related Risks:

Components process larger electric power

Drives become smaller, more compact

- CONSEQUENCES:

- ➔ *increase* heat development
- ➔ *decrease* air circulation
- ➔ *increase* ventilation demand
- ➔ *increase* internal contamination
- ➔ *decrease* heat exchange
- ➔ *increase* ΔT in components



Disruption of functioning of processors & in the end break down

Increased Exposure to Contamination:

New Building phase of ship: wide range of (contaminating) activities

- Welding
- Cutting
- Drilling
- Grinding
- Blasting
- Painting

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- Abrasive, metal particles

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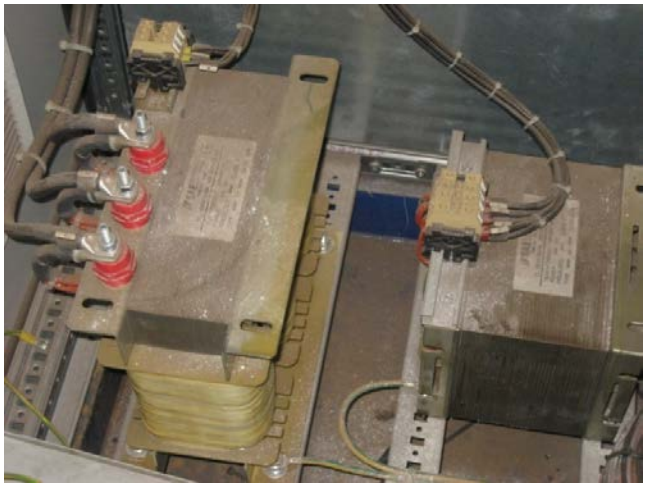
Consequences!!! Vapours



- Abrasive, metal particles
- Conductive particals

Increased Exposure to Contamination:

New Building phase of ship: wide range of (contaminating) activities

- Welding
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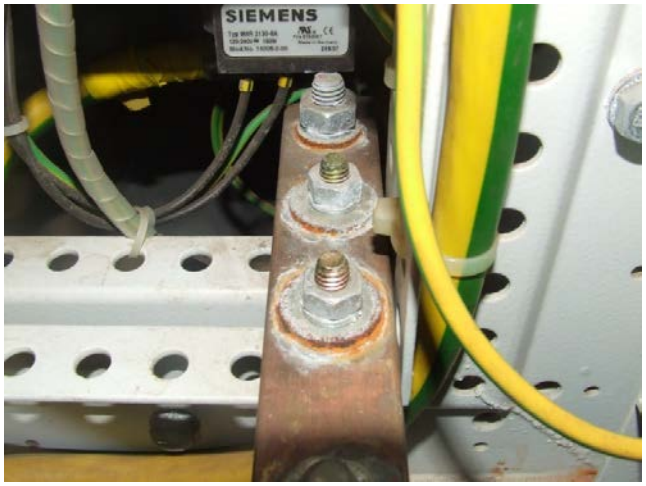
Consequences!!!

Vapours

- Abrasive, metal particles
- Conductive particles
- Hygroscopic particles
- Corrosive sediment



Exposure to Contamination:

Operational period of ship:

- "Salty" Environment
- Variable Temperature
- Variable Relative Air Humidity
- Carbonaceous Vapours

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Operational period of ship:

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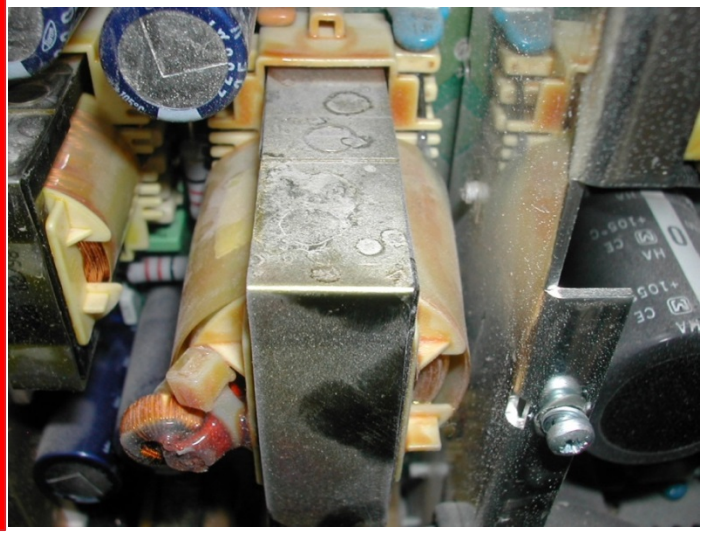
Consequences!!!



- Heat exchange retarding & corrosive sediment
- Conductive & hygroscopic sediment

Criteria for Condition Assessment

consist of limit values for contamination.

have to be applicable both on electronic equipment and the maritime situation.

must be measurable and practical.

must be acknowledged and accepted.

should form a framework in which maintenance restoration is committed.

- Standard J-STD-001F
- ISM-code

Criteria for Condition Assessment

Standard J-STD-001F

Modern electronics are sensitive (susceptibility to faults) towards contamination.

Limit values allowed levels of contamination.

- Standard J-STD-001F (2014) demands a maximum limit value of 1.56 µg/cm² of sodium chloride (NaCl) equivalents which corresponds with 0,95 µg/cm2 of chloride equivalents.
- According to J-STD-001F (2014) circuit boards must show a minimum surface insulation resistance of 10^4 MΩ.
- After the effects of high relative air humidity or condensation, water damage or dusts on circuit boards, a maximum contamination with chlorides or other anions of 3 µg/cm² is permissible in order to avoid a dropping of the surface insulation resistance to less than 10^4 MΩ.
- Continuing dependability, however, can only be achieved with a maximum concentration of 1 – 2 µg/cm² of chloride equivalents. For the considerably more aggressive acids and alkalis, the limit value has to be set at a maximum of 1 µg/cm² of chloride equivalents.

Criteria for Condition Assessment

Standard J-STD-001F

Modern electronics are sensitive (susceptibility to faults) towards contamination.

Limit values allowed levels of contamination.

• Conductivity	• Total Anion Concentration	• Danger of Corrosion
• < 260 µS/cm	• 1 ≤ 3 µg/cm^2	• Conductive & corrosive uncritical range
• 260 ≤ 600 µS/cm	• 3 ≤ 5 µg/cm^2	• Conductive & corrosive critical transition range
• > 600 µS/cm	• > 5 µg/cm^2	• Conductive & corrosive critical range

Criteria for Condition Assessment

International Safety Management Code

10 MAINTENANCE OF THE SHIP AND EQUIPMENT

10.2 in meeting these requirements the company should ensure that:

1 inspections are held at appropriate intervals;
2 any non-conformity is reported, with its possible cause, if known;
3 appropriate corrective action is taken; and
4 records of these activities are maintained

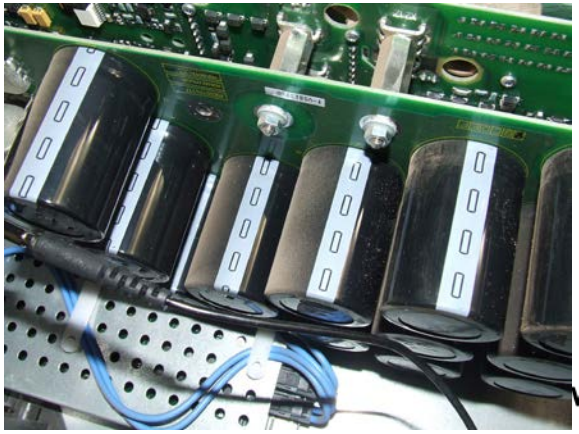
Condition Assessment

New Building & Operational phase of the ship:

Limits Standard J-STD-001F

	• Conductivity	•Total Anion Concentration	•Danger of Corrosion
New→	• < 260 µS/cm	• 1 < 3 µg/cm^2	• corrosively uncritical range
Operational→	• 260 ≤ 600 µS/cm	• 3 ≤ 5 µg/cm^2	• corrosively critical transition range

Visual inspection & situation survey before sea trial or dry docking



Condition Assessment

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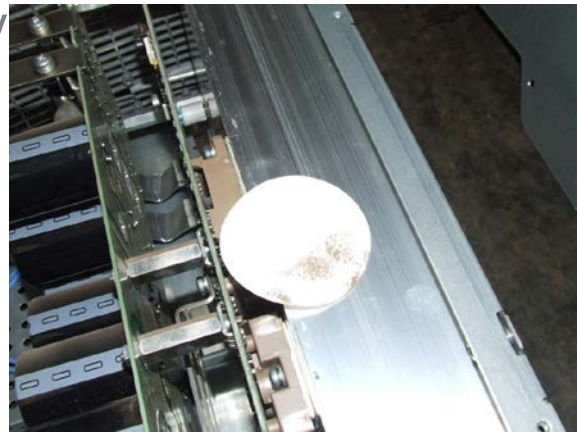
Visual inspection & situation survey before sea trial or dry

Wipe samples & analysis before sea trials or dry docking



Condition Assessment

New Building & Operational phase of the ship:

Limits Standard J-STD-001F

Sample Date: 02-07-2013 ..... **by:** Ton van den Broek ..... ☒ **before /** ☐ **after restoration**

Job No.: 13-FE-xxxx..... **Customer:** Xxxx.....

Kind of Damage: Unknown contamination **Reference:** yyyy.....

Remarks: R 1300xxx-01

Item No	Device / Unit / Subassembly	Posi-tion	Sur-face	Appea rance	Surface area [cm²]	Contamination								
						Conductivity µS/cm *	Fluoride µg/cm²	Chloride µg/cm²	Nitrate µg/cm²	Sulfate µg/cm²	Calcium µg/cm²	Iron µg/cm²	Sodium µg/cm²	Zinc µg/cm²
1	MEDP br. xxxx	h	m	D	100	861	0,42	3,11	8,91	21,43	5,53	15,02	2,09	11,84
2	MCC Cubicle X	h	m	D	100	262	0,14	1,41	5,97	1,59	1,05	2,52	0,79	12,34
3	MCC Cubicle Y	h	m	D	100	379	0,24	1,76	8,14	4,13	1,97	4,07	1,13	6,37
4	MCC Cubicle Z	h	m	D	100	367	0,28	1,97	9,27	2,09	1,88	4,85	1,09	16,50

Abbreviations

< dl =< detection limit
n.a. =not analyzed

* normalized to 500 cm² and 50 ml extraction volume acc. DIN-report 28 (2002)

Position

i = inside
o = outside
h = horizontal
v = vertical
t = top
b = bottom
hx = hight x cm
l/r = left / right

Surface (general)

C = Ceramic
CC = Concrete
G = Glass
L = Lacquer
LP = Latex Paint
M = Metal
P = Plastic
W = Wood

Surface (Metals)

Al = Aluminum
Cr = Chromium
CrZn = Chromated Zinc
Cu = Copper
AAl = Anodized Al
Ni = Nickel
Sn = Tin
Zn = Zinc
SS = Stainless Steel
Fe = Iron / Steel general
CFe = Cast Iron
BS = Blued Steel
St = Mild Steel

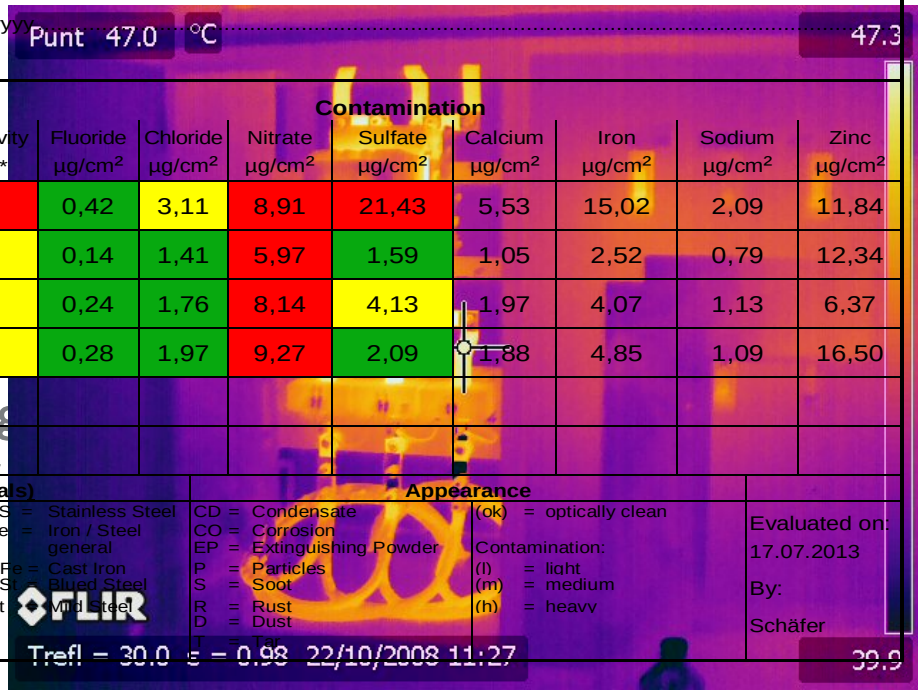
Appearance

CD = Condensate
CO = Corrosion
EP = Extinguishing Powder
P = Particles
S = Soot
R = Rust
D = Dust
T = Tar

(ok) = optically clean

Contamination:
(l) = light
(m) = medium
(h) = heavy

Evaluated on:
17.07.2013
By:
Schäfer



Condition based Maintenance - Decontamination

Purpose of Condition based Maintenance - Decontamination

- Increase of effectiveness during the same longevity
- Prevent malfunctioning, breakdown & damages

	Industrial Electronics
Environmental Specifications	*Longevity*
Neutral / Dry	*15 (15-20) years*
Damp / Moist	*10 (8-15) years*
Acid / Corrosive / Salt	*10 (8-15) years*
High Temperature > 40 ºC.	*10 (8-15) years*
Low Temperature < 0 ºC.	*10 (8-15) years*

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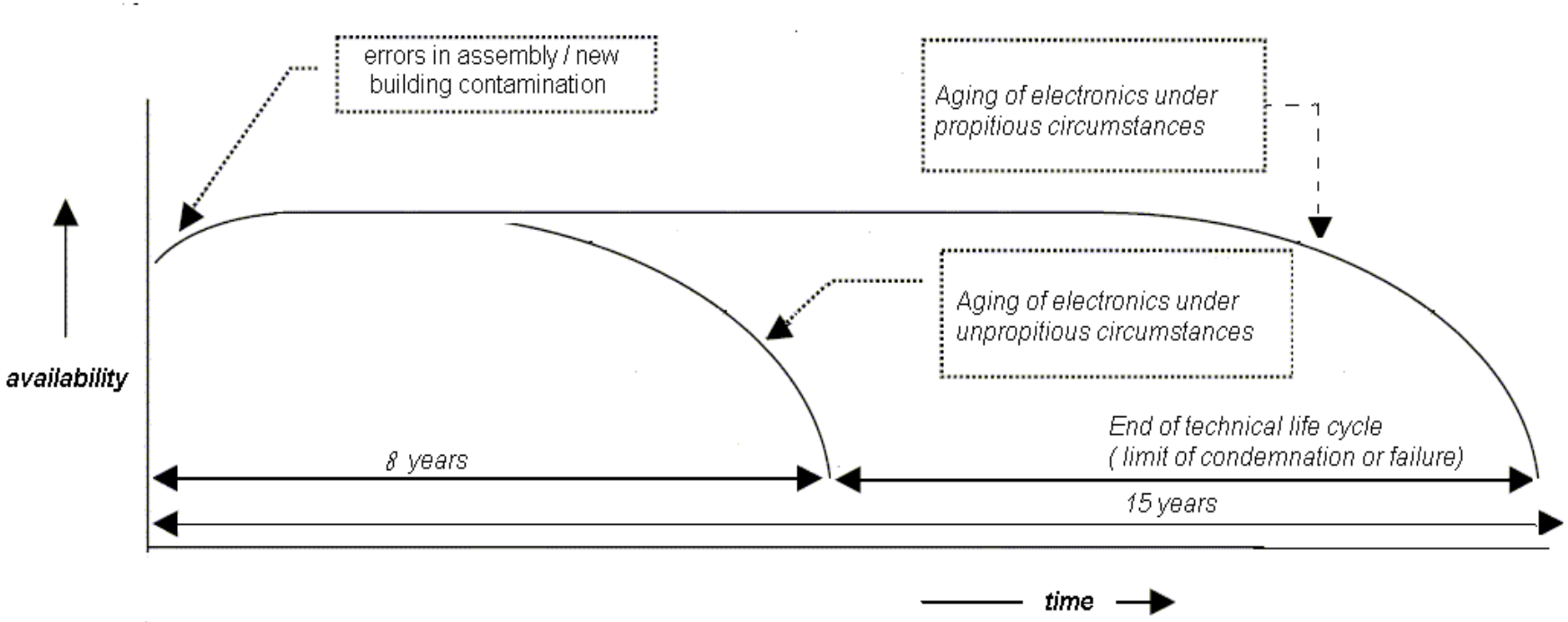

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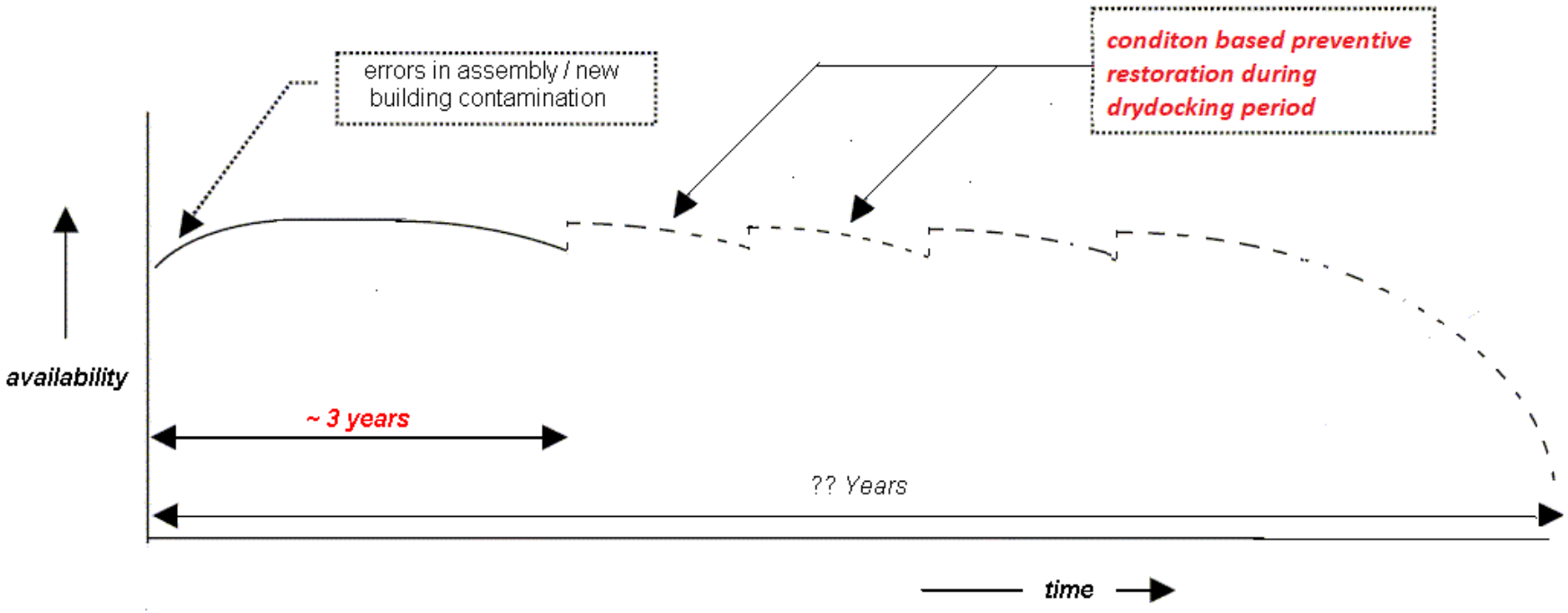

Condition based Maintenance

Advantages of CBM

Decrease of unexpected shutdowns = Improvement System Reliability

Reduction of Stress and Workload of Maintenance Personnel

Reduction of Down Time = Reduction of L.O.H.

Condition based Maintenance

Resume

risks involved in contamination and electrics / electronics

most riskey moments

condition assessment

solutions

Condition based Maintenance

THANK YOU

FOR YOUR ATTENTION