Evaluating the effect of surface preparation standards on Zinc rich primers

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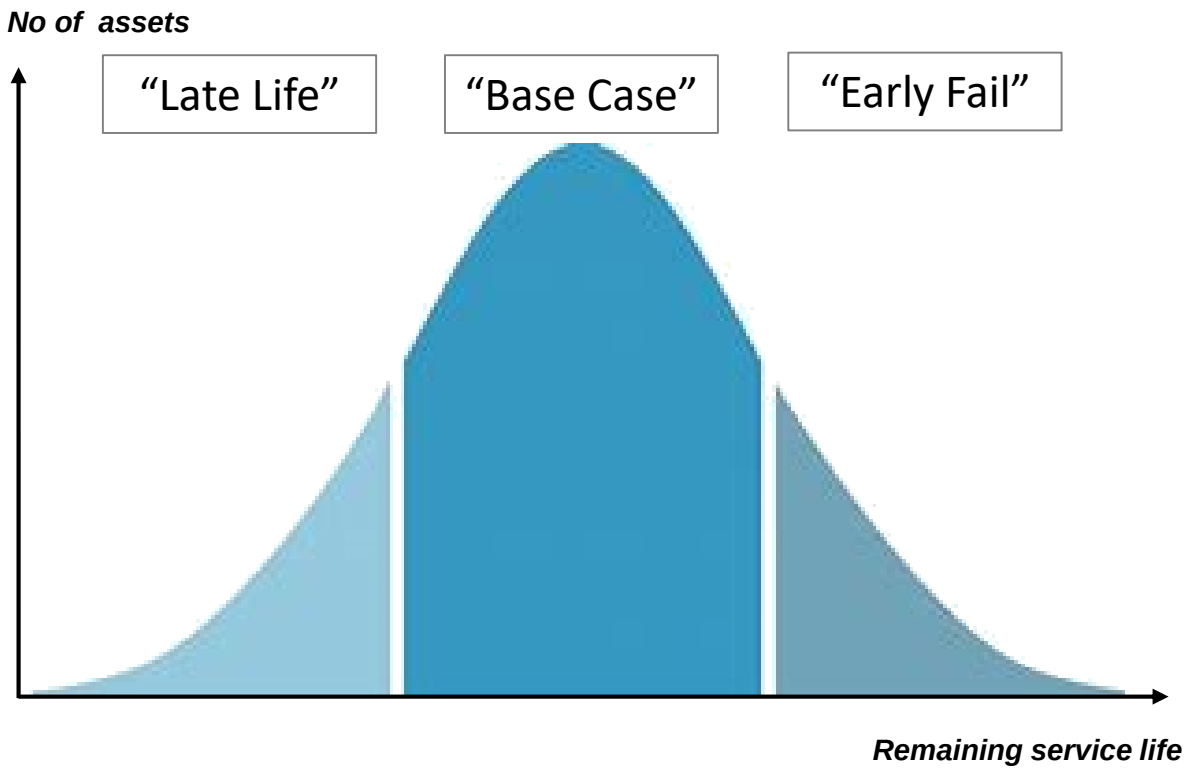
Objectives

- Why zinc?
- Surface preparation challenges
- Creating a realistic standard for maintenance
- Impact of surface preparation / salt contamination
- Case study for approval of Zinc rich epoxy offshore maintenance systems
- Role of topcoat in system durability

Why zinc for offshore maintenance?

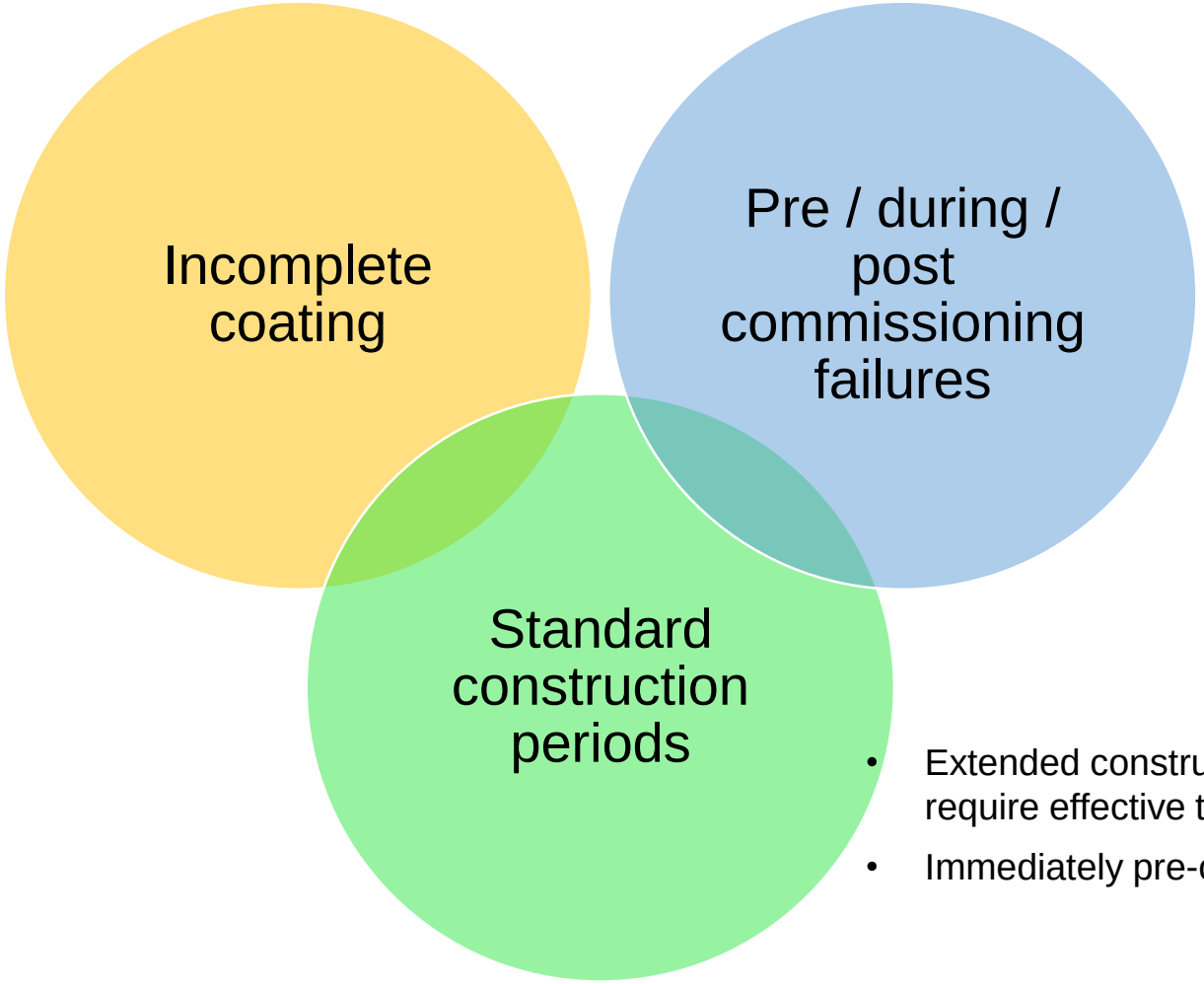
- Extensive track record
- Performance mechanism is generally understood
- No specification barriers
  - Organic – Zinc rich epoxy
  - Inorganic – Ethyl zinc silicate
- Offers protection in the even of damage / imperfect application
- Perceived as not being "maintenance friendly"
- Maintenance versus corrective actions



Increasingly we see assets delivered without painting having been fully completed or already in "maintenance mode"

The need for manual preparation at new construction

- Schedule prevents completion of coating / installation over shop primer at time of shipping
- Remaining work to be carried out at integration yard or in the field



- Increasing levels of coating failures within 2-5 year period
- 2 year period may precede commissioning in some cases
- High complexity of remedial work alongside “new” operations

- Extended construction periods still require effective tie-ins again
- Immediately pre-commissioning

Surface Preparation Challenges

Surface Cleanliness

Surface Profile

Productivity

Operational constraints

Loss of Adhesion

Under-film corrosion

Osmotic Blistering

Corrosion “Creep”

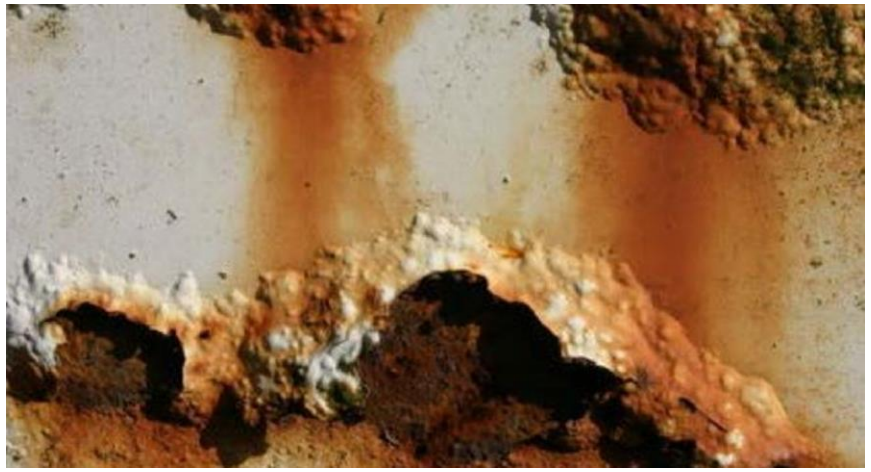
Can we challenge this graph?

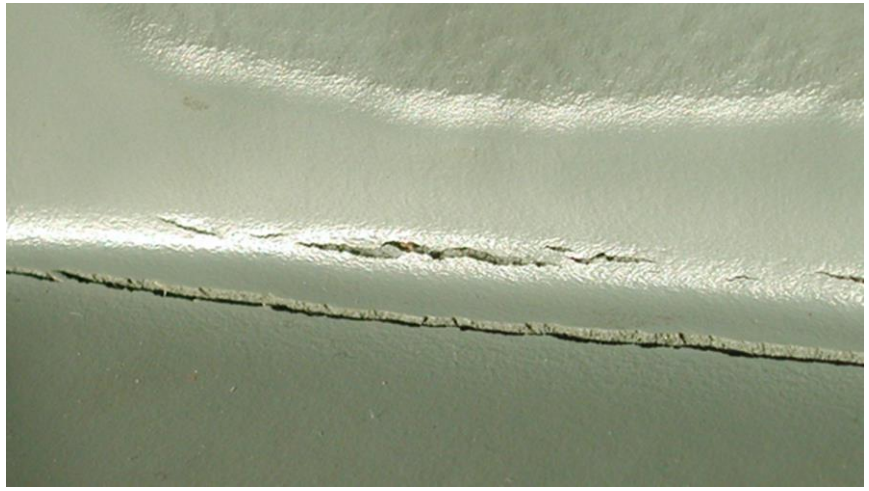
Zinc rich epoxy benefits?

- Proven International generic, system and compositional standards
- Galvanic protection
- More consistent / robust in exposure testing
    - Zinc versus non zinc systems
- Available from all manufacturers
- Increasingly higher performing grades

but

- Standards are not specific to “maintenance”
- Limited data available in “maintenance” studies



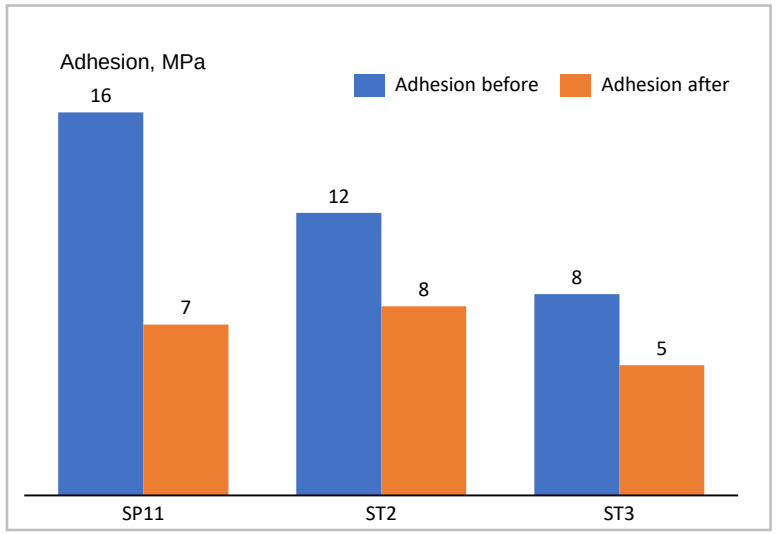


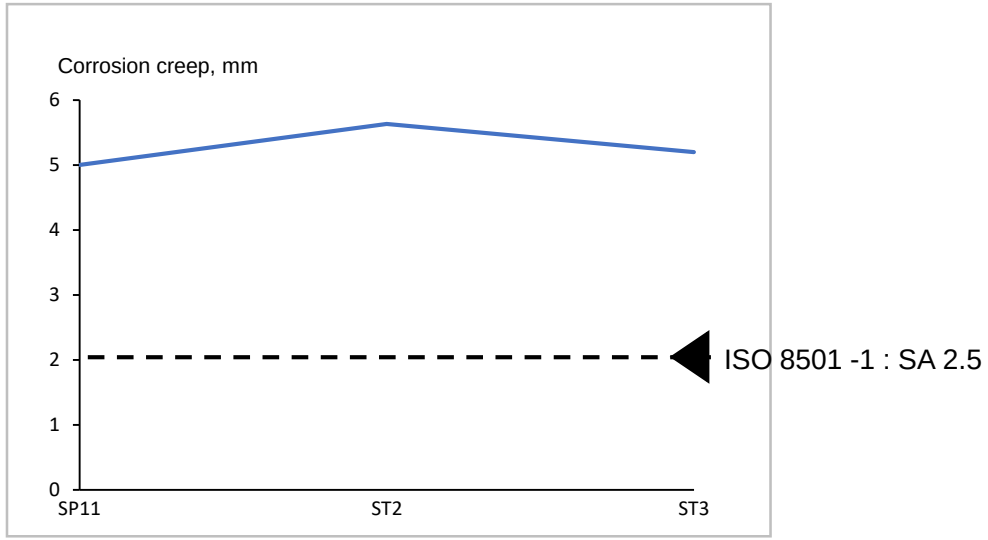
Creating a realistic “Maintenance standard” standard

- Currently no real standard for maintenance
- 1st challenge was to replicate corrosion
- Ensure uniform surface preparation
- Over a variety of geometries
- Contamination (salt introduced at a later date)
- ISO 20340 was selected as current best practice (now ISO 12944 – 9 : 2018)
- Different surface preparation standards

ISO 8501 – 1 : Rust Grade C - Steel Surface on which the mill scale has rusted away or from which it can be scraped, but with slight pitting visible under normal vision

Impact of surface preparation standard and contamination



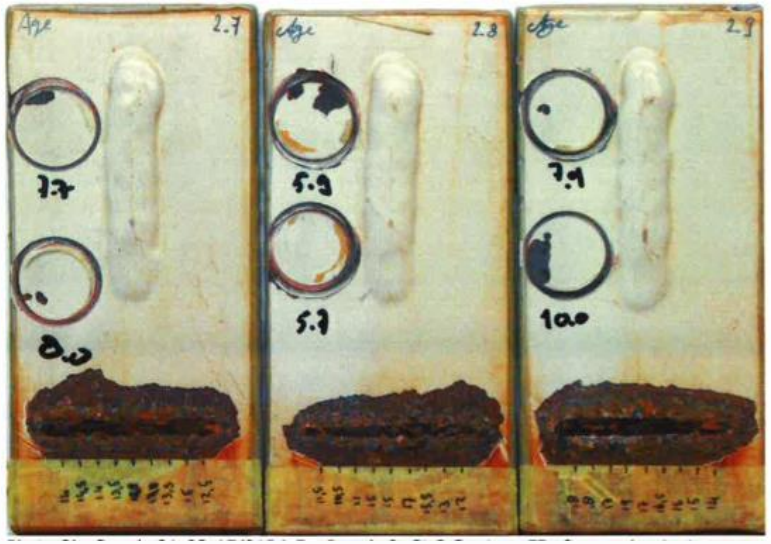


- ISO 20340 : 2009 * (4200 hours)
- 6 months duration
- Activated zinc rich epoxy / epoxy / polyurethane
- Surface preparation standards
  - ISO 8501 – 1 : ST2 Thorough hand and power tool cleaning
  - ISO 8501 – 1 : ST3 Very Thorough hand and power tool cleaning
  - SSPC SP11 : Bare metal power tool cleaning
- Evident adhesion difference
- Less obvious post-exposure
- No significant difference in corrosion creep
- No blistering rusting, cracking flaking (ISO4828 - 2 to 5) evident

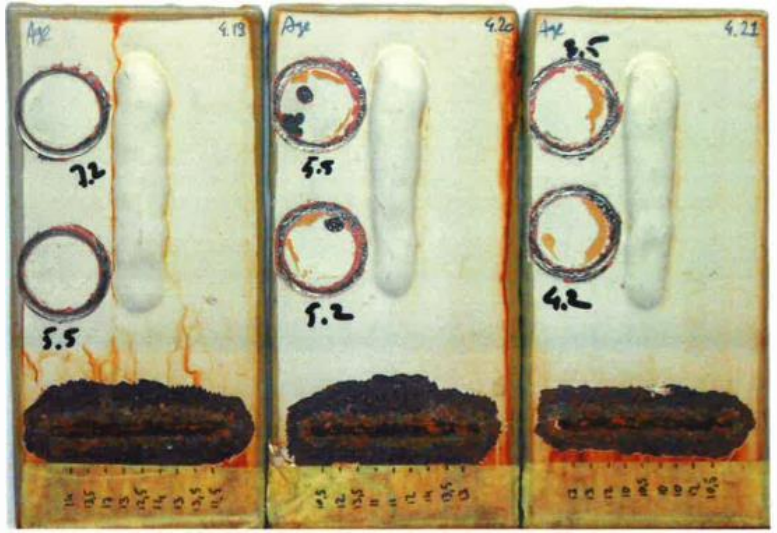
* Now ISO 12944 – 9 :2018

Impact of surface preparation standard and contamination

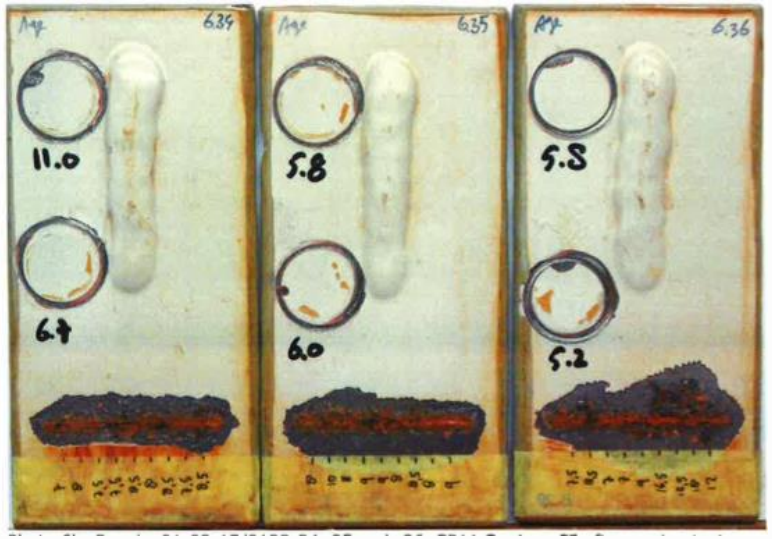
Effect of surface preparation standard on panel performance after exposure to ISO 20340 : 2009 (4200 hours)



ISO 8501 : ST2



ISO 8501 : ST3

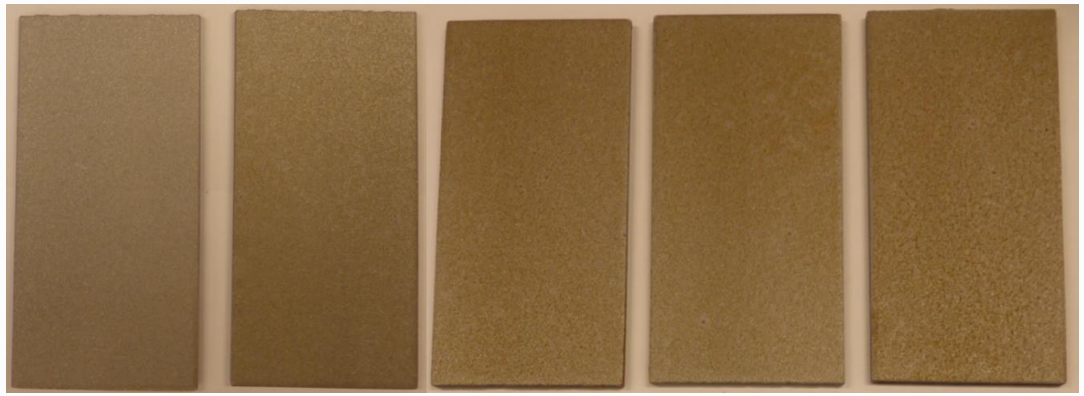


SSPC SP11

- Corrosion creep would be compliant for ISO 20340 : 2009 (all areas) for non-zinc systems
- Corrosion creep would be compliant for ISO 12944 - 9 : 2018 for high impact areas
- ISO standards create an unnecessary complexity in this area

Impact of surface preparation standard and contamination

- Salt contamination on freshly blasted plates 4.5mg/m^2
- Salt solution and methanol
  - Promotes evaporation
  - Inhibits initial rusting
  - Reduces surface tension easing application
- Dried at 80° C and 5% RH
- Salt level re-evaluated (Bresle Method)
- Subjected to the following tests
  - Chemical resistance (ISO 2812 for 168 hours)
  - Condensation exposure (ISO 4628 for 720 hours)
  - Neutral salt spray (ISO 9227 for 1440 h)
  - Cyclic salt fog UV exposure (ASTM 5894)



5 20 50 75 100

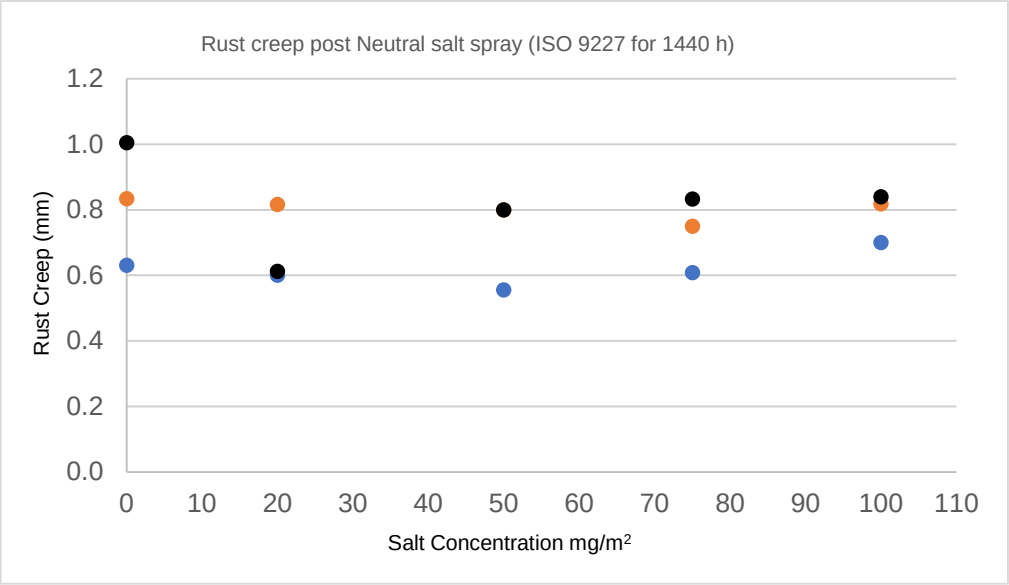
Salt concentration mg / m^2

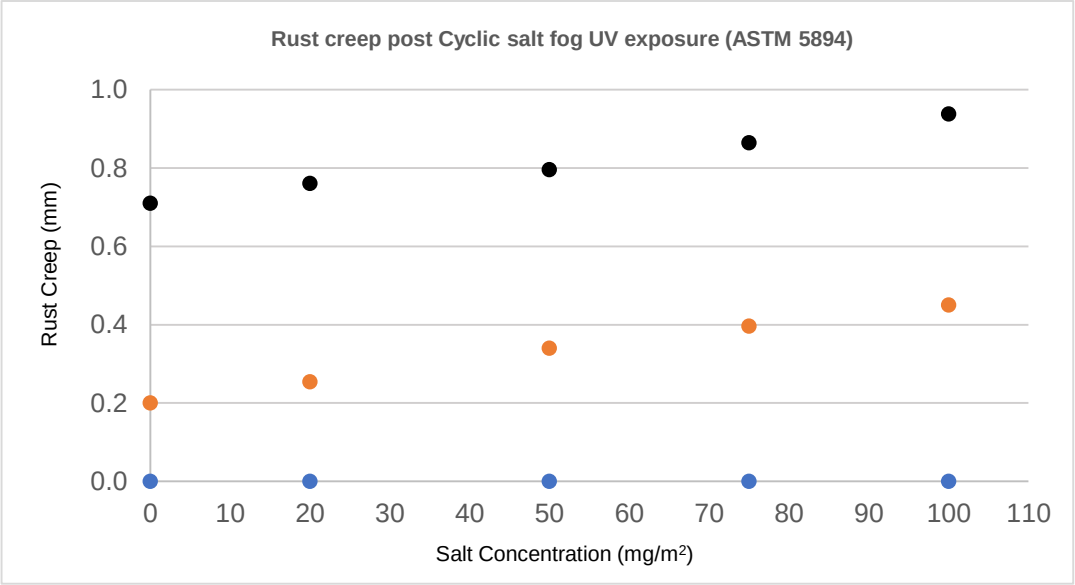
Desired Salt concentration of panels (mg/m^2)	Acquired Salt concentration on batch of panels (mg/m^2)	Standard Deviation (mg/m^2)
0	5.31	± 0.60
20	19.50	± 0.67
50	48.66	± 2.86
75	74.64	± 7.15
100	102.06	± 4.05

Impact of surface preparation standard and contamination

Coating System	Coating Type	DFT (microns)
I	Single coat of Zinc rich epoxy (Activated Zinc Technology)	75
II	An innovative 2 coats system of: Zinc rich epoxy (Activated Zinc Technology) High build polyurethane	 75 125
III	Zinc rich epoxy (Activated Zinc Technology) Epoxy intermediate Polyurethane top coat	60 160 60

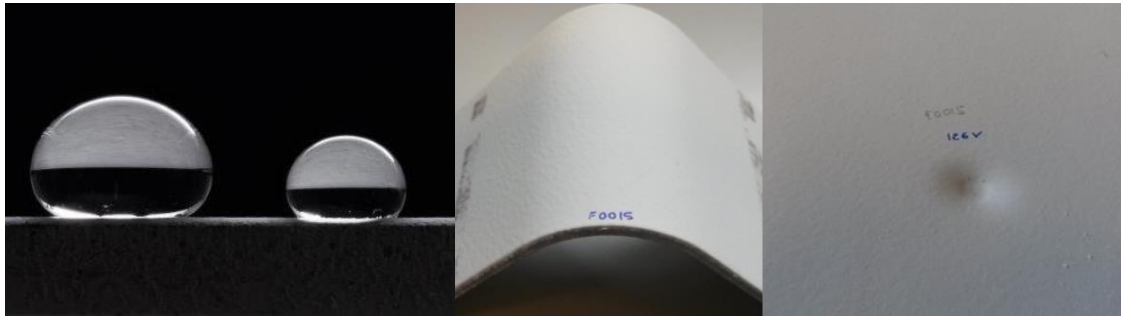
Blistering of System II in 75 and 100 mg/m^2 salt concentrations

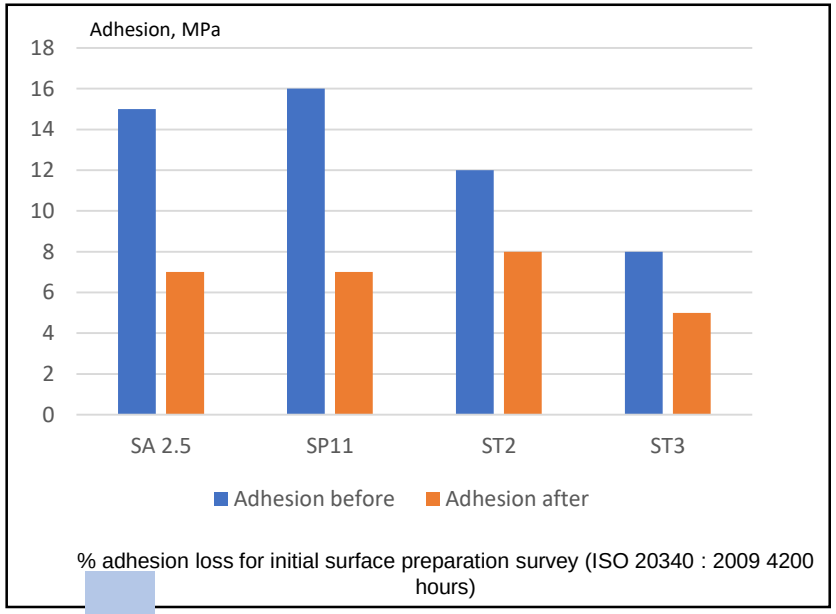




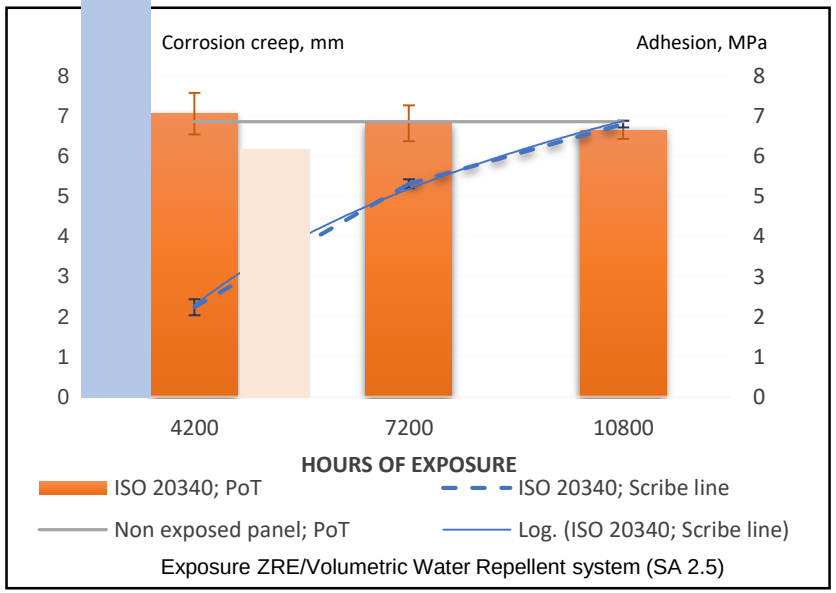
Adhesion performance as an indicator

- Blistering may not be a good indicator (Duration)
- If no blistering then no cracking, flaking and rusting
- Corrosion creep vs. adhesion loss
- How does short term adhesion loss reflect long term performance?
- More predictable materials required
- Short intervals drive compliance – is it good enough?
- Extended intervals drive performance
- Still within current acceptance limits for non zinc / high impact areas as per ISO 12944 – 9 : 2018 without grit-blasting





% adhesion loss for initial surface preparation survey (ISO 20340 : 2009 4200 hours)



Exposure ZRE/Volumetric Water Repellent system (SA 2.5)

Summary

- Insufficient evidence for maintenance systems in the market place
- True impact of manual surface preparation requires exposure to quantify
- Only leaves corrosion creep and adhesion loss as a predictor
- Effect of salt contamination is system specific?
- Corrosion creep is not the sole indicator of performance
- Extended intervals allow trends rather than numbers / compliance to be evaluated
- Zinc rich epoxy materials have a high degree of surface tolerance not usually expected

References

Volumetric Superhydrophobic Coatings for Offshore Corrosion Protection, NACE 2018

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Effect of soluble salt concentration on performance of offshore coating systems, NACE 2018

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