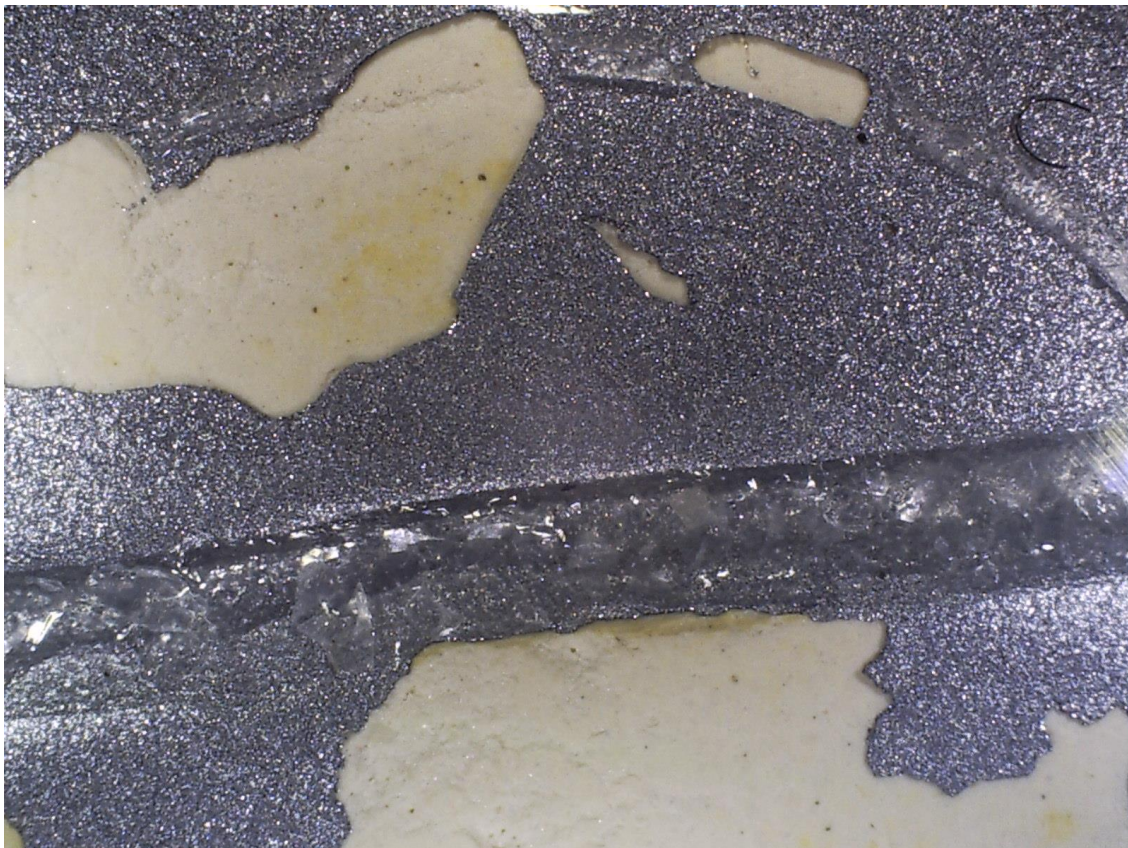


Evaluating the Performance of MCU-Coatings' Penetrating Chemical Cleaner & MCU-Aluprime Coating Over Micro-Cracked Phenolic Epoxy

1st February 2022



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TESTING MCU-COATINGS ECOCLEANER & ALUPRIME PROTECTIVE COATINGS OVER WEATHERED PHENOLIC & NOVOLAC EPOXY RESIN COATINGS

DATE: 1st February 2022

OBJECTIVE:

To evaluate the performance of MCU-ECOCLEANER GEL:

- a) as it is used to prepare a ST3 steel surface and remove minor rust creep on cured phenolic epoxy and novolac epoxy coatings;
- b) testing MCU-Aluprime's ability to adhere to a ST3 surface prepared using MCU-Ecocleaner Gel and to assess the quality of the final coating.

TEST PANELS:

Seven test panels have been coated Numbers 1 to 5 are phenolic epoxy with Nos 6 & 7 are epoxy novolac.



On the 19th of October these test panels were scribed to simulate cracking and then placed outside to weather. They were periodically wetted with salt water to accelerate their corrosion.



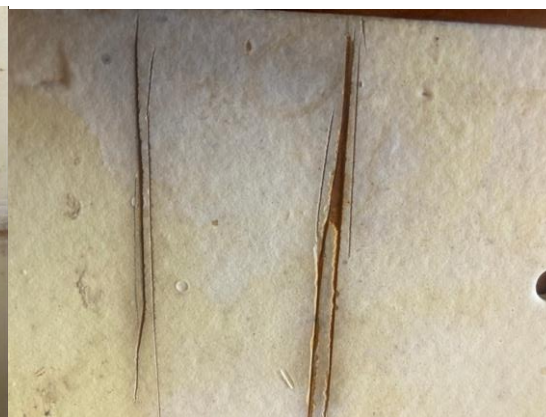
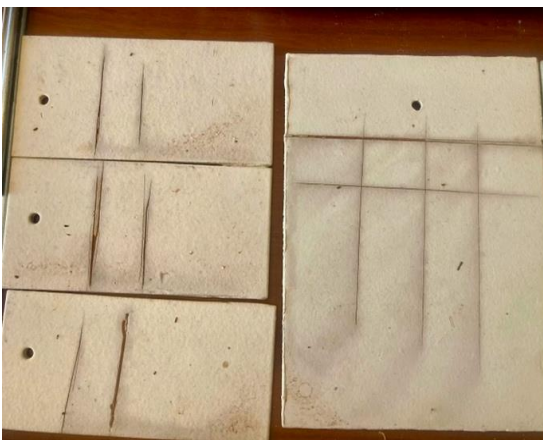
FILM THICKNESS:

The dry film on test panels varied from 275µm (Phenolic Epoxy) to 532µm (Novolac Epoxy)



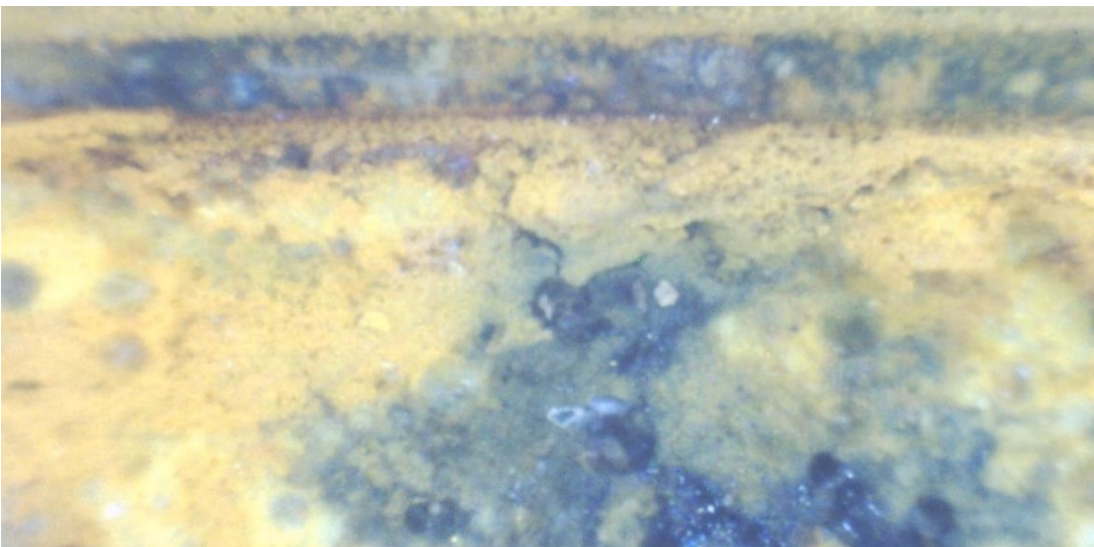
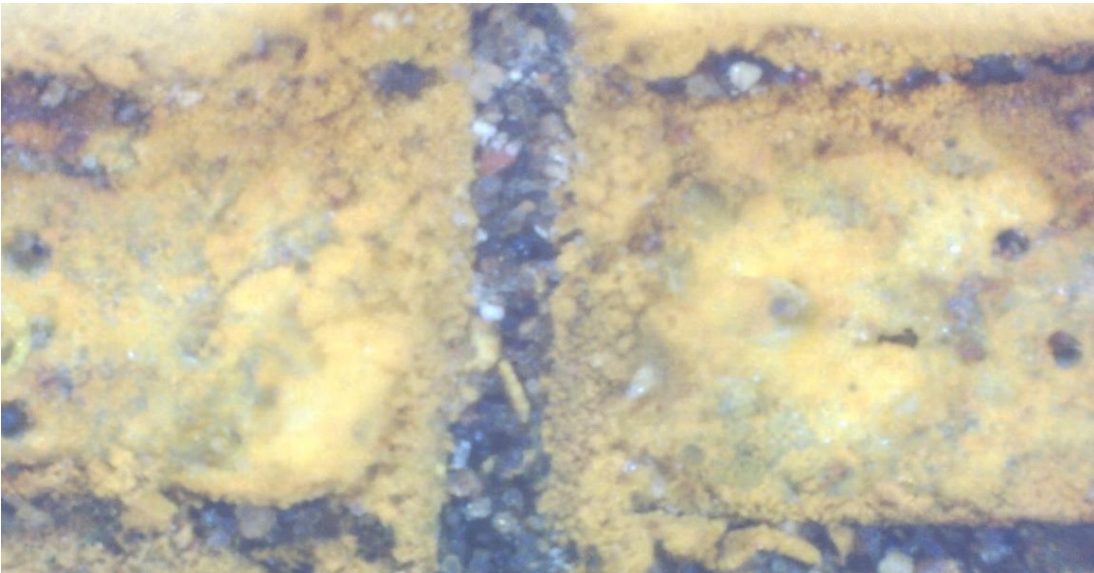
WEATHERING:

The panels were collected on the 7th of January 2022, after two and a half months, with results shown below





Above - Corrosion shown under 3.5x magnification



Above: - Corrosion shown at 35x magnification

CHLORIDE TESTING:

To ascertain the cleaning characteristics of MCU-Ecocleaner Gel, chloride testing using ISO 8502-9, test measurement is in $\mu\text{g}/\text{cm}^2$



Above - Confirmation of a reduction in chlorides from $5.0 \mu\text{g}/\text{cm}^2$ to $1.0 \mu\text{g}/\text{cm}^2$

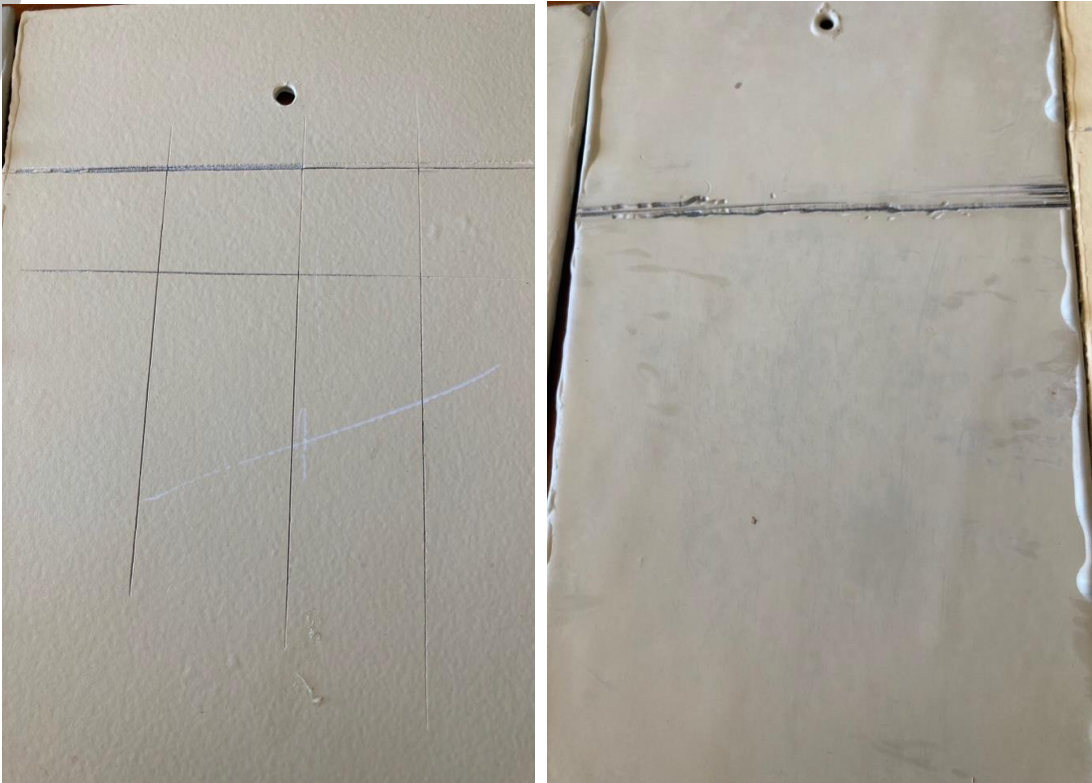
APPLICATION OF MCU-ECOCLEANER GEL:

A single coat of MCU-Ecocleaner Gel applied approximately 800µm then covered with plastic film to minimise evaporation and prevent the gel from drying out.



MCU-Ecocleaner Gel then left for 14 hours





After 15 hours the panels were brushed clean with tap water

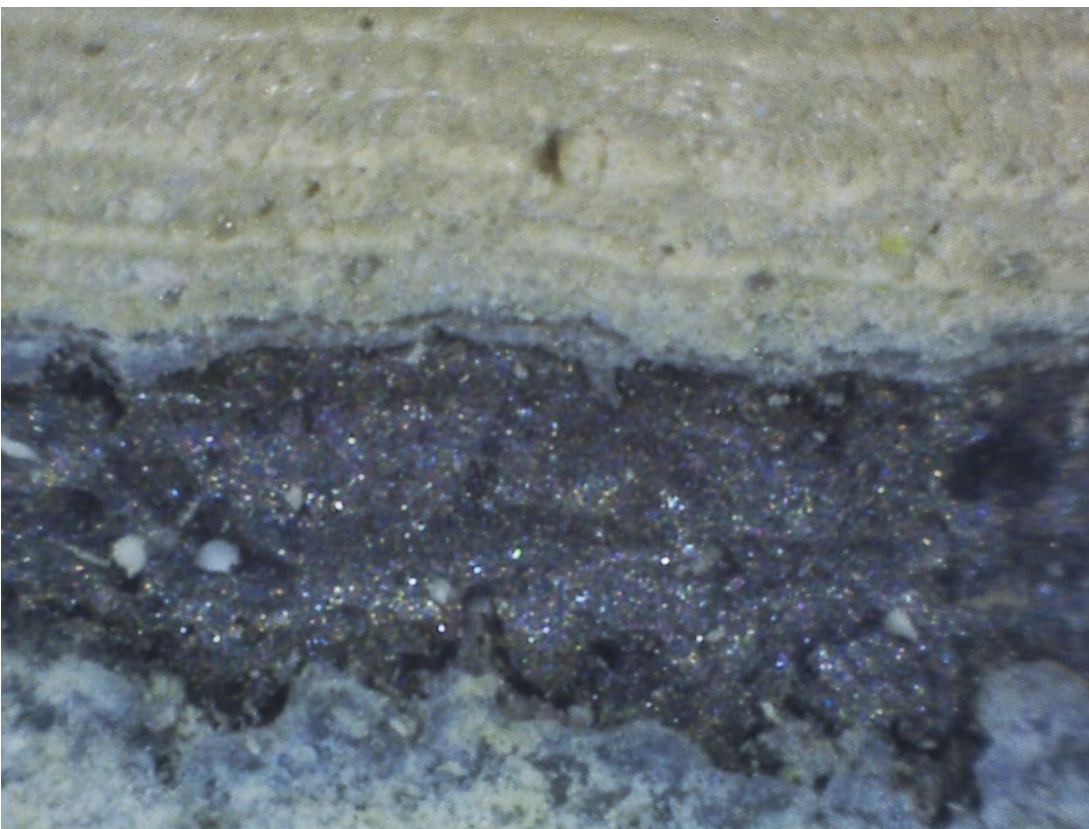
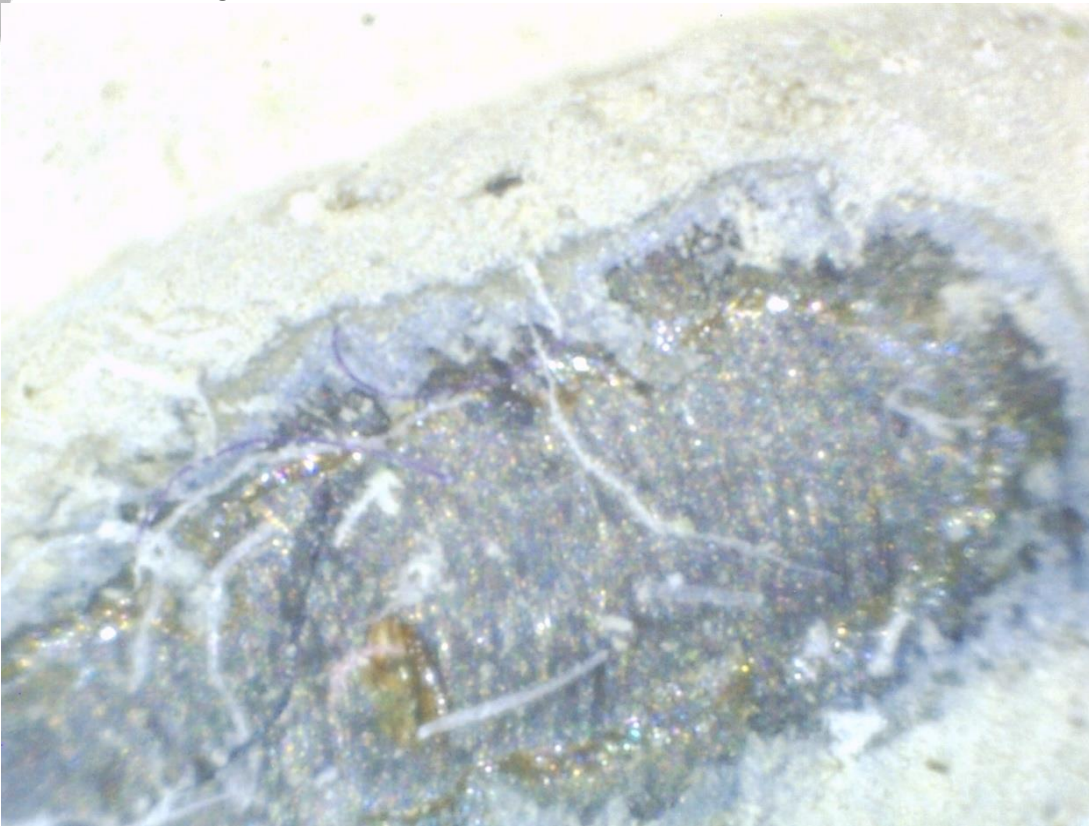


COMPARISONS:

Before and after cleaning at 3.5x magnification

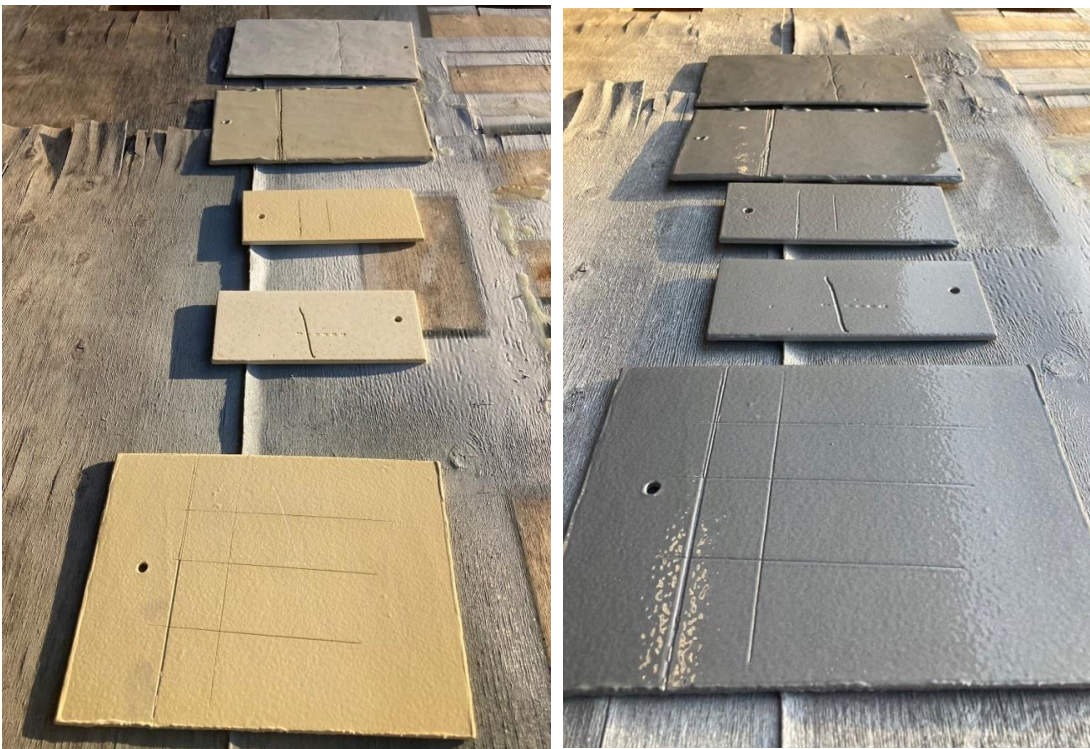
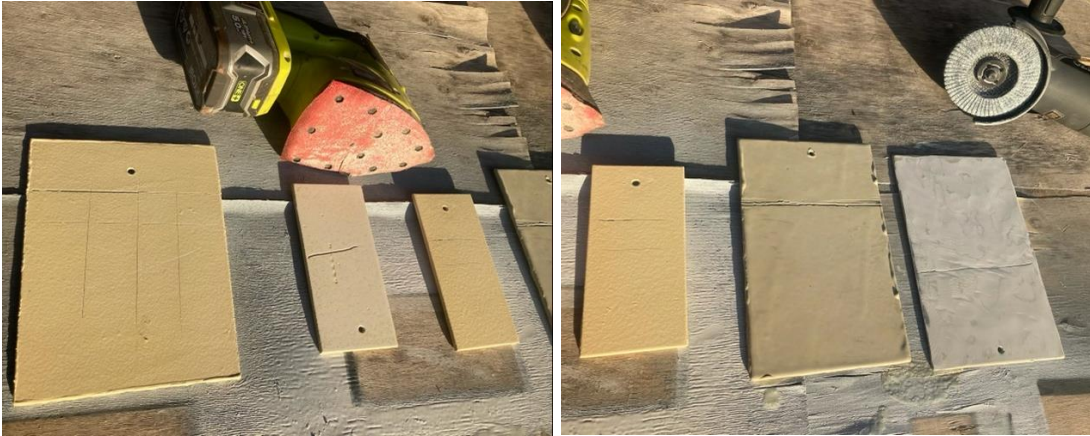


Below: At 35x magnification – resultant corrosion reduction and near elimination.



APPLICATION OF MCU-ALUPRIME:

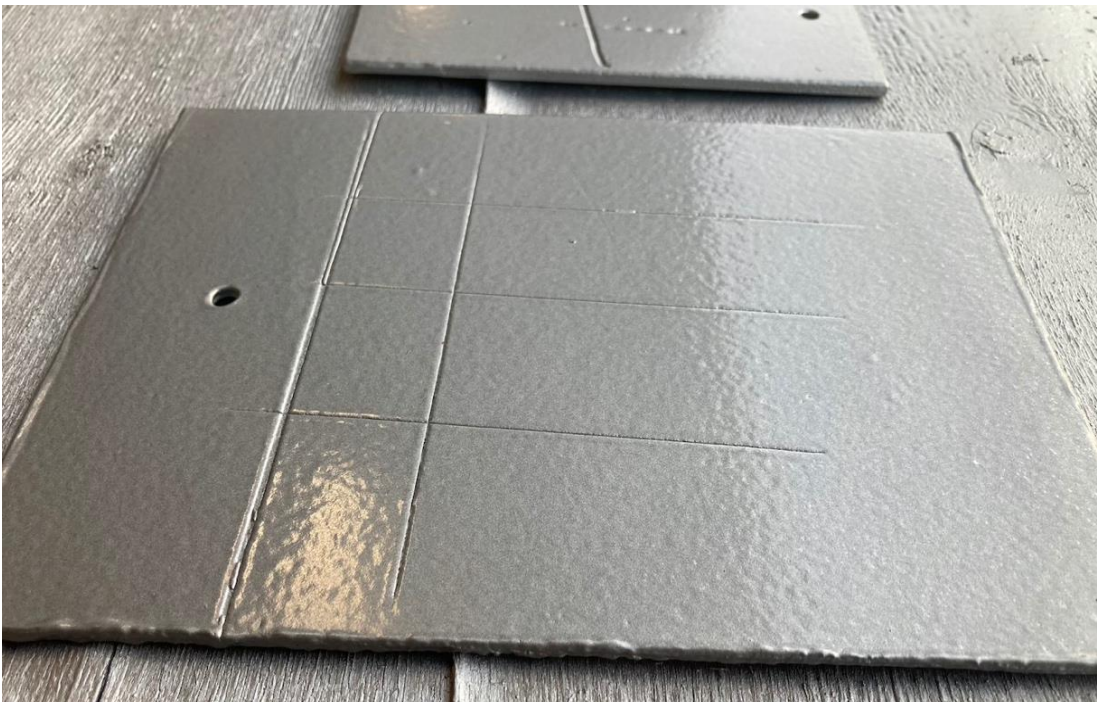
Panels #2 and #7 were power tool cleaned using 40 grit on an orbital sander (#2 Phenolic Epoxy) and 40 grit flappy wheel (#7 Novolac Epoxy)



Bottom right: After applying a single coat of MCU-Aluprime - 75 μ m WFT



Application atmospherics were RH = 47%. Surface temperature of 26.7°C (11.7°C above dew point)



MCU-Aluprime – Applied with a conventional gravity feed spray gun using a 1.3mm fluid tip.

FILM THICKNESS:

MCU-Aluprime DFT averaged 65µm



POROSITY TESTING:

Using an Elcometer 270 Pinhole Detector to NACE SP 0188 set at 9v DC (for up to 300µm as film to be measured is below 70µm), no porosity was detected over the scribed areas.

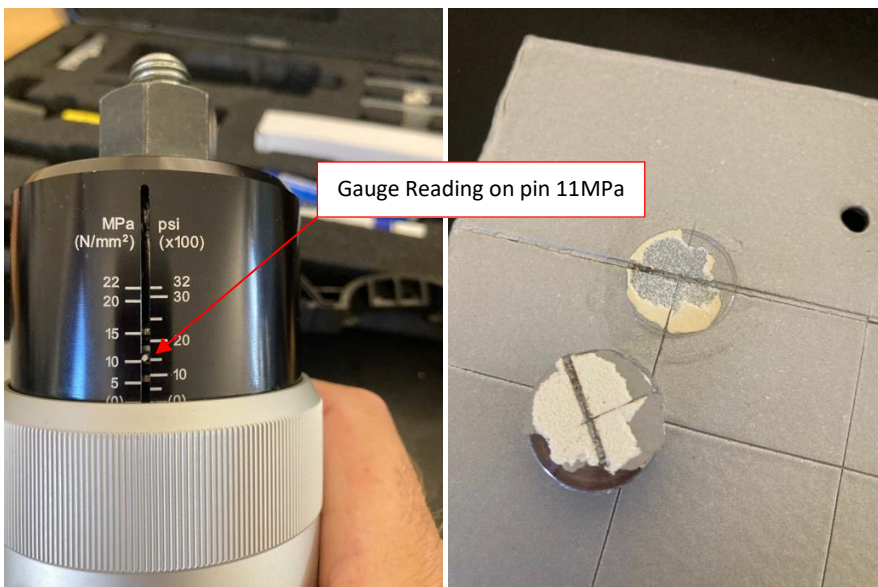


ADHESION TESTING:

TEST PANELS

Panel No.	Substrate	Substrate Measured DFT μm	Surface Preparation	Total DFT μm	MCU-Aluprime DFT μm	Pull Test Mpa	Comments and Failure Analysis
1	Phenolic Epoxy	275	MCU-Ecocleaner Gel	351	76	11	Adhesion failure Steel / Phenolic
2	Phenolic Epoxy	566	Zero	566	0	N/A	Observation Panel no surface prep no topcoat
3	Phenolic Epoxy	635	MCU-Ecocleaner Gel / Power Tool Clean	702	67	10	40 grit orbital sander Cohesive failure Phenolic / MCU-Aluprime
4	Phenolic Epoxy	580	MCU-Ecocleaner Gel	640	60	10	Adhesion failure Steel / Phenolic
5	Phenolic Epoxy	532	MCU-Ecocleaner Gel	532	0	N/A	Observation Panel surface prep only no topcoat
6	Novolac Epoxy	504	MCU-Ecocleaner Gel	575	71	8	Cohesive failure Epoxy Zinc
7	Novolac Epoxy	473	MCU-Ecocleaner Gel / Power Tool Clean	544	71	8	40 grit flappy disk Cohesive failure Epoxy Zinc

Panel # 1: Adhesion pull test value recorded was 11MPa with the failure occurring between the blasted steel panel and the phenolic epoxy. This panels surface preparation was using MCU Ecocleaner Gel only showing the Gel can clean and prepare a coated substrate to allow high levels of adhesion saving significant labour times in power tool or hand cleaning, with a simple chemical surface treatment.

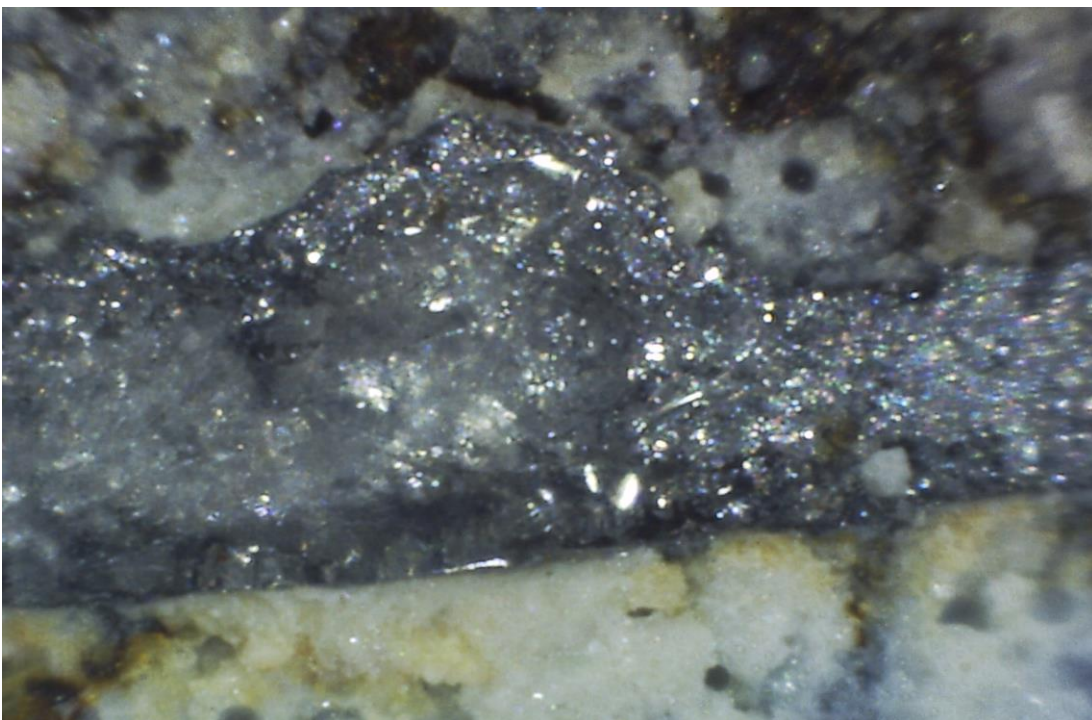


Above: Adhesion measured at 11MPa on Elcometer 106 and dolly illustrating the nature of the adhesion failure

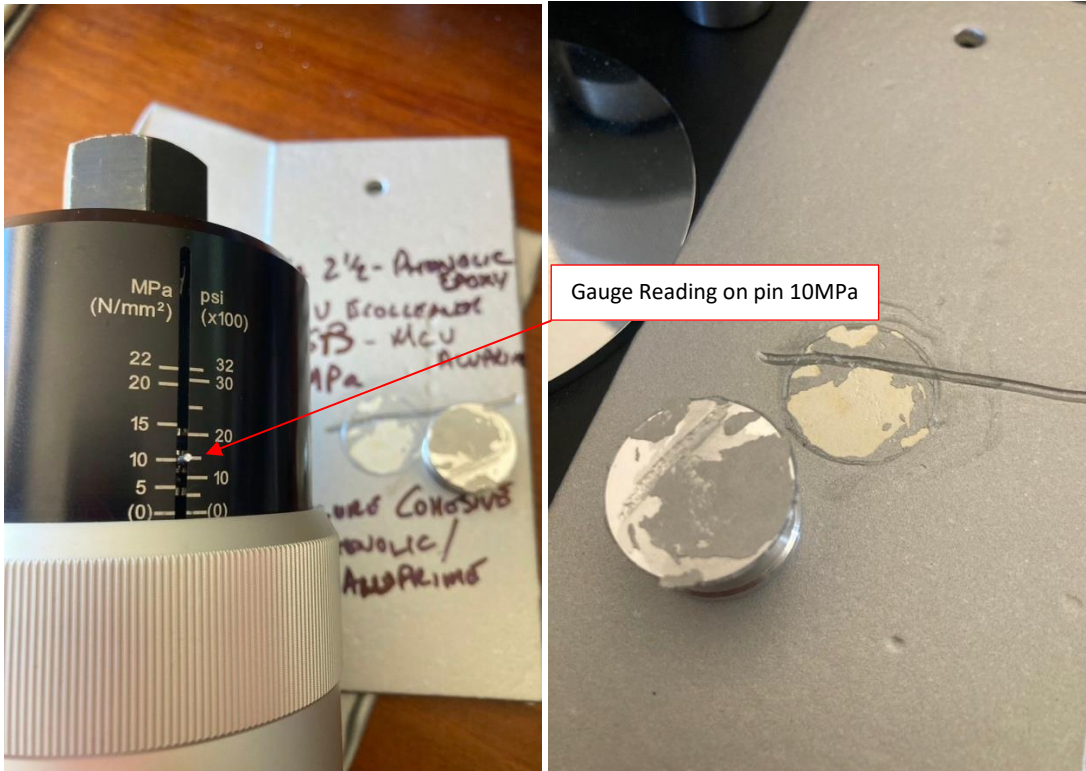
Below: Surface under 3.5x magnification showing the scribed damaged area, weathered, and corroded then treated with MCU-Ecocleaner Gel. The steel surface was clean, with the edge rust from the "rust creep" under the phenolic epoxy as it weathered.



Below under 35x magnification

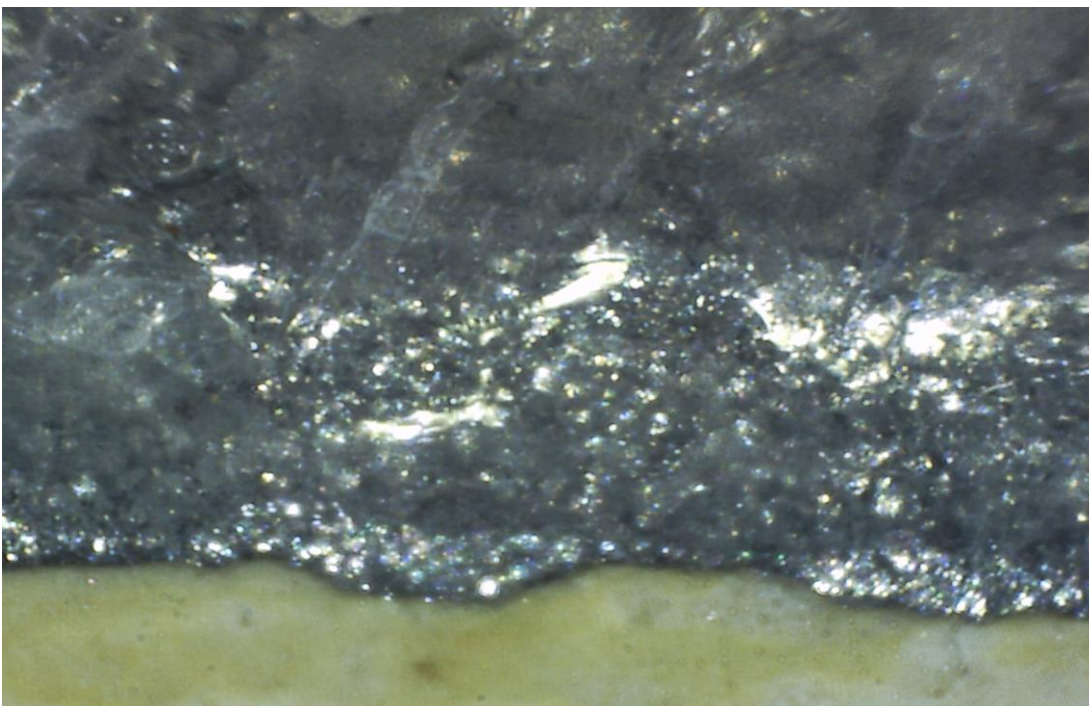
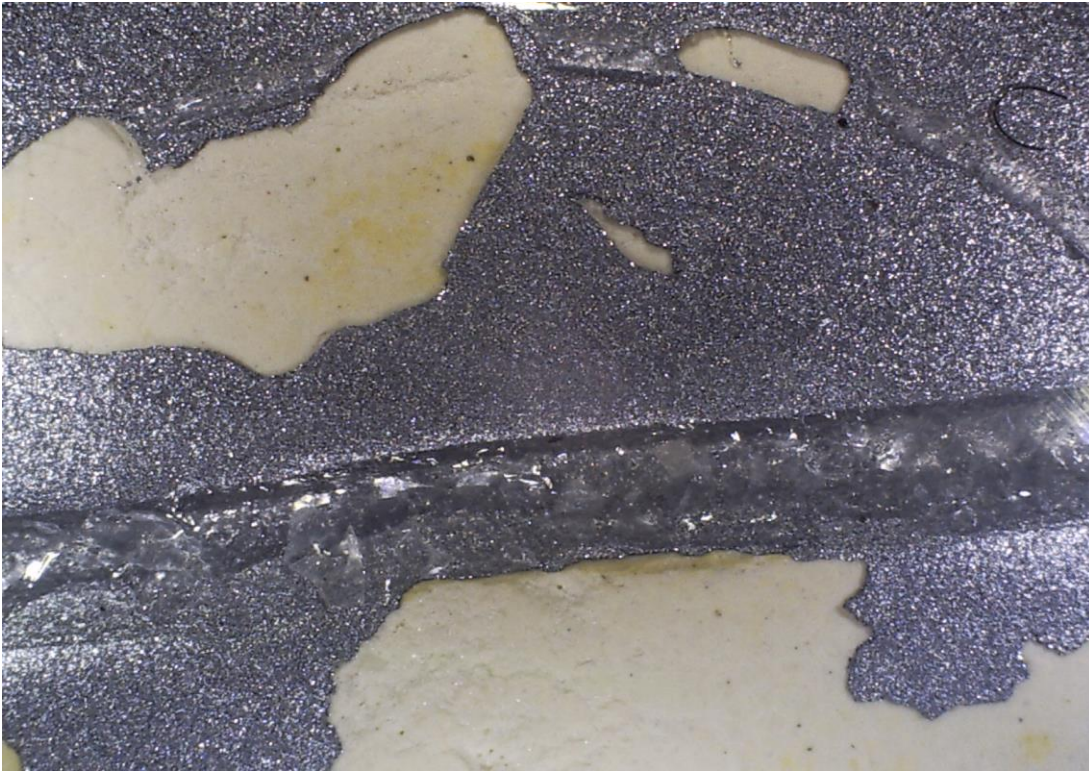


Panel # 3: Adhesion pull test value recorded was 10MPa with the failure occurring between the phenolic epoxy and the MCU-Aluprime, this panel was surface treated with MCU-Ecocleaner Gel followed by a power tool cleaning, highlighting that adding surface treatment of ST3 does little to improve adhesion. Observation to note that the scribed area weathered, corroded then cleaned with MCU-Ecocleaner Gel the MCU-Aluprime adhered while the phenolic epoxy has fractured along this transition line.

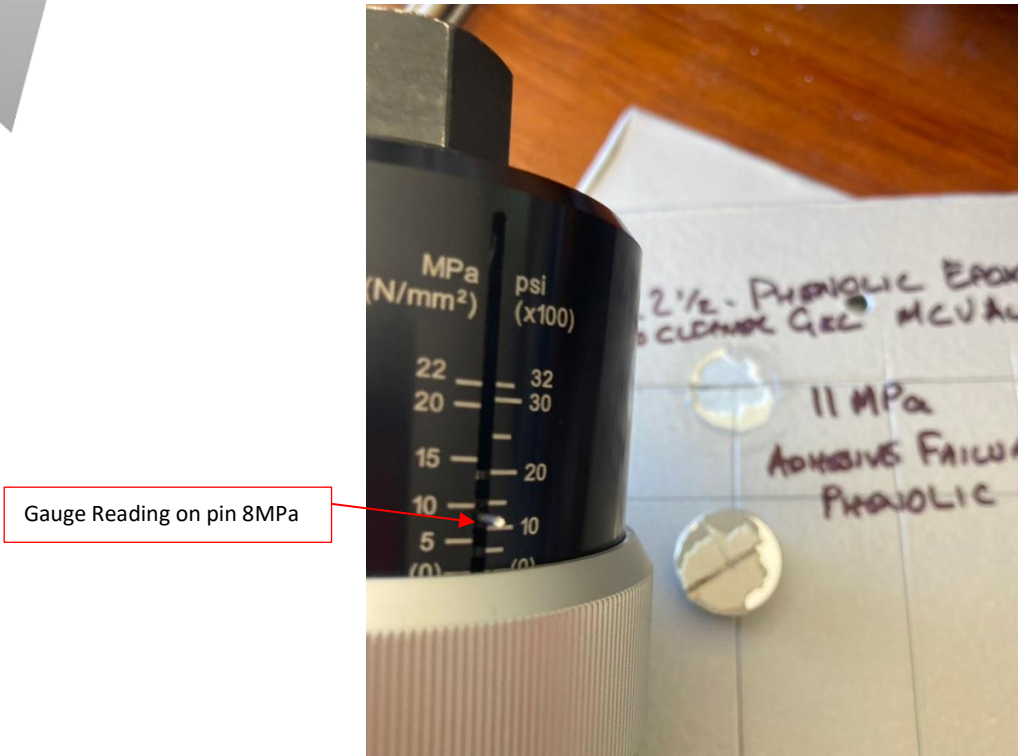


Above: shows the 10MPa adhesion value on Elcometer 106 and the nature of the failure

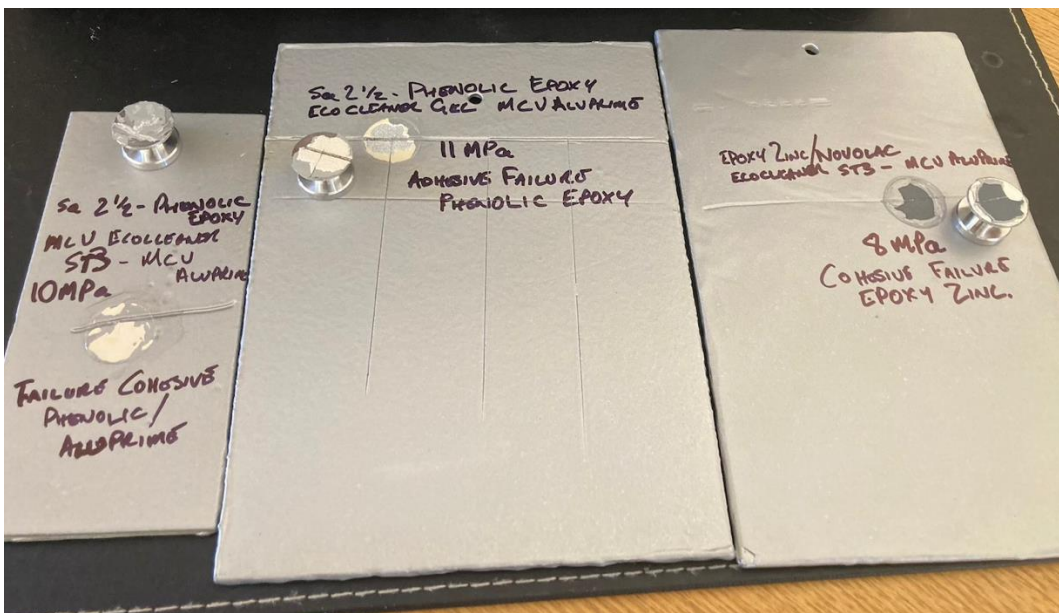
Below, at 3.5x and 35x magnification you can see the transition between scribed area filled with MCU-Aluprime is intact. This proves that MCU's adhesion on the chemically treated surface is better than the adhesion achieved by the old phenolic epoxy coating. Previously there was no method to adequately clean the micro-cracked surface.



Below: Panel # 7 Adhesion pull test value recorded was 8MPa with a cohesive failure within the epoxy zinc. This was on an MCU-Ecocleaner Gel prepared surface, highlighting the solid MCU-Aluprime adhesion.



Below: Summary of the adhesion results:



CONCLUSIONS:

Based on the testing outlined above MCU-Ecocleaner Gel:

- a) is effective at removing corrosion in areas that cannot be accessed with power tool or hand cleaning
- b) is able to reach the surface and remove micro-corrosion between the cracks in existing phenolic epoxy / novolac coatings that has good adhesion
- c) appears to reduce undercreep-corrosion - to some extent
- d) removes all rust traces of exposed rust, effectively etches the steel and facilitates good adhesion to the steel with MCU-Aluprime
- e) is effective at removing / reducing chlorides and contaminants to levels below ISO 8502-9 Norsok 1 'guidelines'.

Our test samples also confirmed that:

- a) MCU-Aluprime is not porous when applied between 60 µm and 75µm
- b) MCU-Aluprime has a low viscosity and is able to penetrate the prepared substrate visible microcracks (as opposed to conventional coatings which fail to penetrate sufficiently and wet the surface)
- c) MCU-Aluprime has a good bond to suitably prepared steel and epoxy phenolic / novolac coatings
- d) MCU-Aluprime shows no evidence of air entrapment or blistering
- e) MCU-Ecocleaner Gel is a highly effective surface preparation 'treatment' when applied to previously coated steel and sound phenolic coatings; and
- f) MCU-Aluprime establishes an impressive, serviceable, adhesion bond when used in conjunction with MCU-Ecocleaner Gel on weathered phenolic and novolac epoxy resin coatings.

Based on the testing we have conducted the MCU-Ecocleaner Gel and MCU-Aluprime coating system overcomes many of the coating challenges experienced by conventional coating systems. We have no hesitation in recommending it to MCU-Coatings' clients as it is a complete solution that none of our competitors can compete with.

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