

Introduction:

Due to the nature and conditions of Corrosion Under Insulation (CUI) extensive testing procedures are vital to be able to identify a coating system which is suitable for CUI and will provide long lasting protection in such harsh environments. This report shows the procedures and results of Performance Polymers' CUI testing program, this incorporates a diverse range of carefully selected testing methods which the resulting coating will be subjected to during the course of its lifetime of CUI exposure. The test program is designed to be an extension of current CUI testing methods. This report is the demonstration of Thermaguard™ CUI 650 properties relating to Corrosion Under Insulation environments. The coating conforms to the international NACE SP0198-2010 classification, Inert Multi Polymeric Matrix.

Coating:

1. **Thermaguard™ CUI 650** – one component, ambient curing polysiloxane coating. (Dark Grey & Light Grey)

Tabulated test procedure:

All testing was in accordance with appropriate ISO standard for each specific test.

Panels were prepared by solvent cleaning (SSPC – SP1) and blast cleaning to Sa 2 ½ standard (8501-1), blasting profile (R_z) 40-75µm, followed by approx. 2 x 150µm DFT of each coating system via airspray application on 5mm steel panels. Unless otherwise stated.

Thicknesses of the coating systems was measured according to ISO 2808.

All coating systems were cured for 7 days @ 23°C and approx. 50% RH before testing.

Test type	Exposure in practice
<p>CUI test (shell test): To simulate a typical CUI environment of which the coating can demonstrate long term durability in cyclic fashion in such an aggressive scenario.</p>	<p>The subjected coating will be in a CUI environment throughout its required service life.</p>
<p>Thermal resistance: Demonstrates that the coating can endure high temperatures without any degradation occurring. Both cryogenic & high temperatures.</p>	<p>Substrate temperatures are likely to be cryogenic or elevated and cyclic throughout service life.</p>
<p>Salt spray: The product is able to provide high levels of anti-corrosive protection to the substrate while waiting for and during its service life.</p>	<p>Waiting for service, during transit and during service.</p>
<p>Hot water immersion: Immersion is a part of CUI hence the coating must be able to endure to prevent any corrosion of the substrate.</p>	<p>During a CUI environment, waiting for service or during transit.</p>
<p>Adhesion: To demonstrate the coating is capable of adhering to the required substrate which sufficient strength to provide long term service life.</p>	<p>Continuous throughout service life.</p>
<p>Chemical resistance: High performance against acidic & hydrocarbon chemical environments demonstrates the coating can perform without degrading from corrosive foreign contaminants.</p>	<p>During service from leaching insulation, waiting for service & during transit or spillages on-site.</p>
<p>Impact resistance & cylindrical mandrel testing: Demonstrates the coating is flexible and hard and it can endure stresses applied to the coating in practice. Good adhesion is also essential to obtaining high performance.</p>	<p>During service with maintenance procedures & during transit.</p>
<p>Pencil hardness: Demonstrates the coatings film hardness & the physical state of the polymer in question.</p>	<p>During transit and service life.</p>
<p>Abrasion testing: Abrasion testing will show the levels of; film hardness, cohesive and adhesive strength of the coating system.</p>	<p>During transit and service life.</p>

Test results of Thermaguard™ CUI 650:

Test type	ISO standard	Test procedure	Length of test (days)	Thermaguard™ CUI 650
Corrosion Under Insulation (CUI)	N/A	<ol style="list-style-type: none"> 16 hours @ 204°C. Thermal shock (water, 23°C). 8 hours in HWI (95°C). Repeat 80 cycles.	122	No cracking, delamination, blistering or corrosion.
Adhesion: cross cut & pull-off	2409 4624	PosiTest AT-A Automatic Adhesion Tester.	8	5A – cross cut (X-Cut). 5 MPa 100% cohesive – dolly.
Salt spray	12944-6	Q-FOG cyclic corrosion chamber. 1440h, C5	60	Max 1mm corrosion creep & no blistering.
Hot water immersion	2812/2	Immersion for 4000h @ 90°C (5% NaCl solution).	167	No cracking or blistering or adhesion loss. 99% corrosion free.
Impact resistance	6272-1	TQC Direct impact tester.	8	25 cm
Cylindrical mandrel (bend)	1519	TQC Cylindrical bend test 100mm (SP1820). 0.75mm panels	8	32 mm – Microcracking
Pencil hardness	15184/ASTM 3363	TQC Pencil Hardness Test (750g) VF2377.	8	7H (ambient cured 7 days).
Thermal resistance	N/A	Heat to 650°C. Allow to cool to ambient temperature.	8	No cracking, blistering or adhesion loss.
Cryogenic testing	N/A	Third party (UK university) <ol style="list-style-type: none"> Heating at 200°C for 30mins Cooling to 23°C for 30mins Immersing in liquid nitrogen at -196°C for 30mins Directly returned to the oven at 200°C The process repeated 5 times. 	8	No cracking, delamination or blistering.
Abrasion resistance	7784-3	Taber Abraser (Abrader) – Model 5135.	8	Passes 500 cycles Ambient - 110µm film loss
Chemical resistance	ISO 2812- 4:2007 (method A)	Using 10% HCL & H ₂ SO ₄ , Diesel & Benzene (hydrocarbons)	8	720 hours – acid resistance + 1 year – hydrocarbon resistance No removal of coating or blistering. Discolouration from chemical. Film remains hard with 100% integrity.

Conclusion:

To provide and methodise a testing procedure, which will subject the coating to extremely harsh environment, of which, can replicate the expected conditions during its required service life has been established. The PPBV CUI testing program combines all parameters, which are required for long service life in CUI conditions. Testing broad relative parameters for CUI coatings & obtaining conclusive results will distinguish the differences between CUI coatings & aid the selection process. The results herein show the Thermaguard™ CUI 650 coating clearly offers superior performance levels than the current (documented) market standards. Offering exceptional protection for steel structures, which are undergoing & subjected to CUI environments.

The novel single component, ambient curing polysiloxane technology of the Thermaguard™ CUI 650 coating raises current & excepted performance levels while offering a single pack coating system, which cures fully at ambient conditions. This removes the need for post curing (150 – 200°C), therefore, eliminating the need for heating and obtaining full corrosion & mechanical properties from ambient application conditions which eradicates low temperature (<200°C) operating problems & before service requirements (transportation etc.). This new technology allows for 'next generation' higher performance levels, which can combat and mitigate CUI across the industry.

Signed:



James C Reynolds

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Performance Polymers b.v

Pencil hardness test

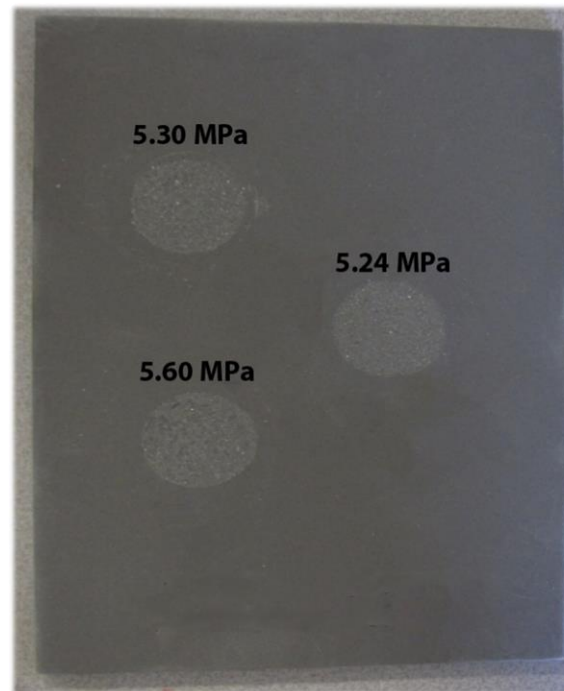


Thermaguard™ CUI 650

Pencil hardness (gouge)

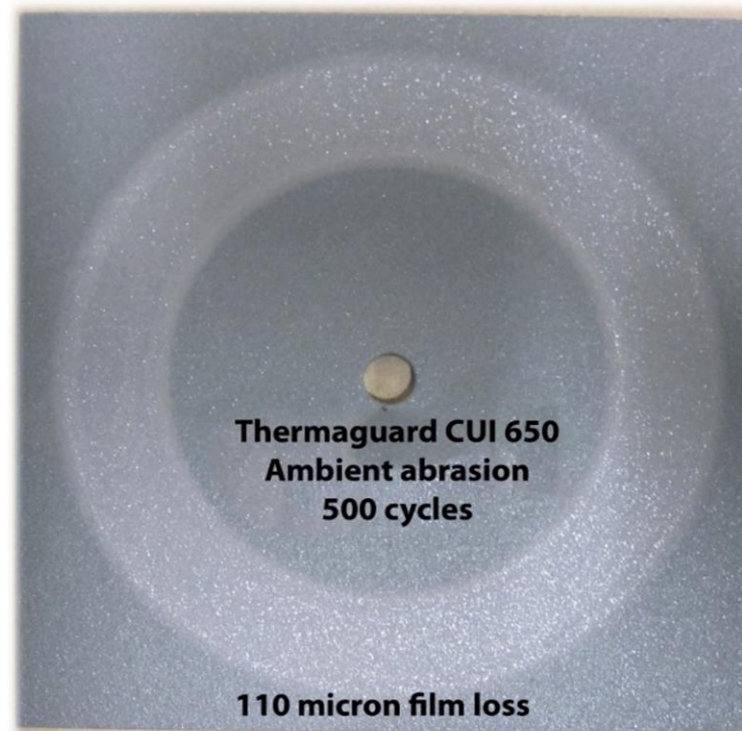
7H

Adhesion test (Dolly pull-off)



Thermaguard™ CUI 650

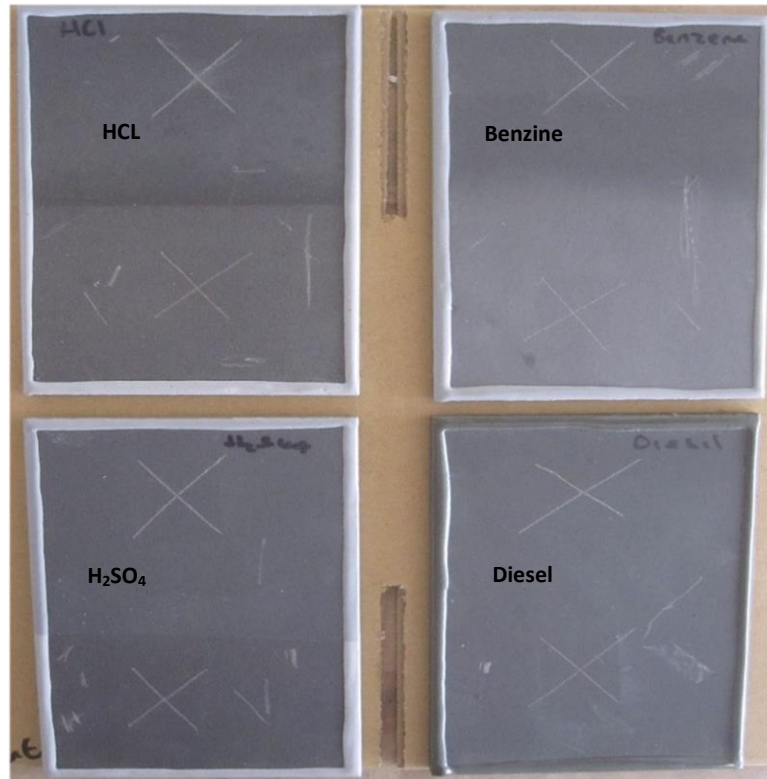
Abrasion test



Cylindrical mandrel test



Chemical resistance test



Thermaguard™ CUI 650

Shell CUI test



Thermaguard™ CUI 650

1440 hours' salt spray test



Thermaguard™ CUI 650

4000 hours' Hot water immersion test



Thermaguard™ CUI 650