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 300. All the coatings tested herein are conforming to the international NACE SP0198-2017 classification.

Coatings:

1. **Thermaguard™ CUI 300** – one component, solvent free, ambient curing polysiloxane coating. (RAL 7035)

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) 40-50µm, followed by approx. 2 x 100µm DFT of the coating system via airspray application on 5mm steel panels. Unless otherwise stated.

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

Coating system was cured for 7 days @ 23^{o}C and approx. 50% RH before testing.

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Test type	Exposure in practice
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.	The subjected coating will be in a CUI environment throughout its required service life.
Thermal resistance: Demonstrates that the coating can endure high temperatures without any degradation occurring. Both cryogenic & high temperatures.	Substrate temperatures are likely to be cryogenic or elevated and cyclic throughout service life.
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.	Waiting for service, during transit and during service.
Hot water immersion: Immersion is a part of CUI hence the coating must be able to endure to prevent any corrosion of the substrate.	During a CUI environment, waiting for service or during transit.
Adhesion: To demonstrate the coating is capable of adhering to the required substrate which sufficient strength to provide long term service life.	Continuous throughout service life.
Chemical resistance: High performance against acidic & hydrocarbon chemical environments demonstrates the coating can perform without degrading from corrosive foreign contaminates.	During service from leaching insulation, waiting for service & during transit or spillages on-site.
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.	During service with maintenance procedures & during transit.
Pencil hardness: Demonstrates the coatings film hardness & the physical state of the polymer in question.	During transit and service life.
Abrasion testing: Abrasion testing will show the levels of; film hardness, cohesive and adhesive strength of the coating system.	During transit and service life.
QUV weathering: QUV testing will demonstrate resistance to UV light and weathering	During storage and transit

Test results of Thermaguard™ CUI 300:

Test type	ISO standard	Test procedure	Length of test (days)	Thermaguard™ CUI 300
Corrosion Under Insulation (CUI)	N/A	**1. 16 hours @ 204°C.** **2. Thermal shock (water, 23°C).** **3. 8 hours in HWI (95°C).** Repeat 80 cycles.	122	No cracking, delamination, blistering or corrosion.
Adhesion: cross cut & pull-off	2409 and 4624	PosiTest AT-A Automatic Adhesion Tester.	8	5A – cross cut (X-Cut). >7 MPa 100% cohesive – dolly.
Salt spray	12944	Q-FOG cyclic corrosion chamber (1440h, C5)	60	Max 1mm corrosion creep & no blistering.
Hot water immersion	2812	Immersion for 4000h @ 90°C (5% NaCl solution).	167	No corrosion, cracking, blistering or adhesion loss.
Impact resistance	6272	TQC Direct impact tester.	8	30 cm
Cylindrical mandrel (bend)	1519	TQC Cylindrical bend test 100mm (SP1820). 0.75mm panels	8	32 mm
Pencil hardness	15184/ ASTM 3363	TQC Pencil Hardness Test (750g) VF2377.	8	>10H (ambient cured 7 days).
Thermal resistance	N/A	Heat to 300°C. Allow to cool to ambient temperature.	8	No cracking, blistering or adhesion loss.
Cryogenic testing	N/A	Third party (UK university) 1. **Heating at 200°C for 30mins** 2. **Cooling to 23°C for 30mins** 3. **Immersing in liquid nitrogen at -196°C for 30mins** 4. **Directly returned to the oven at 200°C** 5. **The process repeated 5 times.**	8	No cracking, delamination or blistering.
Abrasion resistance	7784	Taber Abraser (Abrader) – Model 5135.	8	Passes 500 cycles Ambient - 50µm film loss
Chemical resistance	2812-4 (method A)	Using 10% HCL & H_2SO_4, hydrocarbon solvents (xylene, MEK, alcohol)	8	720 hours – acid resistance + 1 year – hydrocarbon resistance No removal of coating or blistering. Discolouration from chemical. Film remains hard with 100% integrity.
QUV weathering	11507	QUV weathering cycle UVB and condensation	125	3000 hours - no discolouration, chalking or blistering

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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 and obtaining conclusive results will distinguish the differences between CUI coatings and aid the selection process.

The novel single component, solvent free, ambient curing polysiloxane technology of the Thermaguard™ CUI 300 coating demonstrates exceptional performance levels while offering a single pack coating system which cures fully at ambient conditions eliminating the requirement for heating >150^{o}C as seen with IMM (inert multi polymeric), IC (inorganic copolymer) and silicone type coatings

Thermaguard™ CUI 300 is specifically designed to provide CUI mitigation from -196 to 300^{o}C temperature range for steel substrates. Demonstrating elevated performance levels of CUI cycling resistance, thermal security and hot water immersion capabilities when compared to organic based coatings.

Signed:

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