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Laboratory Work Report

Project Title	Corrosion and Performance Testing		
LWR Number	27374	**Report Date**	
Direct Customer		**Account Representative**	B. Pernice
Coatings Evaluated	Xylan® 1424/D6584 Blue #524	**Application Description**	Industrial/Offshore (I-08)

Background and Objectives

Fasteners and nuts which had been coated with Xylan 1424/D6584 over zinc phosphate (reported to be 2.0-3.0 g/ft^2) were received. Each set consisted of one A913 B7 stud and two A194 2H nuts. The studs were numbered 1 – 3 and the corresponding nuts on each stud were labeled "1" and "2". Photographs of the parts were taken prior to and after testing.

Methods

ID	Test Description	Test Method Number	Date	Tested By
1	Evaluation of Appearance	WTM 120A	03/22/13	MR
2	Evaluation of Completeness of Cure by Solvent Rub Test	WTM 115A	04/15/13	MR
3	Adhesion by Crosshatch/Tape Pull	WTM 132C	04/15/13	MR
5	Salt Fog Corrosion Resistance	ASTM B117	03/22/13 – 07/02/13	MR

Results and Discussion

1. Evaluation of Appearance (WTM 120A):

All three sample sets were used for appearance testing. All samples had an excellent appearance with uniform color/gloss and a smooth surface free of defects consistent with the standard. All nuts spun freely along the studs. Photographs of the samples as received after labeling are below in **Figure 1.**

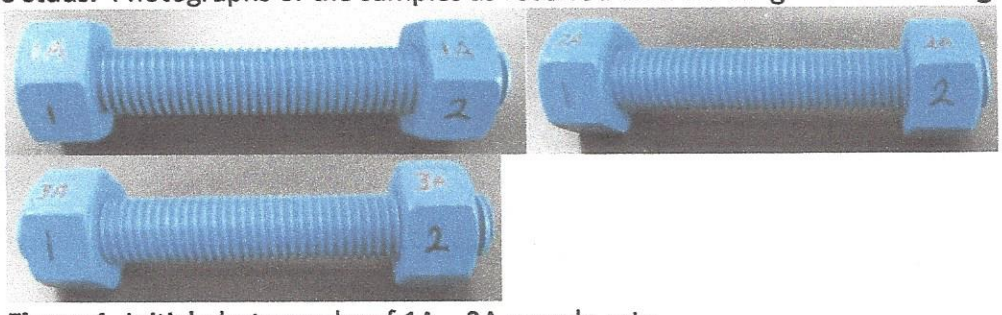

Figure 1. Initial photographs of 1A – 3A sample sets

2. Evaluation of Completeness of Cure by Solvent Rub Test (WTM 115A):
Testing was conducted at 77°F (25°C) with TIC Crockmeter fabric squares. Sample 3A Nut 1 was subjected to fifty double rubs with a MEK soaked fabric square. The sample passed the cure test, exhibiting minimal color transfer and no softening of the coating. A photograph of the sample after testing is below in **Figure 2.**

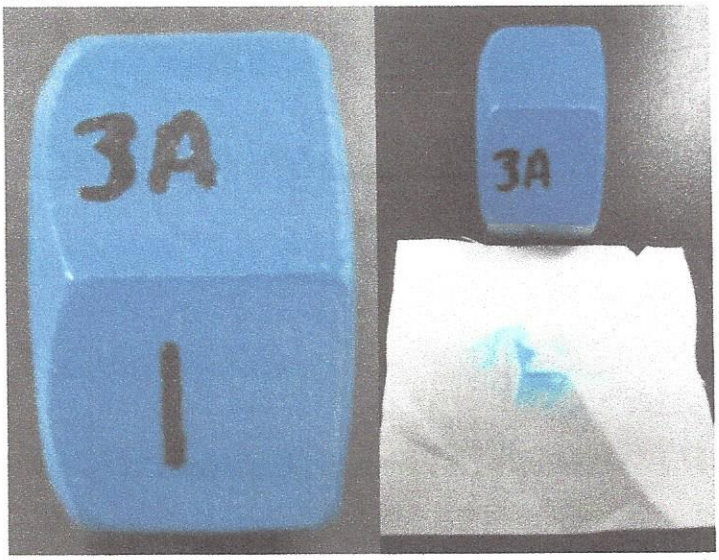

Figure 2. Photograph of sample 3A Nut 1 cure test results

3. Adhesion by Crosshatch/Tape Pull (WTM 132C):
Sample 3A Nut 1 was used for adhesion testing. The sample was tested at 77°F (25°C) using 1" 3M Scotch™ 897 tape. A 10x10 grid of squares with 1mm spacing was cut. Five tape pulls were then performed on the crosshatch area. The sample passed testing with 100/100 squares intact. A photograph of the sample after testing is below in **Figure 3.**

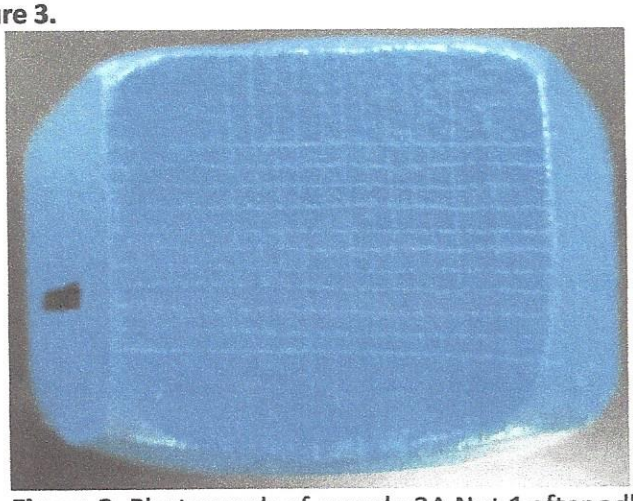

Figure 3. Photograph of sample 3A Nut 1 after adhesion test

4. Dry Film Thickness (DFT) by Confocal Microscopy:

The DFT of the coating on stud 3A was measured by taking a cross-section of the stud and measuring the thickness via microscopy. The thicknesses of the Xylan 1424 were measured at the top, sidewall and bottom of the threads. Five measurements were taken in each area. The average, standard deviation and range of the measurements for each area are shown in **Table 1.** The images of the cross section of stud 3A that the measurements were taken from are in **Figures 4-6.**

Layer	Top			Sidewall			Bottom		
	Average ± σ (µm)	Range (µm)		Average ± σ (µm)	Range (µm)		Average ± σ (µm)	Range (µm)	
		Min.	Max.		Min.	Max.		Min.	Max.
Xylan 1424	54.794 ± 5.92	45.593	63.275	19.687 ± 4.28	14.717	25.423	47.515 ± 7.88	33.001	56.155

Table 1. DFT results from stud 3A

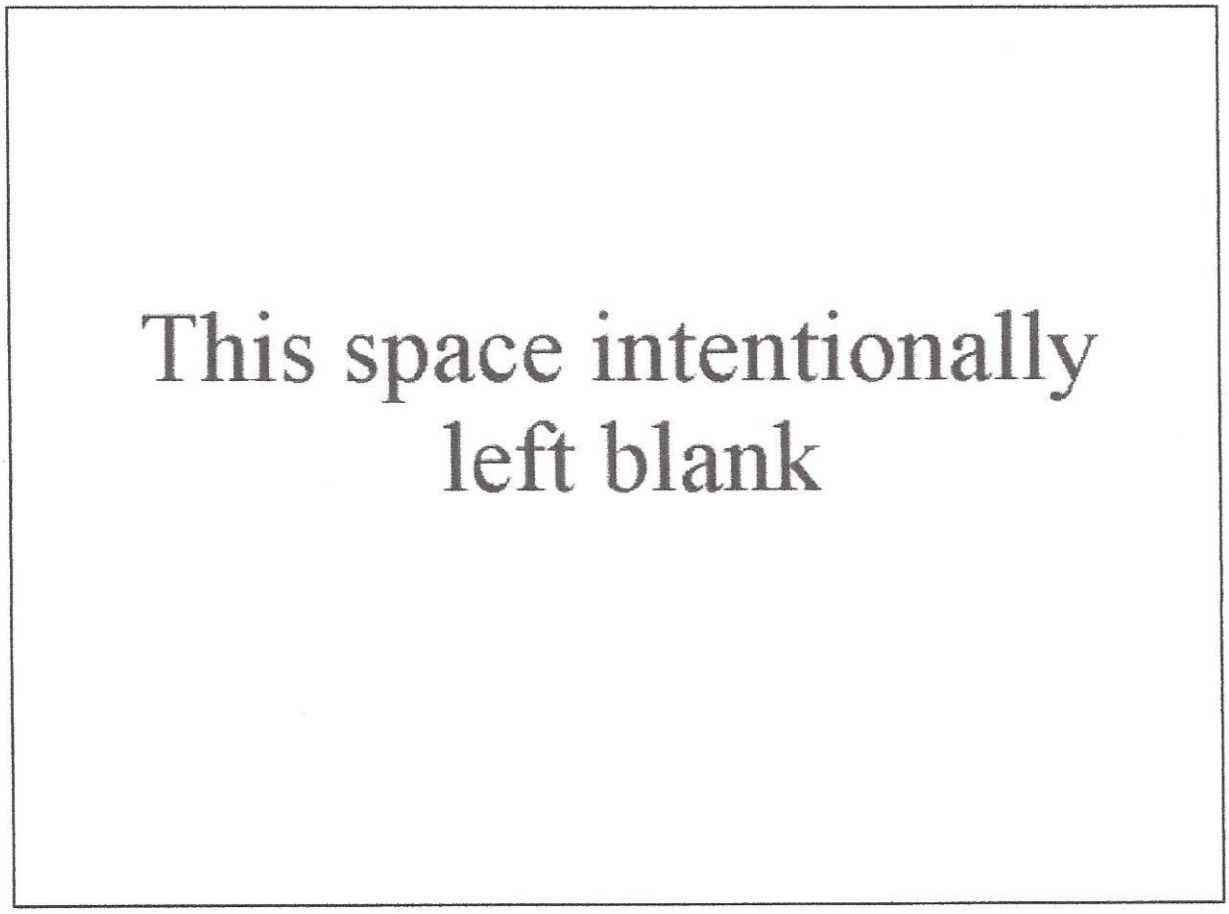

Figure 4. Cross-sectional image of Stud 3A, thread top at 1000x

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5. Salt Fog Corrosion Resistance (ASTM B117):

Sample set 1A, consisting of one stud and two nuts was exposed to ASTM B117 testing until 15% Red Rust (RR) on the stud. Photographs were taken at prior to, at the 500 hour intervals and after testing. The results of the testing are in **Figure 7.** Photographs of the sample from the testing are in **Figure 8.**

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Environmental Test Report

Test Type: Salt Fog — End Point: 15%RR
Test Conditions: ASTM B-117
Customer & LWR No.: [illegible] LWR 27374 — Date Started: 19-Mar-13
Description of Samples
Type/Appearance: 3/4" X 5" stud with two nuts
Substrate: Carbon Steel
Substrate Preparation: Phosphate 2000-3000 mg/ft^2
Description of Coating: 1424 Blue (0.9 - 1.2 mil)

		Sample Number:					
		1A Nut 1		1A Stud		1A Nut 2	
Date:	Hours or Cycles	% Red Rust Corrosion		% Red Rust Corrosion		% Red Rust Corrosion	
22-Mar-13	*72*	0%		0%		0%	
26-Mar-13	*168*	TRR		0%		0%	
2-Apr-13	*336*	TRR		TRR		TRR	
9-Apr-13	*504*	TRR		TRR		TRR	
16-Apr-13	*672*	TRR		TRR		TRR	
23-Apr-13	*840*	1%	Staining	TRR	Staining	TRR	Staining
30-Apr-13	*1008*	1%	Staining	TRR	Staining	1%	Staining
7-May-13	*1176*	2%	Staining	2%	Staining	2%	Staining
14-May-13	*1344*	2%	Staining	4%	Staining	23%	Staining
22-May-13	*1536*	2%	Staining	4%	Staining	3%	Staining
28-May-13	*1680*	3%	Staining	5%	Staining	3%	Staining
4-Jun-13	*1848*	3%	Staining	5%	Staining	3%	Staining
11-Jun-13	*2016*	3%	Staining	5%	Staining	3%	Staining
18-Jun-13	*2184*	5%	Staining	8%	Staining	3%	Staining
25-Jun-13	*2352*	5%	Staining	11%	Staining	4%	Staining
2-Jul-13	*2520*	8%	Staining	15%	Staining	6%	Staining
	End Test @ 2520hrs						

Key: Indicate white (W) or red (R) corrosion after % corrosion. Refer to Whitford TM120A for rating system.
Comments: TRR = Trace Red Rust (<1%)
Staining = Non-Red Rust discoloration of the coating.

Tester: Matt Rossi

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Figure 7. Salt fog record sheet for 1A sample set

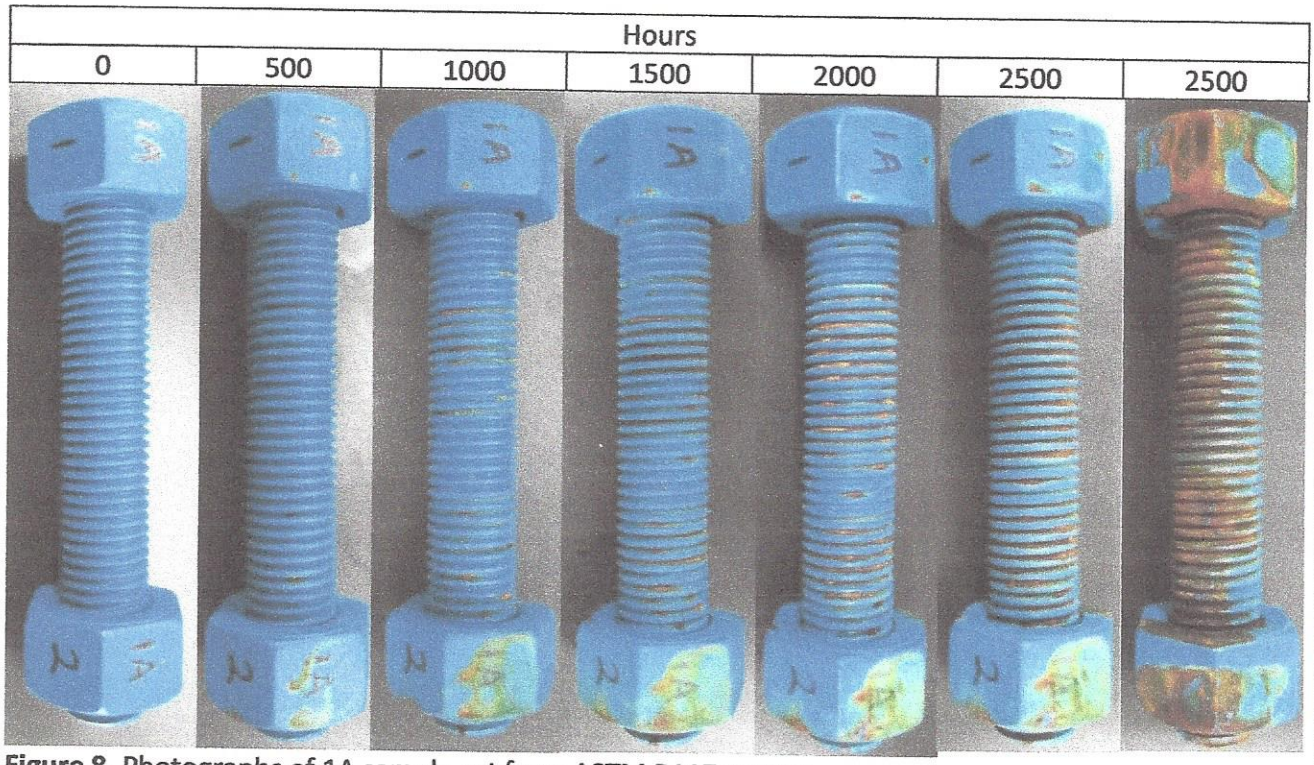

Figure 8. Photographs of 1A sample set from ASTM B117 testing

At the end of the ASTM B117 testing both nuts were able to be spun by hand with some resistance along the stud.

Conclusions and Recommendations

The coated parts had an excellent appearance with no film defects. The DFT of the coating was found to be above the recommended levels but the nuts were able to be spun freely by hand along the studs before and after corrosion testing. The performance of the coated parts in cure, adhesion and corrosion resistance testing met or exceeded the expectations for the zinc phosphate and Xylan 1424 coating system.

Appendices

None