August 1997

MEMORANDUM TO FILES

SUBJECT: Analysis of Submitted Coating Samples of Zinga

The Paint Technology Center received samples of Zinga and AquaZinga with a request to evaluate. Laboratory tests were selected to determine if the products were equal to or superior to the system currently used by the Corps (System 21 A-Z, and System 6 A-Z).

Panel Preparation

Panel Number	Surface Profile	Primer	DFT	Second Coat	DFT	Third Coat	DFT
3154	1.5	Zinga	3.92	AquaZinga	8.71		
3155	2.2	Zinga	3.22	MIL-P-24441/F151	10.40		
3156	1.7	Zinga	3.20	AquaZinga	8.65	C-200a (Coal Tar Epoxy)	19.1
3157	2.2	Zinga	3.92	Alufur N (Polyurethane)	14.00		
3175	1.6	Zinga	4.78	Alufur N (Polyurethane)	14.20		
3176	1.6	Zinga	4.85				
3177	1.7	Zinga	2.73	V-106d (Vinyl)	6.42		
3179	1.8	Zinga	3.34	AquaZinga	7.28	MIL-P-24441/F151	14.38

All paints were applied to 3" x 9" x 1/16" cold-rolled steel panels. These panels were abrasive blasted to meet SSPC SP-5 requirements. The panels were wiped with a 50/50 mixture of Methyl Isoamyl Ketone (MIAK) and an aromatic naphtha, (HI-SOL 10), to remove any deposits of oil or grease. All coatings were thinned according to manufacturer's

instructions. Applied using a DeVilbiss MBC conventional spray gun. This spray gun was equipped with a DeVilbiss MBC-444E needle, a .070" fluid tip, and a #30 air cap. The air pressure was maintained at 45 psi. A standard gun to substrate distance of 8-10 inches was maintained. After application of the prime coat, a 24 hour drying time was allowed before top coating. After a cure time of one week a diagonal cut (approximately 3 inches long) was made on the lower half of one side of each exposure panel. This cut extended from the surface of the coating through to the substrate.

A major problem was noted during the application of the MIL-P-24441/F151 and the C-200a topcoats. After the first spray application on the front side of panels #3155, bubbles were noted to be forming rapidly in the topcoat film. After drying, small pinhole-like voids were evident in the film. This problem was viewed through a lighted microscope, after the coating was slashed open with a razor blade. The pinholing extended through the MIL-P-24441/F151 topcoat, but did not extend through the prime coat to the substrate. This pinholing problem was thought to have been caused by solvent entrapment in the porous zinc layer. An initial spray mist coat was suggested as a possible cure for the problem.

Panels numbered 3156 were top coated with C-200a after a week cure of the primer. Zinga literature indicated that this time delay would not be a problem. The panels were mist coated with C-200a to avoid the bubbling problems which were encountered during top coating. Mist coating did not help, and bubbles still formed in the topcoat layer.

The pinholing problem was not noted with the Alufur N and AquaZinga topcoats.

After the first four sets of panels were evaluated at a meeting with Mr. Van Riet, he indicated that better results could be obtained if the Zinga surface was cleaned with water and a soft brush before top coating. The last three panel sets reflect that suggestion. The panels were scrubbed, as instructed, before the topcoats were applied.

Panels 3175 were top coated with Alufur N. After coating, large blisters became apparent after approximately 48 hours. Mr. Van Riet indicated that these blisters were caused by an excessively thick topcoat.

Panels 3177 were top coated with V-106d. Entrapped

solvent resulted in immediate blistering.

Panels 3179 were scrubbed with water and a soft scrub brush before top coating. Panels were misted coated prior to a full spray pass. The bubbling of the topcoat was noted during the application even with the mist coat procedure.

Environmental Testing

Following application and cure, the panels were exposed to several environments. Exposure conditions included: warm (85°F) aerated tap water, cold (70°F) aerated tap water, cold (70°F) aerated synthetic sea water (ASTM D 1140), and atmospheric exposure (ASTM G 7; 45° south, Champaign, IL). The first four systems (3154,3155,3156,3157) were placed into test 25 August 1995. The last three systems (3175,3177,3179) were placed into test 17 July 1996. The first four sets of panels remained in test for twelve months before a visual inspection was performed. The results of that initial visual inspection are below.

Test Results

The following test results were observed for the first four test systems evaluated on 20 May 1996.

Cold Water Immersion:

3154: The panels were covered with a smoky haze. The score marks looked excellent and no corrosion was present. Aesthetically, the panels were poor, having an extremely mottled gray appearance.

3155: All panels looked excellent. A slight rust color was limited to the scored area.

3156: Large blisters were present under the C-200a topcoat. The adhesion of the C-200a at the blistered area was poor, but the Zinga prime coat still had excellent adhesion. Adhesion of C-200a in an unblistered area was excellent. Mr. Van Riet indicated that the blistering might be caused by a layer of zinc salts which were present on the Zinga layer. This problem could be solved by washing the prime coat with water prior to top coating.

3157: Rusting pinholes were present on the backsides of both panels. During application, the pinholes had not

been noted.

Warm Water Immersion:

3154: The panels were covered with a smoky haze. The score marks looked excellent with no corrosion visible.

3155: All panels looked excellent. A slight rust color was limited to the scored area.

3156: Large blisters were present under the C-200a topcoat. The adhesion of the C-200a in the blistered area was poor. The Zinga prime coat had excellent adhesion. Adhesion of C-200a in an unblistered area was excellent.

3157: All panels looked excellent. A slight rust color was limited to the scored area.

Salt Water Immersion:

3154: Rusting pinholes were present on the edges. A chalky coating which was lightly adherent was present at the waterline.

3155: Panels exhibited pinholes, but did not appear to be rusting. Scribe had a slight rust color.

3156: Large blisters were present under the C-200a topcoat. The adhesion of the C-200a at the blistered area was poor. The Zinga prime coat had excellent adhesion. Adhesion of C-200a in an unblistered area was excellent.

3157: Panels looked excellent. Scribes were clean and no rust was noted.

The following test results were observed for systems evaluated on 9 December 1996.

Cold Water Immersion:

3154: Adhesion on was fair to poor. The coating was extremely brittle at all areas of the panel. No corrosion around the scored area was evident.

3155: The pinholing in the topcoat was evident on these panels. A few pinholes were rusting. The scored area

was in excellent condition, with only slight corrosion present. Again the prime coat was extremely brittle. Adhesion was good. Adhesion at the scored area was also good with no underfilm corrosion present.

3156: The C-200a exhibited blistering. These blisters were evident at the first inspection of the panels, and were believed to be caused by a zinc salt buildup on the prime coat layer. Blistering at this time was now dense with many blisters 1.5 - 2 cm. in diameter. Adhesion of the coal tar at an unblistered area was excellent. Adhesion of the prime coat was good, but the coating was extremely brittle.

3157: The pinholing in the topcoat was evident on these panels. A few pinholes were rusting. Adhesion on these panels was fair. Slight corrosion at the scored area was present.

3175: Blistering of the topcoat, believed to be because of excessive thickness, was apparent. Corrosion was limited to the scored area. No underfilm corrosion was present. The topcoat adhesion was fair.

3176: Scored area looked excellent with only slight corrosion present. The panel had an extremely mottled gray appearance. The adhesion was excellent.

3177: Pinholing of the topcoat was noted, but no rusting of the pinholes was apparent. Corrosion was limited to the scored area. Adhesion of the vinyl topcoat to the prime coat was extremely poor. The topcoat could easily be removed using only slight fingernail pressure.

3179: Panels looked excellent, and corrosion was limited to the scored area. The adhesion of the prime coat and the topcoat was excellent, but the prime coat appeared to be extremely brittle. No underfilm corrosion was present.

Warm Water Immersion:

3154: Adhesion was fair to excellent. The coating becomes powder like when probed with a knife. No corrosion around the scored area was evident. Gray mottled appearance was evident.

3155: The pinholing in the topcoat was evident on these

panels. A few pinholes were rusting. The scored area was in excellent condition, with only slight corrosion present. Again the prime coat was extremely brittle. Adhesion was excellent. Adhesion at the scored area was also good with no underfilm corrosion present.

3156: The C-200a exhibits blistering. These blisters were evident at the first inspection of the panels, and were believed to be caused by a zinc salt buildup on the prime coat layer. Adhesion of the coal tar at an unblistered area was excellent. Adhesion of the prime coat was good, but it was extremely brittle. In the areas which the topcoat was removed while evaluating the adhesion (first evaluation) the prime coat layer has started blistering, and was easily removed using minimal pressure with a jackknife. The scored area remains excellent and no corrosion was present.

3157: Adhesion was excellent. Corrosion was limited to the scored area.

3175: Blistering of the topcoat, believed to be because of excessive thickness, was apparent. Corrosion was limited to the scored area. No underfilm corrosion was present. The topcoat adhesion was fair.

3176: Scored area looked excellent, and only slight corrosion was present. The panel had an extremely mottled gray appearance. The adhesion was excellent, but the removed coating was powdery.

3177: Severe blistering was present at the waterline on both sides of the panel. The pinholing from the application was apparent, but no rusting was noted. The scored area was free of corrosion. The intercoat adhesion was extremely poor, and the coating could be pulled from the substrate with ease. The prime coat had excellent adhesion, but the removed coating was powdery.

3179: Pinholing was severe on these panels. Coating sags were present on both panels due to poor application technique. Corrosion was limited to the scored area. Adhesion of the topcoat was excellent. The adhesion of the prime coat was slightly degraded and the coating was flaky. No underfilm corrosion was present.

Salt Water Immersion:

3154: Adhesion of the prime coat was good to excellent. The removed coating was extremely powdery. The scribe looks excellent and no corrosion was present. No underfilm corrosion was present.

3155: Application pinholing was severe on this set of panels. Some pinholes were showing rust. The scribed area looked excellent and no corrosion was present. Adhesion of the system was excellent. It should be noted that the adhesion test from the first examination was left unprotected. No corrosion was present at this location.

3156: The C-200a exhibits blistering. These blisters were evident at the first inspection of the panels, and were believed to be caused by a zinc salt buildup on the prime coat layer. Adhesion of the coal tar at an unblistered area was excellent. Adhesion of the prime coat was good, but it was extremely brittle. The scored area remained excellent and no corrosion was present. The exposed prime coat under the blistered area was corroded.

3157: Dark stains are present on the panels. The adhesion in these areas was not substandard. Adhesion at the scored area was good to excellent and corrosion was limited to this area.

3175: Blistering of the topcoat, believed to be because of excessive thickness, was apparent. No corrosion was present at the scored area. No underfilm corrosion was present. The topcoat adhesion was fair to good.

3176: No corrosion was present at the scored area. The adhesion was fair to good. The coating was extremely powdery.

3179: Severe pinholing was evident on these panels. Slight corrosion was limited to the scored area. No underfilm corrosion was apparent. The adhesion was excellent, but the removed coating was extremely powdery.

Conclusions

The typical Army Corps of Engineers applications for high performance coatings involves immersion in water. We have found that topcoats are required in this application for optimum performance. For this reason, the testing of the Zinga products included the application of topcoats. It was found that blistering and pinholing occurred when topcoats

were applied to Zinga. The problem was observed to some extent with all topcoats tested and was also seen on a panel topcoated with a CARC paint supplied by Zingametall.

The company representative suggested that the curing process resulted in the formation of zinc salts which could be removed by washing with water. It was not found that this process alleviated the bubbling and pinholing during application. Even if it had solved the problem, the inherent complexity and sheer size of Civil Works structures would make scrubbing the Zinga layer with water impractical and extremely time consuming. In addition there was no guidance to assure that all of the zinc salts have been removed.

Until such time as these problems are addressed by Zingametall, this laboratory considers our existing system to offer the best performance when applied to properly prepared steel.

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