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ANALYTICAL REPORT

REQUESTER: McCall, G., Code 487	RECEIPT DATE: 09 November, 2000
CONTROL NO.: N/A	REPORT DATE: 27 November, 2000
REFERENCE: N/A	REPORT NO.: FA-0079-00
SAMPLE IDENTIFICATION: Coating System, Non-Skid (MIL-C-24667A)	
PARENT EQUIPMENT: CVN-74	

1. BACKGROUND.

During resurfacing operations of the flight deck, several areas that displayed dark staining remained after being hydro-blasted. Hydro blasting is a process that uses high-pressure water (vice grit blasting) to remove the old non-skid coating system and prepare the metal deck prior to resurfacing.

During resurfacing operations on the deck, NADEP NORIS Code 487 personnel requested Materials Engineering Laboratory personnel (Code 434) assist in an on-site evaluation of the dark areas. The evaluation included a visual inspection, solvent swabbing, and sampling of the surfaces by scraping.

Evaluated areas included two separate hydro-blasted surfaces and a grit-blasted surface. Both hydro-blasted areas displayed dark stains. One of these hydro blasted areas was sampled within a few hours of being stripped by the blasting operation. The other area was reported to have been hydro-blasted the previous day. The grit-blasted surface displayed intermittent areas of superficial rust (reddish coloration) but no dark staining. Reportedly, this rusting had appeared after a day or two following grit blasting.

Stained and non-stained areas (adjacent to the dark spots) were included in the evaluation. Additionally during the sampling, a section of loose non-skid coat was noted in an area that was being hydro-blasted. A small section of this loose coating was removed from the flight deck for examination.

2. LABORATORY ANALYSES.

a. Visual Inspection.

The on site visual inspection was conducted with the aid of a lighted 20x magnifier. Pitting was noted in the dark stained areas. The pitting appeared relatively clean yet a dark discoloration was evident. No obvious difference was observed with respect to the "recent" and "old" hydro-blasted stained areas. The pitting appeared relatively superficial with no associated loose or flaking material noted. Areas immediately adjacent to the dark stains displayed a texture very similar to the grit blasted surfaces that also were inspected.

The inspected grit blasted surfaces appeared relatively uniform in texture with no pitting observed. In intermittent areas, red colored corrosion products were noted loosely adhering to the inspected surfaces.

The loose section of non-skid coating was examined with the stereo light microscope. As shown in Figures 1 and 2 of Enclosure (1), red and black corrosion products were present on the underside of the sample.

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b. Solvent Swabbing.

Hexane soaked swabs were used to collect any hydrocarbon residue (oil, JP, hydraulic, etc.) from the stained and non-stained areas. The swabbing residues were then analyzed by Gas Chromatography and Fourier Transform Infrared Spectroscopy. No hydrocarbon residues were detected in the swabs.

c. Surface Sampling.

600-grit silicon carbide sanding paper and a carbide-tipped tool were used to collect scrapings from the deck surfaces. The scrapings were then analyzed by Energy Dispersive Spectroscopy (EDS) via the Electron Microscope for overall composition and relative oxygen concentration. For comparison, the corrosion products noted on the sample of loose non-skid coating were similarly analyzed.

In each sample analyzed, only iron and oxygen was detected. The relative concentration of oxygen and iron in each sample was compared. This was performed by computing the ratio of peak heights in each EDS spectrum for oxygen and iron. The ratios are given below (larger numbers correspond to a larger oxygen concentration).

Dark stain, recent hydro-blast	0.8
No stain, recent hydro-blast	0.4
Dark stain, old hydro-blast	0.9
No stain old hydro-blast	0.3
Red stain, grit-blast	0.9
No stain, grit-blast	0.4
Corrosion products on non-skid sample	3.1

Note- look at Momber's graphs for different rust types
from ppt to NSRP Jan 2006

3. CONCLUSIONS.

Visual inspection of the dark areas revealed features characteristic of pitting corrosion that existed prior to hydro blasting. These areas appeared to have been scrubbed free of any loose or flaking material yet not completely cleaned of corrosion, hence the discoloration. This conclusion is supported by the findings of slightly increased levels of oxygen in the scrapings taken from the stained areas as compared to the non-stained areas.

Although the stained areas showed a slight increase in oxygen levels these amounts are minute compared to the oxygen in the obvious corrosion found of the section of loose non-skid coat that was taken from the flight deck. Additionally, no oily or greasy contamination was detected in the stained areas. This was confirmed by swabbing the stained areas with solvent and then chemically analyzing the swabs.

In conclusion, no gross differences were found between the non-stained hydro-blasted and non-stained grit-blasted samples. The stained areas showed slightly elevated levels of oxygen but whether or not these levels will reduce the durability of the adhesion of the non-skid coating system once it is in service is difficult to predict.

4. RECOMMENDATIONS.

A common test method for determining the pull-off strength of a coating is provided by ASTM D4541. This method relies on a fixture that applies a perpendicular force to a stub that has been bonded to the coating. Failure occurs along the weakest plane (cohesive or adhesive) within the system comprised of the test fixture, adhesive, coating, and substrate. This method maximizes tensile stresses as compared to other stresses such as shear or impact. Hence this type of test may not be directly comparable to actual in-service loading in all situations.

MIL-C-24667A states that in case of dispute, durability tests shall be performed on steel panels prepared in accordance with given guidelines. These guidelines state that the steel panels shall be abrasive-blasted to a uniform white-metal finish and show no signs of visible discoloration. The non-skid coating is then applied and various tests are performed such as a cable abrasion and an impact test. Unfortunately, no guidance is given for testing the durability (with respect to the adhesion of a coating) of a surface preparation technique that is used to prepare a previously corroded substrate.

Recommend investigating the feasibility of developing and performing a suitable durability test. One possible approach would be to prepare grit-blasted and coated steel test panels, subject them to cable and impact damage, then expose the panels to a salt fog (ASTM B117) environment. Next, hydro-blast the damaged panels and resurface with the non-skid coating. Finally, subject the resurfaced panels to cable and impact tests and compare the results.

5. ENCLOSURES.

(1). Figure 1, photograph of loose non-skid taken from flight deck.
Figure 2, magnified view of corrosion products found on above sample.

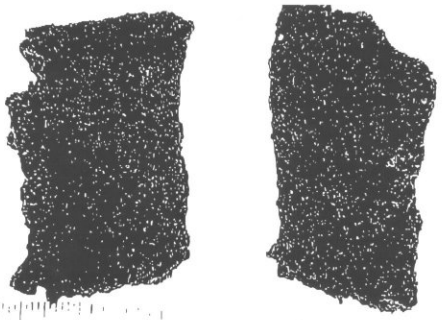

Figure 1. Sections of non-skid coat removed from flight deck. Underside surface shown with obvious corrosion products visible (scale shown).

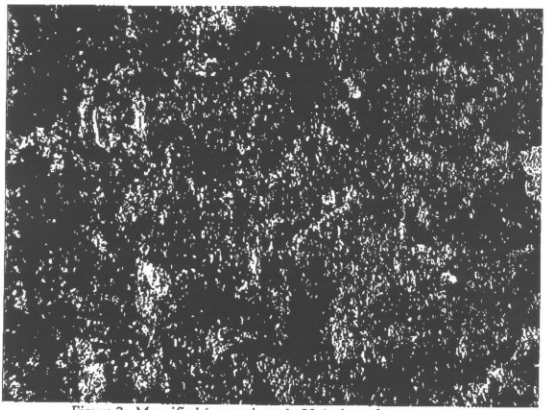

Figure 2. Magnified (approximately 20x) view of above sample.