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U. S. NAVAL APPLIED SCIENCE LABORATORY
NAVAL BASE, BROOKLYN 1, NEW YORK

9370:JZL:im
Lab. Project 4759-14

2 AUG 1963

From: Commanding Officer and Director, U. S. Naval Applied Science Laboratory
To: Distribution List

Subj: Patrol Craft (Hydrofoil), PCH-1, Cavitation erosion resistant coating applied to foils, struts, flaps and rudders. Condition after static immersion for four month period. SF 013-13-01, Task 0906. Bureau of Ships Identification No. 14-906-1

Ref: (a) NAVSHIPYDNYK ltr 9370:JZL:nr, Lab. Project 4759-14, Progress Report 11 of 27 Mar 1963
(b) BUSHIPS ltr SF 013-13-01, Ser 634C1-[illegible] of 7 May 1962
(c) FONECON btwn P. M. Sias (SUPSHIPS, USN, Seattle, Code 252) and J. Z. Lichtman, (MATLAB, Code 9370) of 14 Dec 1962
(d) FONECON btwn J. Z. Lichtman (MATLAB, Code 9370) and P. M. Sias (SUPSHIPS, USN, Seattle, Code 252) of 17 Dec 1962
(e) Spec MIL-P-22298(SHIPS). Paint, Black, Polyisobutylene
(f) Spec MIL-P-22299(SHIPS). Paint, Anti-fouling, Polyisobutylene

1. Introduction. The Applied Science Laboratory* has developed an ambient curing neoprene AD20 cavitation erosion resistant coating, formulation ML-C570, as authorized under reference (a). This coating was applied to the foils, struts, flaps and rudders of the PCH-1 as described in reference (b), during the period of 11 June to 16 August 1962. The time required to coat individual structures was 4 to 6 days. From the date of launching (17 August 1962) to 14 December 1962 when the boat was drydocked at the Tacoma Boatbuilding Company, 132 Sitcum Waterway, Tacoma 2, Washington, the boat was water-borne at the J. M. Martinac Shipbuilding Corporation, 1501 East D Street, Tacoma 2, Washington. The water at this location is fresh to brackish and contains little industrial waste, so that a degree of fouling could develop on underwater surfaces.

2. On the occasion of reference (c) it was reported that a preliminary inspection of the neoprene-coated areas revealed blistering and peeling of the coating in undefined areas. It was requested that a Laboratory engineer inspect the coating to evaluate its condition; determine the suitability of the coating for continued service and need for repairs of the coating; and to supervise such repairs prior to undocking. On the occasion of reference (d) it was indicated that J. Z. Lichtman, Laboratory engineer, would be in Tacoma on 19, 20 and 21 December to carry out the above inspection and evaluation of the neoprene coating and supervise repairs of the coating.

3. Condition of coating. Inspection of the neoprene coating on the foils, struts, rudders and flaps on 19 December 1962 revealed the following conditions:

*Applied Science Laboratory as of 1 July 1963; formerly Material Laboratory, New York Naval Shipyard.

a. Areas with no defects. Approximately 80% of the areas coated (approximately 800 sq. ft.) showed no damage or defects in the coating.

b. Areas showing peeling. Approximately 15% of the areas coated showed peeling of the coating between the outermost ply (consisting of five coats, 4 mils thick total) and the inner plies. The last coats comprising the outermost ply on the aft struts had been applied on 16 August preceding the date of launching on 17 August 1962. The plies below the last one were intact and showed no separation or blistering. The areas showing outerply peeling included:

(1) Aft strut starboard inboard and outboard from strut-nacelle joint to 2 feet above joint.

(2) Aft strut port inboard from strut-nacelle joint to 2 feet above joint.

(3) Forward foil, starboard and port, upper surfaces.

(4) Forward port flap, upper surface.

c. Areas showing blistering. Approximately 5% of the coating area showed scattered blistering in the coating, the distance between blisters varying from 1/2 inch to 1 foot. The diameter of the blisters varied from 1/8 to 3/8 inch. The blisters projected 1/16 inch or less above the coating surface. The blisters near the outer surface were soft because of the thinness of the film enclosing the blister, while blisters away from the outer surface were firmer because of the higher coating thickness enclosing the blister. The areas showing blisters included:

(1) Forward foil, port, upper surface.

(2) Forward flaps, port and starboard, upper surface.

(3) Upper rudder, starboard side.

(4) Aft foil, starboard and port, upper side.

(5) Starboard nacelle, forward area.

(6) Aft foil, port flap, upper surface.

d. Areas showing impact damage. Impact damage of the coating to the base metal was shown in the following areas and was caused by the indicated occurrences:

(1) Upper rudder, trailing edge. Caused by impact of rudder with the strut well when the foil-strut assembly was retracted while the rudder was not in the center position.

(2) Lower rudder, upper trailing edge. Caused by impact with flap at extreme position of rudder because of interference.

(3) Aft foil, starboard upper outboard edge. Impact of falling object during launching caused cutting of coating because of sharp edge of foil at this location.

4. Occurrence of fouling. When the PCH-1 was drydocked on 14 December, attachment of barnacles, tube worms and grasses to the neoprene coating was observed. The organisms and grasses were sloughed off easily by hand, and when the coating was examined on 19 December, it was found to be mostly clean of any fouling organisms.

5. Repairs made to coating:

a. Areas showing peeling of the uppermost ply. The poorly bonded plies were cut at the margins where good adhesion to the underplies existed, to remove any loosely hanging coating. The margins were skived, and faired in by sanding with fine grain abrasive finishing paper, to remove abrupt transitions. The faired margins were wetted with toluene and coated with several coats of the accelerated ML-C570 coating material to provide a smooth transition at this margin without loose edges. Because the thickness of the intact coating below the loosened ply was greater than 30 mils, the intact coating was recoated only at the skived margin.

b. Areas showing blistering. No repairs were made to the scattered blistered areas as there was no indication of coating weakness or degradation impairing erosion resistance of the coating. Also, the surface of the coating was smooth despite the slight variation of the coating profile in the region of the blisters.

c. Areas showing impact damage of the coating. Before recoating of impact-damaged areas of the coatings, sharp edges of the structures were rounded off to approximately 1/8 in. radius minimum. The lower rudder was also cut back at the upper corner to prevent contact with the flaps during operation. The coating was skived at the margin of a damaged area, where no separation to the base metal was shown. The bare metal was disk ground and degreased with trichloroethylene. This metal was then primed with Formula 117 pretreatment primer and coated with 1 coat of Bostik 1007. The adjacent skived coating was made tacky with toluene and the entire patch area was recoated with accelerated ML-C570 coating material to a total dry film thickness of 30 to 40 mils (25 coats). The structures being recoated were enclosed by wood and polyethylene film enclosures in which infrared heat lamps were placed, or to which hot air heaters were ducted to maintain an air temperature in the enclosure of 80-95F while the outside atmospheric temperature was 45-50F. The enclosures also served to maintain a low relative humidity in the vicinity of the coating and to accelerate the drying and cure of the coating.

6. In summary:

a. About 80% of the areas of the PCH-1 coated with the ML-C570 neoprene coating showed no visible defects after immersion in brackish water for four months, as indicated in paragraph 3.a.

b. Approximately 15% of the coated areas showed peeling of the coating between the outermost ply and the inner plies, as described in paragraph 3.b.

c. Approximately 5% of the coated areas showed scattered blistering in the coating, as described in paragraph 3.c.

d. The neoprene coating showed impact damage in several isolated edge areas, as described in paragraph 3.d.

e. Only moderate attachment of fouling organisms occurred during the immersion period, and this fouling could be sloughed off readily by hand, as indicated in paragraph 4.

f. Appropriate repairs were made to the damaged areas of the coating as indicated in paragraph 5a and c.

7. Conclusions:

a. It is considered that application of the ML-C570 coating in accordance with instructions of reference (a), including adequate solvation between plies to achieve adequate ply-to-ply bond strength, will result in a coating free of peeling. An increase in the post-application dry time prior to submersion from 1 day (as indicated in paragraph 3.b.) to 7 days (as indicated in reference (a), enclosure 2, section e (1)), would also contribute to prevention of peeling.

b. To minimize impact damage of the coating, all edges of the structure to be coated should be rounded to a minimum radium of 1/8 inch.

c. Although the attachment of fouling organisms was relatively weak as indicated in paragraph 4, the coating does not possess inherent anti-fouling properties which would prevent any organism attachment.

8. Future studies and inspections:

a. Laboratory investigations are underway to determine the causes of the observed blistering of the ML-C570 coating. In these investigations, the effects of discontinuities in the metal pretreatment and adhesive coats, and in the toluene wash films between coating plies, will be determined. Other factors, including thoroughness of mixing of the coating base and accelerator components, and cleanliness of the substrate, will also be studied.

b. Modification of the ML-C570 coating system to include anti-fouling components, and also the application of anti-fouling coatings over the ML-C570 coating, are being investigated to provide anti-fouling properties to the coating system. Preliminary results show good bond strength between the ML-C570 coating and Formulae 133 and 134 anti-fouling paints, references (e) and (f) brush applied to the ML-C570 coating. Although the 133 and 134 coatings are not as cavitation-erosion resistant as the ML-C570 coating, they may be expected to provide anti-fouling protection under the more critical dockside periods. Cavitation erosion under flying conditions may be expected to result in only localized removal of the 133 and 134 coatings, with retention of fouling protection to the major elastomer-coated area.

c. The ML-C570 coating will be inspected during ship's trials to determine its behavior under operating conditions. The ship's trials were scheduled to commence during March 1963.

D. 2. [illegible]
By direction

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