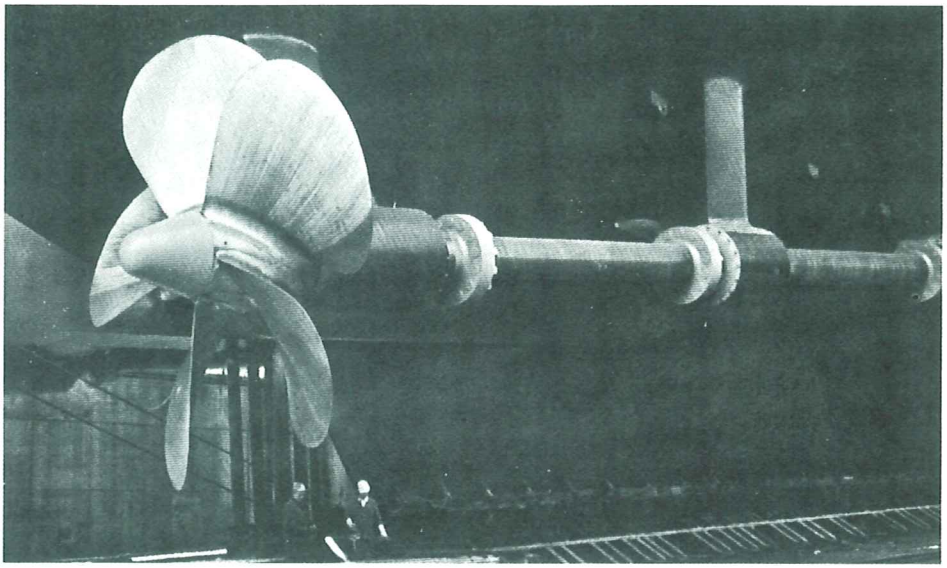
Bulletin 970B

Phillyclad®

PROPELLER SHAFT COATING SYSTEM



Properly applied glass-reinforced epoxy laminate will provide the most effective long wearing, corrosion protection for water-borne main propulsion propeller shafting and other metal surfaces exposed to severe marine environments.

ITW Philadelphia Resins

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The three basic requirements for satisfactory shaft protection

1. Use of a qualified materials system
2. Correct surface preparation
3. Proper application technique

MATERIAL SELECTION

ITW Philadelphia Resins' PHILLYCLAD® 1775/620TS was developed to exceed the requirements of Navy, Coast Guard and commercial shaft coating specifications. It is the most generally used shaft coating in the world. Meeting NATO requirements and those of most other navies and Classification Societies it is also in use on U.S., Canadian and Russian icebreakers. In particular, it meets the U.S. Navy's present MIL-R-23461 (Ships) and the proposed new specification.

SURFACE PREPARATION— NEW AND USED SHAFTS

Sandblast to near white metal with clean grit or sand. Number 2 sand shot is recommended with a minimum air pressure of 5.5 kg/cm^2 (75 psi). A surface profile of at least 0.075 mm (0.003") is desirable. Schedule the blasting so there is a minimum delay before the coating is applied. Wrapping the shaft with polyethylene sheet may protect the finish for up to 24 hours if there is unavoidable delay. If the coating finishes on a shrunk-on sleeve, the sleeve end should be faired so there will not be a step in the coating. Use PHILLY-BOND® No. 6 for this. Use it also to fill any corrosion pits or other surface irregularities. Allow at least one hour for hardening. Rinse the shaft with PRT-59 Solvent, trichlorethane or other chlorinated solvent. Do not use hydrocarbon solvents. Pour ample solvent over the shaft so that it runs off. Do this twice. Do not use any cloth, paper or waste to dry it. Do not handle or contaminate the shaft in any way.

NOTES

1. Do not prepare the shaft until it is ready to be coated.
2. Temperature is important. The shaft and resin should not be below 20°C (68°F), 27°C (80°F) is desirable. Both the cure time and tape wet-out by the resin are significantly affected at low temperature.

Estimating the materials required

1. To determine the quantity of glass tape required per layer, the following formula is used:

$$L = \frac{3.5DH}{W}$$

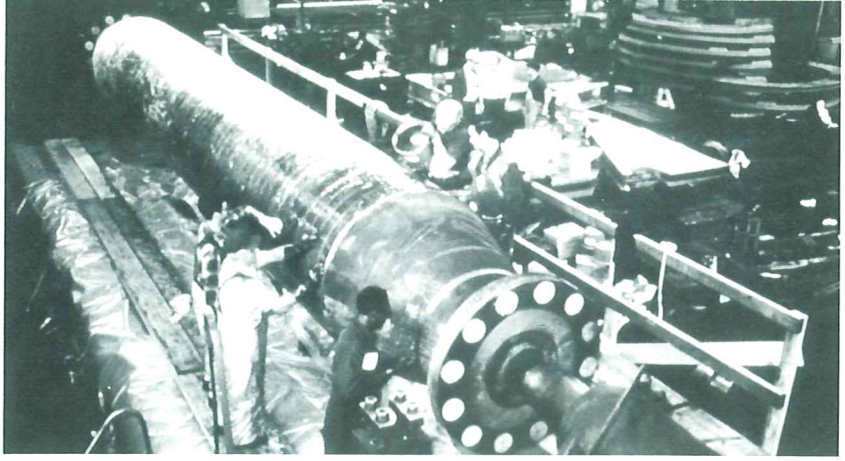
L	=	Length of glass tape in millimeters (inches) per layer
D	=	Diameter of shaft in millimeters (inches)
H	=	Length of shaft to be covered, millimeters (inches)
W	=	Width in millimeters (inches) of glass tape

Small shafts under 150 mm (6") in diameter, use 75 mm (3") wide glass tape. Larger shafts use 150 mm (6") wide glass tape. All shafts require 4 layers.

MATERIALS REQUIRED

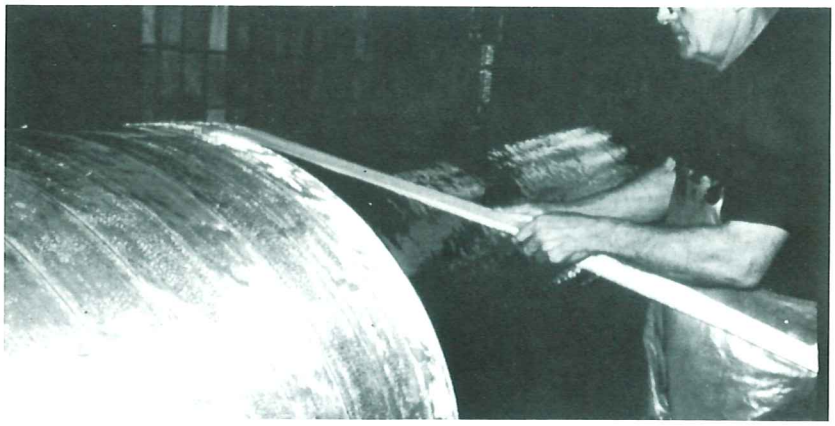
PHILLYBOND® No. 6	0.454 kg (1 lb) kit, 267 cc (16.3 in^3) or 3.785 liter (1 gallon) unit, 3785 cc (231 in^3).	MIL-R-17882C
PRT 69 Solvent	3.785 liter (1 gallon) cans and 18.925 liter (5 gallon) pails.	
Glass Tape	Woven edge 150 mm (6") or 75 mm (3") wide. 40 m (150') rolls.	
PHILLYCLAD® 1775/620TS	Clear epoxy resin and hardener. 3.785 liter (1 gallon) unit. See the last note on the back page for when the shaft cannot be rotated during application.	
PHILLYCLAD® 6470	Heavy duty gray epoxy coating for couplings and bolts after assembly. Coverage 2 m^2/liter (80 ft^2/gallon) at 250 µm (10 mils). 2 gallon (7.57 liters) unit.	
Jiffy H Mixer Blade	To be driven by an electric drill.	

Polyethylene sheet or heavy paper is required to protect the lathe bed or floor from drips and spillage.



2. To determine the quantity of resin required per coat, find the number of square millimeters (sq ft) to be covered. (3.5 x diameter x length.) One liter covers 2 square meters. (One gallon covers 80 sq ft)
3. Four layers of tape require 5 coats of Resin.
4. Quantity of solvent to wash shaft will vary but usually two washdowns are needed to obtain oil and dirt free surface. Figure on 19 liters (4 gallons) per 6 meters (20') of shaft. PRT-59 is also useful for cleaning mixing tools, etc.

APPLICATION TECHNIQUE



Do not mix the resin and hardener until ready to start the application. Check the shaft with a clean cloth to be sure there is no oil or dirt from handling.

Power mix a pre-measured unit of resin and hardener with a Jiffy type H mixer blade at about 175 rpm. The mix must be thorough and complete, making sure the resin and hardener on the sides of the container are blended together thoroughly. Generally 3 to 5 minutes is sufficient. The resin and hardener temperature must be 22°C (72°F) or above. If the mixture turns milky upon mixing, it is too cold or the mixing RPM are too high.

Pour mixed resin on top of the shaft as it rotates in a lathe or on powered rollers. Spread it with gloved hands or roller to completely wet out the surface. (Use throw-away plastic gloves or clean re-usable rubber gloves.) Two men can typically cover a shaft 500 mm (20") by 6 meters (20') long in 10 to 15 minutes. It is essential that there be no dry spots. Two persons are required for the tape application. One holds the roll of tape on a horizontal axle, and feeds it on to the rotating shaft. The other stands by with a large pair of scissors to assist in any way necessary.

When starting the layer of tape, wind one complete turn around the shaft to cover the tape end completely. Use moderate tension so the tape sinks in the resin but does not slip excessively. Once the turn is complete, apply more tension by braking the roll with the thumbs and lead off with decreasing tape overlap into an open helical wind. Take care not to create wrinkles, but also avoid unnecessary overlapped turns. Once the helix is established the adjacent tape edges should be about 3 mm (1/8") apart. Continue the helical winding until the other end of the shaft is approached, start progressive overlapping and finish up with one complete straight turn. Cut the tape without stopping the shaft rotation.

Allow the resin to soak through the tape completely, it may take 15 minutes. When it has, apply a second layer of mixed resin. Wind on a second layer of tape, starting at the end where the first layer finished. Allow this to soak through and repeat the procedure until four alternating layers of tape have been put on the shaft.

When the fourth layer of tape has soaked through thoroughly, apply a generous fifth coat of resin. Keep the shaft rotating slowly until the resin has hardened. Excessive speed at this stage may cause ridges in the resin coat.

Do not use short left-over pieces of tape if they will cause extra joins. When a tape roll ends part way along a shaft, overlap its end with the new tape and put a complete turn around the shaft. Progress out to a helix as normal. Wrinkles should be pressed out if possible. If too large, cut the fold with the scissors and press it flat. A large fold may require a narrow triangle to be cut out.

Long tapers, whether to a coupling or to a sleeve, should always be wrapped going up the taper. When the general winding direction of a layer is in the contrary direction make a separate winding for the taper. Start along the shaft sufficient distance so that the com-

Phillyclad® Propeller Shaft Coating System

plete starting turns of these two sections of the layer do not overlap each other.

1. Convenient speed range for wrapping shafts with tape:

   14.5 meters to 25.5 meters (48′ to 84′) per minute surface speed.

   If shaft diameter is d, turning speed range in revolutions per minute will be:

   $\frac{4650}{d}$ to $\frac{8150}{d}$ rpm when d is in millimeters,

   $\frac{183}{d}$ to $\frac{321}{d}$ rpm when d is in inches.

2. Cure Time: May be handled after 8 hours at 24°C (75°F). Faster at higher temperatures. Allow 18-24 hours at 18°C (65°F) and below.

3. Shafts already coated and in for repairs or inspection which show pin holes must be repaired as follows:

   (a) Mechanically sand area in and around pin hole and fill hole with PHILLYBOND No. 6 Paste.

   (b) Sand flush.

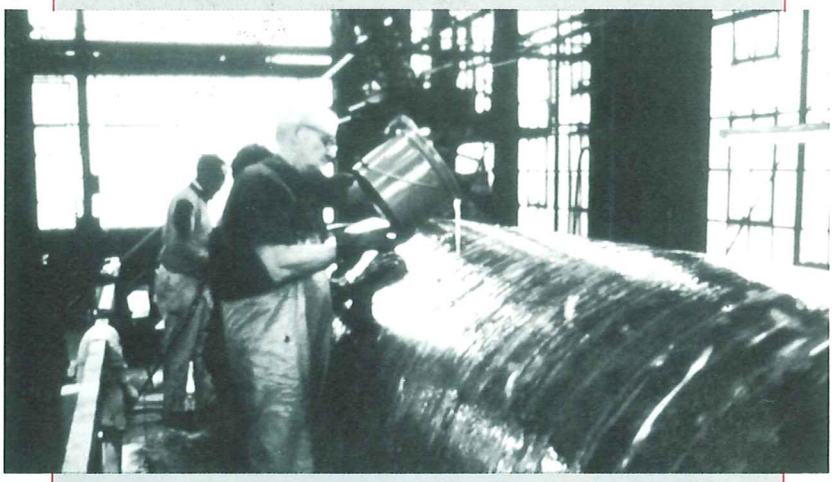
   (c) Apply one coat of epoxy resin PR-1775 with PRH-620TS hardener. More extensive repairs can utilize glass tape and resin.

4. Flange, nuts and strut areas difficult to coat with glass tape are cleaned as described and coated with PHILLYCLAD 6470 — two coats (10-12 mils per coat).

5. When the shaft cannot be rotated during application or a section has to be repaired when installed in the ship, then PHILLYCLAD 1762/620TS resin/hardener system should be used. This is non-sagging but otherwise similar to PHILLYCLAD 1775/620TS.

Whenever possible PHILLYCLAD 1775/620TS and rotary application is preferred because it gives a smoother finish and is also transparent.

TAILSHAFT COATING SYSTEM



PHYSICAL PROPERTIES

COLOR:	Clear Amber
CURE TIME:	24 hours @ 22°C (72°F)
% ELONGATION:	30% ASTM D-638
FLEXURAL MODULUS:	8050 kg/cm^2 (1.15 x 10^5 psi) ASTM D-790
FLEXURAL STRENGTH:	366 kg/cm^2 (5,200 psi) ASTM D-790
MIXING RATIO:	4:3 by volume and weight
SPECIFIC GRAVITY:	1.08
NET WEIGHT per 3.8 liter (1 gallon) Unit	4.1 kg (9 lbs)
PACKAGING:	3.8 liters (1 gallon) unit
POT LIFE:	40 min. @ 22°C (72°F) 3.8 liters (1 gallon) unit
SHELF LIFE:	One year
TENSILE STRENGTH:	285 kg/cm^2 (4,050 psi) ASTM D-638
VISCOSITY:	1000-1500 cps @ 22°C (72°F)

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