Section	
Name	General Underwater Application Notes.
Last Updated	08/04.
Aim	To provide guidance and assistance towards the preparation and application of NMP products underwater.
Scope	Covers general notes on surface preparation and application methods in fresh and salt water environments.
References	

Application of NMP Epoxies Underwater

Common applications for NMP's underwater epoxies include piers, marine pilings, ship repair, dam/structure re-surfacing, tank repair, and water void filling. The following document details the procedures when using NMP epoxies underwater. NMP 1720/25 are primary examples of underwater products, as they have been specifically formulated for diver usage and incorporate many features and benefits for the underwater industry.

1 Surface Preparation

While surfaces may be wet, it is imperative that they are clean for coating longevity. Remove any marine growth, slime, loose coatings, or rust before recoating with NMP epoxies. While "white metal" surfaces aren't necessary, the cleaner the surface, the better the adhesion.

It is recommended that underwater surface preparation be performed by water jetting with entrained abrasive at a pressure of 2,500psi. In the absence of abrasive, a higher pressure in the order of 5,000psi is required. Sand blasting with ordinary, above water equipment is possible, but very slow and uneven (where the jet makes contact will be bright metal, however within a few centimetres either side there will minimal effect). As a general rule of thumb, on open flat surfaces, allow for a surface preparation rate of $18m^2$ per hour per nozzle for pressure cleaning. It is recommended to work in "boxes" by marking out sections to be cleaned and applied at a time, and to progressively work through these boxes.

Conventional air/abrasive blasting works well for small areas, however tends to produce uneven results – where the jet of air and abrasive strikes the surface there will be a "white-metal" blast, however the cleaning only 2-3mm away may be very poor. Water-jetting tends to deliver a much broader and more uniform effect.

Hand held tools such as grinders and needle scalers are only useful for very small areas of the $0.1\text{-}0.2m^2$size range. Wire brushes underwater are rather ineffective.

It is important to apply the particular coating within 40 minutes of blasting; otherwise the cleaned surface will become re-contaminated with marine fouling settlement. This initial settlement is just like a film of jelly and will interfere significantly with adhesion. Firmly attached remnants of shell fouling such as barnacle bases are acceptable for coating. After water jetting the surface should appear to be all concrete or shell bases and should feel gritty and granular. A slimy feel to the fingertip is not acceptable.

Remove any source of electrical current. Stray electrical currents through steel pilings or hulls will prevent the epoxy from adhering. Such currents are commonly caused by active galvanic protection systems, nearby anodes, shipboard arc-welding operations etc. Usually such current sources can be located and isolated, but not always. See further information below in section 4.2.3 – Cathodically Protected Surfaces.

Below is a listing of the surface preparation methods, annotated with comments on their effectiveness in underwater application.

- Wire brushing – is not recommended except in the smallest areas where vigorous brushing can be made to remove most contamination.

- Grinding – can work well in small areas provided sufficient attention can be afforded to all areas receiving the coating. Grinding is especially useful in localised repairs above or below water.

- Needle gunning – has been used successfully above and below water provided the area is small enough to receive complete attention.

- High-pressure water blasting – is effective provided the water pressure is high enough to remove all contamination. Pressures in excess of 5,000psi will be required to remove tight contamination such as marine growth on steel and concrete. The nozzle must be held close in to ensure effectiveness since its efficiency falls off rapidly as it leaves the surface.

- Abrasive blasting high-pressure water – is the preferred method of preparation. Abrasive blasting with high-pressure water is particularly effective underwater and may be accomplished with most commercial equipment down to 18 HP 2,500psi units with venturi sand injection.

2 Application

2.1 Application Tools

Underwater application is typically more compatible with "spreading" type tools rather than brushes or rollers. Rollers tend to leave a very rough surface and brushes can be wasteful and messy as material is forced out of the edges.

The following application tools have been found to be effective:

- Brushes – are useful in a combination spreading/brushing motion. To be effective they have to be stiff – extra stiffness in a standard brush can be obtained by either cutting off half the bristles, or wrapping duct tape around half of the bristles at the handle end. NMP 1530, 1535, 1710 and 1715 are suitable for brushing underwater.

- Painters Mitts or "Fuzzy" Gloves – are mitts worn over a rubber glove. Underwater-applied product can be lifted from its pail and simply smeared onto the surface with good results. This method works especially well for pipes or irregular shaped surfaces.

- Spreaders – such as plastic, straight-edged spreaders used for applying wall joint compound are ideal for large, flat areas.

- Customised Spreaders – spreaders can be customised by wrapping carpet scraps around a plywood base and stapling in place. A 20cm x 10cm spreader with a handle on top makes an excellent tool for applying larges volumes. The carpet serves as a cushion and reservoir to smooth out the application, especially over welds.

2.2 Application Procedure

The diver's assistant mixes about 2-3 litres of material on the surface and hands it to the diver in a bucket. This bucket is generally hung from the diver's belt. By doing this, the diver has the use of both hands for navigation and application.

When applying the product underwater it is important to work steadily and slowly. Allow the product to sit on the surface for a short time before beginning to brush, smear etc. The weight of the water tends to tear off loose product at the edges if the applicator is too vigorous - slowing down and working methodically will yield a better job with less wastage. Lift the product from its pail and apply to the surface. Under some circumstances, it will be found that two or three passes over the surface may be required for the product to "reach down" and adhere strongly. This can happen when the surface is contaminated and a couple of sweeps over the surface is required to clean and condition it for coating.

The freshly applied material is immune to wave action at the surface (NMP 1720/25 in particular) and will only be damaged by prolonged water flow such as in the path of a propeller current before curing. Under normal water conditions of approximately 26^{o}C, products will have hardened appreciably after about 4-6 hours. At 36^{o}C, it will reach the same state in only 2-3 hours, whereas in 16^{o}C water it will take 8-12 hours to achieve the same hardness. Once the product has reached the stiff, "gummy" condition it will be resistant to damage from flowing water and gentle impact.

Some other useful suggestions and observations regarding underwater application are offered below:

1. In cold conditions it is worthwhile to pre-heat the product tins in hot water to deliver a quick and effective reduction in viscosity. This can be done in an esky or any other available container. This is particularly relevant to the high viscosity pastes, such as NMP 1710/15/20/25.

2. Only mix smaller, manageable amounts and while the product is still warm, quickly take under and apply.

3. If the water is too cold, the product will display a tendency to roll up on itself, which makes brushing/smearing the product a difficult task.

4. As always, the product must be mixed thoroughly until the colour and texture reaches a good consistency.

5. When applying the product, allow it to sit for a short time (so it can begin displacing the water) and then begin to smear and work the product to the specified areas.

6. Temperature will exert a considerable influence on the rate of chemically cured coatings. In broad terms expect each 10^{o}C rise or fall in temperature to half or double pot lives respectively.

2.3 Cathodically Protected Surfaces

Cathodically protected surfaces underwater can have application difficulties if the protection is above about –0.85V (Ag/AgCl system). A polarised steel surface has products of polarisation on it that might be due to a high pH environment or possibly saponified (fatty acid salts or soaps that result from the breakdown of triglyceride by sodium hydroxide) biological material resulting from the contact of micro-organisms.

In order to minimise cathodic protection problems, recommendation is made for the following:

a) Turn off cathodic protection the day before coating; undo continuity straps on pier sections if possible.

b) Apply coating within 40 minutes of surface preparation. This also avoids problems for early settlement of biological fouling.

c) If sacrificial anodes are to be replaced, do this after coating rather than before. If possible, remove the exhausted anodes and discard them before beginning coating work.

For more information on cathodically protected surfaces, consult General Corrosion Notes section of the manual.