Selecting the right finish

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Preventing corrosion

In planning any cabling or support installation the choice of an appropriate corrosion resistant finish is always a key issue at the specification stage, ranking alongside installation time and load carrying ability. However, unlike these other factors, which are only of importance during the installation phase, the correct choice of finish has long term implications and is crucial for ensuring the longevity (and aesthetics) of the complete installation in order to meet with the client's expectations.

Since future maintenance of any support system is virtually impossible, it is vital that the finish specified for the equipment is capable of providing lifetime protection from corrosion within the intended environment - ideally with some margin of safety.

The following pages give information on how corrosion occurs and supporting technical data on the standard construction materials and surface finishes available within each range of products supplied by Legrand. Contact our technical team on +44 (0) 845 605 4333 for further information.

Corrosion occurs on all metals to some extent. With some, such as stainless steel, its effects are usually only slight but even then the presence of certain chemicals or physical contact with other metals may cause rapid corrosion. It is therefore important to consider every aspect of the environment surrounding any intended installation in order to choose a material or finish which will minimise the risk of damage to the support system through the effects of corrosion.

1 Chemical corrosion

Few metals will suffer corrosion damage in a dry, unpolluted atmosphere at a normal ambient temperature. Unfortunately such environments are exceptional and atmospheric pollutants are likely to be present to some degree in most situations where support systems will be installed. Thus mild chemical corrosion is normal in almost all situations and useful information on the types of material or choices of finish which will inhibit and control this are given within the following pages.

Any support installation which will be situated in an area where higher concentrations of chemicals exist must receive more detailed consideration in order to select a finish which provides the best combination of initial cost and expected life. To assist in this, tables on page 117, give guidance on the suitability of the standard materials and finishes used for support systems in the presence of those chemicals most commonly found within industry. More detailed information is available upon request, please contact us on +44 (0) 845 605 4333.

2 Electrochemical corrosion

When two dissimilar metals are in contact and become damp it is possible for corrosion to be induced in one of the metals. Such corrosion may progress rapidly and cause considerable damage so it is important to consider and, if necessary, take steps to eliminate this process occurring.

Electrochemical (or electrolytic) corrosion takes place because the two different metals each behave as electrodes and the moisture as the electrolyte in a simple battery; as with any battery the resulting flow of current will cause corrosion of the anode. The likely effects of this reaction can be predicted using the Galvanic Series.

3 Galvanic Series

Even when two dissimilar metals are in moist contact, electrochemical corrosion need not necessarily take place. Its likelihood depends upon the potential difference between the two metals; this can be obtained by taking their respective values from the chart below and subtracting one from the other.

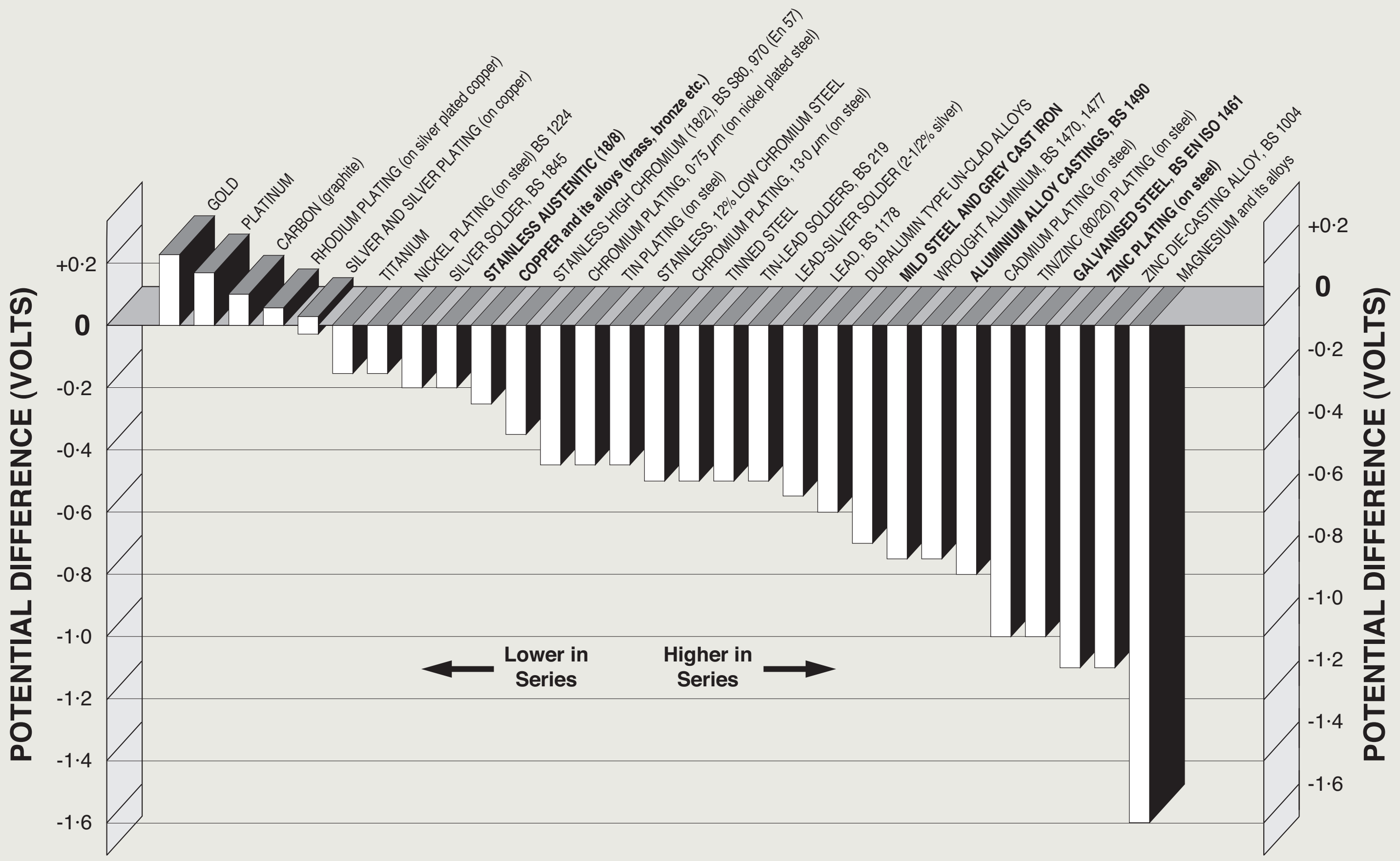
When the potential difference is less than the values given in the table to the right corrosion is unlikely to occur.

Environment	Maximum Potential Difference
Marine and outdoor	0·3 volts
Indoor	0·5 volts
Indoor, hermetically sealed (dry)	No restriction[1]

(1) With no moisture to act as the electrolyte no electrochemical corrosion can take place

If corrosion does take place the metal which is higher in the Series (to the right) will be corroded in preference to that which is lower in the Series (to the left).

Galvanic Series chart



The Galvanic Series illustrates the potential difference between a section of metal and a Calomel electrode when both are immersed in sea water at 25°C. This chart contains most commonly used engineering or plating metals.

If corrosion does take place the metal which is higher in the series (to the right) will be corroded in preference to that which is lower in the series (to the left).

If the affected metal has a small surface area in relation to its counterpart it will be corroded very aggressively and any sacrificial protection it provides may be short-lived. If on the other hand it has a large surface area in comparison to its less reactive counterpart, some minor corrosion may take place at points of contact but the process is likely to reach equilibrium rapidly so that any further reaction is insignificant.

If from consideration of this Series excessive corrosion does appear likely then the risk can be largely eliminated by insulating the dissimilar metals from one another, breaking the electrical path between them. A layer of paint on either surface is usually sufficient to achieve this.

4 The merits of Zinc

The Galvanic Series does show why zinc is such a useful corrosion resistant coating for mild steel.

Firstly, it forms an impervious zinc barrier around the steel, coating it with a metal whose own rate of chemical corrosion is both low and predictable in most situations.

Secondly, if the coating is damaged at any point (e.g. at a cut edge) the zinc surrounding the damaged area becomes the anode of the electrolytic cell and is sacrificially corroded away very slowly in preference to the underlying steel. This ensures the strength of the steel structure remains unaffected.

Because zinc appears near the top of the Galvanic Series it will act as a sacrificial anode in relation to most other metals; thus its relatively low cost and the ease with which it can be applied as a galvanised coating on steel means that it continues to be the most commonly specified protective finish for support systems.

Life expectancy of zinc coatings

The resistance of galvanising to atmospheric corrosion depends on a protective film which forms on the surface of the zinc. When the steel is withdrawn from the galvanising bath the zinc has a clean, bright, shiny surface. Over time the appearance will change to a dull grey patina as the surface reacts with oxygen, water and carbon dioxide in the atmosphere. A complex but tough, stable and protective layer is formed which adheres to the zinc. Contaminants in the atmosphere affect the nature of this protective film.

The most significant contaminant which will accelerate the corrosion rate of zinc is sulphur dioxide (S02) and it is the presence of S02 which largely controls the atmospheric corrosion of zinc.

The Galvanizers Association has undertaken significant research based upon the positioning of reference canisters placed throughout the UK and the Republic of Ireland to establish background corrosion rates for 10 km square grids which has resulted in the formation of The Zinc Millennium Map.

For most sites on this map an average hot dip galvanised coating will last between 40 to 100 years, highlighting the potential for significant financial savings when galvanising is specified. However, with the correct use of the map specific locations can be analysed for average zinc corrosion rates per year.

The Zinc Millennium Map

The definitive geographical guide to the different corrosion levels of galvanised steel products used in the construction industry

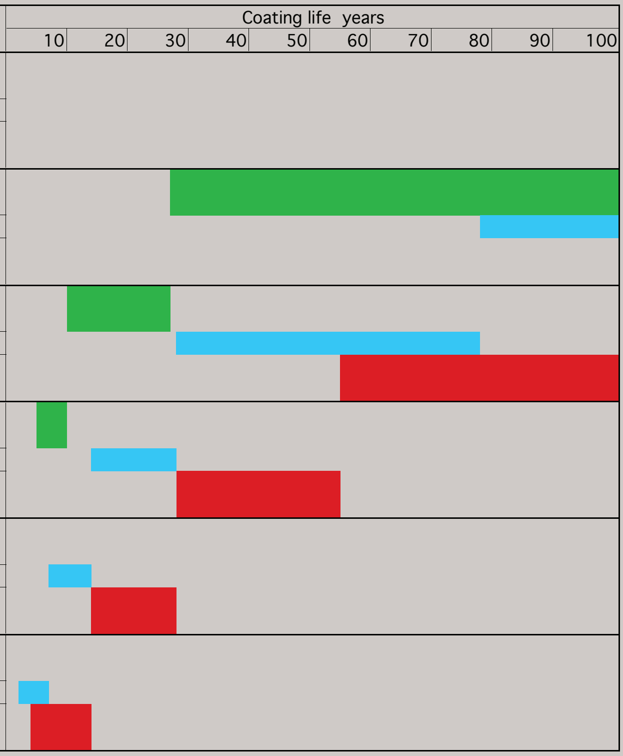
Corrosion rate key	1	2	3	4	5
Average Corrosion rate (µm/year)	0·5	1	1·5	2	2·5
Average life of 85µm galvanised coating (years)	187	85	57	43	34

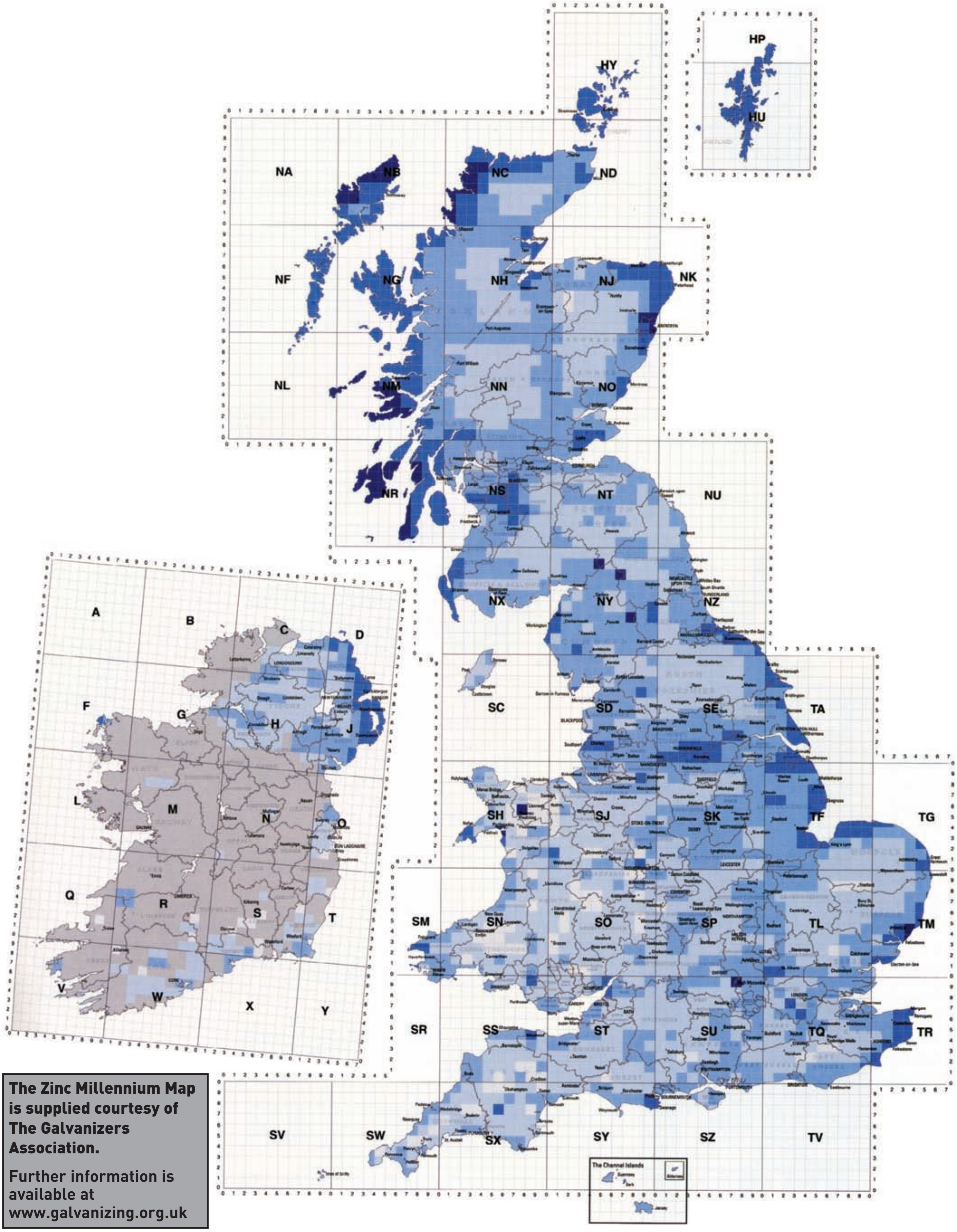
Please note this is an average background corrosion rate for zinc

For further information please contact the Galvanizers Association

BS EN ISO 14713 general corrosion effects and life expectancy for zinc coated products

Corrosivity category	Corrosion rate of	Environment - interior	Environment - exterior	Pollution level	Zinc coating thickness	Coating life years
C1	< 0.1 Very low	Warm, dry, no pollution		0	PG (Z275) = 19 microns	> 100
					G = 55 microns	> 100
					D = 110 microns	> 100
C2	0.1 to 0.7 Low	Unheated, low condensation, low pollution	Temperate, rural, urban with low pollution	<5	PG (Z275) = 19 microns	> 100
					G = 55 microns	> 100
					D = 110 microns	> 100
C3	0.7 to 2 Medium	Moderate condensation & pollution eg food processing plants	Temperate, urban with medium pollution, mild coastal	5 to 30	PG (Z275) = 19 microns	
					G = 55 microns	
					D = 110 microns	> 100
C4	2 to 4 High	High condensation, high pollution eg chemical or industrial plants,	Temperate, urban with high pollution, industrial, coastal	30 to 90	PG (Z275) = 19 microns	
					G = 55 microns	
					D = 110 microns	
C5	4 to 8 Very high	Very high condensation & industrial pollution, eg mines	Temperate, very high pollution, industrial & high salinity coastal	90 to 250	PG (Z275) = 19 microns	
					G = 55 microns	
					D = 110 microns	
CX	8 to 25 Extreme	Permanent condensation & high pollution	Very high pollution, extreme industrial, coastal & offshore with occasional salt	>250	PG (Z275) = 19 microns	
					G = 55 microns	
					D = 110 microns	





The Zinc Millennium Map is supplied courtesy of The Galvanizers Association.

Further information is available at www.galvanizing.org.uk

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5 Common corrosion situations

Finally, the most common occurrences of contact between dissimilar metals within support systems are :

a. Where stainless steel components are being fixed to a carbon steel structure

b. Where galvanised or zinc plated components are being fixed onto a stainless steel support system

c. Where copper components (e.g. copper tubing or MICC cable) are being installed onto a galvanised steel support system

In relation to these three sets of conditions the following comments apply :

(i) Stainless steel – mild steel

This situation has been the subject of much consideration and debate over recent years, particularly in the offshore energy industry.

Whilst Legrand can supply kits of components (including, according to the circumstances, insulating pads, sleeves for fasteners or insulating coatings) the latest metallurgical advice from both the manufacturers of stainless steel and other bodies is that these metals are sufficiently close together in the Galvanic Series for any electrolytic effects to be ignored in normal offshore environments. One exception is when a small mild steel (or galvanised mild steel) component is in direct contact with a large mass of stainless steel.

It is now accepted that the application of a simple paint coating to one of the juxtaposed surfaces will provide sufficient insulation to break the electrical circuit, effectively eliminating any problems.

(ii) Small galvanised components on stainless steel

The zinc coating will provide very limited protection to its underlying steel because of the rapidity with which it will erode away. Once exposed the base steel (often a fastener) will be aggressively corroded causing unsightly staining of the stainless steel and premature failure to the component. In the case of fasteners such failure could be catastrophic to the installation so appropriate stainless steel fasteners should always be used with a stainless steel support system.

(iii) Copper on zinc

If copper is laid directly onto a galvanised surface the zinc will rapidly erode. Thus MICC cable should always have an insulating sheath if it is to be installed on galvanised cable ladder.

Suitability of finishes

1 Metallic finishes

The table on the following page outlines the suitability of metallic finishes under a variety of conditions. The following notes apply to the data :

1. Hard water promotes the formation of a stable protective film on a hot dip galvanised coating.

2. Salt spray testing should not be used on galvanised coatings; the data provided by such accelerated weathering tests is misleading and inaccurate on this finish since the formation of the protective film (patina) is prevented from forming under the artificial conditions.

3. No information is available on the resistance of galvanised coatings to contact with this type of oil. However, in general terms galvanised coatings are resistant to oil-based products.

4. Resistant provided that the oil is stable, free from acidity and of mineral origin.

5. Under immersed conditions contact with this chemical is not recommended and over-coating with a paint or powder system is necessary. When this chemical is an airborne aerosol the coating performance depends on various factors specific to the particular application. Corrosion rates will be high and if condensation is likely to be heavy and its pH value is outside the range pH5 - pH12.5 then overpainting or coating of the galvanising is normally recommended.

If the galvanised surface is frequently washed by fresh water and allowed to periodically dry out then the level of corrosion will be less severe.

2 Organic finishes

Refer to the table on the following page for information on the suitability of organic finishes under a variety of conditions.

Suitability of metallic finishes

		Stainless steel 316		Stainless steel 304		Pre-galvanised steel		Hot dip galvanised steel		Deep galvanised steel		Aluminium	
ENVIRONMENTS	Fresh water	✓		✓		✗		✓	see note (1)	✓	see note (1)		
	Salt spray B177 Test	✓		✓		✗		✓	see note (2)	✓	see note (2)	✓	
	Polluted marine environment	✓		✗		✗		✓		✓		O	
SOLVENTS	Acetone	✓		✓				✓		✓		✓	
	Petroleum (gasoline)	✓		✓				✓		✓		✓	
	Trichloroethylene	✓		✓				✓		✓			
	Glycerine	✓		✓				✓		✓			
	Methyl chloride	✓		✓				✓		✓		O	
OILS	Linseed oil	✓		✓		O	see note (3)	O	see note (3)	O	see note (3)		
	Penetrating oil	✓		✓		O	see note (3)	O	see note (3)	O	see note (3)		
	Lubricating oil	✓		✓		O	see note (5)	O	see note (4)	O	see note (4)		
ACIDS	10% Sulphuric acid	✗		✗		O	see note (5)	O	see note (5)	O	see note (5)	✗	
	Conc. Sulphuric acid	✓	✗ at high temp.	✓	✗ at high temp.	O	see note (5)	O	see note (5)	O	see note (5)	✓	✗ above 40°C.
	10% Hydrochloric acid	✗		✗		O	see note (5)	O	see note (5)	O	see note (5)	✗	
	10% Nitric acid	✓		✓		O	see note (5)	O	see note (5)	O	see note (5)	✓	
	50% Phosphoric acid	✓		✗		O	see note (5)	O	see note (5)	O	see note (5)	✗	
	10% Acetic acid	✓		✓		O	see note (5)	O	see note (5)	O	see note (5)		
	5% Tartaric acid	✓		O		O	see note (5)	O	see note (5)	O	see note (5)	✗	
	5% Citric acid	✓		✓	✗ at high temp.	O	see note (5)	O	see note (5)	O	see note (5)	✗	
	10% Lactic acid	✓		✗		O	see note (5)	O	see note (5)	O	see note (5)		
ALKALINES	10% Caustic soda sodium hydroxide	✓		✗		O	see note (5)	O	see note (5)	O	see note (5)		
	25% Caustic soda	✓		✗		O	see note (5)	O	see note (5)	O	see note (5)	✗	
	10% Ammonia	O		O		O	see note (5)	O	see note (5)	O	see note (5)		

KEY : ✓ Probably suitable ● ✗ Probably unsuitable ● O Investigate if no alternative

For notes (1) to (5) see left hand page

Suitability of organic finishes

		Epoxy powder		Polyester epoxy mix coating		PVC coating		GRP polyester		GRP vinylester		PVC	
ENVIRONMENTS	Fresh water	✓		✓		✓		✓		✓		✓	
	Salt spray B177 Test	✓		✓	500 hours	✓	500 hours	O		O		✓	
	Polluted marine environment	✗		✗		✗		✗		✓		✗	
SOLVENTS	Acetone	✗		✓		✗		✗		✗		✗	
	Petroleum (gasoline)	✓		✓		✓	✗ above 75°C.	✓	✗ above 60°C.	✓		✓	✗ above 75°C.
	Trichloroethylene	✗		✓		✗		✗		✗		✗	
	Glycerine	✓		✓		✓	✗ above 75°C.	✓		✓		✓	✗ above 75°C.
	Methyl chloride	✗		✓		✗		✗		✗		✗	
OILS	Linseed oil	✓		✓		✓	✗ above 75°C.	✓		✓		✓	✗ above 75°C.
	Penetrating oil	✓		✓		✓	✗ above 75°C.	✓		✓		✓	✗ above 75°C.
	Lubricating oil	✓		✓				✓	✗ above 60°C.	✓			
ACIDS	10% Sulphuric acid	✓		✓		✓	✗ above 75°C.	✓		✓		✓	✗ above 75°C.
	Conc. Sulphuric acid	✗		✗		✗		✗		✓		✗	
	10% Hydrochloric acid	✓		✓		✓	✗ above 30°C.	✓	✗ above 60°C.	✓		✓	✗ above 30°C.
	10% Nitric acid	✗		✓	✗ above 20°C.	✓	✗ above 30°C.	✗		✓	✗ above 50°C.		
	50% Phosphoric acid	✓		✓		✓	✗ at high temp.	✓		✓		✓	✗ above 75°C.
	10% Acetic acid	✓		✓		✗		✓		✓			
	5% Tartaric acid	✓		✓		✓	✗ above 75°C.	✓		✓		✗	
	5% Citric acid	✓		✓		✓		✓		✓		✓	✗ above 75°C.
	10% Lactic acid	✓		✓		✓		✓	✗ above 60°C.	✓		✓	✗ above 75°C.
ALKALINES	10% Caustic soda sodium hydroxide	✓		✓		✓		✗		✓		✓	✗ above 75°C.
	Caustic soda	✓		✓		✓	✗ above 75°C.	✗		✗			
	10% Ammonia	✓		✓		✓		✗		✓	✗ above 35°C.	✓	✗ above 75°C.

KEY : ✓ Probably suitable ● ✗ Probably unsuitable ● O Investigate if no alternative