

2. Surface Preparation

INTRODUCTION

Proper surface preparation is essential for the success of any marine coating scheme. The importance of removing oil, grease, old coatings and surface contaminants (such as millscale and rust on steel, and zinc salts on zinc containing primers or galvanised surfaces) cannot be over emphasised.

The performance of any paint coating is directly dependent upon the correct and thorough preparation of the surface prior to coating. The most expensive and technologically advanced coating system will fail if the surface preparation is incorrect or incomplete.

STEEL

Some of the various methods of surface preparation of steel are briefly described below. For more explicit details and recommendations please refer to full specifications, such as:

1. International Standard ISO 8504-1:2000, which is in three parts:
 - ISO 8504-1:2000 Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 1: General principles.
 - ISO 8504-2:2000 Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast-cleaning.
 - ISO 8504-3:1993 Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 3: Hand- and power-tool cleaning.
2. The Society for Protective Coatings (SSPC), Pittsburgh, PA, USA. Full range of surface preparation standards.
3. International Standards ISO 8501-1:1988 and ISO 8501-2:1994. Preparation of steel substrate before application of paints and related products – visual assessment of surface cleanliness.
4. Shipbuilding Research Association of Japan – Standard for the Preparation of Steel Surfaces prior to Painting (“JSRA Standard – 1984”).
5. International Marine Hydroblasting Standards.
6. International Marine Slurryblasting Standards.
7. International Marine Pictorial Abrasive Sweep Blasting Standards – for shop primed surfaces.
8. International Marine Pictorial Abrasive Sweep Blasting Standards – for previously coated surfaces.

REMOVAL OF CONTAMINANTS

The performance of marine coatings applied to steel is significantly affected by the condition of the steel substrate immediately prior to painting. The principal factors affecting performance are:

- a) surface contamination including salts, oils, grease, drilling and cutting compounds,
- b) Rust and millscale,
- c) Surface profile.

The main objective of surface preparation is to ensure that all such contamination is removed to reduce the possibility of initiating corrosion and to create a surface profile that allows satisfactory adhesion of the coating to be applied. Recommended procedures are outlined in International Standard ISO 8504:2000 and SSPC SP Specifications.

It is essential to remove all soluble salts, oil, grease, drilling and cutting compounds and other surface contaminants prior to further surface preparation or painting of the steel.

Oil and Grease

The presence of even a very thin layer of oil or grease can destroy or seriously impair adhesion of paint. Solvents (e.g. paraffin or white spirit) can be used to dissolve the grease, but the problem then becomes one of completely removing the solution of oil in the solvent. Drying with cloths is only effective if two or three treatments are carried out, each time drying with clean cloths. A single treatment is rarely satisfactory and can aggravate the situation by spreading the oil or grease over an area greater than that originally affected.

Commercial chemical cleaners such as water rinsable detergents are available but before they are used it must be determined that they will not adversely attack the painted surface. It is usual to apply sufficient cleaner to incorporate the contaminant, leave for a few minutes and then hose down thoroughly with fresh water. It is imperative that all traces of the cleaner should be removed before painting. When cleaning old tanks which have contained crude oil before overcoating, it is likely that a combination of steam cleaning and degreasing will be necessary.

Salts

Sea salts are fairly easily dissolved by fresh water. Surfaces should therefore be thoroughly hosed with fresh water.

The major difficulty however is not the solubility of the salt but surface irregularities and porosity. Fine hair cracks in a paint surface can hold salt quite tenaciously. Spent and spongy antifouling films also prevent easy salt removal.

For this reason high pressure fresh water washing should always be used to flush out all the salt from the surface cracks and crevices. If high pressure fresh water washing is not available then normal fresh water hosing with thorough scrubbing should be employed. This is time consuming, but necessary, as to paint over salt residues will certainly lead to detachment or blistering of the fresh paint.

Weed Fouling

The term “weed fouling” is meant to encompass not only those organisms which are readily recognised as marine weeds, but also the algal slimes which are often only visible when wet.

They are most effectively removed by high pressure fan jet fresh water washing, the pressure being in the range 140-350 bar (2000-5000 p.s.i.).

If high pressure fresh water washing equipment is not available, scraping, hosing and scrubbing should be employed. Results are not as good as high pressure fresh water washing but with care and attention a satisfactory result can be achieved. It must be remembered that with manual methods the final phase of the operation should be to thoroughly hose the surface with fresh water.

Shell Fouling

Acorn barnacles, tubeworms, etc. are much more difficult to dislodge from a surface than weed. Quite often high pressure water washing will not remove acorn barnacles, although other species such as goose necked barnacles, tubeworms and hydrozoa may be removed. In all cases the first step should be to determine the effect of high pressure fresh water cleaning.

Those organisms which resist removal by high pressure fresh water washing should be removed by scraping, although in many cases it will be found that either shell bases remain or the underlying paint coatings are broken. After scraping, the surface should be re-washed to clear away all the shell splinters, barnacle bases, cement residues, tissue remnants and soluble material.

HIGH PRESSURE FRESH WATER CLEANING

The operation consists of directing a high pressure fresh water jet at the surface. As with sweep blasting the effect will depend on the nature and condition of the surface and also on the pressure of water. Distance of the nozzle Fan Jet Lance or Rocky Washer from the surface will also have an effect. Usually for removing surface contamination or weed fouling, pressures in the range 140-350 bar (2000-5000 p.s.i.) are employed. Shell fouling and antifouling paint leached layers may resist the water jet. See the section “Shell Fouling”.

HAND TOOL CLEANING

Loosely adhering millscale, rust and old paint coatings may be removed from steel by hand wire brushing, sanding, scraping and chipping. However, these methods are incomplete, and always leave a layer of tightly adhering rust on the steel surface. Methods for hand tool cleaning are described in SSPC-SP2 and should be to ISO 8501-1:1988 grade St2-B, C or D and also in the JSRA Standard – 1984, this standard is particularly useful for Newbuilding projects.

**POWER TOOL
CLEANING**

Generally more effective and less laborious than hand tool cleaning for the removal of loosely adhering millscale, paint and rust. However, power tool cleaning will not remove tightly adhering rust and millscale. Power wire brushes, impact tools (such as needle guns), grinders and sanders are all commonly used, the cutting actions of grinding discs would be the preferred choice. Care should be taken, particularly with power wire brushes, not to polish the metal surface as this will reduce the key for the subsequent paint coating. Methods are described in SSPC-SP3 and SSPC-SP11 and should be to ISO 8501-1:1988 grade St3-B, C or D. SSPC-SP11 describes a degree of surface profile which can be achieved by power tool cleaning. JSRA standard – 1984 describes power tool cleaning methods of particular use in Newbuilding projects.

BLAST CLEANING

By far the most effective method for removal of millscale, rust and old coatings, using abrasives such as garnet, grit or shot under high pressure.

The grade of blasting suitable for a particular coating specification depends on a number of factors, the most important of which is the type of coating system selected.

The primary standard used in marine product datasheets is ISO 8501-1:1988, preparation of steel substrate before application of paints and related products – visual assessment of surface cleanliness. This standard represents a slight extension of the old Swedish Standard (SIS 05 59 00), which was developed by the Swedish Corrosion Institute, in co-operation with the American Society for Testing & Materials (ASTM), and the Society for Protective Coatings (SSPC), USA, and is already used on a worldwide scale. The JSRA Standard 1984 is the principal standard quoted for Japanese Newbuilding projects.

In North American marine product datasheets the nearest equivalent SSPC specification has been quoted. It is recognised that the SSPC and ISO standards are not identical, and as a consequence worldwide/North American product datasheets may show grade Sa2½ (ISO 8501-1:1988) as equivalent to SSPC-SP6, (commercial blast cleaning), whilst others will be equivalent to SSPC-SP10 (near white metal). The selection of these blast cleaning grades have been assessed using a number of factors including coating type, performance expectation, and in-service conditions.

As a general principle, where products are recommended for immersion or aggressive atmospheric conditions the blasting standard required will be to Sa2½ (ISO 8501-1:1988) or SSPC-SP10, however, when products are recommended for general atmospheric exposure the blasting standard required will be Sa2 (ISO 8501-1:1988) or SSPC-SP6.

Prior to blasting, steelwork should be degreased and all weld spatter removed. If salts, grease or oil are present on the surface it will appear to be removed by the blasting process, but this is not the case. Although not visible, the contamination will still be present as a thin layer, and will affect the adhesion of subsequent coatings. Weld seams, metal slivers and sharp edges revealed by the blasting process should be ground down, as paint coatings tend to run away from sharp edges, resulting in thin coatings and reduced protection. Weld spatter is almost impossible to coat evenly, in addition to often being loosely adherent, and it is a common cause of premature coating failure.

The surface profile obtained during blasting is important, and will depend on the abrasive used, the air pressure and the technique of blasting. Too low a profile may not provide a sufficient key for coating, while too high a profile may result in uneven coverage of high, sharp peaks possibly leading to premature coating failure, particularly for thin film coatings such as blast primers. The following table gives a brief guide to typical roughness profiles obtained using various types of abrasive.

| Type of Abrasive | Mesh Size | Max. Height of Profile |
|---|------------------|-------------------------------|
| Very fine sand | 80 | 37 microns (1.5 mils) |
| Coarse sand | 12 | 70 microns (2.8 mils) |
| Iron shot | 14 | 90 microns (3.6 mils) |
| Typical non metallic "copper slag" 1.5-2.0mm grain size | - | 75-100 microns (3-4 mils) |
| Iron grit No. G16 | 12 | 200 microns (8.0 mils) |

Grit Blasting

When large areas of a vessel's hull or tanks are cleaned by grit blasting a variety of steel surface conditions will be found. Previously coated or superficially corroded steel, can be readily cleaned to Sa2½. However, cleaning heavily corroded or pitted surfaces is more difficult and Sa2½ may not be practically achievable.

The effectiveness of various types and particle sizes of abrasives has been examined in carefully controlled practical trials and the most efficient grit particle size for corroded steel is found to be mineral slag with a range of 0.3-1.5mm (12-60 mils).

After grit blasting, surface dust must be removed. In open conditions, blowing with dry compressed air from the blasting kettle is satisfactory. Tanks however require careful cleaning normally using vacuum cleaners to remove all grit and dust particles.

Spot Blasting

This localised abrasive cleaning is often carried out on the outside of the hull of a vessel where patchy corrosion has occurred. It will effectively remove corrosion and yield surfaces cleaned to Standards described in ISO 8501-1:1998. In practice there are some precautions which need to be taken in order to prevent subsequent breakdown:

The surrounding paint film (particularly epoxy coatings) can be undercut by the abrasive particles and the edges around the blasted patch loosened from the steel surface. If this occurs the loose edges must be removed by thorough scraping or feathering, using a rotary disc.

The surrounding paint will be peppered by stray abrasive particles and the protective value of the scheme in the vicinity may be destroyed. In making good the coating system it is necessary to treat the area of damage around the blasted area.

Damage can also occur in the areas between patches if the jet of abrasive particles is played across the surface. Blasting should be discontinued whilst moving from one patch to the next. Any damage which is sustained in this way should be made good as described above.

It is recommended that whenever possible the patches to be blasted should be defined by "marking in" the boundaries.

Sweep Blasting

Sweep blasting is the treatment of a surface by the sweeping of a jet of abrasive across the surface. Its effectiveness depends on the nature and condition of the surface, the type and particle size of the abrasive and above all the skill of the operator.

a) Light Sweeping

Rapid sweep blasting will clean the surface of contamination or loose coatings. It may be used to etch the surface of an existing hard and tough coating to improve the adhesion of the following coat. Superficial corrosion such as that found on weathered shop primed steel also responds well to this type of treatment, but more deep seated corrosion is not removed. Where such removal is required, Sa2½ by 'full blasting' should be specified. Particle size of the abrasive is important, a fine abrasive is most suitable when the paint surface under treatment is not to be destroyed (grit or sand particle size 0.2mm-0.5mm, 8-20 mils).

b) Hard/Heavy Sweeping

The old coatings are removed to shop primer or bare steel. The surface standard of steel exposed will vary but all standards, nevertheless, are satisfactory provided rust scale has been removed.

Hard/heavy sweeping is used for example to upgrade otherwise unsuitable vessels to higher performance coating systems.

Particle size considerations are the same as those described in the sections dealing with blasting/grit blasting.

c) Sweeping of Shop Primers

At Newbuilding it is often necessary to remove the shop primer coat (fully or partially) prior to subsequent overcoating. The surface preparation standard to be achieved is agreed and is to one of : JSRA Standard 1984 or International Marine Pictorial Abrasive Sweep Blasting Standard

**WET ABRASIVE
BLASTING/SLURRY
BLASTING**

Wet abrasive blasting uses a slurry of water and abrasive rather than dry abrasive alone. This has the advantage that the hazards of dust and associated health problems are largely overcome.

A further advantage is that when wet blasting old, well rusted surfaces, many of the soluble corrosion products in the pits of the steel will be washed out, which will greatly improve the performance of the applied coating system. However, a disadvantage of this technique is that the cleaned steel begins to rust rapidly after blasting.

The use of corrosion inhibitors is not recommended when wet blasting areas which will be exposed to marine environments.

Where wet blasted surfaces have been allowed to corrode, they should be mechanically cleaned or preferably sweep blasted, to remove the corrosion prior to painting.

HYDROBLASTING

Hydroblasting is a technique for cleaning surfaces, which relies entirely on the energy of water striking a surface to achieve its cleaning effect. Abrasives are NOT used in hydroblasting systems. Consequently the problems caused by dust pollution and by the disposal of spent abrasives are eliminated. Two different hydroblasting operating pressures are commonly encountered.

- High pressure hydroblasting, operating at pressures between 680 bar (10,000 p.s.i.) and 1,700 bar (25,000 p.s.i.).
- Ultra high pressure hydroblasting, operating at pressures above 1700 bar (25,000 p.s.i.).

The terms hydroblasting, hydrojetting and water jetting essentially mean the same thing, with all being used to describe the same process. There can be confusion however over the difference between simple water washing and hydroblasting. To clarify the situation, International Paint have adopted the following commonly accepted definitions.

Low Pressure Water Washing:

Operates at pressures less than 68 bar (1,000 p.s.i.).

High Pressure Water Washing:

Operates at pressures between 68-680 bar (1,000-10,000 p.s.i.).

High Pressure Hydroblasting:

Operates at pressures between 680-1,700 bar (10,000-25,000 p.s.i.).

Ultra High Pressure Hydroblasting:

Operates at pressures above 1,700 bar (25,000 p.s.i.) with most machines operating in the 2,000-2,500 bar range (30,000-36,000 p.s.i.).

The International Marine Hydroblasting Standards have been prepared using ultra high pressure hydroblasting equipment. This standard however is also applicable to surfaces produced by a whole range of hydroblasting pressures, providing the equipment used is capable of cleaning to the visual standard depicted.

The steel surfaces produced by hydroblasting do NOT look the same as those produced by dry abrasive blasting, or slurryblasting. This is because water on its own cannot cut, or deform steel in the same way as abrasives. Hydroblasted surfaces therefore tend to look dull, even before they "flash rust". In addition steel, with active corrosion pitting, shows a mottled appearance after hydroblasting. Mottling occurs when the corrosion products are washed out of the pits, leaving a bright patch, and the surrounding areas are left a dull grey, brown to black colour. This pattern is the reverse of that left by abrasive blasting, where anodic pits are often dark, due to corrosion products not being entirely removed, and the surrounding areas are bright. "Flash rusting", i.e. light oxidation of the steel, which occurs as hydroblasted steel dries off, will quickly change this initial appearance.

When flash rusting is too heavy for coating application, it may be removed or reduced by brushing with a hard bristle brush, or by washing down with high pressure fresh water. High pressure washing, at pressures above 68 bar (1,000 p.s.i.) using either the rotational nozzles, or fan jet lances of the hydroblasting equipment itself is the preferred method. It will cause the area to re-rust, but it is possible to reduce the degree of flash rusting from heavy to light using this method. Hand wire or bristle brushing to remove heavy flash rusting may be acceptable for small areas, but will generally produce an inadequate surface. Mechanical rotary wire brushing can however produce acceptable surfaces for large areas.

When large areas are hydroblasted, flash rusting which obscures the original blast standard may occur, before an inspection can be carried out. Establishing the required standard by blasting a small test area prior to the main blast may help, providing the rest of the job is blasted to the same standard. Methods of ensuring the rest of the job is blasted to the same standard will vary from project to project.

The use of corrosion inhibitors is not recommended when wet blasting areas which will be exposed to marine environments.

The temperature of steel substrates can rise during the hydroblasting process. There are two reasons for this:

- a) Compression of the water to reach hydroblasting pressure will create a temperature rise in the water itself,
- b) the velocity of the water striking the steel will impart energy to it as heat. This temperature rise can be substantial and may help hydroblasted surfaces dry off more quickly, with a corresponding reduction in the severity of flash rusting.

An important property of the hydroblasting process is that it can emulsify and remove oil and grease from a surface as it is blasted. However, this does not preclude the need for proper degreasing procedures as specified in SSPC-SP1, prior to hydroblasting.

Hydroblasting will not produce a surface profile, although the process can eventually erode steel and result in metal loss. The surface profile exposed after hydroblasting will have been produced by earlier surface preparation work, or by corrosion. For most coating schemes, International Paint will accept a profile in the 50 to 100 microns range.

NON FERROUS METALS

Galvanised Steel

The surface should be clean, dry and grease free (see under Steel – Degreasing). Degreasing of most galvanised surfaces requires some effort to obtain a clean surface. Any white zinc corrosion products should be removed by high pressure fresh water washing, or fresh water washing with scrubbing. When using the preferred method of surface preparation, i.e. sweep blasting, it is still advisable to fresh water wash to remove soluble zinc salts. Many coatings based on non-saponifiable polymers can be applied directly to galvanised surfaces prepared in this way.

When sweep blasting is not possible, then an acid etch solution or etch primer should be used to passivate the surface and provide a key for further paint coatings. Details of coatings which can be applied to sweep blasted galvanised steel and of suitable etch solutions and primers can be obtained from International Paint.

When steel has been treated with a passivating treatment immediately after galvanising, then this must either be allowed to weather off over a period of several months exterior exposure or be abraded before application of a coating. In general etch treatments have no effect on fresh materials of this type.

Other Non Ferrous Metals/Aluminium (Abrading)

The surface should be clean, dry and grease free (see under Steel – Removal of Contaminants). Any corrosion salts should be removed by light abrasion and water washing. The cleaned surface should then be prepared by abrasive blasting at low pressure, using aluminium oxide or garnet abrasive. The specified surface profile should be achieved.

Aluminium (Acid Etching)

International Paint do not normally recommend the use of acid etch primers, however in non-immersed areas they may be used.

Before painting, apply one thin coat of a proprietary etch primer to provide a key for further coats. A colour change from pale yellow to green/brown should occur. If this reaction does not take place, adhesion will be found to be poor. The surface should be scraped clean, and treated with a proprietary aluminium pre-treatment solution, and the acid etch primer then re-applied.

SAFETY CONSIDERATIONS

Always carefully read and completely follow the safety procedures and instructions recommended by manufacturers of surface preparation devices, application equipment, media or products and the job site safety measures.

Prior to use, obtain and consult the Material Safety Data Sheet for this product concerning health and safety information. Read and follow all precautionary notices on the Material Safety Data Sheet and container label. If you do not fully understand these warnings and instructions or if you cannot strictly comply with them, do not use this product. Proper ventilation and protective measures must be provided during application and drying to keep solvent vapour concentrations within safe limits and to protect against toxic or oxygen deficient hazards. Actual safety measures are dependent on application methods and work environment.

These are general statements to alert you to the importance of specific warnings and instructions on individual products. These statements are not intended to be specific warnings or advice.