

Additional Information

Surface Preparation: Metallic Surfaces

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INTRODUCTION

Proper surface preparation is essential for the success of any protective coating scheme. The importance of removing oil, grease, old coatings and surface contaminants (such as mill scale and rust on steel and zinc salts on 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. Even the most expensive and technologically advanced coating system will fail if the surface preparation is incorrect or incomplete.

**STEEL: SURFACE
EVALUATION**

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

- surface contamination including salts, oils, grease, drilling and cutting compounds
- rust and mill scale
- surface profile

The main objectives of surface preparation are to ensure that all contamination is removed, a surface profile created that allows satisfactory adhesion of the coating to be applied and to reduce the possibility of corrosion initiating from the presence of any surface contaminants. Recommended procedures are outlined in International Standard ISO 8504:2000 (E) and SSPC-SP Specifications.

Surface Contamination

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. Perhaps the most common method is by solvent washing, followed by wiping dry with clean rags. The wiping is critical, because if this is not carried out thoroughly the result of solvent washing will simply be to spread the contamination over a wider area. Rags should be changed frequently. Proprietary emulsions, degreasing compounds and steam cleaning are also commonly used. Recommended procedures are described in International Standard ISO 8504:2000 (E) and SSPC-SP1.

Surface Imperfections

Imperfections on the substrate should be rectified prior to coating. Such corrections form part of the surface preparation process that should always be carried out before coating application.

Mill scale: A layer of ferric oxide formed on the surface of steel during hot rolling. Adherent mill scale should be removed by abrasive blasting or power tool cleaning to SSPC-SP11 or SSPC-SP15. Hand and power tool methods can be effective on loosely adherent mill scale.

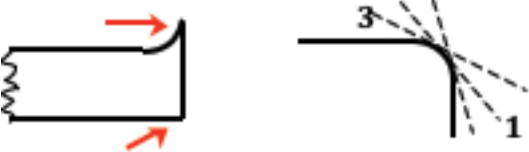
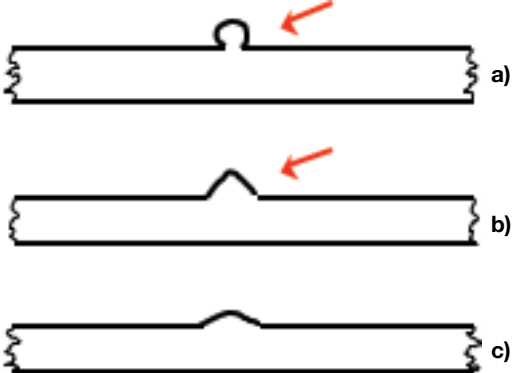
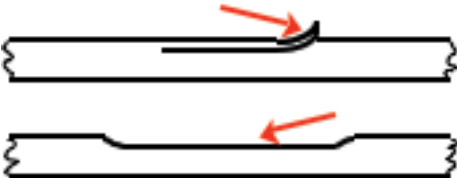
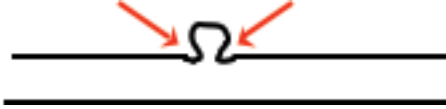


Existing coatings: Removal by abrasive blasting is most effective; hand and power tool cleaning methods are also possible but much more labour intensive and best suited to small areas.

Rust: Should ideally be removed by abrasive blasting prior to coating but the extent of removal required will depend on the coating system to be applied. Hand and power tool methods are also possible but again, are more labour intensive and best suited to small areas.

If allowed to remain, loosely adhering mill scale, paint or rust can cause delamination of the coating from the substrate.



Welds, cut edges and surface imperfections: Preparation grades are described in ISO 8501-3. International Protective Coatings recommends the following methods and minimum levels of preparation on any new steelwork:

SHARP EDGE	<p>Edges should be treated to a rounded radius of minimum 2mm, or subjected to three pass grinding or equivalent.</p>	
WELD SPATTER	<ol style="list-style-type: none"> 1. Remove spatter observed before blasting by grinder, chipping hammer etc. 2. For spatter observed after blasting: <ol style="list-style-type: none"> a) Remove with chipping hammer / scraper etc. b) Where spatter is sharp, use disc sander or grinder until obtuse c) Obtuse spatter – no treatment required 	
PLATE LAMINATION	<p>Any lamination to be removed by grinder or disc sander</p>	
UNDERCUT	<p>Where undercut is to a depth exceeding 1mm and a width smaller than the depth, repair by welding or grinding may be necessary</p>	
MANUAL WELD	<p>For welding bead with surface irregularity or with excessive sharp edges, remove by disc sander or grinder</p>	
GAS CUT SURFACE	<p>For surfaces of excessive irregularity, remove by disc sander or grinder</p>	

**STEEL: SURFACE
PREPARATION
METHODS**

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:

- International Standards ISO 8501-1:2007(E) and ISO 8501-2:1994. Preparation of steel substrate before application of paints and related products - Visual assessment of surface cleanliness.
- International Standard ISO 8504:2000 (E). Preparation of steel substrates before application of paints and related products - Surface preparation methods.
- The Society for Protective Coatings (SSPC), Pittsburg, PA, USA. Full range of surface preparation standards, including visual standards to accompany written ones.
- Swedish Standard SIS 05 59 00 (1967 - Pictorial Surface Preparation Standards for Painting Steel Surfaces).
- Shipbuilding Research Association of Japan - Standard for the preparation of steel surface prior to painting ("JSRA" Standard).
- International Protective Coatings Hydroblasting Standards.
- International Protective Coatings Slurry Blasting Standards.
- International Protective Coatings Abrasive Sweep Blasting Standards.

Hand Tool Cleaning

Loosely adhering mill scale, 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 are described in SSPC-SP2, Hand Tool Cleaning and typically the level of preparation should be to ISO 8501-1:2007 grade St2-B, C or D.

Power Tool Cleaning

Generally power tool cleaning is more effective and less laborious than hand tool cleaning for the removal of loosely adhering mill scale, paint and rust. Power wire brushes, grinders, sanders and impact tools such as needle guns are all commonly used. Care should be taken, particularly with power wire brushes, not to polish the metal surface as this will reduce the key for adhesion of the subsequent paint coating. Mechanical bristle blasting is also an effective method and can produce a surface profile of up to 75µm (3 mils) in areas where blast cleaning is not feasible.

Methods are described in SSPC-SP3, Power Tool Cleaning, SSPC-SP11, Power Tool Cleaning to Bare Metal and SSPC-SP15, Commercial Grade Power Tool Cleaning and typically the level of preparation should be to ISO 8501-1:2007 grade St3-B, C or D. SSPC-SP11 and SSPC-SP15 describe a degree of surface profile which can be achieved by power tool cleaning.

Abrasive Blast Cleaning

This is by far the most effective method for removal of mill scale, rust and old coatings using abrasives such as sand, grit or shot under high pressure.

The preparation grade 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 International Protective Coatings' product data sheets is ISO 8501-1:2007(E), preparation of steel substrate before application of paints and related products - visual assessment of surface cleanliness. This standard represents a slight extension of the 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 was used on a world-wide scale up until the introduction of ISO 8501-1.

Where appropriate, the nearest equivalent SSPC-SP specification has been quoted on individual product data sheets. It is recognised that the SSPC and ISO standards are not identical and as a consequence data sheets may show grade Sa2½ (ISO 8501-1:2007) as an alternative to SSPC-SP6, Commercial Blast Cleaning or to SSPC-SP10, Near White Blast Cleaning. The selection of these blast cleaning grades will have been assessed using a number of factors including coating type, performance expectation and in-service conditions.



**STEEL: SURFACE
PREPARATION
METHODS
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As a general principle, where products are recommended for immersion or aggressive atmospheric conditions the blasting standard required will be to Sa2½ (ISO 8501-1:2007) or SSPC-SP10; when products are recommended for general atmospheric exposure the blasting standard required will be Sa2½ (ISO 8501-1:2007) or SSPC-SP6.

Prior to blasting, steelwork should be degreased and all weld spatter removed. If salt, grease or oil is 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; paint coatings tend to run away from sharp edges, resulting in thin coatings and reduced protection. Weld spatter is almost impossible to coat evenly and is often loosely adherent; these factors mean 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 satisfactory adhesion of the 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)

Wet Abrasive Blasting / Slurry Blasting

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

A further important 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. When flash rusting (light oxidation of the steel following blasting) is considered 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 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.

Proprietary inhibitors can be added to the blast water but these are not recommended by International Protective Coatings. The use of a moisture tolerant primer, which can be applied to wet blasted steel while it is still damp, may be considered.

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 that 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.

**STEEL: SURFACE
PREPARATION
METHODS
Continued...**

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 Protective Coatings has 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 less than 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.)

Methods are described in SSPC-SP12, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating. SSPC-Vis 4, Guide and Reference Photographs for Steel Surfaces Prepared by Waterjetting can be used alongside SSPC-SP12. The International Protective Coatings Hydroblasting Standards have been prepared using ultra high pressure hydroblasting equipment. These standards are 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. Note that hydroblasting will not produce a surface profile.

The steel surfaces produced by hydroblasting do NOT look the same as those produced by dry abrasive blasting or slurry blasting; water on its own cannot cut or deform steel in the same way as abrasives, so hydroblasted surfaces therefore tend to look dull, even before they flash rust. Flash rusting, which occurs as hydroblasted steel dries off, will quickly change this initial appearance.

As with wet abrasive / slurry blasting, heavy flash rusting may be removed or reduced by brushing with a hard bristle brush or by washing down with high pressure fresh water. High pressure washing is the preferred method and can reduce the degree of flash rusting from heavy to light. 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.

Flash rusting can be prevented by the use of water soluble chemical corrosion inhibitors, however these are not recommended by International Protective Coatings. Such inhibitors must be thoroughly washed off with fresh water as they can leave a crystalline layer on the steel surface as the water evaporates; this can lead to loss of adhesion and osmotic blistering in coatings subsequently applied.



**STAINLESS
STEEL: SURFACE
EVALUATION**

As with carbon steel substrates, stainless steel should be dry and free from contaminants such as rust, scale, oil and grease and should have a defined surface profile prior to coating.

Surface Contamination

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 stainless steel. As with carbon steel, this can be done by solvent washing. Chloride solutions should not be used for cleaning as these can promote pitting corrosion of the stainless steel.

Surface Imperfections

Scale: May be removed by pickling or by mechanical abrasion (hand or power tool or abrasive blasting).

Rust staining: Caused by contact with carbon steel or iron particles, rust staining should ideally be removed before coating. Light staining can be removed with Interplus 614; heavier staining may require pickling or abrading.

Heat tint: Discolouration indicating a thickening of the oxide layer on the surface of the stainless steel. This is caused by heat from activities such as welding and should ideally be treated prior to coating; when allowed to remain it is possible that the corrosion resistance of the substrate can be adversely affected. For severe heat tint grinding or abrading may be necessary; in mild cases pickling may be sufficient.

**STAINLESS
STEEL: SURFACE
PREPARATION
METHODS****Hand and Power Tool Cleaning**

Suitable for rust staining, loosely adherent scale and existing coatings. Power tool cleaning can also be used to treat heat tint. Abrasive paper, wire brushes etc must be iron free and it is recommended that where possible tools should not have previously been used to prepare carbon steel to avoid the possibility of iron particles being embedded in the substrate. Hand and power tool preparation is unlikely to produce a sufficient profile for coating application.

Abrasive Blast Cleaning

This is by far the most effective method for removal of scale, rust and old coatings. Non-metallic abrasives, for example aluminium oxide or garnet, must be used; abrasives such as iron grit or shot are unlikely to provide a satisfactory profile and can leave traces of iron on the surface of the stainless steel and lead to staining. A surface profile of 50µm (2 mils) can typically be achieved using hard non-metallic abrasives such as aluminium oxide.

Care should be taken to support thin sections of stainless steel plate to avoid distortion of the substrate during blasting.

Hydroblasting

As with carbon steel, hydroblasting will not produce a surface profile. In the case of stainless steel hydroblasting is typically used to remove scale and existing coatings. It can also be used following pickling treatment of weld tint to remove traces of pickling products and detached metal. Rinsings must be carefully disposed of in accordance with local environmental legislation.

Pickling and Passivation

Pickling treatments can be used to remove scale and to correct heat tint and as long as the substrate is properly clean and free from any other contamination then it will usually be left passivated once the pickling product has been removed. Again, care must be taken to properly dispose of any waste from pickling.

Passive surfaces will require mechanical abrasion (preferably abrasive blasting) in order to ensure a sufficient profile for adhesion of the subsequent coating.

**NON-FERROUS
METAL: SURFACE
EVALUATION**

The principal factors affecting performance are:

- surface contamination including salts, oils, grease, drilling and cutting compounds
- surface profile

The main objectives of surface preparation are to ensure that all contamination is removed, a surface profile created that allows satisfactory adhesion of the coating to be applied and to reduce the possibility of corrosion initiating from the presence of any surface contaminants.

**NON-FERROUS
METAL: SURFACE
PREPARATION
METHODS****Aluminium**

The surface should be clean, dry and grease-free. If any corrosion salts are present they should be removed by lightly abrading the surface. This can be achieved by wire brushing or by lightly blasting with fine non-metallic abrasive. Before painting, apply one thin coat of a proprietary acid etch primer to provide a key for adhesion of further coats.

Galvanised Steel

The surface should be clean, dry and grease free. 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. A surface suitable for coating will ideally be prepared by sweep blasting but 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, mordant solution or etch primer should be used to provide a key for the adhesion of further paint coatings. Details of coatings that can be applied to sweep blasted galvanised steel and of suitable etch solutions and primers can be obtained from International Protective Coatings.

When steel has been treated with a passivating treatment immediately after galvanising, 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 freshly passivated galvanised materials.

Other Non-Ferrous Metals

The surface should be clean, dry and grease free. Any corrosion salts should be removed by light abrasion and water washing. The cleaned surface should be abraded or very lightly abrasive blasted using low pressure and non-metallic abrasive and then primed with a coat of etch primer prior to painting. For lead, if the surface is thoroughly abraded, the etch primer may be omitted.

