

SURFACE PREPARATION AND BLASTING STANDARDS

We will look at both primary and secondary standards for the surface preparation of steel. The primary standards refer to steel that is prepared for painting from a millscaled, rusted or previously coated state. The secondary standards refer to the preparation of shop primed steel at newbuilding, and cover subjects such as the removal of zinc salts and the preparation of welds and burn damage.

1. PRIMARY SURFACE PREPARATION STANDARDS

The most widely used standard for primary surface preparation is the Swedish Standard SIS 05 59 00. This standard was originally developed by the Swedish Corrosion Institute in cooperation with the American Society for Testing and Materials (ASTM) and the Steel Structures Painting Council (SSPC) of the United States. Other national standards such as the German DIN SS.928 and the Danish DS 2019 were also closely based on this standard. This Swedish Standard has now been superseded and incorporated into the International Standard ISO 8501-1:1988. The formal definitions and photographs of the Swedish Standard have been largely retained but it is the ISO standard that is now referred to.

1.1 ISO STANDARD 8501-1:1988 (SWEDISH STANDARD SIS 05 59 00)

This standard uses both written definitions and color photographs. It shows four initial grades of steel before preparation, ranging from intact millscale to rusted and pitted steel. These grades of steel are then shown after abrasive blast cleaning to various standards and after hand or power tool cleaning to various standards. There is also a section showing the steel after flame cleaning, but this method of preparation is not widely used and we shall not cover it here.

1.1.1 Rust Grades

Four initial rust grades of unpainted steel are designated as follows:-

- A. Steel surfaces largely covered with adhering millscale but little, if any, rust.
- B. Steel surface which has begun to rust and from which the millscale has begun to flake.
- C. Steel surface on which the millscale has rusted away or from which it can be scraped, but with slight pitting under normal vision.
- D. Steel surface on which the millscale has rusted away and on which general pitting is visible under normal vision.

Although the photographs were prepared from unpainted steel, this standard can be, and is widely used for depicting the appearance of painted steel after blast cleaning. However, you should be aware that previously painted steel has to be classed as grade C or D.

1.1.2 Blast Cleaning “Sa” Standards

Blast standards are designated by the letters “Sa”. The standards range from Sa1 which is the lowest, through Sa2, Sa2½ to Sa3. Sa2½ was not included in the original Swedish Standards, but was added when it became obvious that achieving Sa3 on-site was impractical, but a higher defined standard than Sa2 was needed. In practice Sa2½ is the best standard that will normally be achieved on-site.

The written definitions for these standards are as follows:

Sa1 Light Blast Cleaning

When viewed without magnification, the surface shall be free from visible oil, grease and dirt, and from poorly adhering millscale, rust, paint coatings and foreign matter.

Sa2 Thorough Blast Cleaning

When viewed without magnification, the surface shall be free from visible oil, grease and dirt, and from most of the millscale, rust, paint coatings and foreign matter. Any residual contamination shall be firmly adhering.

Sa2½ Very Thorough Blast Cleaning

When viewed without magnification, the surface shall be free from visible oil, grease and dirt, and from millscale, rust, paint coatings and foreign matter. Any remaining traces of contamination shall show only as slight stains in the form of spots or stripes.

Sa3 Blast Cleaning to Visually Clean Steel

When viewed without magnification, the surface shall be free from visible oil, grease and dirt, and shall be free from millscale, rust, paint coatings and foreign matter. It shall have a uniform metallic colour.

You should note the following two points:

- 1 The term ‘foreign matter’ in these definitions includes water soluble salts and welding residues which cannot be removed by blast cleaning or power tool cleaning. The notes in the standards book suggest that this type of foreign matter can be removed by wet blast cleaning.
- 2 Millscale, rust, or a paint coating is considered to be poorly adhering if it can be removed by lifting with a blunt putty knife.

1.1.3 Hand and Power Tool Cleaning “St” Standards

Hand and power tool cleaning standards are designated by the letters ‘St’. The standards range from St1 which is the lowest, through St2 to St3. The St1 standard is not included in the ISO standard book, or considered here, because it corresponds to a surface that is unsuitable for painting.

The written definitions for the “St” standards are as follows:

St2 Thorough Hand and Power Tool Cleaning

When viewed without magnification, the surface shall be free from visible oil, grease and dirt, and from poorly adhering millscale.

St3 Very Thorough Hand and Power Tool Cleaning

As for St2, but the surface shall be treated much more thoroughly to give a metallic sheen arising from the metallic substrate.

1.2 STEEL STRUCTURES PAINTING COUNCIL STANDARDS, SSPC-SP2 TO SSPCSP11

These United States standards cover hand and power tool cleaning and abrasive blasting, and they are very similar to the ISO standards described above. Written definitions of the standards are given in Volume 2 of the ‘Steel Structures Painting Manual’. Visual standards to supplement the definitions for abrasive blasting are given in a separate booklet ‘SSPC-VIS-1-189’. They show four initial grades of rust before preparation, then after varying degrees of blast cleaning. Visual standards for hand and power tool cleaning were not originally given by the SSPC. However, they have now produced a visual standard SSPC-VIS 3, in response to the increasing use of hand and power tool cleaning that is more environmentally acceptable than abrasive blasting.

1.2.1 SSPC-VIS 1-89 Rust Grades

Four initial rust grades before surface preparation are designated as follows:

- A. Steel surface completely covered with adherent millscale; little or no rust visible.
- B. Steel surface covered with both millscale and rust.
- C. Steel surface completely covered with rust; little or no pitting visible.
- D. Steel surface completely covered with rust; pitting visible.

1.2.2 SSPC Blast Cleaning Standards

There are four SSPC blast cleaning standards:

SSPC-SP7 Brush-off Blast Cleaning

SSPC-SP6 Commercial Blast Cleaning

SSPC-SP10 Near White Blast Cleaning

SSPC-SP5 White Metal Blast Cleaning

You should note that SSPC-SP10 which corresponds to an Sa2½ has obviously been added after the original coding of the standards was designated.

The written definitions for these standards are as follows:

1.2.3 SSPC-SP7 Brush-off Blast Cleaning

A Brush-off Blast Cleaned surface when viewed without magnification, shall be free from all visible oil, grease, dirt, dust, loose millscale, loose rust, and paint. Tightly adherent millscale, rust, and paint may remain on the surface. Millscale, rust and paint are considered tightly adherent if they cannot be removed by lifting with a dull putty knife.

1.2.4 SSPC-SP6 Commercial Blast Cleaning

A Commercial Blast Cleaned surface when viewed without magnification, shall be free from all visible oil, grease, dirt, dust, millscale, rust, paint, oxides, corrosion products and other foreign matter, except for staining.

Staining shall be limited to no more than 33% of each square inch of surface area and may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of millscale, or stains of previously applied paint. Slight residues of rust and paint may also be left in the bottom of pits if the original surface is pitted.

1.2.5 SSPC-SP10 Near White Blast Cleaning

A Near White Blast Cleaned surface when viewed without magnification, shall be free from all visible oil, grease, dirt, dust, millscale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining.

Staining shall be limited to no more than 5% of each square inch of surface area and may consist of light shadows, slight streaks, or other minor discolorations caused by stains of rust, stains of millscale, or stains of previously applied paint.

1.2.6 SSPC-SP5 White Metal Blast Cleaning

A White Metal Blast Cleaned surface, when viewed without magnification, shall be free from all visible oil, grease, dirt dust, millscale, rust, paint, oxides, corrosion products and other foreign matter.

SSPC Hand and Power Tool Cleaning Standards

There are three SSPC hand and power tool cleaning standards.

SSPC-SP2	Hand Tool Cleaning	Power Tool Cleaning	Power Tool
SSPC-SP3	Cleaning to Bare Metal		
SSPC-SP11			

The new visual standards SSPC-VIS 3 are meant to supplement these standards. They show 51 photographs illustrating the appearance of unpainted, painted and welded hot-rolled carbon steel prior to and after power and hand tool cleaning. Degrees of cleaning achieved with six different surface preparation methods and tools are illustrated. We will not consider the visual standards further, however the written definitions for SP2, SP3 and SP11 are given below.

SSPC-SP2 Hand Tool Cleaning

Hand Tool Cleaning removes all loose millscale, loose rust, loose paint and other loose detrimental foreign matter. It is not intended that adherent millscale, rust and paint be removed by this process. Millscale, rust and paint are considered adherent if they cannot be removed by lifting with a dull putty knife.

SSPC-SP3 Power Tool Cleaning

Power Tool Cleaning removes all loose millscale, loose rust, loose paint and other detrimental foreign matter. It is not intended that adherent millscale, rust and paint be removed by this process. Millscale, rust and paint are considered adherent if they cannot be removed by lifting with a dull putty knife.

SSPC-SP11 Power Tool Cleaning to Bare Metal

This is a new specification and it fills the obvious gap between the SSPC-SP3 and the ISO St3 standards. The definition is as follows:

Metallic surfaces which are prepared according to this specification when viewed without magnification, shall be free from all visible oil, grease, dirt, dust, millscale, rust, paint, oxides, corrosion products and other foreign matter. Slight residues of rust and paint may be left in the lower portions of pits if the original surface is pitted.

It also states that the surface must be roughened to produce a suitable profile for the specified paint system and will not be less than 1 mil or 25 microns.

1.3 NACE STANDARDS

The 'National Association of Corrosion Engineers', NACE, has also produced written definitions for blasting standards. They are not widely used in the Marine industry and they will only be mentioned here briefly for comparison purposes. The standards are as follows:

NACE 1 **White Blast**

NACE 2 **Near White Blast**

NACE 3 **Commercial Blast**

NACE 4 **Brush Blast**

1.4 JSRA STANDARDS

The 'Shipbuilding Research Association of Japan', JSRA, has also produced a set of visual standards for surface preparation. The standards are mainly concerned with secondary preparation, but they also include standards for primary preparation of steel before it is shop primed. The JSRA primary standards are described here.

1.4.1 Rust Grades

Two initial grades before preparation are designated as follows:

JA: Steel surface covered with millscale (rarely with a little rust).

JB JA steel surface exposed to weather one and a half months. (The surface is covered with red rust, but there remains millscale without pitting underneath the red rust).

1.4.2 JSRA Blast Cleaning Standards

There are four grades of blast cleaning described in this standard for both JA and JB steels. These standards are further divided into surfaces produced by steel shots, designated Sh, and surfaces produced by slag, sands or grits designated Sd. The written definitions for both Sh and Sd standards are virtually the same, as follows:

Sh(d)0: Surface prior to blast cleaning of steel shots (slag, sands or grits).

Sh(d)1: Surface prepared by light blast cleaning of steel shots (slag, sands or grits).
Loose millscale, rust and foreign matter are fairly removed.

Sh(d)2: Surface prepared by thorough blast cleaning of steel shots (slag, sands or grits). Almost all millscale, rust and foreign matter are removed.

Sh(d)3: Surface prepared by very thorough blast cleaning of steel shots (slag, sands or grits). Millscale, rust and foreign matter are removed to the extent that the surface has a uniform metallic sheen.

1.5 COMPARISON OF ISO, SSPC, NACE AND JSRA STANDARDS

Although the different standards are not exactly the same, Table 7 will give you some idea of how the standards compare in a descending order of cleanliness. The JSRA Pt standards of secondary surface preparation are also included for reference. They will be described next.

DESCRIPTION	ISO	SSPC	NACE	JSRA
Blast Standards				
White Metal Blast	Sa3	SP5	1	Sh(d)3
Near White Metal Blast	Sa2½	SP10	2	Sh(d)2
Commercial Blast	Sa2	SP6	3	Sh(d)1
Brush-off Blast	Sa1	SP7	4	Sh(d)0
Hand and Power Tool Cleaning		SP11		
Power Tool Cleaning to Bare Metal Thorough	St3	SP3 and		Pt3
Hand and Power Tool Cleaning	St2	SP2		Pt2 Pt1

Table 7 – Comparison of ISO, SSPC, NACE and JSRA Standards

2. SECONDARY SURFACE PREPARATION STANDARDS

In most instances ships are constructed from flat steel plate and shaped stiffening bars, which have been blasted and painted in wheelabrator and shop priming plants. The wheelabrator blasting is considered as primary surface preparation. Unfortunately the shop primer will suffer a great deal of damage from burning, welding, abrasion and weathering during the construction process. This means that it cannot be directly overcoated with the specialized paint schemes. There are two options open to the shipyard.

- 1 They can reblast the shop primer to bare steel. This is expensive and will only be done when absolutely necessary. For example in certain ballast or cargo tank applications.
- 2 They can re-prepare the damaged shop primer. This is considered as secondary surface preparation and is the preferred option, because it is less expensive.

There are two standards of secondary surface preparation you should be familiar with. The first, already mentioned in Section 2 is International Paint's Pictorial Abrasive Sweep Blasting Standards'. The second is the widely used and recognised JSRA standard.

2.1 PICTORIAL ABRASIVE SWEEP BLASTING STANDARDS

This standard shows three different colored shop primers in an untreated state:

red oxide

green

grey

The standard then shows these primers after sweep blasting to different standards. The three sweep blasting standards are defined as follows:

AS1 Light abrasive sweeping of a shop primed surface

AS2 Medium abrasive sweeping of a shop primed surface

AS3 Heavy abrasive sweeping of a shop primed surface

You will see these code numbers used in International Paint's specifications for newbuildings.

2.2 JSRA SECONDARY SURFACE PREPARATION STANDARDS

The JSRA standards look very complex, because they cover so many possibilities. However, they are quite easy to understand if looked at logically.

2.2.1 JSRA Codes before Secondary Surface Preparation

The standards initially show three shop primers before secondary preparation.

WO Wash primer

ZO Organic zinc primer

IO Inorganic zinc primer

The standards then show these primers in a damaged or rusted grade. There are five different grades which are defined as follows:

HO Steel surface with shop primer (W, Z, I) which is exposed to weather about one and a half months after hand welding.

AO Steel surface coated with shop primer (W, Z, I) which is exposed to weather about one and a half months after automatic welding.

FO Steel surface coated with shop primer (W, Z, I) which is exposed to weather after gas burning and water cooling for removing stain of the steel.

DO Steel surface coated with shop primer (Z, I) on which white zinc salts are generated.

RO Steel surface coated with shop primer (W, Z, I) on which little rusts in the form of spots are visible because of exposure to weather.

For example, IHO refers to an Inorganic zinc shop primer which has been hand welded and exposed to weathering for about one and a half months.

2.2.2 JSRA Codes After Secondary Surface Preparation

The JSRA standards then show each of these surfaces **after** it has been prepared by varying degrees of power tooling standards which are the most widely used in the Marine industry and with which you should be familiar.

The JSRA definitions for power tooling and sand blasting are given below:

Pt1: Surface prepared by wire brushing for the surface conditions (H, A, D, R) and by disc sander for the surface condition (F). Loose rust and foreign matter are fairly removed.

Pt2: Surface prepared by wire brushing for the surface conditions (A, D, R), by wire brushing and disc sander for the surface condition (H) and by disc sander for the surface condition (F). Almost all rust and foreign matter are fairly removed.

Pt3: Surface prepared by wire brushing and disc sander for the surface conditions (H,A) and by disc sander for the surface condition (f). Rust and foreign matter are removed to the extent that the surface has a uniform metallic sheen.

Ss: Surface prepared by light blast cleaning of slag, sands or grits. (Shop primer with the little trace of rust is noticeable).

Sd2: Same surface as the grade (Sd2) of the primary surface preparation.

Sd3: Same surface as the grade (Sd3) of the primary surface preparation.

For example, a surface which has been coded WA Pt3 shows a wash primer with an automatic weld seam which has been power tooled to the highest standard.

3. WATER JETTING PREPARATION STANDARDS

3.1 INTERNATIONAL HYDROBLASTING STANDARDS

In the absence of an internationally recognised standard for steel surfaces prepared by water jetting, International Paint have produced pictorial “Hydroblasting” standards. These standards cover two initial rust grades of steel (C and D), two levels of preparation (HB2 and HB2½, being comparable to Sa2 and Sa2½ standards as described in ISO 8501-1 for dry abrasive blasting) and three levels of flash rusting (L,M and H).

3.2 ISO/DIS 8501-4

At the time of writing this training module, ISO are preparing a visual standard for preparation of steel by water jetting. This standard will cover six initial surface conditions, three preparation grades and three flash rusting grades. When ISO 8501-4 is published, it will supersede our own hydroblasting standards. It should also be noted that ISO 8501-4 redefines both nomenclature and operating pressures associated with water jetting (or hydroblasting) and that it is these which have been used in the preparation of this training text.