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## Iron contamination and rust staining on stainless steel

### Introduction

To have their optimum corrosion resistance, stainless steel surfaces must be clean and have an adequate supply of oxygen to maintain their passive surface layer. Rust staining can occur and has been reported as anything from a slight brown 'bloom' on the surface to severe surface pitting or rusty scour marks on items such as handrails. These effects are usually due to surface contamination from contact with non-stainless steel items.

Iron contamination can be costly to remedy, and is avoidable. These issues have been well documented and most publications on stainless steels deal with the problem.

### Key issues to consider

Avoid contamination during all storage, handling and fabrication stages and also during the service life of the stainless steel item.

If contamination is suspected then test the surface.

Where contamination is detected take steps to remove it all and avoid spreading it around during the removal operation.

### Avoiding 'iron' contamination

Stainless steel supplied by reputable manufacturers, stockholders or fabricators will normally be clean and contamination free. These items should not show rust staining, unless contamination is introduced.

The use of non-stainless steel processing and handling equipment is a frequent source of contamination. Work table bearers, lifting 'dogs' and chain marks have all been noted as causes. Non-metallic contact materials and vacuum lifting equipment should be used to avoid process contamination.

Handling or fabricating stainless steel on equipment, using tools also used for non-stainless steels should be avoided. Working in 'mixed-metal' fabrication shops, without taking segregation and cleaning precautions can result in contamination. Cutting or grinding debris from non-stainless steels should not be allowed to settle on stainless steel items.

As soon as any of this contamination becomes wet, rust staining will result.

### Testing for 'iron' contamination

American standards ASTM A380 and A967 outline iron contamination tests. Some of the tests simply look for rust stains from contact with water or high humidity environments, but for detection of the 'cause' ie free iron on the surface, rather than the 'effect', which is the resulting rust stains, then the 'ferroxyl test' is probably the better method. This will detect either free iron or iron oxide and is sensitive enough to detect small levels of contamination. ASTM A380 outlines the procedure in section 7.3.4.

Nitric acid is added to distilled water, followed by the potassium ferricyanide. The 'recipe' is shown in the table.

Distilled water	94 weight %	1000 cm <sup>3</sup>
Nitric acid	3 weight %	20 cm <sup>3</sup>
Potassium ferricyanide	3 weight %	30 grams

Preparation of the solution must be done using equipment where no iron or steel comes into contact with the reagents. It should be applied to the stainless steel surface preferably using an atomizer spray.

A blue stain, appearing in about 15 seconds, indicates the presence of iron. The solution has to be removed from the surface as quickly as possible after testing using either water or 5-20% acetic acid (or vinegar) and scrubbing with a fibre brush, finally rinsing with the solution used, several times.

The standard notes that potassium ferricyanide is not toxic but that the fumes may become toxic if the solution is heated.

Test kits are available commercially from some BSSA member companies.

### Removing 'iron' contamination

Any cleaning process that can remove embedded iron can be used.

It is important to ensure that all the contamination is removed or not spread to other areas of the stainless steel product surfaces, otherwise rust staining can recur. In this respect, chemical, rather than abrasive cleaning may be advisable.

Cleaning and iron recontamination is well documented in stainless steel cleaning product suppliers literature and literature published by the Nickel Development Institute.

As with cleaning, a stepwise approach, depending on the severity of the staining should be considered. Nitric acid or nitric / hydrofluoric acid preparations are the most effective but may cause surface etching, which may be unacceptable on the restored item.

### Methods for removing 'iron' contamination

#### Mild staining or surface 'bloom'