

BRISTLE BLASTING SURFACE PREPARATION METHOD FOR MAINTENANCE

Neil Wilds

International Paint Ltd., Protective Coatings
Stoneygate Lane, Gateshead
Tyne and Wear, NE10 0JY
United Kingdom

ABSTRACT

It has been generally recognised that the best method of surface preparation in maintenance situations allowed by either regulation or situation is either grit blasting or even UHP (ultra-high pressure hydroblasting). Hand tool and power tool preparation has always been regarded as methods which will afford poorer surface preparation standards and therefore reduced lifetime of the maintenance coating. However, a new power tool equipment has been introduced which is portable and achieves cleanliness and surface profile approaching that which is obtainable by blasting cleaning equipment. This paper details this method of preparation and the performance comparison of various standard maintenance products across various accelerated test methods.

Key Words: Maintenance, surface preparation, power tool, bristle blast.

INTRODUCTION

In maintaining offshore or indeed onshore structures in corrosive environments the key concern for the end user is how long the remedial coating system will last. When maintenance is carried out in areas which are difficult to access the cost of maintenance can be up to 20 times more expensive than if the coating was properly maintained in the shop. For this reason it is becoming essential to evaluate alternative methods of remedial surface preparation to give longer lifetimes of maintenance painting. Traditionally for areas where wet or dry abrasive blasting to SSPC-SP 5 or SP 10 was not possible (see Figures 1 and 2) this has meant that a SSPC-SP11 standard utilizing methods such as:

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- Power wire brush
- Grinding
- Needle gunning (less acceptable these days to HSE,(Vibration white finger, Carpal Tunnel Syndrome)

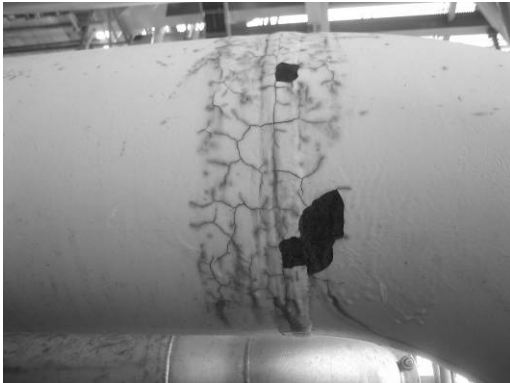


FIGURE 1: Poor field joint repair



FIGURE 2: Small intricate areas for repair

These methods tend to give less than desirable surface preparation standards, especially with regard to surface profile. In the case of power wire brushing, the surface tends to be polished which ultimately leads to adhesion failure of the coating system.

However, new technologies have been introduced such as chemical cleaning using 'rust removers' or more recently Bristle Blasting. The latter of these has been shown to give surface profiles (see Table 2) approaching that of grit blasting. Figure 3, 4 and 5 show a comparison of the surface cleanliness achieved via the different methods of power tool cleaning to that of bristle blasting and grit blasting.

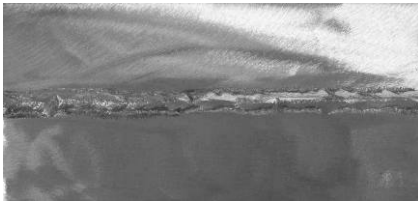


FIGURE 3: Power tool discing

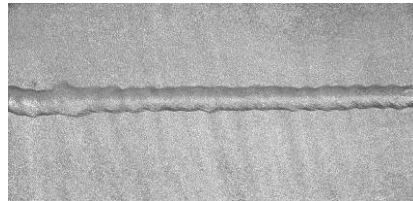


FIGURE 4: Bristle blasting

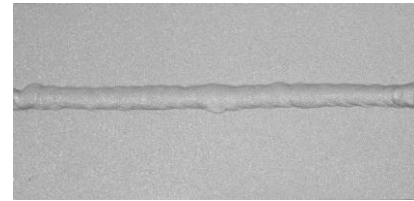


FIGURE 5: Abrasive blast cleaning

The bristle blasting technology utilizes a specially designed rotary head which removes coatings and affords an anchor pattern on the surface being treated. The process derives its name from the sharp, hardened bristles which upon impacting the surface immediately retract to leave a profile from an impact crater which resembles that of a freshly grit blasted surface. This differs from more traditional wire brushing preparation techniques which actually generate score markings or striations.

Although precise comparative data in the field for the three different methods is not available, it is currently estimated that bristle blasting to a standard similar to SSPC SP11 can take four times the amount of time of grit blasting to SSPC SP5 or SP10.

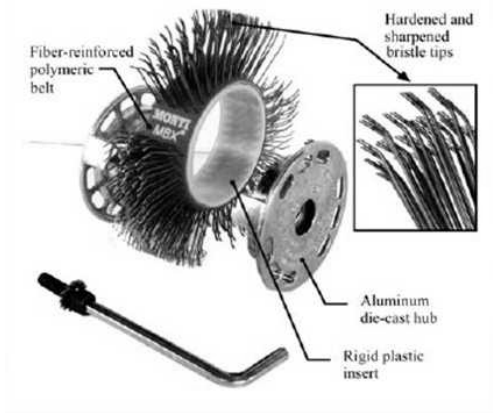


FIGURE 6: Bristle blasting

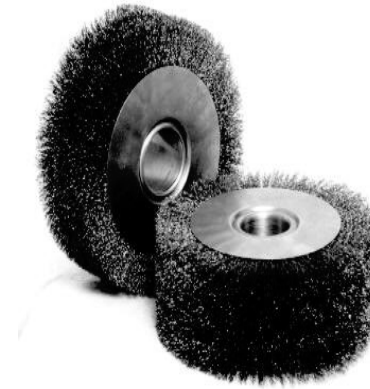


FIGURE 7: Typical wire brush head

Experimental

The various preparation techniques were first evaluated for the effect they have on surface profile as this has been previously shown as a good indicator of performance (An Investigation into the Effect of Surface Profile on the Performance of Coatings in Accelerated Corrosion Tests; D. Ward, NACE Paper 2007). To do this the three methods of surface preparation we carried out onto carbon steel rust grade A and carbon steel rust grade D, see Figures 8 and 9.

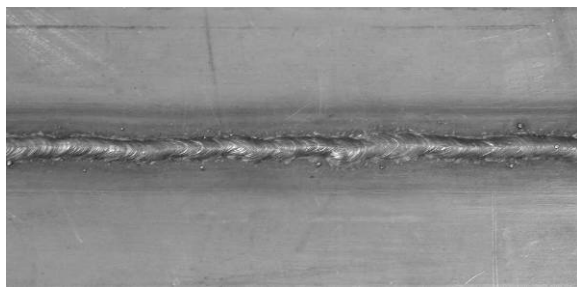


FIGURE 8: Rust Grade A

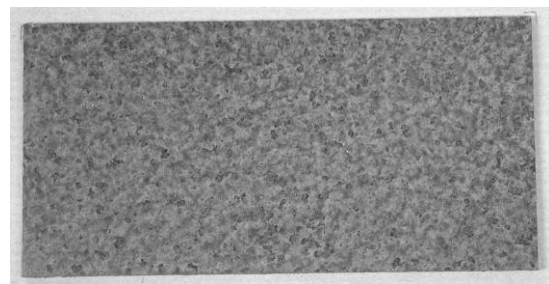


FIGURE 9: Rust grade D

The surface profile was measured after steel preparation with a MAHR PS1 surface profilometer. Both Rmax and Rpc were recorded, where:

- Rmax – the largest peak to valley measurement in the sampling length
- Rpc – the number of peak/valley pairs per unit length.

**TABLE 1
PROFILE MEASUREMENTS**

Surface Preparation Method Rust Grade A	Rmax Range (mils)	Rpc Range
Bristle Blasting	2.4 – 4.6	23 - 35
Power Tool Discing	1.0 – 1.8	38 - 78
Grit blasting	2.9 – 3.4	45 - 51

Surface Preparation Method Rust Grade D	Rmax Range (mils)	Rpc Range
Bristle Blasting	2.7 – 4.3	14- 30
Power Wire Brush	1.9 – 3.2	8 - 17
Grit blasting	3.5 – 4.9	37- 50

In the cases of both Rust Grade A and D the Rmax values are much higher for bristle blasting than for standard power tooling techniques. The values are similar to that of grit blasting.

The resulting prepared panels were subject to a variety of tests to allow comparative performance. Panels utilizing Rust Grade D were tested to ISO 20340. Panels utilizing Rust Grade A were tested for Shell Thermal Cycling, Condensation and Sea Water Immersion as these tests relate to the conditions seen in Korean Shipyards

Systems tested

**TABLE 2
APPLIED COATING SYSTEMS**

System 1	Surface Tolerant Epoxy Hydrocarbon Modified Epoxy 1 Polyurethane Finish	3 mils (75 microns) 7.4 mils (185 microns) 2.4 mils (60 microns)
System 2	Epoxy Anti-corrosive Primer Epoxy Intermediate Polyurethane Finish	3 mils (75 microns) 8 mils (200 microns) 2.4 mils (60 microns)
System 3	Hydrocarbon Modified Epoxy 2 Hydrocarbon Modified Epoxy 2	10 mils (250 microns) 10 mils (250 microns)
System 4	Hydrocarbon Modified Epoxy 1 Hydrocarbon Modified Epoxy 1	7.4 mils (185 microns) 7.4 mils (185 microns)
System 5	Pure Epoxy Aluminum Pure Epoxy Aluminum	7 mils (175 microns) 7 mils (175 microns)
System 6	Pure Epoxy Aluminum	20.4 mils (510 microns)
System 7	Hydrocarbon Modified Epoxy 1	24.6 mils (615 microns)

Modified Shell Thermal Cyclic Test (with reference to document Shell DEP 70.48.11.30 (January 2007) Section 2.2.11.4.)

**TABLE 3
TEST DURATION OF 74 CYCLES (148 DAYS) – ONE CYCLE (2 DAYS):**

Duration (Hrs)	Condition
1	Heating up from +68°F (+20°C) up to +140°F (+60°C)
6	Exposure at +140°F (+60°C)
1	Ambient cooling from +140°F (+60°C) to +68°F (+20°C)
16	Conditioning at +68°F (+20°C)
1	Cooling from +68°F (+20°C) to -4°F (-20°C)
6	Exposure at -4°F (-20°C)
1	Warming up from -4°F (-20°C) to +68°F (+20°C)
16	Conditioning at +68°F (+20°C)

If the cycle is broken, e.g. at weekends, specimens shall remain conditioned at 68°F (20 °C) until the cycle is re-started. The test cycle may only be interrupted for a maximum of 7 days.

The testing was carried out using Systems 6 and 7 as these systems were applied at three times the specified film thickness. After 74 cycles it was observed that all three methods afforded a substrate which gave no failure. This was surprising as it has been well documented that discing as a surface preparation method for hook-up areas for offshore and marine has resulted in many reported failures. This is probably attributable to the coatings employed in the testing which have been known to be very robust to varying surface preparation. Further more in depth work in this area is being carried out in the Marine Laboratories of International Paint.

ISO 20340 Annex B (no freeze)

ISO 20340 is a cyclic corrosion test primarily used to evaluate coatings for use in offshore environments, such as oil and gas exploration. The test has two possible ageing procedures

**TABLE 4
ISO 20340 EXPOSURE CONDITIONS**

Exposure	Annex A	Annex B
UV/condensation - ISO11507	3 days	3 days
Neutral salt spray – ISO 7253	3 days	3 days
Dry cycle (24 hours)	-20°C	Ambient

Only Annex B was followed for this study

From the results summarised in Figures 10 &11 it can be seen that the bristle blasting method of preparation performs very well against the other two methods studied.

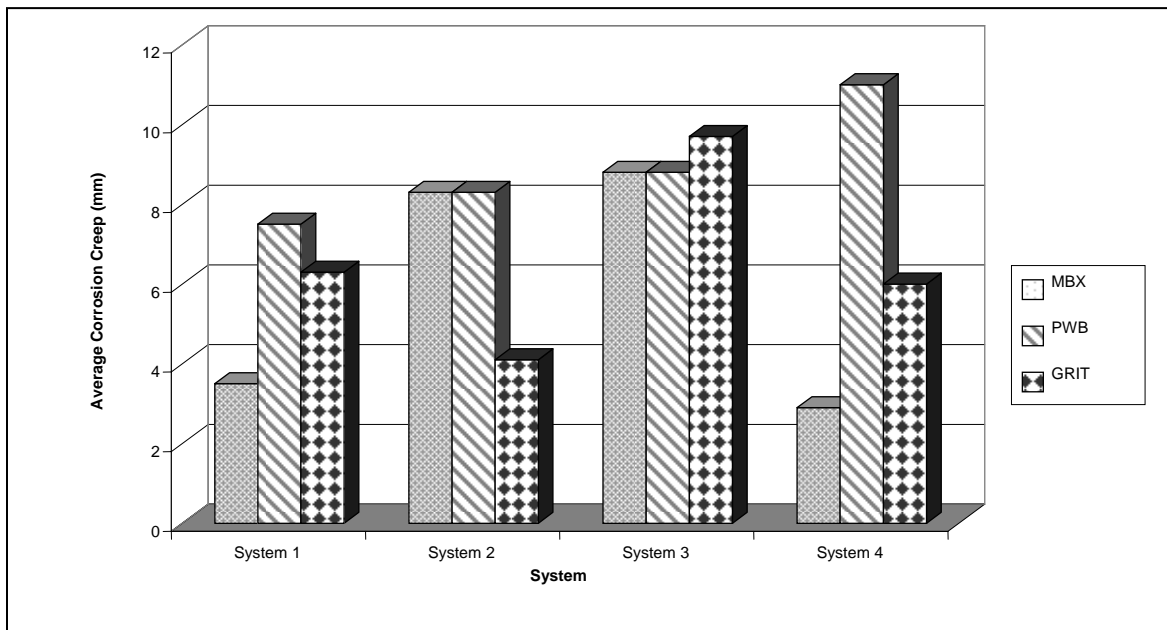


FIGURE 10: Average corrosion creep (MBX – Bristle Blasting, WB – Power Wire Brushing & Grit – Abrasive Blast Cleaning)

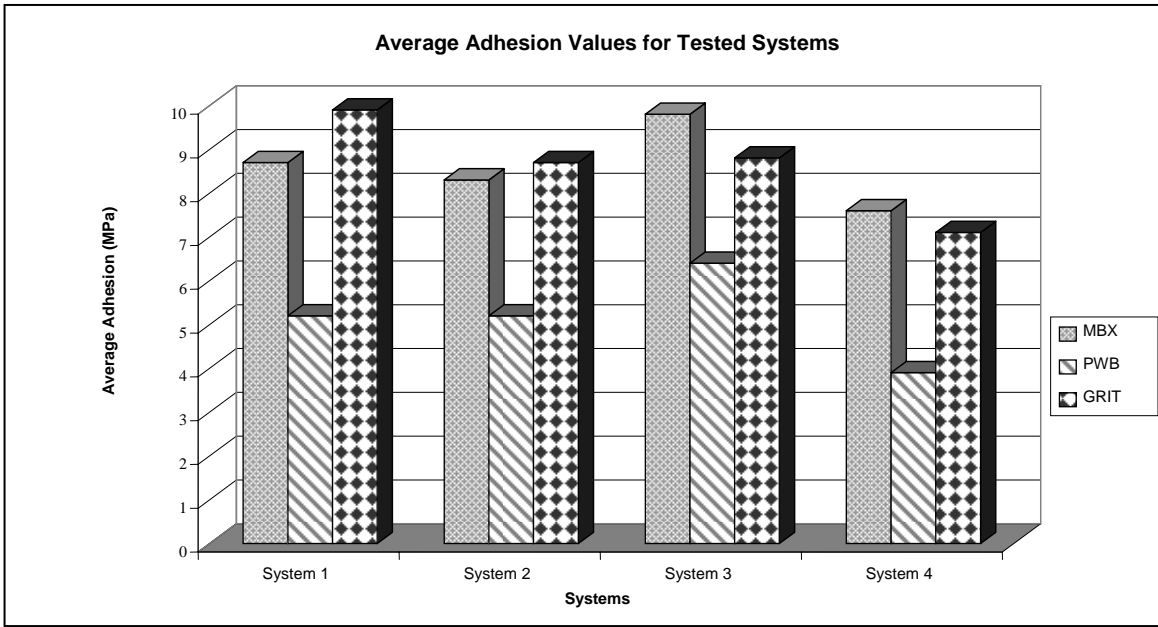


FIGURE 11: Average adhesion test values (MBX – Bristle Blasting, PWB – Power Wire Brushing & GRIT – Abrasive Blast Cleaning)

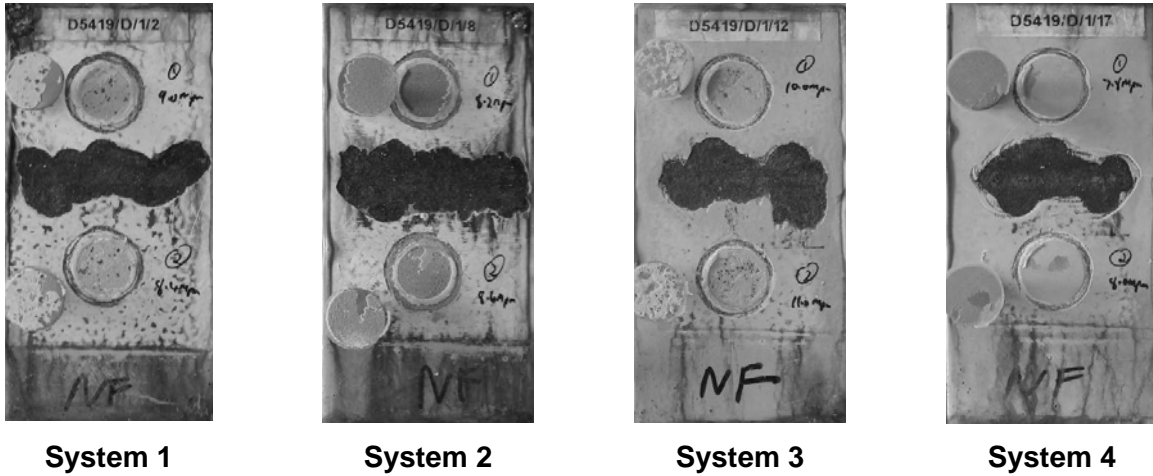


FIGURE 12: ISO 2340 Annex B – Bristle blasting

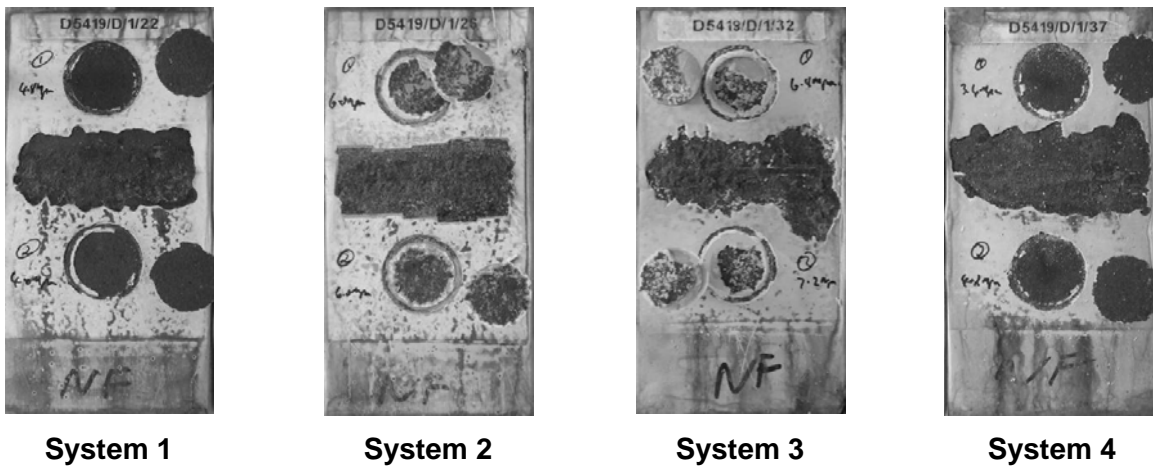


FIGURE 13: ISO 20340 Annex B – Power wire brush

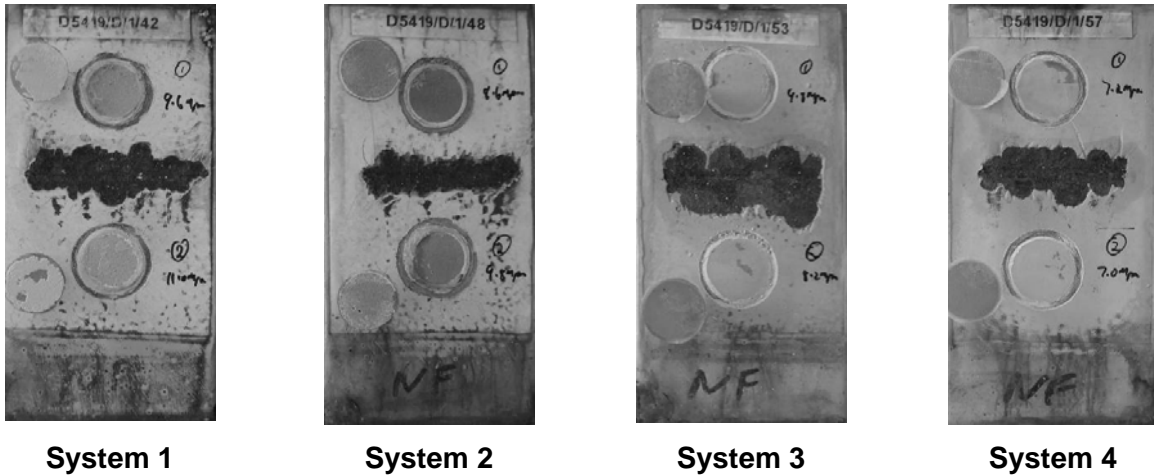


FIGURE 14: ISO 20340 Annex B – Grit blasting

The corrosion graph shown previously, although detailing the differences between the alternative surface preparation techniques, they do show the fact that in the case of power wire brushing (PWB) the substrate is still rusted and therefore unstable. In fact, in the case of the PWB it was very difficult to assess corrosion creep as all the substrate was corroded. The adhesion graph shows the increased adhesion that is afforded by the use of grit blast and bristle blasting. This can be also viewed in the photographs (Figures 12-14) as the PWB panels show further disbondment away from the area of corrosion creep.

Continuous condensation – ISO 6270

Coating system test panels are subjected to a continuous condensation of water at a temperature of 35°C via a Cleveland humidity chamber.

Bristle blasting, power wire brushing and grit blasting were evaluated as surface preparation techniques and Systems 1, 2, 3 and 4 were applied. After 6 months testing all panels showed good performance with no rusting or disbondment observed. Testing is still on going for longer period of time

Sea water immersion ISO 2812-2:

ISO 2812-2 is an immersion test. The coated test panels are immersed in water and the effects of immersion are evaluated for Blistering (ISO 4628-2), Rusting (ISO 4628-3), Cracking (ISO 4628-4) and Adhesion (ISO 4624). A tank is filled with Grade 2 purity water so that when the panels are in position, they are immersed for three-quarters of their length. The temperature of the tank is adjusted to maintain a constant 104°F (40°C) ± 1° throughout the test. This test was modified and the water the panels were immersed in changed to artificial sea water (according to ISO 15711), this was to better replicate marine immersion conditions.



Figure 15: Sea water immersion 6 months no adhesion failure System 4 on any substrate

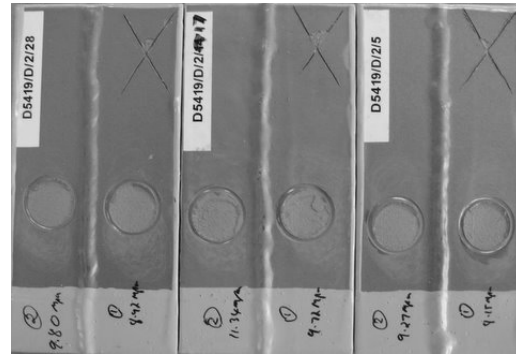


Figure 16: Sea water immersion 6 months no adhesion failure System 5 on any substrate

Bristle blasting, power wire brushing and grit blasting were evaluated as surface preparation techniques and Systems 4 and 5 were applied. After 6 months testing all panels showed no rusting or disbondment observed. Tests are still on going for longer period of time. At 12 months one panel will be removed and adhesion a check again. The assessment will be carried out again after 18 months

CONCLUSIONS

From the work carried out in the laboratory there is no question that the bristle blasting technique has shown that it can improve the surface cleanliness in a situation where grit blasting cannot be used. This can be seen in terms of improvement of adhesion of maintenance coating systems to the substrate through improved surface profile thus leading to improved corrosion resistance in the ISO 20340 cyclic corrosion testing. Continuous Condensation ISO 6270, Sea Water Immersion ISO 2812 and Thermal Cyclic Testing could not, in this case, differentiate between the three types of surface preparation after 6 months testing. However in the case of the ISO 2812-2:2007 Sea Water Immersion testing this will continue to be monitored up to 18 months . It must be noted, however, that bristle blasting by its nature being a power tool will not be a suitable alternative to grit blasting because of the vastly increased production times that can be achieved with grit blasting and the large areas that can be treated. It does have a position though in the area of power tooling small areas such as pipe field joints, when significantly better long term performance is required from the maintenance system. This is definitely the case in areas of very high corrosion such as Offshore C5M according to ISO 12944 or Onshore C5I environments.

If a comparison of the degree of cleaning offered by bristle blasting is made utilizing the pictorial standard issued by the Steel Structures Painting Council (SSPC Vis 3) as well as the performance testing carried out by the author, the following observations can be made:

- Bristle blasting clearly outperforms conventional power tool technique, Power Wire Brushing, tested in the ISO20340 Cyclic Corrosion test.
- Bristle blasting can at least be equivalent to and exceed the cleaning that is achieved by White Metal blast cleaning (SP5) on the ISO20340 Cyclic Corrosion test.

As this technique removes most of the corrosion products apart from slight residues of rust in the lower pits it may also allow the use of high performance systems such as zinc epoxies, which in turn may further enhance the life of a maintenance coating system

As this is a relatively new type of surface preparation technology it still needs to be proven how reliable and tough it can be against the old surface preparation methods, but it is already finding its way into specifications in Europe and the Far East as a recommended method of surface preparation.