High quality surface preparation of railcar interiors is necessary for successful, long-term performance of linings. The measure of quality in surface preparation is a visual standard, either a color photograph or a steel coupon, the appearance of which approximates the desired end condition of the steel after blast cleaning.

The most widely used visual standards are SSPC-VIS 1 (the Swedish Standards); TM-01-70 and TM-01-75 (the NACE coupons); and job standards, which are created at the worksite, using a section of the actual substrate and the blast cleaning methods, equipment, and materials to be used on the job.

While these visual standards can be used successfully to gauge the quality of surface preparation according to the criterion of visible cleanliness, they fail to take into account a second, and vitally important, criterion; degree of contamination by non-visible chemicals on the steel substrate.

The protective coating and lining industry has become aware that chemical contamination by soluble salts, even after meticulous cleaning by abrasive blasting, is the source of many premature failures. Appleman, in his comprehensive review article on the subject (see October JPCL, p.68), concludes that “the issue of soluble salts is one that can no longer be considered a research curiosity or a specialized occurrence. Soluble salts have a significant effect on the lifetime and hence the cost of coating systems and corrosion protection.”

In lining railcars, non-visible contaminants become most important during relining work. It has been observed that linings in new, covered hopper cars carrying road salt that were well lined with a high quality system will perform handsomely for 10 or 15 years. When the lining ultimately fails and the car is relined with the same quality system and with meticulous abrasive blasting, failures often reoccur in precisely the same areas that the initial lining failed. Five to seven years becomes good service life for a relined salt car; a two-or three-year service life is common. It is now believed that residual, non-visible chlorides on or in the steel after blasting are the cause of these early failures.
Another case of relining work that reveals sensitivity to non-visible contaminants involves thermal spray. In 1962, two coal cars were lined with only 6 to 8 mils of aluminum by thermal spray (aluminum metallizing). They were “discovered” in 1984 in amazingly good condition after 22 years of busy coal hauling. There had been virtually no steel lost by internal corrosion or abrasion. Since 1984, aluminum thermal spray has been tried in a number of additional coal cars, but all were used cars, not new ones. The performance has been dismal in comparison. There has been blistering, spalling, and cases of the aluminum falling off in sheets. It is alleged that all were applied after careful abrasive blasting to a good quality of surface preparation. It appears that the presence of non-visible contaminants, in this case sulfates from the coal hauled in the cars, was the source of the poor performance, as compared to the thermal spray applied to new cars.

The Effect of Salt Contamination

Clean steel, when carefully blasted with clean, proper abrasive and protected from water impingement and/or a contaminated atmosphere, does not bloom or rust for weeks. We relate the speed with which steel rerusts or blooms to relative humidity, but if metal temperature is even a little above the dew point, “clean” steel does not bloom even in high humidity. The presence of a water soluble salt is necessary to start the rust.

The chlorides and sulfates are hygroscopic; they draw water from the atmosphere with which to dilute themselves causing a corrosion or rust cell to start. Recently, a fascinating experiment has been reported.\(^2\) Test panels were immersed in salt brine for several days. They were removed, cleaned by rinsing in distilled water, dried, and abrasive blasted. This cleaning procedure was repeated and, on some pieces, several times. Then each panel was coated with a clear protective coating and placed in a humidity cabinet. The surface of the metal was observed through the clear coating. In as little as a few hours corrosion cells were visible as a spot of red rust. This indicated that sufficient residual, non-visible salt contamination was left on the steel to draw water through the coating to dissolve the salt and start the cell.

Osmosis, the phenomenon that brought the water through this film, is powerful enough to bring water in time through any coating. Osmosis, for purposes of this paper, is best defined as the passage of water through a semipermeable membrane from a solution of less concentration to one of greater concentration. That little speck of invisible residual contaminant when touched by moisture becomes the concentrated solution, and it draws more water through the film to dilute itself. The time that it takes is a factor of the moisture vapor transfer or permeability rate of the coating system used, but all coatings have some degree of permeability. Further, as the permeation and corrosion continue, the products of that corrosion are always larger in volume than the elements from which they have come and so ultimately, either a blister is formed or the point of permeation is enlarged to let the corrosion products escape. When this latter occurs and
we observe the now visible small hole and rust stain around it, we often erroneously conclude that it was caused by a pinhole, when in fact it was caused by a contaminated surface. To overcome these effects, it is obviously desirable to use coatings of a quality that have low moisture vapor transfer rates. They should be properly applied, but they must be on a chemically clean surface, not merely a visibly clean surface.

**Study of Non-Visible Contaminants**

A study\(^{10}\) was undertaken to identify and remove all contaminants, visible and nonvisible, from a group of five-year-old coal cars, and then to abrasive blast them and apply 6-8 mils of aluminum by thermal spray.\(^{1}\) By chemical analysis it was determined that the non-visible contaminants were almost solely sulfates.\(^{11}\)

There is not yet a commercially practical way to accurately quantify these residuals. Also, it is not known how much contamination, if any, a particular coating will tolerate. But realizing that a “clean” abrasive blasted surface does not quickly bloom, the investigators set about to find a cleaning procedure that would remove the scale, and when followed by abrasive blast, would allow the used coal car steel to stay “white metal” (SSPC-SP 5) in appearance for three days (72 hours). Many and varied procedures that were investigated and discarded include dry abrasive blasting using various abrasives; steam cleaning; low pressure (garden hose) water wash; high pressure water wash through 8000 psi; and baking at 450 F.

Each of the above methods were tried alone and in combination. Dry abrasive blasting, steaming, and low pressure water were tried in combination and through repeated cycles. On days of high humidity, the rerust or blooming time after the abrasive blast varied from as little as 20 minutes to as long as fourteen hours. It was realized that the old specifications of priming before the first rerust or bloom appeared really meant, “hurry up and prime before you learn how dirty it really is.” Ultimately, an entirely satisfactory procedure was worked out that involved ultra-high pressure water. Using a commercially available pump and nozzle unit that supplies a very low volume of water but at pressures of 34,000-35,000 psi with the water released through the nozzle at approximately 22,000 ft per second, all visible corrosion was rapidly removed. When followed by a careful abrasive blast at the conventional 90 to 100 psi, a surface was provided that easily met the arbitrary three day standard of no rust or bloom. The thermal spray aluminum that followed was carefully inspected after 9 months of service in summer, 1987, and found to be in perfect condition.

Industry is just now becoming universally aware of the presence and significance of non-visible, residual contaminants. Work is underway, but much effort is needed to find commercially practical ways to identify nonvisible contaminants, quantify them, determine the tolerance of each paint and coating system to a specific amount of contamination, and to remove them.
References

(Because of recentness of this work and today’s more rapid growth of knowledge, each of the following must be studied with an awareness of its date of publication.)

2. Frenzel, Dr. Lydia M., Private Work, Ione, CA.
6. Steel Structures Painting Council SSPC 8602, “Evaluation of the Effectiveness of Wet Blast Cleaning Methods on Surface Preparation.”
10. Private work of Tank Lining and Railcar Repair Company, a subsidiary of Trinity Industries, Inc.
11. Private work of KTA-Tator, Inc.

December 1987