Corrosion of steel surfaces in industrial plants is an expensive problem that is difficult to eliminate. New OSHA and EPA regulations have made abrasive blasting more difficult and costly to prepare steel surfaces for repainting, particularly surfaces coated with paint containing lead. This edited version of a presentation at SUR/FIN® '96—Cleveland examines one alternative that provides longer-lasting corrosion control in industrial plants.

The industrial coating business is undergoing significant change because of a need to develop and utilize more cost-effective solutions. The presence of lead-based paint (LBP) on 30–80 percent of steel surfaces is causing excessive costs and complications for refinishing to the extent that traditional paint maintenance budgets are no longer adequate.

Encasement allows available dollars to be spent on new, more efficient equipment rather than on continued repainting to control corrosion of structural steel, siding, tanks, etc. While considerable information is available on corrosion of bridges and, to some extent, outdoor tanks, other steel applications have not received adequate attention. Such steel applications include structural members, siding, roofing, floor decks, piping, indoor tanks and equipment. What follows is a discussion of the technical and cost aspects of spraying several layers of thick materials over new or corroding steel, eliminating the need for surface preparation and without disturbing existing paints.

Safety is a Benefit
Encasement is of particular benefit when used to stop corrosion of steel previously painted with LBP and often at the lowest initial cost with greater longevity. Because encasement does not disturb the LBP, the lead does not become airborne. It eliminates or greatly reduces the need to provide containment to control lead dust emissions and the disposal of LBP as hazardous waste. This allows maintenance of the steel surface to proceed in a timely and cost-effective manner.

Moreover, 11-year case histories in corrosive environments document the superior long-term performance of encasement materials compared to traditional paint. Because encasement materials have very low permeability to air and oxygen, further corrosion of the encased steel is eliminated or significantly reduced, which is a benefit not possible with porous paint films.

The Generic Approach
Encasement deals with spray-applying one or more materials over new or corroding steel with minimal surface preparation.

The ability of the encasement materials to stay in place during the life of the building is a function of the longevity of the materials and the structural strength of the completed encasement system. Projects where encasement has been used over steel have already been in place for about 16 years and are performing well. A comparison can be made to encasing steel in concrete because its structural strength negates the importance of the adhesion of existing coatings to the steel, including LBP. Unlike concrete, however, available polymeric encasement materials can be easily sprayed in retrofit situations with immediate cure at virtually any temperature, and they have proven long-term performance, as will be shown here.

The finished surface of a particular encasement system is an unsaturated polyester resin commonly described as glass-reinforced polyester (GRP), or “fiberglass” resins well known for their excellent durability, chemical resistance and weatherability. Flammability is a drawback of standard polyester resins, but this has been solved by developing proprietary formulations that actually provide fireproofing performance. A 1/16-in. thickness of the polymeric encasement material being described has the same fire ratings as 1/2-in. gypsum board for suitable fire protection over foam plastic insulation. This material has building code approvals throughout the U.S., and is approved for buildings of unlimited height in New York City. The polyester resin finish provides chemical resistance similar to “fiberglass” gasoline storage tanks, chemical process piping and corrugated sheet.

Because the polyester resin finish is catalyst-cured and contains no free water or solvents that must evaporate to effect cure, the materials can be applied at virtually any temperature. The finish is nonporous. More importantly, a vapor barrier permeability rating of .10 at 1/8-in. thickness prevents oxygen from reaching the steel. This significantly reduces or eliminates further steel corrosion, as
Insulation is a Benefit
Polyurethane foam insulation is often used in a 1/2 to 1-in. thickness as the initial sealer, followed by a 1/16-in. polyester finish to provide a two-layer system (Fig. 1). This provides energy savings that often enables the system to pay for itself.

The encasement system described here weighs about a half-pound per ft² and can withstand delamination tests exceeding 200 lb per ft², an engineering safety factor of over 400. Because buildings are usually designed with an engineering safety factor of three, structural engineers can have confidence in the long-term ability of the encasement system to stay in place. In some cases, mechanical fasteners are attached to the steel, or to the building structure, with the encasement materials covering the fasteners. This mechanically locks the encasement system into the substrate and eliminates concern about the condition of existing coatings or their adhesion to the substrate.

Some Thoughts for Owners
Because corroding steel is a continuous problem in industrial facilities, and steps required to remove and replace LBP are complicated, hazardous, time-consuming and very expensive, it can be prudent to evaluate encasement to assess its technical and economic features and benefits. Because a limited number of options are available, an investment in encasement installation can save facility owners a lot of money during the life of their buildings.

Encasement systems can also provide benefits for other applications, such as thermal insulation and asbestos encasement.

Some Actual Cases:

Encasement of Lead Paint On Structural Steel In a Galvanizing Plant

Problem: Owners of an East Coast steel galvanizing plant were faced with severely corroding structural steel caused by hydrochloric acids emitted during the galvanizing process (Fig. 2).

Owners budgeted $275,000 for abrasive blasting and painting 65,000 ft² of structural steel (see Table 1). The building was unheated and the work had to be performed during nights in winter months to avoid interfering with production. These working conditions precluded paints containing water or solvents, because heating the building would be too costly.

Concerns were raised by paint contractors about the adequacy of surface preparation after abrasive blasting because the extent of acid impregnation into the steel could not be determined. Consequently, long-term performance of the new paint could not be assured.

Abrasive blasting would also have required production operations to be curtailed, causing detrimental effects on customer commitments.

An analysis of the existing paint confirmed it contained lead. Removal would require compliance with OSHA and EPA regulations for air-monitoring and proper disposal of lead-containing debris. Market studies of the total costs for abrasive blasting LBP and repainting indicated the...
Table 1
Cost Comparison of Lead Paint Encasement
To Removal & Painting
(Steel galvanizing plant; East Coast environment of hydrochloric and nitric acid vapors—65,000 ft² of structural steel.)

<table>
<thead>
<tr>
<th></th>
<th>Total $</th>
<th>$ Per ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original budget:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abrasive blasting &amp; painting—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-lead paint</td>
<td>$225,000</td>
<td>$3.50</td>
</tr>
<tr>
<td>Cost of lost production</td>
<td>50,000</td>
<td>.77</td>
</tr>
<tr>
<td>Total</td>
<td>$275,000</td>
<td>$4.27</td>
</tr>
<tr>
<td>Projected costs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abrasive blasting &amp; painting—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paint containing lead</td>
<td>$590,000</td>
<td>$9.08</td>
</tr>
<tr>
<td>Cost of lost production</td>
<td>75,000</td>
<td>1.15</td>
</tr>
<tr>
<td>Total</td>
<td>$665,000</td>
<td>$10.23</td>
</tr>
<tr>
<td>Encasement system contract (No lost production)</td>
<td>$279,000</td>
<td>$4.29</td>
</tr>
<tr>
<td>Savings</td>
<td>$386,000</td>
<td>$5.94</td>
</tr>
<tr>
<td>(58 %)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Results: The system was spray-applied at night by a two-man crew in cold temperatures with no surface preparation or disturbance. Table 1 shows the 58 percent cost savings based on $4.29/ft² of steel surface area. The expected lifetime is at least 20 years, based on other similar encasement installations.

Encasement of Open Bar Joists & Steel Roof Deck Over Aluminum Anodizing Line

Problem: An Ohio aluminum anodizing plant had a severely corroded metal roof and open bar joists. In some locations the roof had corroded completely, and the only weather protection was a thin layer of insulation and protective covering on the exterior surface. Abrasive blasting was not possible, because it would further damage the metal roof. Pressure washing and painting would last only three years.

Solution: A three-layer encasement system was selected, because of its proven longevity, quick installation time and cost-effectiveness. Roofing that was completely corroded was replaced. Figure 3 shows the project before encasement.

Results: Figure 4 shows the completed project. The encasement was installed on 15,000 ft² of roof deck and open bar joists over a five-day plant shut-down. Surface preparation was limited to vacuuming dirt off ledges of the joists. Cellular foam was used to fill all cavities of the bar joists and the spaces between the corrugated roof deck and the top cord of the trusses. This is not possible with traditional thin coatings because cleaning or spraying in these inaccessible cavities cannot be done. Comparative costs were $6/ft² for the encasement system with an estimated 20-year life, or an annual cost of 30 cents/ft². Washing and painting would have cost $3/ft² with an estimated life of three years, or $1/ft² annual costs. Savings of 70 percent were achieved.

Problem: A Chicago plating company had corrosion problems with its aged metal building. A new plating line was determined to be feasible. A new 100,000 ft² building was designed to be built with precast concrete walls and roof to eliminate steel corrosion. This design was quite expensive.

Solution: The plating company considered an encasement system installed underneath a traditional metal roof deck and supported by open bar joists. This alternative was selected based on the proven performance of the encasement system in more severe chemical environments and the fact that the system also provided necessary insulation.

Results: The encasement system was applied on all sprinkler piping, conduit and columns, as well as the underside of the metal roof deck and on the open bar joists for complete corrosion protection and energy savings. Estimated cost savings exceeded $200,000.

A Practical Approach
For Corrosive Environments
The encasement approach eliminates the need for abrasive blasting and provides a half-inch thick, durable, corrosion resistant covering at costs comparable to those of traditional abrasive blasting and painting. Surfaces painted with lead-based paint can also be encased at these same reduced costs, because the lead paint is not disturbed and regulatory compliance is greatly simplified.

Encasement has been used successfully in buildings having chemically strong corrosive environments for more than 11 years. P&SF

About the Author
John A Stahl is the founder and president of Preferred Solutions, Inc., 7819 Broadview Rd., Cleveland, OH 44131. His company manufactures materials used for thermal insulation and corrosion control in commercial and industrial buildings. He holds an MBA degree from Ohio State University and has more than 30 years’ experience in building construction. He worked for 12 years with B.F. Goodrich chemical division, where his department invented solid vinyl siding and hot & cold water plastic piping.