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ENCASEMENT: AN INNOVATIVE SOLUTION FOR LBP MANAGEMENT

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Editor's note:

Much information has been published regarding the presence and removal of lead-based paint (LBP) in residential structures. LBP removal issues in industrial facilities have not been widely discussed since removal is not required and many facility owners are not aware of LBP regulations. However, it's estimated that 30-80 percent of structural steel and other surfaces in these facilities have been primed and/or painted with lead-based paints. In addition, industrial facilities often have corrosive or high humidity environments requiring periodic painting to avoid deterioration and eventual replacement.

While it is not expected that LBP removal will be mandated in industrial facilities, OSHA regulations apply when facilities undergo repainting projects due to the necessity of abrasive blasting or other surface preparation methods that disturb LBP. The stringent work practices required by OSHA for this type of work has significant impact on project cost (compared to non-LBP projects) resulting from passage of Title X - The Residential Lead-Based Paint Hazard Reduction Act of 1992.

This paper addresses the technical and cost aspects of spraying a polymer-based composite over LBP in a manner which eliminates surface preparation and disturbance. As a result, lead is not released and therefore the need and requirement to provide containment to control lead dust emissions and the disposal of LBP as hazardous waste are eliminated. This enables the project to proceed in a timely and cost effective manner.

Moreover, independent test data proves the superior long-term performance of encasement materials over traditional paints in corrosive environments. Because encasement materials have very low permeability, further corrosion of the encased steel is eliminated or significantly reduced, a benefit not possible with porous paint films.

Regulations Affecting Industrial LBP Projects

On October 28, 1992, Title X - Residential Lead-Based Paint Hazard Reduction Act of 1992 was passed as federal legislation. The title is somewhat misleading in that the Act is very comprehensive and includes private, public, commercial and industrial buildings, tanks, bridges and superstructures as well as demolition and dismantling projects.

One significant aspect of the law is that virtually every person dealing with LBP is required to receive special training and licensing by their respective state in order to perform LBP work. Individuals and contractors found not to be performing LBP work in accordance with all applicable regulations will be subject to having their licenses revoked, which could result in their inability to perform further work and termination of business operations.

Individuals and contractors must inform property owners if surfaces to be prepared and/or painted contain LBP so that appropriate work practices and resultant pricing are properly determined. This will have the effect of acquainting many facility owners of the appropriate regulations that must be followed and the resultant price increases compared to previous painting projects, raising the owner's interest in quicker, safer and lower cost solutions such as encasement.

On May 4, 1993, OSHA published the Interim Final Standard on Lead Exposure in Construction effective June 3, 1993 which reduced Permissible Exposure Limit of persons exposed to lead from 200 micrograms to 50 micrograms of lead per cubic meter of air. When such limits are exceeded, facility owners, individuals, consultants, contractors, material and equipment suppliers and others must assure all employees comply with the Standard, including proper training, medical monitoring, work practices, respiratory protection and suitable protective clothing.

Medical monitoring of employees, including blood sampling, is required when the Action Level of 30 micrograms of lead per cubic meter of air occurs or when any of the three OSHA defined high-risk "trigger" tasks are performed.

Cost Impact of Existing Regulation On Industrial LBP Projects

Industrial painting contractors can no longer perform open abrasive blasting and must contain or isolate the work area to assure existing OSHA air quality regulations are met in order to protect facility employees from being exposed to lead. Containment of lead dust increases the lead exposure to workers, therefore requiring more stringent training, protective clothing and respirators. Productivity is detrimentally affected and existing EPA regulations often require the lead debris to be transported, treated and disposed of as hazardous waste.

Because of these factors, facility owners are receiving paint bids that are often $8.00 to $12.00 per square foot of surface area compared to previous and current budgets of $3.00 to $4.00 per square foot. Additionally, plant production can be detrimentally affected since surface preparation work is much more involved and time consuming.

Lessons From the Asbestos Experience

Compared to asbestos, LBP is being recognized as being more pervasive, more hazardous from a health viewpoint and more difficult and expensive to remove.

Lessons learned as a result of spending billions of dollars to control asbestos fiber release are relevant to LBP. From a regulatory point of view, even though the EPA never required removal of asbestos from buildings, removal usually was done because it was erroneously perceived that removal was required or even preferred by the EPA.

Additionally, only a very limited number of technically-viable alternative solutions to manage asbestos in place were available and EPA had no authorization of funding to evaluate and approve such methods. More recently, however, EPA has issued new guidance documents that recommend facility owners consider managing asbestos in place before considering removal. These documents also describe the suitability or unsuitability of control options and describe the encasement approach as having the unique distinction of being “generally suitable for all forms and thicknesses of asbestos” compared to encapsulation which has numerous limitations.

At national conventions dealing with LBP issues, EPA personnel have repeatedly stated their asbestos experiences have been very beneficial in their determination that management in place of LBP is their recommended solution where technically and economically feasible. Hopefully, the billions of dollars needlessly spent on asbestos removal will not be repeated with LBP.

Overcoating, Encapsulants and Encasement

Overcoating is a term sometimes used to describe materials applied over existing LBP instead of removal. In some cases surface preparation might be necessary.

Encapsulants are paint-type coatings that are usually water based and are generally spray applied in thickness ranging from .003” to .020”.

Encasement materials are usually 100% reactive polymers containing no water or solvents and are generally spray applied in thicknesses ranging from .250” to 1.00” which is up to fifty times the thickness of encapsulants or traditional paints. The photo on page two shows a typical one inch thick, two-layer encasement system over LBP on structural steel.

Table 1 (page seven) is a comparison of three LBP treatment options. **Table II** (page seven) compares the long-term performance while **Table III** (page eight) compares the cost of each of the three treatment options.

Encasement as a Generic Approach to LBP Control

Industrial facility owners are not currently faced with any existing or proposed regulations that require in-place LBP to be addressed in their facility as long as air quality levels are acceptable. On the other hand, issues dealing with LBP regulatory and safety issues must be properly addressed when LBP is delaminating (requiring hazardous disposal) and when steel surface preparation is necessary prior to maintenance painting.

The encasement approach deals with spray applying one or more materials over LBP without surface preparation in such a manner that no lead disturbance occurs, eliminating the need and expense of having full isolation of the work area (commonly called containment area). Such containment is required by OSHA since lead-laden dust is usually created during most surface preparation methods.

Encasement procedures have been used for asbestos and lead paint control for 25 years. Independent laboratory results have documented the ability of encasement materials to be sprayed as a fine mist over fluffy asbestos without fiber disturbance due to contact pressures of the encasement materials being less than .03 psi. Since LBP is usually a harder and better adhered material compared to asbestos, chance of disturbance is further reduced.

The ability of the encasement materials to stay in place during the life of the building is function of the longevity of the materials and the structural strength of the completed encasement system. A comparison can be made to encasing an I-beam in concrete since the encasement system locks itself mechanically in place. Unlike traditional coatings, it's not dependent on surface adhesion for long term ability to stay in place.

Fortunately, available polymeric encasement materials can be easily sprayed in retrofit situations with immediate cure at virtually any temperature and has proven performance as shown in this report's case history examples.

The encasement system shown on page 2 is a two part system as follows: Spray polyurethane foam insulation was first applied 1" thick. It has an R-value of 6.5, almost twice that of fiberglass & cellulose. Polyurethane foam insulation has been used for decades to insulate buildings, where its' superior insulation efficiency/value, seamless application, high strength, moisture resistance and durability are required. The energy efficient insulation provides payback through energy savings (see **Table IV** page eight).

The finished surface is a vinyl-ester resin coating (commonly described as "fiberglass") applied at 1/16" or greater thickness to provide a durable, washable, seamless and fire retardant finish required by building codes. It has low permeability (.09 perms @ 1/16") and excellent chemical resistance to keep chemical vapors, moisture and air from affecting the foam and steel substrates.

The encasement system weighs approximately ½ pound per square foot and can withstand pull-off or resistance-to-delamination tests exceeding 200 pounds per square foot for an engineering safety factor of over 400. Since buildings are usually designed with an engineering safety factor of 3, structural engineers can easily determine, and have confidence in, the long-term ability of the encasement system to stay in place.

Monitoring Strength of Encased Steel

Steel that is covered by concrete, fireproofing, insulation or other thick materials including encasement should be periodically monitored to determine the presence of corrosion, fatigue, cracking, metal loss or other factors that could affect the steel's strength. Analysis of steel encased with the polymeric encasement system described in this paper has confirmed no apparent further steel corrosion after twenty five years in a hydrochloric and nitric acid environment.

Suggested Steps for Facility Owners

Because of the significant amount of LBP in industrial facilities and the complicated, hazardous, time consuming, and very expensive procedures required for LBP removal and replacement, it's a prudent business decision to evaluate encasement solutions in order to obtain first-hand information about their technical and economic features and benefits.

If numerous encasement solutions were available, facility owners would need a research program to evaluate the many options. However, since only a limited number are available with documented proven performance, investing in an initial encasement installation (to verify features, benefits and cost), will confirm that the encasement approach can save facility owners hundreds of thousands (if not millions) of dollars during the life of their buildings. This type of return on investment analysis is needed in order to maximize cost effectiveness in dealing with environmental, maintenance and energy issues.

Experience with encasement systems can also provide benefits in using these technologies for non-LBP applications such as corrosion control, thermal insulation and asbestos encasement.

TABLE I

Comparison of LBP Treatment Options*

	Encasement	Encapsulation	Removal & Replacement
Surface preparation required	NO	YES	YES
Lead disturbed and made airborne during surface preparation	NO	YES	YES
Workers and building occupants must be protected from airborne lead	NO	YES	YES
Work area must be isolated using physical barriers, negative air pressure and air filtration equipment	NO	YES	YES
Disposal of lead required	NO	YES	YES
Cold weather prevents abatement method from being used	NO	YES	YES
*Assumes LBP is partially delaminating or peeling			

TABLE II

Long Term Performance Comparison of LBP Treatment Options

Expected Longevity	Encasement	Encapsulation	Removal & Replacement
Corrosive Environments	25+ years 25 Year Documented Performance History	5-10 years	5-10 years
Materials are thick and highly resistant to delamination and peeling	YES	NO	NO
Materials are vapor barriers that prevent further steel corrosion	YES	NO	NO
Materials minimize maintenance costs	YES	NO	NO
Materials can provide thermal insulation to provide energy savings	YES	NO	NO

TABLE III

Long Term Cost Comparison of LBP Treatment Options
(Costs per square foot of surface)

	Encasement	Encapsulation	Removal & Replacement
Initial Costs	$5.00 - $6.00 per square foot	$5.00 - $6.00 per square foot	$6.00 - $15.00 per square foot
Expected longevity	25+ years	5 - 10 years	5 - 10 years
Cost per square foot per year	$.18 - $.22 (60% - 85% less cost than encapsulation) (70% - 95% less than removal and replacement) Energy savings provided by encasement can further reduce overall costs	$.45 - $1.10	$.60 - $3.00

TABLE IV

Cost Comparison and Expected Longevity

Encasement of LBP on Roof Deck vs. Removal and Replacement of Roof Deck
Precious metal refining plant
Environment of hydrochloric and nitric acid vapors - 11,000 square feet of roof deck

	Total	Per Square Foot
Low bid for roof deck replacement and reinsulation	$115,000	$10.46
Encasement contract	$58,080	$5.28
Savings provided by encasement	$56,920 (49%)	$5.18

Energy savings provided by encasement/insulation system: > $8,000.00 per year = 7.3 year payback
100% savings on lead control since energy savings paid for complete encasement system

Case History

Twenty-Five Year Performance: Structural Steel and Roof Deck Encasement

Problem

In 1984, engineers at an 11,000 square foot New England metals refining plant needed to find a chemical resistant insulation and corrosion control system that would eliminate further corrosion and deterioration of their structural steel and roof deck.

Plant operations generated strong hydrochloric and nitric acid vapors that condensed on the steel and caused sufficient corrosion requiring some steel to be removed and replaced. Attempts to protect the steel by abrasive blasting and application of epoxy-based coatings had repeatedly failed.

Their needs were defined as follows:

- A system that could be applied without abrasive blasting the painted steel surfaces since lead paint primers and paints had been used.
- A chemical resistant insulation and corrosion control system capable of withstanding exposure to a variety of acid fumes.
- A high R-value (6.5 per inch) insulation that would insulate the underside of the roof sufficiently so that winter temperatures would not chill the metal roof and allow destructive condensation to form.
- A spray-applied system having no water or solvents that would fill all contours and provide a seamless vapor barrier to prevent water, air and chemical vapors from deteriorating the protected substrate.
- A tough surface that could be scrubbed with brushes, soap and water and cleaned by high pressure washing.
- A system that could be installed during two weekends without the lengthy time and disruption involved with abrasive blasting and applying three coats of paints.

Solution

After several candidate solutions were evaluated by subjecting them to liquid acids, the client chose the three-layer, encasement system manufactured by Preferred Solutions, Inc. The STAYFLEX™ Corrosion Control and Thermal Insulation System consists of 2" thick STAYCELL™ 245-2.0 Spray Polyurethane Foam Insulation covered by 1/16" thick STAYFLEX™ 2505 Thermal Barrier Coating and top-coated with .005" thick (5 mils) STAYCOAT™ 200 Topcoat for enhanced chemical and abrasion resistance. The entire project was completed in the necessary two weekends.

Result

As shown in **Photo 1**, the encasement system is performing in an excellent manner with no deterioration. Since the roof deck surface temperature has been kept above the dew point of the acid-bearing vapors and by the system being a barrier to air, moisture and chemicals, further corrosion of the steel has been prevented and maintenance costs have been virtually eliminated. The expected service life of the structural steel and roof deck has been greatly extended.

PHOTO #1

Case History

Encasement of LBP 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 and nitric acids emitted during the galvanizing process. **Photo 2** shows the condition of the steel before encasement.

As shown in **Table V** (page twelve), $266,500 had been budgeted for sandblasting and painting 65,000 square feet of this steel. Due to the presence of lead-based paint, cost projections for removal and repainting greatly increased to $590,000 not including the costs associated with any production losses that could occur since full containment was required to contain the lead during sandblasting.

The building was unheated and the work needed to be performed during nights in winter months with temperatures in the building often below freezing precluding water or solvent-based paints unless the contractor heated the high, open building, which was not economically feasible. In addition, several industrial painting contractors had told the building owner that even with complete sandblasting and painting with the best paints available, long-term performance was questionable due to the strong chemical environment.

Solution

Preferred Solutions, Inc. (PSI) was asked to visit the jobsite to review the owner's needs and discuss the feasibility of encasing the lead paint without surface preparation and disturbance. After concurring that encasement would meet the job requirements, PSI personnel flew the owner to a previously installed project where production practices also utilized hydrochloric and nitric acids.

Based on seeing the long-term proven performance, the STAYFLEX™ Corrosion Control and Thermal Insulation System was selected for application to all structural steel in the building. The system consisted of 1" thick STAYCELL™ 245-2.0 Spray Polyurethane Foam Insulation covered by 1/16" thick STAYFLEX™ 2505 Thermal Barrier Coating.

Results

The STAYFLEX™ System was spray-applied at night by a two-man crew in cold temperatures with no surface preparation or disturbance. **Table V** shows the 41% cost savings based on $5.41 per square foot of steel surface area. The expected longevity is greater than 25 years based on other similar encasement installations. See results **Photo 3**.

PHOTO #2

PHOTO #3

TABLE V

Cost Comparison and Expected Longevity

LBP Encasement vs. Removal and Replacement

Steel galvanizing plant

Environment of hydrochloric and nitric acid vapors - 65,000 square feet of structural steel

	Total	Per Square Foot
Original budget for sandblasting and painting: non-lead paint	$266,500	$4.10
Low bid for sandblasting and painting; paint containing lead	$590,000	$9.05
Encasement contract	$351,000	$5.41
Savings provided by encasement	$239,000 (41%)	$3.64

Expected longevity of sandblasting and Epoxy Paints: Unknown since no painting contractor would provide warranty.

Expected longevity of encasement: 25+ Years, backed by independent test data.