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EXPECTED SERVICE LIFE AND COST CONSIDERATIONS FOR MAINTENANCE AND NEW CONSTRUCTION PROTECTIVE COATING WORK

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ABSTRACT

This paper is an update to "Expected Service Life and Cost Considerations for Maintenance and New Construction Protective Coating Work" co-authored by J. L. Helsel, M. F. Melampy, K. Wissmar for NACE Corrosion 2006.

Designed to assist the coatings engineer or specifier in identifying candidate protective coating systems for specific industrial environments, this paper provides: 1) commonly used generic coating systems in typical service environments, 2) service life for each, 3) current material costs, 4) current field and shop painting costs, and 5) guidelines for calculating approximate installed costs of the systems. Guidelines for developing long-term life-cycle costs and number of paintings for the expected life of the structure are included. The basic elements of economic analysis and justification are addressed together with guidance on the preparation of a Present Value Analysis. Worksheets and examples are provided to aid the reader in the proper use of the information.

Updates to the paper also include additional information related to metallizing, updated cost data, and the inclusion of new coating systems.

Keywords: protective coatings, life-cycle costs, coating selection, coating system life, containment costs, industrial maintenance, maintenance painting costs, industrial environments, corrosive, solvent-free, metallizing, galvanizing, Present Value Analysis, installed coating costs.

INTRODUCTION

Major manufacturers of protective coatings, steel fabricators, painting contractors, galvanizers, and end users, were surveyed to identify surface preparation and coating application costs, coating material costs, typical industrial environments and available generic coatings for use within those environments, and expected coating service lives.

The approach to this cost data is meant to be practical. Instead of burdening the coating engineer with complicated cost formulas based on hourly wages, supervision, equipment rates, overhead, profit, and other cost elements, this guide supplies total costs, which include all of these elements. The costs are intended to reflect current, competitive/commercial prices charged in today's market.

Surface preparation and application costs are primarily based on major steel fabricators and painting contractors. Material costs are secured from major suppliers who furnish approximate prices at which coatings are being sold on commercial-sized jobs. The current cost data presented is a number developed from the collected data along with leading industry cost references.

This guide produces a base cost of painting steel on the ground at the site that is then adjusted to an installed cost, using multipliers based on input from painting contractors. Most elements used in the guide have come from these contractors, and have proven to be practical over the guide's long history.

Limitations

The costs in the guide are not intended to be absolute, nor are they intended for use in estimating or negotiating. Specific job costs will vary depending on the job size, geographic location, logistics, competitive climate, and other factors including available working hours, allowable time to completion, traffic restrictions and level of inspection required. The purpose of the guide is to provide an easy-to-use, practical means to identify, compare, select, and justify suitable, cost-effective protective coating systems for specific environments, and to answer fundamental questions such as: What will work? How much will it cost installed? How long will it last? What is the cost per year per square foot?

DISCUSSION

Product Trends, System Changes, Service Environment and Updates

1. Coating System Update: The information detailed for designated "coating systems" include the level of surface preparation, generic coating type(s), and a minimum coating dry film thickness. The categories for surface preparation include either hand/power tool cleaning or abrasive blast cleaning. A distinction is not made between grades of blast cleaning (e.g. Near-White versus Commercial Blast). The coating systems are divided into two categories: those for atmospheric exposure listed in Table 1A, and those for immersion (water) service listed in Table 1B. Tables 1A and 1B list the expected service life (as subsequently defined) for each "coating system" corresponding to particular service environments as described below.

2. Service Environment: The "service environment" defines the anticipated environmental exposure conditions for a coating system. For atmospheric exposure, there are four service environments that correspond to ISO 12944-2, "Classification of Environments." These categories are defined as follows:

   C2: Low - Atmospheres with low levels of pollution; mostly rural areas

C3: Medium - Urban and industrial atmospheres, moderate sulfur dioxide pollution; coastal areas with low salinity

C5-I: Very High, Industry - Industrial areas with high humidity and aggressive atmosphere

C5-M: Very High, Marine - Coastal and offshore areas with high salinity

For water immersion service, there are three service environments corresponding to exposure to potable water, fresh water, and salt water.

3. Hot Dip Galvanizing: Hot dip galvanizing is a shop applied coating (installed by dipping the parts in special cleaning and molten zinc baths) which provides a combination of physical properties that can be superior to many other coating systems. A galvanized coating consists of a progression of zinc-iron alloy layers metallurgically bonded to steel substrates. The resulting coating is anodic to steel, resists underfilm corrosion, has excellent abrasion resistance, and provides excellent film build at sharp corners, edges and projections. The service life, material costs, and all labor and equipment costs associated with surface preparation, fluxing, dipping, and cooling for hot dip galvanizing are included in Tables 1A and 3.

4. Metallizing Systems: Metallizing is the application of zinc and/or aluminum directly to a steel surface. For atmospheric exposure, a typical composition of the metal is 85% zinc and 15% aluminum. The metal is applied by "thermal spray" where the metal, in wire or powder form, is heated, liquefied, and sprayed onto the substrate. A sealer coat is often applied to the metal coating since metallizing results in a somewhat porous coating layer. Metallizing provides galvanic protection to the steel and is a very durable and abrasion resistant coating. This system's performance (life) is provided in Tables 1A and 1B. The costs for metallizing are estimates based on information published by the Federal Highway Administration.[7,8]

5. Paint Removal: The Containment Multiplier Guidelines in Table 5 are included to aid in developing approximate costs for paint removal depending upon the containment type. These are to be used in conjunction with surface preparation costs developed in Table 4. The containment type (class) is based on SSPC Guide No. 6, "Guide for Containing Debris Generated During Paint Removal Operations."

6. Maintenance Painting Sequences: This guide presents a sequence for typical maintenance painting. This sequence includes: Original Painting, Spot Touch-up and Repair, Maintenance Repaint (spot prime and full coat), and Full Repaint. Examples of maintenance painting following this convention for various coating systems are presented in the guide. It is important to note, however, that this sequence does not always represent the most economical approach to maintenance painting. Often, several cycles of touch-up and maintenance repainting can be performed prior to the need for full repainting. The determining factors involved with this type of extended maintenance painting sequence are the amount of corrosion present and the physical characteristics of the existing coatings. These factors should be investigated prior to the next scheduled painting operation.

   Decisions involving whether or not a full repaint is required, as opposed to a maintenance repaint or touch-up, should be based on the results of a field investigation. Generally, touch-up procedures are used when the amount of corrosion is limited or found in discrete areas. The success of maintenance repainting depends on the coating type, thickness, and adhesion of the existing coating system, as well as the substrate condition. The general procedures outlined in this guide may be used to determine installed costs and life-cycle costs for any combination of maintenance painting sequences.

Table 6 can be used as a guide to determine maintenance repainting risk (i.e. whether the existing coating might be a candidate for repair)[2].

7. Worksheets (Shop and Field Application): These worksheets were developed to aid in preparing initial installation costs (see Figures 1 and 2). The step by step, fill-in worksheets are designed to minimize the omission of important information. It must also be recognized that every job may have unique conditions that will prevent the development, or use, of general overall multipliers.

PRACTICAL SERVICE LIFE

How long will the coating system last? The answer depends on the user's approach to, and philosophy of, maintenance painting. Is protection alone important, or is appearance also a primary consideration? Is painting viewed as an unfortunate necessity, or is cost-effective corrosion protection the objective?

This guide supplies system life estimates for a "Practical" maintenance approach. Practical life is considered to be the time until 5 to 10% coating breakdown occurs (SSPC-Vis 2 Rust Grade 4[3]), and active rusting of the substrate is present. It should be noted, however, that the distribution of the breakdown must also be considered when making judgments regarding the feasibility and costs of maintenance painting. For example, 5% breakdown that occurs in well-defined areas can be practically repaired through localized touch up, whereas 5% breakdown uniformly scattered across 100% of the surface is beyond spot repair. At a minimum, a full coat is required, if the coating is even salvageable. The guide does not address these differences, but the user must take them into consideration when making painting decisions and determining the costs of painting.

Note that this "Practical" maintenance sequence is based on one approach, but it may not always represent the most economical approach to maintenance painting. The determining factors are the amount of corrosion present and the physical characteristics of the existing coatings. These factors should be assessed prior to the next scheduled painting operation. In some cases, multiple cycles of touch-up and maintenance repainting can be performed, pushing the need for full repainting further into the future. Decisions involving whether or not a full repaint is required, as opposed to another maintenance repaint or touch-up, should be based on the results of an investigation of coating thickness, adhesion, substrate condition, and extent and distribution of corrosion.

TYPICAL MAINTENANCE PAINTING PRACTICES

The sequences followed by users in maintenance painting vary widely. For some, the only criterion is, "Does it need to be painted?" However, when reviewing the subject with quality painting contractors, the consensus is that most users generally follow this sequence:

- Original Painting
- Spot Touch-Up and Repair
- Maintenance Repaint (spot prime and full coat)
- Full Repaint (total coating removal and replacement)

"Spot Touch-Up and Repair," which is the first time coating repairs are made, are intended to be completed at the "Practical Life" ("P") of the coating system as listed in Tables 1A or 1B. The time until "Maintenance Repaint" is estimated to be the "Practical Life" plus 33% (i.e. "P" x 1.33). A "Full Repaint," involving total coating removal and replacement, is expected to occur at the year of "Maintenance Repaint" plus 50% of the "Practical Life" (i.e. Maintenance Repaint year + ["P" x 0.5]).

For example, if the practical life of a system is 21 years, the spot touch up would occur at year 21, with an overcoat at year 28, and full replacement of the system at year 39. Even though complete removal and replacement of a system is no longer a "maintenance" operation, it may be included in the life cycle analysis (as subsequently discussed) to allow for a comparison of different coating systems that have varying lengths of practical service life. The continuing cycle of maintenance painting also is necessary when the design life of the structure exceeds the design life of the coating system. In this case, the cost of complete coating replacement and additional maintenance cycles must be calculated to determine the total cost of the corrosion protective system over the entire life of the structure. Note that the coating replacement and continued maintenance painting assumes the same type(s) of coatings for the particular protective coating system are used over time.

COST COMPARISONS

Shop versus Field Painting – New Construction

Shop blasting and priming are about half the cost of doing work in the field when a minimum of 250 tons of steel are involved and the steel fabricator has rotary wheel-blasting equipment (see Tables 3 and 4). Field touch-up is necessary to repair in-transit damage, but cost savings are often enough to justify shop preparation and painting. Application is easier on the ground, spray loss is reduced, and safety enhanced. Job-site conflicts, scheduling difficulties, and compromised applications that can be common on new projects are greatly reduced or eliminated. Field touch-up however, may lead to a spotty appearance, and special handling procedures are necessary to protect the finish during shipping and erection.

Costs for Typical Maintenance Painting Practices

The life and cost of the repainting steps following typical maintenance painting practices will vary according to whether the original work was shop or field applied. Table 7 provides an example of costs for a typical maintenance painting sequence, based on both shop and field application for the original work. This table includes multipliers for determining the approximate cost for each field repainting step based on whether the original work was done in the shop or field.

Painting Costs Compared to Hot Dipped Galvanizing Costs

The initial and life-cycle costs of shop prepared and applied inorganic zinc coating can compared to the initial and life-cycle costs of hot dipped galvanizing, as shown in Figure 4. The initial costs were based on a job size of 75,000 to 125,000 square feet of steel surface area, and steel member sizes ranging from 126 to 200 pounds per linear foot. The environment chosen for this example was moderate (industrial, C3: medium). Life-costs for each system were determined over a 35 year structure life using 4% for inflation and 7% for interest, and the practical "P" service life of each coating system. The results of this specific example show that the initial cost of galvanizing is 43% higher than a single coat of shop applied inorganic zinc. However, the life-cycle cost of galvanizing was 15% less than painting with inorganic zinc, which represents a reduction in corrosion maintenance costs over 35 years. If the budget for this project is large enough to bear the initial cost, galvanizing would be the most cost effective alternative. It is important to note that galvanizing is typically used only for new construction and limitations on the size of the steel members exist. Additional costs may be incurred when using galvanizing due to fabrication design alterations and the need for additional machining or cutting. These additional procedures are sometimes necessary to provide proper venting and drainage as the members are submerged and removed from the bath of molten zinc.[4] It should be noted that if color is of concern, it can be difficult to paint galvanizing. Special pretreatments or surface preparation procedures may be required in order to assure that the coating system achieves the desired level of adhesion and performance.

ECONOMIC ANALYSIS AND JUSTIFICATION

This subject is sometimes misunderstood and overly complicated for paint and coating systems. Capital items require intricate analyses to identify the full financial impact. Paint and coating systems are basically expense items without salvage value or depreciation considerations. However, they are tax deductible, in most instances. Only a few calculations are needed to compare one system with another and to measure each system's true cost in comparable dollars.

For each system used or considered, simply list the timing, number, and cost of painting operations required to protect the structure for its projected life. This should include such items as original painting, touch-up, touch-up and full coats, and full repaintings. The cost of each painting operation should be calculated in three categories:

1. At Current Cost levels

2. At Net Future Value (*NFV*) levels – the current cost with inflation included. How much will it cost, in inflated dollars in the year scheduled.

3. At Net Present Value (*NPV*) levels – the present worth of the inflated cost (*NFV*) in monies today invested at current interest rates.

For example, assuming 5% inflation, a current cost of $10 today inflates to $12.76 in five years. $12.76 is the Net Future Value (*NFV*). The formula[5,6] for calculating this is (i = inflation; n = number of years):

$$NFV = Current\ Cost[(1 + i)^n] \qquad (1)$$

To calculate the Net Present Value (*NPV*), or what $12.76 (*NFV*) is worth today if invested at current interest rates (10%) for five years, use the following formula[5,6]: (i = interest rate; n = number of years):

$$NPV = NFV\left[\frac{1}{(1+i)^n}\right] \qquad (2)$$

Invested today at 10% for five years, $7.92 will yield $12.76.

By making these calculations for each of the system's painting operations, the true cost and number of painting operations can be compared, and the coating selection made on a comparable basis. One system may be less costly to install initially, but if it has a shorter life and requires frequent repaintings, the financial cost and impact of the additional repaintings, and the disruption of the structure's intended service must be recognized.

An additional calculation called the Average Equivalent Annual Cost (*AEAC*) is popular with many engineers. This simply converts the entire stream of present and future costs to a present worth (*NPV*) and then distributes that sum in equal annual amounts over the structure's life. The formula[5,6] to calculate this is (i = interest; n = structure life):

$$AEAC = NPV\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right] \qquad (3)$$

An example using the *AEAC* is presented in Figure 4, which compares the life-cycle costs of painting to galvanizing.

To summarize, the steps for calculating an economic analysis of a paint and coating system are:

1. For each candidate system (using a separate sheet for each), develop a time table for the design or projected life of the coating on the structure. See example in Figure 3.

2. For each system, indicate in the time table when all painting operations will take place: Original painting, Touch-Up, Maintenance Repainting, and Full Repainting. If the analysis is based on the design life of the structure, repeat the painting cycle(s) as necessary to achieve the desired life. Insert the Current Costs for these operations (i.e., the costs if they were performed today).

3. Using the current inflation rate, calculate and record the Net Future Value (*NFV*) for each of the painting operations.

4. Using the current interest rate, calculate and record the Net Present Value (*NPV*) {of the *NFV*} for all of the painting operations.

5. For each system, total the sum of the three categories (*Current Cost*, *NFV*, and *NPV*).

6. Compare these values, particularly Net Present Value, for a direct comparison of number of painting operations and each system's true cost in monies today. See Figure 3 for an example of a Present Value Analysis.

7. To compare the life-cycle costs for each system, calculate the Average Equivalent Annual Cost (*AEAC*). See Figure 4 for an example.

On new capital projects, coating costs may be capitalized, which will require considerations for depreciation. However, most maintenance costs are tax deductible and when deducted, reduce the taxable income of the owner. The same Present Value Analysis outlined above should be followed for making the coating selection and the analyses turned over to Project Management for further financial treatment, and tax considerations.

SUMMARY

1. This guide defines a wide variety of coating systems in terms of required surface preparation and generic coating product(s). The practical service life of coating systems in atmospheric exposure are defined for four different standard service environments. The service life for coating systems in water immersion service are defined for three categories of water exposure.

2. Hot dip galvanizing and metallizing provide excellent corrosion protection in many environments at relatively low life-cycle costs.

3. Regulations on containment, capture, and disposal of removed coatings (especially coatings containing hazardous metals) continue to impact the cost of painting projects.

4. Surface preparation techniques which use water or non-traditional abrasives may adequately remove coatings and may reduce potential risks to the environment and the workers involved in coating removal.

5. Steps for selecting suitable, cost-effective systems for specific environments, and the calculation of a Present Value Analysis to define long-term protection costs over the structure's life are reviewed and outlined.

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Saureisen Inc.
Seaway Coatings, Inc.
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TABLE 1A
Estimated Service Life for Practical Maintenance
Coating Systems for Atmospheric Exposure
(in years before first maintenance painting)[4]

Type	Coating Systems for Atmospheric Exposure (primer/midcoat/topcoat)	Surface Preparation[2]	Number of Coats	DFT Minimum (mils)	Service Life[1,3]			
					Mild (rural)/C2	Moderate (industrial)/C3	Severe (heavy industrial)/C5-I	Seacoast Heavy Industrial/C5-M
Acrylic	Acrylic Waterborne/Acrylic WB/ Acrylic WB	Hand/Power	3	6	12	8	5	5
Acrylic	Acrylic Waterborne/Acrylic WB/ Acrylic WB	Blast	3	6	17	12	9	9
Alkyd	Alkyd/Alkyd	Hand/Power	2	4	6	3	2	2
Alkyd	Alkyd/Alkyd/Alkyd	Blast	3	6	14	9	5	5
Alkyd	Alkyd/Alkyd/Silicone alkyd	Blast	3	4	11	6	3	3
Epoxy	Surface Tolerant Epoxy (STE)	Hand/Power	1	5	12	8	5	5
Epoxy	Surface Tolerant Epoxy/STE	Hand/Power	2	10	17	12	9	9
Epoxy	Surface Tolerant Epoxy/STE	Blast	2	10	21	15	12	12
Epoxy	Surface Tolerant Epoxy/Polyurethane	Hand/Power	2	7	17	11	6	6
Epoxy	Surface Tolerant Epoxy/Polyurethane	Blast	2	7	20	14	9	9
Epoxy	Surf-Tolerant Epoxy/STE/Polyurethane	Hand/Power	3	12	23	17	12	12
Epoxy	Surf-Tolerant Epoxy/STE/Polyurethane	Blast	3	12	26	20	15	15
Epoxy	Epoxy 100% Sol Pent Sealer/Epoxy	Hand/Power	2	6	13	8	5	5
Epoxy	Epoxy 100% Solids Penetrating Sealer/Polyurethane	Hand/Power	2	6	13	8	5	5
Epoxy	Epoxy/Epoxy	Blast	2	6	18	12	9	9
Epoxy	Epoxy/Epoxy	Blast	2	8	20	14	11	11
Epoxy	Epoxy/Epoxy/Epoxy	Blast	3	10	23	17	14	14
Epoxy	Epoxy/Polyurethane	Blast	2	6	17	11	8	8
Epoxy	Epoxy/Epoxy/Polyurethane	Blast	3	8	20	14	11	11
Epoxy	Epoxy waterborne	Blast	3	9	18	12	9	9
Epoxy	Coal Tar Epoxy	Blast	2	16	21	17	14	14
Epoxy Zinc	Epoxy Zinc/Epoxy	Blast	2	7	26	18	12	12
Epoxy Zinc	Epoxy Zinc/Epoxy/Epoxy	Blast	3	11	30	21	15	15
Epoxy Zinc	Epoxy Zinc/Polyurethane	Blast	2	7	24	17	12	12
Epoxy Zinc	Epoxy Zinc/Polyurethane/Polyurethane	Blast	3	11	32	23	15	15
Epoxy Zinc	Epoxy Zinc/Epoxy/Polyurethane	Blast	3	9	29	20	14	14
Inorganic Zinc	Inorganic Zinc (IOZ)	Blast	1	3	27	17	12	12
Inorganic Zinc	IOZ/Epoxy	Blast	2	7	26	18	14	14
Inorganic Zinc	IOZ/Epoxy/Epoxy	Blast	3	11	32	23	17	17
Inorganic Zinc	IOZ/Polyurethane/Polyurethane	Blast	3	11	32	23	17	17
Inorganic Zinc	IOZ/Epoxy/Polyurethane	Blast	3	9	30	21	15	15

Type	Coating Systems for Atmospheric Exposure (primer/midcoat/topcoat)	Surface Preparation[2]	Number of Coats	DFT Minimum (mils)	Service Life[1,3]			
					Mild (rural)/C2	Moderate (industrial)/C3	Severe (heavy industrial)/C5-I	Seacoast Heavy Industrial/C5-M
Inorganic Zinc	IOZ/Waterborne Acrylic	Blast	3	6	24	17	12	12
Metalizing	Zinc Metalizing (minimum 90% zinc)	Blast	1	5	33	22	16	16
Metalizing	Zinc Metalizing/Sealer	Blast	2	9	34	24	17	18
Metalizing	Zinc Metalizing/Sealer/Polyurethane	Blast	3	13	39	27	22	22
Moisture Curing Polyurethane	MCU Pent Sealer/MCU/MCU	Hand/Power	3	7	15	14	7	9
Moisture Curing Polyurethane	Zinc Rich MCU/Polyaspartic	Blast	2	11	25	20	14	14
Moisture Curing Polyurethane	Zinc Rich MCU/Polyurethane/ Polyurethane	Blast	3	9	30	21	15	15
Moisture Curing Polyurethane	Zinc Rich MCU/MCU/MCU	Blast	3	9	29	21	14	15
Misc	Universal primer/Epoxy	Hand/Power	2	6	12	8	5	5
Misc	Universal primer/Epoxy/Polyurethane	Hand/Power	3	8	14	9	6	6
Misc	Epoxy/Epoxy Siloxane	Blast	2	7	23	17	14	14
Misc	Epoxy/Acrylic Siloxane	Blast	2	6	23	17	14	14
Misc	Polyurethane 100% Solids Elastomeric	Blast	1	20	24	18	14	14
Misc	Epoxy Zinc/Epoxy/Fluorinated Polyurethane	Blast	3	10	27	22	17	17
Misc	Polyurea (aliphatic)	Blast	1	20	20	18	16	16

NOTES:

1. Service Life Estimates:
   All estimates (in years) are for the "Practical" life of the system. Practical life is considered to be the time until 5 to 10% coating breakdown occurs (SSPC-Vis 2 Grade 4), and active rusting of the substrate is present.

2. Surface preparation definitions:
   Hand/Power - Requires SSPC-SP 3 "Power Tool Cleaning" or SP 2 "Hand Tool Cleaning"
   Blast - Requires SSPC-SP 6 "Commercial Blast" or SP 10 "Near White Blast"

3. Service Life Environments per ISO 12944-2, "Classification of Environments"
   C2: Low - Atmospheres with low levels of pollution; mostly rural areas
   C3: Medium - Urban and industrial atmospheres, moderate sulfur dioxide pollution; coastal areas with low salinity
   C5-I: Very High, Industry - Industrial areas with high humidity and aggressive atmosphere
   C5-M: Very High, Marine - Coastal and offshore areas with high salinity

4. Typical Maintenance Painting Sequence:
   Touch-Up painting occurs at Practical or "P" service life as listed in this Table
   Maintenance Repaint occurs at "P" Life + 33% ("P" x 1.33)
   Full Repaint occurs at Year of Maintenance Repaint + 50% of "P" Life (Maint. Repaint Year + ["P" x 0.50]

5. Service Life for Hot Dip Galvanizing (4 mils minimum) as reported by American Galvanizers Association:
   Mild (rural) = 68 Years; Moderate (industrial) = 33 Years; Severe (heavy industrial) = 21 Years

TABLE 1B
Estimated Service Life for Practical Maintenance
Coating Systems for Immersion Service
(in years before first maintenance painting)[4]

Type	Coating Systems for Immersion Service (primer/midcoat/topcoat)	Surface Preparation[2]	Number of Coats	DFT Minimum (mils)	Service Life[1,3]		
					Potable Water	Fresh Water Immersion	Salt Water Immersion
Epoxy	Coal Tar Epoxy	Blast	2	16	--	17	14
Epoxy	Epoxy/Epoxy	Blast	2	8	12	9	8
Epoxy	Epoxy/Epoxy	Blast	2	6	10	8	6
Epoxy	Epoxy/Epoxy/Epoxy	Blast	3	10	15	12	11
Epoxy	Epoxy 100% Solids	Blast	1	40	15	12	11
Epoxy Phenolic	Epoxy Phenolic/Epoxy Phenolic	Blast	2	12	--	14	12
Metallizing	Zinc Metallizing/Epoxy	Blast	2	9	20	17	15
Metallizing	Zinc Metallizing/Epoxy/Epoxy	Blast	3	13	24	20	18
Misc	Polyurethane 100% Solids	Blast	1	20	16	14	12
Misc	Vinyl Ester/Vinyl Ester	Blast	2	20	--	14	12
Misc	Polyester (composite filled)	Blast	2	25	--	14	12
Misc	Polyurea	Blast	1	20	--	14	12

NOTES:

1. Service Life Estimates:
   All estimates (in years) are for the "Practical" life of the system. Practical life is considered to be the time until 5 to 10% coating breakdown occurs (SSPC-Vis 2 Grade 4), and active rusting of the substrate is present.

2. Surface preparation definitions:
   Blast - Requires SP-10 "Near White Blast" for immersion service

3. Service Life Environment definitions:
   Potable Water - Immersion at an ambient temperature and pressure, coating requires NSF approval
   Fresh Water - Immersion at an ambient temperature and pressure
   Salt Water - Immersion at an ambient temperature and pressure

4. Typical Maintenance Painting Sequence:
   Touch-Up painting occurs at Practical or "P" service life as listed in this Table
   Maintenance Repaint occurs at "P" Life + 33% ("P" x 1.33)
   Full Repaint occurs at Year of Maintenance Repaint + 50% of "P" Life (Maint. Repaint Year + ["P" x 0.50]

TABLE 2
Typical Material Costs of Paints and Protective Coatings
Approximate Cost Per Square Foot @ Typical DFT

Coating	DFT	Theoretical	Practical Spray	Practical Brush/Roll
Acrylic, Waterborne Primer	3.0	$0.201	$0.287	$0.223
Acrylic, Waterborne Topcoat	3.0	$0.212	$0.303	$0.236
Acrylic, Elastomeric Waterborne	6.0	$0.257	$0.367	$0.285
Alkyd Primer	2.0	$0.081	$0.116	$0.090
Alkyd Gloss Topcoat	2.0	$0.091	$0.131	$0.102
Alkyd Silicone	2.0	$0.132	$0.188	$0.147
Coal Tar Epoxy	8.0	$0.205	$0.293	$0.228
Epoxy Primer	2.0	$0.097	$0.139	$0.108
Epoxy Intermediate/Topcoat	4.0	$0.176	$0.252	$0.196
Epoxy, Waterborne	3.0	$0.211	$0.301	$0.234
Epoxy, Phenolic Primer	5.0	$0.280	$0.400	$0.311*
Epoxy, Phenolic Finish	5.0	$0.286	$0.409	$0.318*
Epoxy, Surface Tolerant	5.0	$0.218	$0.312	$0.242
Epoxy, 100% solids	20.0	$1.078	$1.540	$1.198*
Epoxy, Ester, Primer	1.5	$0.051	$0.073	$0.056
Epoxy, Ester, Topcoat	2.0	$0.105	$0.149	$0.116
Polyaspartic	8.0	$0.581	$0.830	$0.646*
Polyester (glass flake)	10.0	$0.355	$0.508	$0.395*
Polyurea, 100% solids	20.0	$0.740	$1.057	$0.822*
Polyurethane, Elastomeric Solvented	20.0	$1.321	$1.887	$1.468*
Polyurethane, Aromatic HB Primer	5.0	$0.238	$0.340	$0.265
Polyurethane, Aliphatic Acrylic	2.0	$0.160	$0.229	$0.178
Polyurethane, Aliphatic HB Acrylic Inter/Top	4.0	$0.288	$0.411	$0.320
Polyurethane, Aliphatic Polyester	2.0	$0.183	$0.262	$0.203
Polyurethane, Fluorinated	2.5	$1.089	$1.556	$1.210*
Polyurethane, Moisture-Cured Aluminum	2.5	$0.161	$0.229	$0.178
Polyurethane, Moisture-Cured Clear Sealer	2.0	$0.136	$0.194	$0.151*
Siloxane, Acrylic	5.0	$0.637	$0.909	$0.707
Siloxane, Epoxy	4.0	$0.580	$0.828	$0.644
Universal Primer, 1-pack	2.0	$0.104	$0.149	$0.116
Vinyl Ester	20.0	$1.327	$1.896	$1.474*
Zinc Rich, Inorganic	3.0	$0.227	$0.324	$0.252*
Zinc Rich, Organic	3.0	$0.284	$0.406	$0.315*
Zinc Rich, Moisture-Cured Urethane	3.0	$0.269	$0.384	$0.299*

NOTES:

* = Brush/roller application is not recommended by some manufacturers
--Costs are approximate based on data secured from representative US paint and coating suppliers
--DFT = Dry Film Thickness in mils (1mil = 25.4 microns)
--Spray Practical = 30% loss
--Roll/Brush Practical = 10% loss

TABLE 3
Shop Painting Costs per Sq. Ft. Including Labor, Equipment, and Related Costs[1]
(No Material Costs Included)

Cleaning Grade	**Cost[2]**
SP-2	$0.50
SP-3	$0.34
SP-6 Automated	$0.40
SP-10 Automated	$0.40
SP-5 Automated	$0.49
SP-6 Conventional with Recyclable Abrasives	$0.85
SP-10 Conventional with Recyclable Abrasives	$1.40
SP-5 Conventional with Recyclable Abrasives	$1.53
SP-6 Conventional with Expendable Abrasives	$0.94
SP-10 Conventional with Expendable Abrasives	$1.77
SP-5 Conventional with Expendable Abrasives	$2.01

Shop Paint Application	**Cost**
One-Pack Products	$0.37
Two-Pack Epoxies	$0.51
Two-Pack Urethanes	$0.54
Zinc Rich Primers	$0.53

Hot Dip Galvanizing	**Cost[3]**
Labor, Equipment, Surface Preparation and Related Costs	$1.76

Metallizing (Including Surface Preparation)	**Cost[4]**
Zinc Metallizing	$5.64
Zinc Metallizing w/sealer	$6.19

Size of Job Multipliers (per square foot)

10,000-25,000	120%
25,000-75,000	110%
75,000-125,000	100%
125,000-300,000	95%
300,000-1,000,000	90%
1,000,000+	80%

Member Size Multipliers For Hot Dip Galvanizing[3]
Member Weight Per Foot (Lbs/Ft)

0 – 20	80%
21 – 50	100%
50 – 125	115%
126 – 200	125%
200+	180%

Conversion of Tons of Steel to Square Feet

Member Type	**Sq Ft/Ton**
Typical mix size/shapes	250
Large Structural	100
Medium Structural	200
Light Structural	400
Light Trusses	500

Notes

1. Costs shown are approximate composite values, based on data secured from representative US steel fabricators; RS Means – Heavy Construction Cost Data; and Craftsman National Painting Cost Estimator. Steel plate cleaning costs are about 20% less than prices listed above for structural steel.

2. Costs labeled automated are for steel fabricators having centrifugal wheel blasting equipment.

3. Costs based on American Galvanizers Association, 2006 Survey. Note there are member size limitations for hot dip galvanizing. The maximum depth is approximately 3 feet and maximum length is approximately 80 feet when double dipped in standard galvanizing kettles.

4. Costs based on information published by the Federal Highway Administration.

TABLE 4
Field Painting Costs per Sq. Ft. Including Labor, Equipment, and Related Costs[1]
(No Material Costs Included)

Cleaning Grade	Cost
SP-2 Hand Tool Cleaning	$0.59
SP-3 Power Tool Cleaning	$0.93
SP-11 Power Tool-Bare Steel	$4.74
SP-7 Brush-Off Blast	$0.67
SP-6 Commercial Blast	$1.08
SP-10 Near White Blast	$1.72
SP-5 White Metal Blast	$2.05
Water Wash Prior to Surface Prep.	$0.20
Hi Pres. Water/Steam Clean prior to Surface Prep.	$0.30
Water Slurry Blast	$1.57
Low Pressure wo/abrasive SP-1	$0.41
Low Pressure w/abrasive SP-10	$1.80
High Pressure w/abrasive SP-10	$3.93
Sponge Media Blast	$4.92
Bicarbonate	$2.11

NOTE: Multiplier for using recyclable grit for: SP-6, SP-10, SP-5 above is 1.5 – 1.9

Field Application	Cost
One-Pack by Brush/Roller	$0.45
One-Pack by Spray	$0.36
Two-Pack Epoxies, by Spray	$0.38
Two-Pack Urethanes, by Spray	$0.42
Zinc Rich Primers, by Spray	$0.49

Metallizing (Including Surface Prep.)	Cost[2]
Zinc Metallizing	$9.48
Zinc Metallizing w/sealer	$10.00

Structure Multiplier[3]		Field labor x's
Simple Structures < 50' high		120%
Simple Structures 50'-100' high		130%
Simple Structures > 100' high		145%
Complex Structures < 50' high		135%
Complex Structures 50'-100' high		145%
Complex Structures > 100' high		150%
Elevated tanks, intricate structures, structures greater than 50' high		150%
Ground Tanks		80%
Piping:	1"-2"	140%
	4"-6"	100%
	12" and 24"	95%
	48"	90%

Size of Job Multiplier[4]	Total $/sq ft x's
10,000-25,000	115%
25,000-75,000	105%
75,000-125,000	100%
125,000-300,000	95%
300,000-1,000,000	90%
1,000,000+	85%

Existing Coating Conditions	Total $/sq ft x's
Light rusting, pitting/paint breakdown (SNAME T&R 21, Fig 5)[5] (Europe Std. Re 5-6)[6] (SSPC Vis. 1-C)[7]	100%
Heavy paint breakdown, severe rusting and pitting (SNAME T&R 21, Fig 3, 6)[5] (Europe Std. Re 8)[6] (SSPC Vis. 1-D)[7]	130%
Extremely heavy paint films >20 mils with extreme breakdown and substantial pitting and rusting (SNAME T&R 21, Fig 7)[5]	160%
Adherent Mill Scale (SSPC Vis. 1-A)[7]	125%

Notes
1. Costs shown are approximate composite values, based on data secured from representative US painting contractors; RS Means – Heavy Construction Cost Data; and Craftsman National Painting Cost Estimator. The costs are for calculating the base price of new steel cleaned and painted on the ground at the job site.
2. Costs based on information published by the Federal Highway Administration.
3. The Structure Multiplier is applied to the field labor costs per square foot.
4. The Size of Job and Existing Coating Condition Multipliers are applied to the total costs per square foot.
5. "Abrasive Blasting Guide for Aged or Coated Steel Surfaces," T & R Bulleting 4-21, The Society of Naval and Marine Engineers
6. "European Scale of Degree of Rusting for Anti-Corrosive Paints," Royal Swedish Academy of Engineering, Stockholm, 1961
7. SSPC: The Society for Protective Coatings, Pittsburgh, PA, "Good Painting Practices," Volume 1

TABLE 5
Paint Removal
Containment Multipliers Guidelines

Containment Designation is in accordance with
SSPC: The Society for Protective Coatings
Technology Guide No. 6
Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations

Containment Designation	Simple Structure			Complex Structure		
	<50' high	50' < x <100'	>100'	<50' high	50' < x <100'	>100'
Class 1-A	3.00	3.25	3.50	3.50	3.75	4.00
Class 2-A	2.50	2.75	3.00	3.00	3.25	3.50
Class 3-A	2.25	2.50	2.75	2.75	3.00	3.25
Class 4-A	1.50	1.75	1.75	1.75	2.00	2.25
Class 1-C	2.25	2.50	3.00	3.00	3.25	3.50
Class 2-C	2.00	2.25	2.25	2.25	2.50	3.00
Class 3-C	1.75	1.75	2.00	2.00	2.25	2.50
Class 1-W	2.75	3.00	3.00	3.00	3.25	3.50
Class 2-W	2.25	2.50	2.50	2.50	2.50	2.75
Class 3-W	2.00	2.25	2.25	2.25	2.50	2.75
Class 1-P	2.25	2.75	3.25	3.25	3.50	3.75
Class 2-P	1.75	1.75	2.00	2.00	2.25	2.50
Class 3-P	1.25	1.50	1.75	1.75	2.00	2.25

Legend:

Class 1: This system provides the highest level of emissions control
Class 2: This system provides a high level of emissions control
Class 3: This system provides a moderate level of emissions control
Class 4: This system provides a minimal level of emissions control
-A: This is used for abrasive blast cleaning
-W This is used for water blasting/water jetting
-C This is used for chemical stripping
-P This is used for hand or power tool cleaning

Notes:
1. Multipliers are applied to the total cost per square foot.

2. Multipliers for chemical stripping are provided for information only.

TABLE 6
Determination of Maintenance Repainting Risk for Alkyd Coatings[1]

Coating Attribute	Test Method	Repair Likely	Repair Possible	Repair Unlikely
Corrosion / Coating Deterioration	SSPC-Vis 2	<10%	10 – 20%	>20%
Knife Adhesion	ASTM D3359	>2A or 2B	1A or 1B	0A or 0B
Film Thickness	SSPC-PA 2	<20 mils	20 – 30 mils	>30 mils
Mill Scale / Rust	Visual	Not Present or Inactive	Not Present or Inactive	Active

NOTE:
1. Table based on article by Kline, E. S.; Corbett, W. D., "Beneficial Procrastination: Delaying Lead Paint Removal Projects by Upgrading the Coating System," Journal of Protective Coatings and Linings, March 1992.

TABLE 7
Practical Maintenance Painting Sequence

Operation	Painting Occurs in Year	Cost if Original in Field	Cost if Original in Shop
Initial Painting	0	Original	Original
Touch-Up	Practical Life or "P"	Original x 40%	Original x 60%
Maintenance Repaint	"P" Life + 33% (i.e. "P" x 1.33)	Original x 70%	Original x 105%
Full Repaint	Year of Maint. Repaint + 50% of "P" Life (i.e. Maint. Repaint Year + ["P" x 0.50])	Original x 135%	Original x 205%

Examples Using Practical Maintenance Sequence
System With 12 Year Practical Life and Original Shop Installed Cost of $1.05 per Square Foot
System With 12 Year Practical Life and Original Field Installed Cost of $1.60 per Square Foot

Operation	Painting Occurs in Year	Cost if Original in Field	Cost if Original in Shop
Initial Painting	0	$1.60	$1.05
Touch-Up	12	$0.64	$0.63
Maintenance Repaint	16	$1.12	$1.10
Full Repaint	22	$2.16	$2.15

Figure 1
WORKSHEET A – SHOP COATING APPLICATION

Project Name: Structural Steel for Bridge Overpass
Project Location: Pittsburgh, PA

(A) Project Size (Sq. Ft. or Tons): 60,000 Sq Ft

Coating System: IOZ/epoxy/polyurethane
Intended Environment: Severe Industrial (C5-I)
Service Life: 15

I. Surface Preparation: SP 10 automated — Cost ($): 0.40 Per Sq. Ft.
(Includes labor, equipment and related costs, no materials) (Note: Automated or Conventional Method)
I. Sub-Total ($ Per Sq. Ft.) = 0.40

II. Application:

a) Paint Material

Method	Coat	Cost ($)	
Spray	1st Coat	0.53	Per Sq. Ft.
Spray	2nd Coat	0.51	Per Sq. Ft.
Spray	3rd Coat	0.54	Per Sq. Ft.

II. Sub-Total ($ Per Sq. Ft.) = 1.58 (a)

OR

b) Hot Dip Galvanizing
(Includes labor, surface preparation and related costs)
II. Sub-Total ($ Per Sq. Ft.) = ______ (b)

Labor Sub-Total ($ Per Sq. Ft.) = 1.98
I + II (a or b)

III. Job Multiplier:

a) Job Size: 60,000 sq ft — %: 110

b) Member Size: ______ — %: ______

III. Adjusted Labor Cost ($ Per Sq. Ft.) = 2.178
(Labor x III.a x III.b.)

IV. Material Costs

Material	Coat	Cost ($)	
Inorganic zinc	1st Coat	0.324	Per Sq. Ft.
Epoxy	2nd Coat	0.252	Per Sq. Ft.
Polyurethane	3rd Coat	0.229	Per Sq. Ft.

Total DFT = ______
IV. Sub-Total ($ Per Sq. Ft.) = 0.805

(B) Preliminary Project Cost ($ Per Sq. Ft.) = 2.98
(III + IV)

(C) TOTAL PROJECT COST ($) = 178,800
(A x B)

Conversion of Tons of Steel into Square Feet:

	Tons	Mult. by	= Square Feet
Typical mix		250	
Large Structural		100	
Medium Structural		200	
Light Structural		400	
Light Trusses		500	

Figure 2
WORKSHEET B – FIELD COATING APPLICATION

Project Name: Elevated Water Storage Tank
Project Location: St. Louis, MO

(A) Project Size (Square Feet): 30,000

Coating System: 2-coat alkyd
Intended Environment: Mild (C2)
Service Life: 6

I. Surface Preparation: (Includes labor, equipment and related costs, no materials)	Power tool, SP3	Cost ($):	0.93	Per Sq. Ft.
Additional Cleaning:		Cost ($):		Per Sq. Ft.
		Cost ($):		Per Sq. Ft.
		Cost ($):		Per Sq. Ft.
		I. Sub-Total ($ Per Sq. Ft.) =	0.93	

II. Application:

Method:	Coat			
Spray	1st Coat	Cost ($):	0.36	Per Sq. Ft.
Spray	2nd Coat	Cost ($):	0.36	Per Sq. Ft.
	3rd Coat	Cost ($):		Per Sq. Ft.
		II. Sub-Total ($ Per Sq. Ft.) =	0.72	

Labor Sub-Total ($ Per Sq. Ft.) = 1.65 (I + II)

III. Structure Multiplier:

General Configuration: Elevated (Simple/Complex) Height: 100 %: 150

OR

_____ (Unique) (Size): _____ (If pipe) %: _____

III. Adjusted Labor Cost ($ Per Sq. Ft.) = 2.475 (I + II) x (%)

IV. Material Costs

Material	Coat			
Alkyd prime	1st Coat	Cost ($):	0.116	Per Sq. Ft.
Alkyd top	2nd Coat	Cost ($):	0.131	Per Sq. Ft.
	3rd Coat	Cost ($):		Per Sq. Ft.

Total DFT = 6 IV. Sub-Total ($ Per Sq. Ft.) = 0.247

(B) Preliminary Project Cost ($ Per Sq. Ft.) = 2.722 (III + IV)

V. Project Multipliers

(C) Existing Conditions %: 130
(D) Project Size %: 105

(E) Adjusted Project Cost ($ Per Sq. Ft.) = 3.72 (B x C x D)

(C) TOTAL PROJECT COST ($) = 111,600 (A x E)

Figure 3
Example of Present Value Analysis

Economic Analysis Worksheet
Total Painting Cost Per Sq. Ft. for 45-Year Plant Life, Field Application
Three-Coat Inorganic Zinc/Epoxy/Polyurethane, SP6, 15 Year System Life (Severe/C5-I)

Painting Operation →	**Original Painting**	**Touch-Up Year 15**	**Maintenance Repaint Year 20**	**Full Repaint Year 28**	**Touch-Up Year 43**	**Totals**
Cost in Current $'s	$3.18	$1.27	$2.23	$4.29	$1.27	$12.24
NFV costs Future value @ 3% inflation	$3.18	$2.29	$4.88	$12.87	$6.87	$30.09
NPV costs Present value @ 7% interest	$3.18	$0.83	$1.26	$1.94	$0.37	$7.58

Figure 4
Comparing Painting Costs and Galvanizing Costs

Economic Analysis Worksheet
Total Painting Cost Per Sq. Ft. for 35-Year Structure Life, Moderate (C3) Environment
1 Coat Inorganic Zinc System, Shop SSPC-SP 10 Automated
17 Year "P" Life, Inflation = 4%, Interest = 7%

Painting Operation →	**Original Painting Year 0**	**Touch-Up Year 17**	**Maintenance Repaint Year 23**	**Full Repaint Year 32**	**Totals**
Cost in Current $'s	$1.25	$0.75	$1.31	$2.56	$5.88
NFV costs Future value @ 4% inflation	$1.25	$1.46	$3.23	$8.99	$14.97
NPV costs Present value @ 7% interest	$1.25	$0.46	$0.68	$1.03	$3.42

$$\text{Average Equivalent Annual Cost} = \$0.27 = \$3.42 \times \frac{(0.07)(1.07)^{35}}{(1.07)^{35} - 1}$$

Economic Analysis Worksheet
TotalGalvanizing Cost Per Sq. Ft. for 35-Year Structure Life, Moderate (C3) Environment
Galvanized to Achieve 4 mils of Zinc Coating
Touch-Up Cost Based on 1 Coat Field Applied Organic Zinc Primer, SSPC-SP 3
33 Year "P" Life, Inflation = 4%, Interest = 7%

Painting Operation →	**Original Painting Year 0**	**Touch-Up Year 33**	**Totals**
Cost in Current $'s	$2.20	$1.83	$4.03
NFV costs Future value @ 4% inflation	$2.20	$6.68	$8.88
NPV costs Present value @ 7% interest	$2.20	$0.72	$2.92

$$\text{Average Equivalent Annual Cost} = \$0.23 = \$2.92 \times \frac{(0.07)(1.07)^{35}}{(1.07)^{35} - 1}$$