

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” by the authors in 2018.¹

Designed to assist the coatings engineer or specifier in identifying candidate protective coating systems for specific service environments applicable to a broad array of industries, this paper provides: 1) commonly used generic coating systems; 2) service life for each in specific environments; 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. Examples are provided to aid the reader in the proper use of the information. Updates to the paper include revisions to the coating systems for atmospheric exposure, new discussion related to maintenance painting strategies and updated cost data.

Key words: protective coatings, life-cycle costs, coating selection, coating system life, containment costs, industrial maintenance, maintenance painting costs, industrial environments, corrosive, solvent-free, metalizing, 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 (practical maintenance time).

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 paper provides total unit costs, which include all of these elements. The costs are intended to reflect current, competitive/commercial prices charged in today's market, but as indicated below, are provided for comparative purposes only, not for developing or assessing project specific cost estimates.

Surface preparation and application costs are primarily based on major steel fabricators and painting contractors. Material costs are provided by major suppliers who furnished approximate prices at which

coatings are being sold on commercial-sized jobs. The current cost data was developed from the collected data along with common industry cost references.

This paper 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 paper have come from these contractors and have proven to be practical over the paper's long history.

Limitations

The costs in this paper are intended to provide a method for estimating the relative costs of alternative coating systems and projected service life from a common basis. The paper provides an easy-to-use, practical means to identify, compare, and justify suitable, cost-effective protective coating systems for specific environments, and to answer fundamental questions such as:

- What systems might work?
- What are the relative installed costs?
- Comparatively, how long will the systems last?
- What are the relative costs per year per square foot?

The tools are based on experience and data gathered over the years on many different types of projects. At times, the cost to complete painting projects with unique aspects of size, location, or market conditions may differ substantially. Large structures may also be exposed to different levels of corrosivity suggesting the use of different coating systems across the structure. Engineering firms, including the authors', may resort to proprietary models for these unique situations.

DISCUSSION

Coating Systems

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. It is assumed that the blast cleaning is thorough, but 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. New coating systems have been added in this update.

Service Environments

The "service environment" defines the anticipated environmental exposure conditions for a coating system. For atmospheric exposure, there are three service environments that correspond to ISO[†] 12944-2, "Classification of Environments." These categories are defined below. It should be noted that ISO Category CX for extreme corrosivity is not included as a service environment.

- C2: Low corrosivity - Atmospheres with low levels of pollution; mostly rural areas
- C3: Medium corrosivity - Urban and industrial atmospheres, moderate sulfur dioxide pollution; coastal areas with low salinity
- C5: Very high corrosivity - Industrial areas with high humidity and aggressive atmosphere and coastal areas with high salinity

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

[†] International Organization for Standardization, 1, ch. de la Voie-Creuse, CP 56 - CH-1211 Geneva 20, Switzerland

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 6.

Metalizing Systems

Metalizing is the application of zinc, aluminum or zinc/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 metalizing results in a somewhat porous coating layer. Additional coats can also be applied to further increase the service life of the system. Metalizing provides galvanic protection to the steel and is a very durable and abrasion resistant coating. This system’s performance (practical maintenance time) is provided in Tables 1A and 1B.

Paint Removal

The Containment Multiplier Guidelines in Table 8 are included to aid in developing approximate costs for containment during paint removal depending upon the containment type. These are to be used in conjunction with surface preparation costs developed in Table 7. The containment type (class) is based on SSPC[†] Guide No. 6, “Guide for Containing Debris Generated During Paint Removal Operations.”

Maintenance Painting Sequences

This paper 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 paper. 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. In recognition of the differences that can be observed from structure to structure, this paper update includes new discussion related to the timing of a maintenance painting sequence.

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 paper may be used to determine installed costs and life-cycle costs for any combination of maintenance painting sequences. Table 9 can be used as a guide to determine maintenance repainting risk (i.e. whether the existing coating system might be a candidate for repair).

[†] Society for Protective Coatings, 800 Trumbull Drive, Pittsburgh, PA 15205

PRACTICAL MAINTENANCE TIME

How long a coating system will last 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 paper supplies time estimates in years for a "Practical" maintenance approach. The practical maintenance time is not when a coating system should be replaced, but rather, the time that the maintenance painting sequence should begin, when there is 5 to 10% coating breakdown (SSPC-Vis 2 Rust Grade 4²), 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 may be beyond practical spot repair. In this case at a minimum, a full coat is required, if the coating is even salvageable. The paper 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. As indicated above, 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 (1 or 2 cycles)
- Maintenance Repaint [spot prime and full coat] (1 or 2 cycles)
- Full Repaint [total coating removal and replacement]

"Spot Touch-Up and Repair," which is the first-time coating repairs are made, is intended to be completed at the "Practical Maintenance Time" ("P") of the coating system as listed in Tables 1A or 1B. The time until "Maintenance Repaint," which includes spot priming and a full overcoat, is estimated to be the "Practical Maintenance Time" plus 33% to 67% depending on the specific coating condition and distribution of coating deterioration for a structure. In other words, the timing for the Maintenance Repaint may range from "P" x 1.33 to "P" x 1.67, with this maintenance step typically required at "P" x 1.5. A "Full Repaint," involving total coating removal and replacement, is expected to occur at the year of "Maintenance Repaint" plus 50% of the "Practical Maintenance Time" (i.e. Maintenance Repaint year + ["P" x 0.5]).

Two examples are provided below for a practical maintenance time of 20 years, assuming the Maintenance Repaint occurs at "P" x 1.5, and either one or two cycles are performed.

- Maintenance Painting Example 1 – One Maintenance Repaint: spot touch-up occurs at year 20, maintenance repaint (overcoat) at year 30, and full replacement of the system at year 40.

- Maintenance Painting Example 2 – Two Maintenance Repaints: spot touch-up occurs at year 20, maintenance repaint (overcoat) at year 30, a second overcoat is performed at year 40, and full replacement of the system at year 50.

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 maintenance painting are used over time.

COST COMPARISONS

Shop versus Field Painting – New Construction

Shop blasting and priming has a substantially lower cost as compared to doing the 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 6 and 7). 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. An alternate approach when a spotted appearance due to touch up is unacceptable involves the application of all coats in the shop except the finish, which is applied in the field after 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 2 provides estimated 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 involving all coats was done in the shop or field. Table 3 shows an example.

Table 2
Cost of Painting Operations

Operation	Painting Occurs in Year	Cost if Original in Field	Cost if Original in Shop
Initial Painting	0	Original	Original
Touch-Up	Practical Maintenance Time or “P”	Original x 40%	Original x 50%
Maintenance Repaint	“P” Life + 50% (i.e. “P” x 1.5)	Original x 70%	Original x 90%
Full Repaint	Year of Maint. Repaint + 50% of “P” Life (i.e. Maint. Repaint Year + [“P” x 0.50])	Original x 135%	Original x 170%