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TECHNOLOGY UPDATE No. 9

Estimating Costs for Protective Coatings Projects

1. Scope

This technology update provides information on approaches and models for estimating the initial and lifetime cost of protective coatings projects.

2. Description

2.1 IMPORTANCE AND USE: Cost is a major factor in determining if protective coatings or another corrosion control alternative should be used for corrosion control. If protective coatings are used, cost is a major consideration in selecting the coating system to be used.

The cost of coating systems can be interpreted in several manners. Of major interest is the cost of the applied or installed coating system (often called turnkey costs). Owners must also be concerned with operational and maintenance costs that occur over the life of the structure. The installation and maintenance costs are often collectively described under the designation life-cycle cost (or long term cost). Additional cost factors include costs for inspection and indirect costs, such as loss of product, downtime, and inconvenience to the community.

The cost of an applied coating system is often an insignificant portion of the overall cost of a facility or structure, but is an important consideration before selection. Coating cost can range from less than 1% to as high as 10% of the overall cost of the project.

Acquiring accurate and reliable cost data is a major challenge for the protective coating industry. This technology update will review some of the major concepts, considerations, and approaches to this critical subject.

2.2 OUTLINE OF CONTENTS: The technology update includes the following sections:

	Section
Types of costs	3
Methods for estimating initial cost	4
Methods for estimating lifetime cost	5
Models and data sources	6

3. Types of Costs

3.1 INITIAL VS LIFETIME COSTS: When discussing costs, it is useful to distinguish between the initial costs for a coating project and the costs incurred in protecting that structure over its lifetime. The initial cost is the most visible cost, since it is the money spent in the short term at the commencement of the period; the financial impact is both immediate and quantifiable. Lifetime costs include the initial cost and all other potential costs involved in the upkeep and maintenance of the coated structure. In the long term, lifetime cost has the greater impact on the financial viability of the company or its project. Short-term budget considerations, however, are often influential in making choices of coating types, working method, contract style, and other alternatives, often ensuring that managers focus on the initial costs. This section and Section 4 will discuss initial costs. Lifetime costs will be covered in Section 5.

3.2 INDIRECT VERSUS DIRECT COSTS: Initial costs can be classified as direct costs or indirect costs. Direct costs are those which are readily attributed to the coating activity, for example, the cost of a coating contract or an engineering service. Direct costs are relatively easy to measure. Indirect costs are those which arise because of the need for coating work, but are not readily identifiable or measurable. Examples are given in Table 1.

Indirect costs are often unpredictable, and are therefore extremely difficult to estimate and often not considered explicitly in cost analysis.

Over the lifetime of a structure (e.g., 40 years), there are likely to be many costs associated with corrosion protection, including both direct and indirect costs.

4. Methods for Estimating Initial Costs

4.1 UNIT COSTS: The most common and straightforward means of estimating costs is by using unit costs. The work is broken into measurable units, e.g., an area of surface to be prepared and coated. In some cases, the estimate is based on the number of hours of labor required. Depending on the complexity of the job, various additional cost items will be added to the base cost. These include

Table 1

Direct Versus Indirect Costs

Direct Costs	Indirect Costs
Cost of coating material	Down time for maintenance or repair work
Initial application cost	Loss of product from leaks or vessel contamination
Repair of damaged coatings	Environmental or worker health damage from deficient corrosion protection or hazardous products
Replacement of corroded parts	Administrative and overhead costs of engineering staff
Complete or partial repainting for maintenance (of exterior coatings or internal linings)	

costs for special equipment and costs for subcontracted items, several of which were described in the previous section.

In this section, we will describe two approaches to the unit cost method,

- Cost per unit area
- Labor and materials

4.2 ACTIVITIES BREAKDOWN (COST PER UNIT AREA): One of the simplest approaches is to estimate the cost per unit surface area (cost per square meter [$\$/m^2$] or cost per square foot [$\$/ft^2$]). These estimates may be based on historical records of similar projects or may be obtained by breaking the unit costs into specific sub-elements (see below). It is assumed that the amount of labor and material is roughly proportional to the amount of surface to be coated. This assumption is certainly valid for coating materials and thinners. For labor, the cost per square meter may vary, but the method allows one to modify labor rates based on different conditions.

The costs of a coating system can be broken into the following components: surface preparation; application of coating; coating materials; number of coats required; and required curing conditions. Numerous analyses have been done to show which proportion of the total cost is attributed to each of these items.

These data are general. As each job is unique, it is important to be aware of the assumptions made in deriving these numbers. Modifications are often made based on the following factors:

- Height of surfaces to be coated
- Condition of the structure (e.g., pitted and rusting, previously painted)
- Type and shape of structure (e.g., for accessibility)
- Location (e.g., shop or field)
- Geographic location
- Weather

Additional modifications may be made for hazardous paint removal or other special considerations.

4.3 LABOR AND MATERIALS METHOD: This approach is based on deriving estimates for the following components:

- Surface area to be painted
- Number of worker hours required to perform each stage of the work
- Labor costs, including benefits
- Material costs
- Equipment costs
- Overhead costs

These components are described below. Appendix 1 provides a sample calculation in US units and Appendix 1M is the metric version.

4.3.1 Surface Area To Be Painted: The surface area of each item to be painted (e.g., tank bottom, walls, piping) is measured or estimated, and the cost of painting per unit area (e.g., a square meter) is then applied to achieve the total painting cost. Books and tables are available to assist estimators in making unit area (square meter) calculations.[2]

4.3.2 Estimate of Required Worker Hours: After the surface area (square meters) has been calculated, the time required for surface preparation and/or paint application must also be calculated for each item of work. The total area of each item (Area) divided by the number of square meters that can be completed per worker hour (Production Rate) yields the total worker hours required to complete the work.

Production rates and worker hour estimates can also be obtained from estimating guides. Most painting contractors and experienced estimators, however, know from past experience the average production rate to be used for a given work item. The estimator must decide on the number and size of crews to be mobilized.

4.3.3 Labor Costs: Wage rates for union blasters and painters can be obtained from the local office of the union having jurisdiction in the project area. Prevailing wage rates are also available from trade publications and government sources. Estimating guides can be useful references as well.

The wage rate should include all labor payments, including the hourly wage, fringe benefits, and insurance. This is often referred to as the "charge-out rate."

4.3.4 Material Costs: The number of liters (gallons) of paint, thinner, cleanup solvents, etc. must be estimated based on the areas being coated and the dry film thickness DFT in micrometers (or mils) of coating to be applied.

Loss factors must also be estimated. Material loss factors, such as overspray, range generally from 10 to 50 percent of the total paint purchased, depending on weather conditions, job location, and the type of surface to be coated. The practical spreading rates are normally more useful than the theoretical spreading rate figures quoted in the coating manufacturer's product data sheets.

The estimate should also include the cost of consumable supplies. Abrasives, cleaning rags, respirators and respirator cartridges, overalls and other protective clothing, masking tape, and small tools such as scrapers and wire brushes are all considered consumable items that are expended during the course of work.

4.3.5 Equipment Costs: The cost of the equipment used on a job must also be estimated; such costs might include charges for the use of compressors, dust collectors, vacuum or recycling equipment, containment, spray guns, airless or conventional spray pots or guns, and air and paint hoses. Fuel costs for diesel compressors and electrical generators should also be estimated. Most painting contractors have standard costs for these items, and charge clients on either a daily, weekly, or monthly basis.

4.3.6 Overhead Costs: Indirect costs of overhead, insurance, licenses, taxes, etc., must be added to the direct cost to arrive at a total cost.

5. Methods for Estimating Lifetime Cost

5.1 LIFE CYCLE COST CONCEPT: Life cycle costs are those costs incurred protecting steel from corrosion over the life of the structure. This includes the initial cost of applying the protective coating system, the various inspections and touch-ups, and maintenance painting activities. It is important to recognize that, in many instances, a strategy that may result in a lower initial cost may cost more in the long run because of higher maintenance or even replacement costs.

Applying life cycle cost in practice is complicated by a number of factors. The cost of purchasing materials or services is not constant over time. The numbers tend to increase because of inflation. Even more significant is the cost of tying up money that could otherwise be invested and generate interest. Also, tax treatments differ for capital costs (incurred as part of the construction and initial coating) compared to maintenance costs.

The total costs of future maintenance or repair can be estimated, but with difficulty, because they are highly variable. This can be attributed to the subjective definitions of "lifetime," the unpredictability of coating system performance, the lack of standard methods for assessing lifetime, and variables associated with protection and maintenance philosophy, time value of money, and others.

It is important to recognize that the data on a coating's lifetime will always be uncertain to some degree. Even with the most thorough testing, there are variables affecting the lifetime that cannot be controlled or precisely defined. For example, the definition of coating failure may vary from one situation to another. There is also variability in the substrate, the particular coating material, and the exposure environment. It is sometimes useful to define a range for the lifetime of a coating system. For example, for alkyds on bridges in moderate exposure environments, the lifetime is often estimated at 7 to 12 years before five percent of the surface is degraded by rusting.

5.1.1 Limitations of Data on Lifetime: As discussed in Section 4, methods are generally available to estimate the initial cost of a coating system. Maintenance costs can also be estimated in a similar manner. Depending on the circumstances, it is normally necessary to assess the condition of the coating and the accessibility of the structure, as well as the presence of lead and other hazardous components of the paint.

For life-cycle costing, however, the most difficult factor to determine is the lifetime of the coating, the time until a full repaint, partial repaint, or touch-up is required. Industry has developed numerous laboratory and field procedures for predicting lifetimes. In addition, data have been compiled on performances of coatings on structures in service. A thorough discussion of these models and methods is beyond the scope of this technology update. Examples of some models are provided in Section 6.

Two life-cycle methods will be discussed in this section: cost per unit area per year, and present value method.

5.2 COST PER UNIT AREA PER YEAR: Lifetime costs of coating systems and other corrosion control options can be calculated using methods of varying levels of sophistication. The simplest approach is to compare alternatives on the basis of cost per unit area per year ($\$/m^2/yr$) over the lifetime being considered. This normally entails determining initial application costs, estimating the service life of the coating system, and calculating the subsequent repainting or regular maintenance costs.

In the following examples, two painting systems are compared for an industrial exposure environment.[1] The data needed for each system are initial cost, maintenance costs, and the lifetime until maintenance.

System A: Two-coat alkyd applied over commercial blast cleaned steel (SSPC-SP 6/NACE No. 3)
- Initial painting: $6.24/m^2; 7-year lifetime
- Maintenance painting: $5.27/m^2; 4-year lifetime

System B: Three-coat inorganic zinc-rich over near-white blast cleaned steel (SSPC-SP 10/NACE No. 2)
- Initial painting: $12.38 /m^2; 15-year lifetime
- Maintenance painting: $11.63 /m^2: 9-year lifetime

First, looking at a 15-year time period:
- Alkyd:
  $6.24 for years 1–7,
  $5.27 for years 8–11,
  $5.27 for years 12–15,
  Total of $16.78 /m^2 for 15 years of protection, or
  $1.12 /m^2 per year

- Inorganic zinc-rich system:
  $12.38 for 15 years of protection, or
  $0.83/m^2 per year.

The alkyd had a lower initial cost ($6.24/m^2 vs $12.38/m^2). However, the inorganic zinc had a lower cost per m^2 per year when averaged over 15 years.

The example is also extended to show costs for a 50-year period.[1] The result of this further analysis shows that total cost was $64.15/m^2 for the alkyd ($1.283/m^2/yr.) system, and $58.88/m^2 for the zinc system ($1.178/m^2/yr.).

5.3 PRESENT VALUE METHOD AND COATING LIFETIME COST

5.3.1 Time Value of Money – Discounted Flow Method: The cost per unit area per year procedure neglects an important factor in determining the economics of corrosion protection systems – the time value of money. Money can earn interest. Because of that, $1.00 today is more valuable than $1.00 a year from now. At a rate of return of 10 percent, $1.00 will be worth $1.10 in one year. Similarly, $0.91 today will be worth $1.00 in one year, and $0.83 today will be worth $1.00 in two years. Calculations for inflation can easily be added. The quantities $0.91 and $0.83 are known as the *net present value* of $1.00 in one and two years, respectively. For example, if a structure were to be painted two years from now at a cost of $100,000, it would be necessary to bank only $83,000 of today's money. Because of the time value of money, it is frequently advantageous to minimize the initial investment and defer the cost to later years.

5.3.2 Using Time Value of Money Approach: The method of analysis is based on the "time value of money" or the "cost of money." Initial application costs are computed, and subsequent yearly maintenance costs are estimated and discounted over the effective protective life of the coating. As will be shown, the principle of this method is to determine or estimate the various expenditures that will occur over the lifetime of the structure or whatever time period is used for calculation. The present value (the value in today's money) of each cash expense is calculated, then totaled to arrive at a present value for each corrosion control option. In this way, cash flows are discounted to their present value, so the method is often referred to as "discounted cash flow." The most accurate and detailed present value analyses often include adjustments for taxes and depreciation.

Methods based on discounted cash flow yield more realistic comparisons because they recognize that money paid out today is worth more than money paid out at a subsequent date.

A complete discussion of discounted cash flow analysis techniques is beyond the scope of this technology update. It must be noted, however, that the results of any type of economic analysis are only as good as the input information. Furthermore, most analytical techniques use only "dollar" costs and do not consider intangible costs such as those related to risks due to environmental or safety hazards/compliance, improved or changed technologies. Some assign probabilities or factors to various intangible costs or risks and attempt to include these in their analysis.

5.3.3 Present and Future Value and Compounding: Present value is a means of assessing the economic merit of various investment alternatives. The basis of the determination is the evaluation of all costs and revenues of an investment alternative at "today's" value—the present value. Using the present value, we can determine the present-day cost of future activity (e.g., maintenance painting).

Another important concept is that of future value. This is what the maintenance painting will cost at some future date, e.g., two years from now. The important terms are:

PV = present value
FV = future value
i = annual rate of return (interest rate expressed as a decimal)
n = number of years

The basic equation is:

$$FV = PV\,(1+i)^n \qquad (1)$$

At 15 percent interest per year (or "rate of return"), $1.00 invested today will be worth $1.15 in one year (i=0.15). Two years from now, that same dollar will be worth $1.32.

$FV_1 = \$1.00 \text{ x } (1+0.15)^1 = \$1.15$
$FV_2 = \$1.00 \text{ x } (1+0.15)^2 = \$1.32$

Tables have been developed that provide the discount factors for various *i* and *n* values. Also available are computer programs that contain the discount factors and perform the calculations, saving time for the analyst.

One can also determine the amount of money to be set aside today (present value) for a future expense. One uses future value (equation 2) which is derived from equation 1.

$$PV = \frac{FV}{(1 + i)^n} \qquad (2)$$

If you needed a dollar a year from now, at 15 percent interest you would have to invest \$0.87. Letting FV = \$1, i=0.15, and n=1, in equation (2) yields

$$\frac{1}{(1+0.15)^1} = 0.87$$

If you needed a dollar in two years, you would only have to invest \$0.76:

FV = \$1, i = 0.15, and n = 2

$$\frac{1}{(1 + 0.15)^2} = 0.76$$

To demonstrate the impact of interest rates on these calculations, the following exercise calculates the amount of money that should be set aside today to pay for an expected \$100,000 project 10 years from now. Assume an interest rate of 15 percent (i = 0.15). The \$100,000 represents a "future value."

Using Equation 2, we compute present value:

$$\text{Present Value} = \frac{\$100{,}000}{(1 + 0.15)^{10}} = \frac{\$10{,}0{,}000}{4.046} = \$24{,}700$$

At 15 percent interest, it is necessary to invest \$24,700 today (present value) to have \$100,000 in 10 years.

At an interest rate of 5 percent (0.05):

$$\text{Present Value} = \frac{\$100{,}000}{(1 + 0.05)^{10}} = \frac{\$100{,}000}{1.629} = \$61{,}400$$

At 5 percent interest, it is necessary to invest \$61,400 today to have \$100,000 in 10 years. This illustrates how sensitive this method is to the interest rate selected.

6. Models and Data Sources

6.1 SOURCES OF APPLICATION/INSTALLATION COST DATA: Over the last several years, various government and private groups have developed models to estimate and analyze the cost for protective coatings projects. This section summarizes the major features of several of these efforts. Several of these models are derived from common practices and data sources.

6.1.1 Data from Applicators and Suppliers (Brevoort-Roebuck): The compilation of data on costs for varying coating activities was prepared by A. Roebuck and G. Brevoort in the early 1970s.[3] Their sources were field and shop applicators in different regions of the US. The data were presented as cost per unit area. The activities covered in this database included:

- surface preparation (e.g., types of methods and degrees of blast cleaning)
- application (e.g., from different methods of airless spraying and for different types of coatings)
- coating materials (for different generic types and thicknesses)
- modification factors: adjustments were made for work done in hard to access areas (e.g., high structures), for different configurations (e.g., different pipe sizes), and others.

These data have not been reconfirmed on a consistent basis, but many have used the original numbers by adjusting them for inflation).[4]

6.1.2 PDCA Estimating Guide: This text provides guidelines on measuring surfaces to be painted and in estimating production rates in square feet per hour for various industrial protective coatings activities. Rates are given for application of one, two, or three coats to pipe; duct work; light, medium, and heavy structural steel; hangers; fasteners; exterior shells and roofs of tanks and spheres; and machinery and equipment. Production rates are also given for surface preparation for four degrees of abrasive blast cleaning, hand scraping and wire brushing, power tool cleaning, pressure washing, steam cleaning, and water blasting. Charts are provided for determining surface areas for cylindrical tanks and standard structural steel shapes.

6.2 SOURCES OF COATING LIFETIME DATA

6.2.1 Roebuck/Brevoort: The authors have developed tables of estimated lifetimes of various coating systems and different exposure environments. The coating systems include generic material for primer, intermediate, and topcoat, system dry film thickness, and degree of surface preparation. The exposures include chemicals, acids and bases, immersions, and several atmospheric exposures. For each combination of systems and exposure the authors defined two lifetimes. The “ideal/optimum life” is defined as a time until the first maintenance painting/touch up should occur, (i.e., 3 to 5 percent breakdown of the topcoats occur and before active rusting begins). The “practical” lifetime is the time until approximately 10 percent of the surface requires surface preparation. The “P” lifetimes are typically about 50 percent longer than the “I” lifetime. The latest version of the tables include 100 coating systems.[3, 4]

6.2.2 SSPC PACE Project Data: These are derived from the long-term SSPC study entitled “Performance of Alternate Coatings in the Environment” (PACE).[6] In this study,more than 200 coating systems were applied to test panels and exposed at three standard exterior exposure sites. The large number of replicates of systems tested allowed for very sophisticated statistical analysis of the coating performance. In this study, different criteria are identified for failure including rusting (e.g., to rust grades 9, 8 or 7), and scribe undercutting (e.g., 3.2 mm [1/8 inch] or 6.4 mm [1/4 inch]). For each coating system the data are presented as the number of months until 20% failure has occurred (based on the failure criteria identified above). The data are available in reports or in electronic format from SSPC. The test series included the following:

- Alternate inhibitive pigments (Branch A)
- Alternative blast cleaning abrasives and degrees of cleaning (Branch B)
- Waterborne coatings (Branch C)
- Vinyl alternate pigment and vehicles (Branch D)
- Alternate blast and non-blast cleaning methods (Branch E)
- New experimental coatings (Branch F)
- Waterborne epoxies (Branch G)
- Bridge site evaluation (Branch H)

7. Examples of Cost Models

7.1 FORMAT FOR COST DATA SYSTEMS: Several published and commercial cost models for protective coating systems have been developed. These can be described using the following format:

a) objective of model
b) user input
c) output
d) extent of data
e) availability
f) comments

7.2 BREVOORT/ROEBUCK/SSPC/NACE: These cost models follow the following format.

a) Objective: Estimate initial and lifetime cost for coating systems

b) User Input

- Coating systems (from tabulated list)
- Exposure environment (from list of chemical and atmospheric exposures
  - Geographical locations (within the US)
  - Method of application (spray, brush, roll)
  - Maintenance strategy (ideal/optimum or practical)

c) Output: Cost per unit area per year.

d) Extent of Database:

- Over 100 coating systems based on combinations of surface preparation, coating materials and film thickness.
- 12 exposure locations
- 2 maintenance schedules (ideal and practical)

e) Availability: The tables and model calculations are available from SSPC and NACE.[3,4]

f) Comments: This model computed installed and lifetime costs using data described in the above data sets. The costs are computed as cost per unit area (e.g., dollars per square foot) for initial costs and for various maintenance costs assumed over the structures’ lifetime. The lifetime cycle cost is computed by adding up the cost for each activity and dividing by the length of the lifetime. Lifetime costs are given in cost per unit area per year (e.g., dollars per square meter per year).

7.3 BREVOORT COMPUTER COST MODEL (SPEC MATE): This is an enhancement of the basic Brevoort/Roebuck model. Additional features include the following:

- Specific adjustments for individual structures (e.g., bridges or water towers)
- Consideration of the cost of money (i.e., including inflation, interest rate and tax factors)
- Computation of alternative scenarios for different coating systems and service environment

7.4 NSRP/SSPC ABRASIVE BLASTING COST MODEL:[4] The format for the NSRP/SSPC abrasive blasting model is given below.

a) Objective: Evaluate cost and productivity of various abrasive blasting media for ship surfaces.

b) User Input: Type of substrate (i.e., coated or uncoated, surface area, degree of cleanliness required, presence of hazardous metal in coating, operation parameters of shipyard [optional]).

c) Output: Production rate for blast cleaning (area per unit time [e.g., square feet per hour]), abrasive consumption rates, [volume of abrasive per unit time or per unit area, [e.g., pounds per area per hour or pounds per square foot], cost per square foot and overall project costs).

d) Extent of Data: Data have been compiled on consumption and production rates and abrasive costs for approximately ten to twelve commercially available abrasives.

e) Availability: Hard and electronic copy of reports available from NSRP and SSPC. The software is not available commercially.

8. Referenced Documents

8.1 SSPC STANDARDS AND JOINT STANDARDS:

SP 6/NACE No. 3	Commercial Blast Cleaning
SP 10/NACE No. 2	Near-White Blast Cleaning

8.2 INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO) STANDARDS:

8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part I: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings – SA 2.5.

9. Disclaimer

This technology update is for information purposes only. It is neither a standard nor a recommended practice. While every precaution is taken to ensure that all information furnished in SSPC technology updates is as accurate, complete, and useful as possible, SSPC cannot assume responsibility nor incur any obligation resulting from the use of any materials, coatings, or methods specified herein, or of the technology update itself.

10. References

1. Appleman, B. R. “Economics of Corrosion Protection by Coatings.” *Journal of Protective Coatings and Linings* 2, 3 (1985): p. 26- 33.
2. Brevoort, G.H., Oechsle, S.J., Sline M. R. , and Feinberg, R.B.“Comparative Painting Costs”, *Good Painting Practice, Steel Structures Painting Manual,* Vol. 1, 3rd Edition. Pittsburgh: SSPC, 1993.
3. “Corrosion and Coating Costs of Highway Structural Steel.” Federal Highway Administration Report No. FHWA-RD-79-121, March 1980.
4. NSRP 0511, “Users Guide to Selection of Blasting Abrasives” (March 1998). Available as .pdf for downloading from http://horsey.umtri.umich.edu/library.
5. *PDCA Estimating Guide*, latest edition. Fairfax, Virginia: Painting and Decorating Contractors of America
6. “Performance of Alternate Coatings in the Environment” (PACE), Vol. III, Executive Summary, SSPC Report 89-12. Pittsburgh, PA: SSPC, 1989.
7. SSPC Tutorial W-8, “Assessing Cost and Cost-Effectiveness of Protective Coatings”, presented at PCE ‘98, the Hague, The Netherlands, April 1-3, 1998.
8. SSPC Tutorial T-52, “Basic Construction Cost Estimating for Owners and Contractors,” presented at SSPC 98, November 14-19, 1998.

Appendix 1 - Example of Labor and Material Methods for Estimating Initial Cost (US Units Version)

The following nine-step process is suitable for estimating initial costs for applying a coating to a structure.

Data furnished:

- Structure: exterior of ground storage tank
- Dimension: 33 ft diameter, 20 ft high
- Surface prep.: SSPC SP-10/NACE 2 (Sa 2.5)
- Surface profile: 1-3 mils
- Abrasive: coal slag
- Coating system
  - * primer: epoxy 6 mil DFT
  - * topcoat: polyurethane 4 mil DFT
- Coating material data
  - * Epoxy: 60% solids, loss factor 20%, cost $24/gal
  - * Polyurethane: 80% solids, loss factor 25%, cost $32/gal
- Abrasive data
  - * consumption rate: 10 lb/ft^2, cost $45 ton
- Labor data
  - * wage rate per hour: $45 (including fringes)
  - * blast cleaning rate: 160 ft^2/h
  - * coating application rate: 650 ft^2/h
- Equipment data
  - * blasting equipment: $30/h
  - * application equipment: $10/h

Nine Step Process for Estimating Initial Cost

Step 1: Compute surface areas:

- Tank: height x diameter x π

  33 ft x 20 ft x 3.14 = 2070 ft^2

Step 2: Compute Labor for Surface Preparation

- Tanks

  2070 ft^2 ÷ 160 ft^2/ h = 12.9 h (round to 13)
  13 h x $45/h = $585

Note: In some jobs, an additional labor cost may be included for mobilization (e.g. set up of equipment/ rigging of tank).

Step 3: Compute Labor for Painting

- Epoxy on tank

  2070 ft^2 ÷ (650 ft^2/h) = 3.18 h (round to 4)
  4 h x $45/h = $180

- Urethane on tank

  2070 ft^2 ÷ (650 ft^2/h) = 3.18 h (round to 4)
  4 h x $45/h = $180

Step 4: Compute Material Cost for Surface Preparation

- Abrasive for tank

  2070 ft^2 x 10 lb/ft^2 = 20,700 lb = 10.4 ton
  10.4 x $45/ton = $468

Step 5: Compute Cost of Coating Material

In general, the spreading rate is computed from Equation A,

$$\text{Spreading rate (actual coverage)} = \frac{\text{Theoretical coverage} \bullet \text{\% solids}}{\text{Target DFT + allowance for profile}} \qquad \text{(Eq. A)}$$

- **Epoxy on tank**

To find the cost of the epoxy primer, the spreading rate must first be computed. The spreading rate of primer to give 6 mil DFT is 137 ft^2/gal, computed as follows. One gallon covers 1604 ft^2 at a thickness of 1 mil. Thus, theoretical coverage is 1604 mil x ft^2/gal. Since the primer is only 60% solids, multiply by 0.60. To account for the effect of filling the profile with primer, add 1 mil to the target DFT.

$$\text{Spreading Rate for epoxy primer } (ft^2/gal) \quad \frac{\frac{1604 \text{ mil} \bullet ft^2}{gal} \times 0.60}{6 \text{ mil} + 1 \text{ mil}} = 137 \; ft^2/gal$$

The coverage computation is then:

$$2070 \; ft^2 \div (137 \; ft^2/gal) = 15.1 \text{ gal}$$

Because of the 20% loss factor, only 80% of the paint falls on the structure. The total volume of paint needed is therefore:

15.1 gal ÷ 0.80 = 18.9 gal (round to 19 gal)

Thus, the cost for the epoxy is:

19 gal x $24/gal = $456

- **Polyurethane on tank**

Compute the spreading rate of the polyurethane topcoat: 80% solids, 4 mils DFT, no adjustment for filling profile; using equation A above,

$$\text{spreading rate of polyurethane topcoat} = \frac{\frac{1604 \text{ mil} \bullet ft^2}{gal} \times 0.80}{4 \text{ mil}} = 321 \; ft^2/gal$$

The theoretical volume of paint required is then

$$2070 \; ft^2 \div (321 \; ft^2/gal) = 6.45 \text{ gal}$$

Correcting as above for a 25% loss factor, the total volume of paint needed is

6.45 gal ÷ 0.75 = 8.6 gal (round to 9 gal)

The cost for the polyurethane is then

9 gal x $32/gal = $288

Step 6: Compute Equipment Cost for Surface Preparation

- Tank
  13 hours blasting x $30/h = $390

Step 7: Compute Equipment Cost for Coating Application

- Tank:
  - 4 hours application (epoxy) x $10/h = $40
  - 4 hours application (polyurethane) x $10/h = $40
  - Total = $80

Step 8: Total Direct Cost

Total Cost (bid cost)

- Direct costs
  - * labor: $945
  - * materials: $1,212
  - * equipment: $470
- Overhead: 20%
- Profit: 15%

The total direct cost is computed by adding up the costs for labor, materials, and equipment as shown in Table A1-1 below.

Step 9: Estimate Overhead and Profit

The above costs do not account for overhead items such as liability insurance, training, maintenance of trailers, weather losses and equipment break down. This can add 20% or more to the cost of the job. In addition, the contractor would like to make a profit, which is set at 15% for this example. In Table A1-1 below, thirty five percent is added to the direct cost to yield a bid price of $3,546 (which could be rounded up to $3,600) for the tank.

Table A1-1. Estimated Labor and Material Cost -- Tank

Cost Element				
labor	surface preparation	$585		
labor	application/primer	$180		
labor	application/topcoat	$180		
			Labor Total	$945
materials	surface preparation (abrasive)	$468		
materials	primer	$456		
materials	topcoat	$288		
			Materials Total	$1,212
equipment	surface preparation	$390		
equipment	application	$80		
			Equipment Total	$470
			Total Direct Cost	$2,627
			profit/overhead@ 35% of $2,587	$919
			Total Bid Price	$3,546

Appendix 1M - Example of Labor and Material Methods for Estimating Initial Cost (Metric Version)

The following nine-step process is suitable for estimating initial costs for applying a coating to a structure.

Data furnished:

- Structure: exterior of ground storage tank,
- Dimension: 10 m diameter, 6 m high
- Surface prep.: SSPC SP-10/NACE 2 (Sa 2.5)
- Surface profile: 25 to 75 micrometers
- Abrasive: coal slag
- Coating system
  - *primer: epoxy 150 micrometers DFT
  - *topcoat: polyurethane 100 micrometers DFT
- Coating material data
  - *Epoxy: 60% solids, spreading rate 6 m^2/liter, loss factor 20%, cost $6/liter
  - *Polyurethane: 80% solids, spreading rate 8 m^2/liter, loss factor 25%, cost $8/liter
- Abrasive data
  - *consumption rate: 49 kg/m^2, cost $50/Mg
- Labor data
  - *wage rate per hour: $45 (including fringes)
  - *blast cleaning rate: 15 m^2/h
  - *coating application rate: 60 m^2/h
- Equipment data
  - *blasting equipment: $30/h
  - *application equipment: $10/h

Nine Step Process for Estimating Initial Cost

Step 1: Compute surface areas:

- Tank: height • diameter • π
  10 m • 6 m • 3.14 = 188 m^2

Step 2: Compute Labor for Surface Preparation

- Tanks
  188 m^2 ÷ 15 m^2/ h = 12.5 h (round to 13)
  13 hrs • $45/h = $585

Note: In some jobs, an additional labor cost may be included for mobilization (e.g. set up of equipment/ rigging of tank).

Step 3: Compute Labor for Painting

- Epoxy on tank
  188 m^2 ÷ (60 m^2/h) = 3.13 h (round to 4)
  4 hrs • $45/h = $180
- Urethane on tank
  188 m^2 ÷ (60 m^2/h) = 3.13 h (round to 4)
  4 hrs • $45/h = $180

Step 4: Compute Material Cost for Surface Preparation

- Abrasive for tank
  188 m^2 • (49 kg/m^2) = 9,212 kg = 9.2 Mg
  9.2 Mg • $50/Mg = $460

Step 5: Compute Cost of Coating Material

$$\text{Spreading rate (actual coverage)} = \frac{\text{Theoretical coverage} \bullet \text{\% solids}}{\text{Target DFT + allowance for profile}} \qquad \text{(Eq. A)}$$

- Epoxy on tank

First, the spreading rate must be computed. The spreading rate of primer to give 150 µm DFT is 3.4 m^2/L, computed as follows. One liter covers 1000 m^2 at a thickness of 1 µm. Thus, theoretical coverage is 1000 µm x m^2/L. Since the primer is only 60% solids, multiply by 0.60. To account for the effect of filling the profile with primer, add 25 µm to the target DFT.

$$\text{Spreading Rate for epoxy primer } (m^2/L) = \frac{\frac{1000\ \mu m \bullet m^2}{L} \times 0.60}{150\ \mu m + 25\ \mu m} = 3.4\ m^2/L$$

The coverage computation is then

$$188\ m^2 \div (3.4\ m^2/L) = 55.3\ L$$

Because of the 20% loss factor, only 80% of the paint falls on the structure. The total volume of paint needed is therefore

$$55.3\ L \div 0.80 = 69.1\ L \text{ (round to 70 L)}$$

Thus, the cost for the epoxy primer is

70 liters x \$6/liter = \$420

- Polyurethane on tank

Compute the spreading rate of the polyurethane topcoat: 80% solids, 100 µm DFT, no adjustment for filling profile; using equation A above,

$$\text{spreading rate of polyurethane topcoat} = \frac{\frac{1000\ \mu m \bullet m^2}{L} \times 0.80}{100\ \mu m} = 8.0\ m^{2/}/L$$

The theoretical volume of paint required is then

$$188\ m^2 \div (8\ m^2/L) = 23.5\ L$$

Correcting as above for a 25% loss factor, the total volume of paint needed is

$$23.5\ L \div 0.75 = 31.3\ L \text{ (round to 35)}$$

The cost for the polyurethane is then

35 liters x \$8/liter = \$280

Step 6: Compute Equipment Cost for Surface Preparation

- Tank
  13 hours blasting x \$30/h = \$390

Step 7: Compute Equipment Cost for Coating Application

- Tank:
  4 hours application (epoxy) x \$10/h = \$40
  4 hours application (polyurethane) x \$10/h = \$40
  Total = \$80

Step 8: Total Direct Cost

Total Cost (bid cost)
- Direct costs
  * labor: $945
  * materials: $1,160
  * equipment: $470
- Overhead: 20%
- Profit: 15%

The total direct cost is computed by adding up the costs for labor, materials and equipment as shown in Table A1-1M below.

Step 9: Estimate Overhead and Profit

The above costs do not account for overhead items such as liability insurance, training, maintenance of trailers, weather losses and equipment break down. This can add 20% or more to the cost of the job. In addition, the contractor would like to make a profit, which is set at 15% for this example. In Table A1-1M below, thirty five percent is added to the direct cost to yield a bid price of $3,476 (which could be rounded up to $3,500) for the tank.

Table A1-1M. Estimated Labor and Material Costs -- Tank

Cost Element				
labor	surface preparation	$585		
labor	application/primer	$180		
labor	application/topcoat	$180	**Labor Total**	$945
materials	surface preparation (abrasive)	$460		
materials	primer	$420		
materials	topcoat	$280	**Materials Total**	$1,160
equipment	surface preparation	$390		
equipment	application	$80	**Equipment Total**	$470
			Total Direct Cost	$2,575
			profit/overhead@ 35% of $2,535	$901
			Total Bid Price	$3,476

Appendix 2 – Example Using Present Value Cost Analysis

A2.1 Present Value of a Series of Payments

It is sometimes necessary to determine the present value of a series of payments made over the life of an investment at a given interest rate.

A company can purchase a fiber-reinforced plastic (FRP) corrosion-resistant tank installed for $50,000. Alternatively, it can purchase a carbon steel tank of the same capacity for $20,000, but will have to line the interior and paint the exterior. Tank lining costs are estimated to be $15,000 initially, with relining repairs every 15 years estimated at $5,000.

Exterior painting costs are estimated at $5,000 initially, with maintenance required every 10 years at $3,000. The service life of either tank is required to be 40 years, and the company in the past has made a 15 percent return on invested capital. Which tank should be purchased?

In order to compare these two options, one needs to look at the cost outlays (cash flows) and when they occur. The total of the costs for the carbon steel tank are $59,000 (see Table A2-1) compared to $50,000 for the FRP tank. However, this analysis did not take into account the time value of money.

A2.2 Analysis Using Time Value of Money

The cash flows over the life of the tank using the time value of money can be computed. The first three costs in Table A2-1 occur at year 0, so the present values of these costs are unchanged at $20,000, $15,000, and $5,000, respectively. However, the fourth item, the cost of maintenance, occurs in year 10, so money can be put aside today to pay for the future cost of $3,000. Today's dollar is worth $0.386 in 10 years (assuming 10% inflation [i= $0.10]), so $3,000 x 0.386, or $1,160, can be set aside today to pay for that future cost. Similarly, present values for other future maintenance costs can be computed, as shown in Table A2-1. The total of the present value costs for the steel tank initial and maintenance costs is $43,300; so this option is more economical than the FRP tank.

Table A2-1. Net Present Value of Carbon Steel Tank*

YEAR	EXPENDITURE	FUTURE VALUE (FV) COST	VALUE OF $1 (for i = 0.10)	PRESENT VALUE
0	Steel Tank	$20,000	$1.000	$20,000
0	Interior Lining	$15,000	$1.000	$15,000
0	Exterior Coating	$5,000	$1.000	$5,000
10	Maintenance Painting	$3,000	$0.386	$1,692
15	Lining Repair	$5,000	$0.239	$1,200
20	Maintenance Painting	$3,000	$0.149	$450
30	Maintenance Painting/ Lining Repair	8,000	$0.057	$460
	TOTAL COST	$59,000 (UNDISCOUNTED)		$43,270 (DISCOUNTED)

* Extracted from Unit 5 of "Economic Considerations When Selecting Coatings", from SSPC Course C-2, Specifying and Managing Protective Coatings Projects.

$$\text{PV of \$1} = \frac{1}{(1 + i)^n}$$

where
i = annual percentage rate in decimal form
n = number of years
PV = cost x (PV of $1)