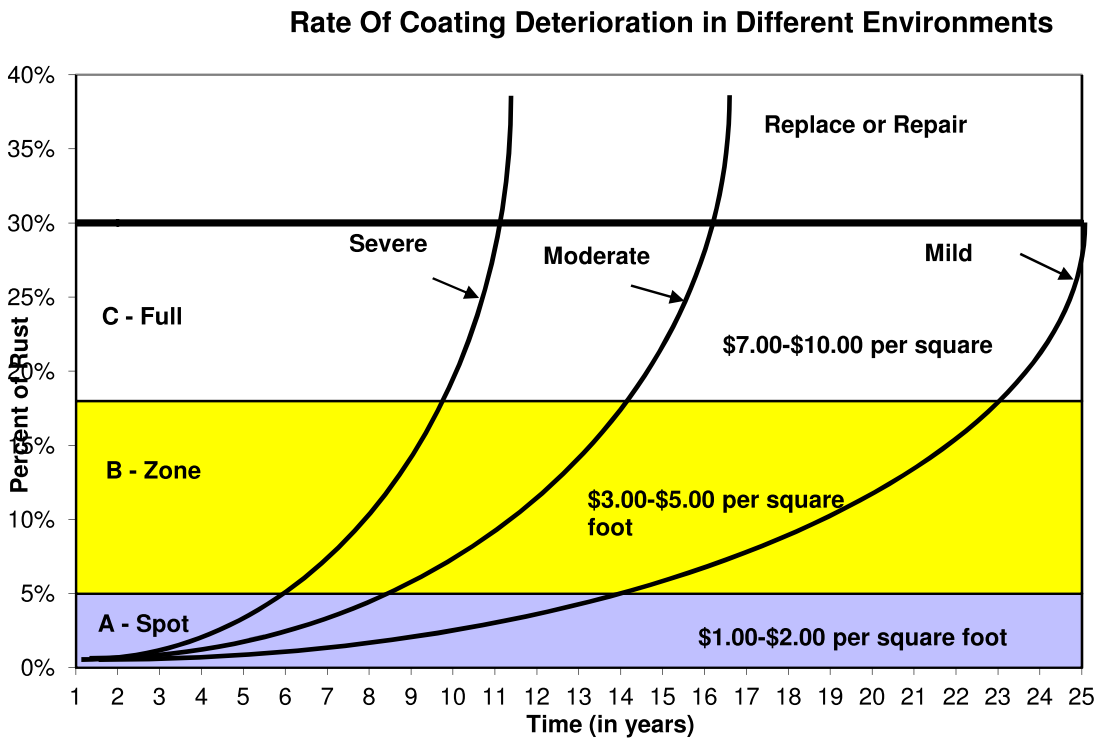
Establishing a Coating Maintenance Plan

Putting together a coating maintenance plan is outside the skill set of a typical inspector but if you are working in a facility, it is possible that someone will expect you to be able to come up with a coating plan. Most inspectors should have the skills be able to perform many of the steps.

It is essential when putting together a plan that you have a well thought out strategy in place. This will consist of several key steps

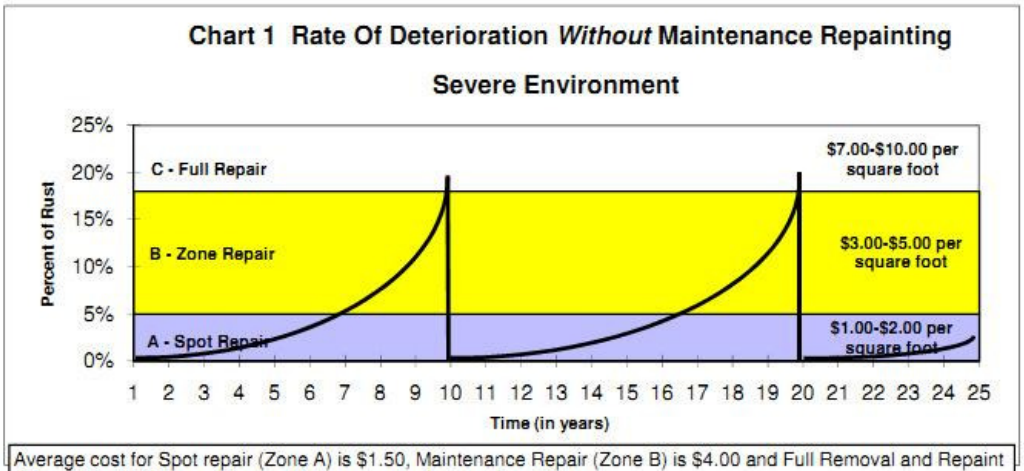
1. Determine the areas that will be surveyed.
2. Determine the level of detail that will be surveyed.
3. Determine the amount of manpower that will be required.
4. Get complete drawings of the areas to be surveyed.
5. Having plant personnel involved is critical to make sure areas are described in that plants terminology.
6. Determine what data will be taken and the format that you will use. it is important that all persons involved with the survey use the same judging criteria.
7. Make sure all personnel conducting the survey are using the same factors for square footage takeoffs

Economics



The above and below graphs are based on a paper presented at Corrosion 96 by Bavoort, Melampy and Shields and the data is over 10 years old and probably needs to be adjusted for

today's costs but the general theory is the same. The above graph shows the cost of coatings as they deteriorate with coatings in the A zone and B zones being much less costly than waiting for them to go to C conditions. The two graphs below show the difference in cost between being reactive (no plan) and being proactive (Good Plan).



Average cost for Spot repair (Zone A) is $1.50, Maintenance Repair (Zone B) is $4.00 and Full Removal and Repaint (Zone C) is $8.50 are estimates. Data presented is based on 25 years.
The Average Equivalent Annual Cost as developed by "Updated Protective Coating costs and Product Life" G. H. Brevoort, Michael MeLampy, Kirk Shields, NACE Corrocion/96. Assumtions are as follows:

i = Inflation rate, assume 5% and n=Number of Years, Use 25 i
NPV=Net Present Value and NFV=Net Future Value And AEAC= Average Equivalent Annual Cost

$$NPV = NFV \times \frac{1}{(1+i)n}$$

NFV = (current cost) x (1+i)n

i = inflation rate

$$AEAC = NPV \times \frac{i(1+i)n}{(1+i)n - 1}$$

i = interest rate

Calculation example:

NFV(year 10)= 13.84 NPV(year 10)= 5.34
NFV(year 20)= 22.55 NPV(year 20)= 3.36 Total NPV =8.70 AEAC = $0.95

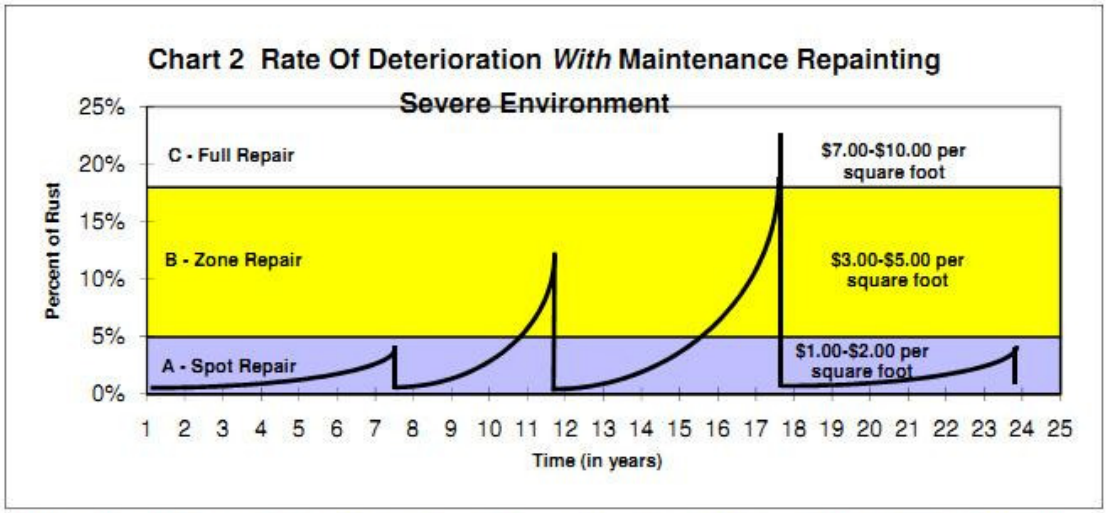


Chart 2 is based on a "Practical" paint maintenance program as described by Corrosion/96 "Updated Protective Coating costs and Product Life" G. H. Brevoort, Michael MeLampy, Kirk Shields.

Practical Maintenance (Based on system #33) NPV = 7.11 AEAC = $0.78

This equates to a savings of approximatly 17%

Subdivision of Facilities and Structures

Because the amount of data that will be collected you will need a well organized breakdown for the data. While you can break it down in any manner that makes sense, one possible breakdown is below.

Data is collected and analyzed by Region, Area, Grid, and Item.

- **Region** - A "Region" can be a whole plant or parts of a plant but will generally be defined as the area that the painting budget covers.
- **Area** - Each Region is divided into major segments identified as "Areas." For example, each Unit or building in a plant, each bridge in a city, or each pipeline substation in a state, is a separate "Area."
- **Grid** - Each Area is subdivided into smaller units identified as "Grids." Grids may be portions of floors or operating areas of a plant or the individual spans of a bridge.
- **Item** - All of the painted “Items” present within each Grid are inventoried and a unique code should be assigned to each item for future identification..

Color coding the drawing as the survey is taken can help keep the survey organized. Make sure that each grid and/or item is clearly marked on the drawings as they are identified in the survey.

IMPORTANT: If you cannot identify a grid or an item when needed or find a grid or item in the survey, then you have wasted a lot of time. Walk the “Area” with the facility personnel and make sure they can locate the grids and items from the survey and in turn pick a grid or an item in the facility and locate it in the survey. Do not count on trying to find the people that did the survey to figure this part out. FIX IT NOW or it may be worthless in the future. (I speak from experience)

Rating Scheme

There are several rating schemes that are commonly used. 1 to 10 or 0 to 5. I generally do not recommend these because it is unclear if higher numbers are better or worse. I prefer a lettering system using the letters A, B, and C to categorize (grade) the coating condition. Coating in good condition are graded "A", while coatings in a touch-up condition receive a "B", and those areas judged to require complete removal and replacement are graded in a "C" condition. Pluses and minuses (+/-) are added to each to provide better discrimination in the data collection as shown below: This is the scale used by the KTA CAPP program.

You may want to add some additional grading categories. A “D” condition for items that will be decommissioned prior to them needing recoating. Why paint it if you no longer need it. And a “F” condition for items that are in too bad a shape to salvage and will need to be replace. Again, it does not make sense to coat these. Also “G” for Galvanized, “I” for insulated and “U” for substrate =cannot be seen

This grading scale is something we have all lived with since Kindergarten, to me it is the easiest scale that puts everyone on the same page and is generally unambiguous.

Category A – Good Condition with No Rework Required

A+ Perfect with no defects.
A Excellent condition with less than 0.1% corrosion and defects.
A- Good condition with 0.1-0.3% corrosion and defects.

Category B – Coating in Touch-Up Condition

B+ Slight touch-up required with 0.3-1% corrosion and defects.
B Average touch-up required with 1-3% corrosion and defects.
B- Considerable touch-up required with 3-10% corrosion and defects.

Category C – Complete Coating Removal and Replacement

C+ Beyond touch-up with 10-17% corrosion and defects.
C Poor condition with 17-33% corrosion and defects.
C- Very poor condition with greater than 33% corrosion and defects.

Take photographs of each of these conditions that the surveyors can use for reference. Pictures should be of typical conditions in your facilities and on typical structures, (e.g., piping, tanks, compressors, etc.). This assures the accurate and consistent rating of deterioration.

A copy of SSPC VIS-2 can be useful to help determine the condition of te coatings.

Other Tests

Part of taking the survey will be addressing the over-coatability of the existing coatings. Since the A conditions will not be over-coated at this time, it would not be worthwhile to check these coatings since by the time they need to be repaired, their conditions may change. Since C conditions need to be removed, it does not make sense to check the coatings. That leaves only the coatings in a B condition that need further assesment

Physical tests of the coating adhesion, thickness, and condition of the underlying substrate should also made as part of the survey in order to determine if the existing material is of adequate strength to be recoated. The survey manager will use the raw data to establish the risk of disbonding if the surface is overcoated. Provisions may also be made to include for the reporting the generic type of coatings present on each item, toxic metal content, recording the brand name, and other conditions or defects as required

OVERCOATABILITY

Not all B conditions are suitable for overcoating. During the survey, all B items should be checked for

1. Dry Film Thickness
2 Number of coats
3. Adhesion (generally an X cut is sufficient)

Pick a numeric grading scale. For these items a 1 through 5 scale works well.

Use your own judgment, but to me of the three, Adhesion is most important. I generally use a cutoff point of 3 as being unsuitable for overcoating

While thickness depends on the coating system, Generally by 30 mils I would start getting concerned. By 50 mils, I would not add anymore.

The number of coats you are willing to overcoat depends on the coating type and can be hard to determine, but I generally start to degrade the overcoatability at about 6 coats and use a cutoff of about 15 coats.

In order of importance, generally I would consider **adhesion** to most important. When setting up a grading scale I would assign the following values{:

X cut adhesion rating of 3, I would assign to a 3 rating

X cut adhesion rating of 4, I would assign to a 2 rating

X cut adhesion rating of 5, I would assign to a 0 rating

X cut adhesion rating of 0, 1 or 2, I would assign to a 5 rating

To determine the coatability number

1. Multiply the adhesion score by 5 giving a maximum score of 25
2. Next would be **number of coats**.

Divide the number of coats by 3 and multiply by 2 giving a maximum score of 10

3. If adhesion is good the **Dry Film thickness** is not as significant

Divide the film thickness by 10 with a multiplication factor of 1.

A B+ coating that is 30 mils thick at 9 coats with and adhesion of 3 would be

LETS ASSUME OUR OVERCOATABILITY CRITERIA IS 25.

(30/10) + (9/3*2) + (5*3) = 3 + 6 + 15 = 24

You are good to go.

If you have the same coating rating but with 12 coats instead of the above 9 coats, the 6 in the above equation becomes 8 and you now have a 26. This is over your overcoatability criteria.

You can message these equations to meet the conditions at your facility. Much of this is a judgment call that should be based on both your experience as well as the experience's of the owner of the facility.

Assembling the Team

Skills Required:

1. Inspectors will be required to estimate percentage of corrosion on painted surfaces. Visual references will be provided to assist in assessments. NOTE: Practice is required to properly compare standards to painted surfaces.
2. Inspectors will be required to make square footage estimates which requires basic math skills. (NOTE: square footage take-offs for painting are different from engineering take-offs)
3. Inspectors should be sufficiently versed in coatings to recognize coating defects that effect coating integrity.
4. Inspectors should be familiar with basic coating inspection instrumentation including:
    a. DFT Gages (ASTM D1186)
    b. Cross Hatch and X cut Adhesion (ASTM D3359)
    c. Pint Inspection Gages (ASTM D4138)
5. Inspectors should be well versed in the terminology of the assets to be surveyed. Nomenclature used in one facility may not be recognized in other facilities.
6. If areas inaccessible from the ground need to be evaluated, inspectors should have the necessary man-lift training or other safety training required to inspect these areas, if necessary, with the assistance of plant personnel.
7. If the interior of vessels are to be evaluated, necessary confined space training needs to be current along with the appropriate hole watch.

Recommended Equipment

To properly perform the evaluations, inspectors should have available and be trained in using the following:

1. Instrumentation
    a. Dry Film thickness
        i. Dry Film Thickness Gage Elcometer 456 or equivalent
    b. Adhesion Testing
        i. Defelsko Pull-Off Tester
        ii. Box Cutter type knife with good razor blades
        iii. Straight Edge
        iv. Cross Hatch Cutter with 2mm spacing or equivalent
    c. Corrosion Assessment
        i. SSPC VIS 2, ASTM B610 or other means of determining per cent corrosion on painted surfaces.
    d. Pit Depth Gage
        i. Western Instrument Trigauge or Equivalent
    e. Flashlight
    f. Inspection Mirror
    g. Digital Camera
    h. Optional – PDA or electronic means for collecting field data

2. Documents
    a. Up to date plant drawings
    b. ASTM D610-01 Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces
    c. ASTM D1186-01 Standard Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base
    d. D3359-02 Standard Test Methods for Measuring Adhesion by Tape Test
    e. D4541-02 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
    f. D4138-94(2001)e1 Standard Test Methods for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive Means
    g. SSPC VIS 2 Evaluating Degree of Rusting on Painted Steel Surfaces
    h. Photographic Standards
    i. Estimators rules of thumb for estimating square footage
    j. Survey Forms

.How the maintenance Plan works

While many areas of facilities have budgets, coating is often thrown into the maintenance budget. In many facilities one or two persons or your paint vendor walks around the plant looking for areas that need to be painted. This can be a very expensive way to keep your facility painted.

The goal of the maintenance plan is to keep the plant in an A or B condition and to eliminate the C condition that requires a full removal and recoat. Depending on the size of the facility, by planning out your painting instead of reacting to the plant condition, you can save thousands and even millions of dollars. The problem with these plans is as management changes, so does commitment to the plans.

You should have all your data from your survey in a nice organized manner. Unless you are up to writing a database, excel should be sufficient to organize most of your data.

If your data is in excel, sort it by condition. To analyze the data you will need to know the approximate cost per sq ft for touchup and overcoat and for total removal and recoat.

To many people it seems logical to start with the C conditions since they need paint the most. This is where most planners go wrong. Unless you are worried about losing the asset due to corrosion, the paint is already past savings so save it for when there is money left over in the paint budget.

When you graded the coatings, in general a B- condition will deteriorate to a C condition within one year if not taken care of. Since it is much more expensive to fix an item in a B- condition than a C condition, it is important in the initial year you spend enough money to take care of these items. Once the B-‘s are taken care of, you have two choices. If there are any items in a C condition that you feel may not last another year if they are not coated, then take care of those items.

My general recommendation is to allot enough funds to get all B, B- and C conditions coated in 5 years. Once this goal is completed you are now in a maintenance mode that if maintained should reduce your coating budget substantially. While there are many factors that determine how fast coatings deteriorate, A general rule of thumb, for planning purposes, if using the A+ to C – system is degrade each item one grade each year.

Year 1 A+
Year 2 A
Year 3` A-
Year 4 B+
Year 5 B
Year 6 B- (needs to be coated or it will require a more expensive Total Removal and Recoat
Year 7 C+ And after this it doesn't matter

Under this scenario, all items will require touch up painting within 6 years. One suggestion, once an item is recoated, I generally return the item to an A not an A+ so it will need to be addressed in 5 years next time.

You can also adjust what should be coated and how long it takes to degrade by taking into account both the Localized Environment (Subject to cooling tower overspray or a corrosive environment) and the importance of the asset. Both are discussed below.

Environments

1 - Mild – Coatings should last their full life cycle if applied properly

2 - Moderate – Environmental conditions are conducive to more rapid deterioration than the coating system is designed for. (e.g. Full sun, coastal area, industrial environment, etc.)

3 - Severe – Rapid breakdown of coating expected. (e.g. cooling tower overspray, acid environment, etc.

Weighting:

How critical is equipment being evaluated to the operation and/or safety of the facility. 1 to 100 scale.

100 - Failure could cause a safety risk. Critical for operation of the facility.

75 - Critical for operation of the facility but no safety risk

50 - Important for operation of the facility but will not cause outage or shutdown of the facility

25 - Items that need to be maintained but do not effect operation of the facility

1 - Auxiliary or spare equipment

NOTE: Any number can be used between 1 and 100. The higher the weighting, the higher the coating priority. e.g. 100 takes precedence over a 50 even if the 50 is in worse shape.

EXAMPLE DATA COLLECTION FORM

Date: _____

Coating Condition Field Form

Region: _____ Area: _____ Subarea: _____

Grid	Item Name	Subitem Name	ID/Location	Coating Grade	Adhesion	DFT Minimum	DFT Maximum	DFT Average	Square Footage	Coating Type	Substrate Type	Photo Number	Comments

NOTES:

Inspector: _____

Page _____of _____

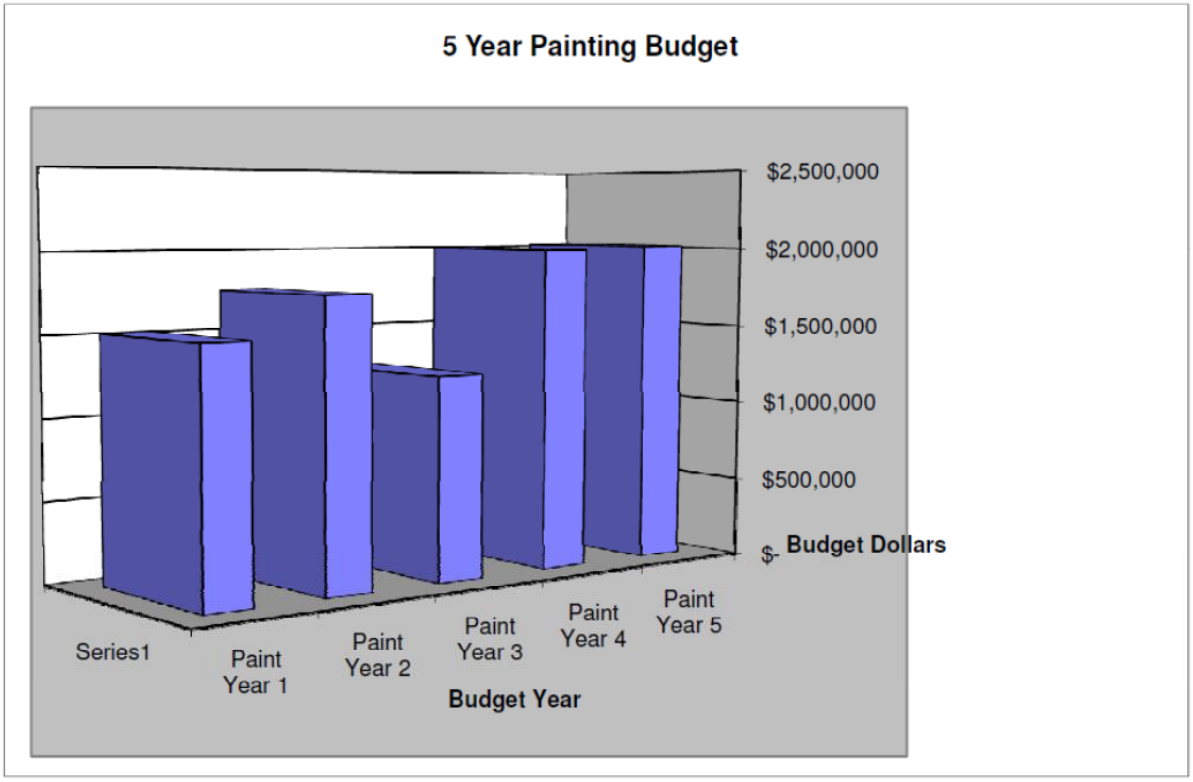
EXAMPLE OF A COATING MAINTENANCE BUDGET

Coating Costs

Item	Rust Grade	Cost Year 1
1	B+	$ 25,000
2	C-	$ 1,250,000
3	C+	$ 1,055,000
4	B-	$ 75,000
5	B-	$ 80,000
6	B+	$ 50,000
7	B+	$ 80,000
8	A-	$ 10,000
9	A-	$ 15,000
10	B-	$ 50,000
11	B	$ 405,000
12	B+	$ 750,000
13	B-	$ 960,500
14	C-	$ 1,755,000
15	C+	$ 2,000,000
	Total	$ 8,560,500

Possible Painting Schedule based on $2,000,000 Annual Budget

Item	Rust Grade				
8	A-	$ 10,000	$ 10,000	Do nothing
9	A-	$ 15,000	$ 25,000	Do nothing
11	B	$ 405,000	$ 405,000	Paint Year 1
1	B+	$ 25,000	$ 430,000	Paint Year 1
6	B+	$ 50,000	$ 480,000	Paint Year 1
7	B+	$ 80,000	$ 560,000	Paint Year 1
12	B+	$ 750,000	$ 1,310,000	Paint Year 1
10	B-	$ 50,000	$ 1,360,000	Paint Year 1
4	B-	$ 75,000	$ 1,435,000	Paint Year 1
5	B-	$ 80,000	$ 1,515,000	Paint Year 1
13	B-	$ 960,500	$ 960,500	Paint Year 5
3	C+	$ 1,055,000	$ 2,015,500	Paint Year 5
15	C+	$ 2,000,000	$ 2,000,000	Paint Year 4
2	C-	$ 1,250,000	$ 1,250,000	Paint Year 3
14	C-	$ 1,755,000	$ 1,755,000	Paint Year 2
	Total	$ 8,560,500		Paint Year 1



Acknowledgements

Bavoort wrote a series of articles on coating life cycles in the 1990 published in the 90's. This resulted in a paper for Corrosion 96 written by Bavort, MeLampy and Shields.

KTA Tator, Inc. Developed a program called CAPP based on this paper. The CAPP System has been significantly improved since the original version, and information can be obtained directly from KTA at 412-788-1300. Kirk Wissmar manages the program. He can be reached at x186 or kwissmar@kta.com. The link to the website is www.kta.com/html/capp.html.

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