Cost-Benefit Analysis
For
Alternatives to Aliphatic Isocyanate Polyurethanes

FINAL

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PREFACE

This report was prepared by ITB, Inc., through the National Aeronautics and Space Administration (NASA) Technology Evaluation for Environmental Risk Mitigation Principal Center (TEERM) under Contract Number NNH06CC40C DO #012. The structure, format, and depth of technical content of the report were determined by NASA TEERM, Government contractors, and other Government technical representatives in response to the specific needs of this project.

We wish to acknowledge the invaluable contributions provided by all the organizations involved in the creation of this document.

EXECUTIVE SUMMARY

NASA and Air Force Space Command (AFSPC) have similar missions and therefore similar facilities and structures in similar environments. The standard practice for protecting metallic substrates in atmospheric environments is the application of an applied coating system.

The most common topcoats used in coating systems are polyurethanes that contain isocyanates. Isocyanates are classified as potential human carcinogens and are known to cause cancer in animals. The primary objective of this effort was to demonstrate and validate alternatives to aliphatic isocyanate polyurethanes resulting in one or more isocyanate-free coatings qualified for use at AFSPC and NASA installations participating in this project.

This Cost-Benefit Analysis (CBA) quantifies the estimated capital and process costs of coating alternatives and cost savings relative to the current coatings. The estimates in this CBA are to be used for assessing the relative merits of the selected alternatives. The actual economic effects at any specific facility will depend on the alternative material or technology implemented, the number of actual applications converted, future workloads, and other factors.

The participants initially considered eighteen (18) alternative coatings as described in the Potential Alternatives Report entitled *Potential Alternatives Report for Validation of Alternatives to Aliphatic Isocyanate Polyurethanes*, prepared by ITB. Of those, 8 alternatives were selected for testing in accordance with the Joint Test Protocol entitled *Joint Test Protocol for Validation of Alternatives to Aliphatic Isocyanate Polyurethanes*, and the Field Test Plan entitled *Field Evaluations Test Plan for Validation of Alternatives to Aliphatic Isocyanate Polyurethanes*, both of which were prepared by ITB.

A Joint Test Report entitled *Joint Test Report for Validation of Alternatives to Aliphatic Isocyanate Polyurethanes*, prepared by ITB, documents the results of the laboratory and field testing, as well as any test modifications made during the execution of the testing.

The coatings selected for evaluation in this CBA are shown in the table below. Only one control coating system is considered in this analysis. These coatings were either down-selected for Phase II or performed well enough to be included in the Qualified Products List in the NASA technical standard NASA-STD-5008, *Protective Coating of Carbon Steel, Stainless Steel, and Aluminum on Launch Structures, Facilities, and Ground Support Equipment*.

Baseline and Alternative Coatings Systems Evaluated under this CBA				
System	***Topcoat***	***Intermediate***	***Primer/Wash***	***Manufacturer***
1	Carboxane 2000	Carboguard 893	Carbozinc-11HS	Carboline
2*	Carbothane 134 HB	Carboguard 893	Carbozinc-11HS	Carboline
3	Polysiloxane XLE	*None*	ZincClad 11	Sherwin Williams
6	Interfine 979	Interseal 670HS	Interzinc 22	International Protective Coatings (IPC)
7	Interfine 878	Interseal 670HS	Interzinc 22	IPC
9	AquaSurTech (AST) D45	*None*	AST Crosslinker	Kimetsan
10	PSX 1001	383H	Dimetcote 9H	Ameron

* Control Coating System

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1.0 INTRODUCTION

Headquarters NASA chartered the Technology Evaluation for Environmental Risk Mitigation Principal Center (TEERM), formerly the Acquisition Pollution Prevention Office, to coordinate agency activities affecting pollution prevention issues identified during system and component acquisition and sustainment processes. The primary objectives of TEERM are to:

- Reduce or eliminate the use of hazardous materials or hazardous processes at manufacturing, remanufacturing, and sustainment locations.
- Avoid duplication of effort in actions required to reduce or eliminate HazMats through joint center cooperation and technology sharing.

NASA and AFSPC have similar missions and therefore similar facilities and structures in similar environments. Both are responsible for a number of facilities/structures with metallic structural and non-structural components in highly and moderately corrosive environments. Regardless of the corrosivity of the environment, all metals require periodic maintenance activity to guard against the insidious effects of corrosion and thus ensure that structures meet or exceed design or performance life. The standard practice for protecting metallic substrates in atmospheric environments is the application of an applied coating system. Applied coating systems work via a variety of methods (barrier, galvanic and/or inhibitor) and adhere to the substrate through a combination of chemical and physical bonds.

The most common topcoats used in coating systems are polyurethanes that contain isocyanates. Isocyanates are compounds containing the isocyanate group (-NCO). They react with compounds containing alcohol (hydroxyl) groups to produce polyurethane polymers, which are components of polyurethane foams, thermoplastic elastomers, spandex fibers, and the polyurethane paints used in NASA and AFSPC applications.

The Occupational Safety & Health Administration states that the effects of isocyanate exposure include irritation of skin and mucous membranes, chest tightness, and difficult breathing. Isocyanates are classified as potential human carcinogens and are known to cause cancer in animals. The main effects of overexposure are occupational asthma and other lung problems, as well as irritation of the eyes, nose, throat, and skin.

The primary objective of this effort is to demonstrate and validate alternatives to aliphatic isocyanate polyurethanes. Successful completion of the project resulted in several isocyanate-free coatings qualified for use at AFSPC and NASA locations.

This Cost-Benefit Analysis (CBA) was prepared to quantify the estimated capital and process costs of coating alternatives and cost savings relative to the current coating processes. The CBA is based on limited information and a number of assumptions. The estimates in this CBA should not be used for any purpose beyond estimating the relative merits of some of the potential alternatives. The actual economic effects at any specific facility will depend on the alternative material or technology implemented, the number of actual applications converted, future workloads, and other factors.

2.0 TECHNICAL APPROACH

The methodology used to conduct this CBA is based on the Environmental Cost Analysis Methodology (ECAM^{SM}). The ECAM^{SM} was developed for the Department of Defense to provide a consistent means of quantifying and evaluating environmental costs and benefits. A copy of the ECAM^{SM} Handbook can be requested at http://www.ndcee.ctc.com/ecam/.

Information about each process was gathered including general process descriptions, process flow diagrams, process equipment, estimated material usage, anticipated wastes and emissions and environmental factors and can be found in the *Potential Alternatives Report for Validation of Alternatives to Aliphatic Isocyanate Polyurethanes*

This CBA is based on a number of assumptions and information gathered during the laboratory testing and field demonstrations that occurred at Stennis Space Center, MS. The estimates in this CBA should not be used for any purpose beyond assessing the relative merits of the alternatives. The actual economic effects at any specific facility will depend on the alternative material or technology implemented, the number of actual applications converted, future workloads, and other factors.

3.0 DIRECT COSTS

The following subsections look at the Direct Costs (conventional costs associated with a process) for the Baseline Process and candidate alternatives.

The unit costs for Direct Costs are based on the surface area, labor costs, material costs, and equipment costs. A brief description of the cost input parameters is provided in Table 3-1.

Table 3-1 Unit Cost Calculation Elements for Direct Costs

Item	*Assumption*
Equipment Costs	Equipment costs are included if there was a change in equipment required by the selected coating.
Material Costs	The material costs are based on the amount of material required for the coating activity. The material costs are based on the material required to meet manufacturer recommended coating thickness.
Work Load	A "job" shall be defined as a surface area of 5,000 square feet (sq ft).
Labor Hours	The number of worker hours required to perform the coating activity are calculated using the average coating application rate per worker. It is estimated that an average painter can apply 400 sq ft of a single coating layer per hour.
Labor Costs for Coating Activities	A labor rate of \$19.75 per hour plus \$8.50 in fringe benefits was used to determine a total labor rate of \$28.25. The labor rate was multiplied by 2.5 to represent a burdened labor rate of \$70.63 that includes the overhead costs associated with coating activities. The burdened labor rate was multiplied by the number of labor hours and the number of laborers to perform the coating operation to get the total labor costs for the coating activities.

3.1 Capital Costs

Capital costs are the capital equipment costs of the proposed technology. The Baseline Process was not evaluated for Capital Costs since new equipment is not required to be purchased. Current process equipment for priming and topcoating specifications are brush or airless, conventional pots, or pressure feed paint spray equipment. If spray equipment is used, a compressor is required.

All of the alternatives can use existing equipment except for System -9 which is a nano-waterborne coating and requires very low pressures. Too much pressure [more than 10 pounds per square inch at the spray gun tip] can:

- Semi-dry the product before it reaches the substrate. This creates a mix of wet and semi-dry materials that do not coalesce together and cure properly.
- Aerate the fluid. When the coating starts to cure, trapped air evacuates and distorts the molecules; they do not properly bond when disturbed this way.
- Leave an imperfect finish more prone to early breakdown from ultraviolet light and exposure.

Some high velocity low pressure (HVLP) spray guns can provide the correct atomization, but only if both the air and fluid is carefully regulated, which may require additional gauges to monitor the individual pressures. The manufacturer of System -9 recommends either an Accuspray HVLP or DUX Area, Inc., spray gun, which are estimated at $1,500.

3.2 Material Costs

The material costs for each system was calculated using information provided by the manufacturer. Data used included cost of material, coverage (how much material is required to obtain a certain coating thickness), and the manufacturer's recommended coating thickness.

Table 3-2 shows the price per sq ft of coverage for each system followed by the cost per "job".

NOTE: Assumptions include:

1. A "job" is 5,000 sq ft.
2. No thinners added.
3. No mixing or spraying waste.
4. All calculations based on 100% application efficiency.
5. Volume solids data from manufacturer's product data sheets.

Table 3-2 Material Costs per Coating System										
System	***Coating***	***Size***	***Price***	***Volume Solids (%)***	***1 mil Coverage (sq ft/ gallon)***	***Recommended millage***	***sq ft/ gallon***	***Cost/ sq ft***	***System Cost/ sq ft***	***System Cost/ Job***
1	Primer	1-gal	$45.20	91	1460	3	487	$0.09	$0.59	$2,963
	Intermediate	1-gal	$24.05	77	1235	3	412	$0.06		
	Topcoat	1-gal	$96.50	75	1203	5.5	219	$0.44		
2*	Primer	1-gal	$45.20	91	1460	3	487	$0.09	$0.33	$1,674
	Intermediate	1-gal	$24.05	77	1235	3	412	$0.06		
	Topcoat	1-gal	$51.50	70	1123	4	281	$0.18		
3	Primer	4-gal	$196.60	68	1091	4	273	$0.18	$0.56	$2,806
	Topcoat	1-gal	$110.00	90	1444	5	289	$0.38		
6	Primer	1-gal	$50.63	78	1251	3	417	$0.12	$0.74	$3,702
	Intermediate	1-gal	$28.61	82	1315	6	219	$0.13		
	Topcoat	1-gal	$119.12	76	1219	5	244	$0.49		
7	Primer	1-gal	$50.63	78	1251	3	417	$0.12	$0.56	$2,807
	Intermediate	1-gal	$28.61	82	1315	6	219	$0.13		
	Topcoat	1-gal	$119.12	72	1155	3	385	$0.31		
9	Primer	1-gal	$260.00	38	610	3	203	$1.28	$2.31	$11,525
	Topcoat	1-gal	$250.00	38	610	2.5	244	$1.03		
10	Primer	1-gal	$40.00	80	1283	3	428	$0.09	$0.43	$2,144
	Intermediate	1-gal	$19.13	77	1235	6	206	$0.09		
	Topcoat	1-gal	$42.75	55	882	5	176	$0.24		

* Control Coating System

3.3 Labor Costs

The most significant factor when considering labor costs is whether the system is a two-coating system or a three-coating system. Not requiring an intermediate coating will generally reduce the labor required by 1/3 as compared to the three-coating systems (which include the baseline systems). The labor for cleaning equipment between different coatings is included in the "Labor hours per Job".

Table 3-3 shows which systems are two-coating systems and which are three-coating systems.

Table 3-3 Identification of Two- and Three-Coating Systems

Two-Coating Systems	System 3
	System 9
Three-Coating Systems	System 1
	System 2*
	System 6
	System 7
	System 10

* Control Coating System

Figure 3-1 shows the process flow diagram for the Two-Coating Systems.

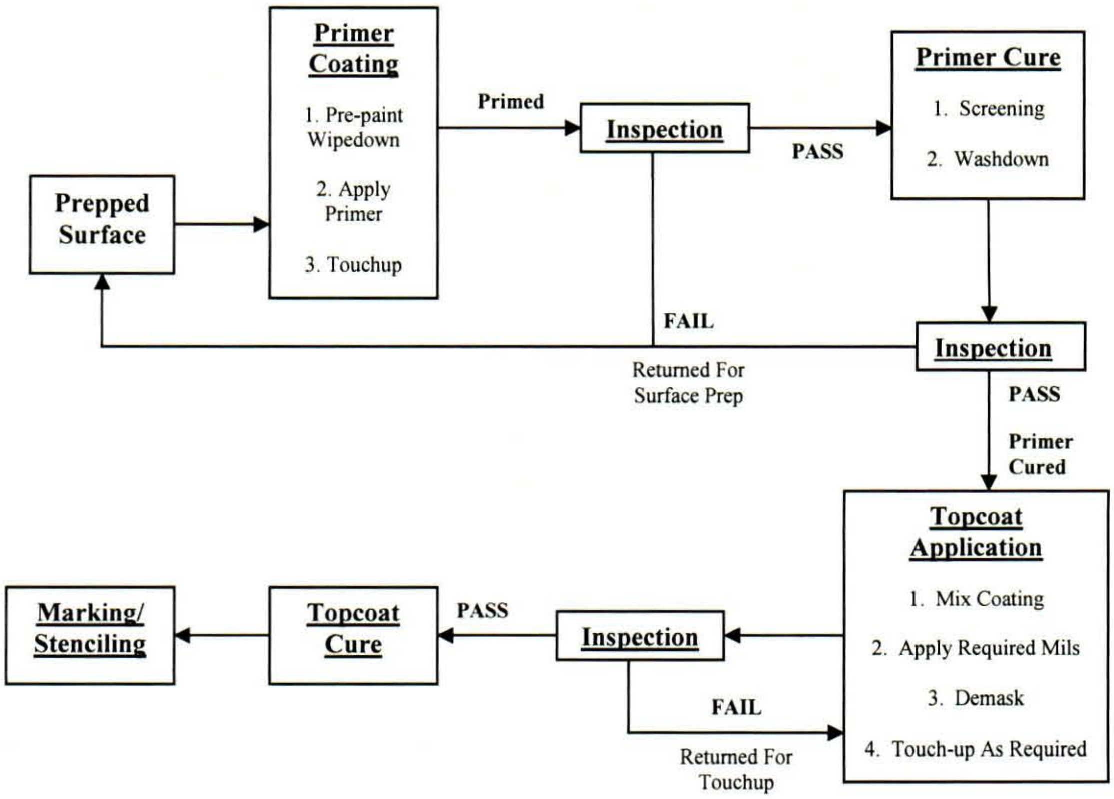

Figure 3-1 Process Flow Diagram for Two-Coating Systems

Figure 3-2 shows the process flow diagram for the Three-Coating Systems (including the Baseline process).

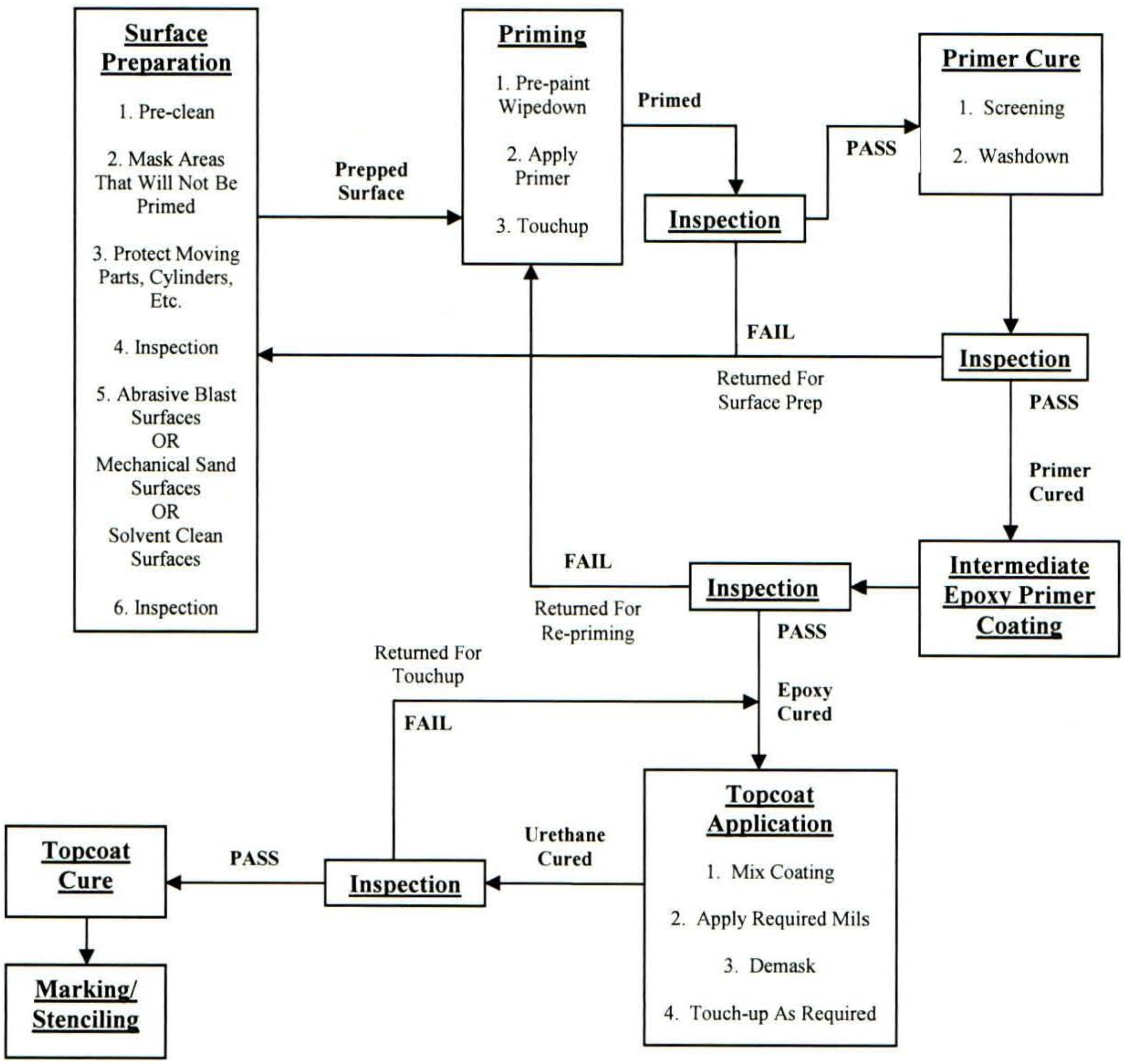

Figure 3-2 Process Flow Diagram for Three-Coating Systems

Table 3-4 shows the labor costs for each system.

Assumptions used are for the labor cost analysis are:

1. Surface Area to be coated = 5,000 sq ft
2. Labor costs = $70.63 / hour
3. Labor hours per coating layer = 400 sq ft/hour

Table 3-4 Labor Costs for Two- and Three-Coating Systems

<table>
<tr><th colspan="2">System</th><th>Total Sq Ft to be Coated</th><th>Labor Hours Required for Job</th><th>Total Labor Cost for Job</th></tr>
<tr><td rowspan="2">Two-Coating Systems</td><td>3</td><td rowspan="2">10,000 (Primer+ Topcoat)</td><td rowspan="2">25</td><td rowspan="2">$1,766</td></tr>
<tr><td>9</td></tr>
<tr><td rowspan="5">Three-Coating Systems</td><td>1</td><td rowspan="5">15,000 (Primer+ Intermediate+ Topcoat)</td><td rowspan="5">38</td><td rowspan="5">$2,684</td></tr>
<tr><td>2*</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>10</td></tr>
</table>

* Control Coating System

4.0 ENVIRONMENTAL ACTIVITY COSTS

The following subsections look at the Environmental Activity (EA) Costs associated with the baseline process and candidate alternatives. Each viable alternative was evaluated to determine the extent of its regulation under the major federal environmental laws. Based on the product MSDS, each alternative was evaluated using the following criteria:

- Air Emissions per Clean Air Act (CAA)
  - Volatile Organic Compounds (VOCs) measured in grams per liter (g/L)
  - Hazardous Air Pollutants (HAPs)
- Solid/Hazardous Waste Generation per Resource Conservation and Recovery Act (RCRA)
- Reporting requirements per Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA)
- Hazardous Substances per Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

Each viable alternative was also evaluated to determine concerns related to safety and occupational health issues. Not all product MSDS contained all of the categories listed below. Only those categories that applied for the specific product are listed on the product MSDS. Using the product MSDS, each alternative was evaluated using the following criteria: acute effects (short term), chronic effects (long term), inhalation, skin contact, and eye contact.

Table 4-1 provides a summary of the Environmental, Safety, and Occupational Health issues for each of the systems included in this analysis.

Table 4-1 Summary of ESOH Analysis of Alternatives

System	*Topcoat VOC[a] (g/L)*	*HAPs[a]*	*RCRA[a]*	*EPCRA[a]*	*CERCLA[a]*	*Ratings[b]*		
						Toxicity	*Exposure*	*Hazard*
1	275	0	0	0	0	M	M	M
2*	419	5	2	3	4	M	M-H	M-H
3	101	2	2	2	2	M	M	M
6	165	0	0	4	0	L	M	M-L
7	246	1	1	7	1	M-L	M	M
9	100	1	1	1	1	L	M	M-L
10	384	3	1	6	5	M-L	M-H	M

*Control Coating System

a. Number of reportable constituents that are listed on the MSDS for a particular coating.

b. L = Low M = Medium H = High (Scoring derived from data reflected in the MSDS)

Activities that differ from the baseline process and are included in this analysis are:

- Documentation maintenance.
- Permitting requirements.
- Reporting requirements.
- Amount of wastes.
- Hazardous waste manifest preparation and container labeling.
- Record-keeping associated with hazardous waste.

The unit costs for EA Costs are based on the surface area, labor costs, and material costs. The number of worker hours required to perform the environmental activity is based on information gathered. A brief description of the EA cost input parameters is provided in Table 4-2.

Table 4-2 Unit Cost Calculation Elements for EA Costs

Item	***Assumption***
Labor Costs Associated with Waste	A labor rate of \$24.75 per hour plus \$10.50 in fringe benefits was used to determine a total labor rate of \$35.25. The labor rate was multiplied by 2.5 to represent a burdened labor rate of \$88.13 that includes the overhead costs associated with EA activities. Cost associated with documentation maintenance, permitting requirements, and reporting requirements: Estimated to be 2 hours for each hazardous constituent found in the coating per Job. Cost associated with time to prepare Hazardous Waste (HW) manifest and label drums: Estimated to be 1 hour per drum. Cost associated with record-keeping of hazardous waste: Estimated to be 1 hour per drum.
Waste Disposal Costs	Cost of 55-gallon drum: \$50 per drum Cost of hazardous waste disposal: \$75 per drum

There are also very high fines associated with environmental violations. CAA violations are currently \$27,500/day. RCRA violations can be as large as \$25,000/day. Laws oftern carry both criminal and civil penalities along with negative public perception and connotations of the agency in question.

4.1 System -1 EA Costs

Based on the Process Flow Diagram and information gathered, Table 4-3 was created to quantify EA costs for System -1.

Assumptions used are:

1. Number of HAPs = 0
2. Number of RCRA, EPCRA, or CERLA substances = 0
3. No hazardous waste means that no 55-gallon drums are required.

Table 4-3 EA Costs for System -1

Resource	*Quantities Used*	*Cost Factors*	*Cost*
Labor (Documentation maintenance, permitting requirements, and reporting requirements)	0 hrs	$88.13 per hr	$0
Labor (HW manifest/labeling/ record-keeping)	0 hr	$88.13 per hr	$0
55-gal drums required	0 drum	$50.00 per drum	$0
Disposal of drums	0 drum	$75.00 per drum	$0
		Total EA Costs Per Job	**$0**

4.2 System -2 (Baseline) EA Costs

Based on the Process Flow Diagram and information gathered, Table 4-4 was created to quantify EA costs for System -2 (Baseline).

Assumptions used are:

1. Number of HAPs = 0
2. Number of hazardous waste constituents = 5
3. Waste in drums includes solvents for cleaning and contaminated rags, PPE, etc.
4. One "job" fills one 55-gallon drum.

Table 4-4 EA Costs for System -2

Resource	*Quantities Used*	*Cost Factors*	*Cost*
Labor (Documentation maintenance, permitting requirements, and reporting requirements)	10 hrs	\$88.13 per hr	\$881
Labor (HW manifest/labeling/ record-keeping)	2 hr	\$88.13 per hr	\$176
55-gal drums required	1 drum	\$50.00 per drum	\$50
Disposal of drums	1 drum	\$75.00 per drum	\$75
		Total EA Costs Per Job	**\$918**

4.3 System -3 EA Costs

Based on the Process Flow Diagram and information gathered, Table 4-5 was created to quantify EA costs for System -3.

Assumptions used are:

1. Number of HAPs = 2
2. Number of hazardous waste constituents = 2
3. Waste in drums includes solvents for cleaning and contaminated rags, PPE, etc.
4. One "job" fills one 55-gallon drum.

Table 4-5 EA Costs for System -3

Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (Documentation maintenance, permitting requirements, and reporting requirements)	8 hrs	$88.13 per hr	$705
Labor (HW manifest/labeling/ record-keeping)	2 hr	$88.13 per hr	$176
55-gal drums required	1 drum	$50.00 per drum	$50
Disposal of drums	1 drum	$75.00 per drum	$75
		Total EA Costs Per Job	**$1,006**

4.4 System -6 EA Costs

Based on the Process Flow Diagram and information gathered, Table 4-6 was created to quantify EA costs for System -6.

Assumptions used are:

1. Number of HAPs = 0
2. Number of hazardous waste constituents = 4
3. Waste in drums includes solvents for cleaning and contaminated rags, PPE, etc.
4. One "job" fills one 55-gallon drum.

Table 4-6 EA Costs for System -6

Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (Documentation maintenance, permitting requirements, and reporting requirements)	8 hrs	\$88.13 per hr	\$705
Labor (HW manifest/labeling/ record-keeping)	2 hr	\$88.13 per hr	\$176
55-gal drums required	1 drum	\$50.00 per drum	\$50
Disposal of drums	1 drum	\$75.00 per drum	\$75
		Total EA Costs Per Job	**\$1,006**

4.5 System -7 EA Costs

Based on the Process Flow Diagram and information gathered, Table 4-7 was created to quantify EA costs for System -7.

Assumptions used are:

1. Number of HAPs = 1
2. Number of hazardous waste constituents = 7
3. Waste in drums includes solvents for cleaning and contaminated rags, PPE, etc.
4. One "job" fills one 55-gallon drum.

Table 4-7 EA Costs for System -7

Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (Documentation maintenance, permitting requirements, and reporting requirements)	16 hrs	$88.13 per hr	$1410
Labor (HW manifest/labeling/ record-keeping)	2 hr	$88.13 per hr	$176
55-gal drums required	1 drum	$50.00 per drum	$50
Disposal of drums	1 drum	$75.00 per drum	$75
		Total EA Costs Per Job	**$1,711**

4.6 System -9 EA Costs

Based on the Process Flow Diagram and information gathered, Table 4-8 was created to quantify EA costs for System -9.

Assumptions used are:

1. Number of HAPs = 1
2. Number of hazardous waste constituents = 1
3. Waste in drums includes solvents for cleaning and contaminated rags, PPE, etc.
4. One "job" fills one 55-gallon drum.

Table 4-8 EA Costs for System -9

Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (Documentation maintenance, permitting requirements, and reporting requirements)	4 hrs	$88.13 per hr	$353
Labor (HW manifest/labeling/ record-keeping)	2 hr	$88.13 per hr	$88
55-gal drums required	1 drum	$50.00 per drum	$50
Disposal of drums	1 drum	$75.00 per drum	$75
		Total EA Costs Per Job	**$566**

4.7 System -10 EA Costs

Based on the Process Flow Diagram and information gathered, Table 4-9 was created to quantify EA costs for System -10.

Assumptions used are:

1. Number of HAPs = 3
2. Number of hazardous waste constituents = 6
3. Waste in drums includes solvents for cleaning and contaminated rags, PPE, etc.
4. One "job" fills one 55-gallon drum.

Table 4-9 EA Costs for System -10

Resource	*Quantities Used*	*Cost Factors*	*Cost*
Labor (Documentation maintenance, permitting requirements, and reporting requirements)	9 hrs	$88.13 per hr	$793
Labor (HW manifest/labeling/ record-keeping)	2 hr	$88.13 per hr	$176
55-gal drums required	1 drum	$50.00 per drum	$50
Disposal of drums	1 drum	$75.00 per drum	$75
		Total EA Costs Per Job	**$1,094**

4.8 Summary of EA Costs per Job

Table 4-10 provides a summary of the EA Costs for the Baseline and alternative coating systems.

Table 4-10 Summary of EA Costs per Job

System	*EA Costs*	*Difference from Baseline per Job*
1	$0	$1,183
2*	$1,183	NA
3	$1,006	$177
6	$1,006	$177
7	$1,711	($529)
9	$566	$617
10	$1,094	$88

* Control Coating System

(XXX) = Negative Number or that the alternative costs more than the Control System

5.0 CONCLUSIONS

For this project, five (5) alternatives met the basic performance requirements as compared to the Baseline systems. When considering the full implication of implementing alternatives, both Direct and EA Costs should be considered along with environmental benefits. Even though an alternative may have higher costs, that difference can sometimes be justified as required to comply with government regulations.

Table 5-1 summarizes the results for the material, labor, EA, and Capital Costs. None of the alternative systems have reduced costs when compared to the Control Coating System, although some show small cost differences per year. Environmental and health considerations may still make some of the alternatives more beneficial for certain locations despite increased costs.

Table 5-1 CBA Summary of Alternatives

	Direct Costs						EA Costs			Life Cycle Costs/Analysis		
Coating System	**Jobs per Year**	**Material Cost per Sq Ft**	**Material Cost per Year**	**Labor Costs per Year**	**Total Direct Costs per Year (Material + Labor)**	**Direct Cost Savings per Year**	**EA Costs per Job**	**Total EA Costs per Year**	**EA Cost Savings per Year**	**Total Costs per Year (Direct + EA)**	**Capital Costs (one-time cost)**	**Total Cost Savings per Year**
1	10	$0.59	$29,500	$28,360	**$57,860**	**($13,000)**	$0	**$0**	**$11,826**	**$57,860**	**$0**	**($1,174)**
2*	10	$0.33	$16,500	$28,360	**$44,860**	**$0**	$1,183	**$11,826**	**$0**	**$56,686**	**$0**	**$0**
3	10	$0.56	$28,000	$18,910	**$46,910**	**($2,050)**	$1,006	**$10,063**	**$1,763**	**$56,973**	**$0**	**($287)**
6	10	$0.74	$37,000	$28,360	**$65,360**	**($20,500)**	$1,006	**$10,060**	**$1,765**	**$75,420**	**$0**	**($18,735)**
7	10	$0.56	$28,000	$28,360	**$56,360**	**($11,500)**	$1,711	**$17,111**	**($5,285)**	**$73,471**	**$0**	**($16,785)**
9	10	$2.31	$115,500	$18,910	**$134,410**	**($89,550)**	$566	**$5,655**	**$6,170**	**$140,065**	**$1,500**	**($83,380)**
10	10	$0.43	$21,500	$28,360	**$49,860**	**($5,000)**	$1,094	**$10,942**	**$884**	**$60,802**	**$0**	**($4,116)**

* Control Coating System

(XXX) = Negative Number or that the alternative costs more than the Control System