



**John F. Kennedy Space Center
Engineering Directorate**

Materials Science Division

Computer-Aided Corrosion Program Management

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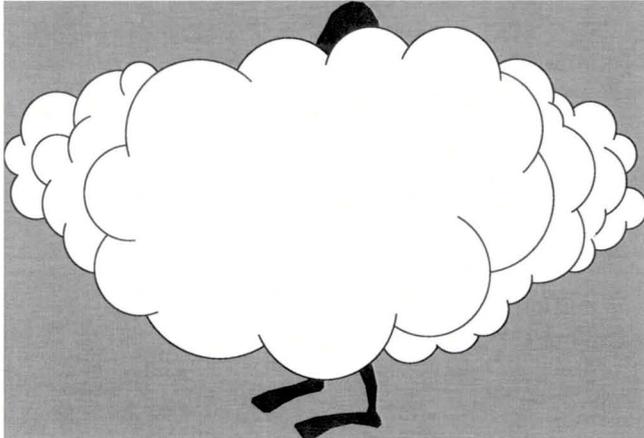
- Corrosion at the Kennedy Space Center (KSC)
- Requirements & Objectives
- Program Description, Background & History
- Approach & Implementation
- Challenges
- Lessons Learned
- Successes & Benefits
- Summary & Conclusions



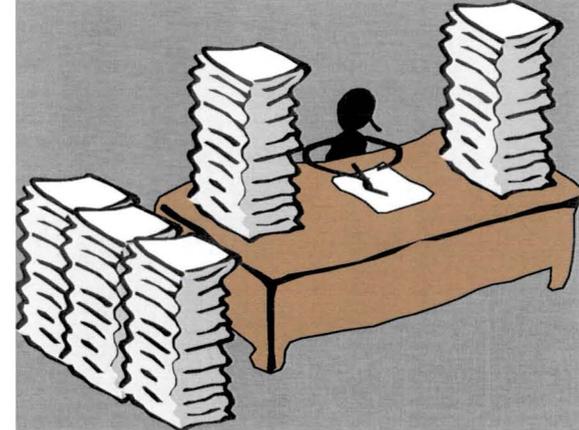
- KSC Corrosive Environment
 - Launch facilities within 1,000 ft. of Atlantic Ocean
 - Acidic exhaust from launch vehicles
 - Documented highest corrosion rate of any U.S. test site
- Importance of Protective Coatings
 - Primary means of protection for critical assets in atmospheric exposure
 - Key role in safety & reliability of facilities & equipment
 - Major factor (direct and indirect) driving maintenance costs
 - Large economic advantage from maximizing service life and reliability of facilities, launch structures, and ground support equipment



- Interdependent Program Elements
 - Accurate Assessment of Conditions
 - Understanding of Corrosive Environment
 - Knowledge-Based Standards
 - Requirement-Based Specifications
 - Qualified Materials
 - Trained and Qualified Personnel
 - Quality Control and Assurance
 - **Data Management (Information System)**



- Difficult to predict where corrosion will occur
- Dispersed throughout facility



- Paper Driven
- Voluminous Data



- Manage & better utilize large amounts of program data
- Increase visibility into corrosion program
- Store & access critical asset data
- Collect, analyze, report & track condition data
- Enable a more proactive approach to corrosion & coating related maintenance
- Create a centralized knowledge base for improved organizational memory
- Facilitate accurate planning & forecasting



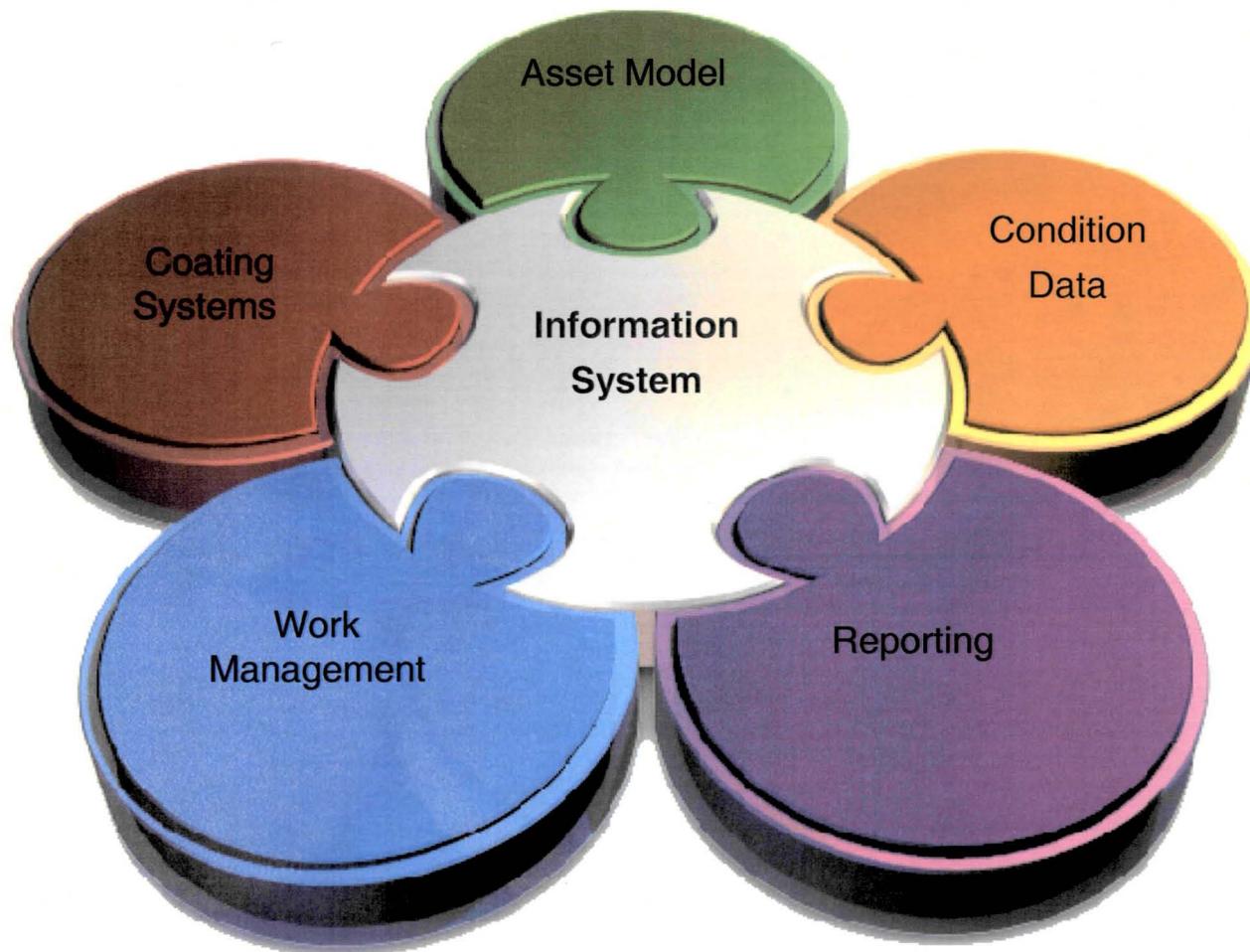
- Computer-aided program initiated in 2000 by United Space Alliance (USA) for Space Shuttle Program assets
- Program utilizes commercially available software (information system) developed specifically for coating program management
- Field inspection, data collection, data entry, software and reporting costs less than 4% of annual coating maintenance budget



- Started as a small pilot program and has grown to more than 3,600 critical components & 7,750,000 square feet of surface area
- Data collection team consists of two full-time NACE CIP inspectors who also enter data
- Program data and reports accessible to USA and NASA employees via computer network.
 - Currently more than 70 registered users



Program Approach





- Inventory & Organize Facilities Into Manageable Components
- Hierarchy
 - Level 1: Program
 - Level 2: Facility
 - Level 3: Item
 - Level 4: Component
- Components defined by change in substrate, system, service environment, color, etc.

The screenshot shows a software application window with a menu bar (File, View, Assets, Condition, Work, Systems, Reports, Tools, Admin, Spread, Help) and a toolbar. On the left is a 'Shortcuts' sidebar with icons for Program, Add Facility, Manage Facility, Add Items, Manage Items, Add Components, Manage Components, Condition Survey, and Condition Manager. The main area is split into two panes. The left pane shows a hierarchical tree structure under 'Accrete' with folders like 'Electrical Sub-Stations', 'Ground Support Equipment', 'Launch Complex 39A', and 'Fixed Service Structure (FSS)'. The right pane is a table with columns: Program, Administrator, Composit, Adjusted, Area, and Facilitie. The table contains data for various facilities and their associated programs and administrators.

Program	Administrator	Composit	Adjusted	Area	Facilitie
Electrical Sub-Stations		3.858	3.804	9387.0	4
Ground Support Equipment	Dennis Crocker	5.000	5.000	13928.0	5
Hangar AF Complex		4.373	4.302	48769.8	11
Hangar N		4.765	4.765	689.0	1
HMF Area		4.111	4.023	17407.3	2
Launch Complex 39A	John H. Jones	4.610	4.545	1377780.6	4
Launch Complex 39B	John H. Jones	3.888	3.796	1415919.3	4
Main Flame Deflectors		4.358	4.259	89732.9	2
Misc. Facilities		4.399	4.342	9081.0	2
Mobile Launcher Platforms	Dennis Crocker	4.275	4.204	388602.0	3
Orbiter Processing Facility	Dennis Crocker	3.588	3.485	185862.0	2
Pump Stations	Dennis Crocker	4.006	3.953	136554.0	4
Shuttle Landing Facility	John H. Jones	4.065	3.986	137675.0	4
Solid Rocket Refurbishment	Dennis Crocker	4.847	4.842	184389.0	6
Towers	Dennis Crocker	4.350	4.292	16652.0	3
Transporters	Dennis Crocker	3.885	3.803	303365.0	3
Vehicle Assembly Building	John H. Jones	4.530	4.519	1346254.8	14



The screenshot displays the 'Component Data' software interface. At the top, a menu bar includes File, View, Assets, Condition, Work, Systems, Reports, Tools, Admin, Spread, and Help. Below the menu is a toolbar with various icons. A 'Shortcuts' sidebar on the left lists actions like Program, Add Facility, Manage Facility, Add Items, Manage Items, Add Components, Manage Components, Condition Survey, and Condition Manager. The main window features a table with columns: Program, Administrator, Composit, Adjusted, Area, and Facilitie. The table contains data for 'Electrical Sub-Stations' and 'Structural Steel'. A 'Component Manager' dialog box is open, showing 'Component Data' for 'Structural Steel' with fields for PROGRAM (Launch Complex 39A), FACILITY (Fixed Service Structure 1), and ITEM (135 Level). The 'Component Data' section includes fields for NAME, TYPE, SUBSTRATE, SURF. AREA, Stripe Length (R), Width (R), CRITICALITY, View, Location, Input Date, Dwg. Sections, and Custom1-6. A 'Notes' field is also present. On the right, a list of components is shown, with 'Structural Steel' selected. Below the list is a 'Picture' field containing an image of a structural steel component. At the bottom, there are buttons for 'OK', 'Cancel', 'Apply', 'Delete Record', and 'NUM'. The Windows taskbar at the bottom shows the Start button, several open applications, and the system clock at 9:04 AM.

Program	Administrator	Composit	Adjusted	Area	Facilitie
Electrical Sub-Stations		3 858	3 804	9387 0	4
				0	5
				8	11
				3	2
				80.64	
				19.34	
				9	2
				0	2
				2.0	3
				2.0	2
				4.0	4
				5.0	4
				9.0	6
				0	3
				5.0	3
				54.8	14

Component Data

PROGRAM: Launch Complex 39A FACILITY: Fixed Service Structure 1 ITEM: 135 Level

NAME: Structural Steel TYPE: Structure Support SUBSTRATE: Carbon Steel SURF. AREA: 11294.0 Stripe Length (R): .0 Width (R): .0 CRITICALITY: Level 2 View: Visible Location: Input Date: 07/19/2000

Dwg. Sections: Custom1: Custom2: Custom3: Custom4: Custom5: Custom6: Finish:

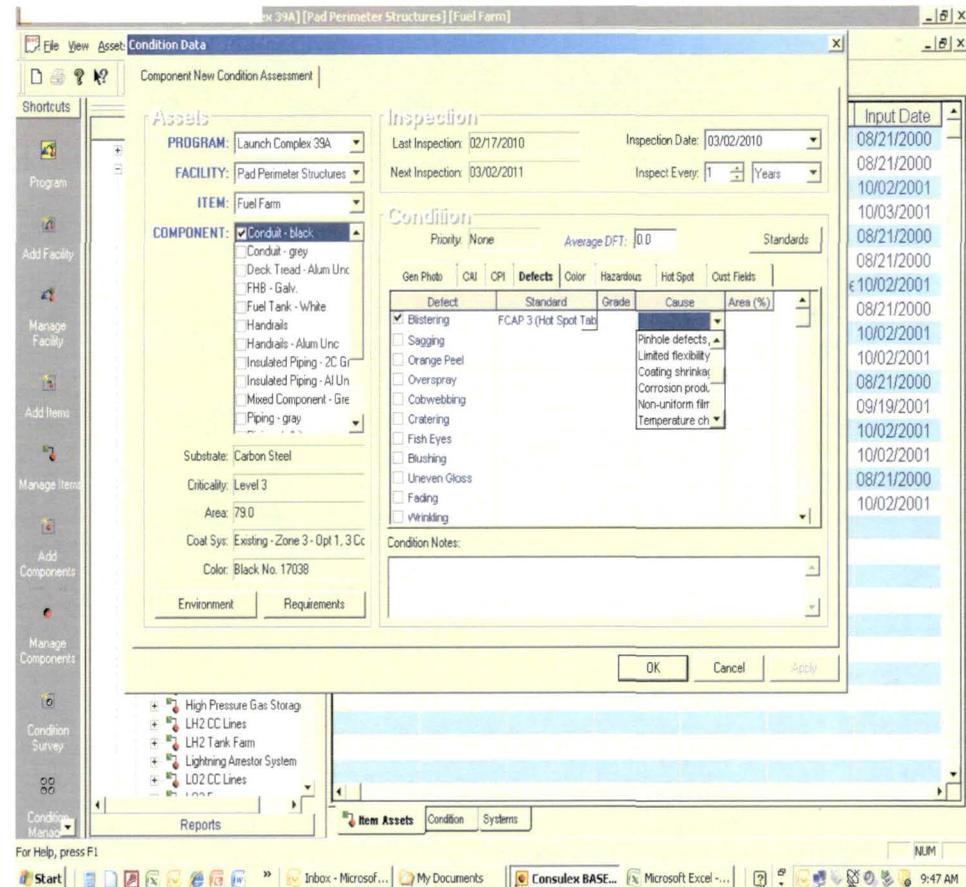
Notes:

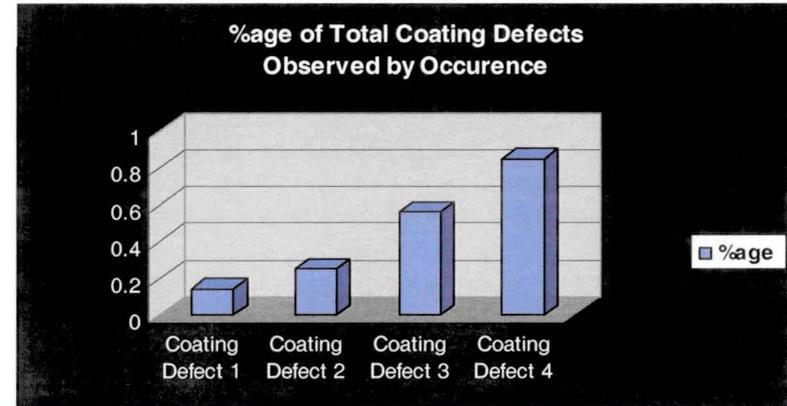
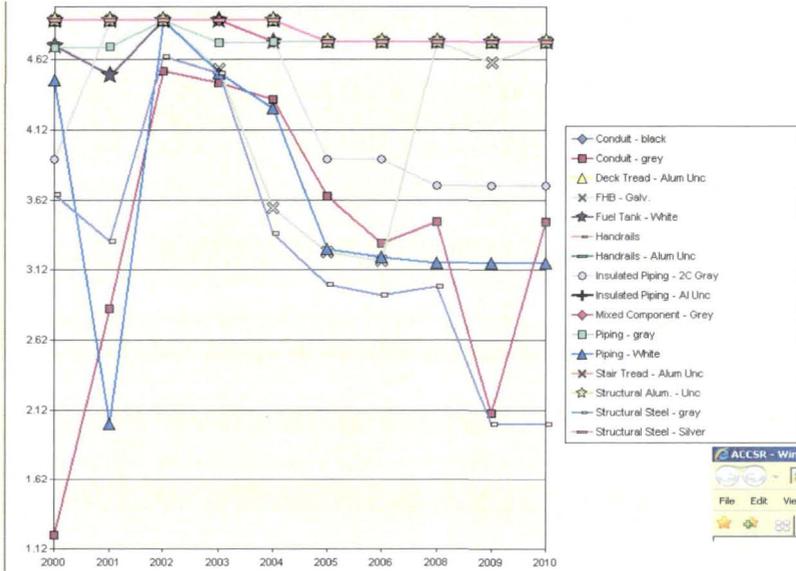
Conduit
Deck tread
Ducting
Fire hose box
Handrail
Mixed components -1
Mixed Components 1-Yellow
Mixed components -2
Piping
Stair tread
Structural Steel

File Clear
Picture Video Sound
Delete Record



- Coating Performance Index
- Coating Appearance Index
- Condition Data Points
 - Defects and Cause
- Photos
- Video





- Trending
- Custom Reports
- Export Data

ACCSR - Windows Internet Explorer

Annual Corrosion Control Survey Report
Launch Complex 39A
Pad Perimeter Structures
Fuel Farm

Components & General Condition Notes:		Component Data:						
Component	Notes	Component	Type	Substrate	Criticality	Surface Area in Sq. Ft.	Zone of Exposure and Coating System	Install Date of Coating System
Conduit - black	FCAP 5 with no corrosion observed	Conduit - black	Electrical Conduit	Carbon Steel	Level 3	79	Existing - Zone 3 - Oct 1, 3 Coat	01-01-1991
Conduit - grey	Overall FCAP 3 with a 2 and a pair of 1s noted	Conduit - grey	Electrical Conduit	Carbon Steel	Level 3	102	Existing - Zone 3 - Oct 1, 3 Coat	01-01-1991
Deck Tread - Alum Unc	FCAP 5 with no corrosion noted	Deck Tread - Alum Unc	Suspended Walkways	Aluminum	Level 3	302	Existing - No Coating	01-01-1991
FHB - Galv.	FCAP 5 with no additional Hot Spots observed	FHB - Galv.	Hose Reel Box	Galvanized Steel	Level 3	18	Existing - No Coating	01-01-1991
Fuel Tank - White	FCAP 5 with no Hot Spots noted	Fuel Tank - White	Fuel Tank	Stainless Steel	Level 3	1271	Existing - Zone 3 - Oct 4, 2 Coat	01-01-1991
Handrails	FCAP 5 with no corrosion noted	Handrails	Fall Protection	Carbon Steel	Level 3	308	Existing - Zone 3 - Oct 1, 3 Coat	01-01-1991
Handrails - Alum Unc	FCAP 5 with no corrosion observed	Handrails - Alum Unc	Fall Protection	Aluminum	Level 3	38	Existing - No Coating	01-01-1991
Insulated Piping - 2C Gray	Overall FCAP 4 with an additional 1 noted	Insulated Piping - 2C Gray	Fluid Piping	Aluminum	Level 3	111	Existing - Zone 3 - Oct 4, 2 Coat	01-01-1991
Insulated Piping - Al Unc	FCAP 5 with no noted Hot Spots	Insulated Piping - Al Unc	Fluid Piping	Aluminum	Level 3	117	Existing - Zone 3 - Oct 4, 2 Coat	01-01-1991
Mixed Component - Grey	FCAP 5 with no corrosion noted	Mixed Component - Grey	Mechanical Panel	Carbon Steel	Level 3	294	Existing - Zone 3 - Oct 4, 2 Coat	01-01-1991
Piping - grey	FCAP 5 with no Hot Spots noted	Piping - grey	Fluid Piping	Carbon Steel	Level 3	1197	Existing - Zone 3 - Oct 4, 2 Coat	01-01-1991
Piping - White	Overall FCAP 4 with a 1 and a 4 noted	Piping - White	Fluid Piping	Stainless Steel	Level 3	70	Existing - Zone 3 - Oct 4, 2 Coat	01-01-1991
Stair Tread - Alum Unc	FCAP 5 with no corrosion observed	Stair Tread - Alum Unc	Suspended Walkways	Aluminum	Level 3	703	Existing - Zone 3 - Oct 4, 2 Coat	01-01-1991
Structural Alum - Unc	FCAP 5 with no corrosion observed	Structural Alum - Unc	Structure Support	Aluminum	Level 3	108	Existing - Zone 3 - Oct 4, 2 Coat	01-01-1991
Structural Steel - grey	Overall FCAP 3 with additional 2s and 3s noted	Structural Steel - grey	Structure Support	Carbon Steel	Level 3	1261	Existing - Zone 3 - Oct 4, 2 Coat	01-01-1991
Structural Steel - Silver	FCAP 5 with no corrosion observed							



- Three Levels of Work Planning

- “Hot Spot” Disposition & Tracking

- Annual Plans

- Multiple Projects Within Plans

- Budget Estimate (Present Value & Future Value)

- Long Range Forecast

Annual Maintenance Plan

PLAN: VAB Cranes PROJECT: VAB Cranes Yr: 0 Int(%): .00 Int(%): .00

PROGRAM: Vehicle Assembly Building Ar FACILITY: Overhead Cranes ITEM: 250 Ton Crane #2 HB 3

Sel Rec	Maint Action	% Rpr	Component	Cr	Pr	Coating System	Coat Sys Install Dt	sq ft
<input checked="" type="checkbox"/>	Replace	0.0	Conduit	3	None	Replace - Zone 4c - Opt 1, 3 (04/23/2004	04/23/2004	1869.0
<input checked="" type="checkbox"/>	Replace	0.0	Deck Tread	3	None	Replace - Zone 4c - Opt 1, 3 (04/23/2004	04/23/2004	2726.0
<input checked="" type="checkbox"/>	Replace	0.0	Handrail - Aluminum	3	None		04/23/2004	252.0
<input checked="" type="checkbox"/>	Replace	0.0	Handrail - Yellow	3	None	Replace - Zone 4c - Opt 1, 3 (04/23/2004	04/23/2004	1464.0
<input checked="" type="checkbox"/>	Replace	0.0	Mixed Components - 1	3	None	Replace - Zone 4c - Opt 1, 3 (04/23/2004	04/23/2004	2362.0
<input checked="" type="checkbox"/>	Replace	0.0	Structural Steel	3	None	Replace - Zone 4c - Opt 1, 3 (04/23/2004	04/23/2004	26168.0

Select All - Repair 50% Select All - Re-coat Select All - Replace De-select All

Coating Material Cost	Surf Prep Material Cost	Coat Apply Hrs	Surf Prep Apply Hrs	Item Total
\$17986.28	\$27325.31	\$1867.81	\$1383.56	\$20788.09
Labor Rt - Apply Coat	Labor Rt - Apply Surf Prep	Coat Apply \$	Surf Prep Apply \$	
\$50.00	\$50.00	\$33390.50	\$69178.00	\$20788.09

Coating Material Cost	Surf Prep Material Cost	Coat Apply Hrs	Surf Prep Apply Hrs	Project Total
\$43018.56	\$65355.12	\$4467.32	\$3309.12	\$497195.69
Coat Apply \$	\$223366.00	Surf Prep Apply \$	\$165456.00	

Coating Material Cost	Surf Prep Material Cost	Coat Apply Hrs	Surf Prep Apply Hrs	Plan Total
\$43018.56	\$65355.12	4467.32	3309.12	\$497195.68
Coat Apply \$	\$223366.00	Surf Prep Apply \$	\$165456.00	

Input Date: 08/21/2000, 08/21/2000, 10/02/2001, 10/03/2001, 08/21/2000, 08/21/2000, 10/02/2001, 08/21/2000, 10/02/2001, 10/02/2001, 08/21/2000, 09/19/2001, 10/02/2001, 10/02/2001, 08/21/2000, 10/02/2001



- Manage systems as an asset as opposed to a commodity
- Focus on Life Cycle costs
- Elements
 - Materials
 - Application Method
 - Surface Prep

Coating System Manager - Materials

Coating Material	Coating Labor
Inorganic Zinc	\$/sq ft: 0.1700 hrs/sq ft: 0.0180

Surf Prep Material	Surf Prep Labor
Conventional Spray (Two Pack)	\$/sq ft: 0.7900 hrs/sq ft: 0.0400

Coating System Manager - Service Life

Select Coating System

None

Repair: Repair - Zone 1 - Opt 1, Zinc Only

Recoat

Replace

% Repair: 0

Year	Action	Coating System	% Repair
3	None		0.00
4	Repair	Repair - Zone 1 - Opt 1, Zinc Only	30.00
5	None		0.00
6	None		0.00
7	Re-coat	Recoat - Zone 3 - Opt 1, 3 Coat	0.00
8	None		0.00
9	None		0.00
10	Replace	Existing - Zone 1 - Opt 1, Zinc Only	0.00



- Consistent method of rating conditions using multiple inspectors
 - Create and use well defined (ideally visual) rating standards for consistency
- Uniform application of Asset breakdown
 - Determining the “right” amount of detail
 - “Bottom up” hierarchy based on grouping of components



- Increased focus on critical assets and environments
- Improved accuracy of budget requirements needed to maintain required standards of performance
- Optimal use of available funds (prioritization)
- Dramatically increased data collection efficiency
 - Inspection cycle frequency adjusted according to component criticality and corrosive environment
 - Reduced level of data collection (only changes after baseline)
- Reduction of Foreign Object Damage (FOD)
- Performance can be measured & improved
- Overall facility conditions have greatly improved



- Informed decisions are better decisions
- An “information system” (made possible by software) can be a critical success factor in a large corrosion/coating program
- Added value and cost savings easily justify expense of implementation of a program information system