

# **DoD Maintenance Symposium**

## ***DoD Corrosion Prevention and Control Program Overview and Cost of Corrosion***

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# Purpose

Provide an overview of the DoD Corrosion program with emphasis on the cost of corrosion methodology and application of study data to the NAVSEA community



# Outline

- DoD Corrosion Organization Restructured
- Corrosion DODI (5000.67) Implemented
- First Cycle of Cost of Corrosion Baseline Study Nearly Complete
- New Initiative to Establish Corrosion Availability Metrics
- FY09 S&T Project Selection
- Education and Outreach
- Future Activities
- Cost of Corrosion Methodology
- NAVSEA Application of Study



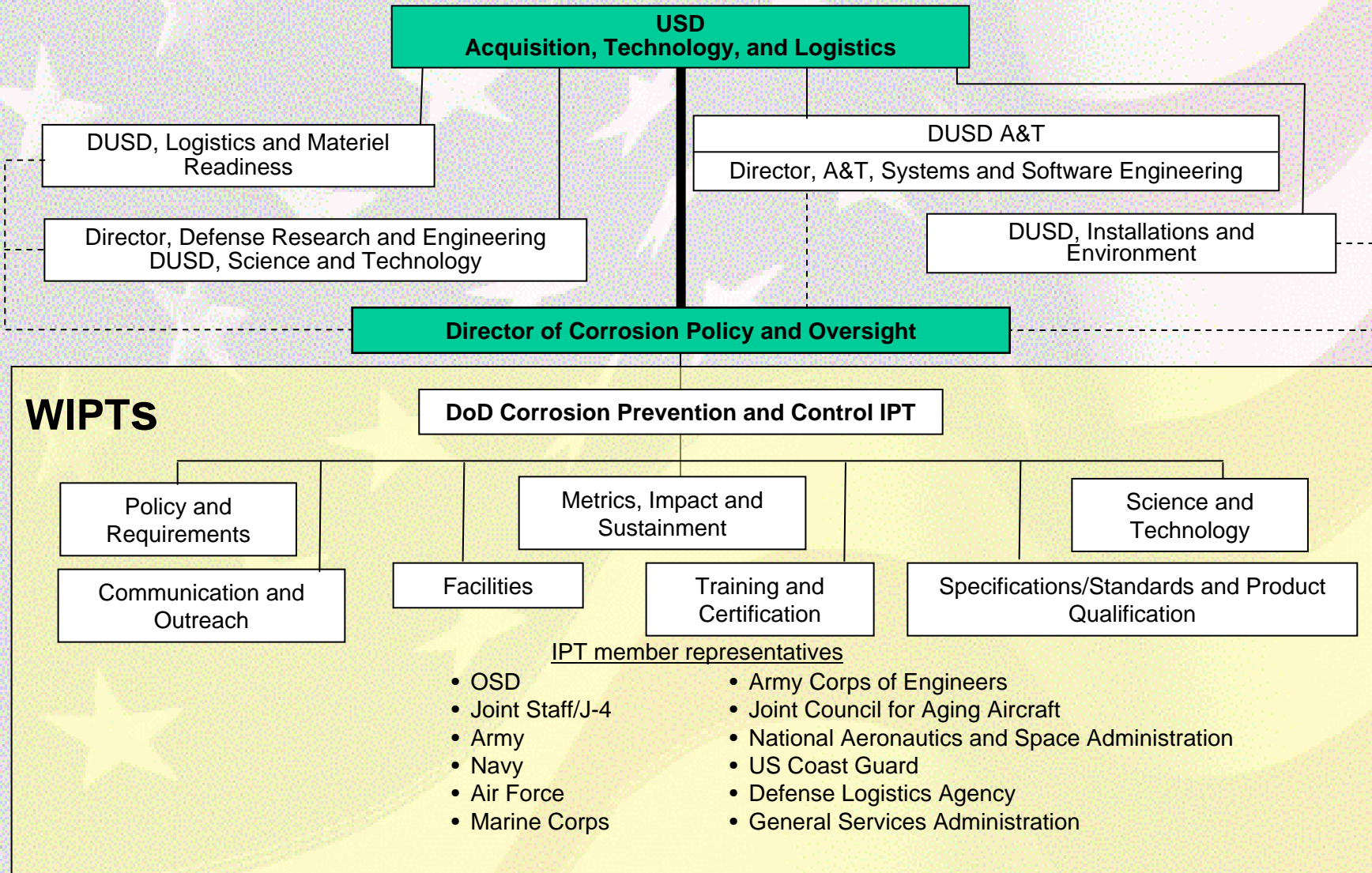
# Recently Revised Law and Organization

- Retains the basic requirements of 10 USC 2228
  - Expand emphasis on corrosion prevention & mitigation
  - Uniformly apply testing and certification for new technologies
  - Collect and share information on corrosion
  - Establish a coordinated R&D program with transition plans

**Include policy guidance & assessment of resources**
- FY08 NDAA changes
  - Eliminates DoD Corrosion Executive
  - Elevates SA/CPO to Director CPO
  - Assigns Corrosion Executive duties to DCPO
  - DCPO becomes direct report to USD(AT&L)
  - Requires annual financial reporting
  - Codifies ongoing CPO activities
- FY09 NDAA changes
  - Assign Service Corrosion Prevention and Control Executives
  - One-time report on inserting corrosion planning into the requirements generation process



# DoD Corrosion Organization



# Strategies and Directions

- **Overarching strategy:** transcend traditional control methods, organizations, management and funding
- **Attack corrosion early** in construction or acquisition  
**Focus life-cycle efforts on four primary areas**
  - Materials and processes that **prevent or reduce corrosion**
  - **Detection** and prognosis of corrosion
  - Coatings, treatments and other **applications to prevent, arrest or retard corrosion**
  - **Repair processes** that restore materials to an acceptable level of integrity and functionality
- Publish policy and strategy **direction and guidance**
- Promote **international cooperative efforts**



# DOD Instruction 5000.67

## *“Prevention and Mitigation of Corrosion on DoD Military Equipment and Infrastructure”*

- Implements policy – assigns responsibilities – prescribes procedures
- Designates a DoD Corrosion Executive (now Director)
- Establishes DoD policy that requires:
  - Acquisition strategies for corrosion prevention & control
  - CPC programs to be implemented throughout life cycle
  - CPC reporting for data collection, archiving, and feedback.
- Requires DoD Component Heads to:
  - Designate a POC for oversight of corrosion matters
  - Establish corrosion planning review & evaluation
- **Being updated to reflect FY08 and FY09 NDAA**



# Using Corrosion Baseline Study to Attack Corrosion Costs

- Focusing on the top 10 corrosion cost drivers for each model/design/series weapon system
- Determining the optimum blend of preventive and corrective corrosion maintenance
- Identifying and assessing cross-Service or cross-platform issues (e.g., rotary wing corrosion issues across all of the Services)
- Selecting corrosion projects
- Influencing Science and Technology efforts



# Cost of Corrosion: Maintenance Cost Estimates

Year	Study area	Annual Corr. Costs	% of Maint. Costs
2004/05	Air Force (USAF funded, USAF methodology)	\$1.5B	UNK
2005/06	Army ground vehicles	\$2.0B	14.8%
2005/06	Navy ships	\$2.4B	19.8%
2006/07	DoD facilities	\$1.8B	15.1%
2006/07	Army aviation and missiles	\$1.6B	18.6%
2006/07	USMC ground vehicles	\$0.7B	20.8%
2007/08	Navy aviation, USMC aviation,	\$3.0B	31.5%
2007/08	USCG aviation and USCG ships	\$0.3B	27.6%
2008/09	Air Force aviation, Navy ships & Army ground	TBD	TBD

# Impact of Corrosion on Availability

- GAO observation – availability (readiness) metrics needed
- Objective: develop metric for assessing impact of corrosion on system availability.
- Metrics, Impact and Sustainment WIPT responsible – currently developing metric(s)



# History of Projects and Activities

- 342 project plans submitted in 5 year period
- 124 projects selected
- \$128 million spent on projects and activities
  - Service project funding - \$51.1 million
  - OSD project funding - \$47.1 million
  - Activities funding - \$30 million
- Combined return on investment
  - Life cycle cost avoidance - \$4.46 billion
  - ROI: ~ 43:1



# Education and Outreach

- Education and training
  - Corrosion Engineering Degree at University of Akron
  - Virtual corrosion simulation & gaming video
- Education productions
  - 3 + training videos: public information and continuous learning
  - 4 podcasts
  - 1 webcast
  - 1 CPAT
- Outreach and culture change
  - 2009 DoD Corrosion Conference in DC in August
  - Implement Phase 3 of supplier online product qualification process
- International Initiatives
  - Australasia, UK, France, Germany cooperative efforts
  - Australasian Conference and World Congress on Corrosion



# CorrDefense Web Site

[www.corrdefense.org](http://www.corrdefense.org)



**Latest issue of CorrDefense magazine now on Web**



# Corrosion Policy and Oversight Office

## Future Activities

- Continue to publish CorrDefense tri-annual epublication
- Continue cost-of-corrosion baseline studies
- Complete Specs & Standards assessment and implement qualification process
- Fully implement Corrosion DoD Instruction
- Complete acquisition workforce corrosion training video
- Complete corrosion education simulation game in cooperation with Defense Acquisition University
- Certify and launch [www.CorrDefense.gov](http://www.CorrDefense.gov) website
- Promote added international cooperative efforts
- DoD Corrosion Conference – August 2009 featuring Kay Granger as keynote speaker and Congressional Staff panel



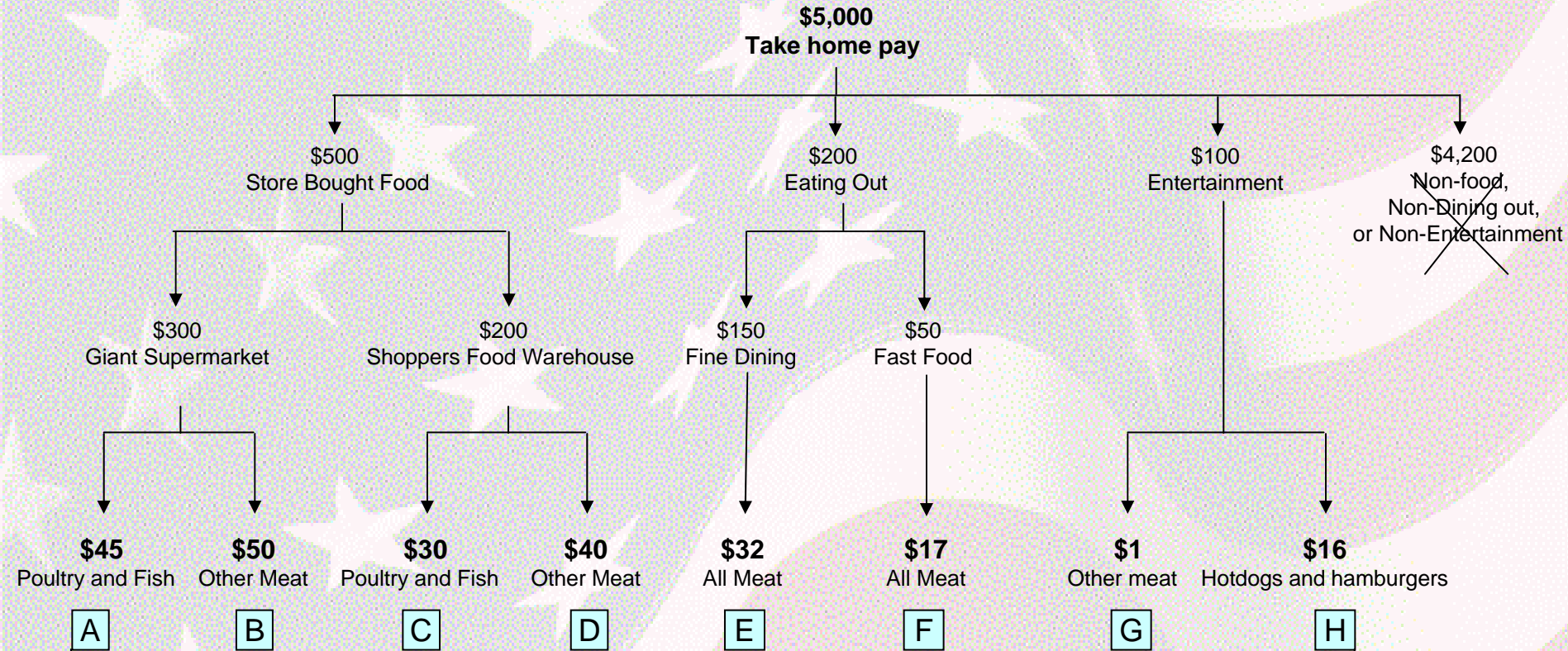
# Cost of Corrosion Methodology Outline

- Background
- Top down and bottom up approach
- Cost trees
- Navy study results
- Data conversion process
- Data structure
- Slice and dice



# Combined Top-down/Bottom-up Methodology

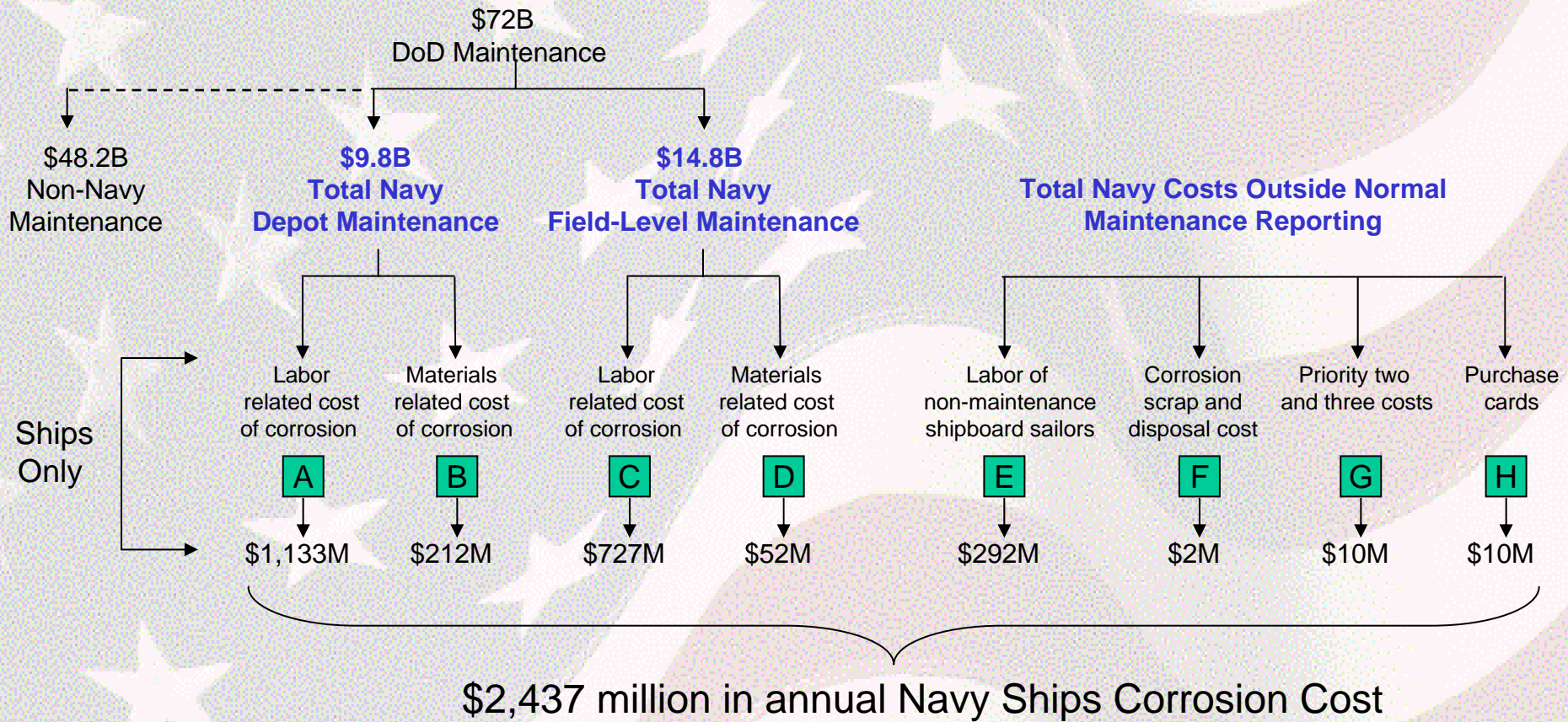
(Example – Determining Monthly Expenses for Meat)



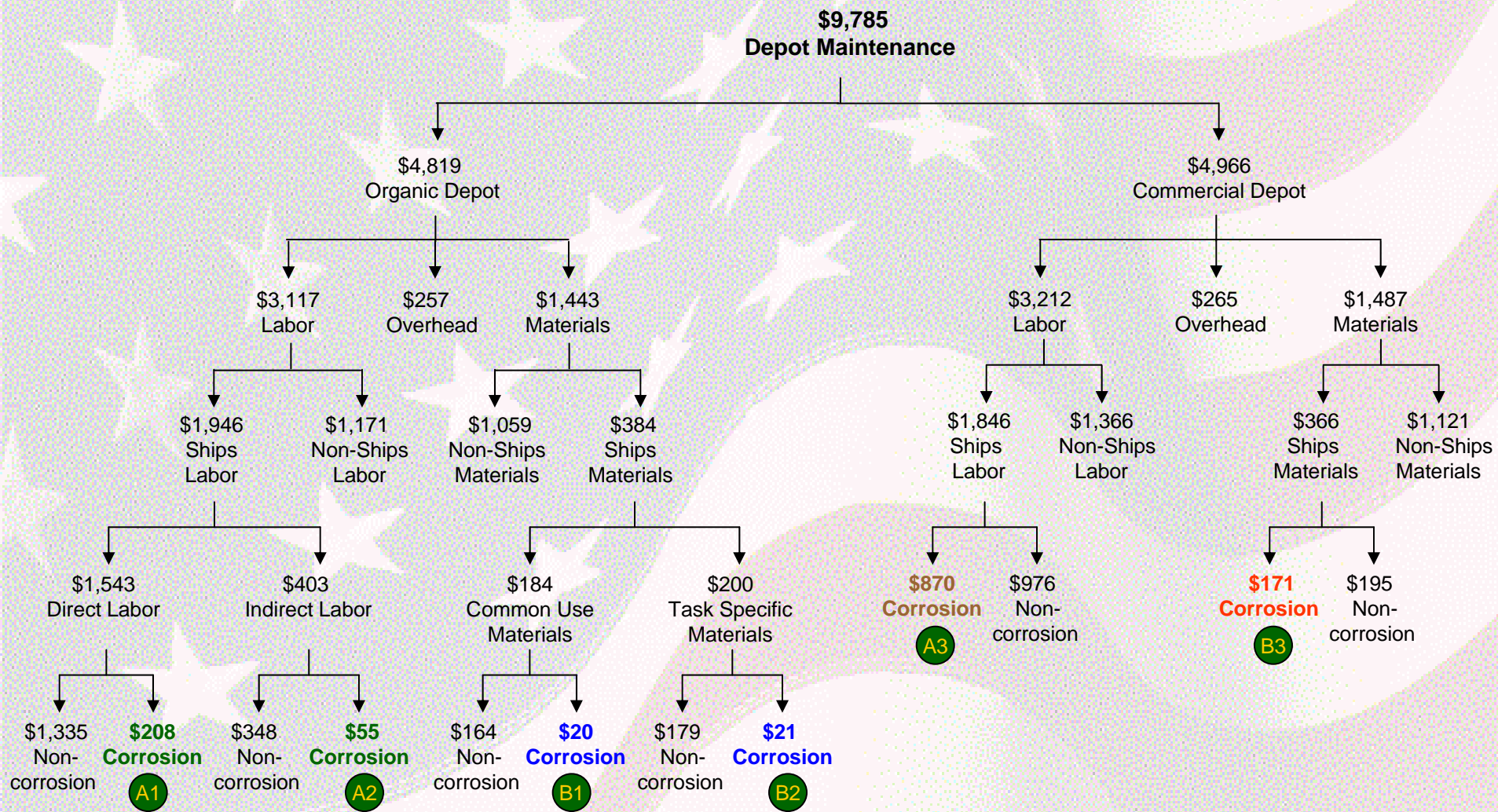
Must use detailed receipts (grocery, restaurant, entertainment) to determine meat expenses



# Cost Tree – Navy Ships



# Navy Depot Sustainment Corrosion Cost Tree (FY2004)



# Data Conversion - Navy

Main <b>Depot</b> Data Sources		Main <b>Field-Level</b> Data Sources		Main <b>"Outside Normal Reporting"</b> Data Sources	
	Data Value		Data Value		Data Value
DMOIR	Top-Down	DDMC	Top-Down	Survey	Top-Down
50-50 Reporting	Top-Down	VAMOSC	Bottom-up	DDMC	Top-Down
DDMC	Top-Down	<b>3M/OARS</b>	<b>Bottom-Up</b>	Purchase Card Records	Bottom-Up
SYMIS/AIM	Bottom-Up	Haystack	Bottom-up	DRMO	Bottom-Up
NMD	Bottom-Up			HAZMAT Centers	Bottom-Up
MRS	Bottom-Up				
VAMOSC	Bottom-Up				
CCIMS	Bottom-Up				



# Data Conversion - Navy

MAINT_L LEVEL	SHIP_CATEGORY	SHIP_HULL	3DIGIT_WBS	WBS	JOB_ORDER_NUM	FAULT_DESCRIPTION	NATURE_OF_COST	TOT_MAINT_ COSTS	TOT_CORR_ COSTS	STRUCTURE	PART
FIELD LEVEL	Amphibious	LCC 20			20001DA01P163	REPLACE PRC DECK COVERING	OTHER	\$418.45			
FIELD LEVEL	Amphibious	LCC 20			20001DA01Z006	MASTS - INSP	PREVENTIVE	\$418.45	\$139.34		
FIELD LEVEL	Amphibious	LCC 20	665	66511	20001DA020242	WORN NYLON NETS	OTHER	\$4,572.29			
FIELD LEVEL	Amphibious	LCC 20	665	66511	20001DA020243	DETERIORATED VENT DUCTING	CORRECTIVE	\$418.45	\$418.45	YES	
FIELD LEVEL	Amphibious	LCC 20	634	63411	20001DA020244	WORN NON-SKID	CORRECTIVE	\$418.45	\$418.45	YES	
FIELD LEVEL	Amphibious	LCC 20	074	07400	20001DA020245	DETERIORATED STUFFING TUBES	CORRECTIVE	\$2,908.71	\$2,908.71		
FIELD LEVEL	Amphibious	LCC 20	654	65400	20001NN011939	RUSTED HAND RAILS ON O-3 LEVEL	CORRECTIVE	\$1,297.57	\$1,297.57	YES	
FIELD LEVEL	Amphibious	LCC 20	665	66511	20001DA020250	VENT SCREENS DETERIORATED	CORRECTIVE	\$418.45	\$418.45	YES	
FIELD LEVEL	Amphibious	LCC 20	511	51111	20001EA014031	6-52-4-A INSTALL ISOLATION VLV	OTHER	\$622.57			YES
FIELD LEVEL	Amphibious	LCC 20			20001DA01Z002	7-40-1-J CLEAN & GAS FREE	PREVENTIVE	\$418.45	\$418.45		
FIELD LEVEL	Amphibious	LCC 20	654	65400	20001DA013168	REFURBISH FANROOM 1-38-2-Q	OTHER	\$1,245.13			
FIELD LEVEL	Amphibious	LCC 20	167	16711	20001DA01P151	QAWTS 1-73-2 WORN HARDWARE	OTHER	\$622.57		YES	

ship_type _hull	uic	jc	issue_date	niin	quantity	unit_price	total_price
LCC 20	20001	20001NN011939	07-Jul-04	002785350	609	0.65	395.85

Corrosion Materials Cost Information



# Data Structure

Ship 256 Age 27 years		Cost	Percent of total			
Ship 125 Age 5 years		Cost	Percent of total			
Ship 001 Age 12 years		Cost	Percent of total	Labor	Materials	ESWBS
Corrective corrosion costs						
Preventive corrosion costs						
Depot maintenance corrosion costs						
Field maintenance corrosion costs						
Outside normal reporting costs						
Structure direct corrosion costs						
Parts direct corrosion costs						

256 Ships



# Navy Ships Corrosion Cost by ESWBS

(Top Ten Cost (\$) - FY04)

	ESWBS	Corrosion Cost	Maintenance Cost	Corrosion %
Tanks & Voids	123	\$203,146,416	\$210,708,199	96.4%
Bilges – Clean and Gasfree	992	\$181,810,026	\$330,092,392	55.1%
Painting	631	\$166,251,278	\$167,417,374	99.3%
Drydock	863	\$148,846,602	\$470,851,745	31.6%
Deck Covering	634	\$103,140,394	\$106,784,609	96.6%
Care & Preservation	993	\$60,317,739	\$61,074,983	98.8%
Intakes and Blowers	251	\$56,523,009	\$115,474,991	48.9%
Hull Decks	130	\$55,368,476	\$123,135,319	45.0%
Masts, Kingposts & Service Platforms	176	\$38,763,458	\$41,919,354	92.5%
Pollution Control Systems	593	\$33,833,215	\$98,171,978	34.5%



# Navy Depot Ships Corrosion Cost

(\$millions FY04)

44.4%

Maintenance Provider	Total Ships Materials Cost	Total Ships Labor Cost	Total Ships Overhead Cost	Total Ships Depot Cost	Corrosion Materials Cost	Corrosion Labor Cost	Corrosion Maintenance Cost
Commercial Depot	\$366.0	\$1,846.7	\$136.7	\$2,349.5	\$171.3	\$870.2	\$1,041.5
Organic Depot	\$383.5	\$1,945.8	\$133.7	\$2,463.0	\$41.3	\$262.6	\$303.8
Totals	\$749.5	\$3,792.5	\$270.4	\$4,812.5	\$212.6	\$1,132.8	\$1,345.4

27.9%

12.3%



# Navy Ships Depot Corrosion Cost - Ship Category

(\$millions per ship - FY04)

Category of Ship	Number of Ships	Average Depot Maintenance Cost	Average Depot Corrosion Cost	% Corrosion Cost	Number in Commercial Depot	Number in Organic Depot
Amphibious	37	\$33.1	\$16.8	50.7	31	21
Carrier	12	\$72.0	\$12.5	17.3	6	12
Submarine	72	\$19.5	\$2.7	13.7	0	62
Surface Warfare	105	\$8.9	\$3.3	36.9	65	25
Other Ships	30	\$4.6	\$1.4	29.6	17	5

**+\$168**

**-\$75**

**-\$167**

**+\$132**

**+\$17**

**Only \$75 million difference explained**



# Navy Ships Depot Corrosion Cost - Ship Category

(\$millions per ship - FY04)

Class of Ship	Number of Ships Common	Avg Comm Depot Corrosion Cost	Avg Comm Depot Maint Cost	% Corrosion Comm Cost	Avg Organic Depot Corrosion Cost	Avg Organic Depot Maint Cost	% Corrosion Org Cost
Amphibious	17	\$22.5	\$38.6	58.3	\$0.1	\$3.3	3.6
Carrier	6	\$9.7	\$23.9	40.5	\$5.6	\$41.4	13.5
Surface Warfare	16	\$2.2	\$5.0	44.0	\$0.6	\$2.9	20.2
Other Watercraft	1	\$0.6	\$1.9	30.8	\$0.2	\$1.4	15.0

Every ship class that has commercial depot work has a significantly higher corrosion cost than the organic depot – especially amphibious ships



# Ships Corrosion Cost Corrective vs. Preventive

(\$millions - FY04)

Depot Level Maintenance	Category of Corrosion Cost	Corrosion Cost	% of Total
	Corrective	\$400	29.7%
	Preventive	\$796	59.2%
	N/A	\$149	11.1%
	Total	\$1,345	
Field-Level Maintenance	Category of Corrosion Cost	Corrosion Cost	% of Total
	Corrective	\$527	67.7%
	Preventive	\$244	31.3%
	N/A	\$8	1.0%
	Total	\$779	
Total Maintenance	Category of Corrosion Cost	Corrosion Cost	% of Total
	Corrective	\$927	43.6%
	Preventive	\$1,040	49.0%
	N/A	\$157	7.4%
	Total	\$2,124	



# Ships Corrosion Cost Ratio - Corrective/Preventive

	Ratio of Preventive to Corrective Cost
Depot Level Maintenance	1.99 to 1
Field-Level Maintenance	0.46 to 1
Total Maintenance	1.12 to 1

Not enough data points to determine optimum ratio – further study required



# Corrosion Cost Working Group

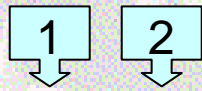
## Charter

- **Assess** corrosion control related cost data to support forward-looking improvement opportunities.
- **Report** actionable findings to decision makers within the Fleet maintenance community.



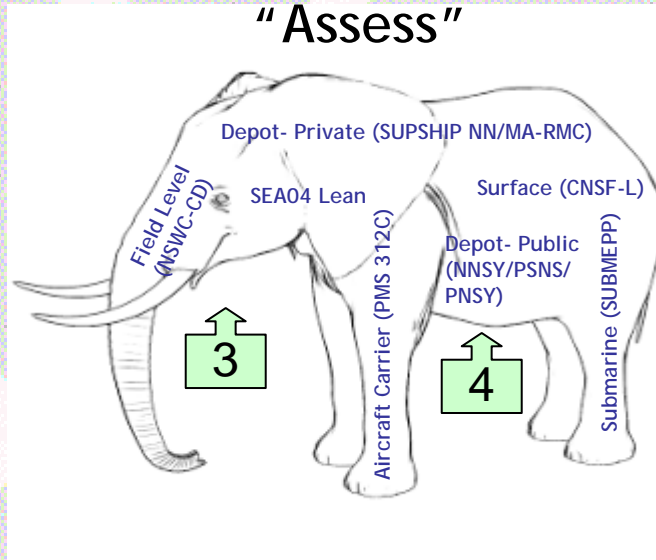
# Eating The Elephant

## "Collect"



CoC High-Cost Drivers

## "Assess"



## "Report"



FFC/ SEA05  
NSTC



### COST/ SCOPE DATA—

- FY04 LMI CoC Study & Database
- FY05 VAMOSC & NMD
- FY06 AIM

### TECHNICAL DATA—

- Component Characteristics
- Component Risk
- Component Reliability

### ASSESSMENT TEAMS—

- I - Comprehensive CoC
- II - High-Level Depot-Level Maintenance (DM)
- III - Detailed Organic DM
- IV - Detailed Commercial DM

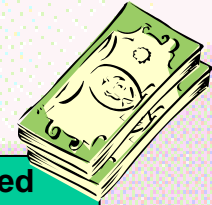
### OBJECTIVES—

1. Collect Data (Cost & Technical)
2. Assess Data Quantity & Quality
3. Report Return Cost Measures
4. Assess Cost Metrics & Risks
5. Report Actionable Findings
6. Community Awareness



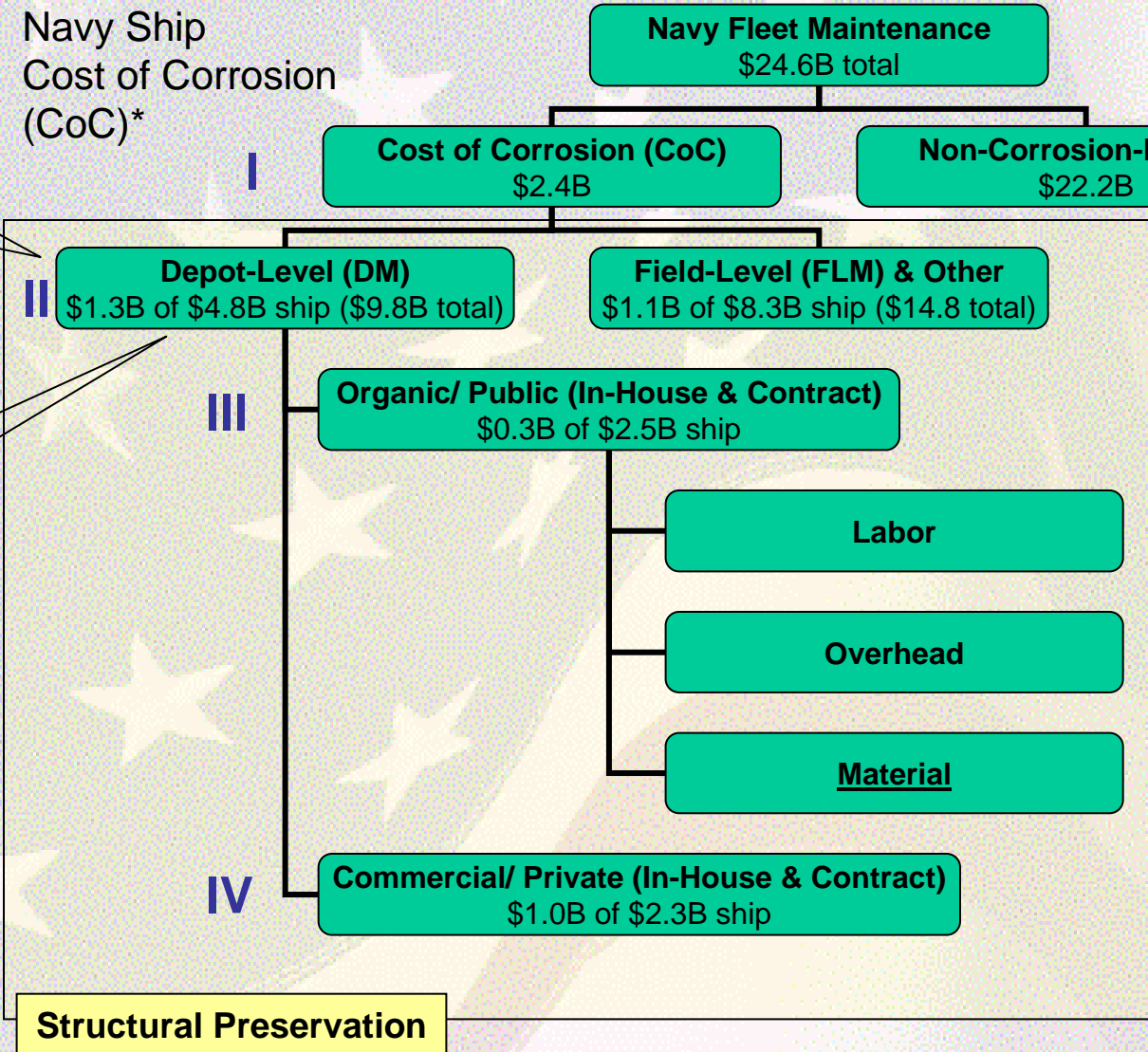
# Eating The Elephant

Navy Ship  
Cost of Corrosion  
(CoC)\*



54%

27%



Team I.  
Comprehensive  
High-Level CoC  
Analysis (FY04)-

- Depot-Level
- Field-Level

Team II.  
High-Level DM  
Analysis (FY05)

- Surface
- Aircraft Carrier
- Submarine

Team III & IV.  
Organic &  
Commercial DM  
Value Stream  
Analysis (FY06)

- Tanks
- U/W Hull
- Non-Skid Deck

•LMI, Annual CoC for Navy  
Ships, Apr 06 (FY 04)



# Eating The Elephant

## Team Leads

		Navy Fleet
I	DM/ FLM	NSWC-CD

Needham

		Surface	Aircraft Carrier	Submarine
II	DM	CNSF-L	CPA	SUBMEPP
III	Organic (NSA)	--	NNSY/ PSNS	NNSY/ PSNS/ PNSY
IV	Commercial (NSA)	MA-RMC	SS-NN	SS-GROTON

Shay  
Cherry  
Puchlopek

Jackson  
Lutovsky  
Adams

Tobin  
Hossinger  
Komorowski

		Logistics
	Support	NSTC

Southard



# Cost Data

## Data Quality

- Return cost data is not always complete, standardized, accurate, or of sufficient level of detail or clarity.
- Poor quality hampers our ability—
  - to identify and prioritize needed action,
  - to justify projects, and
  - to effectively manage and monitor resource allocation.

- Standardize reporting between ship programs, and NSA's to support accurate depot level cost metrics.
- Improve enforcement of NAVSEA SI 009-99 and NAVSEAINST 4790.14 (Ship Departure Reports).



# Navy CoC Study

## Prevalence of Commercial Corrosion Work

- Commercial depot corrosion costs are significantly higher than the organic depot corrosion costs.
- More than \$1.04 billion of the \$1.35 billion depot corrosion cost for Navy ships is attributed to commercial depots.

- Organic yards largely perform submarine and aircraft carrier maintenance and complex alterations (many related to combat systems).
- No further action recommended.



# Navy CoC Study

## Effect of Age on Corrosion (Structure vs. Parts)

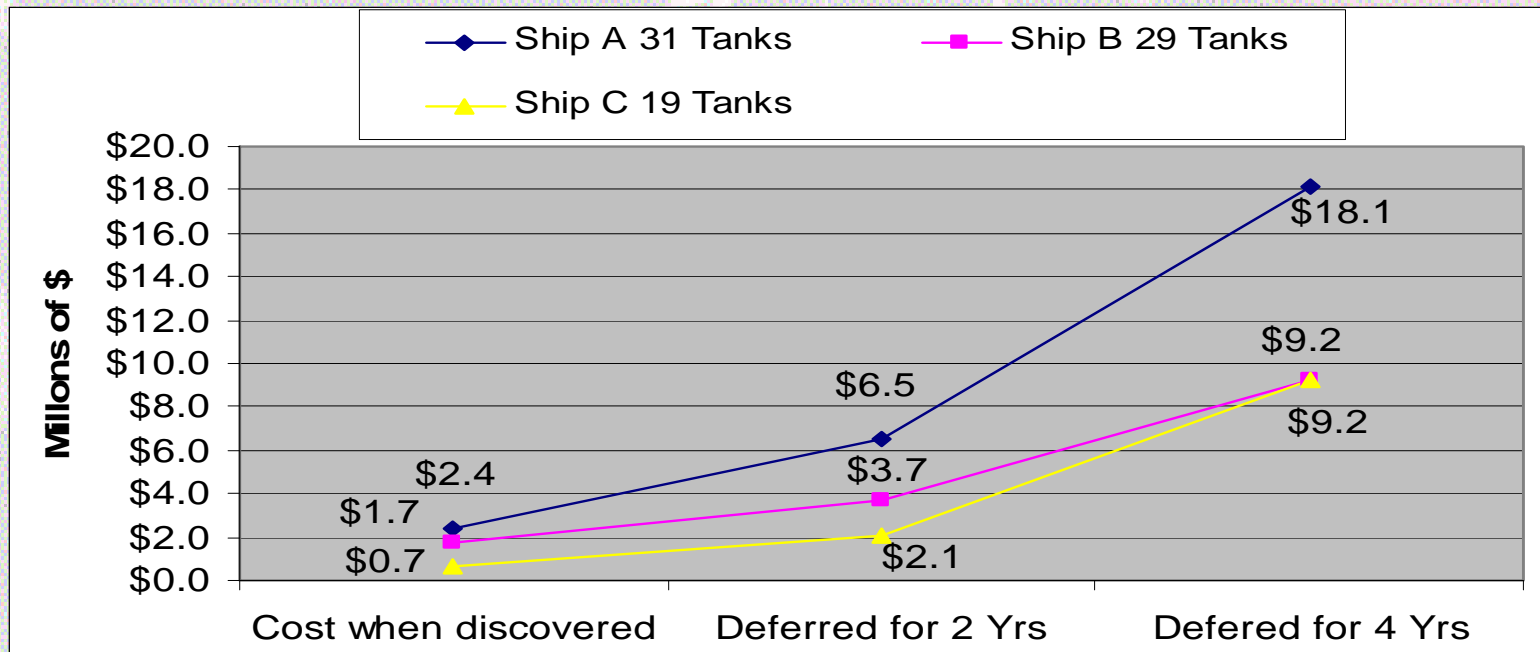
- Based on the initial set of data, there is little apparent relationship between the cost of corrosion and age of a ship in terms of both a dollar value and percentage of maintenance.

- Some age effects are likely, however, a one year study is not adequate to correlate an age effect.
- Unlike vehicles and aircraft, ships generally have robust structure that does not wear out such that corrosion costs are escalated extensively.
- No further action recommended at this time.



# Navy CoC Study

## Corrective vs. Preventive Maintenance



- Recommend a detailed analysis to determine the long-term cost of deferred maintenance to aid maintenance planning.



# Navy CoC Study

## High-Cost Drivers

- Nearly one-third of the Navy's total cost of corrosion is in the top five ESWBS categories.
- This is a significant localization of costs, given more than 550 ESWBS categories.
- An obvious opportunity to focus resources in these areas.

- Trunks and Enclosures (123)
- Bilge Cleaning and Gas Freeing (992)
- Painting (631)
- Dry-docking and Undocking (863)

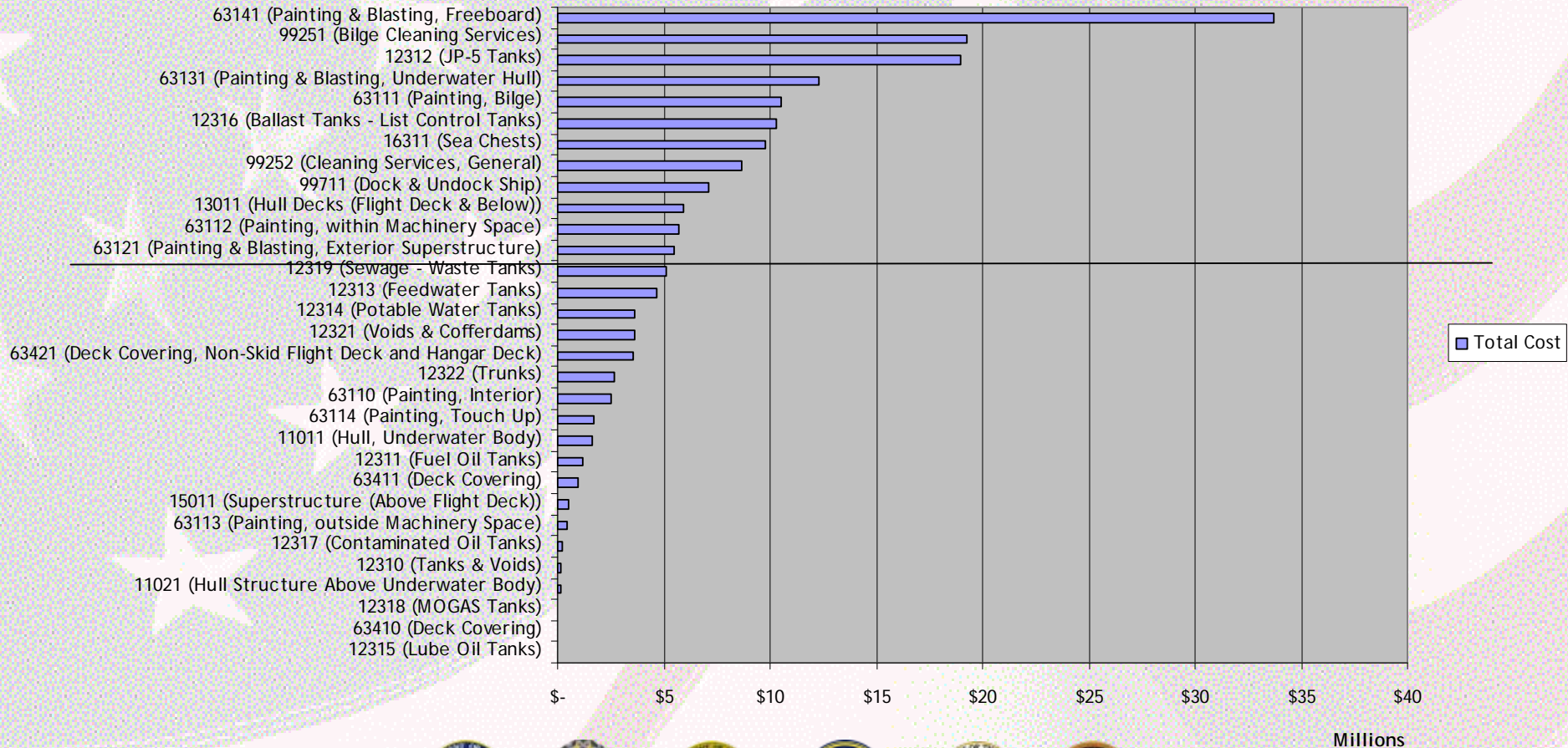
- Agree with high-cost driver's.
- Further detailed breakdown is required to isolate costs.



# High-Cost Drivers

## Aircraft Carrier Spending

Aircraft Carrier Spending (1996-2005)

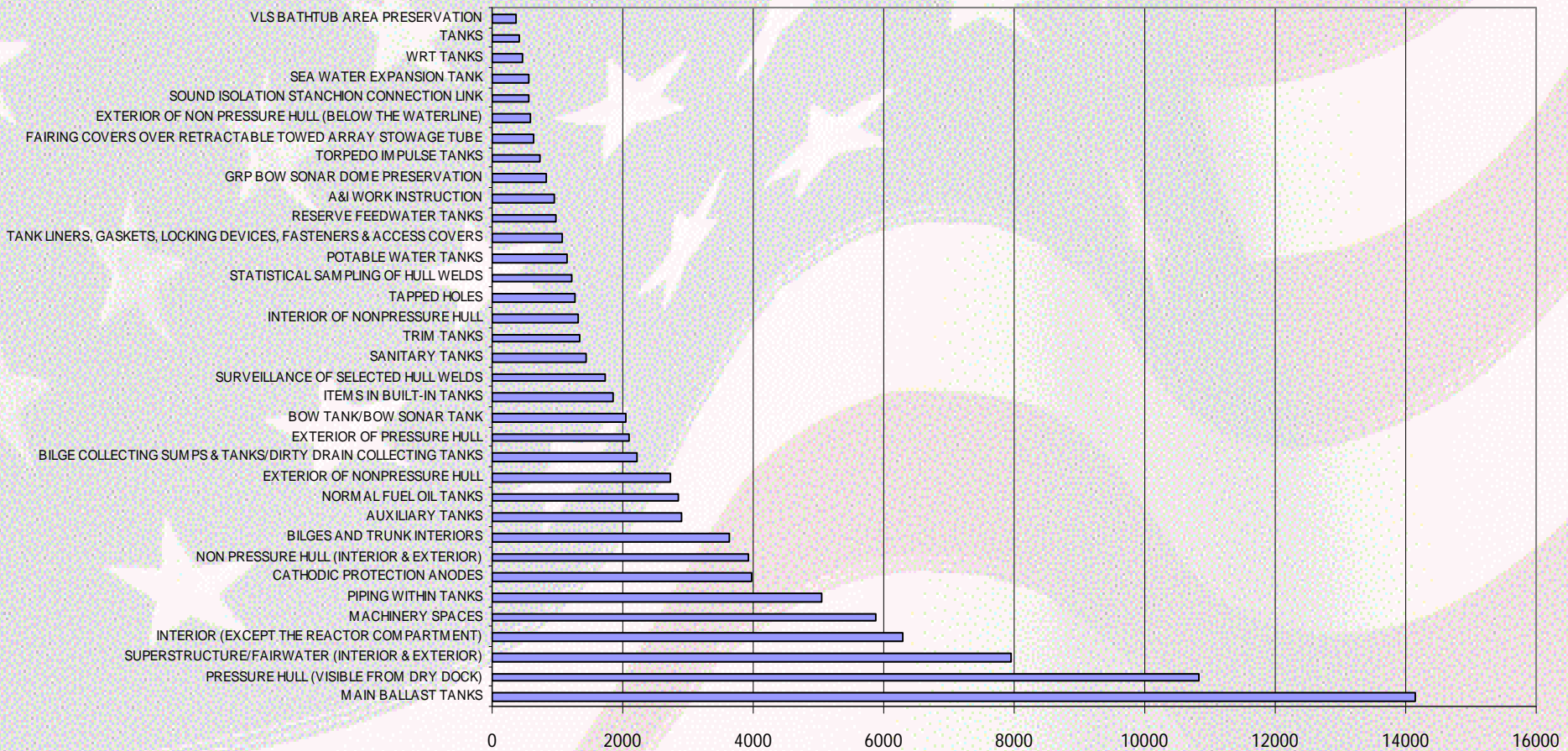


Millions

# High-Cost Drivers

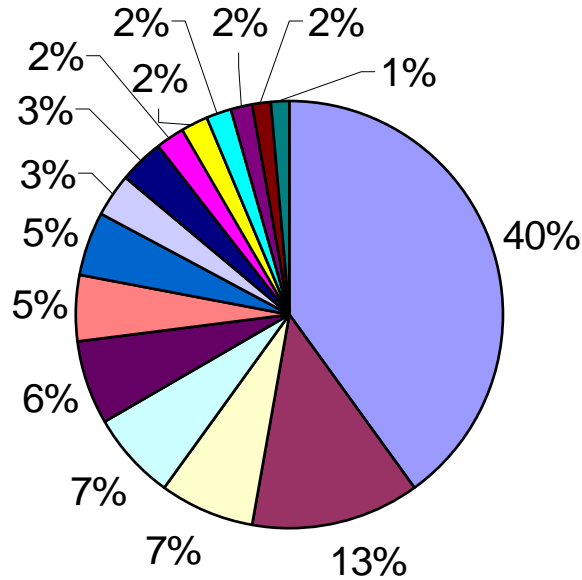
## Submarine Spending

Mandays by GC



# High-Cost Drivers

## Surface Ship Spending



- |                                |                              |
|--------------------------------|------------------------------|
| Ballast Tanks                  | Deck Covering                |
| Painting/Blasting Freeboard    | Flight/Hanger Deck Non-Skid  |
| Exterior Painting              | Painting Outside Mach Spaces |
| Substructure Above Flight Deck | Painting/Blasting U/W Hull   |
| Bilge Painting                 | Hull Structure               |
| Bilge Cleaning and Gas Freeing | Potable Water Tanks          |
| Voids and Enclosures           | Underwater Body Hull         |
| Fuel Oil Tanks                 |                              |



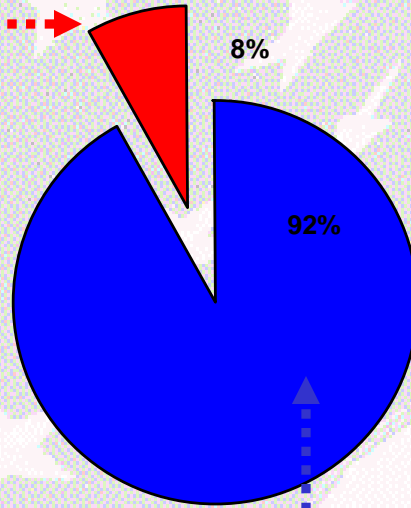
# High-Cost Drivers

## Detailed Spending

FY-06 DOCKING  
AVAIL

Scope of Work  
X each tanks, open, clean,  
blank, cut accesses, blast,  
preserve with Ultra High  
Solid 20-yr paint system.

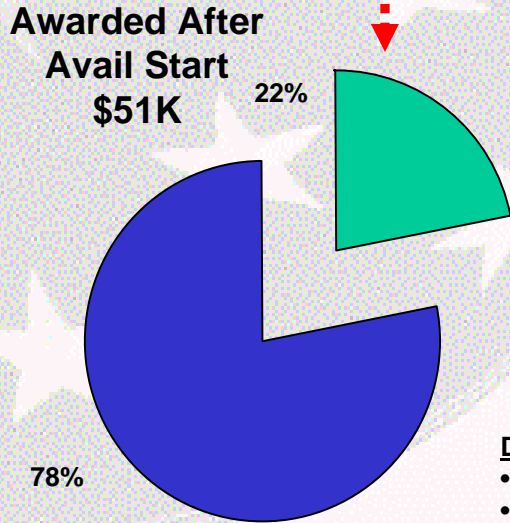
Costs per sq/ft = \$33.30



**Total Cost at Completion**  
**\$656,068**

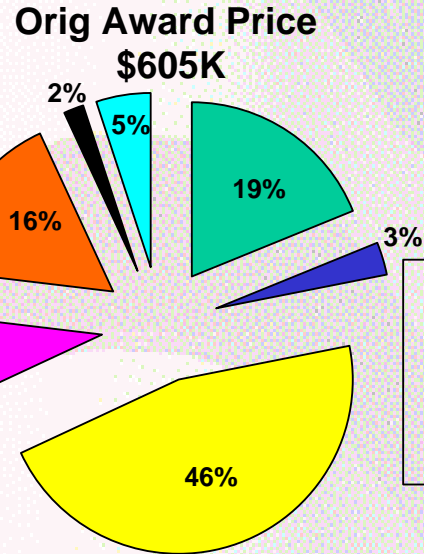
- Orig Award \$605K
- Award After Avail Start \$51K

Orig gov't est \$407K



- Growth \$12K
- D & D \$40K

D&D Summary  
•Schedule shifts  
•Milestone chgs



- Open/Clean/Blank \$115K
- PPG Mods \$18K
- Prep/Blast \$278K
- Painting \$54K
- Close/Misc \$99K
- QA \$12K
- Paint Matl \$28K



# Actionable Items

1. **Touchup Repairs-** cost-effectiveness of making temporary repairs to tank coatings
2. **Cosmetic coatings** – Paint applied by Sailors and shipyard for appearance only
3. **Periodicity** – Each tank inspection requires gas free checks and costly QA time.
4. **Structure** – Extend coating operations with better understanding of structure
5. **Environmental** – Relative humidity in tanks requires extra equipment
6. **Surface preparation** – Materials and methods

