



# Corrosion Control in the US Navy

## *Ships & USMC Vehicles*



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**Corrosion Control & Prevention Executive**

*Presented by E. Dail Thomas II, Consultant*

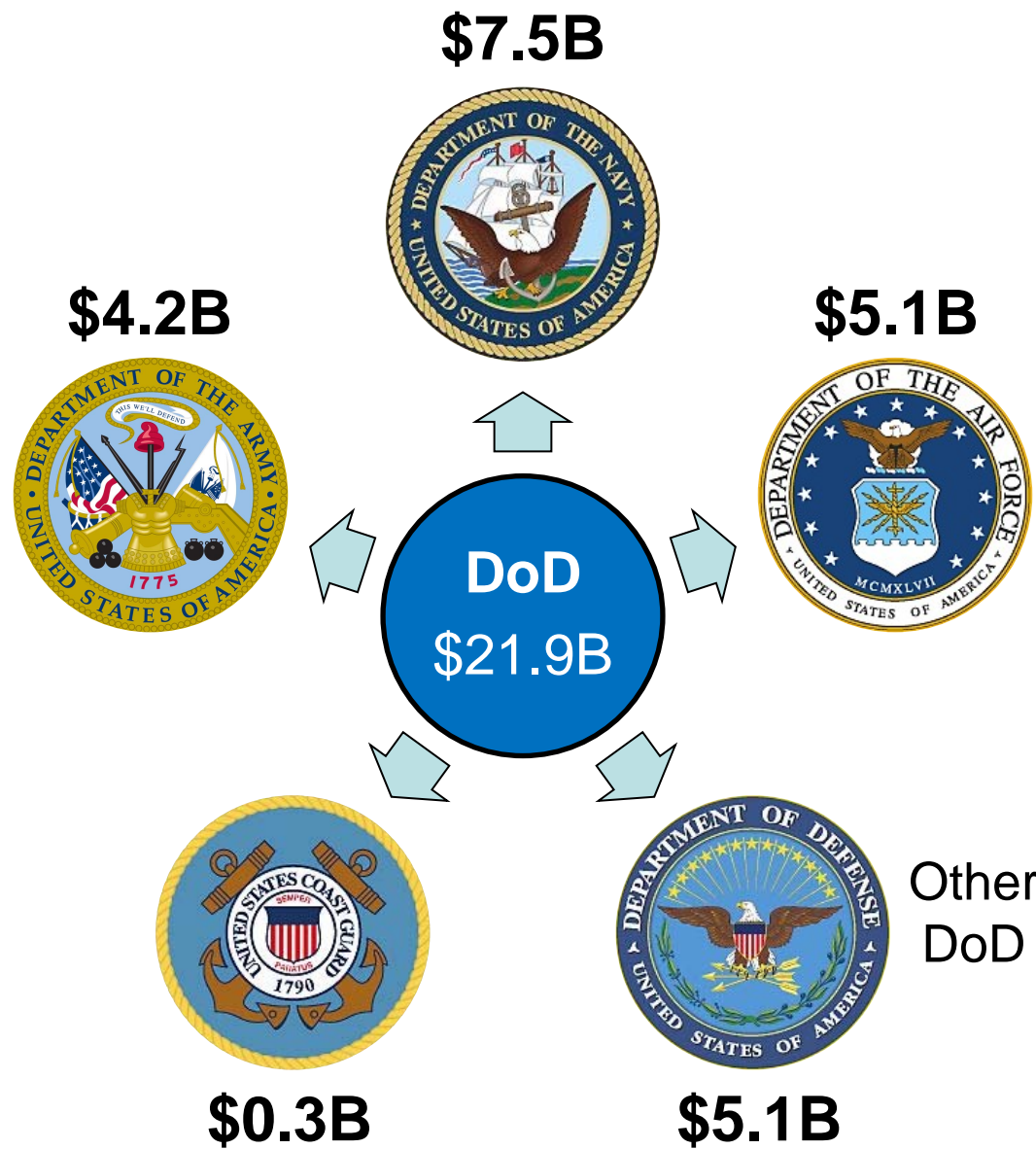
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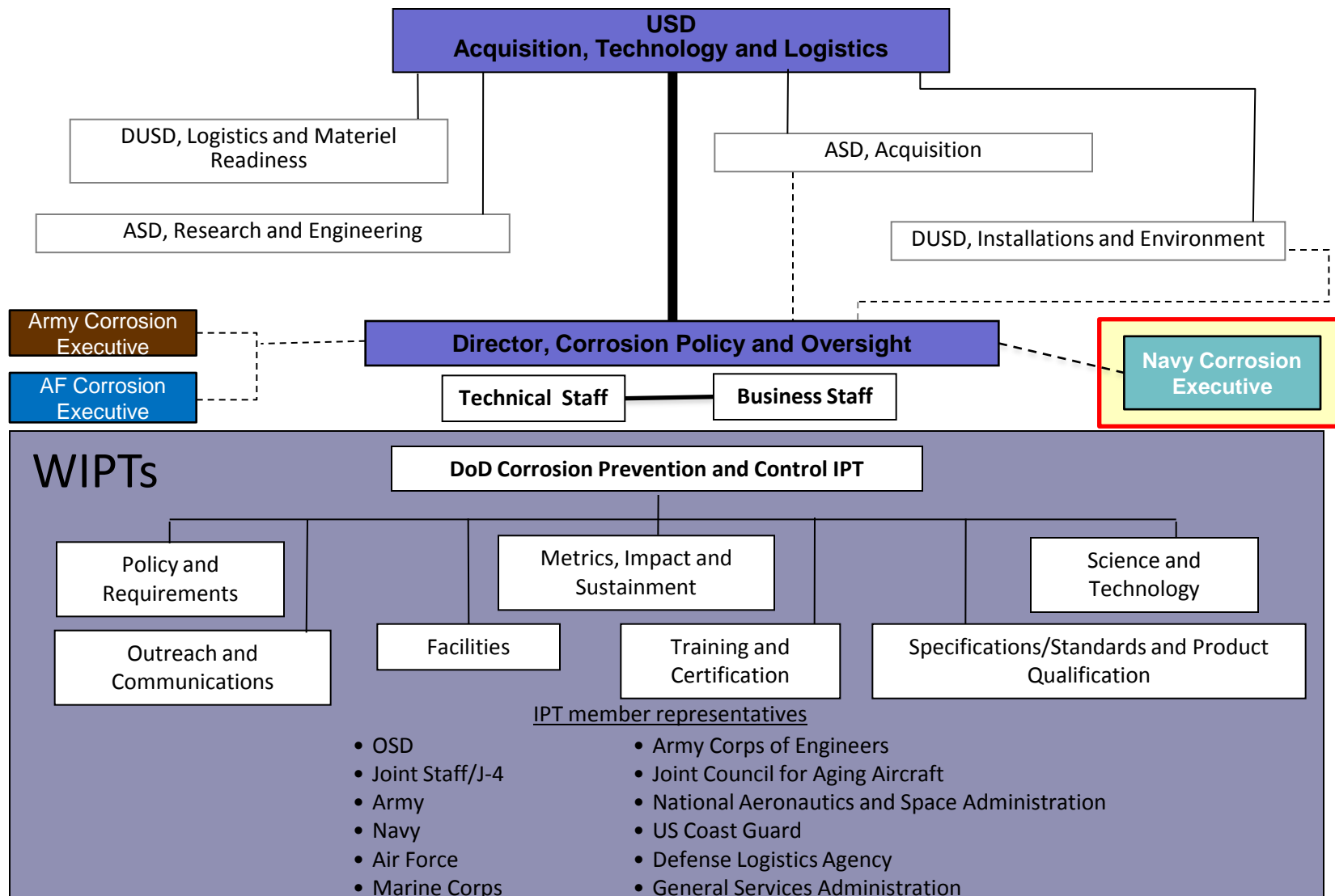


# DoD Annual Cost of Corrosion: **\$21.9B**





# U.S. Department of Defense Corrosion Organization







# DON Annual Cost of Corrosion: **\$7.5B**

## *Aviation*

**\$2.6B**

## *Ships*

**\$3.2B**

## *Ground Vehicles*

**\$0.5B**

## *Facilities*

**\$1.2B**

Additional studies focus on availability, safety impacts ([www.corrdefense.org](http://www.corrdefense.org))



# Role of Navy Corrosion Executive

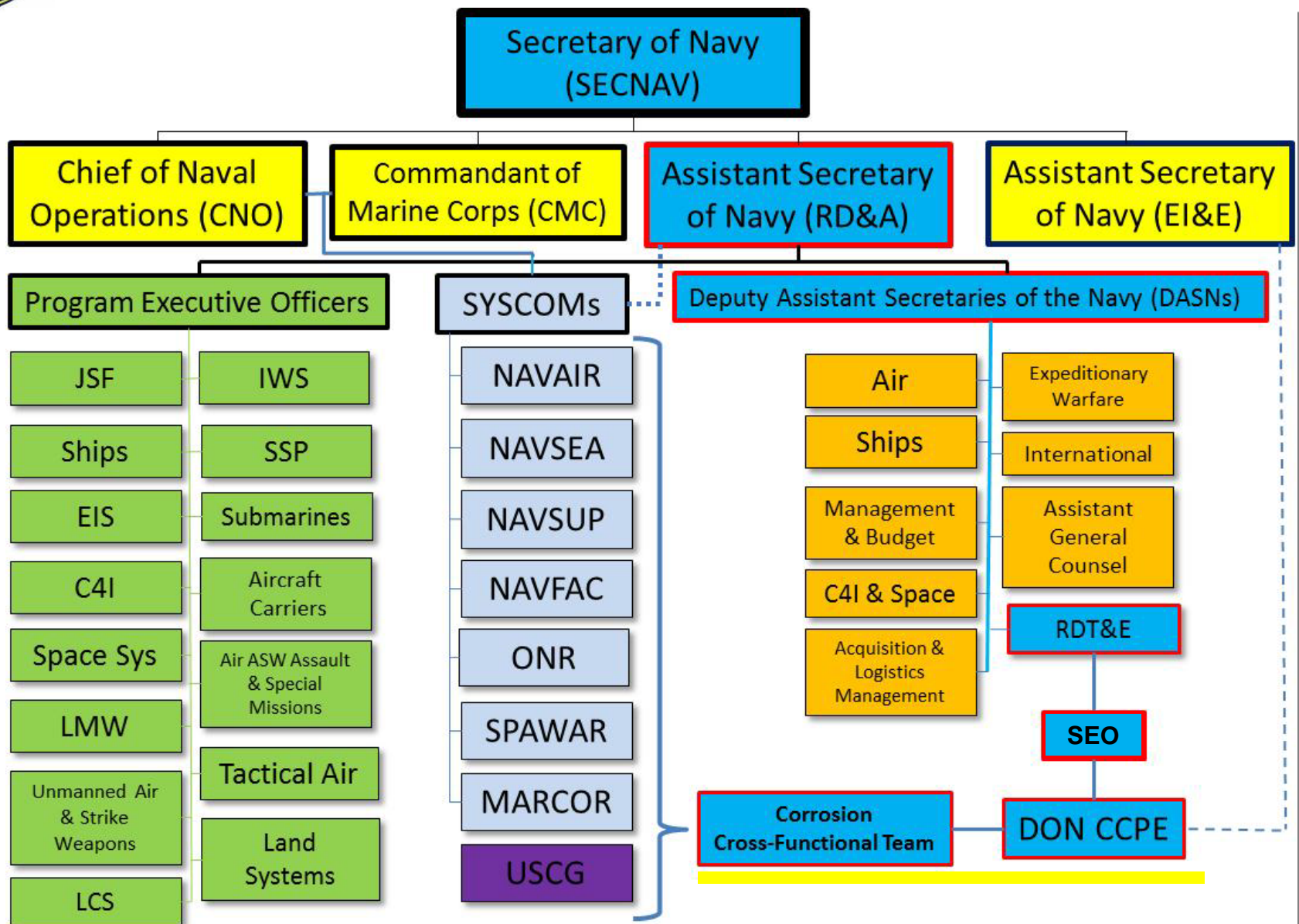
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- Established by act of Congress in FY2009 NDAA; codified in Title 10 USC §2228
- Senior DON official with responsibility for coordinating Department-level corrosion control and prevention activities
- Principal DON point of contact for the OSD Director of Corrosion Policy and Oversight
- Report annually to SECDEF and Congress on the corrosion posture of the DON and provide recommendations
- Develop and execute a *DON Strategic Plan for Corrosion* that reduces the impact of corrosion on Navy equipment and infrastructure

**Reference: DOD Instruction 5000.67, "Prevention and Mitigation of Corrosion on DOD Military Equipment and Infrastructure," February 1, 2010**



# DON Corrosion Organization







# Why Corrosion? Why Now?

- **Congressional Mandates (FY03 → Present)**
  - ❑ **OSD Senior Corrosion Official (2003)**
  - ❑ **OSD CPO Office Establishment (2008)**
  - ❑ **Military Department Corrosion Executives (2009)**
- **DoD Strategic Shift to Pacific Theater & Middle East**
- **Acquisition Excellence & Better Buying Power**

Combined with



- **Increased Demand Signal from Combatant Commanders**
- **Increasingly complex materials systems**
- **Longer Deployments, Shorter Turnaround Times**
- **Reduction in Ship Battle Forces & Reduced Manning**

Resulting in



- **Increased Maintenance Requirements**
- **Difficulty for Assets to Achieve Expected Service Life (ESL)**
- **\$7.5B Annual Cost of Corrosion**
- **Increased Oversight by OSD and Congress**

**“70% of Commissioned Fleet Will Still Be Active in 2020.”**

VADM Burke, VADM McCoy, VADM Architzel Testimony on “Navy Readiness Posture,” 22 March 2012





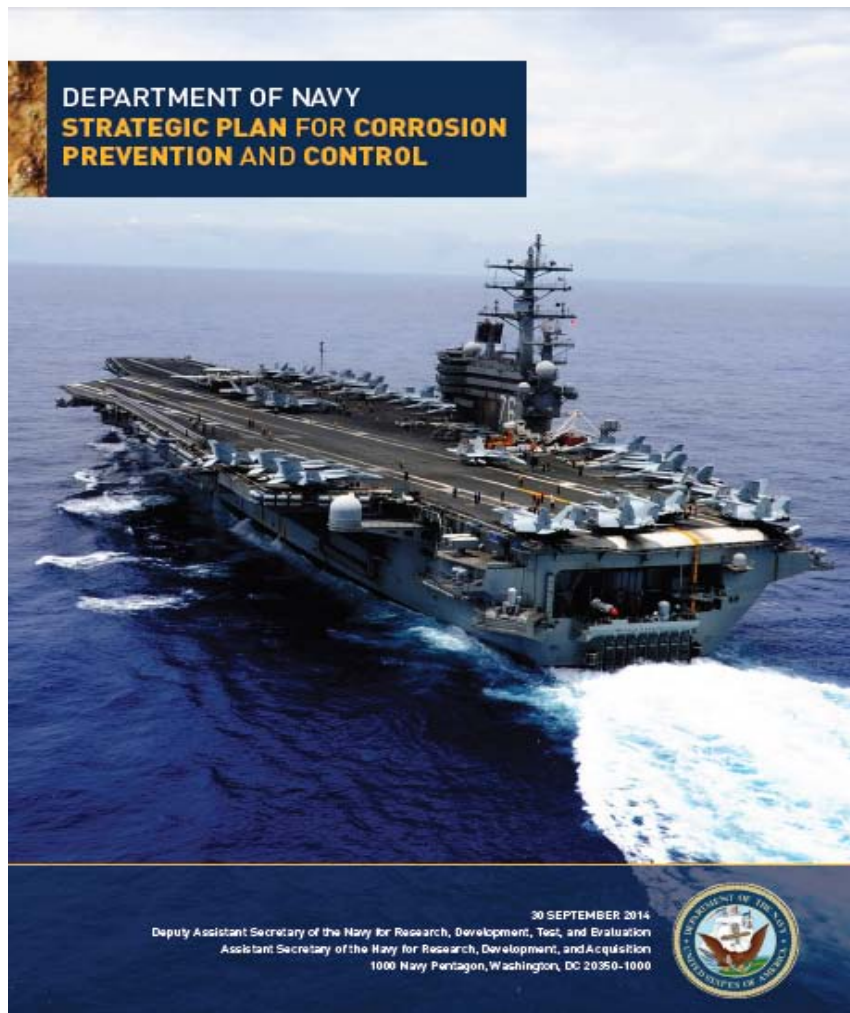
# Recent Changes to Corrosion Requirements

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- **Interim DoDI 5000.02 (Nov 2013) – added requirement to document corrosion considerations in Life Cycle Sustainment Plan (LCSP)**
  - ❑ Opportunity to clearly link acquisition trade-off decisions to life cycle sustainment planning
  - ❑ Chance to improve feedback loop between legacy platforms and new designs
  
- **Revised DoDI 5000.02 (Pending) – will remove formal Corrosion Prevention and Control Plan (CPCP) requirement for ACAT I programs**
  - ❑ Eliminated as part of DoD document streamlining initiatives
  - ❑ Complicates oversight of costly, multi-disciplinary engineering challenge
  
- **SECNAVINST 5000.2E & SETR Process (Pending) – could potentially remove CPC Plan requirement for ACAT I programs**
  - ❑ Eliminates DON-level emphasis on corrosion prevention and control
  - ❑ No clear requirement against which PMs can request fiscal and manpower resources for corrosion



# DON Strategic Plan for Corrosion



## ➤ Requirement

- ❑ Title 10 USC §2228

## ➤ Goals & Objectives

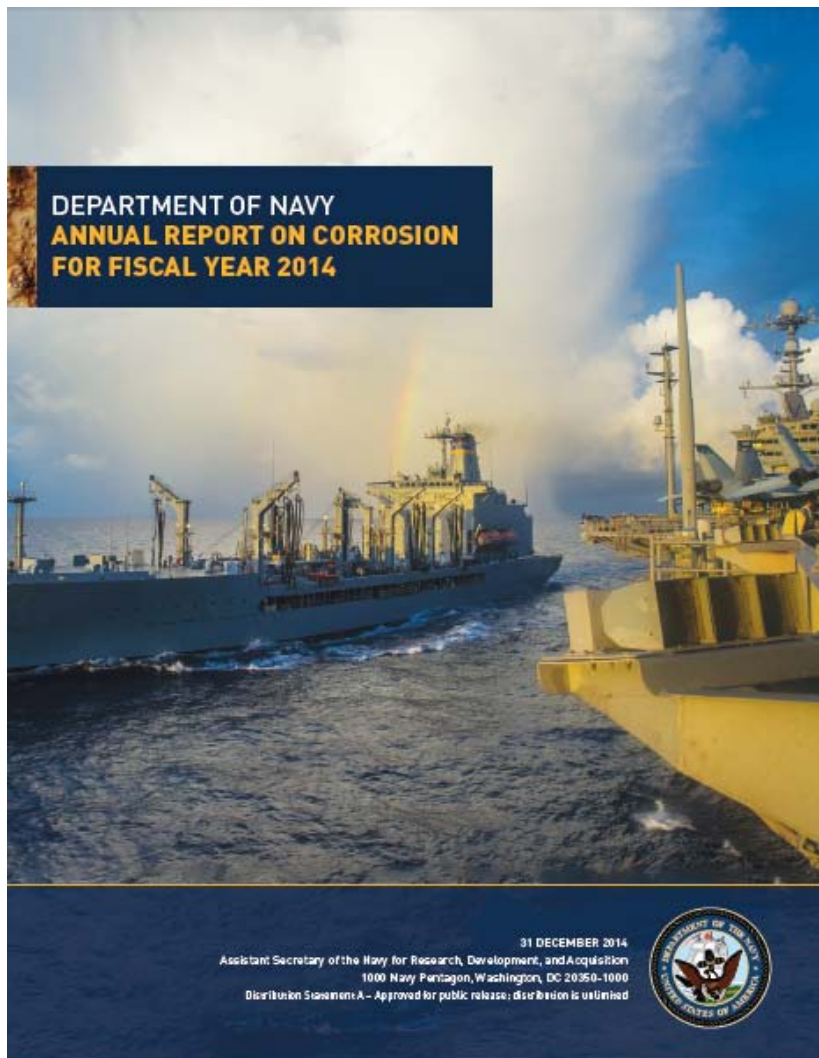
1. Institutionalize Corrosion Prevention & Control
2. CPC in Policy & Guidance
3. CPC in Technology Development & Integration
4. Education & Training for CPC Workforce
5. Communication & Collaboration as a Tool

## ➤ Audience

- ❑ Department of the Navy
- ❑ Secretary of Defense
- ❑ United States Congress



# DON Annual Report on Corrosion



## ➤ Requirement

- ☐ Title 10 USC §2228

## ➤ Scope

- ☐ CPC accomplishments & activities
- ☐ Current FY focus areas & funding levels
- ☐ Recommendations pertaining to Department CPC activities

## ➤ Audience

- ☐ Department of the Navy
- ☐ Secretary of Defense
- ☐ United States Congress



# Hexavalent Chromium

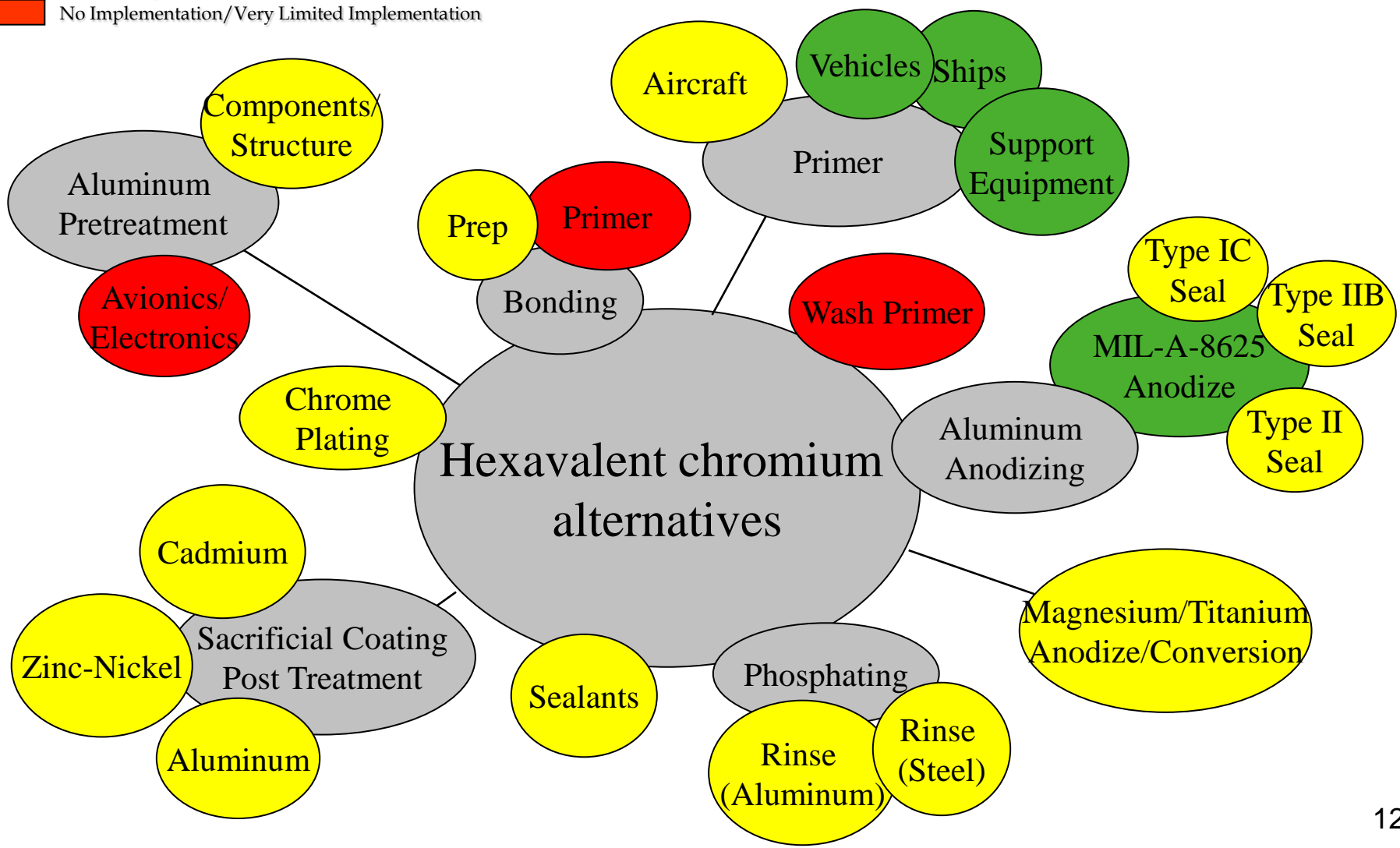
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- **Hex Cr Widely Used for Corrosion Prevention & Control**
- **Hex Cr DFARS Promulgated 5 May 2011**
  - Requires Authorization by PEO in Coordination w/ DON CCPE
  - Drove Development of a DON Process for Authorization
- **DON Process Deployed (Signed by ASN RD&A on 22 Dec 11)**
  - Program Needs to Assess Cr6+ System/Facility Applications and Determine if Proven, Viable Alternatives Exist.
  - Program Needs to Request Cr6+ Authorization if:
    - ❖ Proven Viable Alternatives Do Not Exist, or
    - ❖ If Additional Time Required for Implementation of Alternatives
- **Utilize Agency Materials & Corrosion TWHs/SMEs**
  - Technical Warrant Holders/Subject Matter Experts Crucial to Determining if Cr6+ Alternatives are Viable Based on Analysis of Available Laboratory Test/Field Demonstration Results.



# Application Areas for Chromate Alternatives

- Alternatives Implemented/Niche Chromate Use Remains
- Limited Implementation/Near Term Validation
- No Implementation/Very Limited Implementation

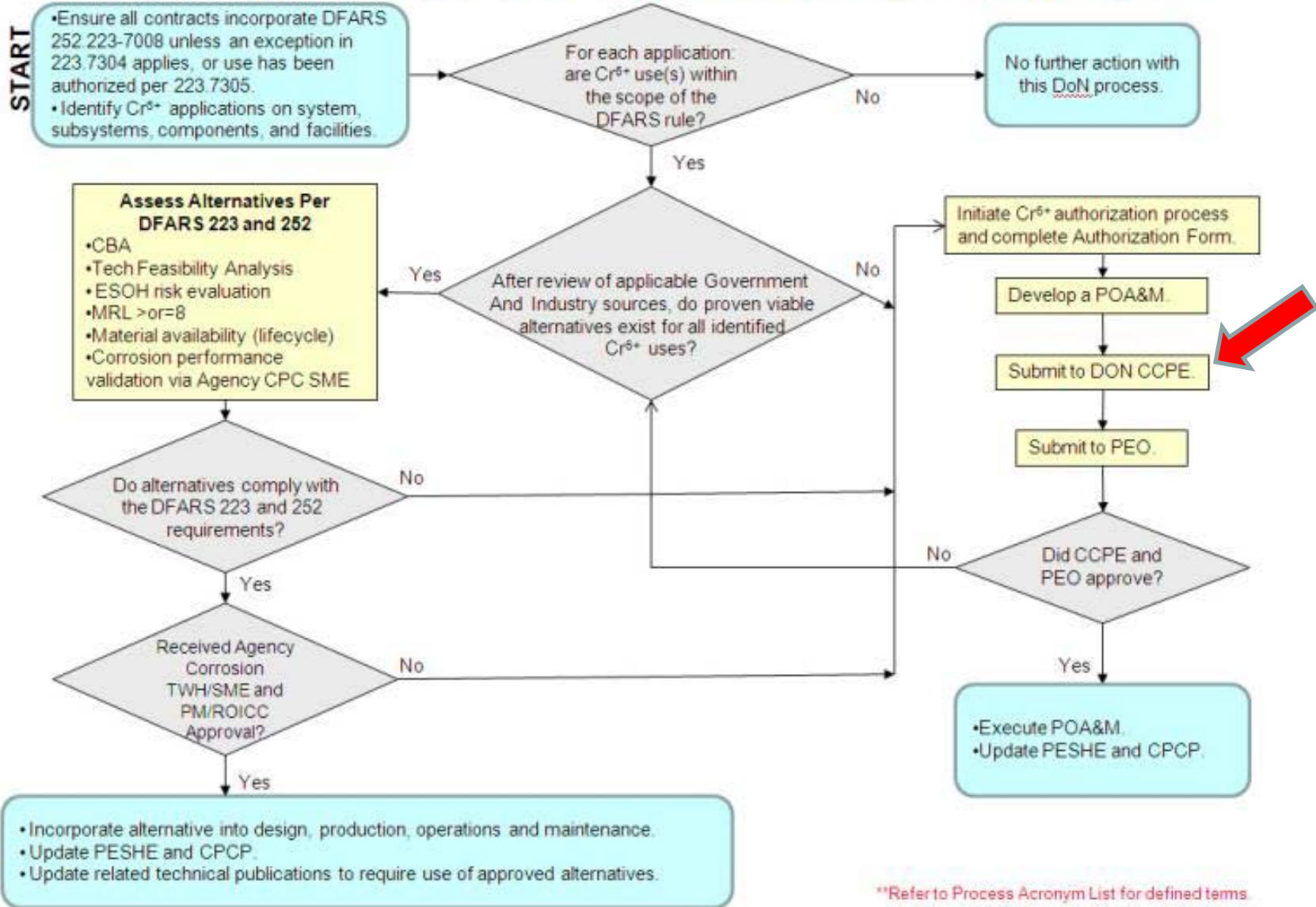






# DON Hexavalent Chromium Process

DON HEXAVALENT CHROMIUM AUTHORIZATION PROCESS FLOWCHART\*\*



\*\*Refer to Process Acronym List for defined terms



# Navy Ship Corrosion Control

- ✓ Interstitial Hardening
- ✓ Topside Corrosion Control (TCC)
  - Polysiloxane Topside Coating Systems
  - Advanced Non-skid Coatings
  - Marine Aluminum Alloys and Stress Corrosion Cracking (SCC)
  - Advanced Cathodic Protection Systems





# Interstitial Hardening (IH) Overview

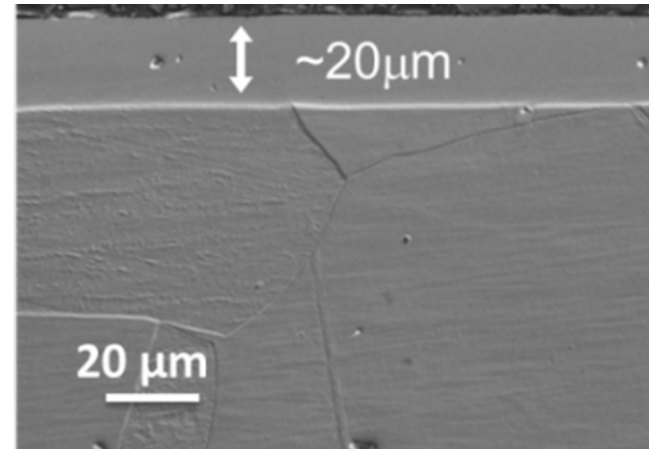
## Process

- The Interstitial Hardening (IH) produce **surfaces alloys** NOT coatings; treated region called the "case"
- IH-treatment with carbon, nitrogen, or carbon plus nitrogen
- Non-line of sight process: treat finished parts of all shapes and maintains dimensions
- Furnace process large parts can be treated.
- Treatment times 2 to 72 hours

## Enhanced Properties

- Increased surface hardness up to 1200 Vickers (best hard chrome coatings are 1100 Vickers)
- Retained ductility
- Enhanced mechanical properties: wear, galling, fatigue, and cavitation resistance
- Enhanced corrosion resistance

IH-treated 316L region, case.



Ion (Plasma) nitriding of large parts:  
140" diameter a low-noise second reduction marine gear



Courtesy E. Rolinski





# Topside Corrosion Control (TCC)



## PEEL + STICK NON-SKID

- Eliminates rust bleed-thru and provides additional protection from undercutting on-deck corrosion
- Engineered for interior or exterior use, mostly in non-critical areas where foot traffic is high
- Installation within Ships' Force capability



## POLYSILOXANE NON-SKID

- Provides excellent wear resistance and can be used in critical areas of surface ships
- Offers superior corrosion and thermal resistance compared to traditional non-skid products
- Easy to apply: spray or roll



## COMPOSITES FOR "RUST RUNNERS"

- Successful corrosion control can be realized through the use of fiber reinforced composite materials
- Examples include composite electrical enclosure and conduit terminals, vent screens, pipe hangers and deck grating



## POLYSILOXANE COATING

- Used for high durability freeboard, topside coating, and anchor chain paint
- Offers longer service life (2 to 3x traditional LSA), requires less maintenance, cures faster when applied, needs fewer overall coats, and can be cleaned rather than repainted
- Reduces the gradual "pinking" of traditional silicone alkyd low solar absorption (LSA) formulas

## C5I CORROSION CONTROL

- Proper coating & weather sealing of C5I foundations and mating surfaces will reduce runny rust
- Proper corrosion control of C5I also improves operational performance



## FLUIDIZED BED (POWDER) COATINGS FOR WT DOORS, LOUVERS, AND OTHER PARTS

- Coats removable ship parts with efficiency and uniformity and prolonging service life
- 6 minutes to coat a WT door compared to 40 for the current powder coating process



Proof of Concept New Technology



# USMC Vehicles

***83K vehicles, CST serviced 53K & CRF refurbished 1700***

## **ONR's Advanced Topcoat System (ATC) Program**

- New CARC topcoat resin chemistry with to address maintenance operation restrictions associated with isocyanate materials.
- Novel metal-rich primers for improved protection of dissimilar material interfaces; weight reduction versus current zinc-rich pigments.

### **Benefits:**

- Elimination of toxic isocyanates
- Exterior color stability, gloss retention, flexibility
- Chemical warfare agent resistance, and mar/impact resistance
- Reduction in flammability & VOCs to 100 g/l



**Goal: 35% reduction in maintenance cost for USMC Ground Vehicles**





# DON CCPE Two-Year Plan

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- **Integrate corrosion prevention and control into established systems engineering processes**
- **Develop a process for engaging acquisition programs to evaluate CPC posture prior to major decision milestones**
- **Develop the framework for a Department-level corrosion prevention and control program**
- **Transition sustainment best practices across asset categories through periodic site visits and senior leadership briefings**
- **Expand international collaboration with allied nations through IEA, DEA meetings and standardization initiatives**

**Communication and collaboration across organizational boundaries can leverage best practices and design methodologies against declining resources.**



# Summary

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- **Corrosion is a \$7.5B annual expense for the Navy and impacts material readiness, availability, and safety**
- **U.S. Congress has taken steps to address corrosion since 2003**
- **DoD and DON have established organizations to institutionalize CPC best practices and design methodologies**
- **Fiscal uncertainty and sequestration present challenges to acquisition and sustainment that must be addressed**
- **International collaboration provides an opportunity to leverage allied partnerships and reduce the impact of corrosion**

**Develop a Plan. Follow the Process. Utilize the Right People.**



# DON CCPE

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## Thank You





# Role of Director, Corrosion Policy & Oversight

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- **Established by act of Congress in FY2003 NDAA; codified in Title 10 USC §2228**
- **Monitor and coordinate DoD efforts to mitigate corrosion during the life cycle of military equipment and infrastructure**
- **Develop and recommend policy and guidance on the prevention and mitigation of corrosion**
- **Develop a long-term strategy to reduce corrosion and evaluate RDT&E funding levels**
- **Annually report recommendations to the Secretary of Defense on military department programs & funding levels**

**Reference: DOD Instruction 5000.67, "Prevention and Mitigation of Corrosion on DOD Military Equipment and Infrastructure," February 1, 2010**



# Statutory & Regulatory Requirements

Documents	Requirement	Impact
Title 10 U.S.C. 2228 (current rev)	DoD and military departments shall establish senior personnel to develop, implement, assess strategies for corrosion prevention and mitigation	Requires CPC planning at highest levels within DoD/DON and establishes responsibilities for coordination and oversight of CPC activities.
DFARS PGI 207.105 (current rev)	All written acquisition plans must include discussion of corrosion prevention and mitigation plans [Para. (b), Subpara. (13), Bullet (ii)]	Required for all development acquisitions of \$10M or more; all production or services acquisitions of \$50M or more (or \$25M per FY) [DFARS Subpart 207.103(d)(i)(A)&(B)]
USD (AT&L) Memo (12 Nov 03)	Corrosion to be objectively evaluated as part of program design and development activities; inevitable trade-offs made through open and transparent assessment of alternatives	Decision authorities <u>at all levels</u> required to address CPC during earliest phases of the acquisition process [Para. 2]
DoD Directive 5000.01 (20 Nov 07)	Program managers shall consider corrosion prevention and mitigation during trade-off decisions involving cost, useful service, and effectiveness; optimize total system availability while minimizing cost [Encl. 1, Para. E1.1.17]	Requires <u>all</u> ACAT programs (I-IV) to consider corrosion prevention and mitigation.
DoD Instruction 5000.02 (8 Dec 08)	ACAT I programs must develop and deliver a CPCP at MS B & C [Encl. 4, Tbl. 3]	ACAT I program managers must deliver a CPCP at MS B & C [Encl. 12, Para. 7]
DoD Instruction 5000.67 (01 Feb 10)	For ACAT I programs, OIPT and DAB shall review and evaluate corrosion planning; trade-off decisions involving cost, useful service life, and effectiveness shall address corrosion prevention and mitigation; CPC programs and techniques shall be implemented throughout the lifecycle [Para. 4]	CPC planning must be executed for <u>all</u> ACAT programs (I-IV), with OIPT and DAB review for ACAT I programs; establishes CPC planning, policy, and oversight responsibilities for DoD/DON senior corrosion officials; requires annual report to SECDEF and Congress detailing funding needs and strategic planning [Encl. 2]
SECNAV Instruction 5000.2E (01 Sep 11)	CPC shall be a focus area for functional WIPTs; CPCP shall be a stand-alone document required for all ACAT I programs at MS B & C. [Para. 1.3.1.2; Tbl. E2T2]	CPC planning must be executed for <u>all</u> ACAT programs (I-IV) as part of WIPT activity; ACAT I programs must document their CPC strategy in CPCP at MS B & C [Para 1.3.1.2; Para. 6.1.5]





# **DoD Acquisition Statistics (as of 2014)**

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- **80 major defense acquisition programs**
- **Net portfolio value of \$1.5 trillion USD for current and future acquisitions**
- **Air, sea, ground, shore support assets**
- **Service life ranging from 20-100 years**

**DoD implementing Better Buying Power and other cost avoidance initiatives that require balancing life cycle risk against fiscal uncertainty.**