



CORROSION OVERVIEW

For the Facility and Infrastructure Professional

Training Objectives



Training Objectives:

- Identify corrosion impacts to facilities & infrastructure and why they are important to the Department of Defense (DoD)
- Identify the “expanded” definition of corrosion, and the current laws and the policies which govern prevention and control
- Identify the environmental factors which induce corrosion and identify the general control and mitigation strategies to employ over the facility life cycle (Note: Detailed technical Corrosion Prevention and Control (CPC) strategies will not be covered in this training)
- Identify CPC policies, guidance, and resources

Reasons why corrosion is important to America



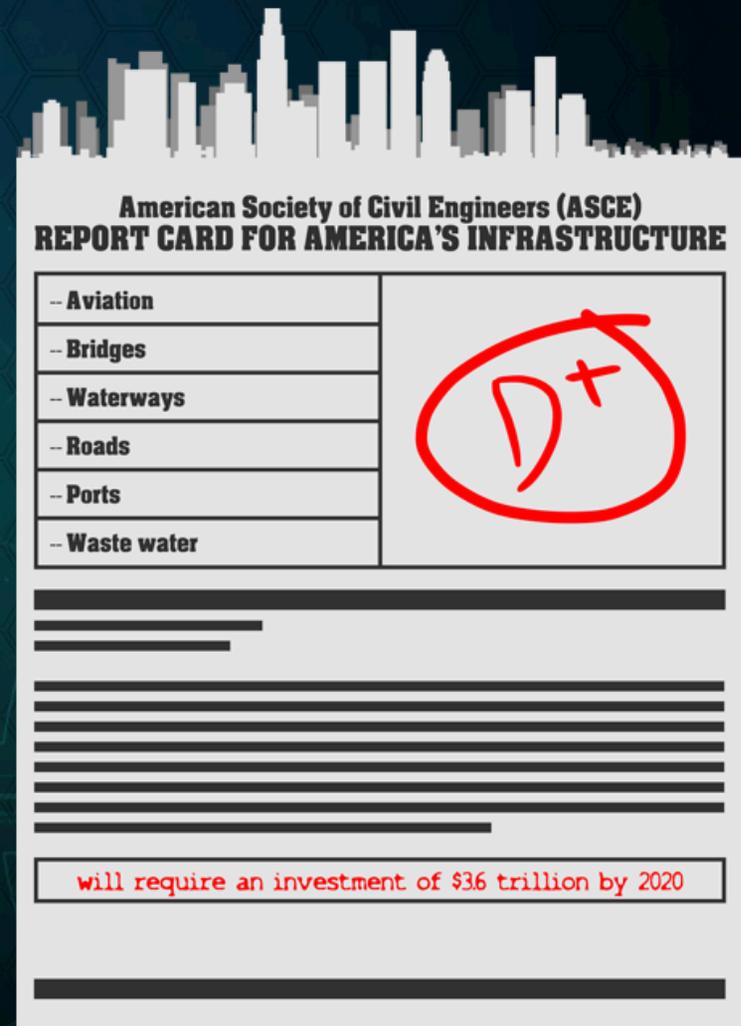
American Society of Civil Engineers (ASCE)



Report Card for America's Infrastructure in 2013

<http://www.infrastructurereportcard.org/a/#p/home>

- Overall grade of D+
- Requires an investment of \$3.6 trillion by 2020



Reasons why corrosion is important to DoD



Department of Defense (DoD) manages **555,000** structures

- Buildings, structures, pipelines, pavement and port facilities
- 28 million acres of real property
- Broad range of environmental severity zones
- Annual corrosion cost of \$1.9 billion



Corrosion impacts DoD's ability to support
The Warfighter

Definition of corrosion – 10 USC Sec. 2228



CORROSION

The deterioration of a material or its properties because of a reaction of that material with its chemical environment.



Definition of corrosion

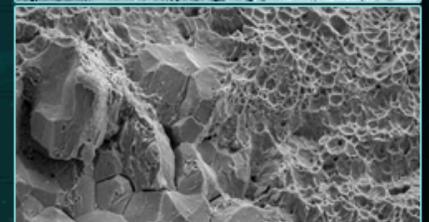


Traditionally thought of as deterioration of metal (e.g., rusting of steel) but includes:

- Degradation of non-metallic materials
- Rotting of wood
- Degradation of concrete (carbonation, alkali-silica reaction phenomena)
- Degradation of composite materials
- Mold and mildew destruction of fabrics and organics

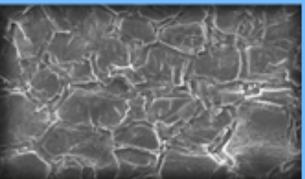
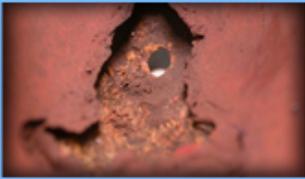
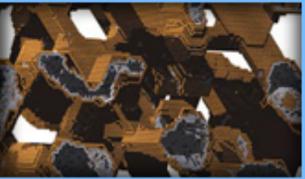
This definition also pertains to degradation due to:

- Fluid flow, i.e. erosion corrosion
- Stress induced, i.e. stress corrosion cracking
- Embrittlement
- Biological processes
- Solar exposure





Major Forms of Corrosion

	Uniform (general)		Intergranular
	Pitting		Selective Leaching/Dealloying
	Crevice		Stress Corrosion Cracking
	Galvanic		Solar Ultraviolet degradation
	Erosion Corrosion		Other less common types and combinations

Most materials of construction have susceptible environments that may induce early and rapid degradation.

Corrosion Impacts on DOD Infrastructure



- **Costs**
 - Adds nearly \$2B in annual costs (Repair, Maintenance, & Restoration)
 - May be as much as 40% of an asset's life cycle cost
- **Mission Readiness**
 - Reduces facility capacity and increases downtime
 - Reduces productivity of personnel and processes
 - Impacts program and asset employment
 - Reduces available funding for new mission requirements & facilities
- **Safety, Health, and Quality of Life**
 - Leads to structure failures resulting in injuries and fatalities
 - Causes health issues such as those associated with mold & mildew
 - Reduces facility quality which affects morale, recruitment, and retention of personnel

Environmental Impact on DOD Infrastructure



The DoD operates it's mission across the entire environmental spectrum.

Corrosive Environmental Factors include:

- Salinity
- Time of wetness
- Humidity
- Chemical - pollution, deicing, industrial processes
- Soil pH level
- Solar radiation
- Biological – insects, fungi (mold & mildew)
- Erosive forces – wind, rain, wave action, fluid flow
- Electrolytic - external currents, bonding and grounding of equipment



Corrosion Prevention and Control (CPC)



Corrosion Prevention and Control (CPC):

CPC is the rigorous application of management principles, engineering design and analysis, quality assurance (QA), non-destructive inspection (NDI), manufacturing, operations, and support technologies and practices to prevent the start of corrosion, avoid functional impairment due to corrosion, and define processes for the tracking and repair of corrosion problems.

Corrosion prevention and control should be applied over the entire facilities lifecycle

Planning & Programming

- Select site to reduce corrosion impacts
- Identify environmental severity
- Identify corrosive potential from user operations (industrial, chemical, equipment - grounding & bonding)
- Budget for CPC features, DD form 1391

Design & Construction

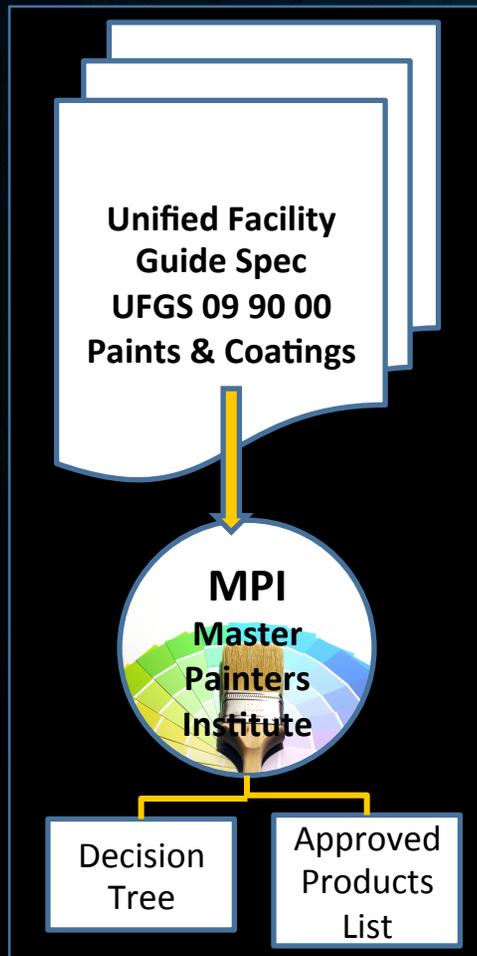
Operations & Maintenance



Corrosion Prevention and Control Design & Construction



Planning & Programming



Design and Construction

- Specify DoD criteria (UFC & UFGS) & industry standards in design and construction contracts to insure corrosion control requirements and solutions are identified – *Whole Building Design Guide* <http://wbdg.org>
- Identify corrosive forces and employ CPC design strategies:
 - * Select materials to prevent dissimilar metal corrosion
 - * Use protective coatings, isolators, & corrosion inhibitors
 - * Shelter building components to reduce corrosive exposure
 - * Prevent entrapment of water
 - * Design-in corrosion allowance to maintain component integrity
 - * Consider cathodic protection
- Insure Construction Quality Control (CQC)
 - * Specify special testing, mock-ups, & submittals for critical elements
 - * Include corrosion prevention as part of the commissioning process
 - * Communicate requirements with the contractor and CQC personnel

Operations and Maintenance

Corrosion Prevention and Control Operations and Maintenance



Planning & Programming

Design and Construction

Operations and Maintenance



- Limit exposure from corrosive elements (deicing salts, chemical spills, etc.)
- Provide water treatment
- Reduce interior humidity
- Employ a preventative maintenance program
 - * identify and repair leaks
 - * insure water removal elements are functioning and free of debris
 - * repair coatings, re-caulk, replace gaskets, & fix cracks
- Employ a condition assessment program (CAP) and a sustainment management system "Builder"
- Devise repair strategies to mitigate corrosion and correct design deficiencies

Policy, Guidance, and Resources



- **USD(AT&L) Memo (2002)** – *Department of Defense Unified Facilities Criteria Corrosion Prevention and Control*
- **DUSD(I&E) Memo(2005)** – *Facility Corrosion Prevention and Control*
- **D, CPO Guidebook (2007 & 2013)** – *Corrosion Prevention and Control Planning Guidebook*
- **DODI 5000.67 (2010)** – *Prevention and Mitigation of Corrosion on Military Equipment and Infrastructure*
- **FAR and DFARS FAR 36, 52, etc.**
- **Corrosion Prevention and Control: A Program Management Guide for Selecting Materials, Spiral 2 (2nd edition), AMMTIAC, Sept 2006**
- **FICES Report, July 2013**
- **DoD Facility Criteria - Whole Building Design Guide** <http://www.wbdg.org>
 - **CPC Resource Page** <http://www.wbdg.org/resources/cpcsource.php>
 - **Unified Facility Criteria** http://www.wbdg.org/ccb/browse_cat.php?c=4
 - **Unified Facility Guide Specifications** http://www.wbdg.org/ccb/browse_cat.php?c=3
 - **NAVFAC Design-Build Performance Technical Specifications (PTS)**
<http://ndbm.wbdg.org/system/html/6/>
 - **Engineering and Construction Bulletins (ECB)**
http://www.wbdg.org/ccb/browse_cat.php?c=268

Policy, Guidance, and Resources



DoD Subject Matter Experts:

- CorrDefense <https://www.corrdefense.org>
- US Army Corps of Engineers, Engineer Research Development Center (ERDC)
<http://www.erd.usace.army.mil/>
 - Construction Engineering Research Lab (CERL), Champaign, IL
<http://www.erd.usace.army.mil/Locations/ConstructionEngineeringResearchLaboratory.aspx>
 - Geotechnical and Structures Laboratory (GSL), Vicksburg, MS
<http://www.erd.usace.army.mil/Locations/GeotechnicalandStructuresLaboratory.aspx>
- Naval Facilities Engineering Command
 - Engineering and Expeditionary Warfare Center (EXWC) Port Hueneme, CA
https://www.navfac.navy.mil/navfac_worldwide/specialty_centers/exwc/products_and_services/capital_improvements.html
 - Engineering Criteria and Programs Office. NAVFAC Atlantic, Norfolk, VA
- US Air Force Civil Engineering Center (AFCEC), Facility Engineering Directorate
<http://www.afcec.af.mil/facilityengineering/index.asp>

Industry:

- Master Painters Institute (MPI) <http://www.mpi.net/>
- NACE International (The Corrosion Society) <http://www.nace.org>
- SSPC (The Society for Protective Coatings) <http://www.sspc.org>

Training Sponsor



This training is provided by the



Office of the Secretary Defense (OSD),
Corrosion Policy and Oversight Office (CPO)

Additional corrosion prevention and control training for F&I professionals is under development and will be offered soon on the Whole Building Design Guide