Corrosion Prevention and Control for DoD Facilities

“A facilities optimization challenge”

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Steve Geusic – Leidos*
Sherri McMillion - NAVFAC

*Contract support to: OSD Corrosion Policy and Oversight
Today’s Discussion
Corrosion Prevention and Control

- Background of the Corrosion Prevention and Control (CPC) effort for Facilities

- Impact of Corrosion to DoD

- Partnerships and Resources

- Focus Areas
  - Identify Areas for Improvements
  - Strategies for Optimization
  - Progress
Defining Corrosion

More than just “Rust”

- **10 USC Sec. 2228**

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

DoD Facilities
(9/30/2017)

585, 816 Facilities (Buildings and structures) + Utilities, pipelines, roads, and ports at 4,775 Sites on 26.9 million acres of real property

Corrosion:
- Adds $2B to annual facility sustainment costs
- Affects mission and asset readiness (availability/capacity/productivity)
- Affects safety, health, quality of life, and the environment
The Optimization Challenge

- Unscheduled Maintenance
- Reduced Capacity
- Repairs
- Reduced Productivity

Asset Availability

Project First Costs vs. Sustainment Costs
How we got here

Law & Policy
- 10 USC Sec. 2228
- DoDI 5000.67

Oversight
- Office of the Secretary Defense Corrosion Policy and Oversight (CPO) – *Management and Risk Assessment*

Analysis & Data
- Facilities and Infrastructure Corrosion Evaluation Study
- DoD Facilities Maintenance Data

Focus Areas
- Training, Education & Knowledge Development
- Technology Transition
- Criteria and Policy– Unified Facilities Criteria
### Partnerships and Resources

#### Focus Areas
- **Training, Education & Knowledge Development**
- **Technology Transition**
- **Criteria & Policy**

#### Partners
- Military Corrosion Prevention and Control Executives
- Unified Facilities Criteria Program (ESEP/CP/DWG)
- DoD Subject Matter Experts NAVFAC/USACE/AFCEC
- Defense Acquisition University
- NIBS - WBDG
- Industry experts (NACE/SSPC/MPI)
- Private Architect and Engineering Consultants
Steve Geusic

Leidos

Contract Support for OSD Corrosion Policy and Oversight

Analysis and Strategy
Partnerships and Resources

Focus Areas

- Training, Education & Knowledge Development
- Technology Transition
- Criteria & Policy

WBDG – A Good Fit

- Facilities Knowledge Center
  - Resources – Training - Criteria
- Unified Facilities Criteria
  - DoD Subject Matter Experts
- WBDG Reach
  - Government
  - Industry
  - Private Architects and Engineers
  - Standards Orgs
Focus Area
Training, Education & Knowledge Development

Areas of Improvement
• Access to **CPC knowledge** across Facilities Life Cycle
• Develop **Training opportunities** and **Competencies**

**Corrosion Prevention and Control (CPC) Source**
Corrosion Prevention and Control Source

CPC Resources

- CPC Overview
- Training
- Best Practices
- Environmental Severity Classification (ESC)
- Planning
- Design and Construction
- Sustainment (SRM)
- Competencies
- Corrosion Costs
- Knowledge Areas (8)

Training Modules

- Corrosion Toolbox
  - ICCET (Metals)
  - Wood Decay Hazard
  - Pollution
CPC Knowledge Areas

Knowledge Areas (Current)
- Cathodic Protection
- Corrosion Science
- Doors
- Fencing
- Paints and Coatings
- Pavements
- Utilities and Buried Structures
- Waterfront and Coastal Structures

Planned Knowledge Areas
- Drydocks, Marine Railways
- HVAC Systems
- Exterior Structures
- Concrete
- Mold, Mildew, Moisture
- Plants (Boiler, Water, Wastewater)
- Weapons Systems Support
- Integrated Logistics Support
- Tropical Engineering Content
CPC Training Modules

Length - (1 hour)
Voice over/transitions/test
Qualifies for Professional Development Hours (PDH)
Leveraging WBDG training courses with DAU

WBDG Available

- Corrosion Fundamentals
- Cathodic Protection Basics
- CPC for Utilities and Buried Structures
- Waterfront and Coastal Structures

On Deck

- Coatings Fundamentals (3 Modules)
- CPC Facilities Lifecycle (Design/Construction/Sustainment)
- Fuel Utilities and Storage Tanks
- HVAC Systems/Building Envelope

1/25/2019
Focus Area
Technology Transfer

Technology Projects - Demonstration and Validation Phase (6.4)

Areas of Improvement
- Greater focus on CPC technologies
- Better transition of technologies to criteria and DoD projects

Outcomes: Improved process (better communication, risk analysis at validation, and development of an integration plan)
Technology Transfer
Case Study

Polysulfide Modified Novolac Epoxy
Low VOC Coating for Interior Welded Steel POL Tanks

**Goal** - Develop / evaluate Low VOC, easily repaired / maintained alternative for interior welded steel tanks for POL

**Demonstration/Application**
- Tested at 5 sites
- 100% solids –no VOC concerns
- 2 coats applied - Compared to traditional 3 coat epoxy systems
Technology Transfer
Results and Validation

**Results**

- Durability - Greater abrasion and impact resistance
- Adhesion - 2x greater (+2000 psi vs 800 to 1000 psi) helps reduce under film corrosion
- Polysulfide acts as “ball bearings”
  - Elongation 5x greater than typical epoxy
  - Flexibility much greater than typical epoxy
- Lower porosity reduced moisture vapor transmission
- Bridges Cracks and pinholes
- Higher water contact angle therefor easier to clean (greater slickness)
Technology Transfer
Benefits and Integration

**Benefits**
- Better chemical and fuel resistance
- Longer Service Life – 50 years vs. 20 years
- Easier to maintain and clean

**Costs**
- Higher material costs
- Reduced application cost – 2 vs. 3 coats
- Lower life cycle costs

**Integration and Impact**
- UFGS 09 97 13.15 “Low VOC Polysulfide Interior Coating of Welded Steel Petroleum Fuel Tanks”
- 1540 Welded Steel tanks DoD wide
- Can be applied to concrete tanks with an additional primer sealer
Focus Area
Criteria

**Extreme Option:** Require the use of the most corrosion resistant materials and coatings for all components and systems at all DoD locations.

**Areas of Analysis and Optimization**
- Systems and components that have high sustainment requirements
- Environmental severity effects (installation location)
- CPC awareness and enforceability in design and construction
Criteria CPC Gaps

Areas of Analysis and Optimization

- **High Sustainment Components and Systems**
  - DoD Maintenance Data - Corrosion related sustainment costs
  - By system (Doors, Windows, HVAC, etc.)
  - By location (installation)

- **Environmental Severity effects**
  - There are increase costs associated with severe environments
  - Need better integration of environmental severity in UFC and UFGS

- **CPC awareness and enforceability**
  - How is CPC communicated to designers and contractors
  - Project acquisition strategy – Design-Build
  - Guide Specifications (UFGS) – How is enhanced CPC requirements triggered
Corrosion Toolbox – ICCET
Environmental Severity Development

Estimates ISO 9223 corrosion categories  *For metals*

Algorithm
- Mass loss data of metal coupons at DoD installations
- NOAA ISD-Lite database (Hourly Temperature, Relative Humidity/Dew Point)
- Three equations based on distance to salt water
  - Less than 1 mile
  - 1 mile to 6 mile
  - Greater than 6 miles

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<tr>
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<th>Corrosivity</th>
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<td>C1</td>
<td>Very Low</td>
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<tr>
<td>C2</td>
<td>Low</td>
</tr>
<tr>
<td>C3</td>
<td>Medium</td>
</tr>
<tr>
<td>C4</td>
<td>High</td>
</tr>
<tr>
<td>C5</td>
<td>Very High</td>
</tr>
<tr>
<td>CX</td>
<td>Extreme</td>
</tr>
</tbody>
</table>
Corrosion Toolbox – ICCET

Environmental Severity Classification

User Inputs

- Coordinates: 40.0218, -74.2207
- Start year/month: 2010
- Range: 5 years
- Site is within 6 miles of saltwater: yes
- If yes, provide distance to saltwater: 4.4 miles
- Data Completeness: 90%

Log

- 542 kB of data downloaded in 2014
- 542 kB of data downloaded in 2013
- 473 kB of data downloaded in 2012
- 501 kB of data downloaded in 2011

“Go”

Review

- Weather Station: MONMOUTH EXECUTIVE AIRPORT
  - Quality: 92.2%
  - Distance: 19.4 km

Result

- Initial Model No 2
- Final Model No 2
- Estimated Steel Mass Loss: 29696 μg/cm²/a
- Estimated ISO Corrosivity Category: C3

Estimated Mass Loss

ISO Category

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<td>C5</td>
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</tr>
<tr>
<td>CX</td>
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### Environmental Severity Classification

UFC 1-200-01  
20 June 2016  
Change 2, 01 Nov 2018

#### Table B-1 ESC for US, Its Territories and Possessions

<table>
<thead>
<tr>
<th>State/Territories/Possessions</th>
<th>Installation Master Name</th>
<th>ESC*</th>
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<tbody>
<tr>
<td>Alabama</td>
<td>Anniston AR Depot</td>
<td>C3³</td>
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<td>Fort McClellan</td>
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<td>Fort Rucker</td>
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<td>Maxwell AF Base</td>
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<td>Redstone Arsenal</td>
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<td>Alabama National Guard</td>
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<td>Alaska</td>
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<td></td>
<td>Clear AF Station</td>
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<td>Eielson AF Base</td>
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<td></td>
<td>Joint Base Elmendorf-Richardson</td>
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<tr>
<td></td>
<td>Naf Adak Ak</td>
<td>C5³</td>
</tr>
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</table>
ESC - “Just the Beginning”

ESC alone cannot always correctly define the final corrosive condition:

Micro Climate & Exposure
- Structure Location
- Orientation
- Local Contaminants (Pollution)

Element Conditions
- Location on structure
- Detailing
- Adjacent materials & connections

Prevailing Wind

Two structural elements - one requires more protection
Sherri McMillion
Naval Facilities Engineering Command, Atlantic

Application:
Design and Construction Criteria
Criteria Strategy

Gaps and Data
- Corrosion Cost Data
- Environmental Severity (ESC)
- CPC Criteria
  - Awareness
  - Requirements
  - Triggers

Integration

Impact

UFC
RFP
UFGS
## Facility Corrosion Cost Drivers

<table>
<thead>
<tr>
<th>Building Envelope</th>
<th>Mechanical</th>
<th>Electrical</th>
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</thead>
<tbody>
<tr>
<td>• Doors/frames/hardware - #1</td>
<td>• HVAC systems</td>
<td>• Panels and breakers</td>
</tr>
<tr>
<td>• Windows/frames and storefronts</td>
<td>• Plumbing (piping and fixtures)</td>
<td>• Transformers</td>
</tr>
<tr>
<td>• Roofing</td>
<td>• Water heaters</td>
<td>• Lighting fixtures</td>
</tr>
<tr>
<td>• Gutters and downspouts</td>
<td>• Boilers</td>
<td></td>
</tr>
<tr>
<td>• Metal Building systems</td>
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</tr>
</tbody>
</table>

### Miscellaneous
- Stairways
- Fencing
- Exterior railing
- Wastewater plants
Transition into Design

UFC 3-101-01
ARCHITECTURE
Window types in ESC C4- C5 locations

UFC 3-110-01
ROOFING

UFC 3-301-01
STRUCTURAL
Concrete Cover Requirements
Discipline Design UFCs

- Defines Corrosion
- Design for ESC at the project location:
  - UFC 1-200-01 Appendix B with ESC for each DoD Installation
  - ESC C3-C5 require higher level of CPC in UFGS
- Applies ESC factors to Interior locations:
  - Bathrooms and locker rooms
  - Interior locations exposed to exterior or unconditioned
- Defines humid locations as ASHRAE 90.1 01A, 1A, 2A, 3A, 3C, 4C, and 5C
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<tr>
<td>Colorado</td>
<td>Pueblo Chemical Depot</td>
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<td>Dover AF Base</td>
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<td>District of Columbia</td>
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<td>Joint Base Anacostia-Bolling</td>
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<td>District Of Columbia National Guard</td>
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<td>Washington DC Reserves</td>
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<tr>
<td>Florida</td>
<td>Florida National Guard</td>
<td>C5^3</td>
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</tbody>
</table>
UFC 1-200-01: Overall Design

- **Drawing Details:**
  - Geometries preventing collection of debris and allowing water to drain
  - Dissimilar metal isolation

- **Material Requirements:**
  - **Coatings:**
    - Galvanized steel with an industrial coating.
    - Aluminum with an industrial protective coating or heavy duty anodized coating.
  - Type 316L stainless steel or duplex stainless steels.
Transition into UFGS

Applied ESC and other factors:
• Updated 35 UFGS sections – NOV 2018
• Selection of systems, components, materials

Example: UFGS 08 71 00 DOOR HARDWARE

2.5 FINISHES

NOTE: Use stainless steel in bathroom and toilet locations and in project locations with Environmental Severity Classifications (ESC) of C3 through C5. See UFC 1-200-01 for determination of ESC for project locations.
CPC Criteria Process
Case Study
Parking Structure – Washington Navy Yard
Cast-in- Place Concrete

Chapter 3
CPC General Requirements
Use ESC (App B)
Evaluate Local Factors

Washington Navy Yard:
ESC – C3 (Medium Corrosivity)

Soil Corrosivity → Pile Foundation
Pollution → Not Severe
Exposure → Salinity at Waterfront
Transfer of Road Salts

Designer consider C4?
CPC Criteria Process
Case Study

ESC – C4 (High Corrosivity)

UFGS 03 31 29 Marine Concrete
- Mix Requirements
- Reinforcement coatings

ESC C3-C5: Concrete cover selection criteria
Next Steps:

- Transition Mechanical and Electrical Tropical Engineering UFC Requirements
- Prioritize UFCs and UFGSs to fully incorporate CPC requirements:
  - Doors and Windows
  - Concrete
  - Metal Buildings
- Perform Life-Cycle-Cost and cost impact analysis
- Incorporate feedback through Criteria Change Request (CCR) process
## Criteria Feedback - CCR

**UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS)**

UFGS Master Updated August 17, 2018; Posted August 23, 2018

Unified Facilities Guide Specifications (UFGS) are a joint effort of the U.S. Army Corps of Engineers (USACE), the Naval Facilities Engineering Command (NAVFAC), the Air Force Civil Engineer Center (HQ AFCEC) and the National Aeronautics and Space Administration (NASA). UFGS are for use in specifying construction for the military services.

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<td>UFGS 03 11 13.00 10 Structural Cast-In-Place Concrete Forming</td>
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<td>05-01-2014</td>
<td>PDF</td>
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</tbody>
</table>
Criteria - Lessons Learned

ESC’s
- General Location
- Atmospheric
- Applies mostly to Metals

Designer Responsibilities
- Micro Climate
- Exposure
- Element Conditions and Detailing

Other Environmental Factors and Materials
- Better quantify and classify corrosive environmental factors such as UV, soil contaminants, insects, and pollution
- Application to non-metals – Timber, composites, concrete, etc.
Way Forward

- Corrosion significantly impacts costs, availability, and safety of DoD facilities
- DoD is taking a comprehensive approach to reduce these impacts:
  - Policy and guidance
  - Training and knowledge deployment
  - Technology and tools
  - Criteria and specifications
- Goal is to achieve required availability and safety with optimal first cost and sustainment investments