DEMONSTRATION AND VALIDATION OF TECHNOLOGIES TO MITIGATE CORROSION ON INFRASTRUCTURE COMPONENTS AT FORT BRAGG: INITIAL RESULTS

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**Report Documentation Page**

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**Standard Form 298 (Rev. 8-98)**
Prepared by ANSI Std Z39-18
Outline

- Corrosion Issues at Fort Bragg
- Project Description
- Technical Approach
  - Evaluation Procedures
- Technology Application
- Results
- Summary
Corrosion Issues at Fort Bragg

- Serious corrosion of infrastructure components evident at Fort Bragg, NC

- Two key issues
  - Mechanical Rooms
    - Example - newly constructed 16th Military Police Barracks
      - Accelerated corrosion of exposed union joints
      - Significant amount of condensate build-up on insulation covering supply lines
  - Cooling Tower Pumps
    - Relatively new (put on line in 1996) central cooling plant
    - Vertical cooling towers and pumps corroding
    - Total failure due to corrosion within two to four years of operation
Corrosion Issues at Fort Bragg (cont.)

- Mechanical Room Piping

Mechanical Room at Fort Bragg, with corroded piping union joints
Corrosion Issues at Fort Bragg (cont.)

- Cooling Tower Pumps

Cooling towers, Central Cooling Plant, Fort Bragg

Overhead view of pump sump
Corrosion Issues at Fort Bragg (cont.)

- Cooling Tower Pumps (cont.)

Removed pump, showing severe corrosion on shaft (near water surface)
Project Description

- “Demonstration and Validation of Technologies to Mitigate Corrosion on Mechanical Room Utility Piping and Cooling Tower Pumps at Fort Bragg, NC”
- Sponsored by the Office of the Secretary of Defense (OSD) under the Corrosion Technologies for Defense Systems and Infrastructure (CTDSI) Program
Technical Approach

- Mechanical Room Piping and Joints
  - Focus on commercial off the shelf (COTS) solutions
  - Mechanical Room A: Evaluation of Two High Performance Coating Systems
    - White-pigmented, moisture-cure polyurethane coating
    - Ceramic-filled, insulating coating
    - Removable insulation system over top of polyurethane coating
  - Mechanical Room B: Evaluation of Dehumidification System
  - Mechanical Room C: Control
Technical Approach (cont.)

• Dehumidification Systems for Corrosion Protection
  – Mechanical Room B
  – Benefits clearly demonstrated in past efforts


Technical Approach (cont.)

- **Cooling Tower Pumps**
  - Focus on COTS solutions
  - Two controls
    - One brand new pump
    - One recently-refurbished pump
  - Two High Performance Coating Systems
    - Paint System No. 21-A-Z
      - Recommended by ERDC-CERL
      - MIL-DTL-24441/19B zinc-rich epoxy (primer), MIL-DTL-24441 Formula 151 (topcoat)
    - “High Performance” Coating System
      - Recommended by coating applicator
      - Already on recently-refurbished pump
      - Epoxy (primer), Multi-Purpose Epoxy (topcoat)
  - Corrosion-Resistant Alloy
    - 316 stainless steel shaft (proposed by manufacturer)
Evaluation Procedures

- **Applied Coatings, Insulation, Systems**
  - Evaluate in accordance with ASTM and other relevant specifications

- **Corrosion Test Coupons in Mechanical Rooms**
  - Mild steel, 3" by 6"
  - Two each of different coating systems and two uncoated, bare steel panels
  - One coated test panel for each coating system scribed to base metal in accordance with ASTM D1654; other unscribed
  - Condition of test panels documented and photographed upon installation
  - Visually inspected on monthly interval
Evaluation Procedures (cont.)

- Corrosion Test Coupons in Cooling Pump Sumps
  - Same procedure as for those in mechanical rooms
- Corrosion Sensors in Cooling Pump Sumps
  - Measure and monitor corrosivity of water system with corrosion rate monitors (electrical resistance sensors)
Technology Application

- Mechanical Room Piping and Joints
  - Existing rust from exposed piping removed
  - Coating systems applied

Pre-installation, chill water pump: rust evident even on stainless steel flanges

Primer: aluminum-loaded polyurethane

Ceramic topcoat
Technology Application (cont.)

- Mechanical Room Piping and Joints
  - Additional protective systems installed

Removable insulation

Dehumidification used in another mechanical room
Technology Application (cont.)

- Cooling Tower Pumps
  - Pumps removed
  - Sandblasted to remove corrosion
Technology Application (cont.)

- Cooling Tower Pumps
  - Coating systems applied
  - Pumps reinstalled

Paint System No. 21-A-Z
Epoxy System

316 Stainless Steel
Results

- Mechanical Rooms
  - Coated test panels in all mechanical rooms pristine after twelve months of exposure
Results (cont.)

- Mechanical Rooms (cont.)
  - Coated fittings generally performed well
    - Some corrosion after twelve months of exposure, but only in certain instances
    - Both coatings performed better on hot water lines than on cold water lines, as expected
      - Condensation on cold water lines is a contributor
    - Performance not consistent on all fittings

Coated Union Joints, Mechanical Room A, Twelve Months of Exposure
Results (cont.)

- Mechanical Rooms (cont.)
  - In general, the removable insulation was not effective
    - Difficult to apply, loose fitting
    - Accumulated water (condensation) that dripped out of the ends
Results (cont.)

- **Mechanical Rooms (cont.)**
  - In general, dehumidification was not effective
    - Dehumidifier, although correctly sized for Mechanical Room B, was not able to effectively and consistently reduce humidity (and subsequently corrosion) in that room

![Graph showing relative humidity over time](image)

**Series1**
**Series2**
**Poly. (Series2)**
Results (cont.)

- Cooling Tower Pumps
  - Corrosion observed on uncoated panels in sumps in Feb 2009 (one-month exposure)
Results (cont.)

- Cooling Tower Pumps (cont.)
  - After twelve months of exposure, Paint System No. 21-A-Z outperformed commercial epoxy system
Summary

- A number of critical infrastructure corrosion issues have been identified at Fort Bragg
  - Two of the most critical involve the corrosion of piping union joints in mechanical rooms and the corrosion of cooling tower pump shafts
- A number of technologies to mitigate the subject corrosion issues have been identified and are being demonstrated
  - Advanced coatings, removable insulation, and dehumidification for mechanical room piping
  - Advanced coatings and materials for cooling tower pump shafts
Summary (cont.)

- **Mechanical Room Technologies**
  - Both coatings were effective in reducing corrosion in twelve months of exposure.
  - Coatings more effective on hot water lines than cold water lines.
  - Corrosion appears to be due to condensation rather than atmosphere.
  - Neither dehumidification nor removable insulation appeared to be effective as stand-alone technologies.
  - Combination of coatings and dehumidification may be optimal.

- **Cooling Tower Pump Technologies**
  - After twelve months of exposure, Paint System No. 21-A-Z outperformed commercial epoxy system.
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  - Dr. Gay Kendall, Fort Bragg
  - Mr. Al Beitelman, ERDC-CERL
  - M&T Machine
  - Honeywell Fort Bragg
Thank You!

Questions?
Backup Slides
Introduction - Corrosion of Military Infrastructure

- Military facilities affected by severe corrosion
  - CONUS and OCONUS
  - From 2003\(^1\):
    • More than two-thirds of military facilities unable to meet certain mission requirements
    • Degradation of runways and airstrips
    • Degradation of maintenance facilities (Navy aircraft hanger ceiling)
    • Corrosion of aircraft refueling equipment
    • Corrosion of fire protection assets
    • Degradation of electrical and command/control facilities

- Application of appropriate available corrosion prevention technologies (coatings, materials, etc.) can address this problem

\(^1\)Source: “Defense Management: Opportunities to Reduce Corrosion Costs and Increase Readiness,” United States General Accounting Office Report to Congressional Committees, July 2003
Project Description (cont.)

- **Project Objectives**
  - Demonstrate/validate technologies to address corrosion problems in barracks mechanical room piping/joints and cooling tower pumps/systems at Fort Bragg, NC
  - Modify standard operating procedures and procurement guidelines as needed
  - Demonstrate enhanced long-term system reliability and safety at reduced costs compared to current practices

- **Project Team**
  - Concurrent Technologies Corporation (CTC)
  - U.S. Army Corps of Engineers, Engineer Research & Development Center Construction Engineering Research Laboratory (ERDC-CERL) – Project Manager
  - Fort Bragg Department of Public Works (DPW)
  - Other contractors