Non-Drip Brush Zn-Ni for Touch Up for Localized Repair

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2018 ASETS Defense Workshop
22 Aug 2018

DISTRIBUTION A. Approved for public release: distribution unlimited. 88ABW-2018-4037, 15 August 2018

Technical Objectives and Team

- Demonstrate/validate and implement Dalistick brush plating station
- Test/evaluate and qualify Zinidal Aero Zn-Ni brush plated coating
- Develop technical package for technology transition and implementation

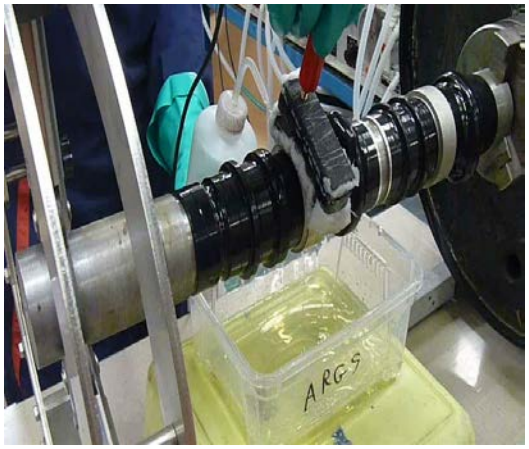
University of Dayton Research Institute

Benefits

- **Brush Plating Repair Operations**

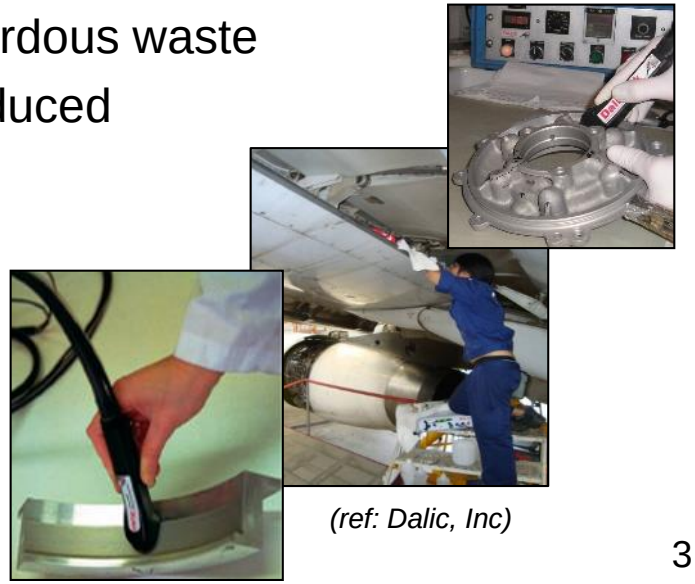
Cd brush electroplating *is used to repair worn and corroded parts in many cases while components are still installed on the aircraft*

- **Traditional Brush Plating**
  - Messy
  - Higher hazardous waste
  - Single use solution



(ref: K.Legg – ASETDefence)

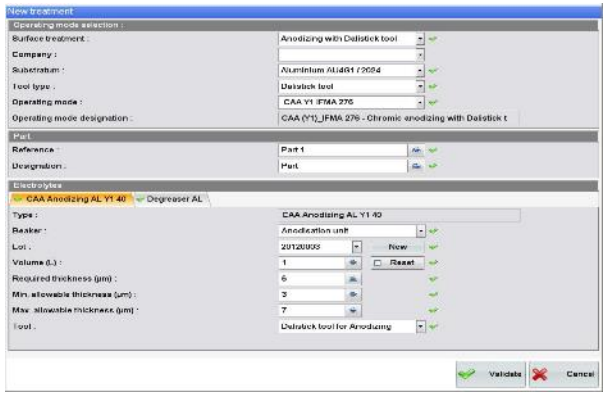
- **Dalistick Station**
  - More environmentally friendly
  - Recycles brush plating electrolyte at for reuse in a closed-loop process:
    - Solution life/use is extended
    - Hazardous waste is reduced



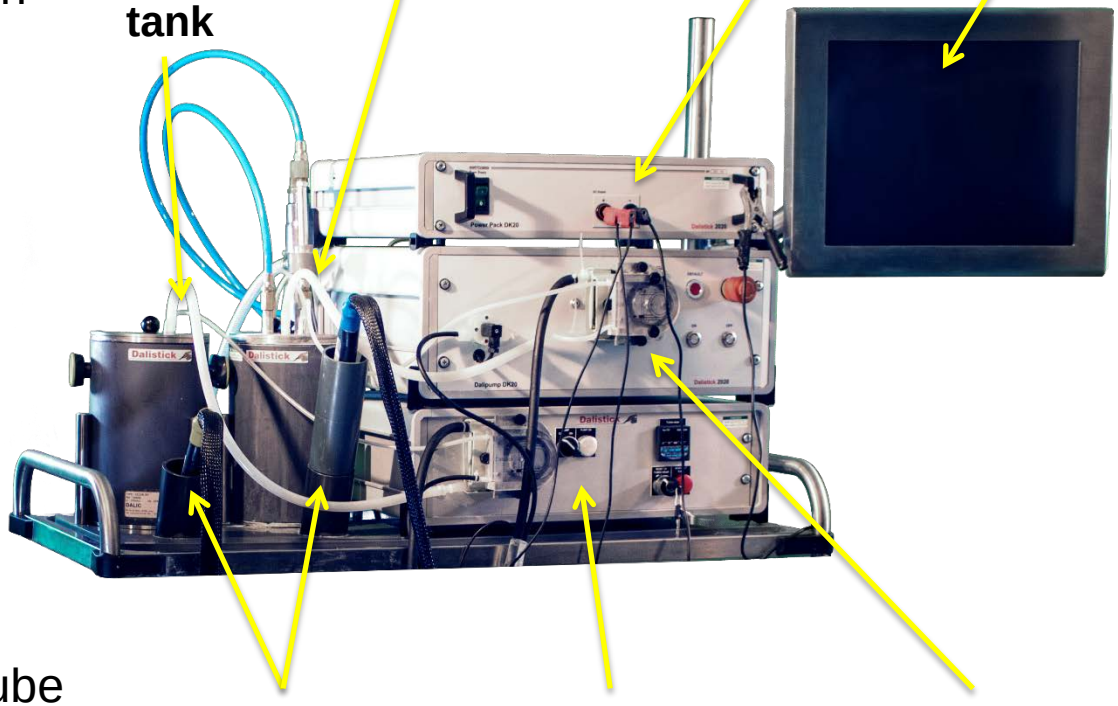
(ref: Dalic, Inc)

Brush Plating Tool

- **Computer control**
  - Automatic quality control
  - Easy operator instructions
  - Data logging to capture run conditions, voltages, currents, times

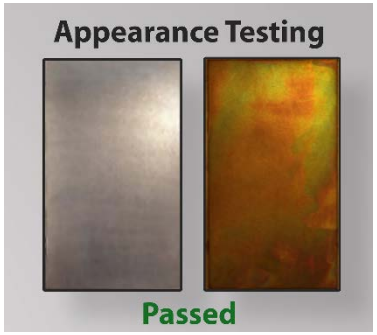


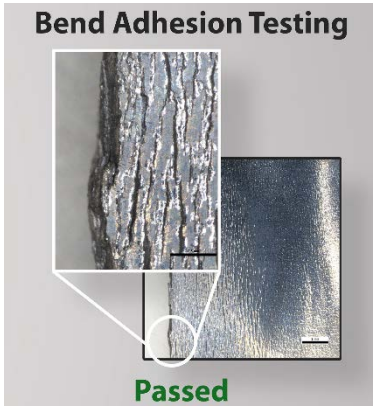
- **Second tank**
  - No solution change and tube rinsing steps between activation and plating processes

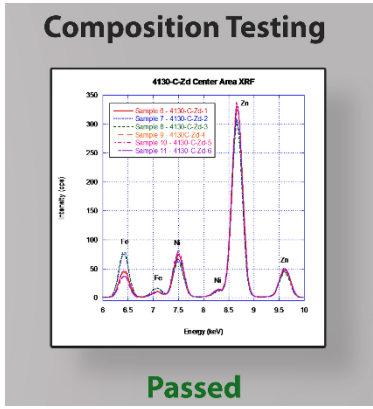


Completed Screening Testing

- Appearance – Passed
  - Must be smooth, continuous, adherent to the basis metal, and visually free from detrimental imperfections
- Coating thickness – Passed
  - 8-18 Microns thick
- Coating composition – Passed
  - Between 10% and 14% percent Ni
- Bend Adhesion – Passed
  - Crazing is acceptable, but flaking or lifting of the deposit is a failure
- Salt spray – Results comparable to Zn-Ni control
  - No red rust on base metal until after 500 hr. of exposure
    - Zn-Ni Specimens did not meet 500 hr. JTP requirement



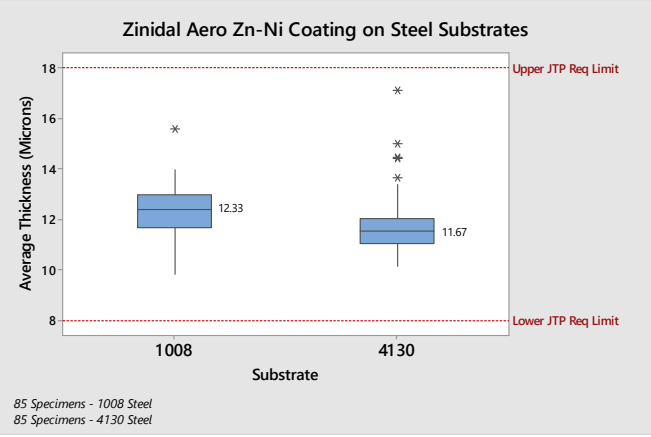


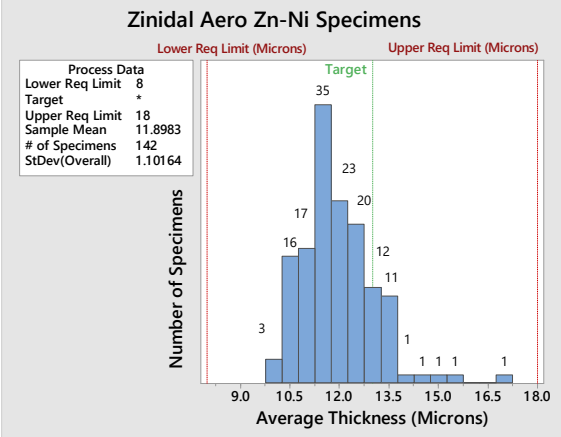


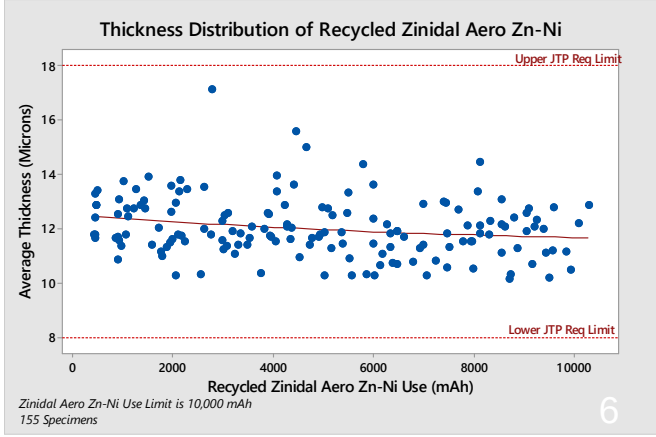
Sensitivity Study

- Thickness variation of Dalistick Station process based on
  - Operators – Minimal Variation
  - Substrate – Minimal Variation
  - Plating area size – Minimal Variation
  - Inside vs. edges of plating area – Minimal Variation
  - As Activator XF solution is recycled – Minimal Variation
  - As Zinidal Aero Zn-Ni solution is recycled – Minimal Variation
- Showed better thickness control than traditional brush plating

*Note: All specimens passed appearance and tape adhesion



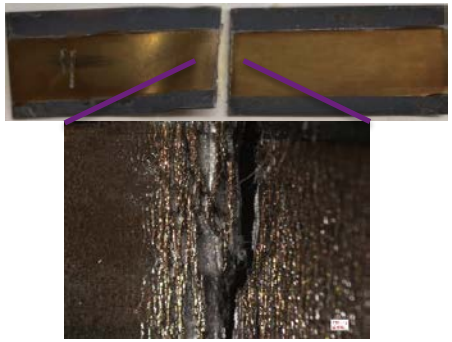




Completed Qualification Testing

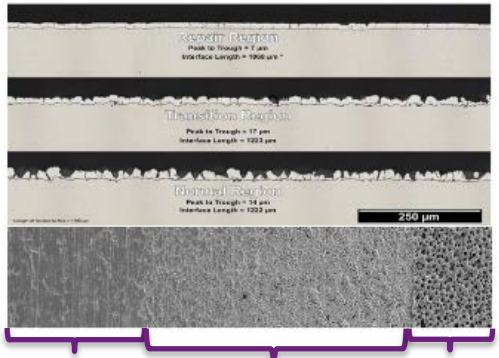
- Testing on simulated Cd and Zn-Ni tank plating repairs
  - Bend Adhesion – All passed
  - Composition – Consistent Zn-Ni composition and good repair capability
  - Galvanic Testing – Comparable performance to control specimens
  - Outdoor Exposure – 1 year 8 month beach exposure, no corrosion

Bend Adhesion



Zinidal Aero Zn-Ni Specimen

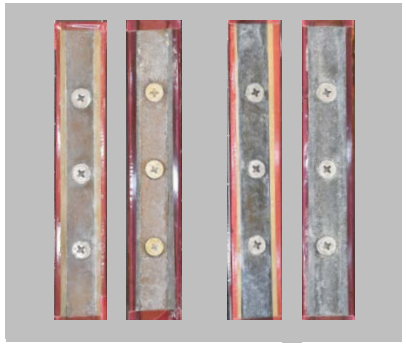
Composition



Brush Repair | *Transition* | Tank Plating

Zinidal Aero Zn-Ni Specimen

Galvanic



Brush Plated Zn-Ni Control | *Zinidal Aero Zn-Ni*

Outdoor Exposure

Beach Exposure Specimens

Completed Qualification Testing Cont.

- Testing on simulated Cd and Zn-Ni tank plating repairs
  - Salt Spray - Comparable performance to control specimens
  - SO2 – All specimens failed 128 hr. exposure
  - Strippability – Comparable removal to control specimens
  - Wet/Dry Adhesion – Worse performance than control specimens

Salt Spray

Zinidal Aero Zn-Ni

Brush Plated Zn-Ni Control

Strippability

Plated

Stripped

SO_2

Zn-Ni Tank Plated Repair

Cd Tank Plated Repair

Wet/Dry Adhesion

Pass

Fail

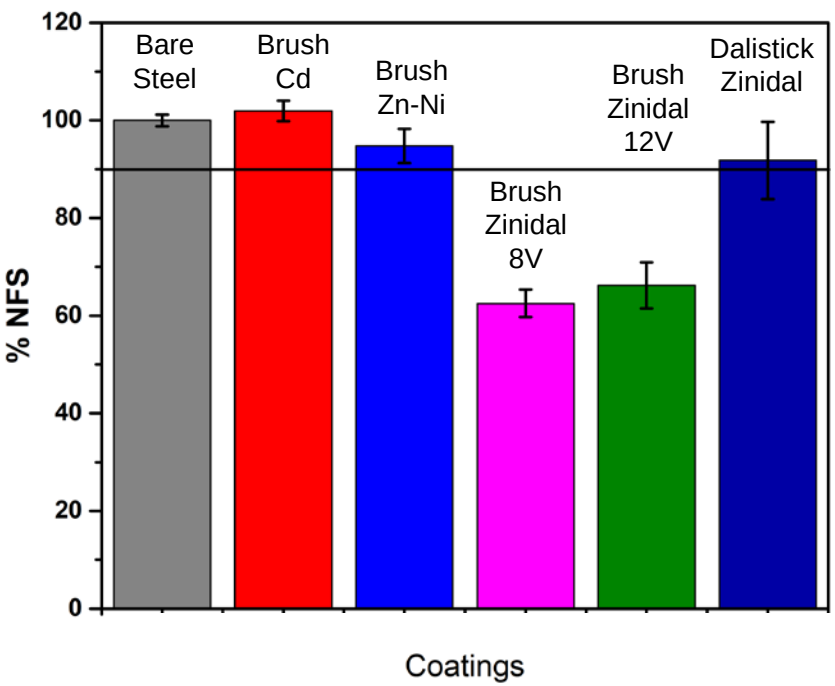
Hydrogen Embrittlement

- Partnered with Boeing and IBECA Technologies
- Goal: To qualify brush plated Zn-Ni coatings as a repair coating without baking requirement
  - Performing testing to determine causes and failure modes of hydrogen embrittlement in Zn-Ni brush plating
  - First phase complete

Hydrogen Embrittlement Phase I

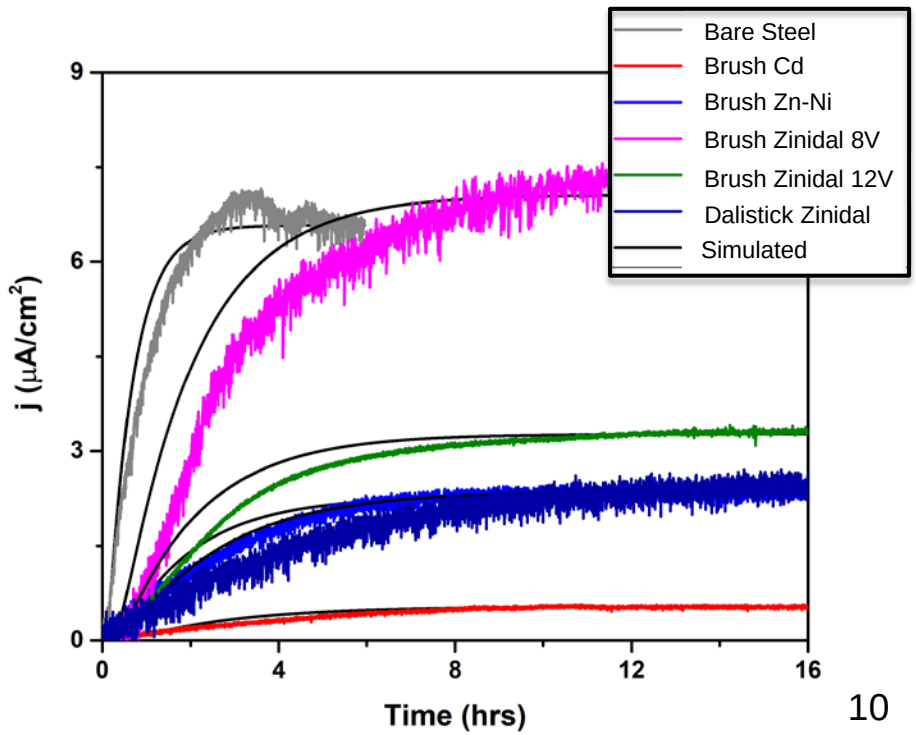
Incremental Step Loading

- Determines if specimen is embrittled
  - Cd, Zn-Ni control, and Dalistick plated Zn-Ni - Pass
  - Traditionally Plated Zinidal - Fails



Electrochemical Permeation

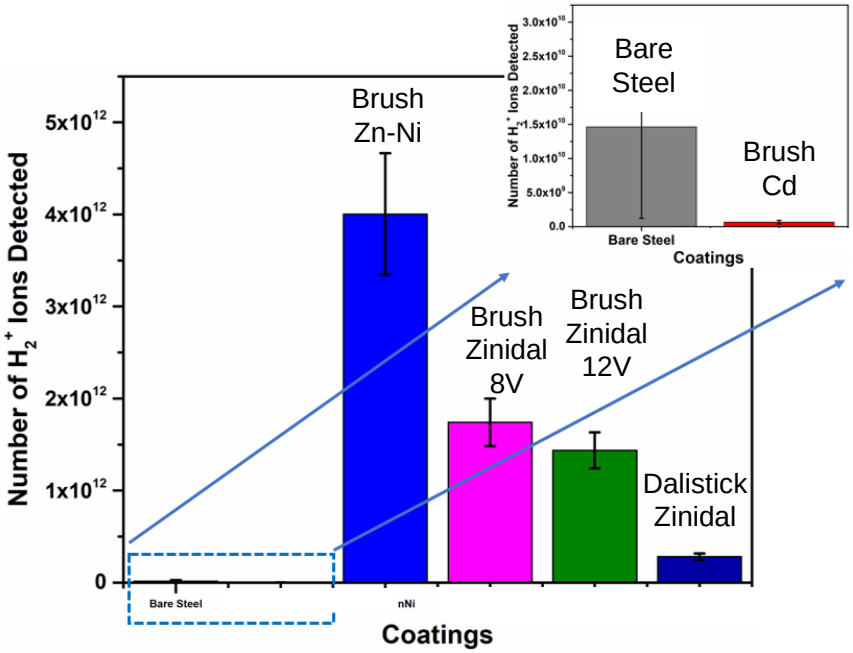
- Measures the dependency of the coating microstructure on effective hydrogen diffusion
  - Zn-Ni control, and Dalistick plated Zn-Ni are similar



Hydrogen Embrittlement Phase I Cont.

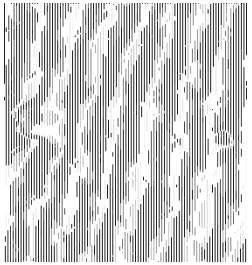
Vacuum Thermal Desorption Spectroscopy

- Measures the amount of hydrogen desorption in a coated specimen
  - Hydrogen desorption for Zn-Ni control is higher than Dalistick plated Zn-Ni

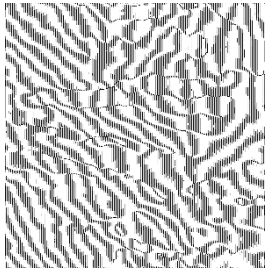


Fractography / Coating Characterization

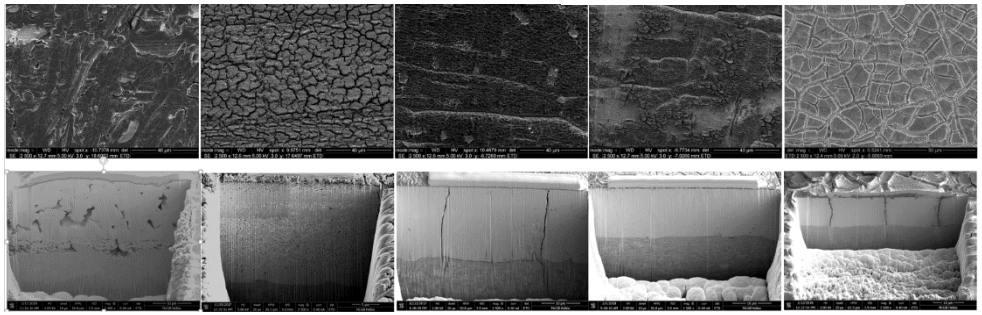
- Understanding Microstructure
  - Presence of dislocations and other crystal defects can influence hydrogen embrittlement of substrate steel



Brush Cd Dislocations



Dalistick Zinidal Dislocations



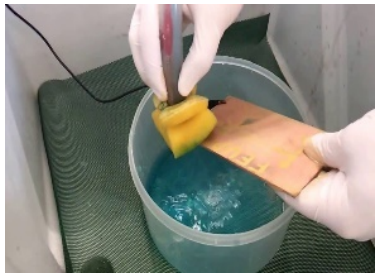
Brush Cd | Brush Zn-Ni | Brush Zinidal 8V | Brush Zinidal 12V | Dalistick Zinidal

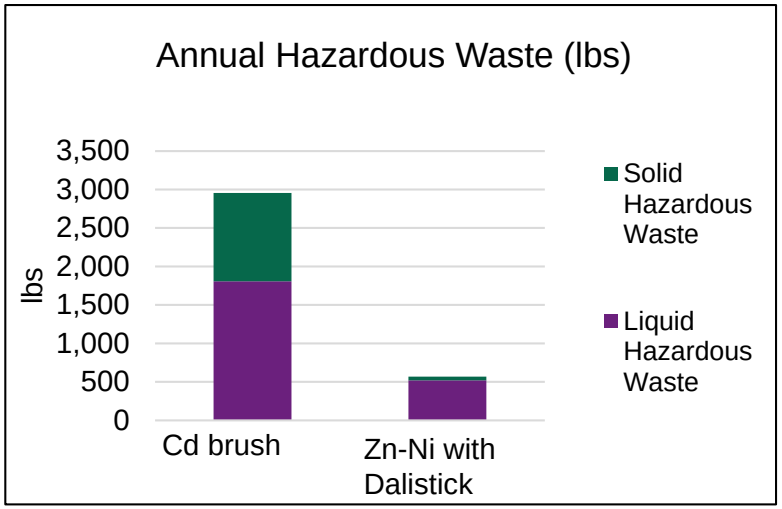
Technology Demonstration

- Technology Demonstration will occur with the Fleet Readiness Center Southeast (FRCSE) at the Naval Air Station in Jacksonville, FL
  - Demonstrate feasibility of the station and Zn-Ni solution to be performed in DoD maintenance
  - Gain operator feedback from experienced platers
  - Currently being planned
  - Expected to being Q3/4 2018

Sustainability Analysis

- NOBLIS performed a sustainability analysis to determine life cycle costs of Dalistick Zn-Ni plating
  - Slightly higher life cycle costs compared to traditional Cd brush plating
  - Lower annual hazardous waste vs. traditional Cd brush plating

Traditional Cd Brush Plating	Dalistick Zn-Ni Plating
	
$4,176,303	**$4,384,022**



Ongoing and Upcoming Work

- Technology Demonstration
- Technology Transition Plan based on demonstration
- Hydrogen Embrittlement Phase II with Boeing/IBECA
  - Determine process effects on hydrogen embrittlement
- ASTM F-519 hydrogen embrittlement testing

Questions?