INDUSTRIAL FASTENERS INSTITUTE

October 9, 2013

***October 2013 Fastener Industry Technology Update***

This document contains information about activities in fastener standard and other technical issues relevant to the fastener industry over the past month.

1. ***Standards Organizations Activities***
    a. ***No standards published during September***
    b. ***Standards in the publishing stage***
        i. ***B18.6.3 –*** Inch machine and tapping screws

    c. ***Standards in the revision process***
        i. ***ASME B18.16.6 –*** Inch Lock Nuts. This has been balloted once. The negatives and comments were responded to and the next ballot will take place in October.
        ii. ***ASME B18.24 –*** Fastener part identification numbering system
        iii. ***ASME B18.31.2 –*** Inch studs
        iv. ***ASME B18.31.3,*** Threaded rod (inch)
        v. ***ASTM F606/F606M,*** Fastener Testing Standard, the inch and metric standards are being combined into a single standard. The first ballot will close in mid-October. The negatives and comments will be addressed and another ballot will go out before the end of 2013.
        vi. ***ASTM F16 Structural Bolt Standard –*** A new standard is in the works which is a compilation of inch and metric bolt standards including A325, A490, F1852, F 2280, A449, A354, A325M, and A490M. This is an effort to make the requirements of these related bolt standards consistent. One ballot has closed the results will be discussed at the F16 November meeting.
        vii. ***ASTM F1941,*** Electroplating Standard for Fasteners.
        viii. **ISO/CD 13469 –** Riveted Joint Testing
        ix. ***ISO 10683 –*** Zinc flake coatings for fasteners, is being prepared for final ballot sometime by mid-2014.
        x. ***ISO 4042 –*** Electroplating finishes for fasteners was discussed for two days in an ad hoc meeting in Paris during June. The majority of the work was on Appendix B which addressed Hydrogen failures and how to manage process variables to decrease its potential effects. No ballot is expected until 2014.
        xi. ***ISO 3269 –*** Fastener acceptance, first draft proposal to convert this standard from an AQL plan to a C=0 plan has been submitted to the ISO TC 2 by the US. The Committee agreed to continue work to rationalize the proposed samples verses the current sample sizes. Formal committee work will begin on this in October, 2013 in Paris.
        xii. ***ISO 6157 –*** Fastener surface discontinuities was discussed in Sydney. Work will continue in working group in 2014.
        xiii. ***ISO 2320 –*** Locking nut performance – agreements were reached in Sydney. A ballot should be issued in early 20114.

2. ***IFI Technical Working Group activities in progress:***
    a. ***Division I – Blind Rivet Standards-***
        i. ***IFI* 116 – Multi-grip Blind Rivet Standard**. This is a new IFI standard covers blind rivets that can cover a wider range of application thicknesses than the rivets covered by IFI 114. The standard will be completed before the end of November.

3. ***Other Technical Information:***
    a. See attached ***Boeing Report on Zinc-nickel alloy Plating*** as a potential replacement for cadmium in aerospace applications.
    b. Note on ***zinc-nickel alloy*** (12 – 16%) plating – the European automakers started aggressively replacing steel components with aluminum several years ago to achieve weight savings. They ran into galvanic corrosion issues early on. After extensive research they have concluded the best steel fastener finish for use in aluminum components is zinc-nickel alloy which is covered by ASTM F1941 as a Fe/Zn-Ni series of plating thicknesses. In addition to eliminating galvanic corrosion it has about 10 times the salt spray resistance then the comparable zinc electroplate and is much less susceptible to hydrogen failures.
    c. The next fastener training opportunity is the Fastener Training Institute Fastener Training Week held at the IFI headquarters in Independence, Ohio on November 18 – 22. For more information see, http://www.fastenertraining.org/fastener-training-week/.

Joe Greenslade
IFI Director of Engineering Technology

# Evaluation of Dipsol IZ-C17 LHE Zinc-Nickel Plating

By:
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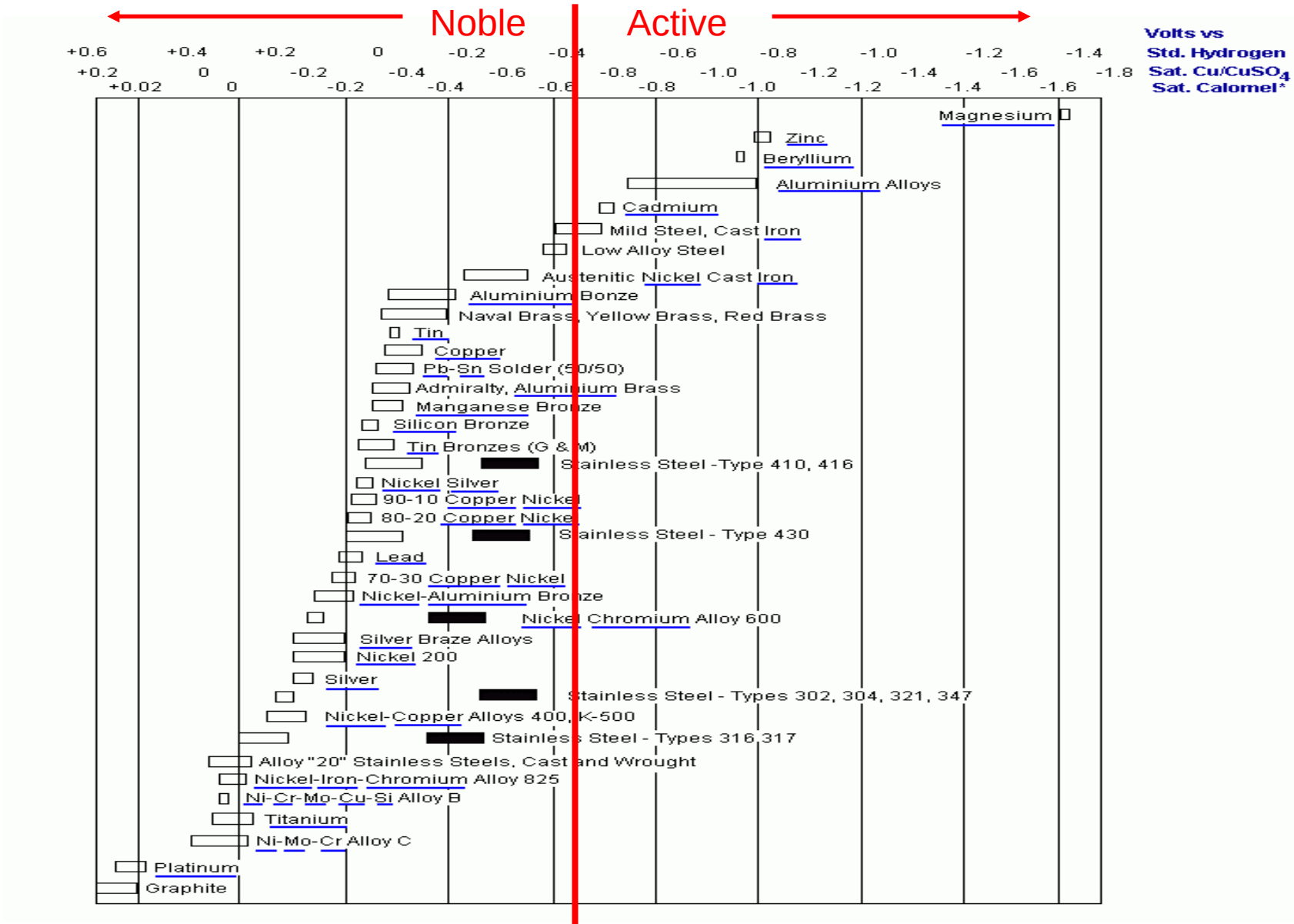
Boeing – St. Louis
for
HCAT/JCAT Meeting
January 24, 2007

# Intro

- Key Attributes for Cadmium Plating Alternatives:
  - Drop-In Replacement
  - Sacrificial to Steel When It Corrodes
  - Corrodes Slowly (Long Life in Salt Water)
  - Non-Embrittling to High Strength Steel
    - Plating Process
    - Maintenance Fluids
- So Why Zinc-Nickel Plating?

# Cadmium Alternatives are Limited!



# Proposed Cadmium Alternatives

- Cadmium Alternative Coatings for Steel
  - Aluminum (IVD-Sputter Aluminum, Alumiplate)
  - Beryllium (Too Toxic)
  - Zinc (Too Active – Corrodes Too Fast)
  - Magnesium (Extremely Active – Corrodes Rapidly)
- Zinc Alloys Can Reduce Activity of Zinc
  - Zinc-Nickel Preferred (Zn-Fe, Zn-Mn, Zn-Co, Zn-Sn, Sn-Zn Not Acceptable)
    - Zinc-Nickel is Sacrificial to Steel if Ni < ~18%
    - Nickel Alloyed to Zinc Has Low Corrosion Rate in Salt Water
      - No Excessive White Corrosion Products

# Zinc-Nickel Alloys

- What is Best Ni Composition in Zinc-Nickel Plating?
  - 4 to 18% Appears to Give Good Corrosion Resistance and Sacrificial Protection to Steel
  - High % Ni Appears to Create a Non-Embrittling Plating Process
- What is Best pH for Zinc-Nickel Plating?
  - Alkaline Plating Appears to Be Easier to Use
    - Bath Easier to Maintain
    - Throwing Power Good and No Variance in % Ni

# Zn-Ni Versions for Aerospace and Automotive Industry

- Aerospace Needs a Different Version of Automotive Zn-Ni Plating
  - High Strength Steel Used In Aerospace
    - Hydrogen Embrittlement
    - Fatigue Life
  - Corrosion Performance
    - Aerospace Parts Required to Have a Longer Service Life and Higher Reliability Than Automotive

# Pre 2003 Zinc-Nickel Plating

- Pre 2003 There Were Two Zinc-Nickel Processes Being Considered at Boeing
  - Boeing Acid Zn-Ni Plating (with BoeNiz)
    - Passes ASTM F 519 Embrittlement Tests - BUT
      - Plating Process is Not Operator Friendly
      - ASTM F 346 Electronic Hydrogen Measurement (or Similar Method) Cannot Be Used
  - Dipsol IZ-260 Alkaline Zinc-Nickel Plating
    - Occasionally Fails ASTM F 519 Embrittlement Test
    - Plating Process is Operator Friendly - BUT
      - Needed a Nickel Strike to Pass ASTM F 519 on a Consistent Basis

# LHE Alkaline Zn-Ni Plating

- C-17 Pollution Prevention Project - 2003 to 2005
  - Develop an LHE (Low Hydrogen Embrittlement) Version of Alkaline Zn-Ni Plating
    - Look at Different Zn-Ni Formulas with Nickel Composition of 5 to 17%
    - Remove Brighteners and Other Additives to Make Plating Dull (Porous)
    - Vary the Current Density

# LHE Alkaline Zn-Ni Plating

- Boeing Teamed with Dipsol of America to Develop an LHE Alkaline Zn-Ni Plating
  - Dipsol Produces IZ-260 Alkaline Zn-Ni Plating
    - Used by Several DoD and Aerospace Subcontractors
      - IZ-260 Has 5 to 8% Nickel – Balance Zinc
    - Dedicated R&D Laboratory in Tokyo, Japan
    - Excellent Technical Support at Laboratory in Livonia, MI
    - Dipsol Understands Zn-Ni Plating Chemistry

# 2003-05 Test Results

- Based on Successful Test Results an LHE Alkaline Zn-Ni Formula was Selected for Further Development
  - Identified as Dipsol IZ-C17 (13 to 17% Ni)
- IZ-C17 Had Good Corrosion Performance
- IZ-C17 Passed Hydrogen Embrittlement and Re-Embrittlement Testing with 1a.1 and 2a
  - Re-Embrittlement Test Specimens Exposed to Distilled Water and 3.5% Salt Water

# Zinc-Nickel Corrosion Test


**IZ-C17 LHE Zn-Ni**


**Cadmium**

**ASTM B 117 – 816 Hours Exposure**

# IZ-C17 – HE Test Results

| Test Description | Specimen Type | ID No. | 200 Hour Result (Pass/Fail) | ISL After 200 Hour Test (% NFS) |
|---|---|---|---|---|
| Set #1 - Plate Entire Specimen | 1a.1 | AQ3789 | Pass | 80 |
| Set #1 - Plate Entire Specimen | 1a.1 | AQ5767 | Pass | 85 |
| Set #1 - Plate Entire Specimen | 1a.1 | AQ3623 | Pass | 90 |
| Set #1 - Plate Entire Specimen | 1a.1 | AQ3675 | Pass | 80 |
| Set #2 - Plate at 3 Times Current Density | 1a.1 | AS1279 | Pass | 80 |
| Set #2 - Plate at 3 Times Current Density | 1a.1 | AS1487 | Pass | 90 |
| Set #2 - Plate at 3 Times Current Density | 1a.1 | AS1026 | Pass | 85 |
| Set #2 - Plate at 3 Times Current Density | 1a.1 | AS1248 | Pass | 85 |
| Set #3 - Plate with No Preplate Acid Activation | 1a.1 | AS1385 | Pass | 95 |
| Set #3 - Plate with No Preplate Acid Activation | 1a.1 | AS1085 | Pass | 90 |
| Set #3 - Plate with No Preplate Acid Activation | 1a.1 | AS1040 | Pass | 90 |
| Set #3 - Plate with No Preplate Acid Activation | 1a.1 | AS1281 | Pass | 95 |
| Set #4 - Plate with Preplate Acid Activation | 1a.1 | AS1264 | Pass | 90 |
| Set #4 - Plate with Preplate Acid Activation | 1a.1 | AS1198 | Pass | 90 |
| Set #4 - Plate with Preplate Acid Activation | 1a.1 | AS1421 | Pass | 90 |
| Set #4 - Plate with Preplate Acid Activation | 1a.1 | AS1148 | Pass | 85 |
| Set #5 - Plate with Preplate Acid Activation | 2a | 44911-12 | Pass | - |
| Set #5 - Plate with Preplate Acid Activation | 2a | 44911-47 | Pass | - |
| Set #5 - Plate with Preplate Acid Activation | 2a | 44911-54 | Pass | - |
| Set #5 - Plate with Preplate Acid Activation | 2a | 44911-1 | Pass | - |

**Hydrogen Embrittlement Results for IZ-C17**

# IZ-C17 – Re-Embrittlement Tests

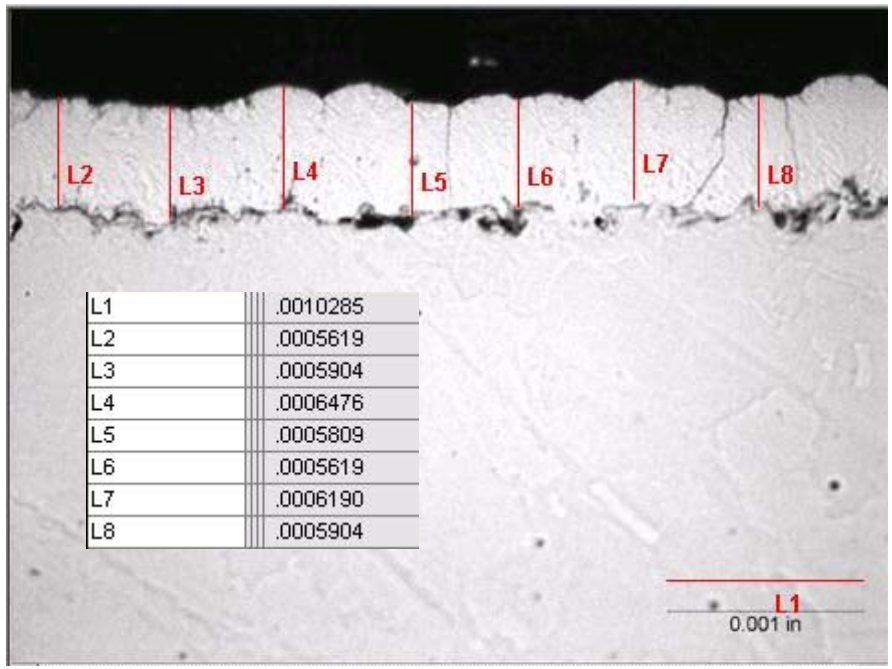
| Re-Embrittlement Test Fluid | Specimen Type | ID No. | 150 Hour Result (Pass/Fail) |
|---|---|---|---|
| | | | |
| Distilled Water | 1a.1 | AS1224 | Pass |
| Distilled Water | 1a.1 | AS1166 | Pass |
| Distilled Water | 1a.1 | AS1368 | Pass |
| Distilled Water | 1a.1 | AS1169 | Pass |
| | | | |
| 3.5% Salt (NaCl) Water | 1a.1 | AS1001 | Pass |
| 3.5% Salt (NaCl) Water | 1a.1 | AS1415 | Pass |
| 3.5% Salt (NaCl) Water | 1a.1 | AS1328 | Pass |
| 3.5% Salt (NaCl) Water | 1a.1 | AS1286 | Pass |
| | | | |
| Distilled Water | 2a | 44911-42 | Pass |
| Distilled Water | 2a | 44911-134 | Pass |
| Distilled Water | 2a | 44911-41 | Pass |
| Distilled Water | 2a | 44911-76 | Pass |
| | | | |
| 3.5% Salt (NaCl) Water | 2a | 44911-42 | Pass* |
| 3.5% Salt (NaCl) Water | 2a | 44911-134 | Pass* |
| 3.5% Salt (NaCl) Water | 2a | 44911-41 | Pass* |
| 3.5% Salt (NaCl) Water | 2a | 44911-76 | Pass* |

* 2a Test Specimens that passed the 150 hour distilled water test were used for the salt water test.

**Hydrogen Re-Embrittlement Results for IZ-C17**

# IZ-C17 Thickness and Adhesion

- IZ-C17 Has Good Adhesion
  - Passes Bend-To-Break Tests
- Thickness Control is Very Good



# 2006 – 2007 Test Objectives

- Install Plating Tank at Boeing – St. Louis with Dipsol IZ-C17
  - Perform More Hydrogen Embrittlement Tests
  - Perform Fatigue Tests
  - Perform Lubricity Tests
  - Optimize Operating Parameters
    - Verify Operating Limits of Plating Bath
  - Plate Parts with Complex Geometries
    - Determine Need for Auxiliary Anodes and Special Tooling
      - Plate ID of Tubular Parts
- Qualify IZ-C17 for C-17 Program
  - Create Draft DPS for IZ-C17
    - Identify Process Controls
    - Hydrogen Embrittlement Test Methods
    - Select Repair Procedures

# 2006 Status

- IZ-C17 Tech Bulletin (Draft) Prepared
  - Information Provided by Dipsol and Boeing
- Purchased and Installed Plating Tank and Support Equipment
  - IZ-C17 Chemical Received From Dipsol of America – Livonia, MI
    - Original Zn-Ni Chemicals Came From Dipsol – Japan
- Bare Test Specimens Prepared

# IZ-C17 Tech Bulletin

DIPSOL OF AMERICA, INC.
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**TECHNICAL BULLETIN**

ZINC AND ZINC ALLOY PLATING PROCESSES

## LHE Zinc Nickel system

## DIPSOL IZ-C17

**Low Hydrogen Embrittlement Alkaline Zinc Nickel Alloy Plating**

# IZ-C17 Zn-Ni Plating Process

1. TCE Vapor Degrease or Solvent Clean with MPK
2. Grit Blast with aluminum oxide (120 grit or finer) at ~ 60 psig
3. Rinse in water to remove loose grit
4. Apply LHE zinc-nickel plate: IZ-C17 – 3 $A/dm^2$ – RT – 30 to 45 minutes (produces 0.3 to 0.6 mils)
5. Rinse
6. Embrittlement Relief Bake at 375 +/- 25$^oF$ for 24 hours. Bake within 4 hours after plating
7. Rinse
8. Chromate Conversion Coating: Apply IZ-258 @ 140$^o$ F, 60 seconds
9. Rinse
10. Dry @ < 140$^o$ F – 10 minutes

# IZ-C17 Plating Tank

- 60 L Plating Tank Installed in Laboratory


# Conversion Coat Tank

- Installed IZ-258 Chromate Conversion Coating Tank

IZ-258

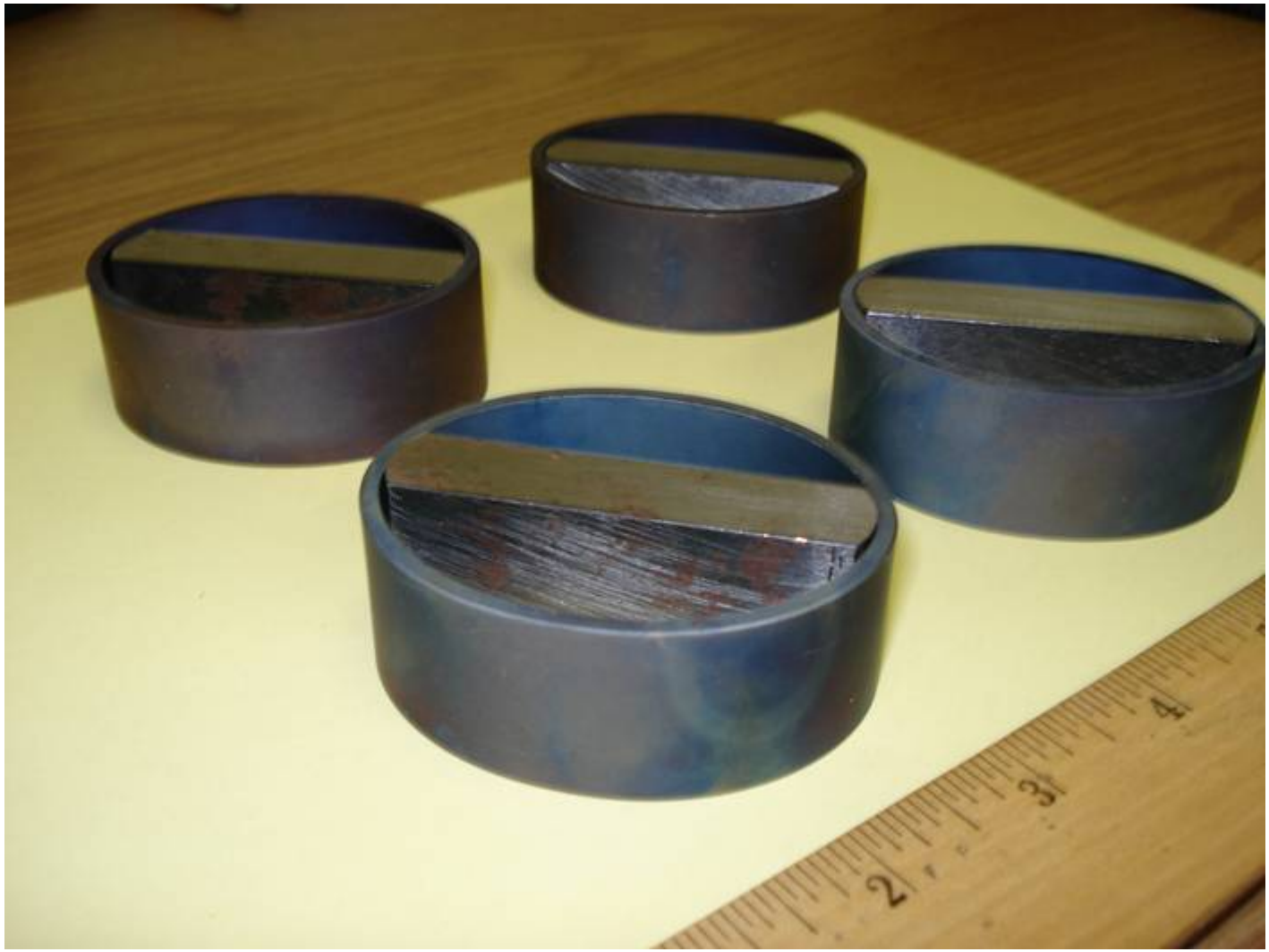
# 2006 Status (Cont.)

- IZ-C17 Test Plan Prepared
  - Hydrogen Embrittlement (1a.1, 1a.2, 2a)
  - Adhesion and Metallurgy
  - Corrosion Testing (Salt Spray and Galvanic)
  - Fluid Immersion (ASTM F 483)
  - Lubricity (Fasteners)
  - Strippability (BCA – Ammonium Nitrate pH 10)
  - Throwing Power (JCAT Method and Tubes)
  - Fatigue

# 2006 Status (Cont.)

- IZ-C17 Tank Up and Running Since 8-18-06
  - Chemistry Meets Specifications
    - Need to Use only Nickel Anodes (or Ni Plated Steel)
  - Passed Thickness, Composition and Adhesion Tests
  - Passed Hydrogen Embrittlement for Type 1a.1, 1a.2 and 2a Specimens
- Prepared Corrosion Specimens (4”x6” Steel)
- Prepared Fatigue Bars
- Prepared Fluid Immersion Test Specimens (ASTM F 483 1”x2” Steel Specimens)
- Prepared Throwing Power Test Specimens

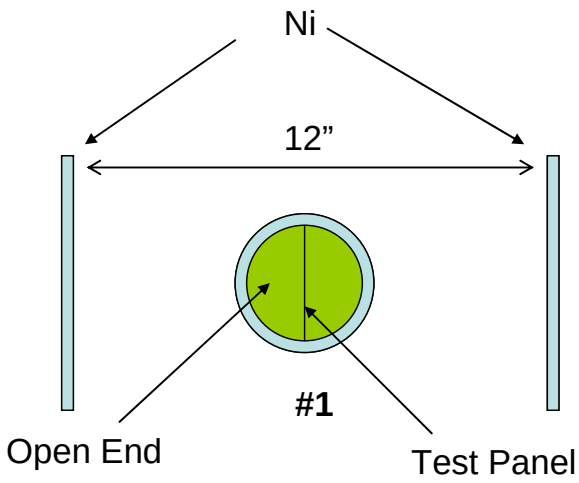
# Type 2a HE Testing

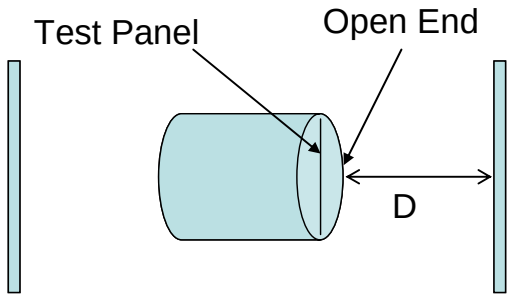


# Fatigue Test Specimens

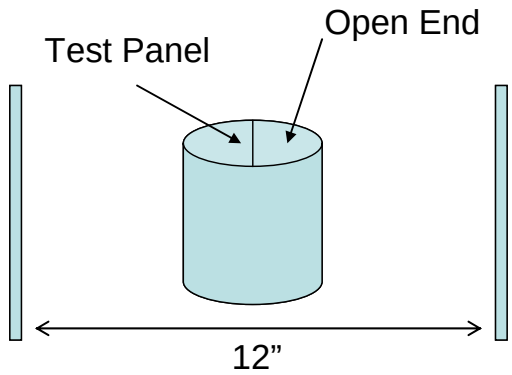
# Throwing Power Test

# Throwing Power Test




**#2: D = 2 to 3 inches (two anodes)**
**#2A: D = 10 to 12 inches and only one anode at open end**




**#3**

# 2007 Activity

- Prepare Zn-Ni Plated Fasteners (In Work)
- Perform Tests on Zn-Ni Plated Specimens
- Plate Tube IDs With Internal Anodes
- Prepare Specimens with Different Zinc – Nickel Ratios in Plating Bath
- Prepare DPS Draft Specification for LHE Zn-Ni Plating
- Support JCAT Phase II and III JTP