

TITLE

PROJECT

POTENTIAL SCAN AND HOLD

Objective: See page 1.

Alloy / Heat No.: C-22 HT# 2277-3-3242 WNS13 w/ T: 7 HT# CW2775 1/3
Welding Solution Annealed See Note #729 for #58 Crevice Washers Nut/Bolt

Specimen Preparation: Specimen machined to dimensions specified in CNWRA Drawing #20.06002.01.322.002. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone then crevice forming washers attached to specimen using hardware. Torque to 50 in-oz. or 75 in lbs.

Torque Screwdriver: True-Craft Model# & Torque: 75 In-lbs SN: 694000 691
Cal: 7/22/05 Due: 7/21/06

Initial Weight: 23.66714g Model: Sartorius Genius SN: 12809099
Final Weight: 22.91351g Cal: 5/11/05 Due: 11/11/05

Solution: 4.0 M $MgCl_2 \cdot 6H_2O$ Lot # 044975
1626.91g $MgCl_2 \cdot 6H_2O$
+ DI water to 2000ml

Test ID: WA22SATi701e

Reagents measured with Model: OHAUS SN: 2883
Cal: 7/12/05 Due: 1/12/06

Initial pH: 2.98 Model: Orion EA 940 SN: 2330
Final pH: 5.31 Cal: 7/25/05 Due: 7/25/06
pH Probe: #13-620-296 SN: 4065156

Test Temperature: 95°C Measured with Hg Thermometer SN: M98-187
Cal: 9/9/05 Due: 9/8/06

Counter Electrode: Platinum Flag

Reference Electrode: Fisher 13-620-52 SN: 3300328

Gas: Zero Air then 99.999% N_2

Ecorr: -156 mV_{SCE} Model: Keithley 614 SN: 0555368
Ept: 426 mV_{SCE} Cal: 9/4/05 Due: 3/14/06

Potentiostat: Solartron 1480 SN: 00238265
Cal: 6/1/05 Due: 12/1/05

DATA FILE: WA22SATi7-75, WA22SATi7-75N2, WA22SATi7Mgel25U, 6, WA22SATi7Mgel25H,
WA22SATi7Mgel25UC, d, e, f, g, WA22SATi7Mgel25Hd e, f
3/24 (24 max.)

Number of Crevice Corrosion Sites:
Crevice Corrosion on 13/24 feet of crevice washers
Deep corrosion on lower facial surfaces - mild surface
staining. Ti7 crevice washers nut/bolt no corrosion
mild surface staining

SIGNA

DATE

11/10/05

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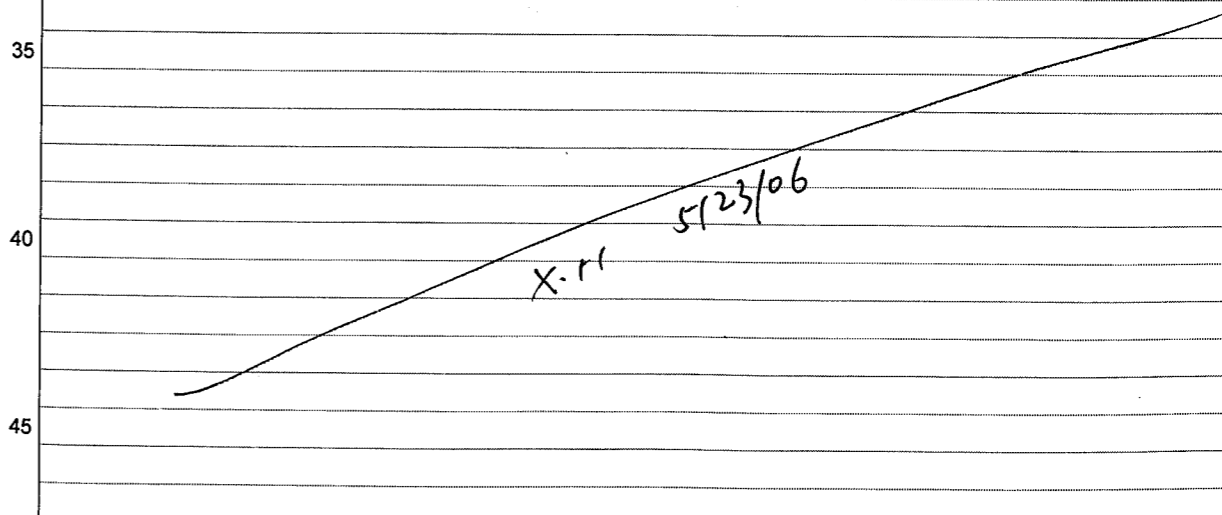
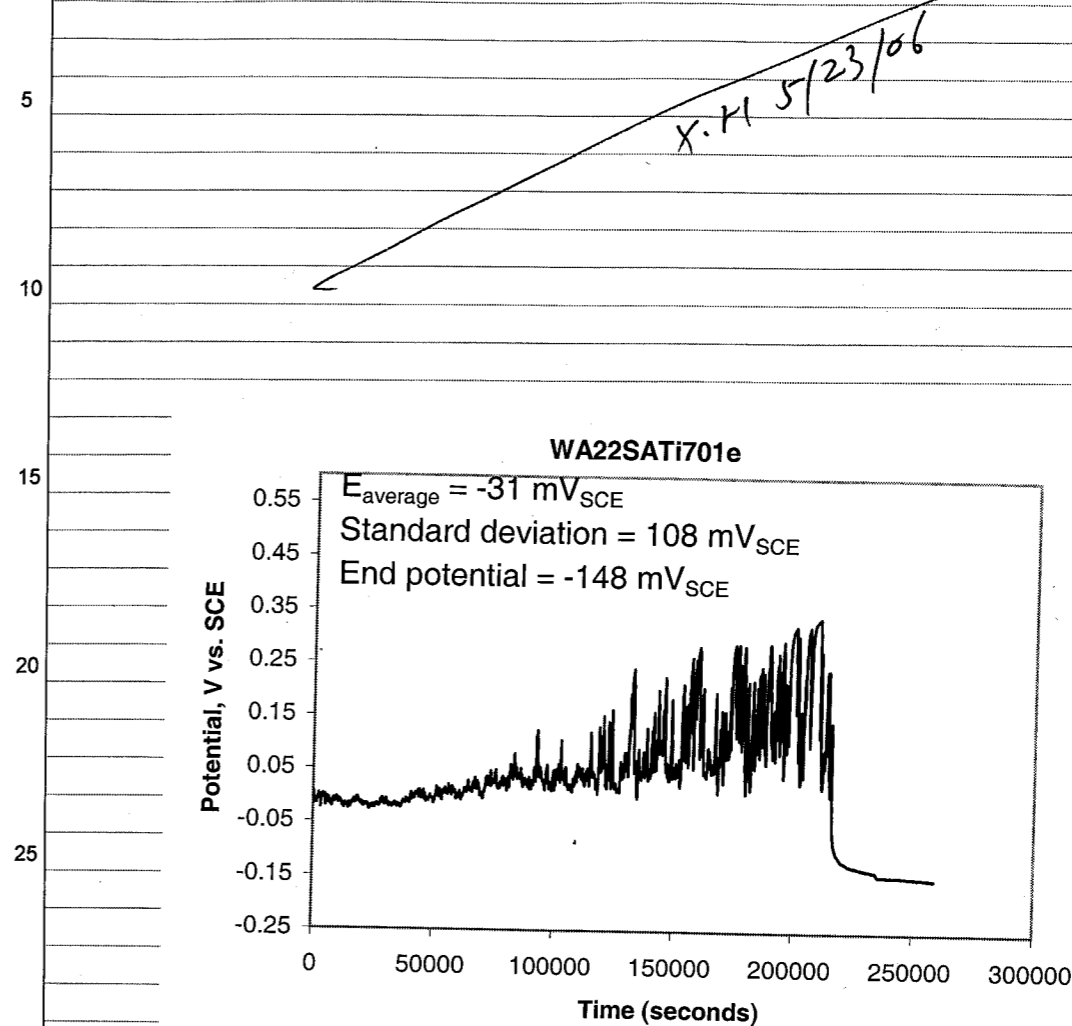
DATE

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PROPRIETARY INFORMATION

TITLE

PROJECT

POTENTIAL SCAN AND HOLD

Objective: See page 1.

Alloy / Heat No.: C-22 HT# 2277-3-3266 Base Alloy w/Ti7 HT# C02775 Crevice washers 1/8 nut/bolt

Specimen Preparation: Specimen machined to dimensions specified in CNWRA Drawing #20.06002.01.322.002. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone then crevice forming washers attached to specimen using hardware. Torque to 50 in-oz. or 75 in lbs.

Torque Screwdriver: Tave Craft Model# & Torque: 75 In lbs. SN: 654000691 Cal: 7/22/05 Due: 7/21/06

Initial Weight: 23.33423g Model: Sartorius Genius SN: 12809099 Cal: 11/14/05 Due: 5/12/06

Solution: 4.0 M MgCl₂·6H₂O 1626.49g MgCl₂·6H₂O lot# 044975 + DI water to 2000mls

Test ID: BA22Ti703e

Reagents measured with Model: OHAUS SN: 2883 Cal: 7/12/05 Due: 4/12/06

Initial pH: 4.73 Model: Orion EA 940 SN: 2330 Cal: 7/25/05 Due: 7/25/06

Final pH: Not Taken pH Probe: #13-620-296 SN: 4065196 Due: 4/27/06

Counter Electrode: Platinum Flag

Reference Electrode: Fisher 13-620-52 SN: 4028037

Gas: 99.999% N₂

Ecorr: -138 mV_{SCE} Model: Keithley 614 SN: 0555368 Cal: 9/14/05 Due: 3/14/06

Ept: -472 mV_{SCE} Potentiostat: Solartron 1287 SN: 00148560 Cal: 5/25/05 Due: 11/25/05

DATA FILE: C22Ti7MgCl2U, C22Ti7MgCl2H, C22Ti7MgCl2Ha, C22Ti7MgCl2Ha, C22Ti7MgCl2Hb, C22Ti7MgCl2Hb, C22Ti7MgCl2Hc, C22Ti7MgCl2Hd, C22Ti7MgCl2Hd, C22Ti7MgCl2Hd, C22Ti7MgCl2Hd, C22Ti7MgCl2Hd

Number of Crevice Corrosion Sites: 22/24 (24 max.)
Crevice Corrosion on 22/24 feet of crevice washer - specimen has deep corrosion paths to bottom of specimen - also some small pitting on surface Ti7 nut/bolt and crevice washers no corrosion just mild surface staining - specimen also has mild surface staining

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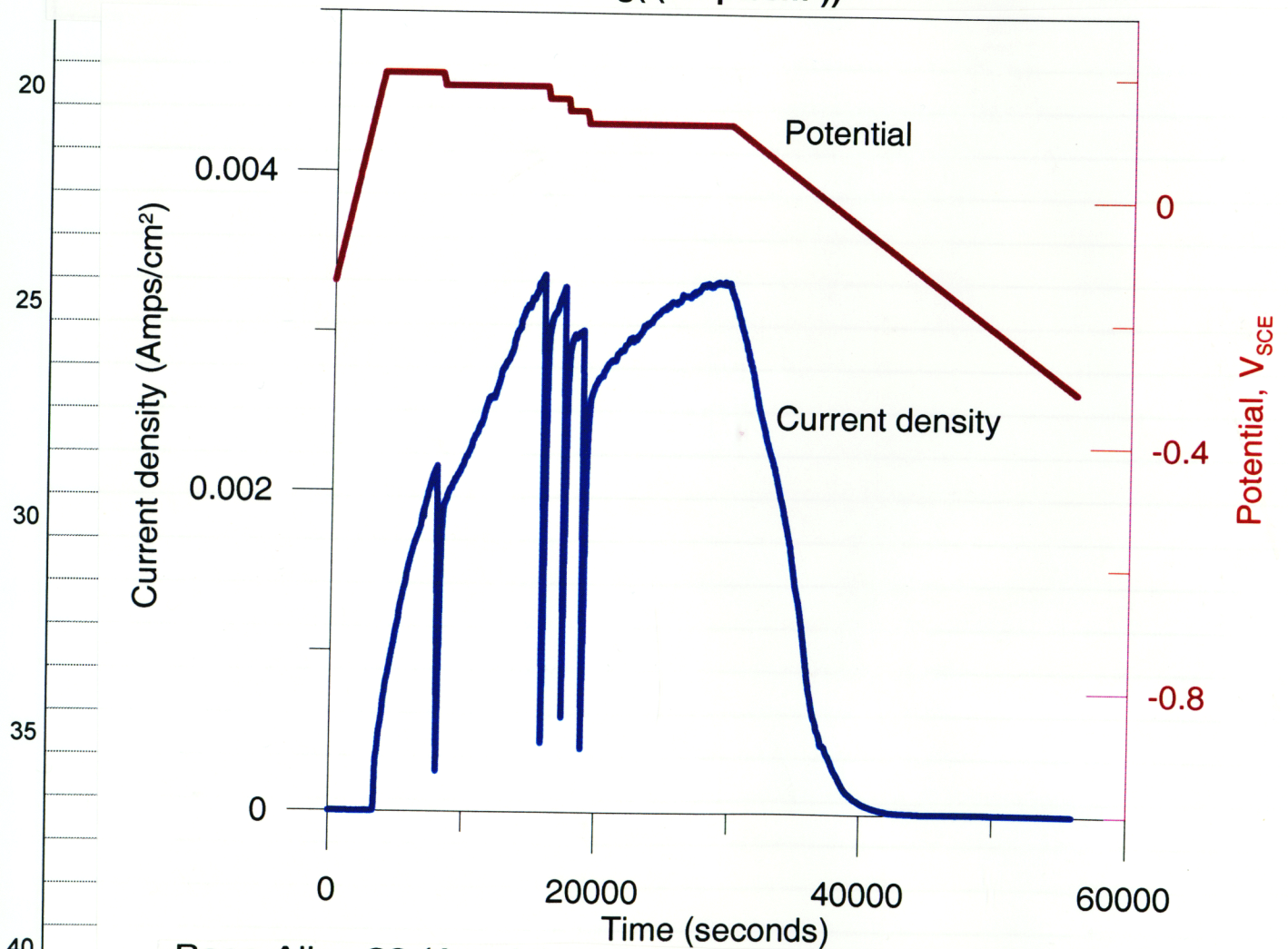
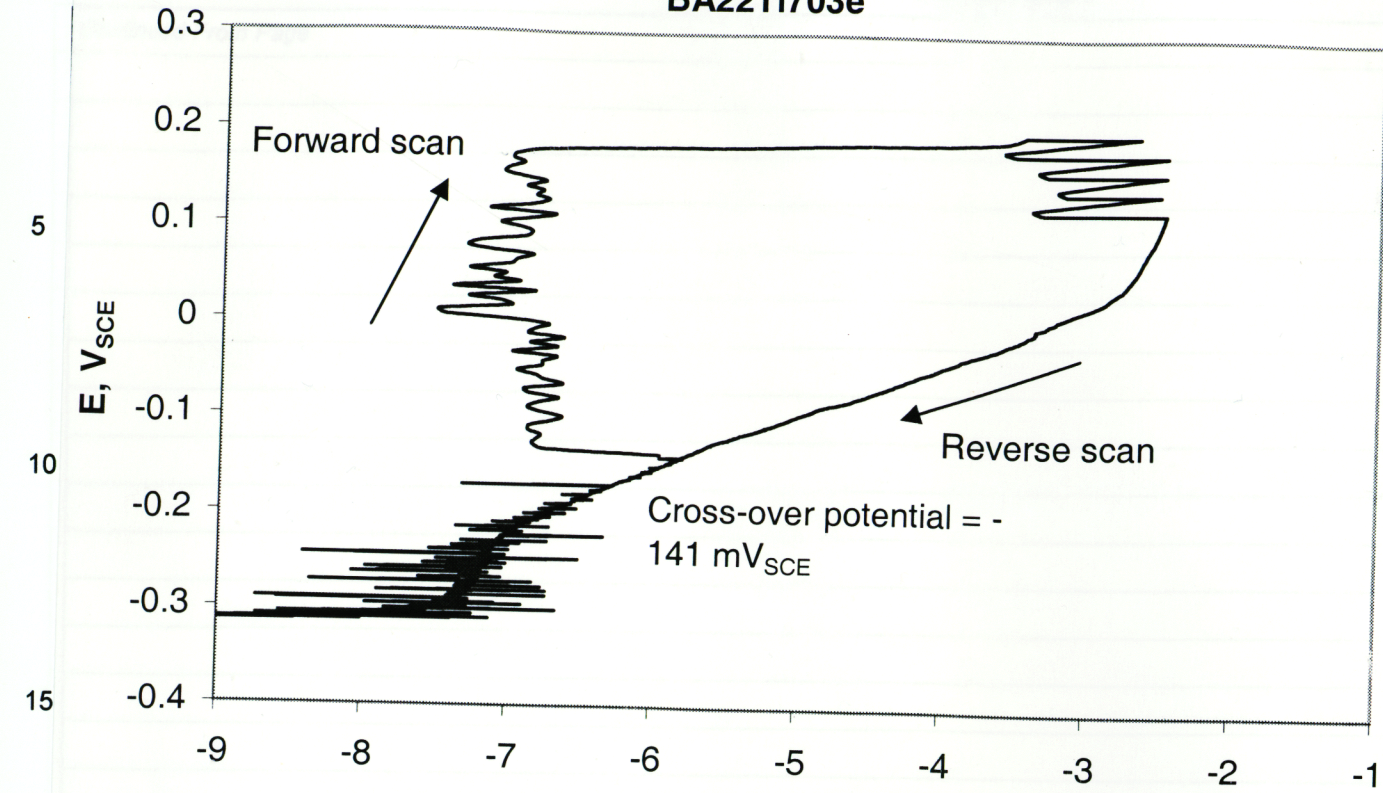
11/15/05

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DATE

PROPRIETARY INFORMATION

BA22Ti703e



Base Alloy 22 (Anode) to Ti Gr7 crevice, Ti7 bolt and nut Anode to cathode area ratio: ~1/3; Torque: 75 in-lbs; N₂ deaerated, 95 °C, 4 M MgCl₂ solution
Forward scan rate: 0.1 mV/s, Potential hold: 120 mV_{SCE} for 3 hours
Reverse scan rate: 0.0167 mV/s
Using entire assembly area for current density calculation:
i < 10⁻⁵ A/cm² at -95 mV_{SCE}; i < 2*10⁻⁶ A/cm² at -133 mV_{SCE};
i < 10⁻⁶ A/cm² at -151 mV_{SCE} x-H 11/8/05 x-H 11/18/05
Using crevice specimen area for current density calculation:
i < 10⁻⁵ A/cm² at -129 mV_{SCE}; i < 2*10⁻⁶ A/cm² at -175 mV_{SCE};
i < 10⁻⁶ A/cm² at -190 mV_{SCE}

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TITLE

PROJECT

POTENTIAL SCAN AND HOLD

Objective: See page 1.

Alloy / Heat No.: C-22 HT# 2277-3-3292 UN813 w/ Ti7 HT# CN2775 1/3 crevice washers Nut/Bolt
Welded Solution Annealed See NS# 729 pg# 58

Specimen Preparation: Specimen machined to dimensions specified in CNWRA Drawing #20.06002.01.322.002. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone then crevice forming washers attached to specimen using hardware. Torque to 40 in-oz. or 75 in lbs.

Torque Screwdriver: Tave Craft Model# & Torque: 75 In-lbs SN: 694000691
Cal: 7/22/05 Due: 7/21/06

Initial Weight: 22.80149g Model: Sartorius Genius SN: 12809099
Final Weight: 21.88334g Cal: 11/14/05 Due: 5/12/06

Solution: 4.0 M MgCl₂ · 6H₂O
1626.54g MgCl₂ · 6H₂O Lot# 0044975
+ DI water to 2000mls

Test ID: WA22SATi701f

Reagents measured with Model: OHAUS SN: 2883
Cal: 7/12/05 Due: 1/12/06

Initial pH: 4.62 Model: Orion, EA 940 SN: 2330
Final pH: 5.39 Cal: 7/25/05 Due: 7/25/06
pH Probe: #13-620-296 SN: 4665196

Test Temperature: 95°C Measured with Hg Thermometer SN: H 98-187
Cal: 9/9/05 Due: 9/8/06

Counter Electrode: Platinum Flag

Reference Electrode: Fisher 13-620-52 SN: 33 06328

Gas: 99.999% N₂

Ecorr: -115 mV_{SCE} Model: Keithley 614 SN: 0555368
Ept: -467 mV_{SCE} Cal: 9/14/05 Due: 3/14/06

Potentiostat: Solentron 1480 SN: 00238265
Cal: 6/1/05 Due: 12/1/05

DATA FILE: WA22SATi7MgCl2U - UNICH2, WA22SATi7MgCl2H - UNICH2,
WA22SATi7MgCl2UA - UNICH2, WA22SATi7MgCl2HA - UNICH2, b, c, d, e, WA22SATi7MgCl2D
Number of Crevice Corrosion Sites: 22/24 (24 max.)

Crevice Corrosion on 22/24 feet of crevice washers. M.l.o surface staining. Corrosion - Deep follows a deep downward path.
Ti7 Nut/Bolt crevice washers No Corrosion. M.l.o surface staining on all surfaces

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11/15/05

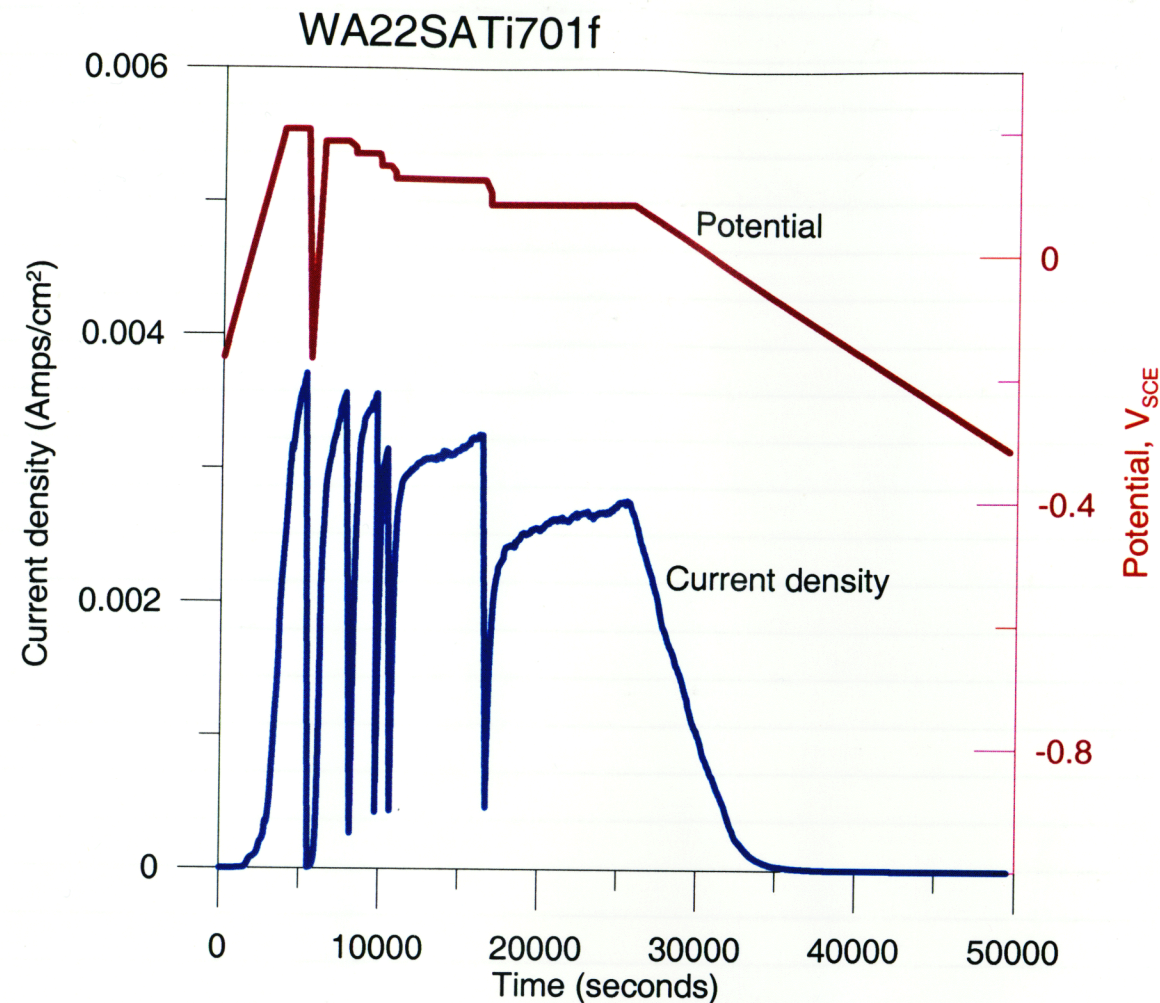
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Welded+Solution Annealed Alloy 22 (Anode) to Ti Gr7 crevice, Ti7 bolt and nut
Anode to cathode area ratio: ~1/3; Torque: 75 in-lbs;
N₂ deaerated, 95 °C, 4 M MgCl₂ solution
Forward scan rate: 0.1 mV/s, Potential hold: 80 mV_{SCE} for 3 hours
Reverse scan rate: 0.0167 mV/s
Using entire assembly area for current density calculation:
i < 10⁻⁵ A/cm² at -101 mV_{SCE}; i < 2*10⁻⁶ A/cm² at -138 mV_{SCE};
i < 10⁻⁶ A/cm² at -151 mV_{SCE}
Using crevice specimen area for current density calculation:
i < 10⁻⁵ A/cm² at -135 mV_{SCE}; i < 2*10⁻⁶ A/cm² at -174 mV_{SCE};
i < 10⁻⁶ A/cm² at -200 mV_{SCE}

X-11 5/23/06

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PROPRIETARY INFORMATION

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TITLE

PROJECT

POTENTIAL SCAN AND HOLD

Objective: See page 1.

Alloy / Heat No.: C-22 HT#2277-3-3266 Base Alloy w/Ti7 HT#C02775 crevice washers 1/3 Nut/Bolt

Specimen Preparation: Specimen machined to dimensions specified in CNWRA Drawing #20.06002.01.322.002. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone then crevice forming washers attached to specimen using hardware. Torque to 50 in-oz. or 75 in lbs.

Torque Screwdriver: Proto 6104 Model# & Torque: 50 In Oz. SN: 139072
Cal: 10/24/05 Due: 4/24/06

Initial Weight: 23.30110g Model: Sartorius Genius SN: 12809099
Final Weight: 23.08971g Cal: 11/14/05 Due: 5/12/06

Solution: 4.0 M $MgCl_2 \cdot 6H_2O$
1626.51g $MgCl_2 \cdot 6H_2O$ Lot# 044975
+ DI water To 2000mls

Test ID: BA22Ti702e

Reagents measured with Model: OHAUS SN: 2883
Cal: 7/12/05 Due: 1/12/06

Initial pH: 2.47 Model: Orion EA 940 SN: 2330
Final pH: 5.26 Cal: 7/25/05 Due: 7/25/06
pH Probe: #13-620-296 SN: 4065196

Test Temperature: 95°C Measured with Hg Thermometer SN: 115858
Cal: 4/27/05 Due: 4/27/06

Counter Electrode: Platinum Flag

Reference Electrode: Fisher 13-620-52 SN: 4628037

Gas: 99.999% N_2 - zero Air then N_2 for E repassivation

Ecorr: -99 mV_{SCE} Model: Keithley 614 SN: 0555368
Ept: 344 mV_{SCE} Cal: 9/14/05 Due: 3/14/06

Potentiostat: Solatron 1287 SN: 06148560
Cal: 5/25/05 Due: 11/25/05

DATA FILE: C22Ti7-BAZR, C22Ti7-50N2, C22Ti7-50SU, C22Ti7-50SH, C22Ti7-50SUa, C22Ti7-50SHa, C22Ti7-50SD

Number of Crevice Corrosion Sites: 3/24 (24 max.)

Crevice corrosion on 3/24 feet of crevice washer Deep Areas Around crevice washer feet going down into to bottom of Specimen m/b surface staining - Ti7 crevice washers No corrosion m/b surface staining

SIGNATURE

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11/18/05

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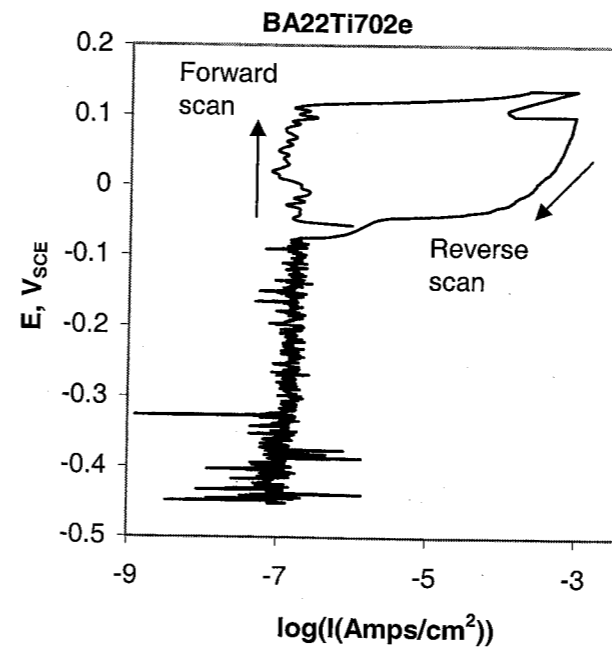
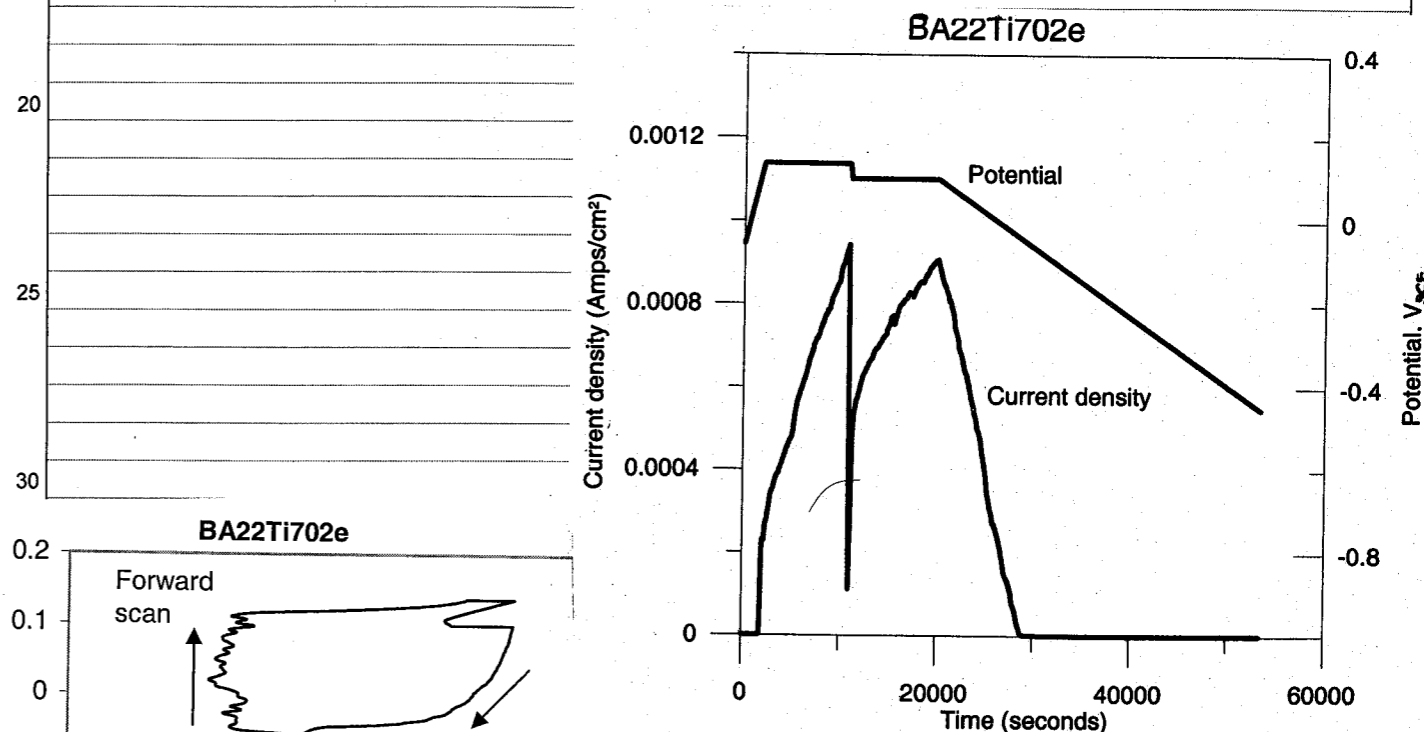
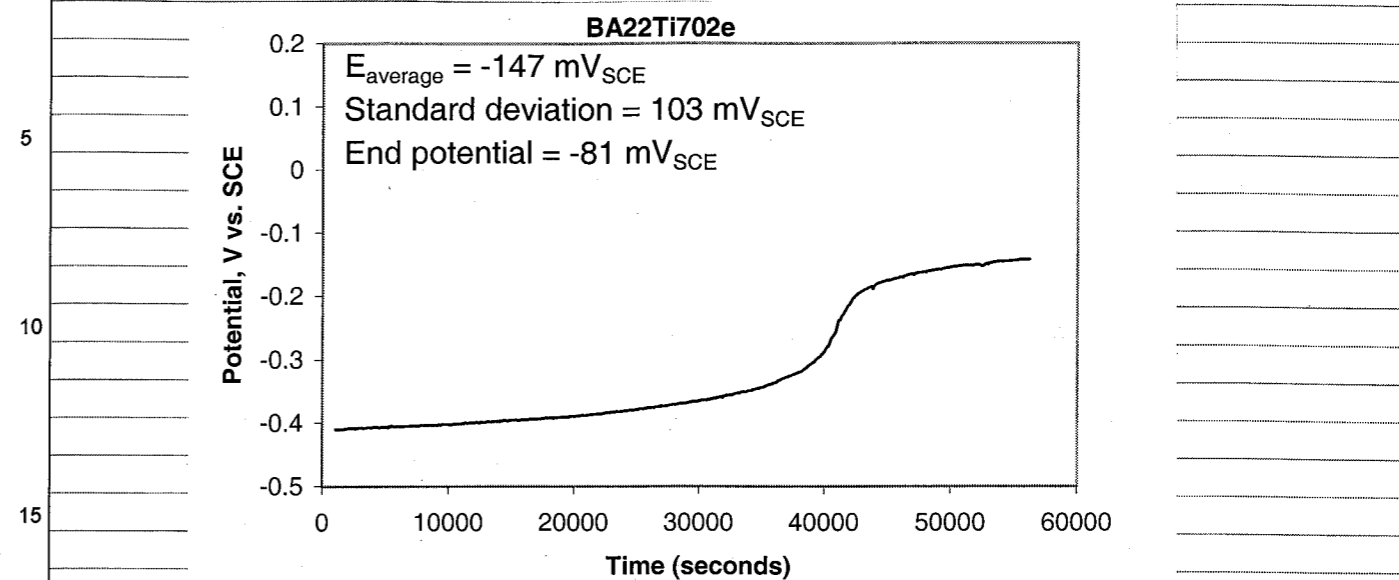
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Base Alloy 22 (Anode) to Ti Gr7 crevice, Ti7 bolt and nut
Anode to cathode area ratio: ~1/3; Torque: 50 in-oz;
 N_2 deaerated, 95 °C, 4 M $MgCl_2$ solution
Forward scan rate: 0.1 mV/s, Potential hold: 137 mV_{SCE} for 2.5 hour;
100 mV_{SCE} for another 2.5 hours. Reverse scan rate: 0.0167 mV/s
Using entire assembly area for current density calculation:
 $i < 10^{-5}$ A/cm² at -43.1 mV_{SCE}; $i < 2 \cdot 10^{-6}$ A/cm² at -48.0 mV_{SCE};
 $i < 10^{-6}$ A/cm² at -63.8 mV_{SCE}
Using crevice specimen area for current density calculation:
 $i < 10^{-5}$ A/cm² at -47.2 mV_{SCE}; $i < 2 \cdot 10^{-6}$ A/cm² at -72.0 mV_{SCE};
 $i < 10^{-6}$ A/cm² at -73.7 mV_{SCE}

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DATE

11/22/05

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TITLE

PROJECT

POTENTIAL SCAN AND HOLD

Objective: See page 1.

Alloy / Heat No.: C-22 HT# 2277-3-3292 WNR13 w/ Ti7 HT# CN2775 1/3 crevice washers nut/bolt welded solution annealed see NB# 72A pg# 58

Specimen Preparation: Specimen machined to dimensions specified in CNWRA Drawing #20.06002.01.322.002. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone then crevice forming washers attached to specimen using hardware. Torque to 50 in-oz. or 75 in lbs.

Torque Screwdriver: Proto 6104 Model# & Torque: 50 In-oz SN: 139072 Cal: 10/24/05 Due: 4/24/06

Initial Weight: 23.51018g Model: Sartorius Genius SN: 12809099 Final Weight: 23.18556g Cal: 11/14/05 Due: 5/12/06

Solution: 4.0 M MgCl2 · 6H2O 1626.56 MgCl2 · 6H2O lot # 044975 + DI water to 2000mls

Test ID: WA22SATi702c

Reagents measured with Model: OHAUS SN: 2883 Cal: 7/12/05 Due: 1/12/06

Initial pH: 2.76 Model: Orion EA 940 SN: 2330 Final pH: 5.82 Cal: 7/25/05 Due: 7/25/06 pH Probe: #13-620-296 SN: 4065196

Test Temperature: 95°C Measured with Hg Thermometer SN: H 98-187 Cal: 9/9/05 Due: 9/8/06

Counter Electrode: Platinum Flag Reference Electrode: Fisher 13-620-52 SN: 3300328

Gas: 99.999% N2 - Zero Air then N2 for E Repassivation Ecorr: -69mV Model: Keithley 614 SN: 0555368 Ept: -198mV Cal: 9/14/05 Due: 3/14/06

Potentiostat: Solatron 1480 SN: 00238265

DATA FILE: WA22SATi7-5D, WA22SATi7-5D N2, WA22SATi7-5D SU, WA22SATi7-5D SH, WA22SATi7-5D SUA, WA22SATi7-5D SHA, WA22SATi7-5D SD

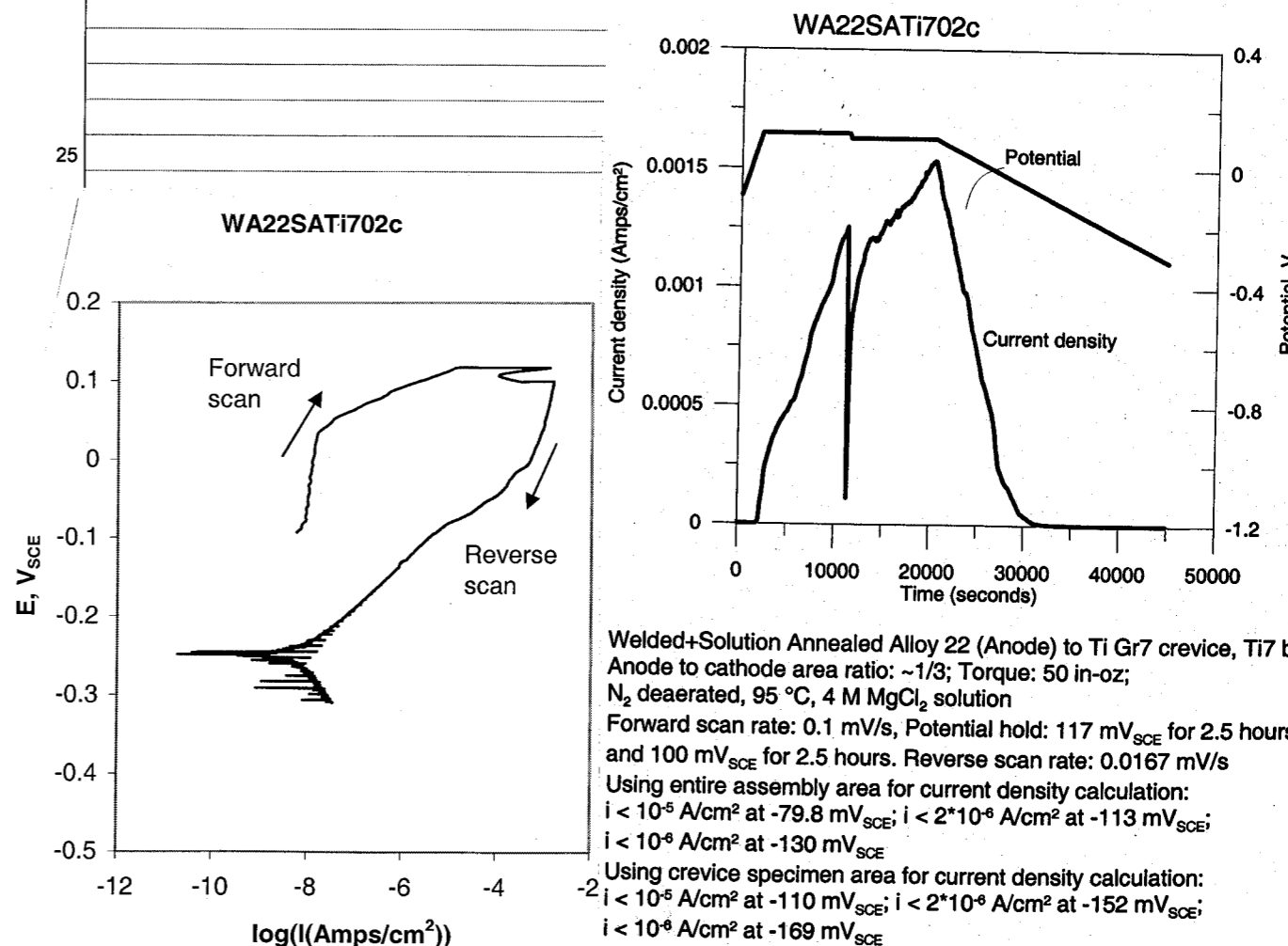
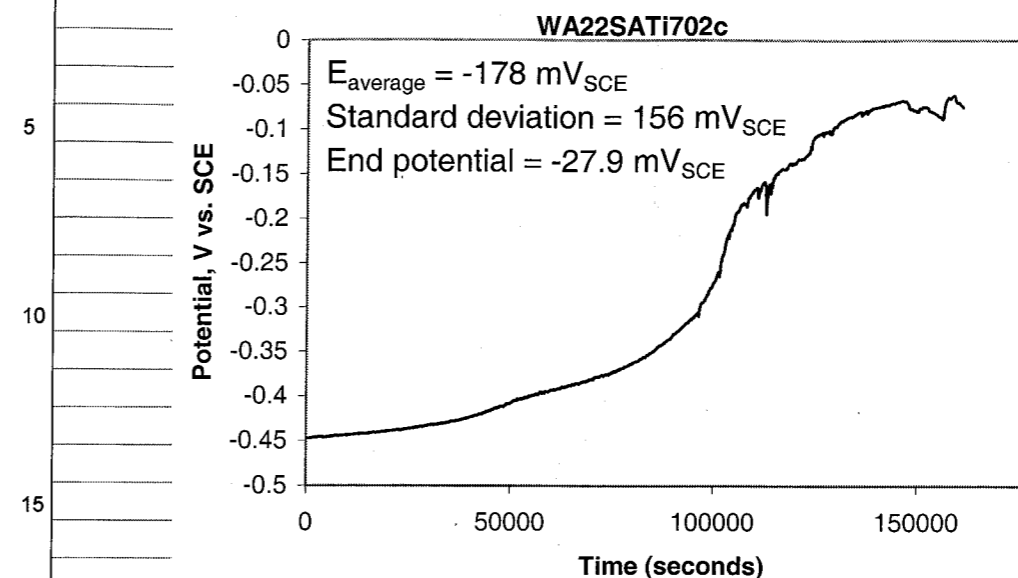
Number of Crevice Corrosion Sites: 10/24 (24 max.) Crevice Corrosion on 10/24 feet of crevice washer Deep Areas Around crevice feet Also Corrosion Area in Bolt hole Area - mild surface staining - Ti7 crevice hardware No Corrosion mild surface staining

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Welded+Solution Annealed Alloy 22 (Anode) to Ti Gr7 crevice, Ti7 bolt and nut Anode to cathode area ratio: ~1/3; Torque: 50 in-oz; N2 deaerated, 95 °C, 4 M MgCl2 solution Forward scan rate: 0.1 mV/s, Potential hold: 117 mV_SCE for 2.5 hours and 100 mV_SCE for 2.5 hours. Reverse scan rate: 0.0167 mV/s Using entire assembly area for current density calculation: i < 10^-5 A/cm² at -79.8 mV_SCE; i < 2*10^-6 A/cm² at -113 mV_SCE; i < 10^-6 A/cm² at -130 mV_SCE Using crevice specimen area for current density calculation: i < 10^-5 A/cm² at -110 mV_SCE; i < 2*10^-6 A/cm² at -152 mV_SCE; i < 10^-6 A/cm² at -169 mV_SCE

SIGNATURE: [Signature] DATE: 11/22/05 DISCLOSED TO AND UNDERSTOOD BY: [Signature] DATE: PROPRIETARY INFORMATION

TITLE PROJECT

Contin

Galvanic Corrosion Test

Objective: SEE PAGE #1

SPECIMENS: Specimens polished to 600 Grit finish then cleaned in acetone
 C-22 HT# 2277-3-3292 welded Solution Annealed See pg 58 In N6# 729
 Teflon Crevice Washer with C-22 Plate - C-22 HT# 2277-3-3266 Plate

Torque Screwdriver: Pento 6104 100 In-Oz. SN: 139072
 Cal: 10/24/05 Due: 4/24/06

Initial Weight: 23.33929g Model: Sartorius Genius SN: 12809099
 Final Weight: 23.32839g Cal: 5/11/05 Due: 11/11/05

SOLUTION: 5.0 M NaCl
 584.41g NaCl Lot# 051510
 + DI water to 2000mls
 Test ID: WA22SAPTFEBA22b

Reagents measured with Model: OHAUS SN: 2883 Due: 1/12/06
 Cal: 7/12/05

Initial pH: 6.30 Model: Orion EA 940 SN: 2330
 Final pH: 4.63 Cal: 7/25/05 Due: 7/25/06
 pH Probe: #13-620-296 SN: 4065196

TEST TEMPERATURE: 95°C Thermometer: Fisher SN: 51046103
 Cal: 6/7/05 Due: 6/7/06
 Thermocouple SN: 333 Cal: 2/26/05 Due: 1/26/05

Reference Electrode: Fisher SCE # 13-620-52 SN: 251439
 GAS: Zero Air

Platinum Flag USED FOR OCP MEASUREMENT ONLY x.r. 1/5/06

Counter Electrode: C22 Plate (CREVICE) (PLATE)
 Ecorr: -104mv Ecorr: +170mv Model: Keithley 614 SN#: 0704936
 Ept: Ept: Cal: 5/27/05 Due: 5/26/06
 X.H. 12/20/05 g.u. 1/30/05

Potentiostat: Solartron 1480 SN#: 00240053 Cal: 8/23/05 Due: 2/23/06

TEST ID: WA22SA PTFE BA22b
 WSA22PTFEC221122-UnlCh7, WSA22PTFEC221122-UnlCh8, WSA22PTFEC221125

DATA FILES: WSA22PTFEC221128, WSA22PTFEC221128A, WSA22PTFEC221201,
 WSA22PTFEC221204, WSA22PTFEC221207, WSA22PTFEC221210, WSA22PTFEC221213

Specimen Examination: Crevice Corrosion on 2/24 feet of crevice washer
 C-22 Plate No corrosion - m.l.b staining on C-22 specimen and m.l.b
 staining on C-22 plate.

SIGN# Number of crevice corrosion sites: 2/24 (24 Mass.)

TITLE PROJECT

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Maximum penetration depth: 280 μm, 265 μm
 Measured with Olympus metallurgical microscope PMG3
 Cal: 12/13/05 Due: 6/13/06

5 M NaCl, 95°C, welded plus solution annealed Alloy 22/Teflon (100 in-oz)
 Coupled to Alloy 22 Plate

Galvanic coupling current density, A/cm²

Galvanic coupling potential, V_{SCE}

Current density

Potential

2x10⁻⁴ M CuCl₂ added

Time, Days

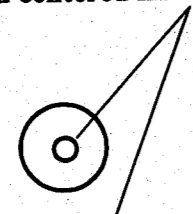
TITLE PROJECT

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Cylindrical Test Specimen

CNWRA Drawing 20.01402.571.019

#5-40 thread centered minimum 0.250" deep



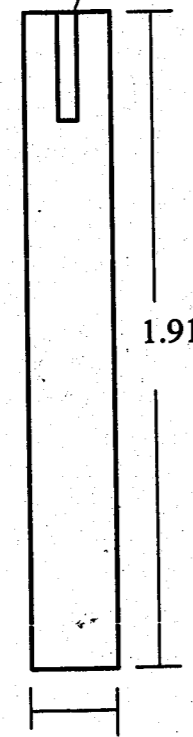
This information is to be completed at time of fabrication

Material: Zr 702

Heat #: 845645

Specimen Orientation: Cut from Rod stock

Other: Thanks Brian



Procedure: 105-W1-821

Project #:

TOTAL POS. INSPECTED

TOTAL POS. ACCEPTED

TOTAL POS. REJECTED

"NR #"" IF REJECTS

INSPECTOR

DATE NOV 22 2005

J.C. # 825402 LOCATION QC 3 / M 5

EQUIPMENT Q1 00508 Dia 9-16-02

DATE 11-19-07

Initiated by: D. Dunn Date 10/15/01

Reviewed by: V. Jain Date 10/15/01

QA Approval: B. Mabrito Date 10/15/01

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SIGNATURE: Xihua He DATE: 11/24/05

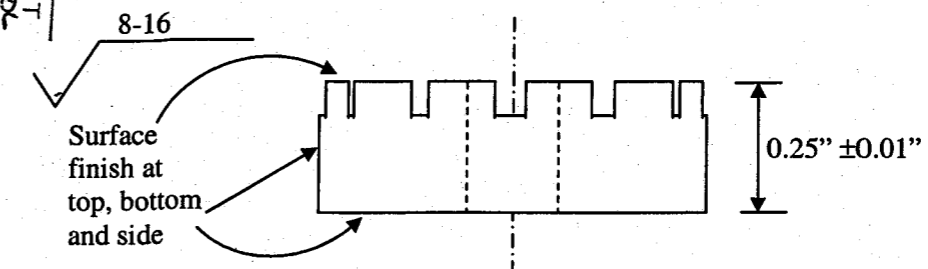
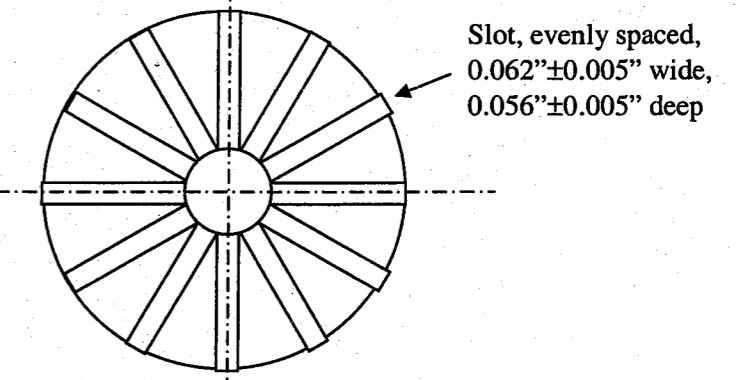
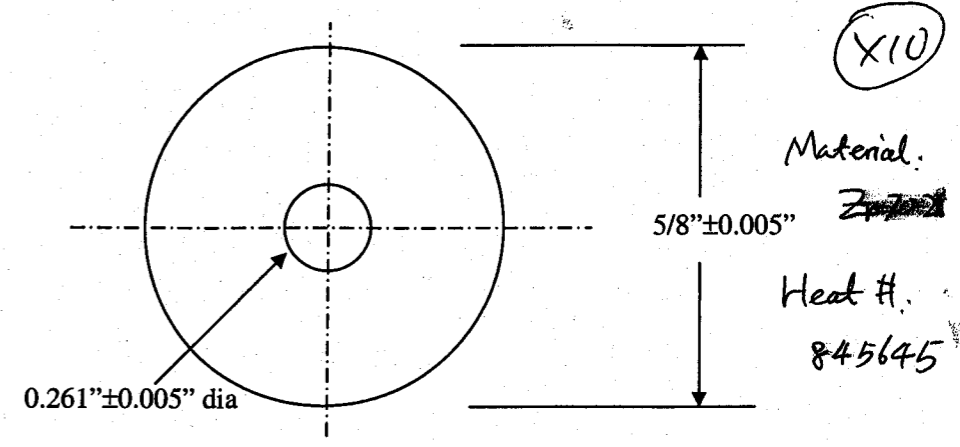
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PROPRIETARY INFORMATION

TITLE PROJECT

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Serrated Zirconium-702 crevice washer with 24 Plateaus



Procedure: 105-W1-821

Project #:

TOTAL POS. INSPECTED

TOTAL POS. ACCEPTED

TOTAL POS. REJECTED

"NR #"" IF REJECTS

INSPECTOR

DATE NOV 22 2005

J.C. # 825402 LOCATION QC 3 / M 5

EQUIPMENT Q1 00508 Dia 9-16-02

DATE 11-19-07

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SIGNATURE: Xihua He DATE: 11/22/05

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PROPRIETARY INFORMATION

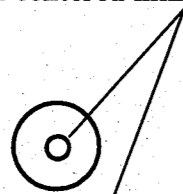
TITLE PROJECT

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Cylindrical Test Specimen

CNWRA Drawing 20.01402.571.019

#5-40 thread centered minimum 0.250" deep



This information is to be completed at time of fabrication

Material: Zr 4

Heat #: 1223217-243687

Specimen Orientation: Cut from Rod stock

Other: Thanks Brian

1.915" ± 0.005"

0.250" ± 0.003"

Procedure	LOCATION	<u>C-31</u>
Project #	J.C. #	
TOTAL P.C.S. INSPECTED	<u>6</u>	EQUIPMENT
TOTAL P.C.S. ACCEPTED	<u>6</u>	<u>Cal 005081 Dia 9-16-0</u>
TOTAL P.C.S. REJECTED	<u>0</u>	<u>TRG 002176 Dia 11-19-0</u>
"NR #" IF REJECTS	<u>NA</u>	
INSPECTOR	DATE	<u>NOV 21 2005</u>

Initiated by: D. Dunn Date 10/15/01

Reviewed by: V. Jain Date 10/15/01

QA Approval: B. Mabrito Date 10/15/01

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SIGNATURE: X. He DATE: 11/24/05

DISCLOSED TO AND UNDERSTOOD BY: _____ DATE: _____

PROPRIETARY INFORMATION

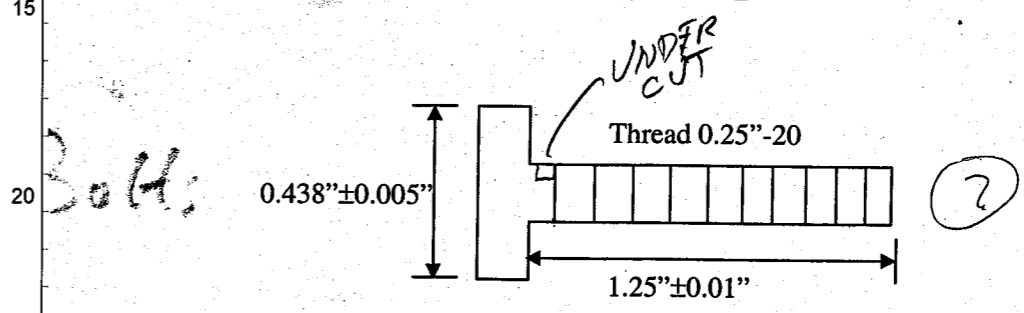
TITLE PROJECT

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Xihua He CNWRA-SwRI Phone: 210-522-5194 Fax: 210-522-6081 e-mail: xhe@swri.org	CNWRA drawing # 20.06002.01.322.010	To be completed at time of order Material: <u>Zr-4 Zircaloy</u> Heat: <u>1223217-243687</u> Specimen orientation: Other:
--	--	--

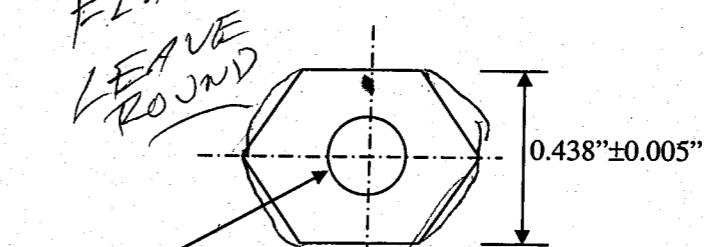
4 using 1/2" rod

Bolts and nuts for multiple crevice assembly



Bolt:

FLATS ONLY
LEAVE ROUND



Procedure	LOCATION	<u>C31 MS</u>
Project #	J.C. #	<u>82252-01</u>
TOTAL P.C.S. INSPECTED	<u>4</u>	EQUIPMENT
TOTAL P.C.S. ACCEPTED	<u>4</u>	<u>Cal 005081 Dia 9-16-0</u>
TOTAL P.C.S. REJECTED	<u>0</u>	<u>TRG 002176 Dia 11-19-0</u>
"NR #" IF REJECTS	<u>NA</u>	
INSPECTOR	DATE	<u>NOV 21 2005</u>

Initiated by: X. He Date _____

Continued To Page

SIGNATURE: Xihua He DATE: 11/22/05

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PROPRIETARY INFORMATION

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Galvanic Corrosion Test

Objective: SEE PAGE #1

SPECIMENS: Specimens polished to 600 Grit finish then cleaned in acetone
C-22 Base Alloy HT#2277-3-3266 with Ti-7 HT#CN2775 1/8 Creevice Washers And Hardware

Ti-7 HT#CN2775 Plate Cathode
Torque Screwdriver: Torq Craft 75 In-lbs SN: 694000691
Cal: 7/22/05 Due: 7/21/06

Initial Weight: 23.59792g Model: Sartorius Genius SN: 12809099
Final Weight: 23.59789g Cal: 11/14/05 Due: 5/12/06

SOLUTION: 5.0 M NaCl
584.42g NaCl Lot#051510
+ DI To 2000mls
Test ID: MA22Ti7Ti7b

Reagents measured with Model: OHAUS SN: 2883
Cal: 7/12/05 Due: 1/12/06

Initial pH: 6.051 Model: Orion EA 940 SN: 2330
Final pH: 4.577 Cal: 7/25/05 Due: 7/25/06
pH Probe: #13-620-296 SN: 4065196

TEST TEMPERATURE: 95°C Thermometer: Fisher SN: 51046103
Thermocouple SN: 333 Cal: 6/7/05 Due: 6/7/06
Cal: 7/26/05 Due: 1/26/06

Reference Electrode: Fisher SCE #13-620-52 SN: 3329075
GAS: Zero Air

Platinum Flag USED FOR OCP MEASUREMENT ONLY X-11 1/5/06
Counter Electrode: Ti-7 plate
(CREVICE) (PLATE)

Ecorr: -163mV Ecorr: +249mV Model: Keithley 614 SN#:0704936
Ept: X-11 12/19/05 Cal: 5/27/05 Due: 5/26/06

Potentiostat: Solartron 1480 SN#:00240053 Cal: 8/23/05 Due: 2/23/06

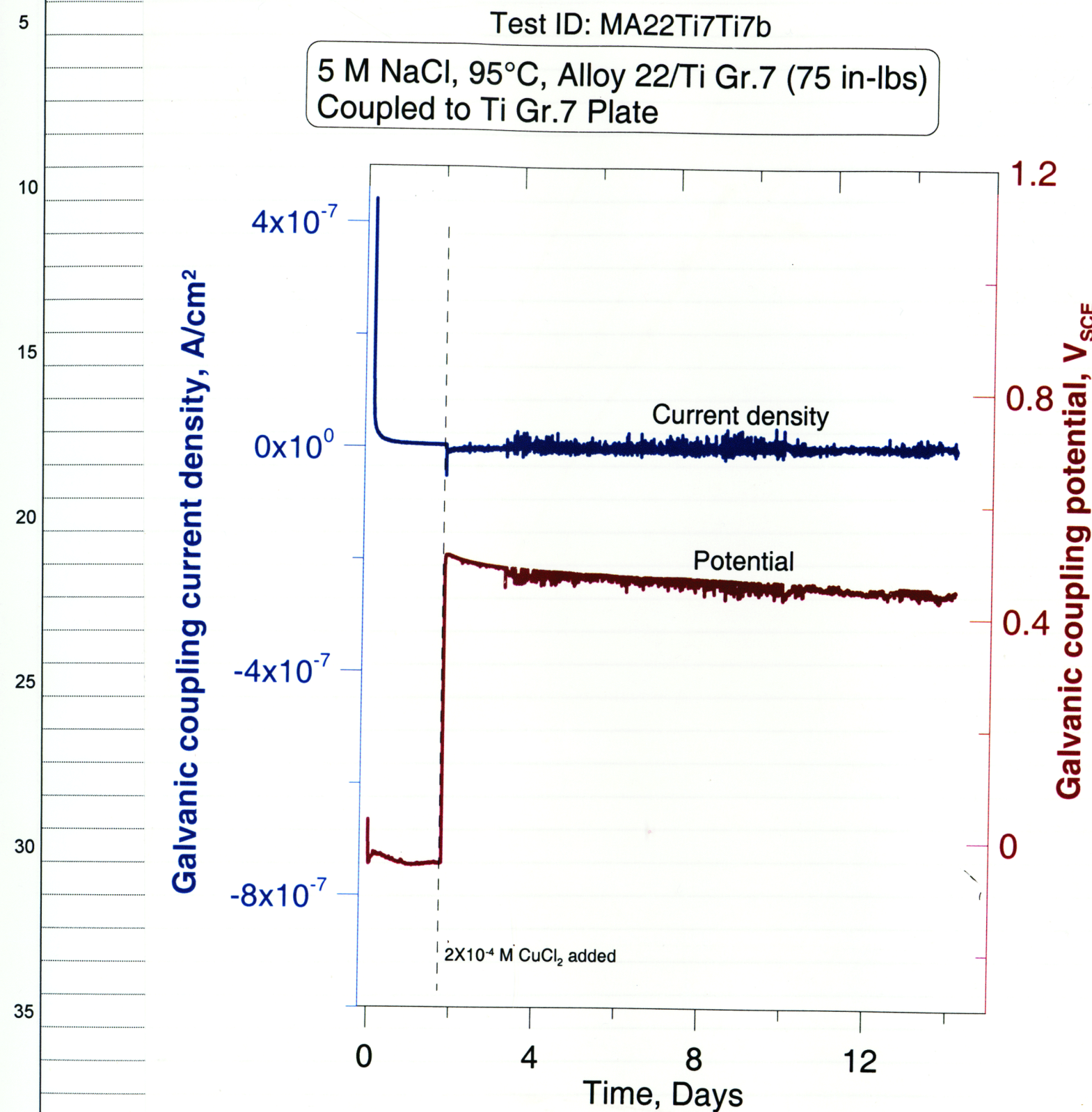
TEST ID: MA22Ti7Ti7b
DATA FILES: C22Ti7202-UNICH2, C22Ti7205-UNICH1, C22Ti7205-UNICH2, C22Ti7208-UNICH1,
C22Ti7208-UNICH2, C22Ti7211-UNICH1, C22Ti7211-UNICH2, C22Ti7214-UNICH1, C22Ti7214-UNICH2
Specimen Examination: No Creevice Corrosion 1/24 feet of Creevice Washers
Ti-7 Creevice Washers - No Corrosion. Ti-7 plate No Corrosion -
Mild dull tint surface staining on C-22 And Ti-7 Hardware

Number of crevice corrosion sites: 0/24 (24 Max.)

SIGN * Specimen Repolished for further testing
DISCLOSED TO AND UNDERSTOOD BY DATE PROPRIETARY INFORMATION
B. E. J. 11/30/05

TITLE PROJECT

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SIGNATURE DATE
DISCLOSED TO AND UNDERSTOOD BY DATE PROPRIETARY INFORMATION
See X-11 5/23/06 12/19/05

Continued To Page

Galvanic Corrosion Test

Objective: SEE PAGE #1

SPECIMENS: Specimens polished to 600 Grit finish then cleaned in acetone
 C-22 HT# 2277-3-3292 UNS13 - welded Solution Annealed S.C. No# 729 P# 58
 C-22 HT# 2277-3-3266 Crevice Washers And Hardware 1/3 - C22 HT# 2277-3-3266 Plate

Torque Screwdriver: Teve Craft 75 lb-lbs SN: 694000691
 Cal: 7/22/05 Due: 7/21/06

Initial Weight: 23.42953g Model: Sartorius Genius SN: 12809099
Final Weight: 23.42919g Cal: 11/14/05 Due: 5/12/06

SOLUTION: 5.0 M NaCl
 584.44g NaCl lot # 051510
 + DI to 2000mls

Test ID: WA22SAMA22MA22b

Reagents measured with Model: OHAUS SN: 2883 Due: 1/12/06
 Cal: 7/12/05

Initial pH: 6.52 Model: Orion EA 940 SN: 2330
Final pH: 4.881 Cal: 7/25/05 Due: 7/25/06
 pH Probe: #13-620-296 SN: 4065196

TEST TEMPERATURE: 95°C Thermometer: Fisher SN: 51046103
 Cal: 6/7/05 Due: 6/7/06
Thermocouple SN: Cal: 7/26/05 Due: 1/26/06

Reference Electrode: Fisher SCE # 13-620-52 SN: 925105
GAS: Zero Air

~~Platinum Flag USED FOR OCP MEASUREMENT ONLY~~ C22 Plate

Counter Electrode: C22 Plate
 (CREVICE) (PLATE)

Ecorr: -148mV Ecorr: +258mV Model: Keithley 614 SN#: 0704936
Ept: Ept: Cal: 5/27/05 Due: 5/26/06
 X-act 12/20/05

Potentiostat: Solartron 1480 SN#: 00240053 Cal: 8/23/05 Due: 2/23/06

TEST ID: WA22SAMA22MA22b X.H 12/19/05

DATA FILES: WSA22C221130 - UNICH5 WSA22C221130 - UNICH6, WSA22C221203 - UNICH5
 WSA22C221203 - UNICH6, WSA22C221206 - UNICH5
 WSA22C221206 - UNICH6, WSA22C221212 - UNICH6

Specimen Examination: No Crevice Corrosion 1/24 feet of crevice washers
 No Corrosion on C-22 Crevice washers or Hardware - C-22 Plate
 No Corrosion - M.I.O Surface staining on All C-22 material

Number of crevice corrosion sites 0/24 (24 Max.)

* Specimen Repaired for further Testing

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Galvanic Corrosion Test

Continued From Page

Test ID: WA22SAMA22MA22b

5 M NaCl, 95°C, Welded plus solution annealed Alloy 22/Alloy 22 crevice
 75 in-lbs torque, Coupled to Alloy 22 Plate

Note: Crevice corrosion was not initiated under this condition

SIGNATURE: [Signature] DATE: 12/19/05

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Continued To Page

TITLE PROJECT

POTENTIAL SCAN AND HOLD

Objective: See page 1.

Alloy / Heat No.: C-22 HT#2277-3-3292 UNS#13 w/ T.7 HT#CN2775 1/3 crevice washers nut/bolt
 Welpen Solution Annealed See MS#729 pg#58

Specimen Preparation: Specimen machined to dimensions specified in CNWRA Drawing #20.06002.01.322.002. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone then crevice forming washers attached to specimen using hardware. Torque to 50 in-oz. or 75 in lbs.

Torque Screwdriver: Teve-Craft Model# & Torque: 75 In-lbs SN: 694000691
 Cal: 7/22/05 Due: 7/21/06

Initial Weight: 23.21578g Model: Sartorius Genius SN: 12809099
 Final Weight: 22.79483g Cal: 11/14/05 Due: 5/12/06

Solution: 4.0 M MgCl₂ · 6H₂O
 1626.50g MgCl₂ · 6H₂O lot#050439
 + DI To 2000mls

Test ID: WA22SATi701g

Reagents measured with Model: OHAUS SN: 2883
 Cal: 7/12/05 Due: 1/12/06

Initial pH: 3.078 Model: Orion EA 940 SN: 2330
 Final pH: 5.832 Cal: 7/25/05 Due: 7/25/06
 pH Probe: #13-620-296 SN: 4065196

Test Temperature: 95°C Measured with Hg Thermometer SN: H98-187
 Cal: 9/9/05 Due: 9/8/06

Counter Electrode: Platinum Flag

Reference Electrode: Fisher 13-620-52 SN: 3300328

Gas: Zero Air then 99.999% N₂ for E repassivation

Ecorr: -165mV Model: Keithley 614 SN: 0555368
 Ept: +457mV Cal: 9/14/05 Due: 3/14/06

Potentiostat: Solartron 1450 SN: 00238265
 Cal: 6/1/05 Due: 12/1/05

DATA FILE: WA22SATi7-75A, WA22SATi7-75N2b, WA22SATi7-75U, WA22SATi7-75H, WA22SATi7-75D

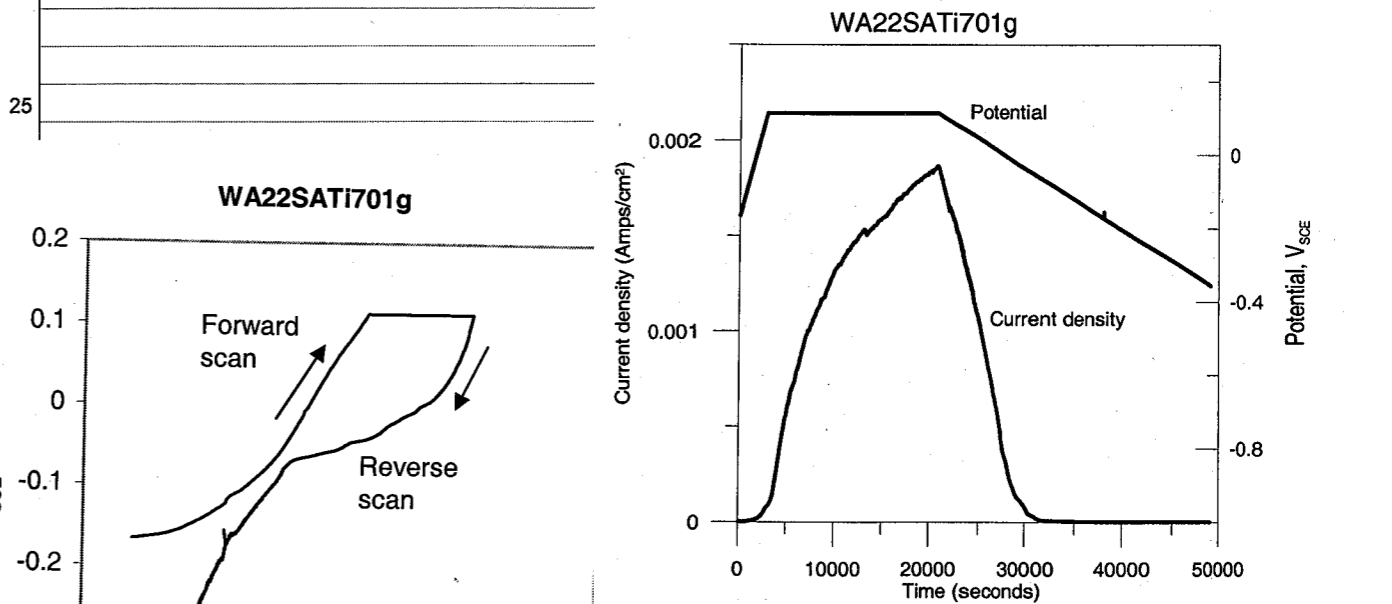
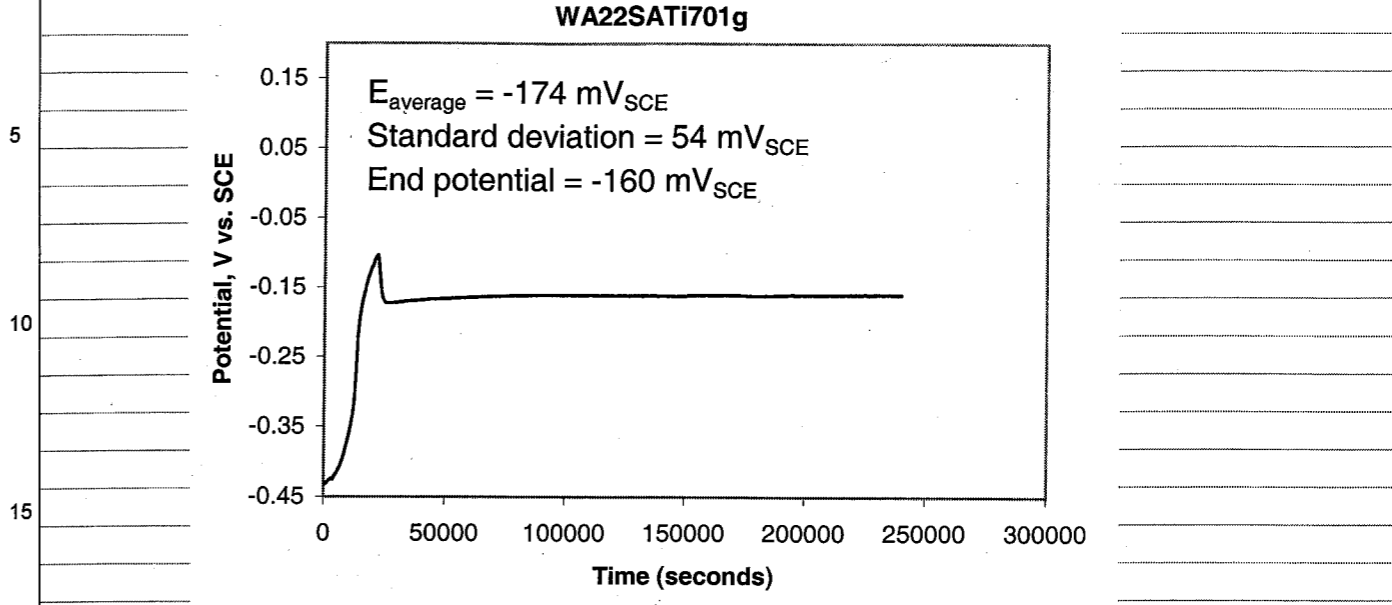
Number of Crevice Corrosion Sites: 12/24 (24 max.)
 Crevice Corrosion on 12/24 feet of C-22 specimen - Deep Corrosion paths - No Corrosion on any T.7 crevice washers or hardware mto surface staining on C-22 - T.7 dull tint surface staining

SIGNATURE: [Signature] DATE: 12/1/05
 DISCLOSED TO AND UNDERSTOOD BY: [Signature] DATE: [Signature]

PROPRIETARY INFORMATION

TITLE PROJECT

Continued From Page



Welded+Solution Annealed Alloy 22 (Anode) to Ti Gr7 crevice, Ti7 bolt and nut
 Anode to cathode area ratio: ~1/3; Torque: 75 in-lbs;
 N₂ deaerated, 95 °C, 4 M MgCl₂ solution
 Forward scan rate: 0.1 mV/s, Potential hold: 113 mV_{SCE} for 5 hours
 Reverse scan rate: 0.0167 mV/s
 Using entire assembly area for current density calculation:
 i < 10⁻⁵ A/cm² at -63 mV_{SCE}; i < 2*10⁻⁶ A/cm² at -132 mV_{SCE};
 i < 10⁻⁶ A/cm² at -165 mV_{SCE}
 Using crevice specimen area for current density calculation:
 i < 10⁻⁵ A/cm² at -124 mV_{SCE}; i < 2*10⁻⁶ A/cm² at -237 mV_{SCE};
 i < 10⁻⁶ A/cm² at -295mV_{SCE}

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PROPRIETARY INFORMATION

TITLE

Continu

PROJECT

POTENTIAL SCAN AND HOLD

Objective: See page 1.

Alloy / Heat No.: C-22 MT#2277-3-3266 Base Alloy w/T: 7 MT#C22775 Crevice Washers 1/3 Nut/Bolt

Specimen Preparation: Specimen machined to dimensions specified in CNWRA Drawing #20.06002.01.322.002. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone then crevice forming washers attached to specimen using hardware. Torque to 50 in-oz. or 75 in lbs.

Torque Screwdriver: True Craft Model# & Torque: 75 In-lbs SN: 694000691 Cal: 7/22/05 Due: 7/21/06

Initial Weight: 23.03187g Model: Sartorius Genius SN: 12809099 Cal: 11/14/05 Due: 5/12/06

Final Weight: 22.84800g

Solution: 4.0 M MgCl₂ · 6H₂O
1626.51g MgCl₂ · 6H₂O lot# 050439
+ DI To 2000 mL

Test ID: BA22Ti703f

Reagents measured with Model: OHAUS SN: 2883 Cal: 7/12/05 Due: 1/12/06

Initial pH: 2.968 Model: Orion EA 940 SN: 2330 Cal: 7/25/05 Due: 7/25/06
Final pH: 5.668 pH Probe: #13-620-296 SN: 4065196

Test Temperature: 95°C Measured with Hg Thermometer SN: 115858 Cal: 4/27/05 Due: 4/27/06

Counter Electrode: Platinum Flag Reference Electrode: Fisher 13-620-52 SN: 4028037

Gas: Zero Air then 99.999% N₂ for E Repassivation
Ecorr: -159mV Model: Keithley 614 SN: 0704934 Cal: 7/12/05 Due: 7/12/06
Ept: +509mV

Potentiostat: Solartron 1287 SN: 00148560 Cal: 5/25/05 Due: 11/25/05

DATA FILE: C22Ti7-75A, C22Ti7-75N26, C22Ti7-75U, C22Ti7-75H, C22Ti7-75D

Number of Crevice Corrosion Sites: 3/24 (24 max.)
Crevice Corrosion on 3/24 feet of C-22 Specimen. Deep Corrosion Paths. Ti7 Crevice Washers And Nut/Bolt Show No Sign of Corrosion. Mild Surface staining on C-22. Ti7 Has Dull tint staining on Crevice Washers And Nut/Bolt.

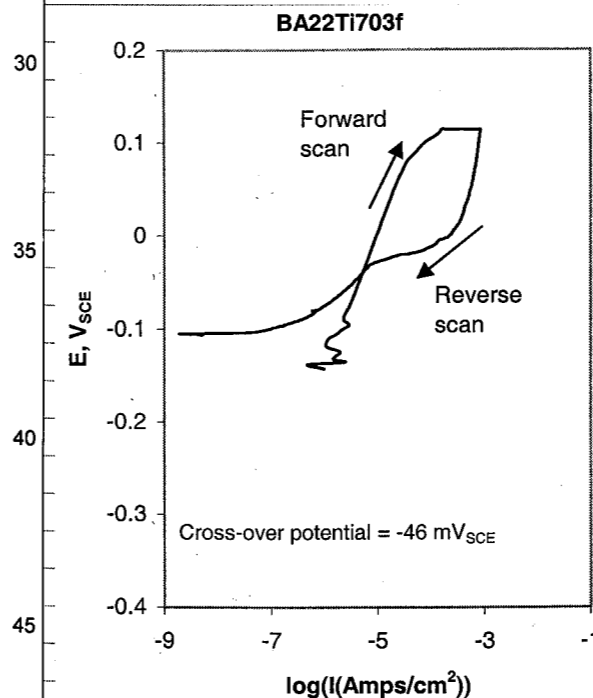
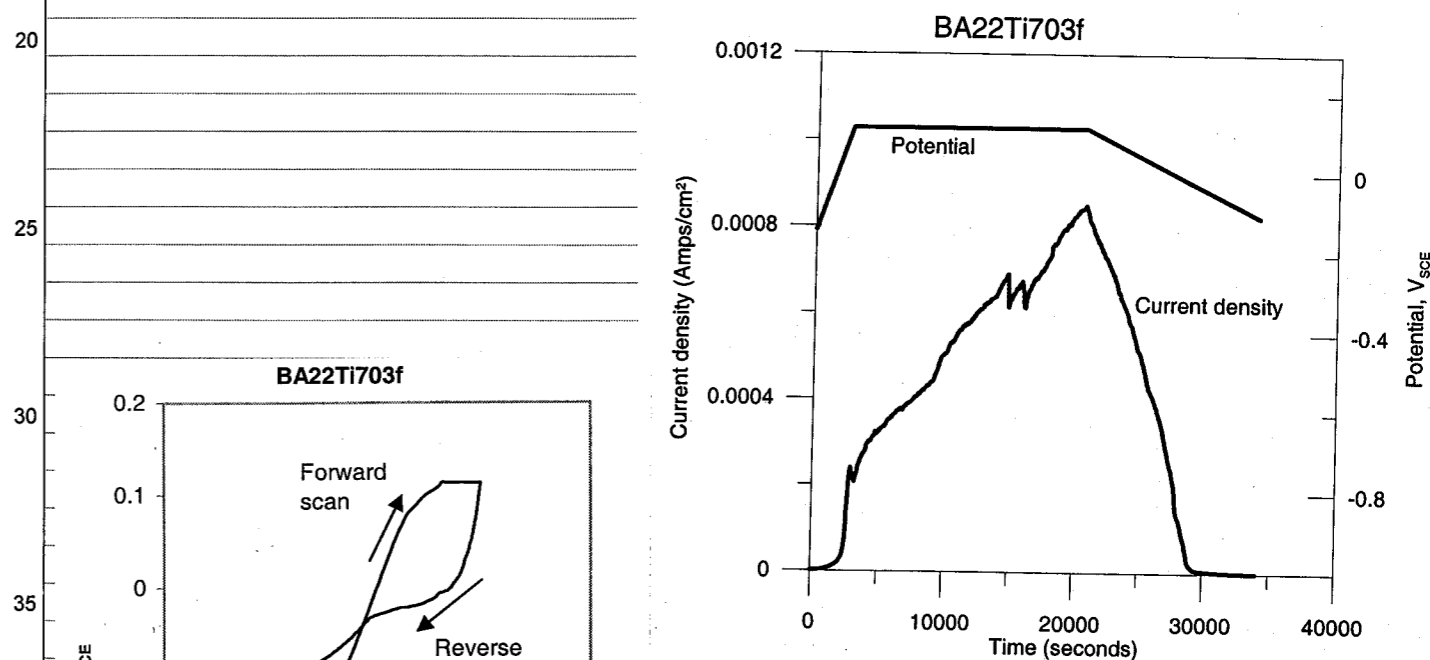
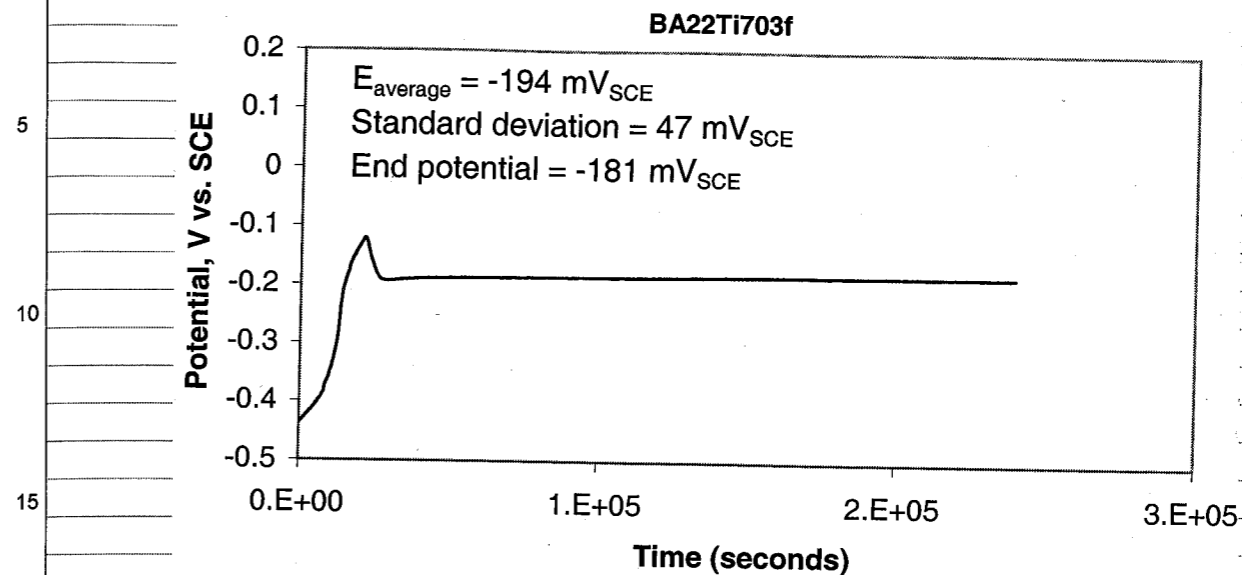
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TITLE

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Base Alloy 22 (Anode) to Ti Gr7 crevice, Ti7 bolt and nut
Anode to cathode area ratio: ~1/3; Torque: 75 in-lbs;
N₂ deaerated, 95 °C, 4 M MgCl₂ solution
Forward scan rate: 0.1 mV/s, Potential hold: 113 mV_{SCE} for 5 hours
Reverse scan rate: 0.0167 mV/s
Using entire assembly area for current density calculation:
i < 10⁻⁵ A/cm² at -28 mV_{SCE}; i < 2*10⁻⁶ A/cm² at -62 mV_{SCE};
i < 10⁻⁶ A/cm² at -75 mV_{SCE}
Using crevice specimen area for current density calculation:
i < 10⁻⁵ A/cm² at -60 mV_{SCE}; i < 2*10⁻⁶ A/cm² at -87 mV_{SCE};
i < 10⁻⁶ A/cm² at -93 mV_{SCE}

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TITLE PROJECT
 Continued From
POTENTIAL SCAN AND HOLD

...ve: See page 1.

Alloy / Heat No.: C-22 HT# 2277-3-3292 WNR13 w/ Ti-7 HT# CN2775/3 crevice washers
 welded Solution Annealed See NB #729 pg #58 Nut/Bolt

Specimen Preparation: Specimen machined to dimensions specified in CNWRA Drawing #20.06002.01.322.002. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone then crevice forming washers attached to specimen using hardware. Torque to 50 in-oz. or 75 in lbs.

Torque Screwdriver: Proto 6104 Model# & Torque: 50 In-oz SN: 12809099
 Cal: 10/24/05 Due: 4/24/06

Initial Weight: 23.3475g Model: Sartorius Genius SN: 12809099
Final Weight: 23.0965g Cal: 11/14/05 Due: 5/12/06

Solution: 4.0 M $MgCl_2 \cdot 6H_2O$
 1627.20g $MgCl_2 \cdot 6H_2O$ lot # 050439
 + DI To 2000ml

Test ID: WA22SATI702d

Reagents measured with Model: OHAUS SN: 2883
 Cal: 7/12/05 Due: 1/12/06

Initial pH: 2.691 Model: Orion EA 940 SN: 2330
Final pH: 5.933 Cal: 7/25/05 Due: 7/25/06
 pH Probe: #13-620-296 SN: 4065196

Test Temperature: 95°C Measured with Hg Thermometer SN: M98-187
 Cal: 9/9/05 Due: 9/8/06

Counter Electrode: Platinum Flag
Reference Electrode: Fisher 13-620-52 SN: 33 00328

Gas: zero Air then 99.999% N_2 for E Repassivation

Ecorr: -95 mV_{SCE} Model: Keithley 614 SN: 0555368
Ept: +420 mV_{SCE} Cal: 9/14/05 Due: 3/14/06

Potentiostat: Solartron 1480 SN: 00238265
 WA22SATI7-50A, WA22SATI7-50N2b, WA22SATI7-50D Cal: 6/1/05 Due: 12/1/05

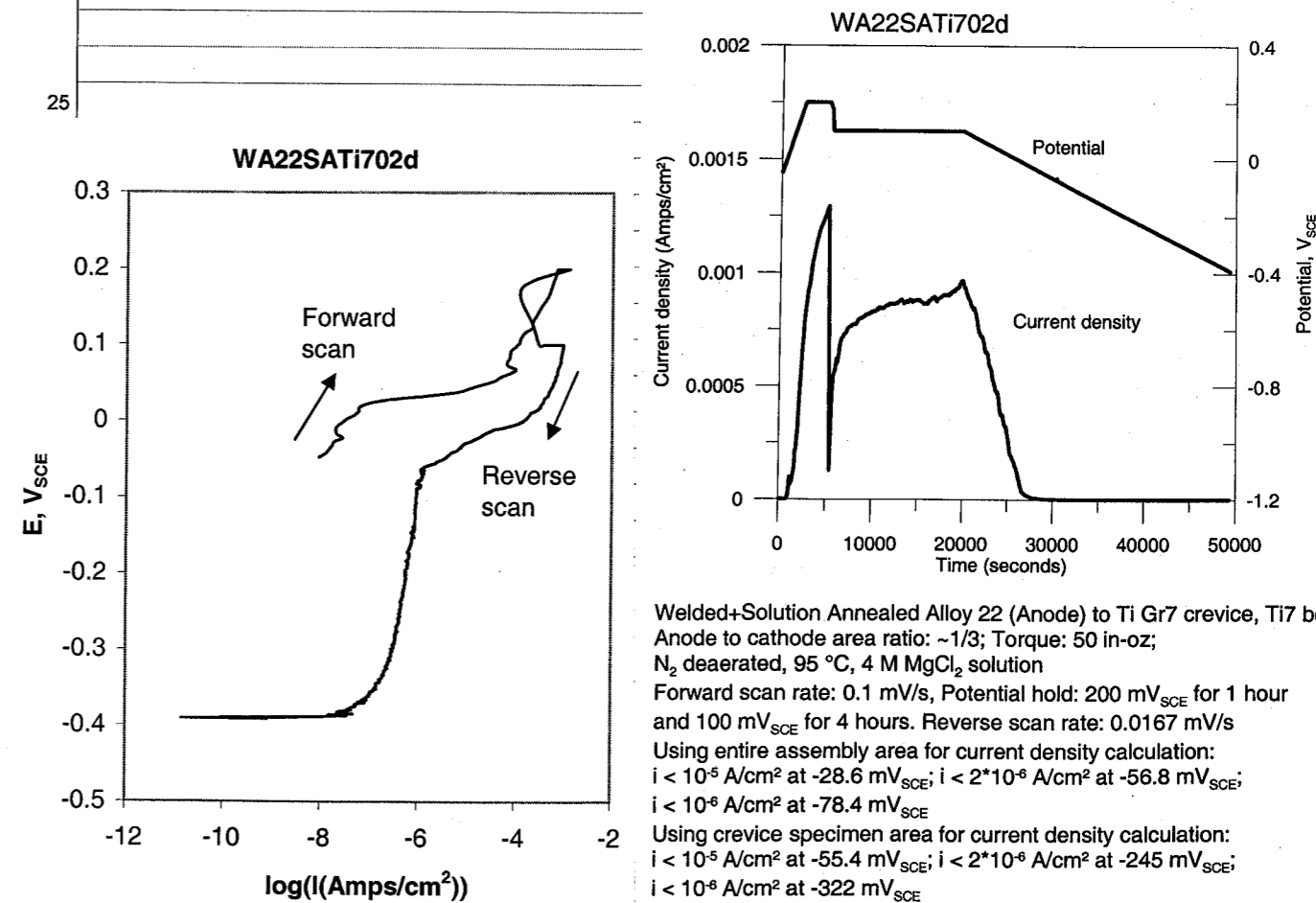
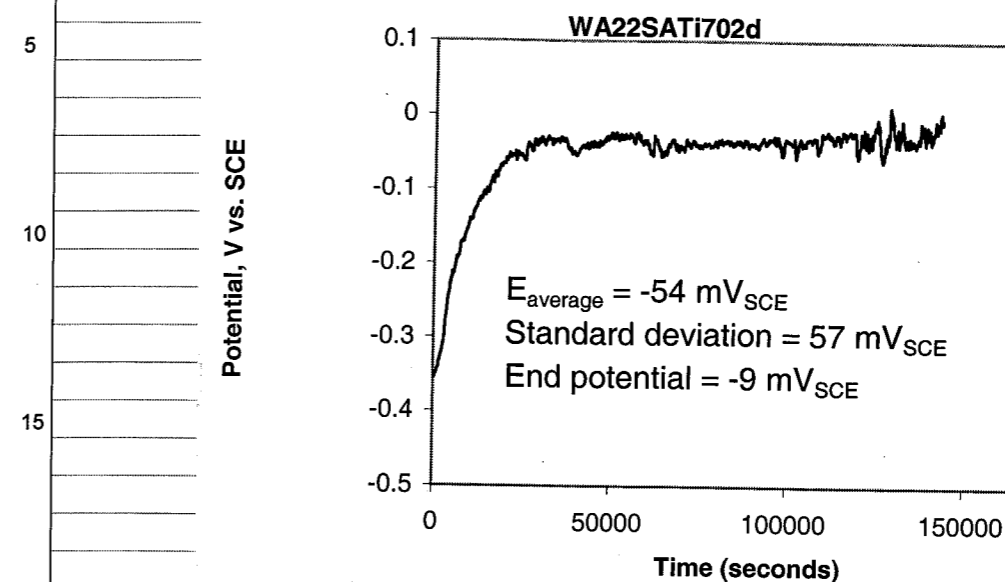
DATA FILE: WA22SATI7-50A, WA22SATI7-50Ub, TI7-50U,
 WA22SATI7-50Hb, WA22SATI7-50D

Number of Crevice Corrosion Sites: 4/24 (24 max.)

Crevice Corrosion on 4/24 feet of Crevice Washers on C-22
 Specimen Deep Corrosion paths on Surface - Ti-7 crevice
 washers Nut Ana Bolt No Corrosion. Mild Surface staining
 on C-22 - Dull tint staining on Ti-7 Hardware

SIGNATURE *[Signature]* DATE 12/6/05
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TITLE PROJECT
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Welded+Solution Annealed Alloy 22 (Anode) to Ti Gr7 crevice, Ti7 bolt and nut
 Anode to cathode area ratio: ~1/3; Torque: 50 in-oz;
 N_2 deaerated, 95 °C, 4 M $MgCl_2$ solution
 Forward scan rate: 0.1 mV/s, Potential hold: 200 mV_{SCE} for 1 hour
 and 100 mV_{SCE} for 4 hours. Reverse scan rate: 0.0167 mV/s
 Using entire assembly area for current density calculation:
 $i < 10^{-5}$ A/cm² at -28.6 mV_{SCE}; $i < 2 \cdot 10^{-6}$ A/cm² at -56.8 mV_{SCE};
 $i < 10^{-6}$ A/cm² at -78.4 mV_{SCE}
 Using crevice specimen area for current density calculation:
 $i < 10^{-5}$ A/cm² at -55.4 mV_{SCE}; $i < 2 \cdot 10^{-6}$ A/cm² at -245 mV_{SCE};
 $i < 10^{-6}$ A/cm² at -322 mV_{SCE}

SIGNATURE *[Signature]* DATE 12/19/05
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PROJECT

POTENTIAL SCAN AND HOLD

Objective: See page 1.

Alloy / Heat No.: C-22 HT# 2277-3-3266 Base Alloy w/Ti7 HT# CN2775 Crevice Washers Nut/Bolt 1/3

Specimen Preparation: Specimen machined to dimensions specified in CNWRA Drawing #20.06002.01.322.002. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone then crevice forming washers attached to specimen using hardware. Torque to 50 in-oz. or 75 in lbs.

Torque Screwdriver: Proto 6104 Model# & Torque: 50 In-oz SN: 12809099 Cal: 10/24/05 Due: 4/24/06

Initial Weight: 23.06260g Model: Sartorius Genius SN: 12809099 Cal: 11/14/05 Due: 5/12/06

Solution: 4.0 M MgCl2 · 6H2O 1626.78g MgCl2 · 6H2O Lot# 050439 + DI to 2000mls

Test ID: BA22Ti702f

Reagents measured with Model: OHAUS SN: 2883 Cal: 7/12/05 Due: 1/12/06

Initial pH: 2.806 Model: Orion EA 940 SN: 2330 Cal: 7/25/05 Due: 7/25/06 Final pH: 5.963 pH Probe: #13-620-296 SN: 4065196

Test Temperature: 95°C Measured with Hg Thermometer SN: 115858 Cal: 4/27/05 Due: 4/27/06

Counter Electrode: Platinum Flag

Reference Electrode: Fisher 13-620-52 SN: 4028037

Gas: Zero-grade air for open circuit potential measurement, N2 for Erepass

Ecorr: -18 mV_SCE Model: Keithley 614 SN: 0704934 Ept: 231 mV_SCE Cal: 7/12/05 Due: 7/12/06

Potentiostat: SE1287 SN: 00148560 Cal: 5/25/05 Due: 11/25/05

DATA FILE: C22Ti750A2R0CP, C22Ti750N2, C22Ti750U, C22Ti750U6, C22Ti750H, C22Ti750UC, C22Ti750HC, C22Ti750D

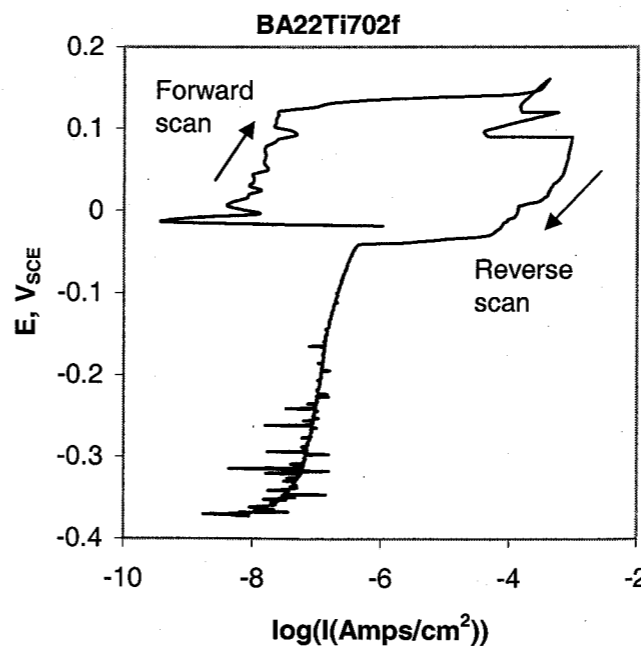
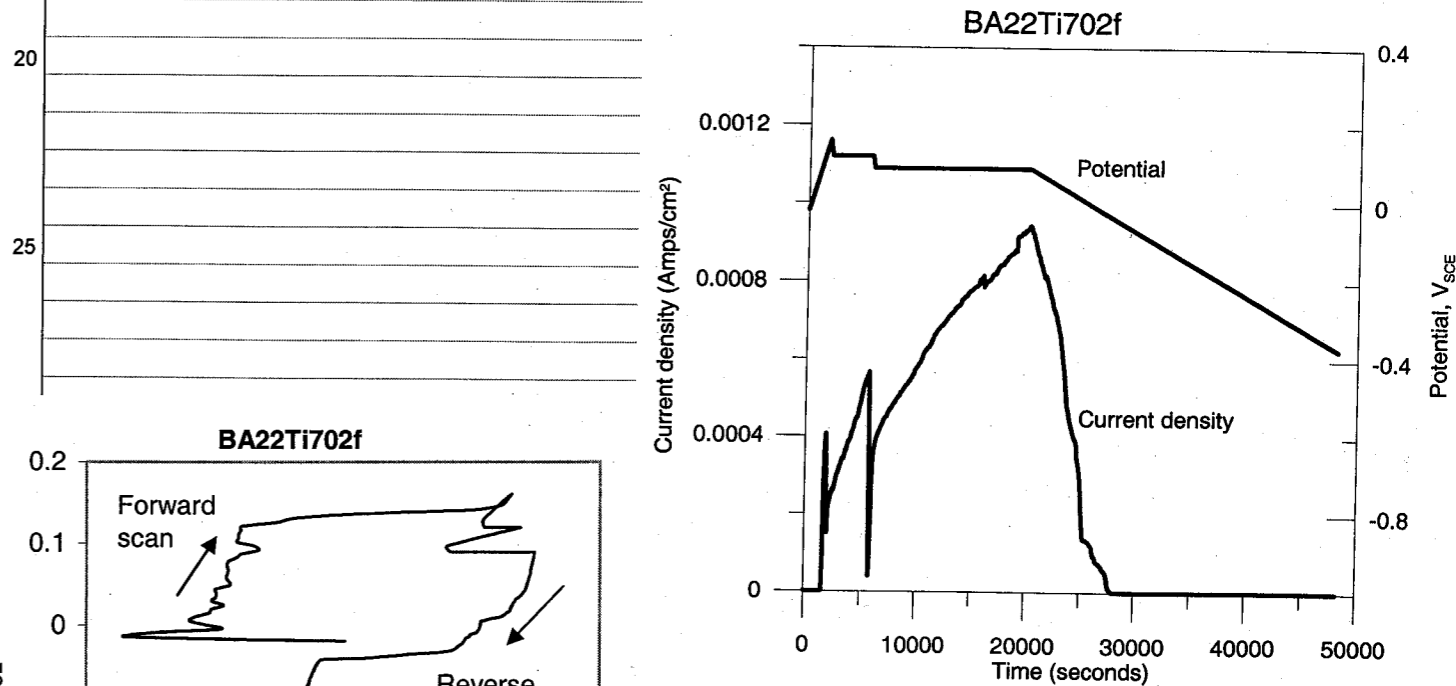
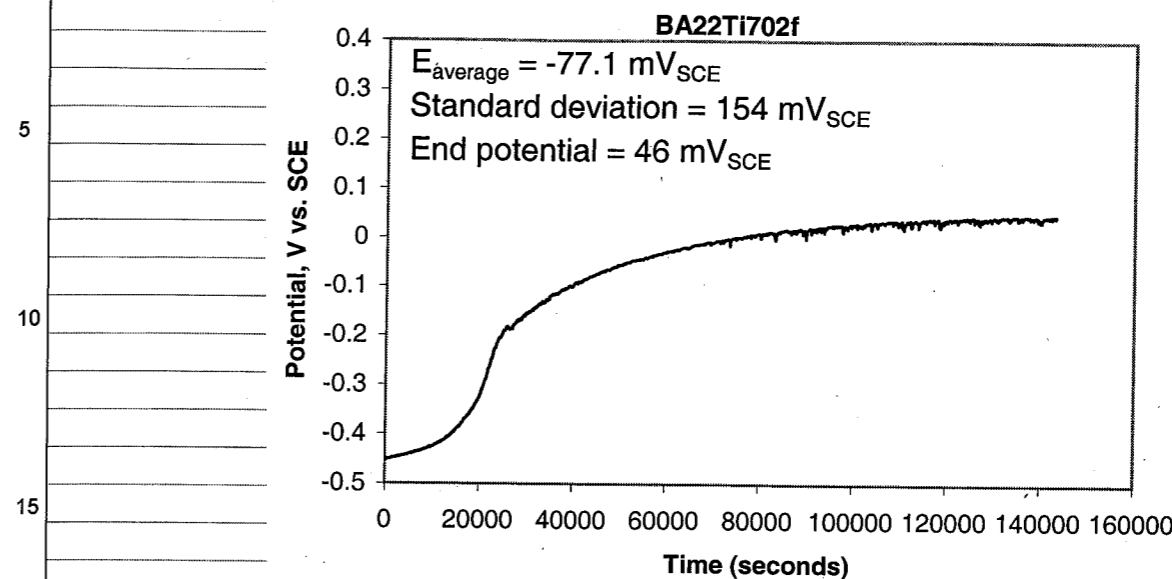
Number of Crevice Corrosion Sites: 3/24 (24 max.) Crevice Corrosion on 3/24 feet of crevice washers on C-22 specimen - Deep corrosion paths on surface - Ti7 crevice washers and nut/bolt no corrosion - mild surface staining on C-22 specimen - Ti7 hardware dull tint staining

SIGNATURE [Signature] DATE 12/6/05 DISCLOSED TO AND UNDERSTOOD BY [Signature] DATE PROPRIETARY INFORMATION

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Base Alloy 22 (Anode) to Ti Gr7 crevice, Ti7 bolt and nut Anode to cathode area ratio: ~1/3; Torque: 50 in-oz; N2 deaerated, 95 °C, 4 M MgCl2 solution Forward scan rate: 0.1 mV/s, Potential hold: 120 mV_SCE for 1 hour 90 mV_SCE for another 4 hours. Reverse scan rate: 0.0167 mV/s Using entire assembly area for current density calculation: i < 10^-5 A/cm² at -34.1 mV_SCE; i < 2*10^-6 A/cm² at -38.3 mV_SCE; i < 10^-6 A/cm² at -39.1 mV_SCE Using crevice specimen area for current density calculation: i < 10^-5 A/cm² at -38.3 mV_SCE; i < 2*10^-6 A/cm² at -40.9 mV_SCE; i < 10^-6 A/cm² at -91.3 mV_SCE

SIGNATURE [Signature] DATE 12/20/05 DISCLOSED TO AND UNDERSTOOD BY [Signature] DATE PROPRIETARY INFORMATION

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Galvanic Corrosion Test

Objective: SEE PAGE #1

Test ID: 316SSPTFEC22

SPECIMENS: Specimens polished to 600 Grit finish then cleaned in acetone

316L C-22 Plate C276 Nut/Bolt
HT#P80746 HT# 2277-3-3266 PTFE crevice washers

Torque Screwdriver: Proto 6104 100 In-oz SN: 139072
Cal: 10/24/05 Due: 4/24/06

Initial Weight: 21.69897g Model: Sartorius Genius SN: 12809099
Final Weight: 21.51855g Cal:11/14/05 Due:5/12/06

SOLUTION: 5.0 M NaCl
584.41g NaCl lot# 052761
+ DI To 2000mls

Reagents measured with Model: OHAUS SN: 2883
Cal:7/12/05 Due:1/12/06

Initial pH: 7.63 Model: Orion EA 940 SN:2330
Final pH: 4.763 Cal:7/25/05 Due:7/25/06
pH Probe: #13-620-296 SN: 4065196

TEST TEMPERATURE: 95°C Thermometer: Fisher SN: 51046103

Thermocouple SN: 331 Cal: 6/7/05 Due: 1/7/06
Cal: 11/7/05 Due: 5/6/06

Reference Electrode: Fisher SCE # 13-620-52 SN: 0199568

GAS: Zero Air

Test line: 12/15/05 - 2/13/06
Platinum Flag USED FOR OCP MEASUREMENT ONLY

Counter Electrode: (CREVICE) (PLATE) X.r 1/5/06

Ecorr: -334mV Ecorr: -130mV Model: Keithley 614 SN#:0704936
Ept: Ept: Cal:5/27/05 Due:5/26/06

Potentiostat: Solartron 1480 SN#:00240053 Cal: 8/23/05 Due:2/23/06

TEST ID: ~~SSPTFEC22~~ 316SSPTFEC22 00238265
X.r 2/13/06 X.r 2/13/06

DATA FILES: 316SSPR0105I - Unich3, 316SSPR0105E - Unich4, 1215, 1218, 1221,
1224, 1227, 1230, 0102, 0105, 0108, 0111, 0114, 0117, 0120,
0123, 0126, 0129, 0201, 0204, 0207, 0210

Specimen Examination:

SIGN

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

[Signature] 12/15/05

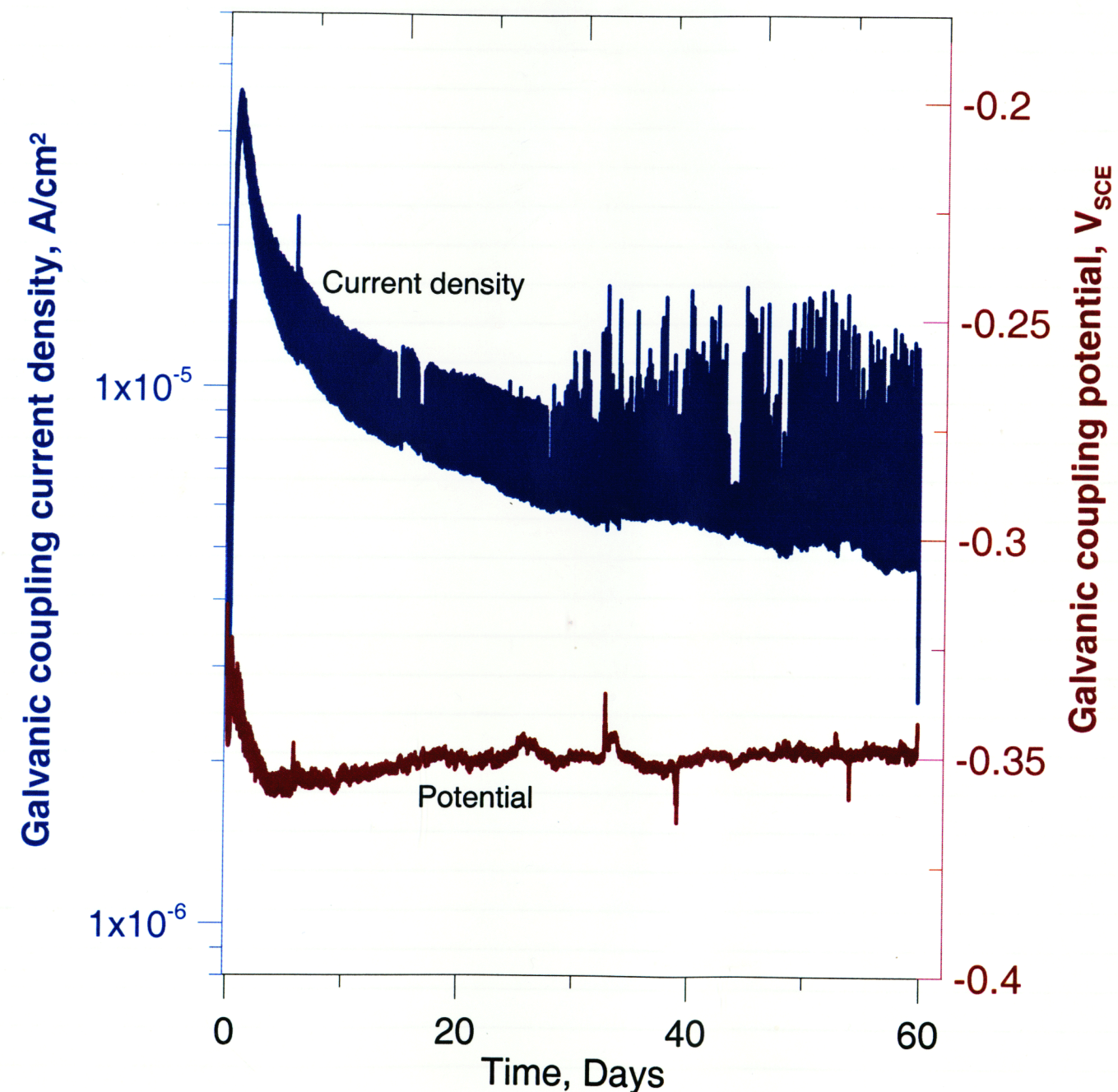
TITLE

PROJECT

Continued From Page

Test ID: 316SSPTFEC22

5 M NaCl, 95°C, 316 Stainless Steel/Teflon (100 in-oz)
Coupled to Alloy 22 Plate



SIGNATURE

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[Signature]

2/13/06

Continued To Page

Galvanic Corrosion Test

Objective: SEE PAGE #1

SPECIMENS: Specimens polished to 600 Grit finish then cleaned in acetone

C-22 HT# 2277-3-3292 w n 813
Solution Annealed 1125°C / 20 min NO# 729 of #58
Ti7 HT# CU2775
Crevice washers Nut/Bolt Plate

Torque Screwdriver: Teve Craft 75 In-lbs
SN: 694000691
Cal: 7/22/05 Due: 7/21/06

Initial Weight: 22.31707g Model: Sartorius Genius SN: 12809099

Final Weight: 22.31675g Cal: 11/14/05 Due: 5/12/06

SOLUTION: 5.0 M NaCl
584.40g NaCl lot # 051510
+ DI To 2000 mL

Reagents measured with Model: OHAUS SN: 2883
Cal: 7/12/05 Due: 1/12/06

Initial pH: 6.579 Model: Orion EA 940 SN: 2330

Final pH: 4.875 Cal: 7/25/05 Due: 7/25/06
pH Probe: #13-620-296 SN: 4065196

TEST TEMPERATURE: 95°C Thermometer: Fisher SN: 51046103

Thermocouple SN: 333 Cal: 6/7/05 Due: 6/7/06
Cal: 7/26/05 Due: 1/26/06

Reference Electrode: Fisher SCE # 13-620-52 SN: 3329075

GAS: Zero Air

Platinum Flag USED FOR OCP MEASUREMENT ONLY x-1 1/5/06

Counter Electrode:

(CREVICE) (PLATE)

Ecorr: -140 mV SCE Ecorr: -144 mV SCE Model: Keithley 614 SN#: 0704936

Ept: Ept: Cal: 5/27/05 Due: 5/26/06

Potentiostat: Solartron 1480 SN#: 00240053 Cal: 8/23/05 Due: 2/23/06

TEST ID: WA22SATi7Ti7a

DATA FILES: C22Ti7k216-UNICh1, C22Ti7E1216-UNICh2,
I1217, 1220, 1223, 1226, 1229, 0101, 0104, 0107, 0110, 0113, 0116, 0117

Specimen Examination: No Crevice Corrosion 24 feet of Ti7 crevice
washers - Ti7 Plate No sign of corrosion - All material C-22
And Ti7 Hardware Have m.l.s surface staining - web Area on
C-22 Specimen Is stained darker than other surface

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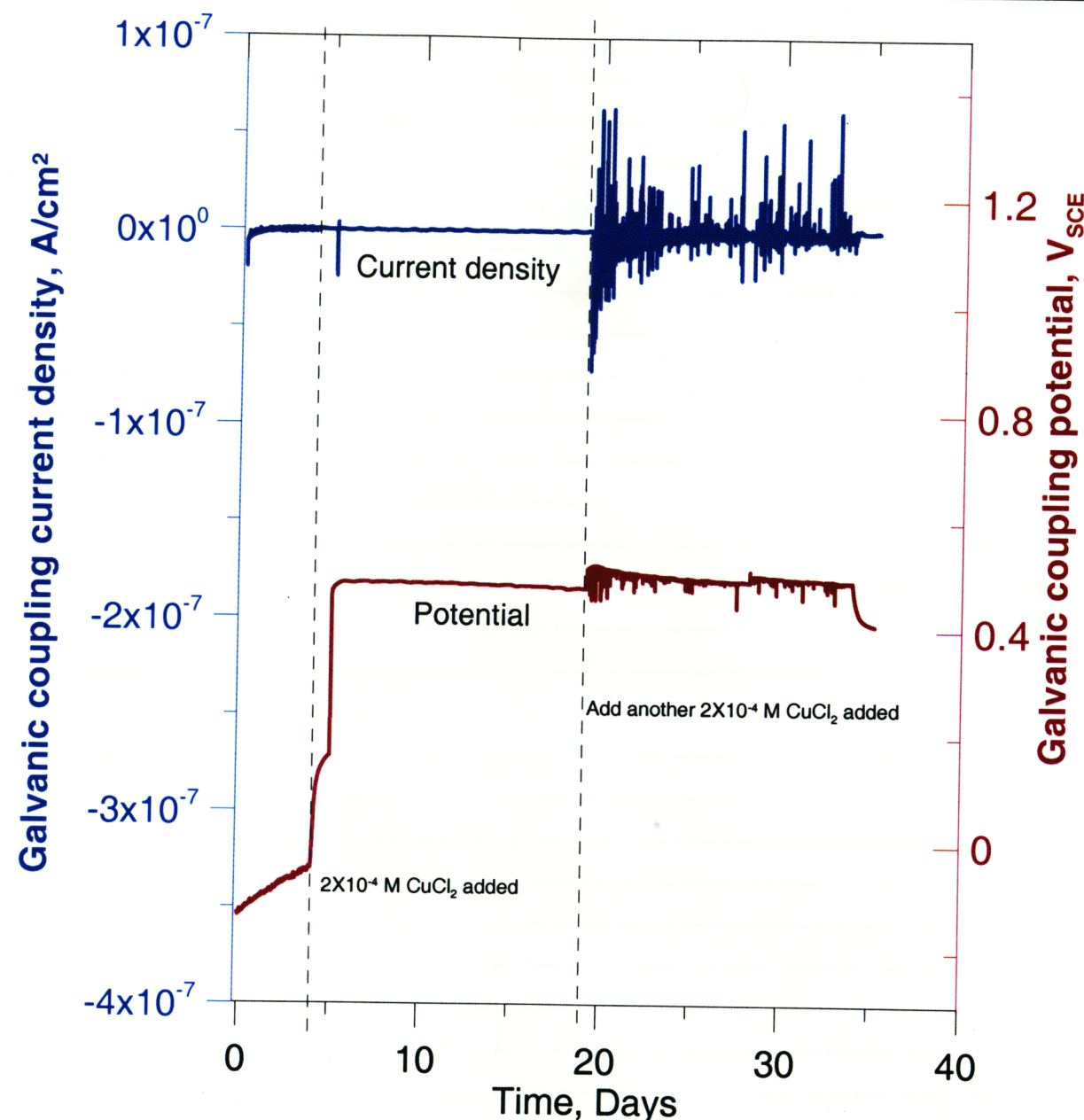
DATE

PROPRIETARY INFORMATION

Continued From Page

Test ID: WA22SATi7Ti7a

5 M NaCl, 95°C, welded plus solution annealed Alloy 22/Ti7 (75 in-lbs)
Coupled to Ti7 Plate



Note: No crevice corrosion initiation in 35 days even with the addition of CuCl₂.

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PROPRIETARY INFORMATION

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TITLE

Galvanic Corrosion Test

Continu

Objective: SEE PAGE #1

SPECIMENS: Specimens polished to 600 Grit finish then cleaned in acetone

C-22 HT #2277-3-3292 WWS13 Ti7 HT #CN2775 Ti7 HT #CN2775
Solution Annealed 1175°C/min NB #729 pg #58 Crevice Washers Nut/Solt Plate

Torque Screwdriver: True Craft 75 In-lbs SN: 694000691
Cal: 7/22/05 Due: 7/21/06

Initial Weight: 23.5897g Model: Sartorius Genius SN: 12809099
Final Weight: 23.58983g Cal: 11/14/05 Due: 5/12/06

SOLUTION: 5.0 M NaCl
584.49g NaCl Lot # 052761
+ PZ To 2000mls

Reagents measured with Model: OHAUS SN: 2883
Cal: 7/12/05 Due: 1/12/06

Initial pH: 7.39 Model: Orion EA 940 SN: 2330
Final pH: 4.877 Cal: 7/25/05 Due: 7/25/06
pH Probe: #13-620-296 SN: 4065196

TEST TEMPERATURE: 95°C Thermometer: Fisher SN: 51046103
Cal: 6/7/05 Due: 6/7/06
Thermocouple SN: 333 Cal: 7/26/05 Due: 1/26/06

Reference Electrode: Fisher SCE # 13-620-52 SN: 3329075
GAS: Zero Air

Platinum Flag USED FOR OCP MEASUREMENT ONLY
Counter Electrode: X.H 1/5/06

(CREVICE) (PLATE)
Ecorr: 27.1mV_{SCE} Ecorr: -231.6mV_{SCE} Model: Keithley 614 SN#: 0704936
Ept: Ept: Cal: 5/27/05 Due: 5/26/06

Potentiostat: Solartron 1480 SN#: 00240053 Cal: 8/23/05 Due: 2/23/06

TEST ID: WA22SATi7Ti7b

DATA FILES: W22Ti7I22I-Unlch3, W22Ti7I22IE-Unlch4, 1224, 1227, 1230,
0102, 0105, 0108, 0111, 0114, 0117, 0120, 0123

Specimen Examination: No sign of corrosion on welds C-22 staining
on web surface Darker In color - Ti7 crevice washers And Ti7
plate No corrosion dull tint staining on specimen hardware And plate

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* Specimen Repolished for further testing

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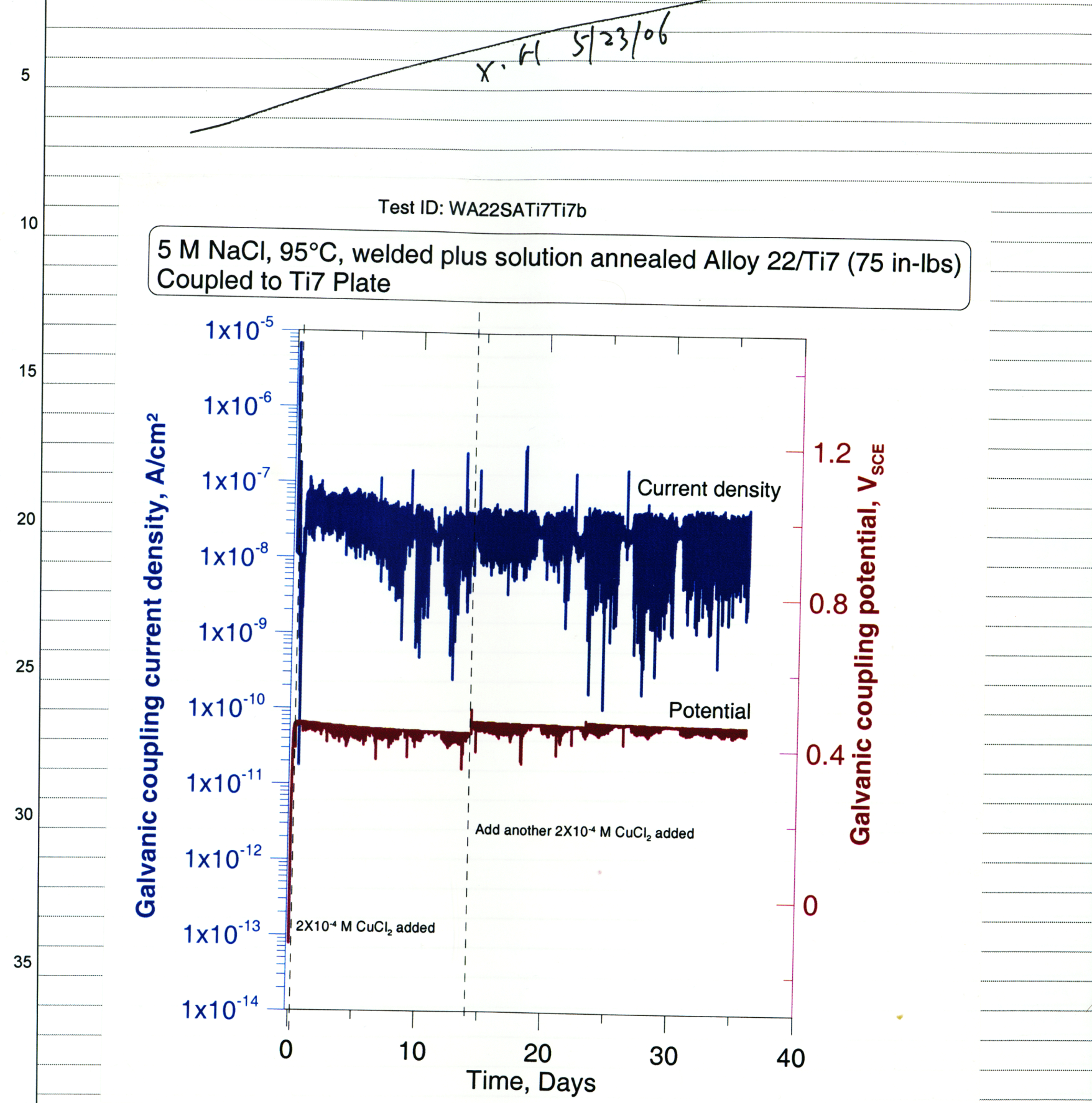
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Note: No crevice corrosion initiation in 35 days even with addition of CuCl₂.

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PROJECT

Conti

Galvanic Corrosion Test

Objective: SEE PAGE #1

SPECIMENS: Crevice Specimen drawing # 20.06002.01.322.002 polished to 600 Grit finish then cleaned in acetone

C-22 HT# 2277-3-3266
Crevice Specimen

Ti7 HT# CN2775
Plate

Ti7 HT# CN2775
Crevice Washers
Nut/Bolt

Torque Screwdriver:

True Craft 75 In-lbs
Cal: 7/22/05

SN: 694000641
Due: 7/21/06

Initial Weight: 23.28996g

Model: Sartorius Genius

SN: 12809099

Final Weight: 23.28484g

Cal: 11/14/05

Due: 5/12/06

SOLUTION:

4.0 M MgCl₂ · 6H₂O
1626.49g MgCl₂ · 6H₂O lot# 050439
+ DI to 2000mls

Reagents measured with

Model: OHAUS
Cal: 1/5/06

SN: 2883
Due: 7/05/06

Initial pH: 4.983

Model: Orion EA 940

SN: 2330

Final pH: Not Taken
Used Solution for Test
on pg 96

Cal: 7/25/05

Due: 7/25/06

pH Probe: #13-620-296

SN: 4065196

TEST TEMPERATURE: 95°C

Thermometer: Fisher

SN: 498-179

Cal: 5/5/05

Due: 5/5/06

Reference Electrode: Fisher SCE

13-620-52

SN: 3329075

GAS: Zero Air

(CREVICE)

Ecorr: 26 mV vs SCE

(PLATE)

Ecorr: -103 mV vs SCE

Model: Keithley 614

SN#: 0704936

Cal: 5/27/05

Due: 5/26/06

Potentiostat: Solartron 1480

SN#: 00240053 Cal: 8/23/05 Due: 2/23/06

TEST ID: MA22Ti7Ti7c

DATA FILES:

C22Ti7I0124-UniCh1, C22Ti7E0124-UniCh2,
0127, 0130, 0202, 0205, 0208, 0211, 0214, 0217, 0220

Number of crevice corrosion sites: 1/24 (24 Max.)

Specimen Examination: Crevice Corrosion on 1/24 feet of crevice hardware - Both Ti7 crevice hardware and Ti7 plate show no sign of corrosion - m. to surface staining on C-22 specimen - slight dull tint staining on Ti7 plate Ti7 crevice washers and Nut/Bolt OK.

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Test dates: 1/24/06 - 2/21/06

Test length: 27.7 days

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5

Test ID: MA22Ti7Ti7c

4 M MgCl₂, 95°C, Alloy 22/Ti Gr.7 (75 in-lbs)
Coupled to Ti Gr.7 Plate

10

15

20

25

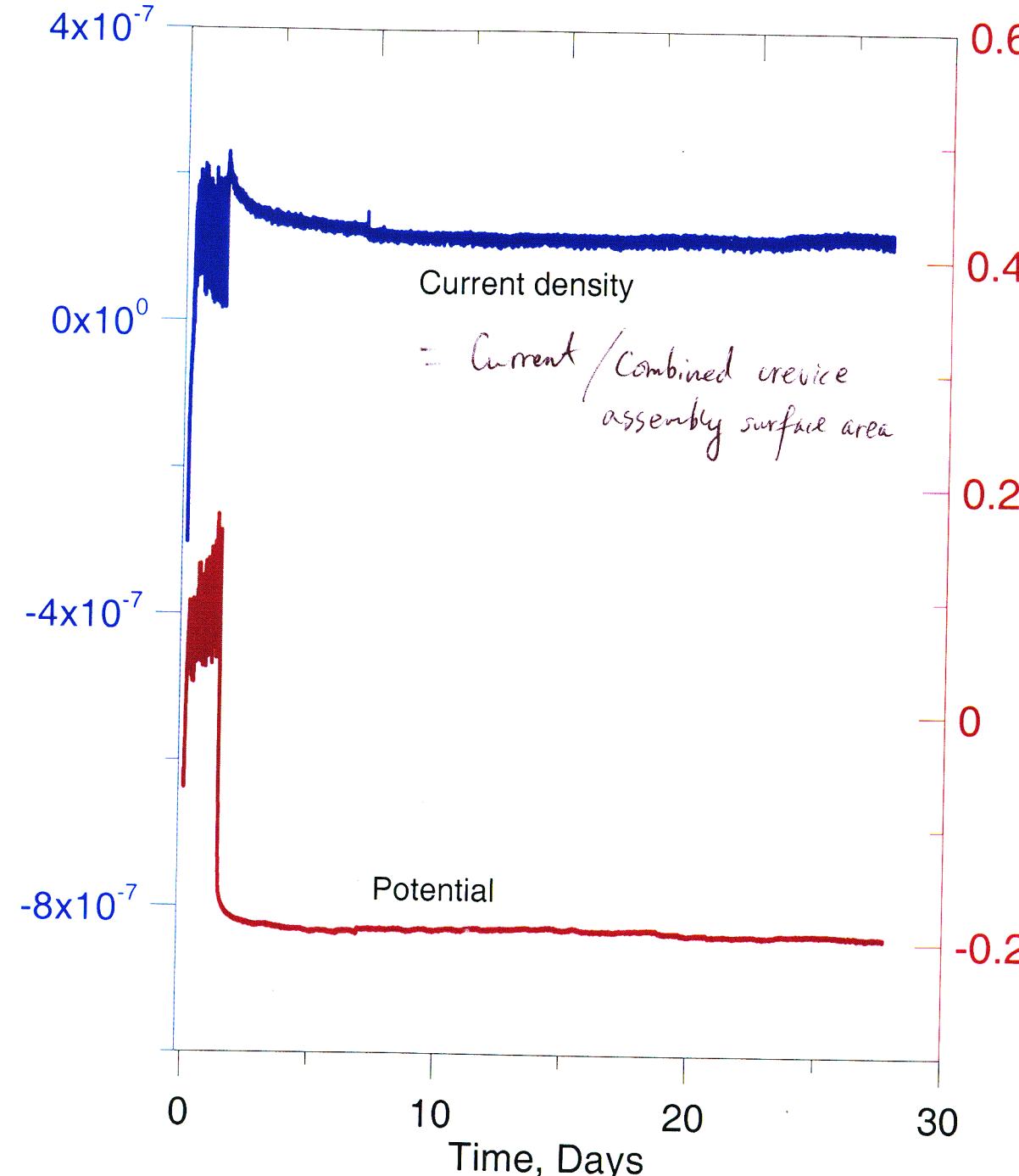
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35

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45

Galvanic coupling current density, A/cm²



Max Penetration depth: 155 μm

Measured with Olympus metallurgical microscope PME 3

Cal: 12/3/05 Due: 6/13/06

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2/21/06

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Galvanic Corrosion Test

Objective: SEE PAGE #1

SPECIMENS: Crevice Specimen drawing # 20.06002.01.322.002 polished to 600 Grit finish then cleaned in acetone

C-22 HT #2277-3-2266

Ti7 HT# CW2775 Plate

C276 Bolt/Nut w/ PTFE Crevice washers

Torque Screwdriver:

Snap On Q Driver 100 In-Oz SN: 100120319 Cal: 11/2/05 Due: 5/2/06

Initial Weight: 23.55579g Final Weight: 23.54999g

Model: Sartorius Genius SN: 12809099 Cal: 11/14/05 Due: 5/12/06

SOLUTION:

Same solution from pg # 102/10/06

4.0 M MgCl2 · 6H2O 1626.51g MgCl2 · 6H2O Lot # 050439 + DI To 2000 mls

Reagents measured with

Model: OHAUS SN: 2883 Cal: 1/5/06 Due: 7/05/06

Initial pH: 3.611

Model: Orion EA 940 SN: 2330

Final pH: Not Taken

Cal: 7/25/05 Due: 7/25/06

(solution used for same test, page 98)

pH Probe: #13-620-296 SN: 4065196

TEST TEMPERATURE: 95°C

Thermometer: Fisher SN: C96-833 Cal: 9/9/06 Due: 3/9/06

Reference Electrode: Fisher SCE # 13-620-52

SN: 4028031

GAS: Zero Air

(CREVICE)

Ecorr: 64 mV vs SCE

(PLATE)

Ecorr: -128 mV vs SCE

Model: Keithley 614 SN#: 0704936 Cal: 5/27/05 Due: 5/26/06

Potentiostat: Solartron 1480

SN#: 00240053 Cal: 8/23/05 Due: 2/23/06

TEST ID: MA22PTFE Ti76

DATA FILES: C22PTFE Ti7 20131 - Unich3, C22PTFE Ti7E0131 - Unich4, 0203, 0206, 0209, 0212, 0215, 0218

Specimen Examination: Crevice Corrosion on 1/24 feet of crevice washers - mild surface staining on specimen. PTFE crevice washers OK. No corrosion or pitting on Ti7 plate. Mild dull tint staining

Number of corrosion sites: 1/24 (24 Max.)

Maximum penetration depth: 450 um

Measured with Olympus Metallurgical Microscope PME3 Cal: 12/13/05 Due: 6/13/06

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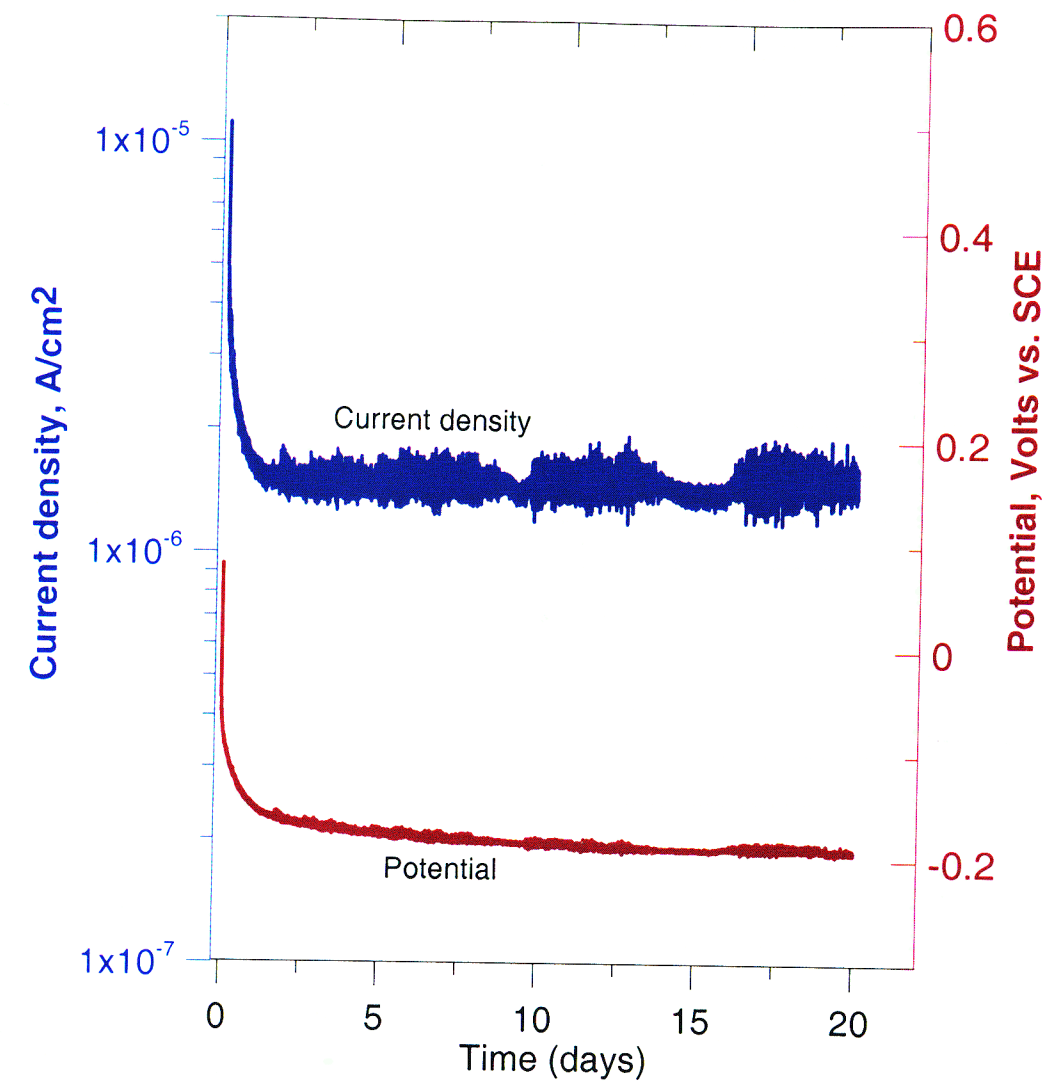
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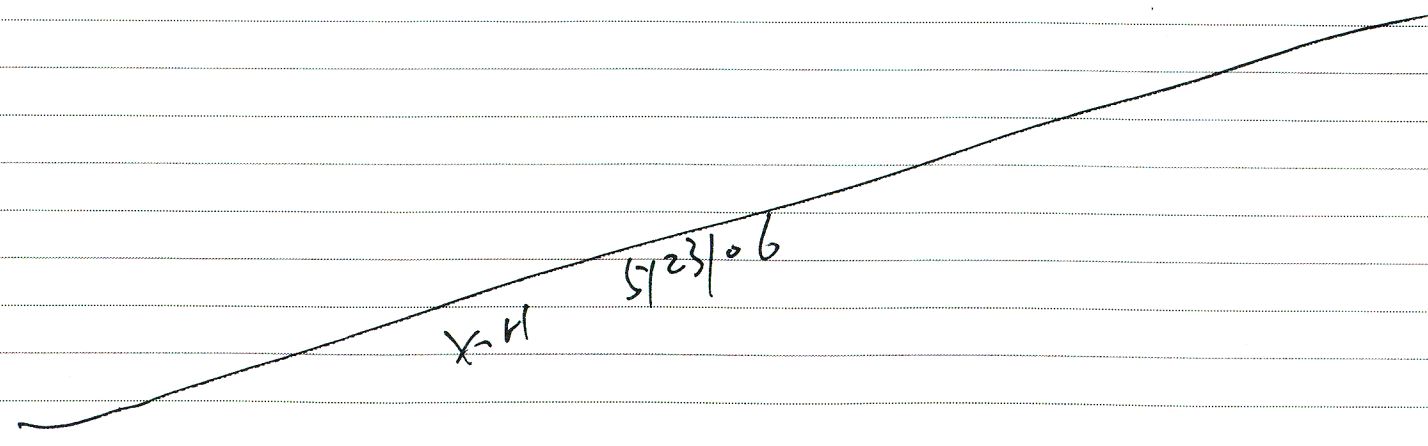
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Test dates: 1/31/06 - 2/22/06

4 M MgCl2, 95°C, mill annealed Alloy 22/Teflon (100 in-oz) Coupled to TiGr7 Plate



Test time: 20.0 days = 1.729 x 10^6 seconds



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Signature: [Signature] DATE: 2/22/06

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OCP TEST

Objective: to monitor open circuit potential

Specimen: 316 L MT# P80746

Specimen Preparation: Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone

Initial Wt: 22.05971g

Final Wt: 22.01958g

Model: Sartorius Genius

SN: 12809099

Cal: 11/14/05

Due: 5/12/06

Solution:

4 M NaCl
467.62g NaCl Lot# 052761
+ DI To 2000mls

Reagents measured with

Model: OHAUS

SN: 2883

Cal: 1/5/06

Due: 7/5/06

Initial pH: 5.768

Adjusted pH: No Adjustment

Final pH: 6.394

Model: orion

SN: 2330

Cal: 7/25/05

Due: 7/25/06

pH Probe: #13-620-296

SN: 4065196

Test Temperature: 95°C

SN: M98-187

Cal: 9/9/05

Due: 9/8/06

Counter Electrode: Platinum Flag

Reference Electrode: Fisher 13-620-52

SN: 0199568

Gas: Zero Air

Potentiostat: Solartron 1480 SN# 00240053 Cal: 8/23/05 Due: 2/23/06

DATA/TEST ID: 316LSSOCP

OCE corr = -296 mV Keithley 641 SN# 0704936 Cal: 5/23/05 Due: 5/24/06
Specimen Examination:

Corrosion on specimen.

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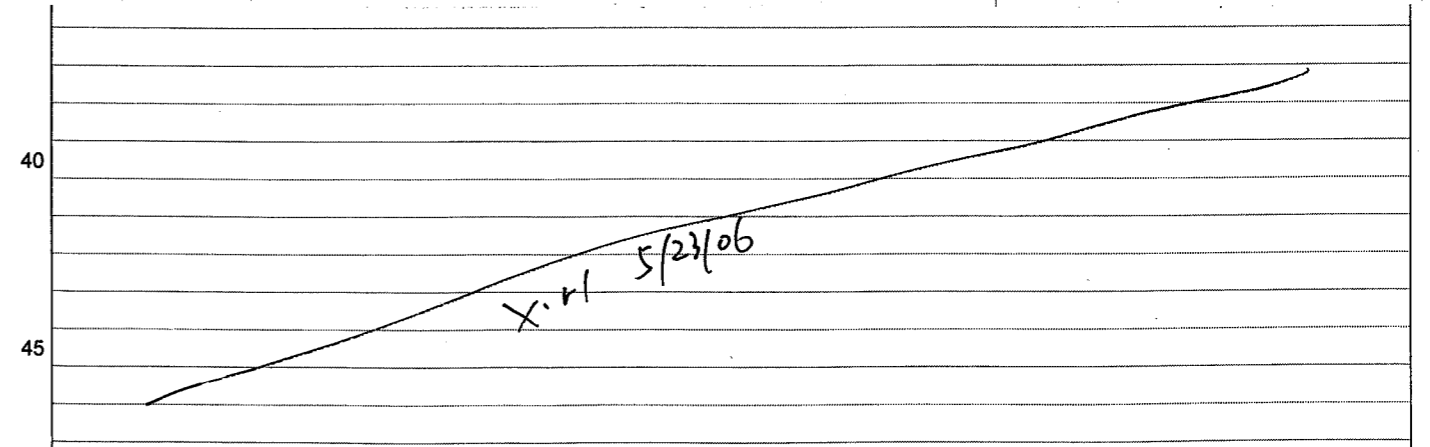
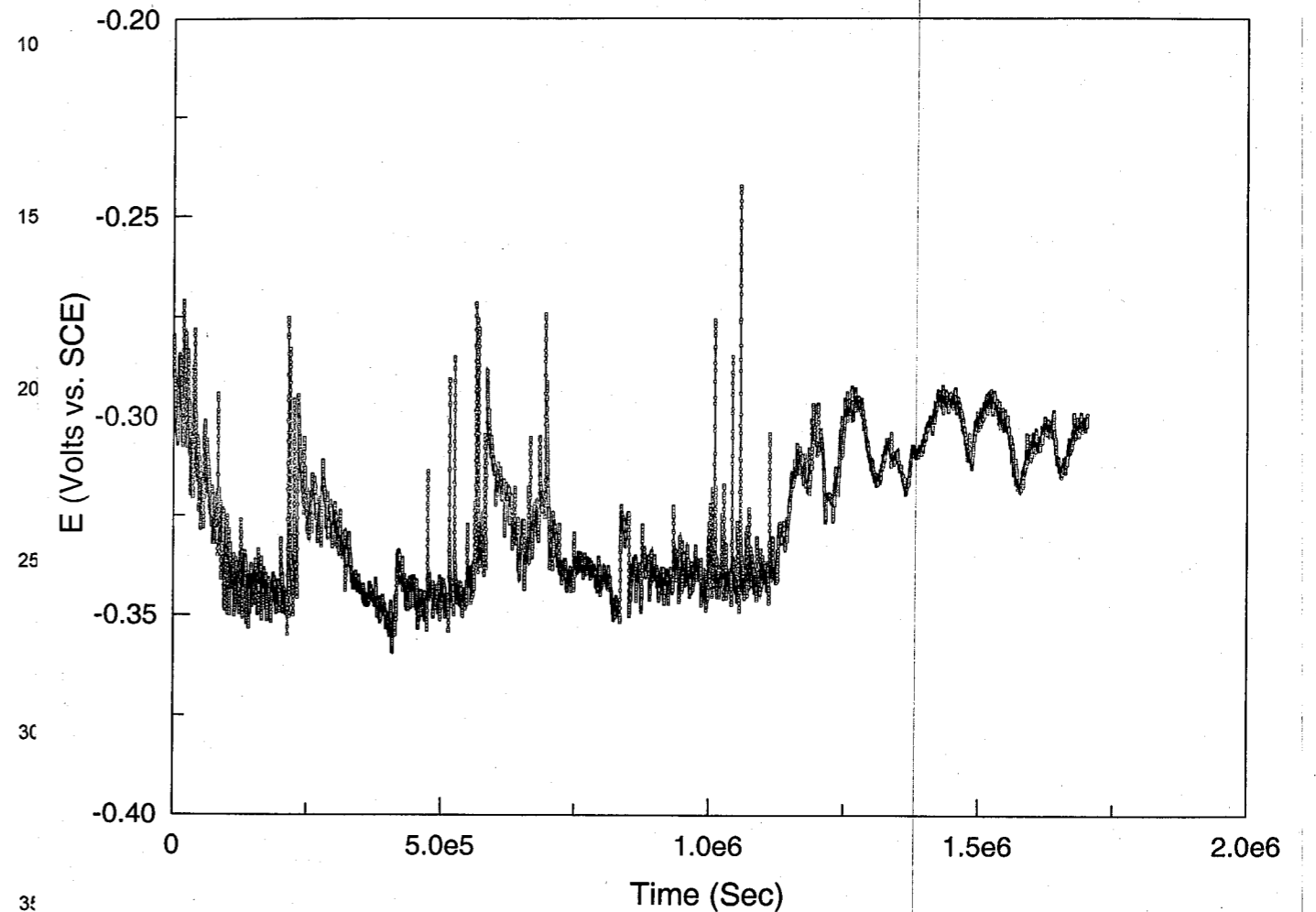
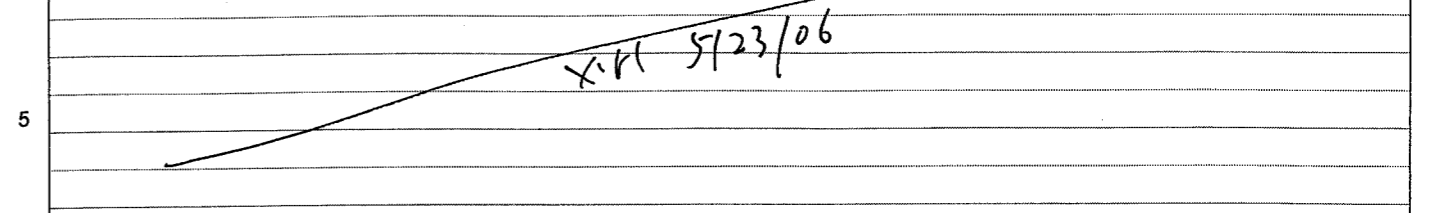
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Galvanic Corrosion Test

Objective: SEE PAGE #1

SPECIMENS: Crevice Specimen drawing # 20.06002.01.322.002 polished to 600 Grit finish then cleaned in acetone
 C-22 HT#2277-3-3266 Crevice Specimen
 Ti:7 HT#CN2775 Plate
 Ti:7 HT#CN2775 Crevice Washers Nut/Bolt

Torque Screwdriver: Torq Craft 75 In-lbs SN: 694000691 Cal: 7/22/05 Due: 7/21/06
 Model: Sartorius Genius SN: 12809099 Cal: 11/14/05 Due: 5/12/06

Initial Weight: 23.5792g
Final Weight: 23.5737g

SOLUTION: 4.0 M MgCl₂ · 6H₂O
 Same solution from 1626.49g MgCl₂ · 6H₂O Lot# 050439
 pH# 90 + DI To 2000 ml

Reagents measured with Model: OHAUS SN: 2883 Cal: 1/5/06 Due: 7/05/06
 Model: Orion EA 940 SN: 2330 Cal: 7/25/05 Due: 7/25/06
 pH Probe: #13-620-296 SN: 4065196

Initial pH: 4.983
Final pH: 4.63

TEST TEMPERATURE: 95°C Thermometer: Fisher SN: H98-179 Cal: 5/5/05 Due: 5/5/06

Reference Electrode: Fisher SCE # 13-620-52 SN: 3329075

GAS: Zero Air

(CREVICE) Ecorr: -355 mV vs SCE
(PLATE) Ecorr: +250 mV vs SCE Model: Keithley 614 SN#: 0704936 Cal: 5/27/05 Due: 5/26/06

Potentiostat: Solartron 1480 SN#: 00240053 Cal: 8/23/05 Due: 2/23/06

TEST ID: MA22Ti7Ti7d
DATA FILES: C22Ti7I0221-Unlch1, C22Ti7E0221-Unlch2, C22Ti7I0224-Unlch1, C22Ti7E0224-Unlch2, 02027, 0302, 0305, 0308, 0311, 0314

Specimen Examination: Crevice Corrosion on 2/24 feet of Ti7 crevice washers on C-22 specimen - No Corrosion on Ti7 plate
 No Corrosion Ti7 crevice washers on Harroware
 Mild surface staining on Ti7 and C-22 specimen

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Test time: 2/21/06 - 3/15/06
1.9457 x 10⁶ seconds = 22.5 days

4 M MgCl₂, 95°C, Alloy 22/Ti Gr.7 (75 in-lbs) Coupled to Ti Gr.7 Plate

Galvanic coupling current density, A/cm²
Galvanic coupling potential, V_{SCE}

Current density
Potential

Time, Days

Maximum penetration depth of corroded sites: 52 um, 130 um
Measured with Olympus Metallurgical Microscope PME3 Cal: 12/13/05 Due: 6/13/06

SIGNATURE: Xihua He DATE: 3/27/06

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Galvanic Corrosion Test

Objective: SEE PAGE #1

SPECIMENS: Crevice Specimen drawing # 20.06002.01.322.002 polished to 600 Grit finish then cleaned in acetone

C-22 HT #2277-3-3266

Ti:7 Plate

C276 Bolt/NUT

HT# CN 2775

w/PTFE Crevice Washers

Torque Screwdriver:

Snap ON Q Driven 100 In-oz

SN: 100120319

Cal: 11/2/05

Due: 5/2/06

Initial Weight: 23.45291g

Model: Sartorius Genius

SN: 12809099

Final Weight: 23.44805g

Cal: 11/14/05

Due: 5/12/06

SOLUTION:

Same solution from #92

4.0 m $MgCl_2 \cdot 6H_2O$
1626.51g $MgCl_2 \cdot 6H_2O$ Lot # 050439
+ DI TO 2000 ml

Reagents measured with

Model: OHAUS

SN: 2883

Cal: 1/5/06

Due: 7/05/06

Initial pH: 3.611

Model: Orion EA 940

SN: 2330

Final pH: 3.521

Cal: 7/25/05

Due: 7/25/06

pH Probe: #13-620-296

SN: 4065196

TEST TEMPERATURE: 95°C

Thermometer: Fisher

SN: C96-833

Cal: 9/9/06

Due: 3/9/06

Reference Electrode: Fisher SCE

13-620-52

SN: 4028051

GAS: Zero Air

(CREVICE)

Ecorr: -276 mV vs SCE

(PLATE)

Ecorr: 138 mV vs SCE

Model: Keithley 614

SN#: 0704936

Cal: 5/27/05

Due: 5/26/06

Potentiostat: Solartron 1480

SN#: 00240053 Cal: 8/23/05 Due: 2/23/06

TEST ID: MA22PTFETi7C

DATA FILES: C22PTFETi7I0221-Unit3, C22PTFETi7E0221-Unit4, E0224, E0227, E0303, E0305, E0308, E0311, I0224, E0227, E0303, E0305, E0308, E0311, I0227, I0303, I0305, I0308, I0311, I0314, E0314

Specimen Examination: crevice corrosion on 1/4 feet of crevice washer

No corrosion on Ti:7 plate.

min surface staining on specimen dull tint staining on Ti:7 plate

Maximum penetration depth: 256 um

Measured with Olympus Metallurgical Microscope PME3 Cal: 12/13/05 Due: 6/13/06

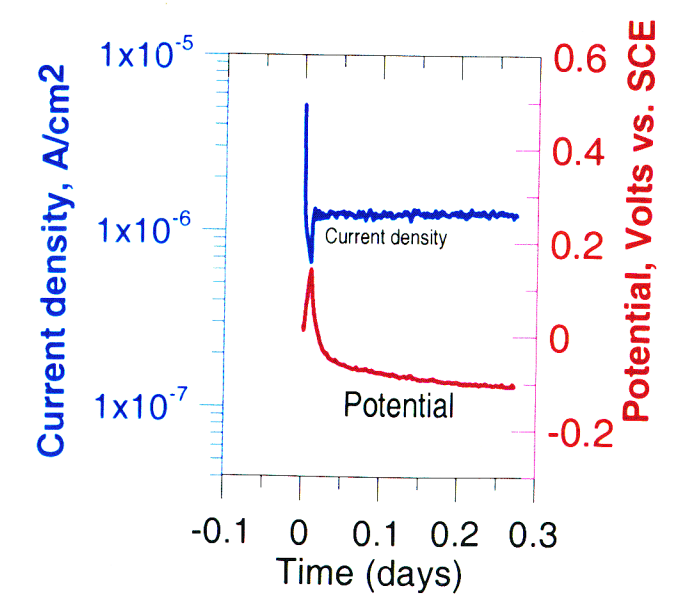
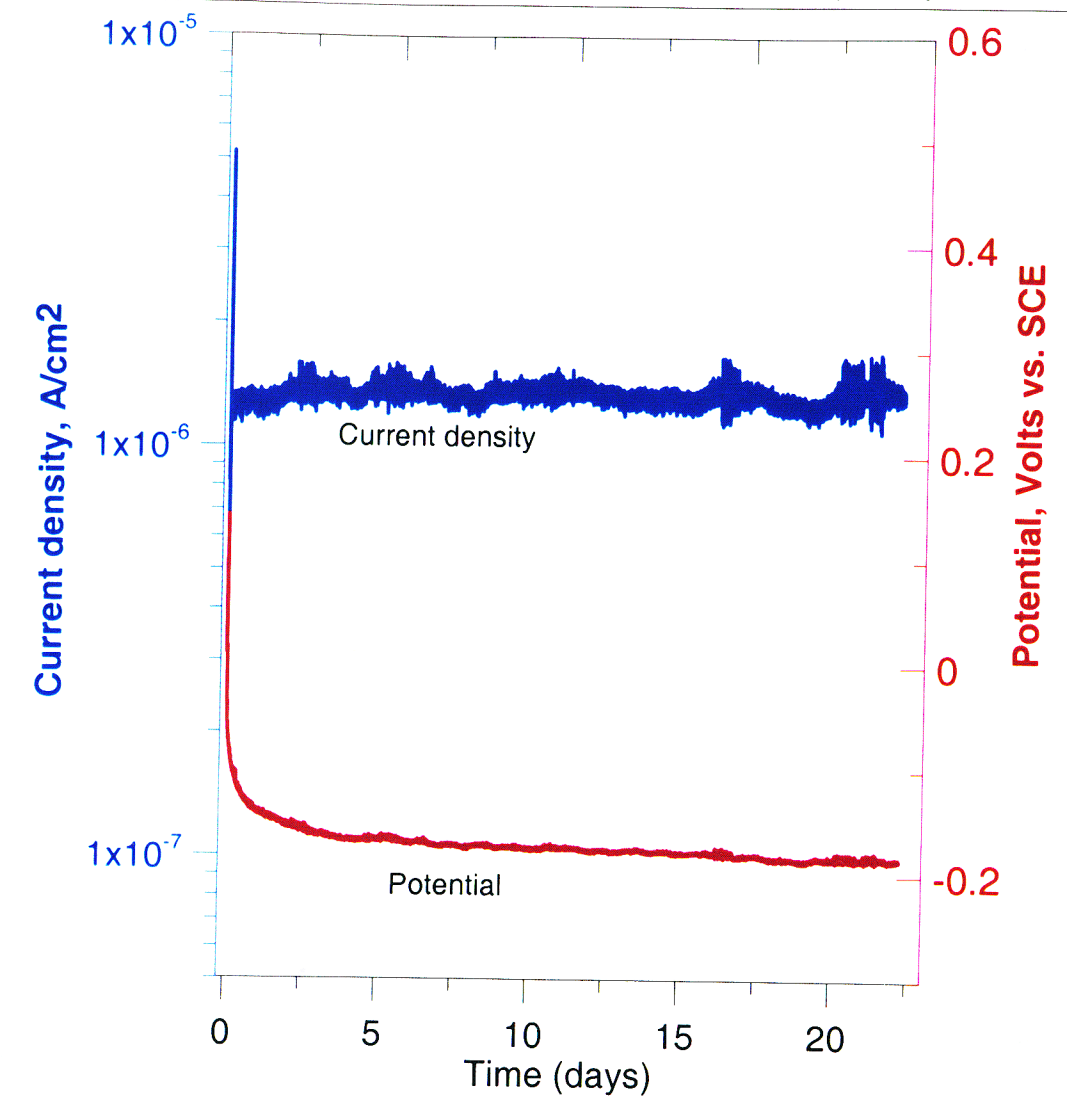
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Total test time: 1.92×10^6 seconds = 22.2 days
2/21/06 - 3/15/06

4 M $MgCl_2$, 95°C, mill annealed Alloy 22/Teflon (100 in-oz) Coupled to TiGr7 Plate



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Zirconia Tests

7 Zr Crevice washers - Zirc 702 HT# 845645 See pg# 67
3 Zr bolts with nut - Zirc 4 HT# 1223217-243687 See pg# 69

Solution = DI Water

started heating @ 10:00am on 1/5/06
8 weeks total time @ 300C

DATE	TIME	SET POINT	Internal Temp.	PSI
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1/5/2006	10:11	150C	78C	10
1/5/2006	10:41	200C	130.6C	25
1/5/2006	11:30	225C	180.4C	110
1/5/2006	12:40	225C	213.4C	280
1/5/2006	1:00	265c	230C	410
1/5/2006	1:21	264c	239.3C	580
1/5/2006	1:30	264c	243.6C	1100

LOST THERMAL COUPLE WELL FITTING NEED TO STOP HEATING AND REDO FITTING

1/5/2006	3:10	Started to reheat		
1/5/2006	4:00	130c	98c	10

1/6/2006	7:00	150c	162.9c	75
1/6/2006	7:20	200C	195C	110
1/6/2006	8:30	225C	227.8C	400
1/6/2006	8:50	275C	241C	560
1/6/2006	10:00	275C	283.4C	1000
1/6/2006	11:00	290C	294.2C	1190
1/6/2006	11:10	300C	302.1C	1300

Dropped to 296C

1/6/2006	11:40	296C	308C	1480
1/6/2006	12:15	293C	309.6C	1480
1/6/2006	1:00	293C	310.4C	1540
1/6/2006	3:00	293C	313C	1520
1/6/2006	3:10	288C	311.2C	1500

1/8/2006	1:00	288C	309.9C	1500
1/8/2006	3:30	288C	310C	1500

1/9/2006	7:00	288C	309.9C	1500
1/9/2006	10:00	288C	309.9C	1500
1/9/2006	12:30	288C	310.1C	1500
1/9/2006	3:00	288C	310.2C	1500

1/10/2006	7:10	288C	309.9C	1500
1/10/2006	12:30	288C	310.1C	1500
1/10/2006	3:45	288C	310.1C	1500

1/11/2006	7:00	288C	310.2C	1500
1/11/2006	12:00	288C	310.1C	1500

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1/11/2006	4:00	288C	310.7C	1500
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1/12/2006	7:30	288C	310.6C	1500
1/12/2006	11:20	288C	310.4C	1500
1/12/2006	3:10	288C	310.5C	1500

1/13/2006	7:00	288C	310.7C	1500
1/13/2006	3:00	288C	309.4C	1500

1/16/2006	7:00	288C	311.1C	1500
1/16/2006	12:00	288C	309.4C	1500
1/16/2006	3:45	288C	310.1C	1500

1/17/2006	7:10	288C	310.9C	1500
1/17/2006	12:30	288C	310.7C	1500
1/17/2006	3:45	288C	310.8C	1500

1/18/2006	7:10	288C	310.7C	1500
1/18/2006	12:30	288C	310.7C	1500
1/18/2006	3:40	288C	311.2C	1500

1/19/2006	7:00	288C	310.8C	1500
1/19/2006	3:00	288C	310.9C	1500

1/20/2006	7:00	288C	310.8C	1500
1/20/2006	2:00	288C	310.8C	1520

1/21/2006	9:00	288C	310C	1520
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1/22/2006	8:45	288C	309.9C	1520
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1/23/2006	8:00	288C	309.9C	1520
1/23/2006	3:30	288C	311.1C	1520

1/24/2006	7:45	288C	310.9C	1520
1/24/2006	3:40	288C	309.6C	1520

1/25/2006	7:10	288C	309.2C	1520
1/25/2006	3:00	288C	310C	1520

1/26/2006	7:00	288C	309.3C	1520
1/26/2006	12:30	288C	310.4C	1520
1/26/2006	3:30	288C	310.8C	1520

1/27/2006	7:15	288C	310.8C	1520
1/27/2006	3:30	288C	310.9C	1520

1/30/2006	8:00	288C	310.6C	1520
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1/31/2006	7:50	288C	310.6C	1520
1/31/2006	3:30	288C	310.7C	1520

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2/1/2006	7:00 288C	310.1C	1520
2/1/2006	3:45 288C	310.8C	1520
2/2/2006	7:00 288C	310.5C	1520
2/2/2006	3:30 288C	311.3C	1520
2/3/2006	7:00 288C	310.9C	1520
2/3/2006	3:30 288C	310.4C	1520
2/6/2006	7:15 288C	311.1C	1520
2/6/2006	3:30 288C	310.8C	1520
2/7/2006	7:20 288C	311.2C	1520
2/7/2006	3:50 288C	311.5C	1520
2/8/2006	7:00 288C	311.1C	1520
2/8/2006	3:45 288C	310.6C	1520
2/9/2006	7:10 288C	311.1C	1520
2/9/2006	3:40 288C	310.1C	1520
2/10/2006	11:15 288C	309.6C	1520
2/10/2006	3:30 288C	310.2C	1520
2/13/2006	7:30 288C	309.6C	1520
2/13/2006	3:00 288C	309.7C	1520
2/14/2006	7:00 288C	309.8C	1520
2/14/2006	3:30 288C	311.3C	1520
2/15/2006	7:30 288C	309.9C	1520
2/15/2006	3:00 288C	309.7C	1520
2/16/2006	7:00 288C	310.8C	1520
2/16/2006	3:30 288C	310.2C	1520
2/17/2006	7:10 288C	310.2C	1520
2/18/2006	7:15 288C	310.7C	1520
2/21/2006	7:10 288C	309.8C	1520
2/22/2006	7:15 288C	309.4C	1520
2/23/2006	7:45 288C	310.4C	1520
2/24/2006	7:30 288C	310.1C	1520
2/27/2006	7:00 288C	309.7C	1520
2/28/2006	NOT TAKEN		

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3/1/2006	7:30 288C	309.7C	1520
3/2/2006	7:11 288C	310.2C	1520
3/3/2006	7:30 288C	309.7C	1520
3/3/2006	3:30 188C	Started to shutdown temperature controller	
3/6/2006	7:00 188C	189.6C	220
3/6/2006	7:05 60C		
3/6/2006	3:30	Shutdown temperature controller	

Equipment Used Fluke 2190 A Digital thermometer
SN# 3133004 Cal: March 2-05 Due: March 2-06

thermocouple Used #334 Cal: Oct 18-05 Due: April 18-06

Paen 4843 Controller with A 316L Autoclave

B. F. J. 3/9/06

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Galvanic Corrosion Test

Objective: SEE PAGE #1

SPECIMENS: Crevice Specimen drawing # 20.06002.01.322.002 polished to 600 Grit finish then cleaned in acetone

C-22 HT # 2277-3-3266 w/ c276 Nut/Bolt PTFE crevice washers
C-22 HT # 2277-3-3266 Plate

Torque Screwdriver: Proto 6104 100 In-oz SN: 139072
Cal: 10/24/05 Due: 4/24/06

Initial Weight: 24.16530g Model: Sartorius Genius SN: 12809099
Final Weight: 24.16519g Cal: 11/14/05 Due: 5/12/06

SOLUTION: 4.0 M MgCl₂ · 6H₂O
1626.52g MgCl₂ · 6H₂O Lot # 050439
+ DI To 2000mls

Reagents measured with Model: OHAUS SN: 2883
Cal: 1/5/06 Due: 7/05/06

Initial pH: 2.873 Model: Orion EA 940 SN: 2330
Final pH: Not Taken Cal: 7/25/05 Due: 7/25/06
pH Probe: #13-620-296 SN: 4065196

solution used for next test (p. 108)

TEST TEMPERATURE: 95°C Thermometer: Fisher SN: 41523645
TC #333 cal: 1/12/06 due: 7/12/06
Cal: 6/7/05 Due: 6/7/06

Reference Electrode: Fisher SCE # 13-620-52 SN: 0251439

GAS: Zero Air

(CREVICE)
Ecorr: -290 mV vs SCE

(PLATE) Model: Keithley 614 SN#: 0704936
Ecorr: -185 mV vs SCE Cal: 5/27/05 Due: 5/26/06

Potentiostat: Solartron 1480 SN#: 00240053 Cal: 8/23/05 Due: 2/23/06

TEST ID: MA22PTFEMA22A

DATA FILES:
C22PTFE I0310- Un1Ch5, C22PTFE0310- Un1Ch6, C22PTFE I0313- Un1Ch6, C22PTFE0313- Un1Ch5

Specimen Examination: No crevice corrosion had computer problem
Needs to Reboot System

No corrosion on C-22 Plate

* Note: Repolishes specimen for further testing

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3/13/06

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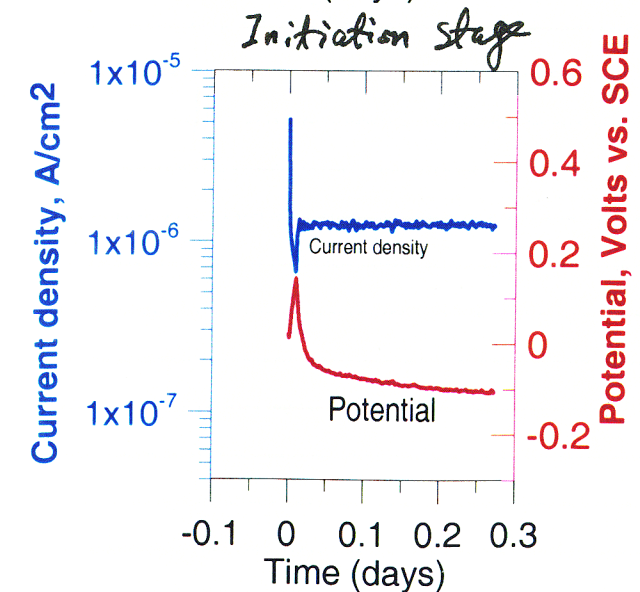
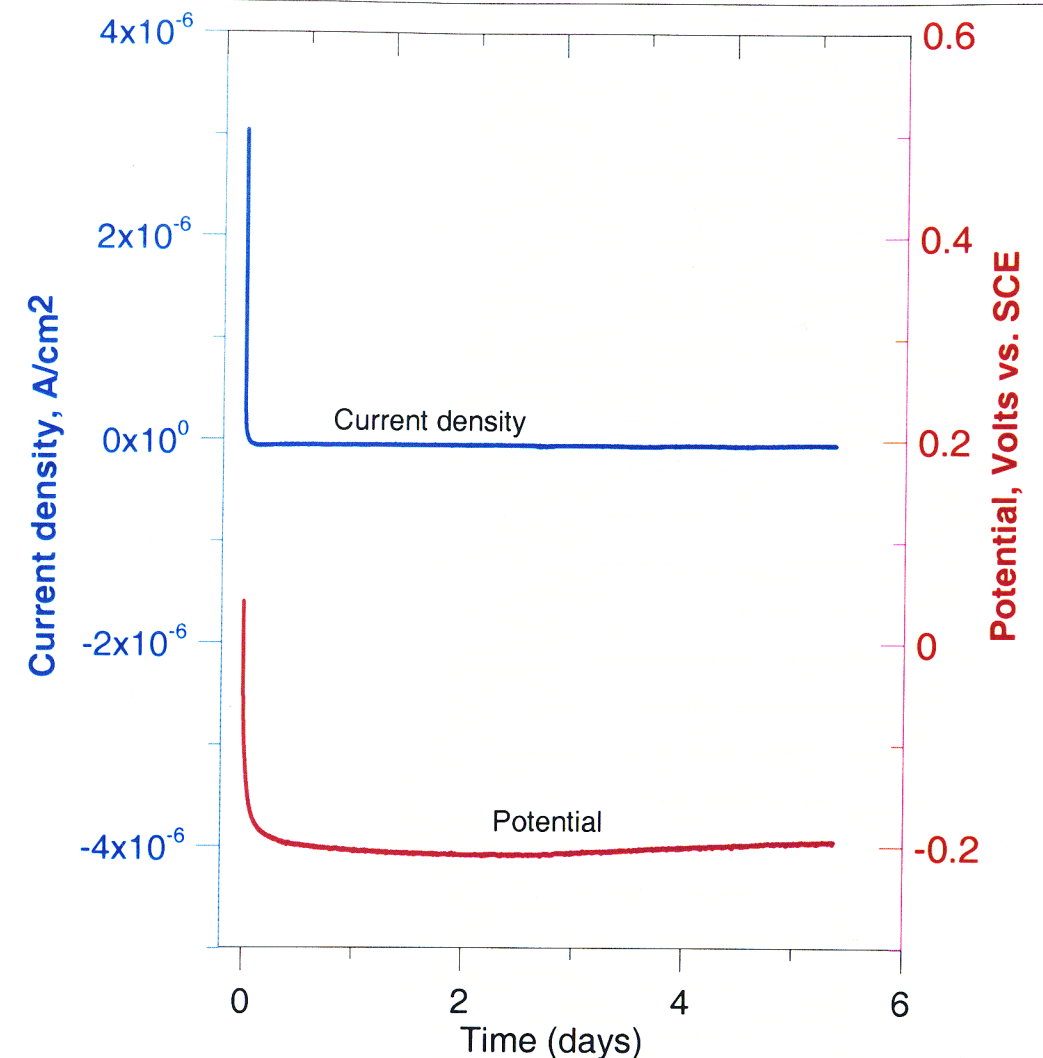
TITLE

PROJECT

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*Test time: 4.64 x 10⁵ seconds = 5.37 days
3/10/06 - 3/15/06*

4 M MgCl₂, 95°C, mill annealed Alloy 22/Teflon (100 in-oz) Coupled to Alloy 22 Plate



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Xihua He

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