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Scientific Notebook No. 672: Alloy 22 Repassivation Tests, Potentiostatic Tests, Cyclic Polarization Test, Crevice Repassivation Tests, Passive Current Density Tests, Critical Pitting Temperature Tests Critical Repassivations Temperature Test

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

# ADDITIONAL INFORMATION FOR SCIENTIFIC NOTEBOOK NO. 672

| | |
|---|---|
| **Document Date:** | 11/08/2005 |
| **Availability:** | Southwest Research Institute®<br>Center for Nuclear Waste Regulatory Analyses<br>6220 Culebra Road<br>San Antonio, Texas 78228 |
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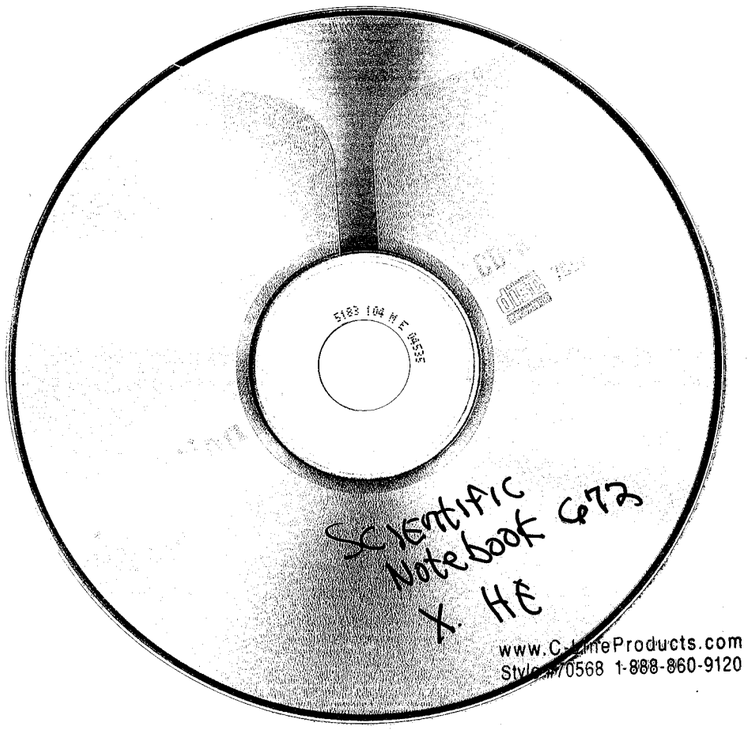
| **File Types:** (.exe, .bat, .zip, etc.) | dat, xsl |
| **Remarks:** (computer runs, etc.) | Media contains: repassivation tests |

CNWRA
CONTROLLED
COPY 672

Project #: 20.06002.01.081
20.06002.01.322. 11/9/05
XIHUA HE - - X.H.
Brian K. Denby - - BKD



Continued Testing from NB #366, #485, #520, #528, #531 #541, #571, and #638

copies from previous notebooks

**Initial Scientific notebook entry for repassivation potential measurements**

**Title:** Alloy 22 Repassivation Tests

**Tests Preformed by:** ~~Darrell S. Dunn, Letai Yang~~ Xihua He 11/7/05, Div 20; Brian Derby, Div. 18

**Objectives:** Determine the effect of thermal aging time and temperature on the localized corrosion susceptibility of Alloy 22.

**Equipment:** Laboratory oven for exposure of test specimens at 600 to 900 °C, Thermocouple and thermocouple meter. Keithley 614/617. Solartron 1287 Potentiostat and CorrView Software or equivalent, Electrochemical test cell.

**Materials:** Alloy C-22, heat 2277-8-3175. Other materials and heats to be added and identified prior to testing.

**Specimen specifications:** Specimens will be equivalent to 20.01402.571.006 unless otherwise specified.

**Measurement Parameters:** Temperature and time of exposure, Potential and Current of specimen during test.

**Required level of accuracy:** Temperature ± 2 °C, Time of exposure ± 1 minute, Potentials ± 1mV, Current ± 0.01 microamp.

**Uncertainty and Sources of Error:** Current measurement error can occur for localized corrosion processes because the actively corroding area is not the same as the surface area of the test specimen.

Xihua He 8/11/04

FROM NB 157 P 208 Ano NB# 571

**Initial Scientific notebook entry for corrosion resistant material potentiostatic and potentiodynamic polarization tests.**

**Title:** Potentiostatic tests, cyclic polarization tests, crevice repassivation tests, passive current density tests, critical pitting temperature tests critical repassivation temperature tests.

**Tests Preformed by:** ~~Darrell S. Dunn~~ Xihua He, Div. 20
X.H 11/7/05

**Objectives:** Measure passive current densities, crevice repassivation potentials, critical pitting temperature and critical repassivation temperature for corrosion resistant candidate materials.

**Equipment:** EG&G Versastat Serial Number 20104. EG&G model 352 corrosion software. NEC 586 computer. Keithley Electrometer model 614 SN 555368 or equivalent. ASTM G-5 polarization cell, Large 2 L glass cells with Teflon tops, Electrochemical Impedance Spectroscopy system including Solartron 1260 FRA and Solartron 1287 Potentiostat. ESC 440 multichannel potentiostats with National instruments Labview data acquisition software or Strawberry Tree data acquisition software.

**Materials:** Alloy C-22, Alloy 825, Alloy 625 and Type 316 L stainless steel

**Specimen specifications:** Cylindrical CPP specimens 1.915" × 0.250" and Crevice repassivation specimens with Teflon crevice washers attached to surface.

**Measurement Parameters:** Current and Potential as described in TOP-008. Temperature of solution ± 2°C

**Required level of accuracy:** Potentials ± 5mV. Current less than 0.1 microamp.

**Uncertainty and Sources of Error:** Current density calculated as current divided by sample area. Actual current density of corroding areas is not determined. Resolution limit of data acquisition systems may limit accuracy of passive current density measurements.

Copies from previous NB # 638

Xihua He 8/11/04



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4/15/2005

X.H

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 ~~thermally aged~~ Heat # 2277-3-3266
8/11/04 X.H

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 03/03/04 **Due:** 9/03/04

**Initial Weight:** 39.86936 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 39.61006 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.16M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ Lot # 040837
102.56 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot # 033942 } + DI water to 2.5L

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~2/04/04~~ 7/15/04 X.H **Due:** ~~8/04/04~~ 7/15/05 X.H 8/11/04

**Initial pH:** 4.48 **Model:** Orion EA 940 8/11/04 **SN:**2330
**Final pH:** 6.08 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −373.6 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +421.6 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r245

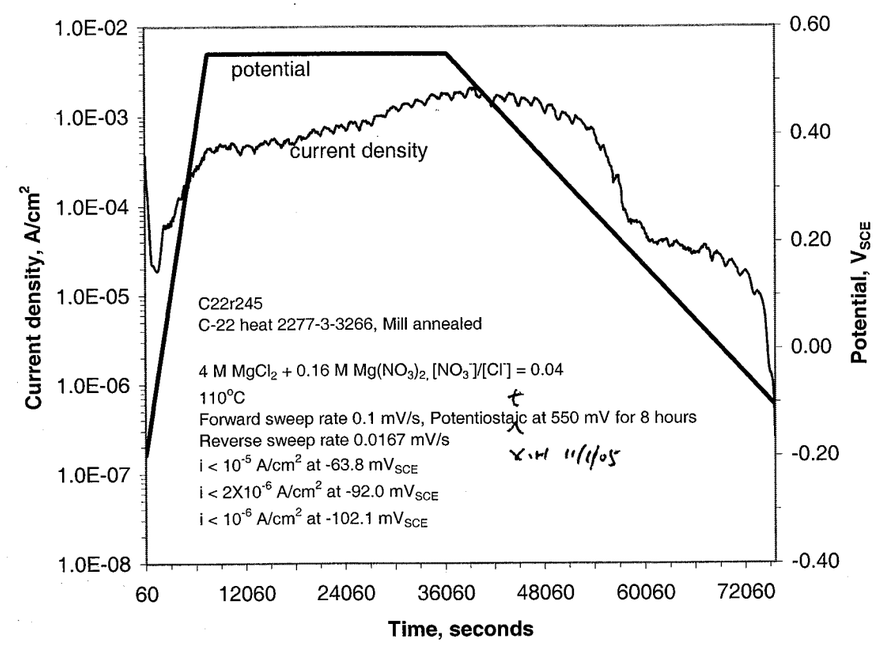
**Number of Crevice Corrosion Sites:** 19 /24 (24 max.)

19 crevice corroded teeth. part of bolt hole is also corroded. It appears that there is pitting corrosion at one side face.

Xihua He 8/11/2004

* Drawing # 20.01402.571.006.
X.H 11/7/05






Xihua He 8/12/2004

## Repassivation Potential Test

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 ~~thermally aged~~ Heat #, 2277-3-3266
8/11/04 X.H

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

| | | |
|---|---|---|
| **Torque Screwdriver:** | Snap-on USA<br>**Cal:** 03/03/04 | **SN:** 1001200319<br>**Due:** 9/03/04 |
| **Initial Weight:** 40.28557 g<br>**Final Weight:** 40.03192 g | **Model:** Sartorius Genius<br>**CAL:** 05/14/04 | **SN:** 12809099<br>**Due:** 11/14/04 |

**Solution:** 4M $MgCl_2$ + 0.16 M $Mg(NO_3)_2$

same solution as test C22r245 (P.4)

| | | |
|---|---|---|
| **Reagents measured with** | **Model:** OHAUS<br>**Cal:** ~~2/04/04~~ 7/15/04 X.H | **SN:** 2883<br>**Due:** ~~8/04/04~~ 11/15/05 X.H 8/11/04 |
| **Initial pH:** 4.48<br>**Final pH:** 6.07 | **Model:** Orion EA 940<br>**Cal:** 7/21/04<br>**pH Probe:** #13-620-296 | **SN:**2330<br>**Due:** 7/21/05<br>**SN:** 4079126P |
| **Test Temperature:** 110°C | **Measured with Hg Thermometer SN:** C96-816<br>**Cal:** 06/09/04 | **Due:** 12/09/04 |

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

| | | |
|---|---|---|
| **Ecorr:** −387.9 mV<br>**Ept:** +391.2 mV | **Model:** Keithley 614<br>**Cal:** 7/12/04 | **SN:** 0704934<br>**Due:** 7/12/05 |
| **Potentiostat:** EG&G Model 273 | | **SN:** 10120 |

**DATA FILE:** C22r246

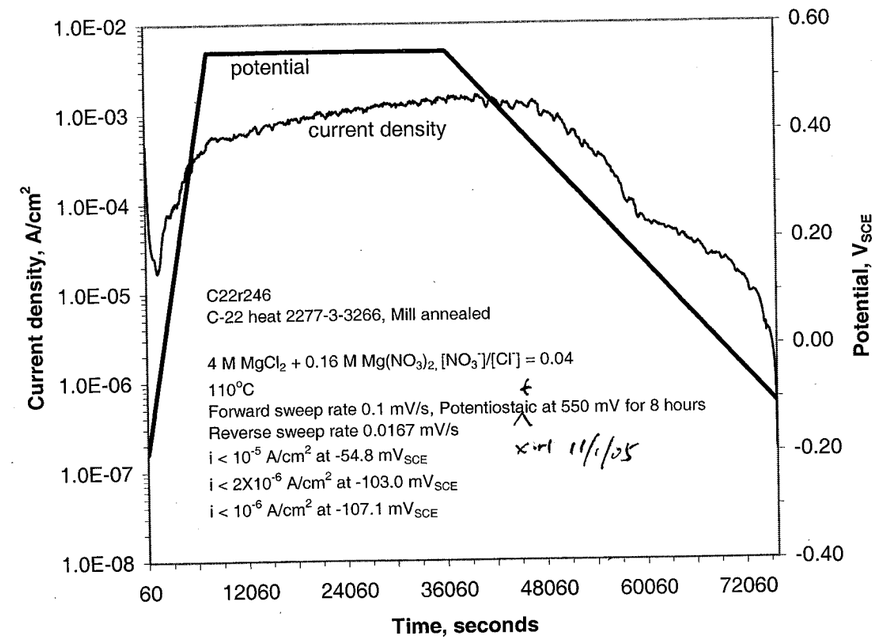
**Number of Crevice Corrosion Sites:** 19 /24 (24 max.)

19 crevice corroded ~~Teeth~~ teeth, part of bolt hole is also corroded.
X.H 8/11/2004

Xihua He 8/11/2004

* Drawing # 20.01402.571.006.
X.H 11/7/05






Xihua He 8/12/2004

## Repassivation Potential Test

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 ~~thermally aged~~ heat # 2277-3-3266 8/12/04 X.H

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 03/03/04 **SN:** 1001200319 **Due:** 9/03/04

**Initial Weight:** 40.43734 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.20232 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.08M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ Lot # 040837 } + DI water
51.28 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot # 033942 } to 2.5L

**Reagents measured with** **Model:** OHAUS **Cal:** ~~2/04/04~~ 7/15/04 **SN:** 2883 **Due:** ~~8/04/04~~ 1/15/05 X.H 8/12/04

**Initial pH:** 2.85
**Final pH:** 5.86

**Model:** Orion EA 940 **Cal:** 7/21/04 **pH Probe:** #13-620-296 **SN:** 2330 **Due:** 7/21/05 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** E98-191 **Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −393.9 mV **Ept:** +464.7 mV **Model:** Keithley 614 **Cal:** 7/12/04 **SN:** 0704934 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r247

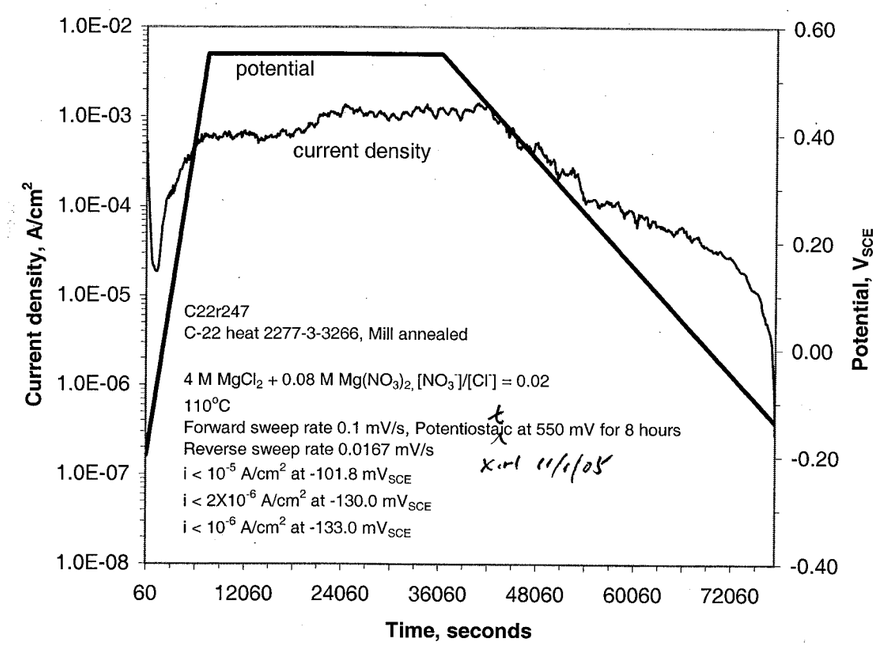
**Number of Crevice Corrosion Sites:** 18 /24 (24 max.)

18 crevice corroded teeth. Part of bolt hole is also corroded.

Xihua He 8/12/2004

* CNWRA drawing # 20.01402.571.006. X.H 11/7/05






Xihua He 8/16/2004

## Repassivation Potential Test

**Objective:** same as pg #1 and #2 XHH 8/12/04

**Alloy/Specimen:** C22 ~~thermally aged~~ Heat # 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 03/03/04 **Due:** 9/03/04

**Initial Weight:** 40.20790 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.05973 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.08M $Mg(NO_3)_2$

Same solution as test C22r247 (p.8)

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~2/04/04~~ 7/15/04 **Due:** ~~8/04/04~~ 1/15/04

**Initial pH:** 2.85 **Model:** Orion EA 940 X.H 8/12/04 **SN:**2330 X.H
**Final pH:** 5.80 **Cal:** 7/21/04 **Due:** 7/21/05 8/12/04
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** C96-816
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −397.3 **Model:** Keithley 614 **SN:** 0704934
**Ept:** +429.6 **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r248

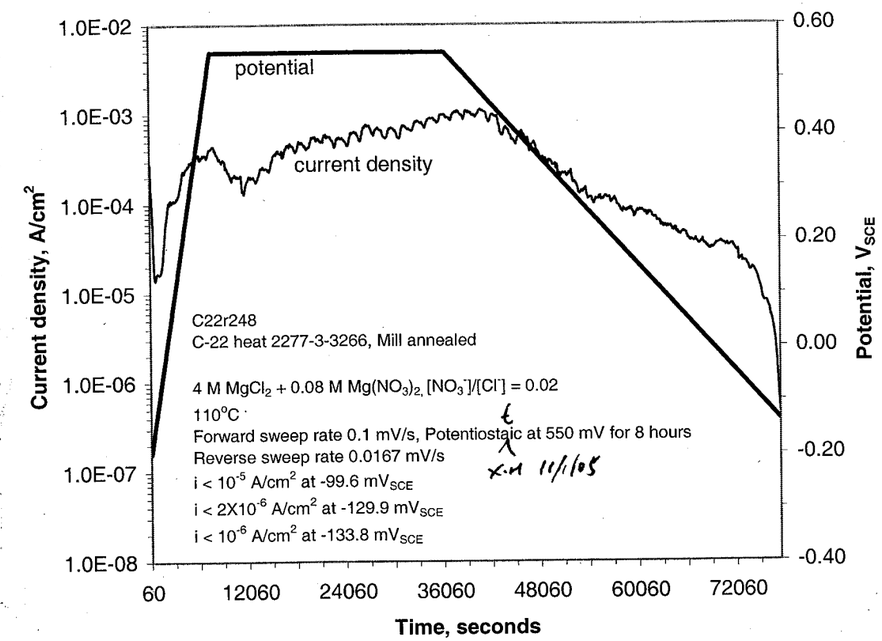
**Number of Crevice Corrosion Sites:** 17/24 (24 max.)

17 teeth are crevice corroded. part of bolt hole is corroded.

Xihua He 8/12/2004

* Drawing # 20.01402.571.006.
X.H 11/7/05






Xihua He 8/16/2004

## Repassivation Potential Test

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 ~~thermally aged~~ Heat # 2277-3-3266 X.H 8/18/04

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torque to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319 **Cal:** 03/03/04 **Due:** 9/03/04

**Initial Weight:** 40.28431 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 39.73273 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ Lot # 040837 + DI water to 2.5L

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~2/04/04~~ 7/15/04 X.H **Due:** ~~8/04/04~~ 4/15/05

**Initial pH:** 3.86 **Model:** Orion EA 940 **SN:** 2330
**Final pH:** 5.60 **Cal:** 7/21/04 8/18/04 **Due:** 7/21/05 X.H 8/18/04
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023F

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −397.7 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +413.8 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r249

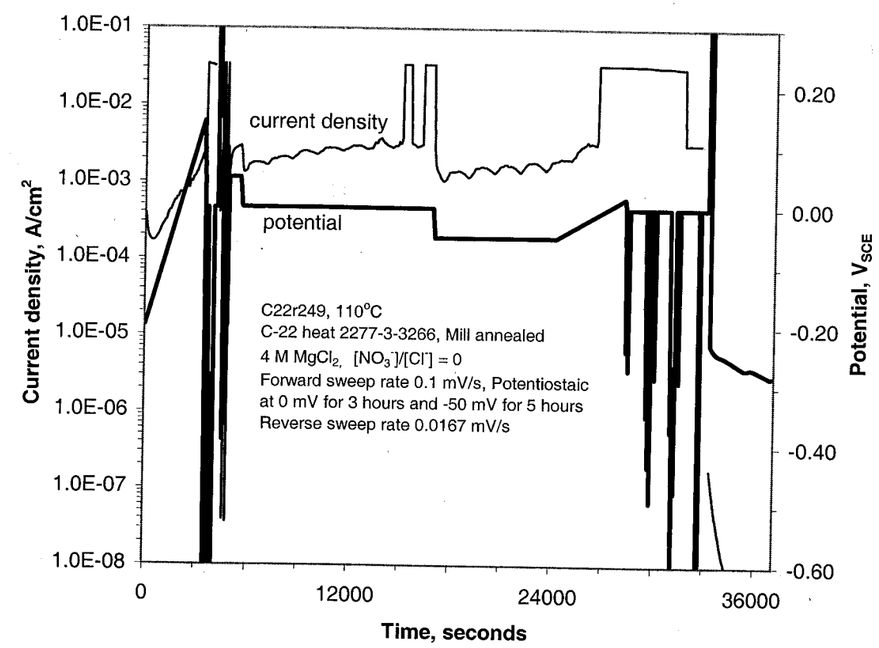
**Number of Crevice Corrosion Sites:** 24 /24 (24 max.)

Severe corrosion

Xihua He 8/18/2004

* CNWRA Drawing # 20.01402.571.006






* Equipment overload. Current & potential had been cutoff.

Xihua He 8/19/2004

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 ~~thermally aged~~ Heat # 2277-3-3266
X.H 8/18/04

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 03/03/04 **Due:** 9/03/04

**Initial Weight:** 38.98723 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 39.71207 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:**
4M $MgCl_2$

Same solution as test C22r249 (p.12)

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~2/04/04~~ 7/15/04 K.H **Due:** ~~8/04/04~~ 1/15/05

**Initial pH:** 3.865 **Model:** Orion EA 940 **SN:**2330 X.H
**Final pH:** 6.851 **Cal:** 7/21/04 8/18/04 **Due:** 7/21/05 8/18/04
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** C96-816
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas
**Ecorr:** − 398.9 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** + 397.9 mV **Cal:** 7/12/04 **Due:** 7/12/05
**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r250

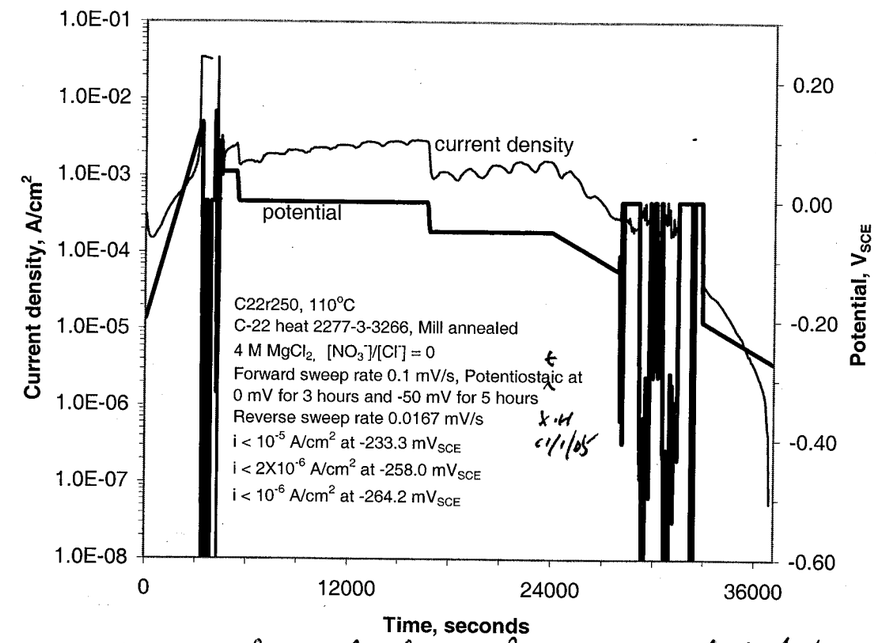
**Number of Crevice Corrosion Sites:** 24 /24 (24 max.)

Severe corrosion.

* Drawing # 20.01402.571.006
K.H 11/7/05

Xihua He 8/18/2004






* Equipment overload. part of current signal & potential has been cut off

Xihua He 8/19/2004

## Thermally Aged Procedure For Alloy C22

Quanity/Specimens = 6 C-22 Specimens Heat # 2277-3-3266

OVEN= Linoberg SN# 909172 Model # 51333

OVEN SETPOINT= 872°C

OVEN TEMPERATURE= 879.4°C

Measurement taken with OMEGA MICROPROCESSOR THEMOMETER MODEL# HH22
SN#= T94140 CAL= 4/27/04 DUE= 10/27/04
Thermocouple= #326 Cal = 7/23/04 Due 1/23/05

**AMOUNT OF TIME =** 5 min

**DETAILS=** All Specimens polished To 600 Grit Prior To thermally Aged Procedure - 5min Time then Water Quenched

8/19/04



8/12/04

## Repassivation Potential Test

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 2277-3-3266

See page 16, NB#672 X.H 11/1/05

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torque to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319 **Cal:** 03/03/04 **Due:** 9/03/04

**Initial Weight:** 40.02360 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.01209 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.60 M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ Lot # 042821
384.6 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot # 033942
} + DI water to 2.5 L

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~2/04/04~~ 7/15/04 **Due:** ~~8/04/04~~ 1/15/05

**Initial pH:** 3.26 **Model:** Orion EA 940 X.H 8/23/04 **SN:** 2330 X.H 8/23/04
**Final pH:** 4.82 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023F

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −282.5 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** −275.1 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r253

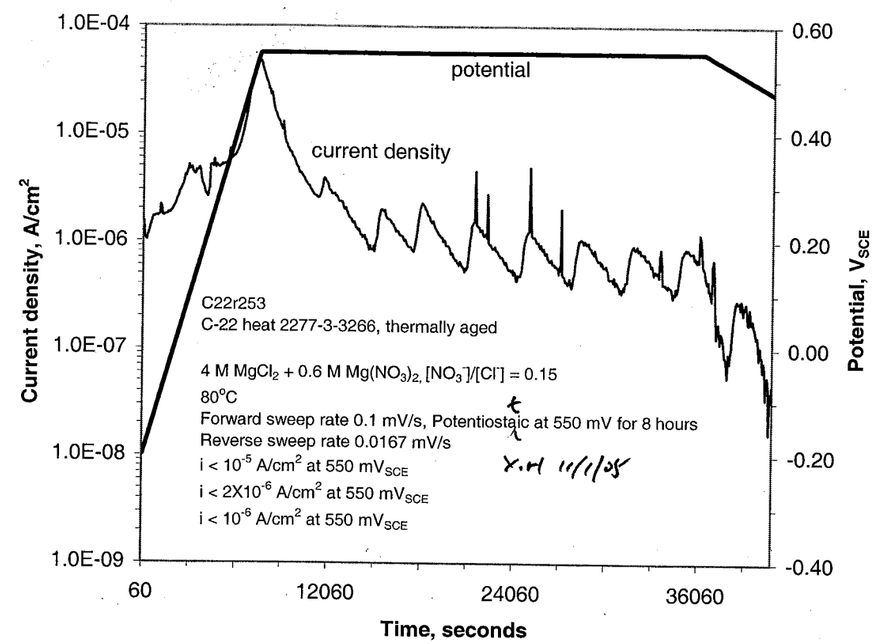
**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

No corrosion, no staining. This will be polished for future use.

* Drawing # 20.01402.571.006.

Xihua He 8/23/04






Xihua He 8/24/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 2277-3-3266
5 min at 870°C (p.16 of NB#6722) X.H 11/1/05

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 03/03/04 **Due:** 9/03/04

**Initial Weight:** 40.50023 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.47499 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.60M $Mg(NO_3)_2$

Same solution as Test C221253 (p.18)

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~2/04/04~~ 7/15/04 **Due:** ~~8/04/04~~ 1/15/05 X.H

**Initial pH:** 3.26 **Model:** Orion EA 940 X.H 8/23/04 **SN:**2330 X.H
**Final pH:** 4.84 **Cal:** 7/21/04 **Due:** 7/21/05 8/23/04
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** C96-816
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** -43.1mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +426.7mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C221254

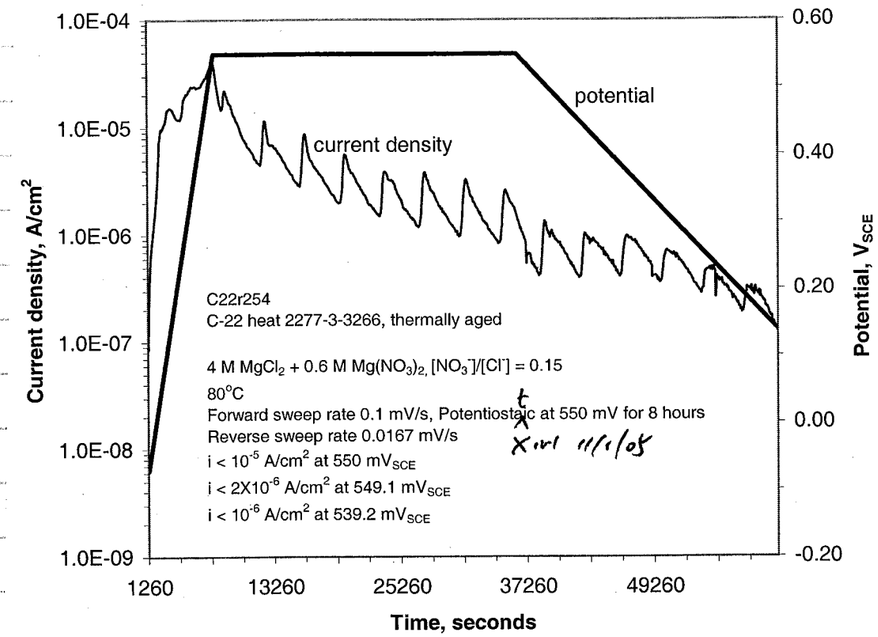
**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

No corrosion, slight surface staining. This will be polished for future use

* Drawing # 20.01402.571.006.
X.H ~~5/7/04~~
X.H 11/2/05

Xihua He 8/23/04






Xihua He 8/24/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 2277-3-3266 5 min at 870°C, p.16 this notebook X.H 11/1/05

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torque to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 03/03/04 **Due:** 9/03/04

**Initial Weight:** 39.84537 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 39.83728 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.4M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ Lot # 042821 } + DI water to
256.4 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot # 037544 } 2.5L

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~2/04/04~~ 7/15/04 X.H **Due:** ~~8/04/04~~ 1/15/05 X.H

**Initial pH:** 2.70 **Model:** Orion EA 940 8/25/04 **SN:** 2330
**Final pH:** 3.65 **Cal:** 7/21/04 **Due:** 7/21/05 8/25/04
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023F

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −88.8 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +441.6 mV **Cal:** 7/12/04 **Due:** 7/12/05
**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r255

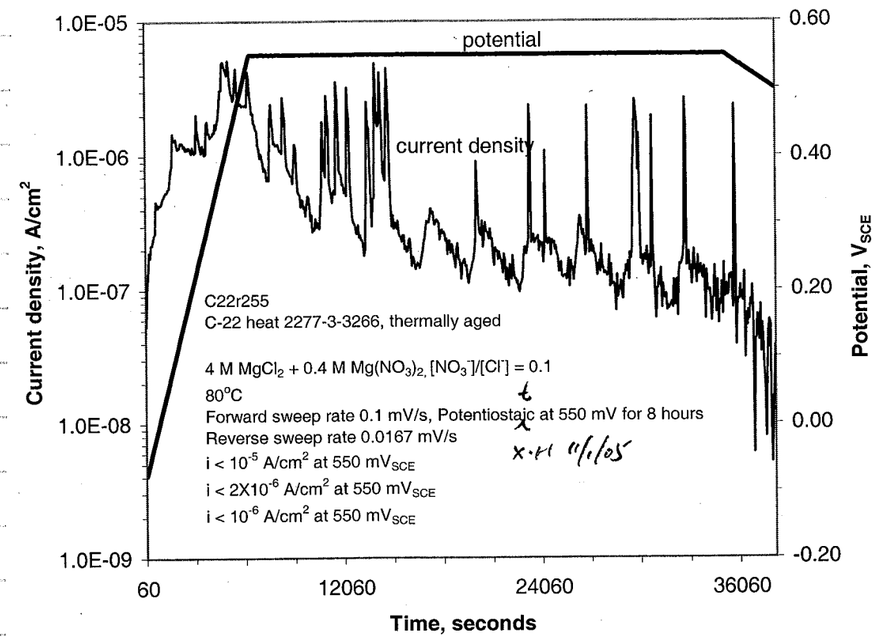
**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

No corrosion, no staining.

*Drawing # 20.01402.571.006. X.H 11/1/05

Xihua He 8/25/04






Xihua He 8/26/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 2277-3-3266
5 min at 870°C, p.16 this notebook X.H 11/1/05

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 03/03/04 **Due:** 9/03/04

**Initial Weight:** 40.33502 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.32233 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.4 M $Mg(NO_3)_2$

Same solution as Test C22r255 (p. 22)

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~2/04/04~~ 7/15/04 X.H 8/25/04 **Due:** ~~8/04/04~~ 8/15/05 X.H 8/25/04

**Initial pH:** 2.70 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 3.66 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** C96-816
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −49.8 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +443.0 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r256

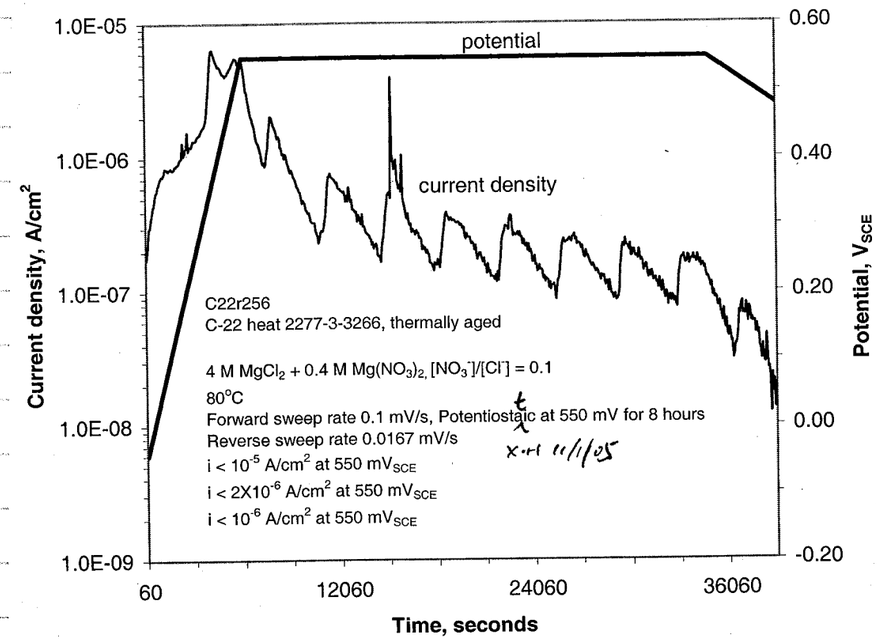
**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

No corrosion, no staining.

*Drawing # 20.01402.571.006. X.H 11/7/05

Xihua He 8/25/04






Xihua He 8/26/04

## Repassivation Potential Test

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 2277-3-3266
X.H 11/1/05 ~~5hr at 5°C~~ 5 min at 870°C, p.16 this notebook X.H 11/1/05

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torque to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 03/03/04 **Due:** 9/03/04

**Initial Weight:** 39.69366 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 39.70384 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.3M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ LA # 042821
192.3 g $Mg(NO_3)_2 \cdot 6H_2O$ LA # 037544 } + DI water to 2.5 L

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~2/04/04~~ 7/18/04 X.H 8/26/04 **Due:** ~~6/04/04~~ 8/15/05 X.H

**Initial pH:** 2.96 **Model:** Orion EA 940 **SN:** 2330
**Final pH:** 4.04 **Cal:** 7/21/04 **Due:** 7/21/05 8/26/04
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023F

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −184.0 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** 436.7 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r257

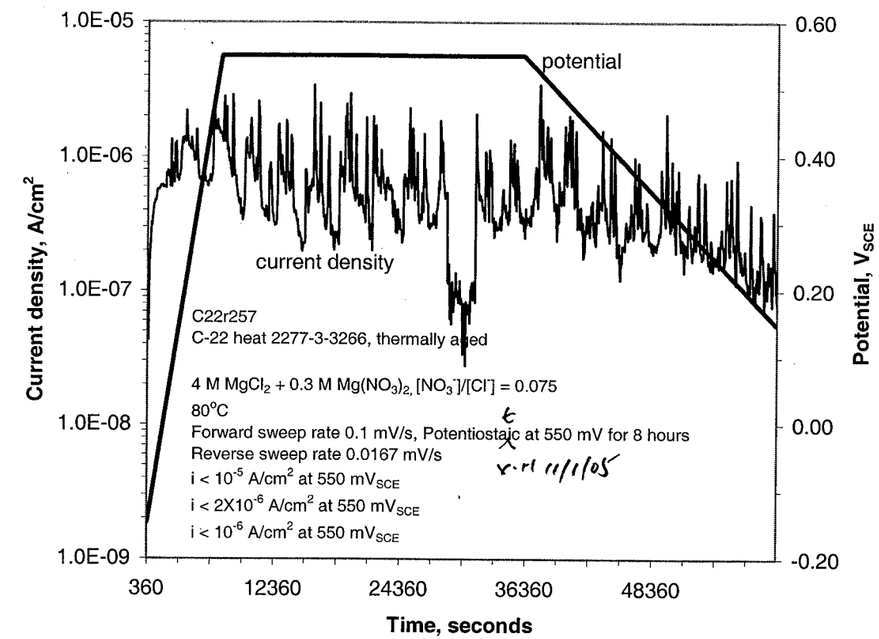
**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

No corrosion, no staining.

*Drawing # 20.01402.571.006. X.H 11/1/05

Xihua He 8/26/04






X.H 11/1/05

Xihua He 8/27/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 2277-3-3266
5 min. at 870°C, p.16 this notebook. X.H 11/1/05

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 03/03/04 **SN:** 1001200319 **Due:** 9/03/04

**Initial Weight:** 40.19616 g
**Final Weight:** 40.19741 g
**Model:** Sartorius Genius **CAL:** 05/14/04 **SN:** 12809099 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.3M $Mg(NO_3)_2$

same solution as C22r257 (p.26)

**Reagents measured with**

**Initial pH:** 2.96
**Final pH:** 3.73

**Model:** OHAUS **Cal:** ~~2/04/04~~ 7/15/04 X.H **SN:** 2883 **Due:** ~~8/04/04~~ 1/15/05 X.H 8/26/04

**Model:** Orion EA 940 8/26/04 **Cal:** 7/21/04 **pH Probe:** #13-620-296 **SN:**2330 **Due:** 7/21/05 **SN:** 4079126P

**Test Temperature:** 80°C

**Measured with Hg Thermometer SN:** C96-816 **Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −169.0mV
**Ept:** 441.3mV

**Model:** Keithley 614 **Cal:** 7/12/04 **SN:** 0704934 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

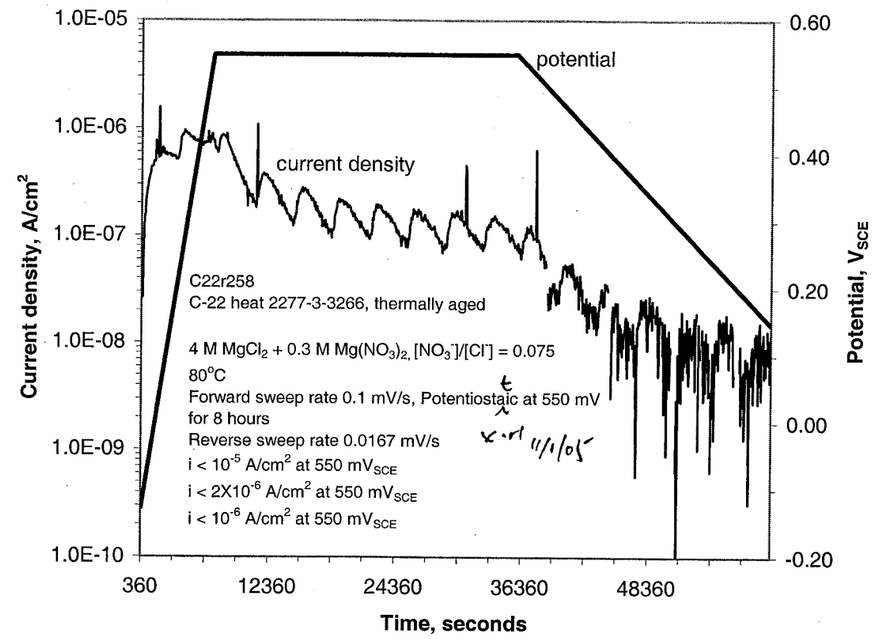
**DATA FILE:** C22r258

**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

No corrosion, no staining

* Drawing # 20.01402.571.006. X.H 11/1/05

Xihua He 8/26/04




Xihua He 8/27/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 2277-3-3266 5 min at 870°C, P16 this notebook X.H 11/1/05

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 03/03/04 **SN:** 1001200319 **Due:** 9/03/04

**Initial Weight:** 39.89276 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 39.64814 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4 M $MgCl_2$

2033.1 g $MgCl_2 \cdot 6H_2O$ Lot # 042821 + DI water to 2.5L

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~2/04/04~~ 7/15 X.H 8/30/04 **Due:** ~~8/04/04~~ 1/15/05 X.H 8/30/04

**Initial pH:** 3.02 **Model:** Orion EA 940 **SN:** 2330
**Final pH:** 5.74 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023F

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −296.0 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +374.5 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

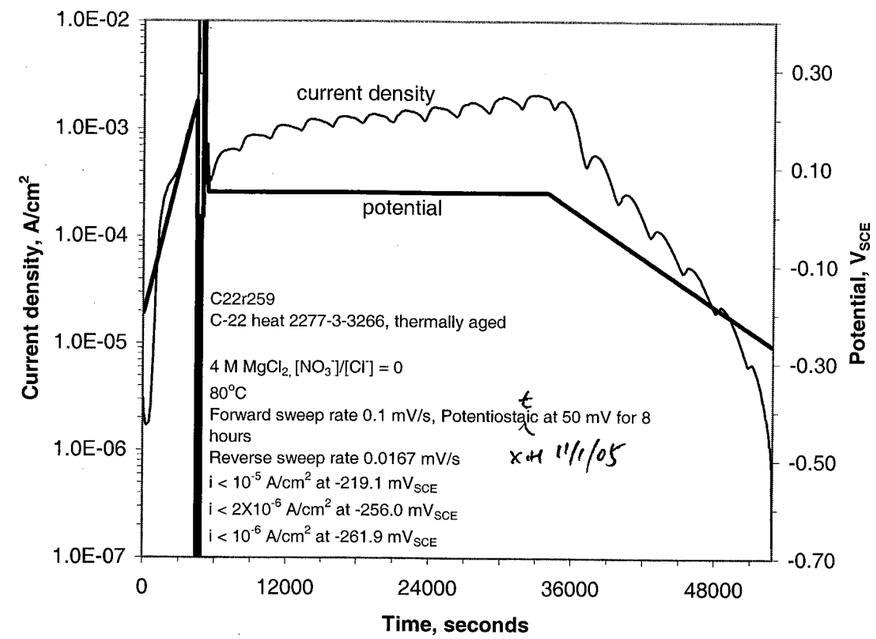
**DATA FILE:** C22r259

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

Severe corrosion. Pitting corrosion at sides. Bolt hole was corroded.

* Drawing # 20.01402.571.006.
X.H 11/7/05 8/30/2004






Xihua He 9/1/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 2277-3-3266

5min at 870° p.16 this notebook. X.H 11/1/05

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 03/03/04 **Due:** 9/03/04

**Initial Weight:** 40.66651 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.44160 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$

same solution as test C22r259 (p.30)

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~2/04/04~~ 7/15/04 X.He 8/31/04 **Due:** ~~8/04/04~~ 11/15/05 X.H 8/31/04

**Initial pH:** 3.02 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 5.97 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** C96-816
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −208.2 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +382.0 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r260

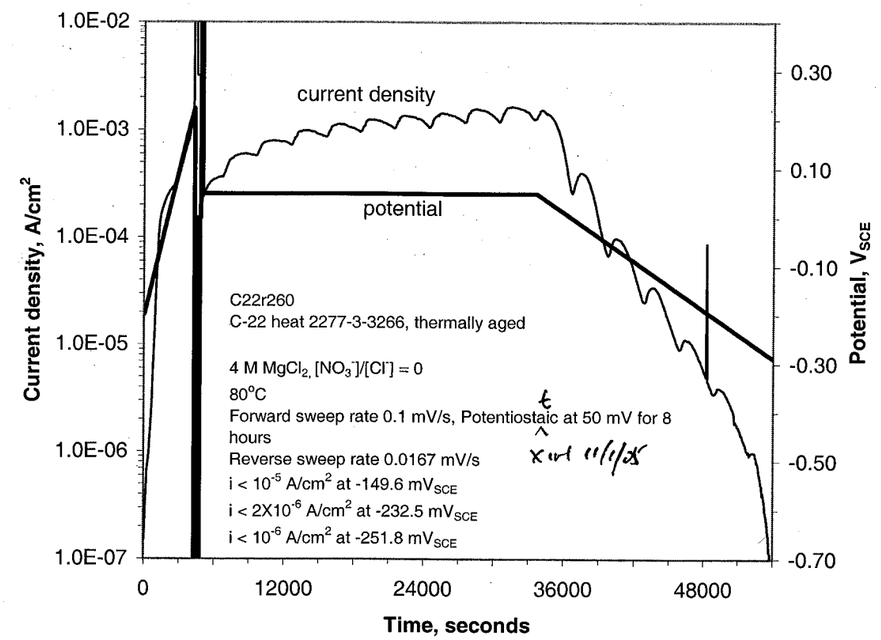
**Number of Crevice Corrosion Sites:** 24/24 (24 max.)

Severe corrosion. Pitting corrosion at sides. Part of bolt hole is corroded.

*Drawing # 20.01402.571.006. X.H 11/2/05

Xihua He 8/31/04






Xihua He 9/1/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 2277-3-3266
5min at 870°C, p.16 this notebook. X.H 11/1/05

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 03/03/04 **Due:** 9/03/04

**Initial Weight:** 39.99550 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 39.99972 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 1M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ Lot # 042821 } + DI water
641.0 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot # 037544 } to 25L

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~7/04/04~~ 7/15/04 X.H 9/2/04 **Due:** ~~8/04/04~~ 1/15/05 X.H 9/2/04

**Initial pH:** 2.45 **Model:** Orion EA 940 **SN:** 2330
**Final pH:** 4.51 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023F

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −132.4mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +290.0mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

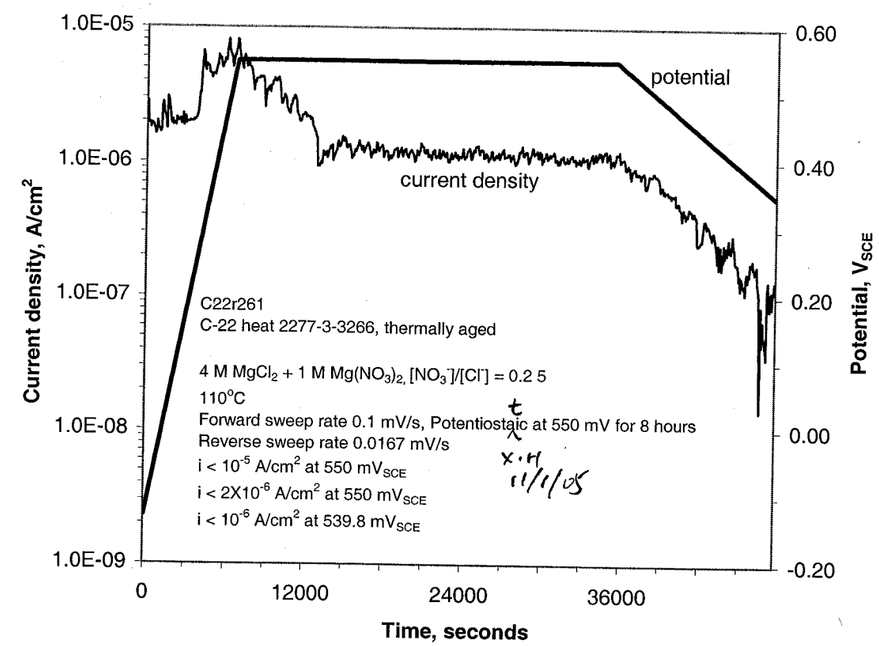
**DATA FILE:** C22r261

**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

No corrosion, no staining

Drawing # 20.01402.571.006. X.H 11/2/05
Xihua He 9/2/04






Xihua He 9/3/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 2277-3-3266 5 min at 870°C, P.16, this notebook. X.H 11/1/05

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319 **Cal:** 03/03/04 **Due:** 9/03/04

**Initial Weight:** 39.49375 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 39.49812 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 1M $Mg(NO_3)_2$

Same solution as C22r261 (p. 34)

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** ~~2/04/04~~ 7/15/04 X.H 9/2/04 **Due:** ~~8/04/04~~ 1/15/05 X.H 9/2/04

**Initial pH:** 2.45 **Model:** Orion EA 940 **SN:** 2330
**Final pH:** 4.05 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** C96-816
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** ~~-281.1 mV~~ -85.1 mV X.H 9/2/04 **Model:** Keithley 614 **SN:** 0704934
**Ept:** -281.0 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r262

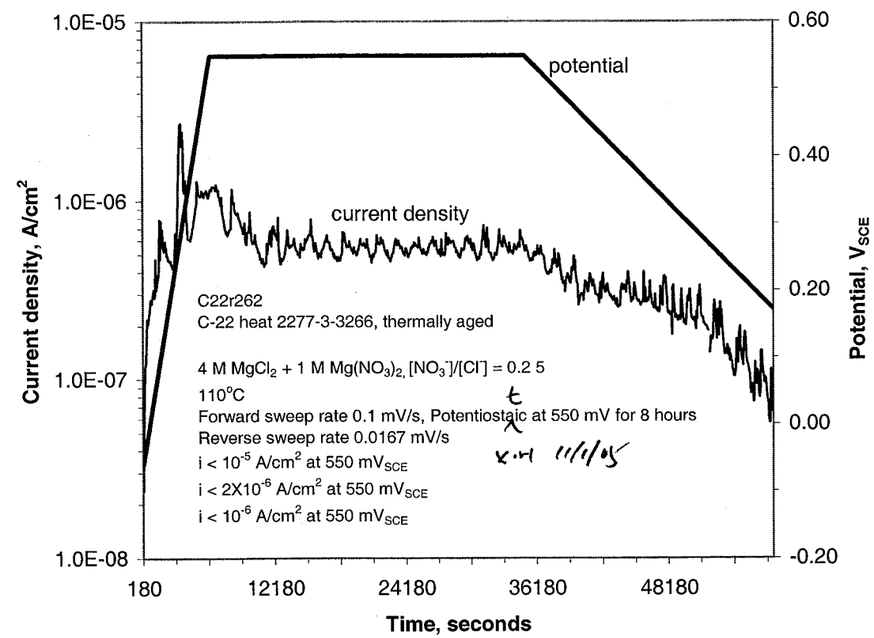
**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

No corrosion, no staining.

Drawing # 20.01402.571.006. X.H 11/7/05

Xihua He 9/2/04






Xihua He 9/3/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 16 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 3/03/05

**Initial Weight:** 39.32464 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 39.35625 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ ; 0.8M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ Lot # 042821 } + DI water
512.8 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot # 037544 } to 2.5L

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** 2.91 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 4.35 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −101.7mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +431.6mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

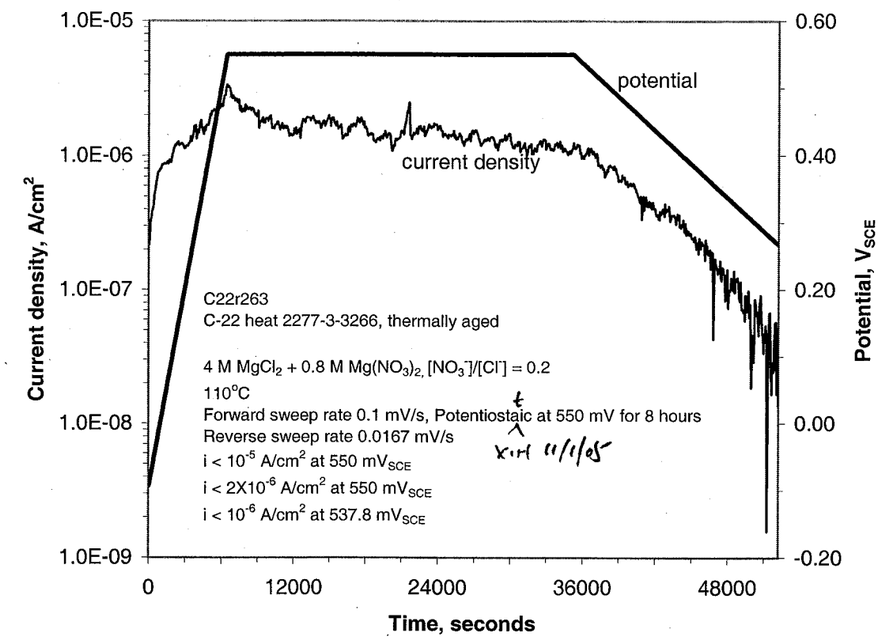
**DATA FILE:** C22r263

**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

No corrosion, no staining

* Drawing # 20.01402.571.006. X.H 11/7/05
9/7/2004
Xihua He






9/8/2004 Xihua He

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 16 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 03/03/05

**Initial Weight:** 29.66522 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 29.70359 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.8 M $Mg(NO_3)_2$
Same solution as test C22r263 (p.38)

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** 2.91 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 4.38 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** C96-816
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −137.2 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +381.6 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r264

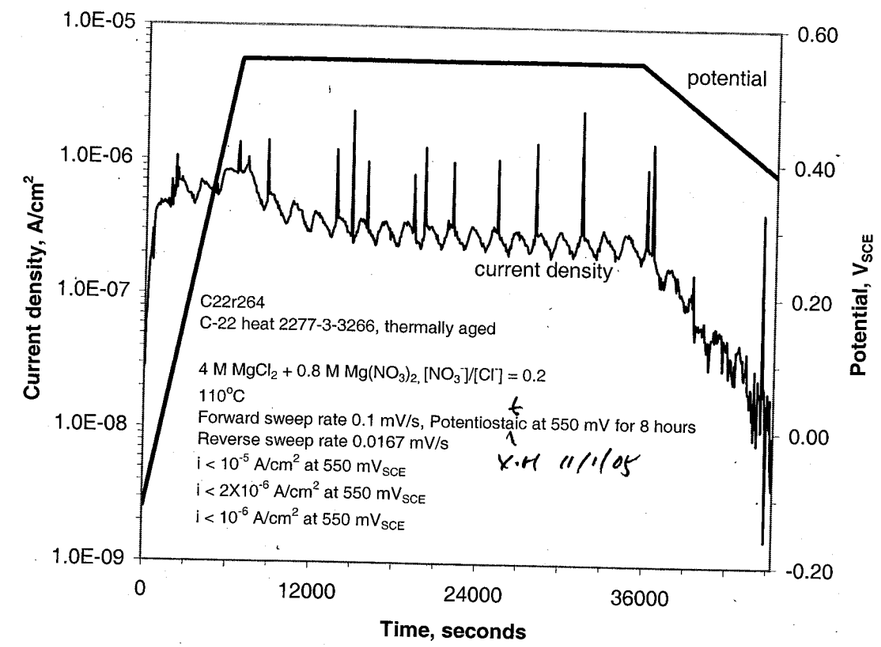
**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

No corrosion, no staining

* Drawing # 20.01402.571.006. X.H 11/7/05

9/7/04 Xihua He






Xihua He 9/8/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 16 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 3/03/05

**Initial Weight:** 40.34741 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.35299 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.6 M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ Lot # 042821 } + DI water to 2.5L
384.6 g $Mg(NO_3)_2 \cdot 6H_2O$ lot # 037544

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** 3.31 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 4.76 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** -63.1 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** 433.4mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r265

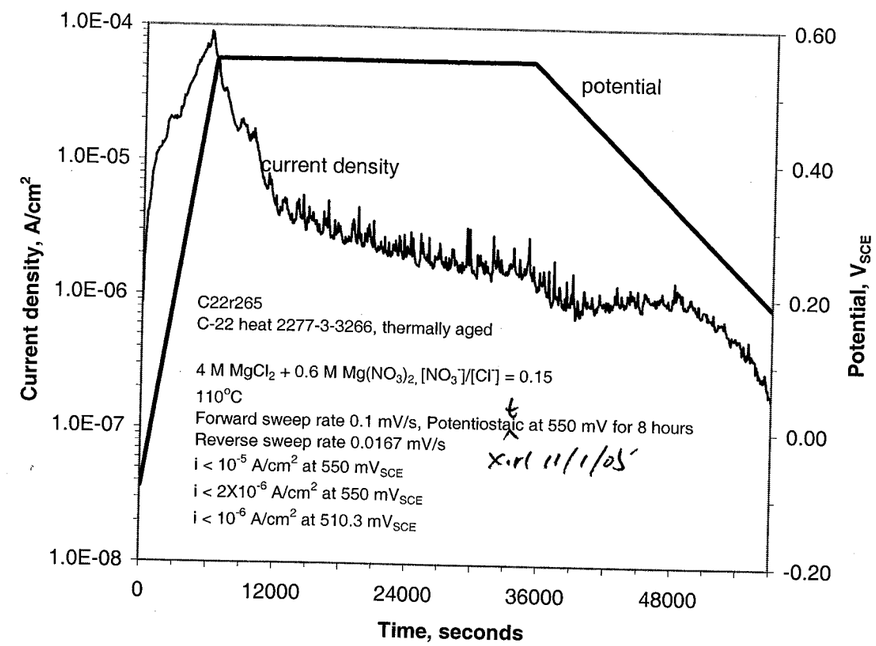
**Number of Crevice Corrosion Sites:** 1 /24 (24 max.)

One tiny corroded spot. small part of bolt hole is corroded. slight surface staining.

* Drawing # 20.01402.571.006. X.H 11/7/05

Xihua He 9/9/2004






Xihua He 9/13/2004

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 16 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 03/03/05

**Initial Weight:** 40.22362 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.23308 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4 M $MgCl_2$ + 0.6 M $Mg(NO_3)_2$

Same solution as Test C22r265 (p.42)

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** 3.31 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 4.79 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** C96-816
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −74.2 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +408.0 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

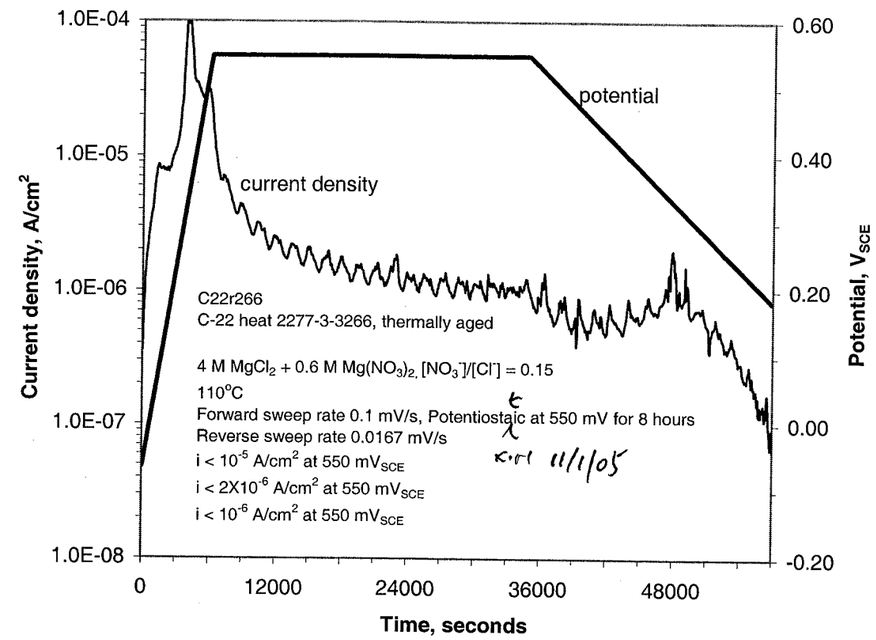
**DATA FILE:** C22r266

**Number of Crevice Corrosion Sites:** 1 /24 (24 max.)

Corrosion on one small area.

* Drawing # 20.01402.571.006.
XH 11/7/05 Xihua He 9/9/2004






XH 11/1/05

Xihua He 9/13/2004

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 16 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 3/03/05

**Initial Weight:** 39.12733 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 39.15672 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.4M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ Lot # 042821 } + DI water to 2.5L
256.4 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot # 037544

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** 2.78 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 4.75 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** -130.1 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** 427.8 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r267

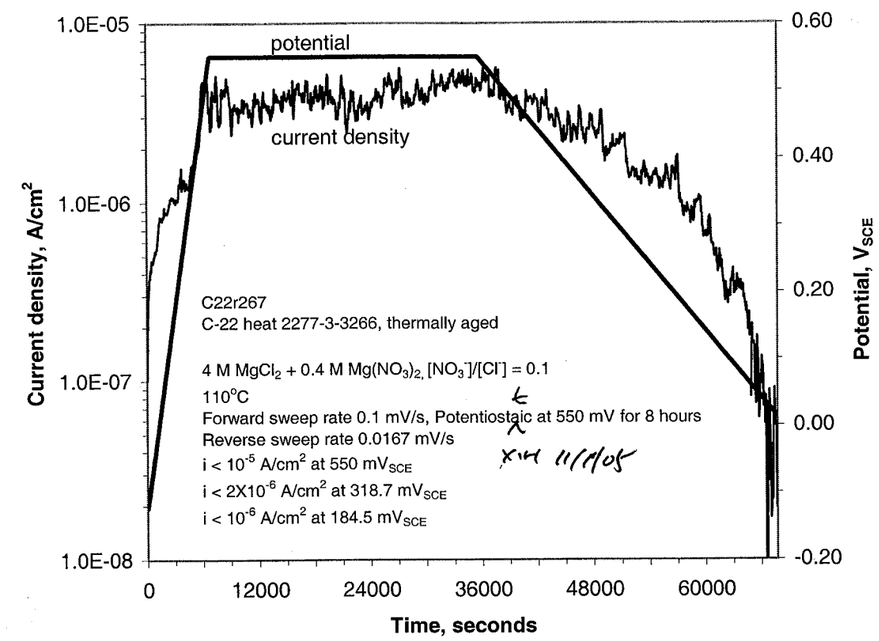
**Number of Crevice Corrosion Sites:** 1 /24 (24 max.)

One corroded spot.

* Drawing # 20.01402.521.006. X.H 11/2/05

Xihua He 9/14/2004






Xihua He 9/15/2004

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 16 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 03/03/05

**Initial Weight:** 39.38253 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 39.38716 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.4 M $Mg(NO_3)_2$

Same solution as test C22r267 (P.46)

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** 2.78 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 4.68 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** C96-816
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −167.3 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** 333.6 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r268

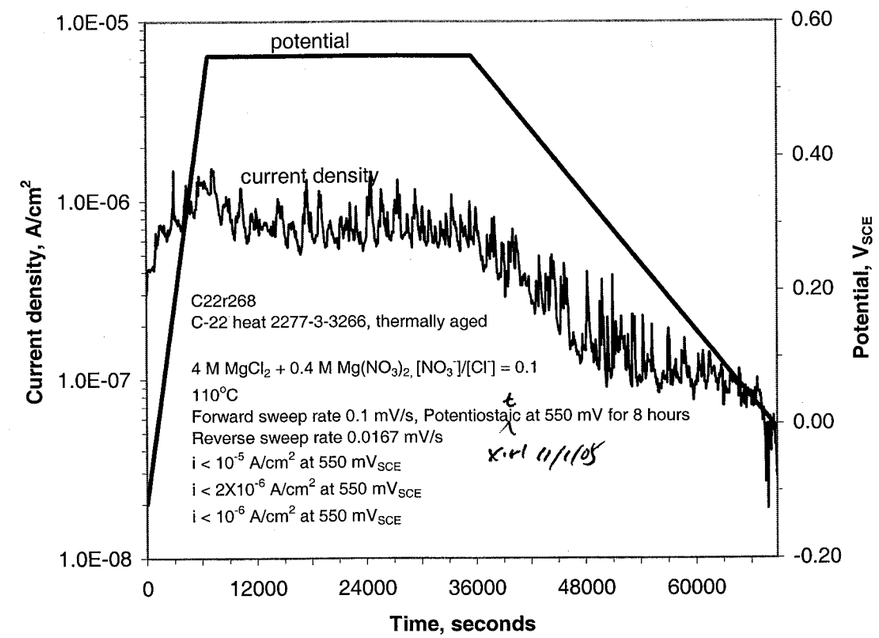
**Number of Crevice Corrosion Sites:** 2 /24 (24 max.)

Two small crevice corroded spots.

* Drawing # 20.01402.571.006. XH 11/7/05

Xihua He 9/14/2004






Xihua He 9/18/2004

Xiuhua He 9/16/04



## THERMALLY AGED PROCEDURE

**Quanity/Specimens =** 6

**OVEN=** Linoberg SN# 909172 Model # 51333

**OVEN SETPOINT=** 870°C

**OVEN TEMPERATURE=** 873.6°C

**Measurement taken with** OMEGA MICROPROCESSOR THEMOMETER **MODEL#** HH22
**SN#=** T-94140 **CAL=** 4/27/04 **DUE=** 10/27/04
**Thermocouple=** #326 Cal 7/23/04 Due 1/23/05

**AMOUNT OF TIME =** 5 min

**DETAILS=** All Specimen polished to 600 Grit prior to thermally Aged Procedure - 5 min Time then water Quenched

9/14/04

9/14/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# ~~16~~ 51 NB# 672) 2277-3-3266 X.H 9/15/04

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

| | | |
|---|---|---|
| **Torque Screwdriver:** | Snap-on USA<br>**Cal:** 09/03/04 | **SN:** 1001200319<br>**Due:** 3/03/05 |
| **Initial Weight:** 40.47201 g<br>**Final Weight:** 40.27527 g | **Model:** Sartorius Genius<br>**CAL:** 05/14/04 | **SN:** 12809099<br>**Due:** 11/14/04 |

**Solution:** 4 M $MgCl_2$ + 0.3 M $Mg(NO_3)_2$
203.31 g $MgCl_2 \cdot 6H_2O$ Lot # 042821 } + DI water to 2.5 L
192.3 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot # 037544

| | | |
|---|---|---|
| **Reagents measured with** | **Model:** OHAUS<br>**Cal:** 7/15/04 | **SN:** 2883<br>**Due:** 1/15/05 |
| **Initial pH:** 2.96<br>**Final pH:** 5.96 | **Model:** Orion EA 940<br>**Cal:** 7/21/04<br>**pH Probe:** #13-620-296 | **SN:**2330<br>**Due:** 7/21/05<br>**SN:** 4079126P |
| **Test Temperature:** 110°C | **Measured with Hg Thermometer SN:** E98-191<br>**Cal:** 06/09/04 | **Due:** 12/09/04 |

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

| | | |
|---|---|---|
| **Ecorr:** -45.1 mV<br>**Ept:** 404.0 mV | **Model:** Keithley 614<br>**Cal:** 7/12/04 | **SN:** 0704934<br>**Due:** 7/12/05 |
| **Potentiostat:** EG&G Model 273 | | **SN:** 41108 |

**DATA FILE:** C22r269

**Number of Crevice Corrosion Sites:** 17/24 (24 max.)

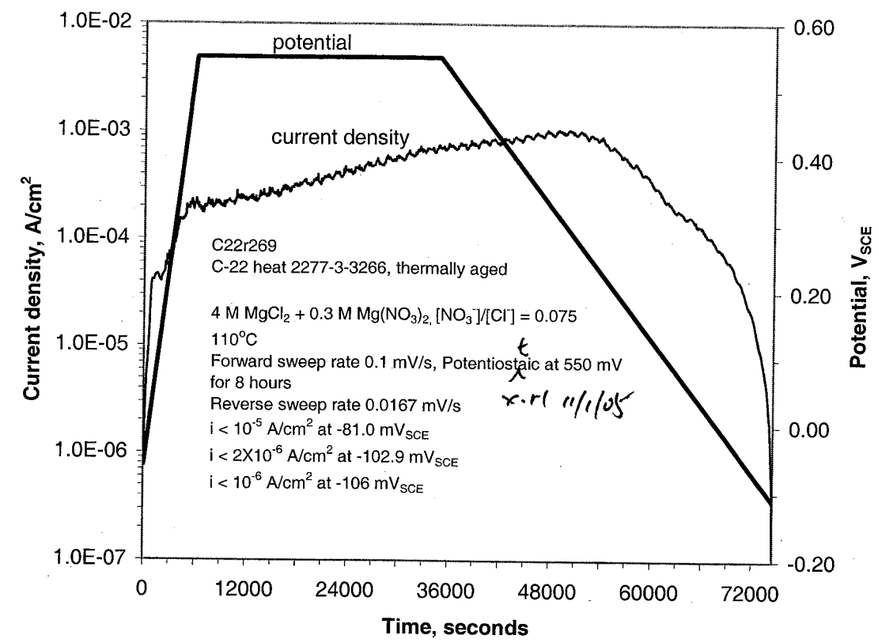
Severe corrosion around bolt holes and bolt hole.

Surface staining at sides.

* Drawing # 20.01402.571.006. X.H 11/7/05

Xihua He 9/15/2004






X.H 11/1/05

Xihua He 9/17/2004

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# ~~16~~ 51 NB# 672) X.H 9/15/04 2277-3-3266 *

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 09/03/04 **SN:** 1001200319 **Due:** 03/03/05

**Initial Weight:** 40.73224 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.56045 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.3 M $Mg(NO_3)_2$
same solution as ~~test~~ C22r269 (P 52)

**Reagents measured with** **Model:** OHAUS **Cal:** 7/15/04 **SN:** 2883 **Due:** 1/15/05

**Initial pH:** 2.96 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 5.78 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** C96-816
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** -75.6mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +378.7mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r270

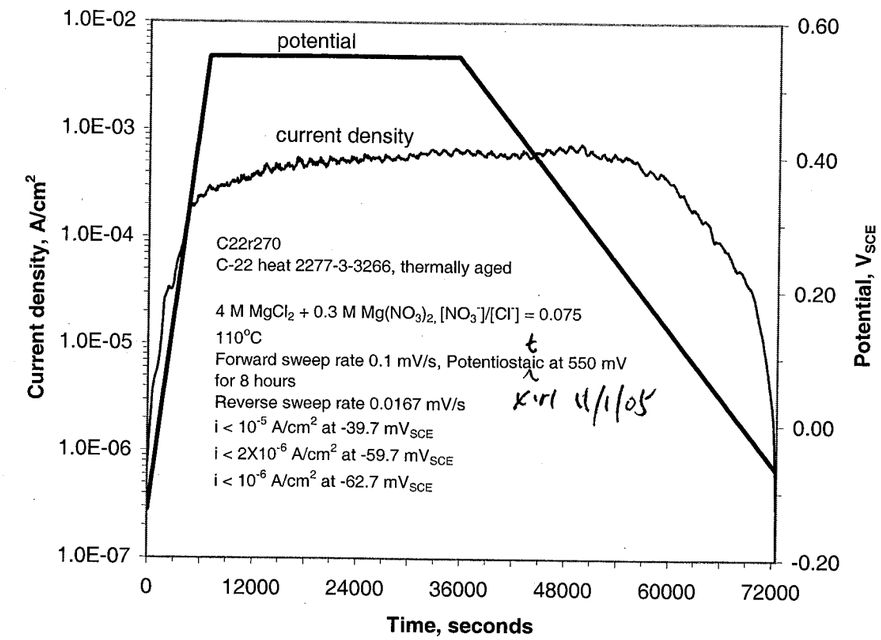
**Number of Crevice Corrosion Sites:** 12 /24 (24 max.)

Bolt hole is severely corroded. Surface staining at all sides.
X.H 9/17/04

* Drawing # 20.01402.571.006.
X.H 11/7/05

Xihua He 9/15/2004






Xihua He 9/17/2004

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# ~~16~~ 51 NB# 672) 2277-3-3266 X.H 9/20/04 *

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 3/03/05

**Initial Weight:** 40.49242 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.04388 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4 M $MgCl_2$, 0.2 M $Mg(NO_3)_2$

2033.1g $MgCl_2 \cdot 6H_2O$ Lot # 042821 } + DI water to 2.5L
128.2g $Mg(NO_3)_2$ Lot # 037544

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** 2.61 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 6.13 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −209.9 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +362.0 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r271

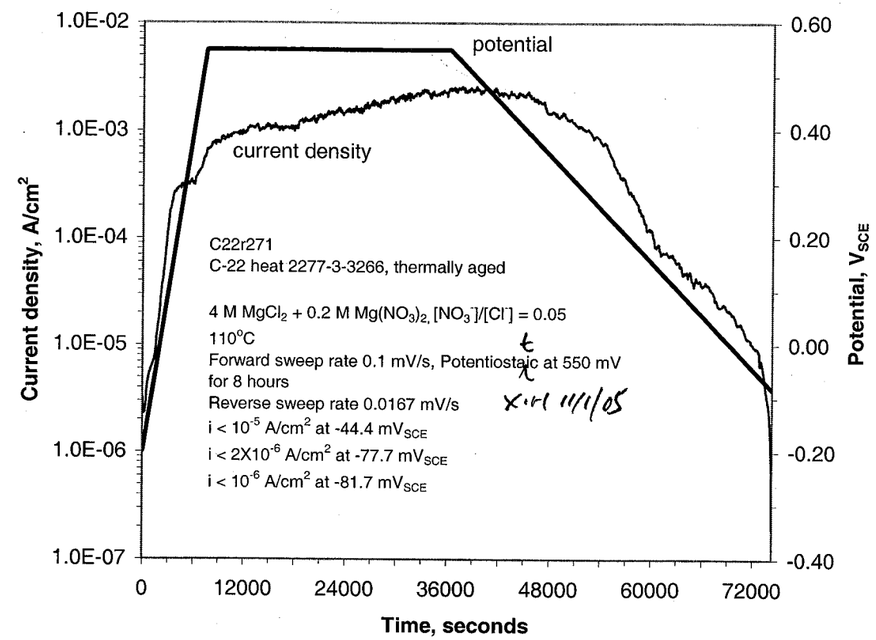
**Number of Crevice Corrosion Sites:** 21 ~~24~~ /24 (24 max.) X.H 9/24/04

Bolt hole is severely corroded.
Surface staining

Xihua He 9/24/04

* Drawing # 20.01402.571.006.
X.H 11/7/05






Xihua He 9/24/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# ~~16~~ 51 NB# 672) X.H 9/28/04 2277-3-3266 *

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319 **Cal:** 09/03/04 **Due:** 03/03/05

**Initial Weight:** 40.45699 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.07723 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:**

4M $MgCl_2$, 0.2M $Mg(NO_3)_2$
Same solution as test C22r271

**Reagents measured with** **Model:** OHAUS **SN:** 2883 **Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** 2.61 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 6.24 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** C96-816 **Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −72.8 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +404.3 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r272

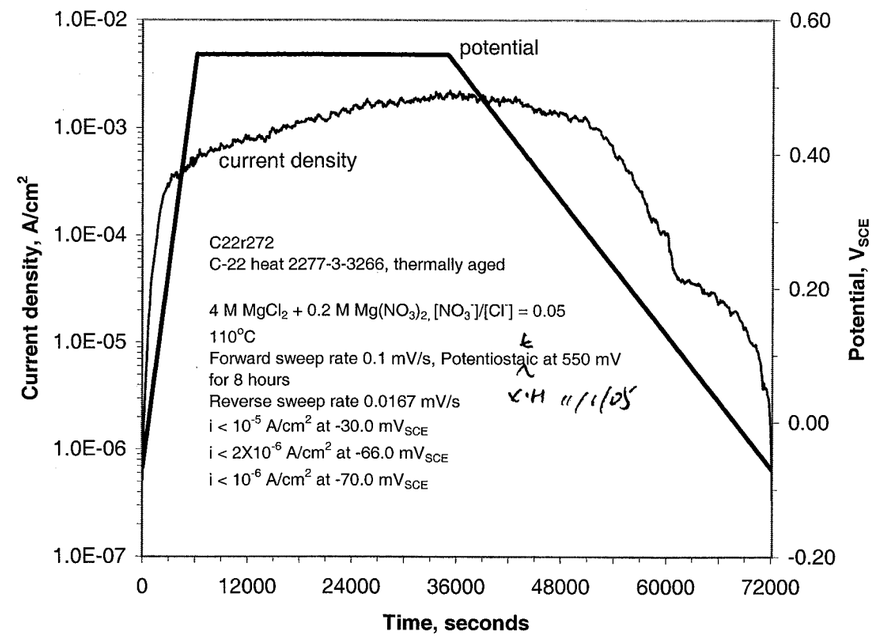
**Number of Crevice Corrosion Sites:** 18 /24 (24 max.)

Bolt hole is severely corroded. Surface staining.

Xihua He 9/24/04

* Drawing # 20.01402.571.006.
X.H 11/7/05






Xihua He 9/24/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# ~~16~~ 51 NB# 672) X.H 9/24/04 2277-3-3266 *

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 3/03/05

**Initial Weight:** 40.73055 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.46729 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4 M $MgCl_2$, 0.16 M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ + 102.56 g $Mg(NO_3)_2 \cdot 6H_2O$ + DI water to 2.5L
Lot # 042821 Lot # 037544

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** 4.04 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 6.24 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −93.36 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +386.4 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r273

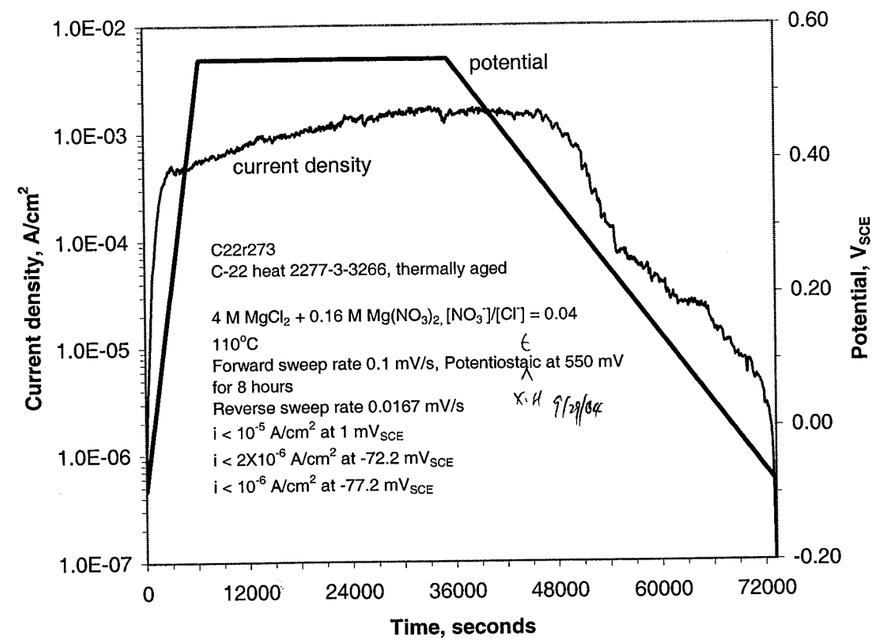
**Number of Crevice Corrosion Sites:** 13 /24 (24 max.)

Severe corrosion in bolt hole and surface staining at all sides.

Xihua He 9/24/04

* Drawing # 20.01402.571.006.
XH 11/7/05






Xihua He 9/29/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# ~~16~~ 51 NB# 672) X.H 9/24/04 2277-3-3266 *

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 09/03/04 **SN:** 1001200319 **Due:** 03/03/05

**Initial Weight:** 40.75850 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.41511 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$, 0.16 M $Mg(NO_3)_2$

Same solution as test C22r273 (P.60)

**Reagents measured with** **Model:** OHAUS **Cal:** 7/15/04 **SN:** 2883 **Due:** 1/15/05

**Initial pH:** 4.04 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 6.08 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** C96-816 **Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** -315.4 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +356.0 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r274

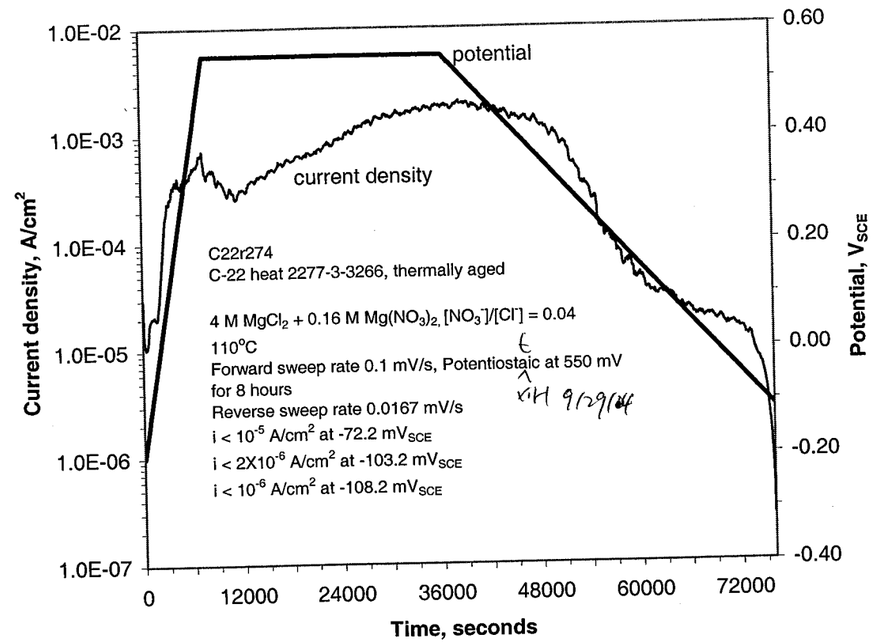
**Number of Crevice Corrosion Sites:** 18/24 (24 max.)

Severe corrosion in bolt hole and surface staining at all sides.

Xihua He 9/24/04

* Drawing # 20.01402.571.006. X.H 11/7/05






Xihua He 9/29/04

## THERMALLY AGED PROCEDURE

Quanity/Specimens = 6

OVEN= Linoberg sn# 909172 model # 51323

OVEN SETPOINT= 872°C

OVEN TEMPERATURE= 874.6°C

Measurement taken with OMEGA MICROPROCESSOR THEMOMETER MODEL# HH22
SN#= T 94140 CAL= 4/27/04 DUE= 10/27/04

Thermocouple= #326

AMOUNT OF TIME = 5m

DETAILS= All specimens polished to 600 grit Prior to thermally Aged Procedure 5min Time then water Quenches

9/29/04

9/29/04



## THERMALLY AGED PROCEDURE

Quanity/Specimens = 6 C-22 Heat # 2277-3-3266

OVEN= Linoberg sn# 909172 Model # 51333

OVEN SETPOINT= 870°C

OVEN TEMPERATURE= 875.3°C

Measurement taken with OMEGA MICROPROCESSOR THEMOMETER MODEL# HH22
SN#= T 94140 CAL= 4/27/04 DUE= 10/27/04

Thermocouple= #326 Cal 7/23/04 Due 1/23/05

AMOUNT OF TIME = 5 mins

DETAILS= All Specimens polished to 600 Grit Finish Prior to thermally Aged Procedure - 5min time the water Quenches

10/18/04

10/18/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 64 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 3/03/05

**Initial Weight:** 40.74466 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.13729 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:**
4M $MgCl_2$ + 0.08 M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ lot # 042821
51.28 g $Mg(NO_3)_2 \cdot 6H_2O$ lot # 037544 } + DI water to 2.5 L

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** 2.87 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 6.29 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −340.6 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** + 347.2 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r275

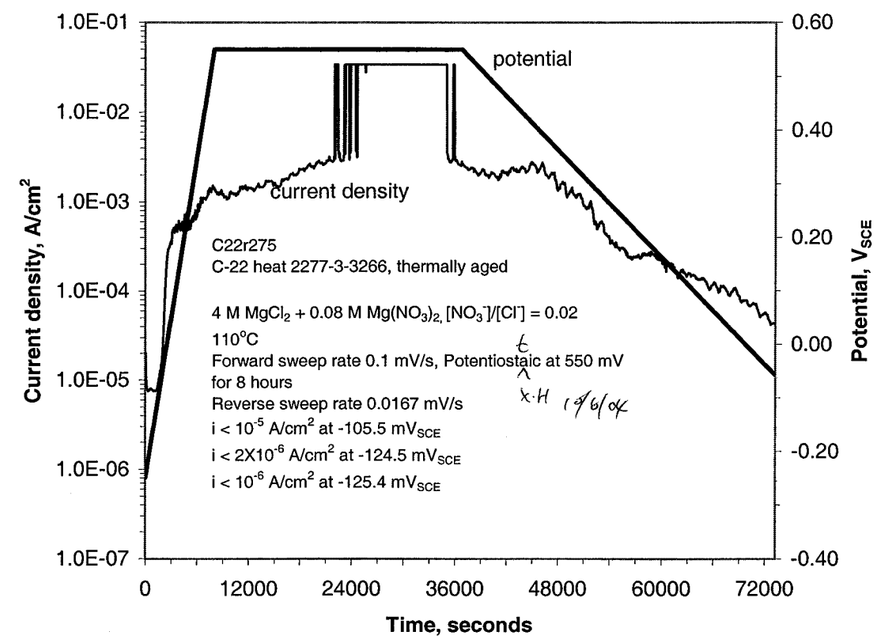
**Number of Crevice Corrosion Sites:** 23 /24 (24 max.)

Severe corrosion on faces and bolt holes and surface staining at sides.

Xihua He 10/6/04

* Drawing # 20.01402.571.006.
v.01 11/7/05






Xihua He 10/6/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 64 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 09/03/04 **SN:** 1001200319 **Due:** 03/03/05

**Initial Weight:** 40.78353 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.14755 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.08M $Mg(NO_3)_2$

same solution as Test C22r275 (Page 66)

**Reagents measured with** **Model:** OHAUS **Cal:** 7/15/04 **SN:** 2883 **Due:** 1/15/05

**Initial pH:** 2.87 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 6.05 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** C96-816
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** -320.3 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** + 337.4 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r276

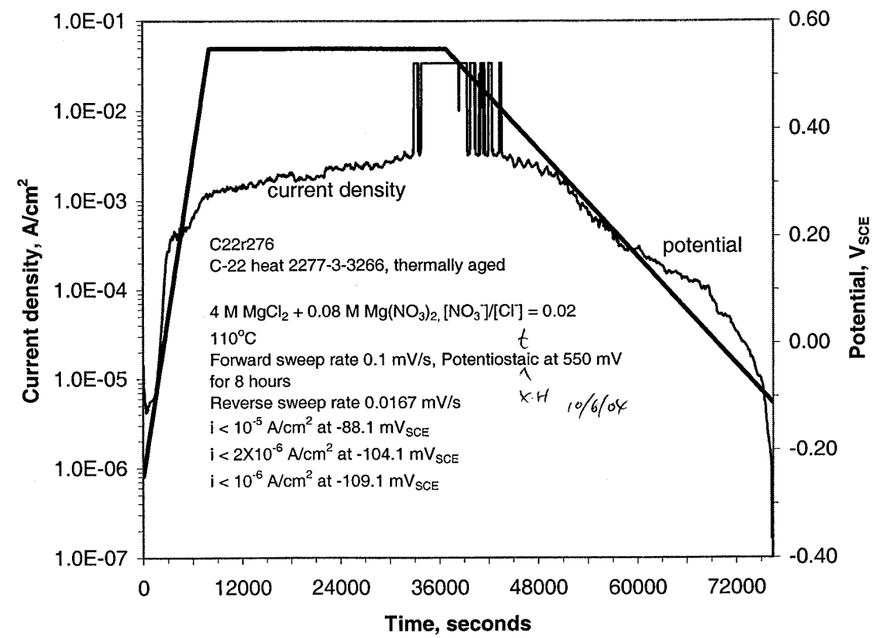
**Number of Crevice Corrosion Sites:** 18 /24 (24 max.)

Severe corrosion on faces and bolt hole, and surface staining at sides.

Xihua He 10/06/04

* Drawing # 20.01402.5X.006.
Y.H 11/7/05






Xihua He 10/06/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 64 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 09/03/04 **SN:** 1001200319 **Due:** 3/03/05

**Initial Weight:** 40.94627 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.37130g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$

2033.1 g $MgCl_2 \cdot 6H_2O$ Lot # 042821 + DI $H_2O$ to 2.5 L

**Reagents measured with** **Model:** OHAUS **Cal:** 7/15/04 **SN:** 2883 **Due:** 1/15/05

**Initial pH:** 2.93 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 5.93 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** -370 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** 350 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r277

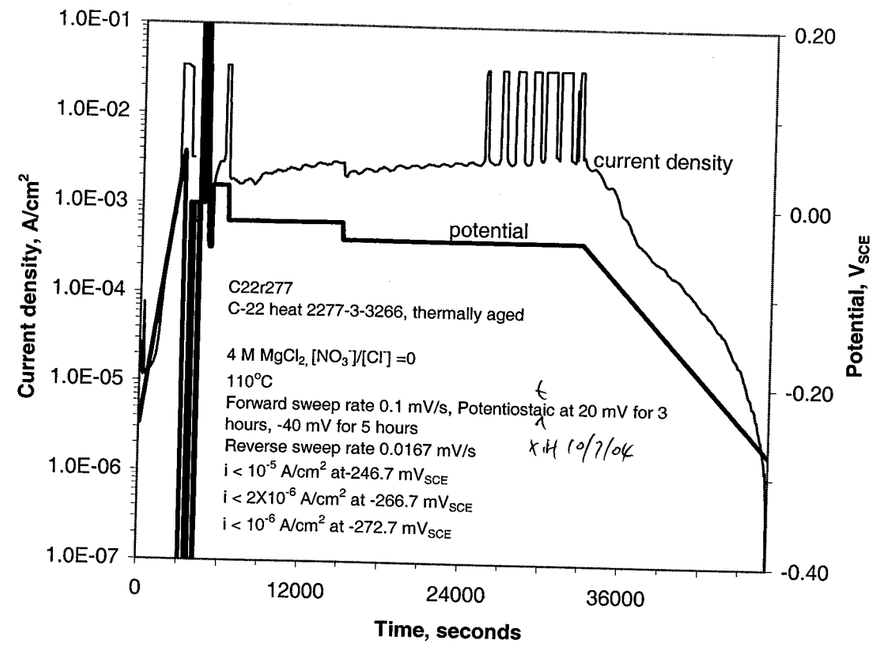
**Number of Crevice Corrosion Sites:** 24 /24 (24 max.)

Severe corrosion on ~~corr~~ crevice faces and all sides.
corrosion in bolt hole X.H 10/7/04 Pitting corrosion and staining on all sides

Xihua He 10/6/04

* Drawing # 20.01402.571.006.
X.H 11/7/05






Xihua He 10/7/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 64 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 09/03/04 **SN:** 1001200319 **Due:** 03/03/05

**Initial Weight:** 40.82505 g
**Final Weight:** 40.42759 g
**Model:** Sartorius Genius **CAL:** 05/14/04 **SN:** 12809099 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$

Same solution as test C22r277 (P. 707)

**Reagents measured with** **Model:** OHAUS **Cal:** 7/15/04 **SN:** 2883 **Due:** 1/15/05

**Initial pH:** 2.93
**Final pH:** 6.07
**Model:** Orion EA 940 **Cal:** 7/21/04 **pH Probe:** #13-620-296 **SN:**2330 **Due:** 7/21/05 **SN:** 4079126P

**Test Temperature:** 110°C **Measured with Hg Thermometer SN:** C96-816 **Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** -360 mV
**Ept:** +310 mV
**Model:** Keithley 614 **Cal:** 7/12/04 **SN:** 0704934 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r278

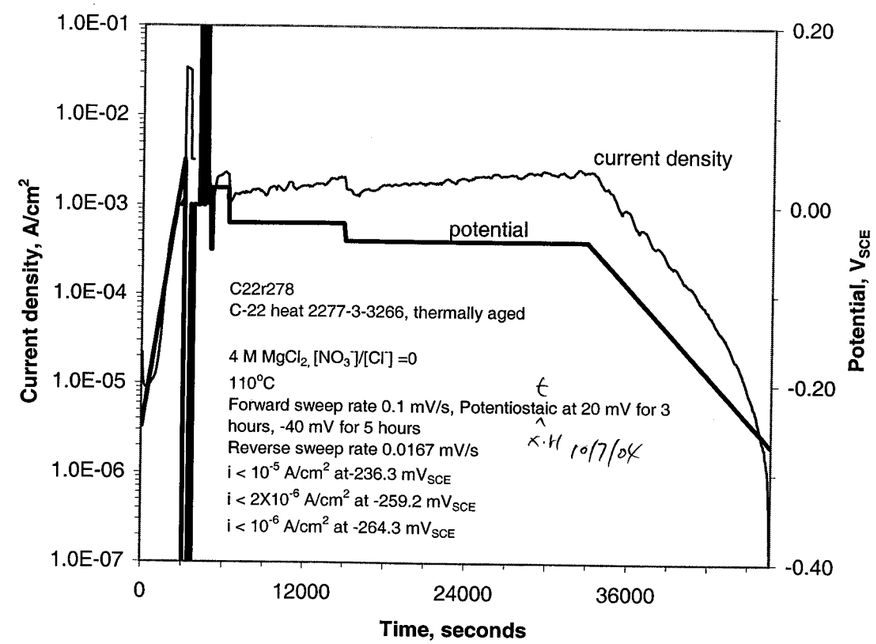
**Number of Crevice Corrosion Sites:** 24/24 (24 max.)

Severe corrosion on all faces and sides. Pitting corrosion and staining at all sides. Severe corrosion in bolt hole

Xihua He 10/06/04

* Drawing # 20.01402.571.006. X.H 11/7/05






Xihua He 10/7/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# ~~16~~ 64 NB# 672) 2277-3-3266 X.H 10/11/04 *

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 3/03/05

**Initial Weight:** 40.63052 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.62730 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:**
4M $MgCl_2$ + 0.2M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ lot # 0428213 + DI water to 2.5 L
128.2 g $Mg(NO_3)_2 \cdot 6H_2O$ lot # 037544

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** 2.65 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 5.89 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −133.01 **Model:** Keithley 614 **SN:** 0704934
**Ept:** −340.7 **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r279

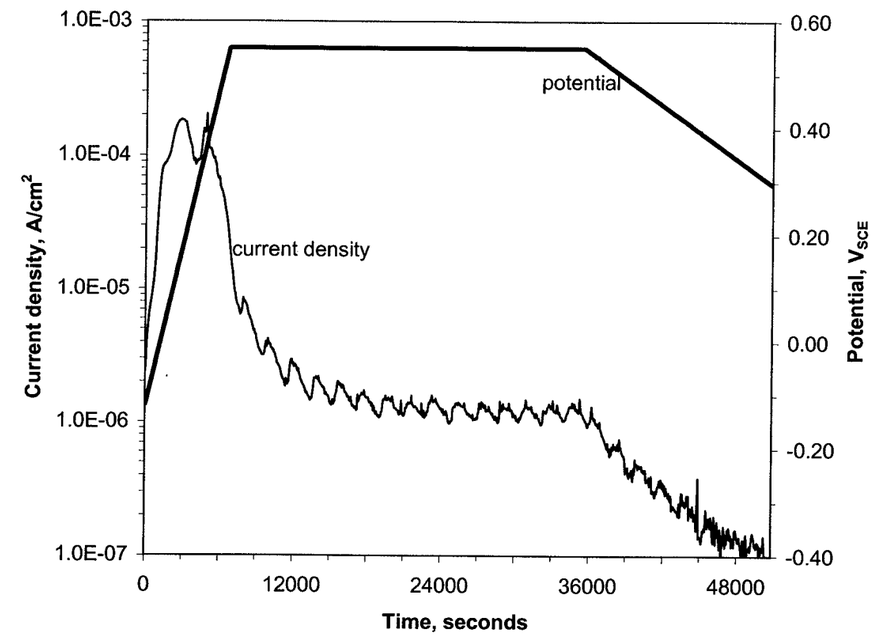
**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

Surface staining. Specimen will polish for future use.

Xihua He 10/11/04

* Drawing # 20.01402.57.006. X.H 11/7/05






C22r279
C-22 heat 2277-3-3266, thermally aged

4 M $MgCl_2$, 0.2 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0.05
80°C
Forward sweep rate 0.1 mV/s, Potentiostatic at 550 mV for 8 hours
Reverse sweep rate 0.0167 mV/s
$i < 10^{-5}$ A/cm² at 550 $mV_{SCE}$
$i < 2X10^{-6}$ A/cm² at 550 $mV_{SCE}$
$i < 10^{-6}$ A/cm² at 534 $mV_{SCE}$

X.H 10/11/04

Xihua He 10/11/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# ~~16~~ 64 NB# 672) 2277-3-3266
X.H 10/11/04 *

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 09/03/04 **SN:** 1001200319 **Due:** 03/03/05

**Initial Weight:** 41.13676 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 41.14052 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.2M $Mg(NO_3)_2$

Same solution as test C22r279 (Page 76)

**Reagents measured with** **Model:** OHAUS **Cal:** 7/15/04 **SN:** 2883 **Due:** 1/15/05

**Initial pH:** 2.65 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 5.74 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** C96-816 **Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** -170.4 **Model:** Keithley 614 **SN:** 0704934
**Ept:** -337.5 **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r280

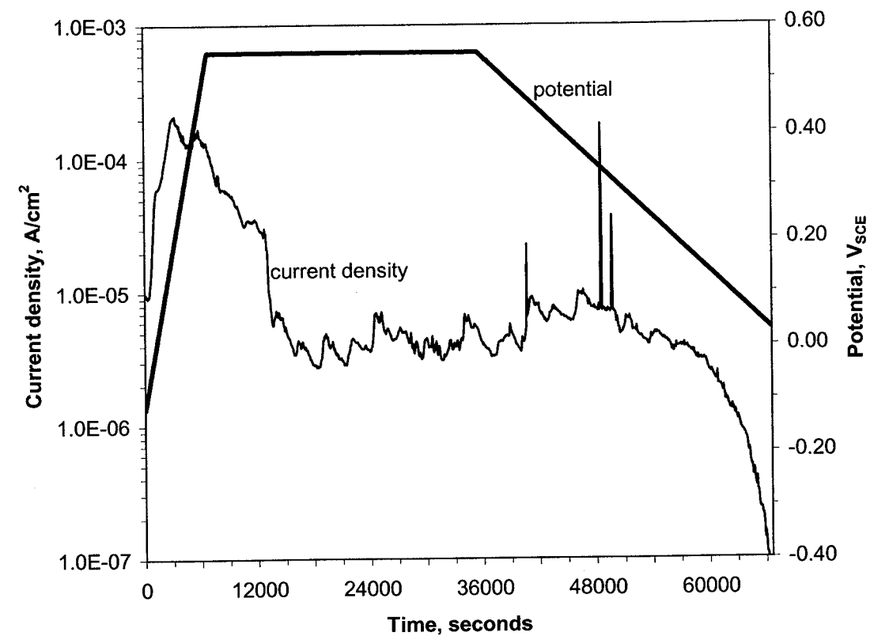
**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

Surface staining. Specimen will polish for future use.

Xihua He 10/11/04

* Drawing # 20.01402.571.006.
X.H 11/7/05






C22r280
C-22 heat 2277-3-3266, thermally aged

4 M $MgCl_2$, 0.2 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0.05
80°C
Forward sweep rate 0.1 mV/s, Potentiostatic at 550 mV for 8 hours
Reverse sweep rate 0.0167 mV/s
X.H 10/11/04
$i < 10^{-5}$ A/cm² at 550 $mV_{SCE}$
$i < 2X10^{-6}$ A/cm² at 123.3 $mV_{SCE}$
$i < 10^{-6}$ A/cm² at 86.1 $mV_{SCE}$

Xihua He 10/11/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 64 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 09/03/04 **SN:** 1001200319 **Due:** 3/03/05

**Initial Weight:** 41.03491 g **Final Weight:** 41.03270 g **Model:** Sartorius Genius **CAL:** 05/14/04 **SN:** 12809099 **Due:** 11/14/04

**Solution:** 4 M $MgCl_2$ + 0.16 M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ Lot # 042821
102.56 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot # 037544
} + DI water to 2.5L

**Reagents measured with** **Model:** OHAUS **Cal:** 7/15/04 **SN:** 2883 **Due:** 1/15/05

**Initial pH:** 3.903 **Final pH:** 5.227 **Model:** Orion EA 940 **Cal:** 7/21/04 **pH Probe:** #13-620-296 **SN:**2330 **Due:** 7/21/05 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** E98-191 **Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −93.17 mV **Ept:** 376.2 mV **Model:** Keithley 614 **Cal:** 7/12/04 **SN:** 0704934 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r281

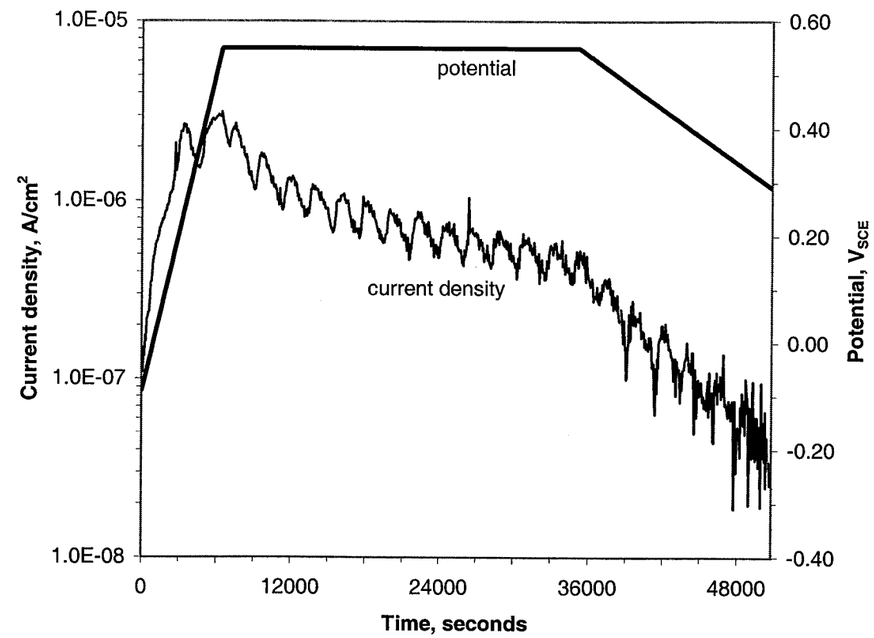
**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

No corrosion no staining.

Xihua He 10/18/04

* Drawing # 20.01402.571.006. X.H 11/7/05






C22r281
C-22 heat 2277-3-3266, thermally aged

4 M $MgCl_2$, 0.16 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0.04
80°C
Forward sweep rate 0.1 mV/s, Potentiostatic at 550 mV for 8 hours
Reverse sweep rate 0.0167 mV/s
$i < 10^{-5}$ A/cm² at 550 $mV_{SCE}$
$i < 2X10^{-6}$ A/cm² at 550 $mV_{SCE}$
$i < 10^{-6}$ A/cm² at 550 $mV_{SCE}$

X.H 10/19/04

Xihua He 10/19/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg#64 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 09/03/04 **SN:** 1001200319 **Due:** 03/03/05

**Initial Weight:** 40.58772 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.58676 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:**
4M $MgCl_2$ + 0.16M $Mg(NO_3)_2$

Same solution as Test C22r281

**Reagents measured with** **Model:** OHAUS **Cal:** 7/15/04 **SN:** 2883 **Due:** 1/15/05

**Initial pH:** 3.903 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 5.248 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** C96-816 **Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −95.12 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +387.5 mV **Cal:** 7/12/04 **Due:** 7/12/05
**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r282

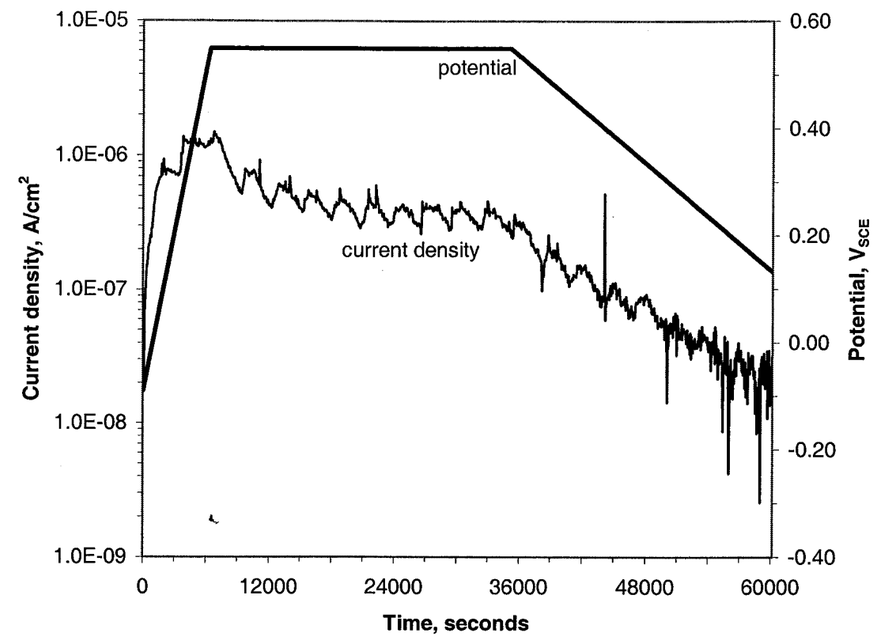
**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)

No corrosion. No staining

Xihua He 10/18/04

* Drawing # 20.01402.571.006. XH 11/7/05






C22r282
C-22 heat 2277-3-3266, thermally aged

4 M $MgCl_2$, 0.16 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0.04
80°C
Forward sweep rate 0.1 mV/s, Potentiostatic at 550 mV for 8 hours
Reverse sweep rate 0.0167 mV/s
$i < 10^{-5}$ A/cm² at 550 $mV_{SCE}$
$i < 2X10^{-6}$ A/cm² at 550 $mV_{SCE}$
$i < 10^{-6}$ A/cm² at 550 $mV_{SCE}$

XH 10/19/04

Xihua He 10/19/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 65 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 3/03/05

**Initial Weight:** 40.80204 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.80192 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 4M $MgCl_2$ + 0.08M $Mg(NO_3)_2$
2033.1 g $MgCl_2 \cdot 6H_2O$ Lot #042821 } + DI water to 2.5L
51.28 g $Mg(NO_3)_2 6H_2O$ Lot # 037504

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** 2.87 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 5.59 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** E98-191
**Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 4028023P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** -153.2 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** 368.2 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r283

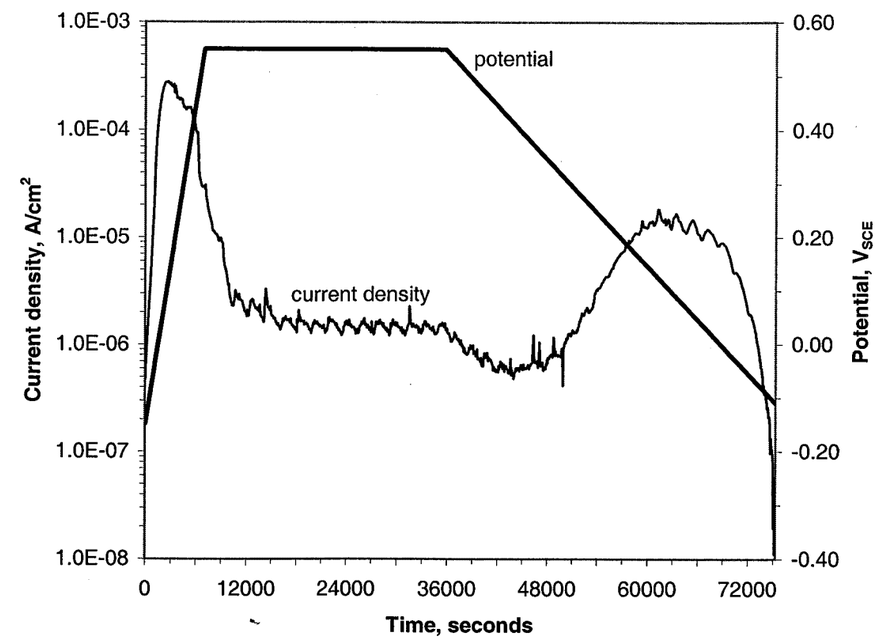
**Number of Crevice Corrosion Sites:** 8 /24 (24 max.)

Corrosion in creviced area and bolt hole.

Xihua He 10/19/2004

* Drawing # 20.01402.571.006. X.H 11/2/05






C22r283
C-22 heat 2277-3-3266, thermally aged

4 M $MgCl_2$, 0.08 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0.02
80°C
Forward sweep rate 0.1 mV/s, Potentiostatic at 550 mV for 8 hours
Reverse sweep rate 0.0167 mV/s
$i < 10^{-5}$ A/cm² at 13.7 $mV_{SCE}$
$i < 2X10^{-6}$ A/cm² at -54.2 $mV_{SCE}$
$i < 10^{-6}$ A/cm² at -73.3 $mV_{SCE}$

X.H 10/21/04

Xihua He 10/21/04

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 65 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 09/03/04 **SN:** 1001200319 **Due:** 03/03/05

**Initial Weight:** 40.92497g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.92482g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:**
4M $MgCl_2$ + 0.08 M $Mg(NO_3)_2$

Same solution as test C22r283 (page 82)

**Reagents measured with** **Model:** OHAUS **Cal:** 7/15/04 **SN:** 2883 **Due:** 1/15/05

**Initial pH:** 2.87 **Model:** Orion EA 940 **SN:**2330
**Final pH:** 5.80 **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 80°C **Measured with Hg Thermometer SN:** C96-816 **Cal:** 06/09/04 **Due:** 12/09/04

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** -141.5 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** 360.9 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 10120

**DATA FILE:** C22r284

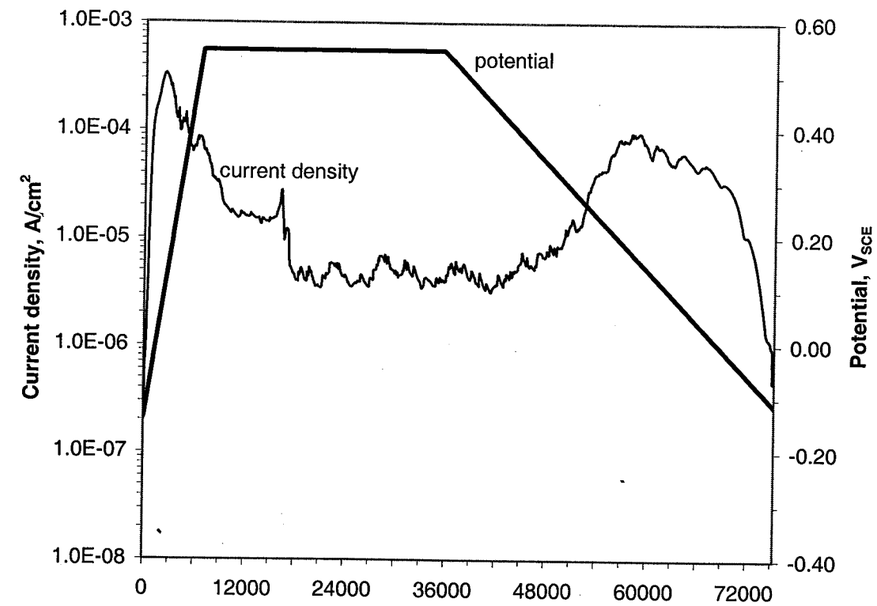
**Number of Crevice Corrosion Sites:** 22 /24 (24 max.)

Corrosion in crevicked area and bitt hole.

Xihua He 10/19/2004

* Drawing # 20.01402.571.006.
X.H 11/7/05






C22r284
C-22 heat 2277-3-3266, thermally aged

4 M $MgCl_2$, 0.08 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0.02
80°C
Forward sweep rate 0.1 mV/s, Potentiostatic at 550 mV for 8 hours
Reverse sweep rate 0.0167 mV/s
$i < 10^{-5}$ A/cm² at -60.3 $mV_{SCE}$
$i < 2X10^{-6}$ A/cm² at -89.2 $mV_{SCE}$
$i < 10^{-6}$ A/cm² at -104.2 $mV_{SCE}$

X.H 10/21/04

Xihua He 10/21/04

## Repassivation Potential Test

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg#65 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **Cal:** 09/03/04 **SN:** 1001200319 **Due:** 03/03/05

**Initial Weight:** 40.57014 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.30861 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 6M $MgCl_2$

732 g $MgCl_2 \cdot 6H_2O$ in 600 ml solution
Lot # 042821

**Reagents measured with** **Model:** OHAUS **Cal:** 7/15/04 **SN:** 2883 **Due:** 1/15/05

**Initial pH:** not taken, solution is hot **Model:** Orion EA 940 **SN:**2330
**Final pH:** Everything is solid at room temperature. **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 130°C **Measured with RTD** SN# 324 Cal 9/13/04 Due 9/13/05

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** -0.229 V **Model:** Keithley 614 **SN:** 0704934
**Ept:** 159.6 mV **Cal:** 7/12/04 **Due:** 7/12/05
**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r285

X.H 12/2/2004

**Number of Crevice Corrosion Sites:** 0 ~~24~~ /24 (24 max.)

Severe general corrosion and pitting corrosion outside of creviced area. All the edges of creviced teeth are corroded.

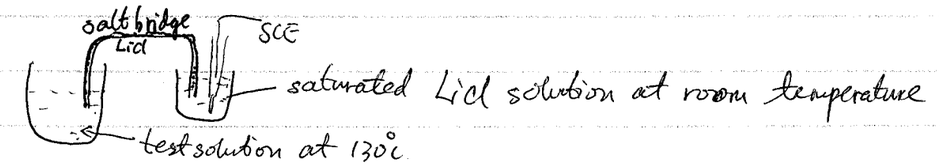
* Drawing # 20.01402.571.006 X.H 11/7/05

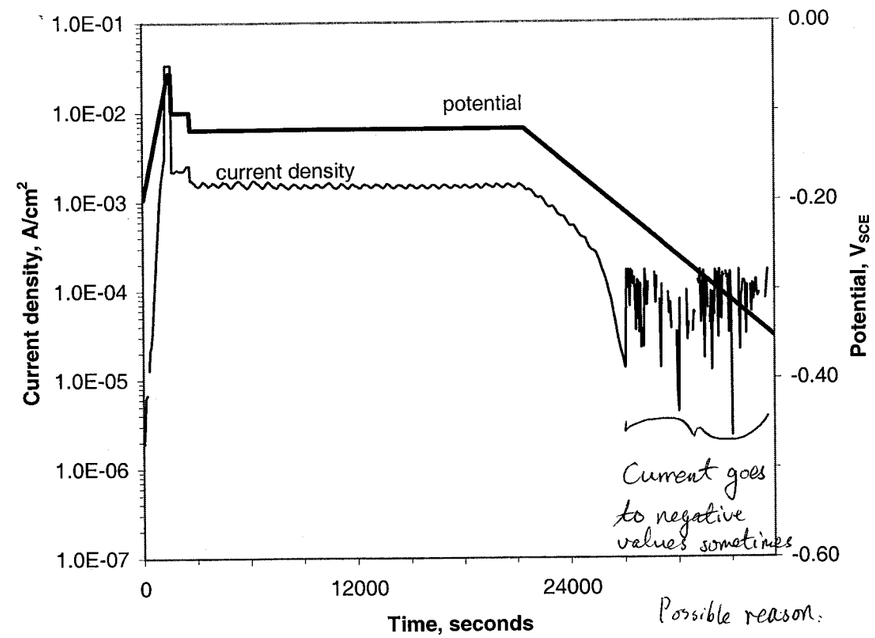
Xihua He 12/2/2004



A salt bridge was ~~made~~ used in the test

X.H 12/6/2004




Possible reason: Zirconia frit is corroded because solution is very aggressive

C22r285
C-22 heat 2277-3-3266, thermally aged

6 M $MgCl_2$, 0 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0
130°C
Forward sweep rate 0.1 mV/s, Potentiostatic at -100 mV for 5 hours
Reverse sweep rate 0.0167 mV/s
$i = 1.32 \times 10^{-5}$ A/cm² at E < -211.8 $mV_{SCE}$

Xihua He 12/6/2004

Test results are invalid. See NCR 2005-06 for additional information, page # 102.

X.H 4/21/2005 X.H 11/7/05

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 thermally aged 5 min. at 870C ( see pg# 65 NB# 672) 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 03/03/05

**Initial Weight:** 40.81539 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.80535 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 6 M $MgCl_2$ , 2.1 M $Mg(NO_3)_2$
732 g $MgCl_2 \cdot 6H_2O$ lot # 042821 } heat up to 600 ml
323 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot #037544

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** } not taken. **Model:** Orion EA 940 **SN:**2330
**Final pH:** solution is hot **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 130°C **Measured with Thermocouple SN:** 329
**Cal:** 07/23/04 **Due:** 01/23/05

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** 134.0 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** 530.9 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 101120

**DATA FILE:** C22r288

**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)
**Specimen examination:**

No crevice corrosion. But there are black marks on all the surfaces

Solution turns to yellowish after the test.

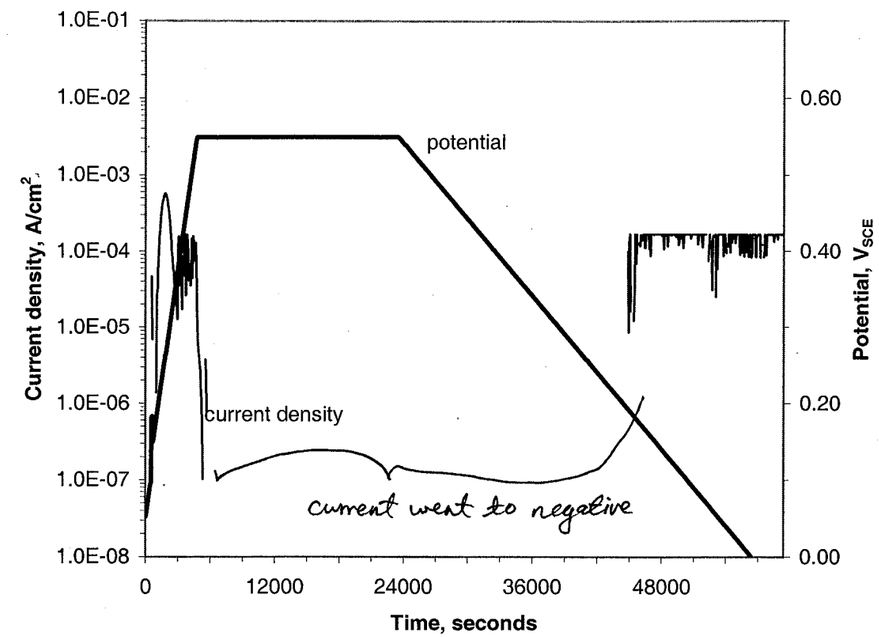
Xihua He 12/3/2004

* Drawing # 20.01402.571.006. X.H 11/7/05



Experiment: a vicor® frit was used. The potential was not stable.

Possible reason: solution is aggressive and corroded the glass frit




C22r288
C-22 heat 2277-3-3266, thermally aged

6 M $MgCl_2$, 2.1 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0.35
130°C
Forward sweep rate 0.1 mV/s, Potentiostatic at 550 mV for 5 hours
Reverse sweep rate 0.0167 mV/s

Xihua He 12/3/2004

Test results are invalid. See NCR 2005-06 for additional information. page #102, this notebook

X.H 4/21/2005

X.H 11/7/05

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 mill annealed, Heat #: 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319 **Cal:** 09/03/04 **Due:** 03/03/05

**Initial Weight:** 41.44272g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 41.22969 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:**
6M $MgCl_2$
732 g $MgCl_2 \cdot 6H_2O$ Lot # 042821 + DI water → to 600 ml
heat up to dissolve

**Reagents measured with** **Model:** OHAUS **SN:** 2883 **Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** } not taken **Model:** Orion EA 940 **SN:**2330
**Final pH:** **Cal:** 7/21/04 **Due:** 7/21/05
solution is hot **pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 130°C **Measured with Thermocouple SN:** 329 **Cal:** 07/23/04 **Due:** 01/23/05

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −415.0 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +350.0 mV **Cal:** 7/12/04 **Due:** 7/12/05
**Potentiostat:** EG&G Model 273 **SN:** 101120

**DATA FILE:** C22r293

**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)
**Specimen examination:**

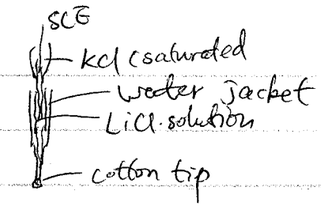
The corrosion is not in the crevided area. Specimen lost its passivity. Severe general corrosion on all surfaces and around the edge of the specimen.

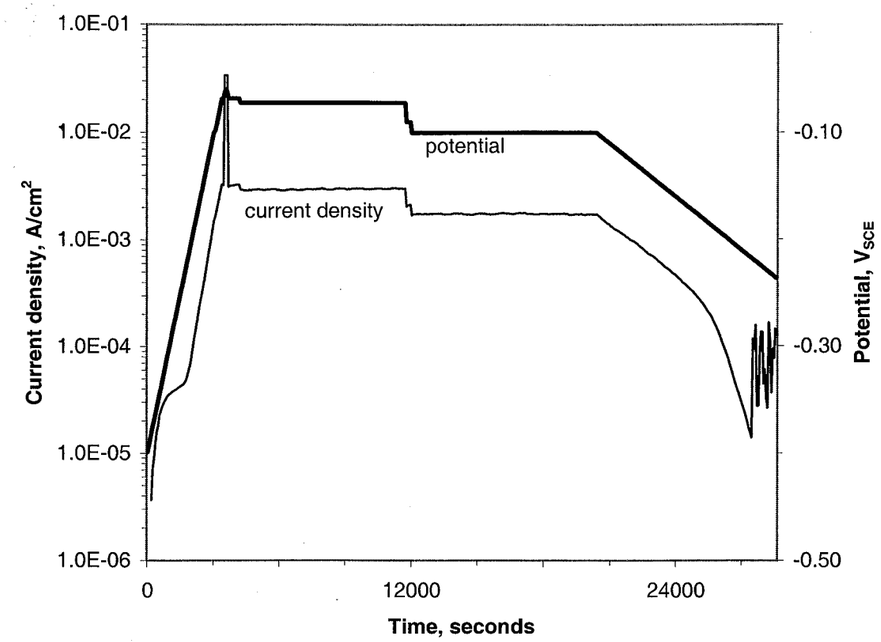
Xihua He 12/6/2003

* Drawing # 20.01(402.571.006. X.H 11/7/05



Salt bridge:




C22r293
C-22 heat 2277-3-3266, mill annealed

6 M $MgCl_2$, 0 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0
130°C
Forward sweep rate 0.1 mV/s, Potentiostatic at -72mV and -100 mV for 2 hours each
Reverse sweep rate 0.0167 mV/s

I = 1.39 X $10^{-5}$ at -218 mV

Xihua He 12/7/2003

Test results are invalid. See NCR 2005-06 for additional information.
X.H 4/21/2005 page 102, this notebook.
X.H 11/7/05

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 mill annealed, Heat #: 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 03/03/05

**Initial Weight:** 41.1625 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.84285 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** 6M $MgCl_2$

732 g $MgCl_2 \cdot 6H_2O$ Lot # 042821 + DI water → to 600ml heat up to dissolve

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** } not taken, solution is hot **Model:** Orion EA 940 **SN:**2330
**Final pH:** **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 130°C **Measured with Thermocouple SN:** 329
**Cal:** 07/23/04 **Due:** 01/23/05

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −286.8 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** 362.0 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 101120

**DATA FILE:** C22r294

**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)
**Specimen examination:**

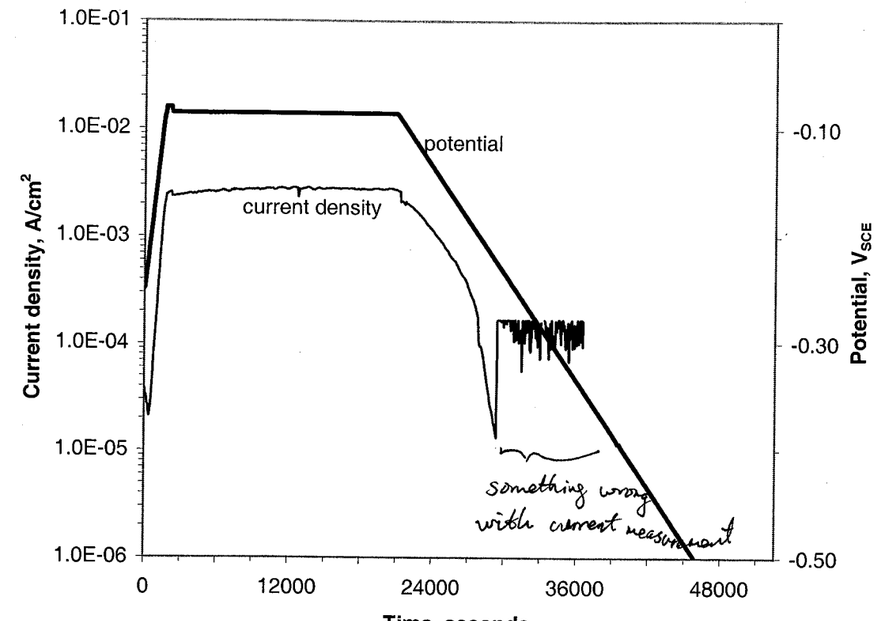
The corrosion is not ~~on~~ in the crevied area. Specimen lost its passivity. Severe general corrosion on all surfaces and around the edge of the crevied area.

*Drawing # 20.01402.571.006. X.H 11/7/05

Xihua He 12/7/2006



Vicor glass as frit material




C22r294
C-22 heat 2277-3-3266, mill annealed

6 M $MgCl_2$, 0 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0
130°C
Forward sweep rate 0.1 mV/s, Potentiostatic at -85mV for 5 hours
Reverse sweep rate 0.0167 mV/s

I = 1.35 X $10^{-5}$ at -224.5 mV

Test results are invalid. See NCR 2005-06 for additional information. X.H 4/21/05
see page # 102, this notebook.
X.H 11/7/05

Xihua He 12/9/2006

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 mill annealed, Heat #: 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing. ** Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

** Drawing # 20.01402.5 X.006. X.H 11/7/05

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319 **Cal:** 09/03/04 **Due:** 03/03/05

**Initial Weight:** 41.15671 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 41.12196 g **CAL:** 05/14/04 **Due:** 11/14/04

**Solution:** ~~X.H~~ 6 M $MgCl_2$ + 0.9 M $Mg(NO_3)_2$
X.H 12/14/04
732 g $MgCl_2 \cdot 6H_2O$ ← X.H 12/14/04
138.5 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot # 042821 } + DI water Heat up → 600 mL
Lot # 093754

**Reagents measured with** **Model:** OHAUS **SN:** 2883 **Cal:** 7/15/04 **Due:** 1/15/05

**Initial pH:** } not taken, solution is hot **Model:** Orion EA 940 **SN:**2330
**Final pH:** **Cal:** 7/21/04 **Due:** 7/21/05
**pH Probe:** #13-620-296 **SN:** 4079126P

**Test Temperature:** 130°C **Measured with Thermocouple SN:** 329 **Cal:** 07/23/04 **Due:** 01/23/05

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 3329075P

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −353.4 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** 506.8 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 101120

**DATA FILE:** C22r302

**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)
**Specimen examination:**

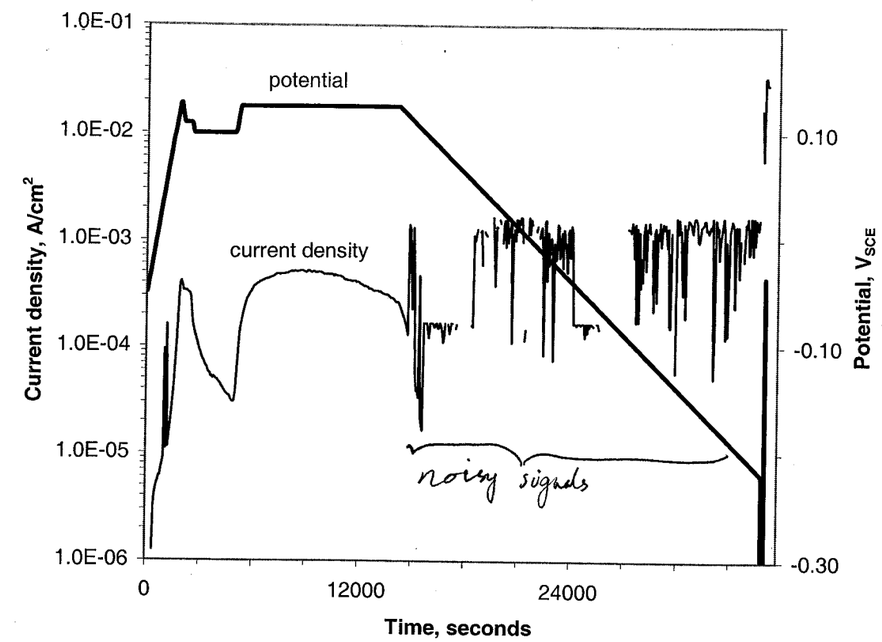
No localized corrosion in the crevice area. Pitting corrosion and general corrosion outside of the crevice area. The corroded area appears black.

* will Repolish for further Testing

Xihua He 12/14/04
X.H 4/2/05



Vicor glass as frit material




C22r302
C-22 heat 2277-3-3266, mill annealed

6 M $MgCl_2$, 0.9 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0.15
130°C
Forward sweep rate 0.1 mV/s, Potentiostatic at 125 mV for 3 hours
Reverse sweep rate 0.0167 mV/s

Possible reason for noisy signals:

1. Frit is corroded
2. Frit is clogged

Xihua He 12/14/04 X.H 4/2/05

Test results are invalid. See NCR 2005-06 for additional information.
See page #102, this notebook. X.H 4/2/05

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 mill annealed, Heat #: 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.* Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 03/03/05

**Initial Weight:** 40.06096 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 40.03389 g **CAL:** 11/10/04 **Due:** 05/10/05

**Solution:** 5 M $MgCl_2 \cdot 6H_2O$ + 1 M $Mg(NO_3)_2$
610 g $MgCl_2 \cdot 6H_2O$ Lt # 042821
153.8 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot # 037544
} + $H_2O$ heat up to dissolve to form 600 ml solution

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 1/14/05 **Due:** 7/14/05

**Initial pH:**
**Final pH:** } not measured, because solution is hot

**Test Temperature:** 125°C **Measured with Thermocouple SN:** 326
**Cal:** 07/23/04 **Due:** 01/23/05

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 8131148

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** 105.1 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** 503.7 mV **Cal:** 7/12/04 **Due:** 7/12/05

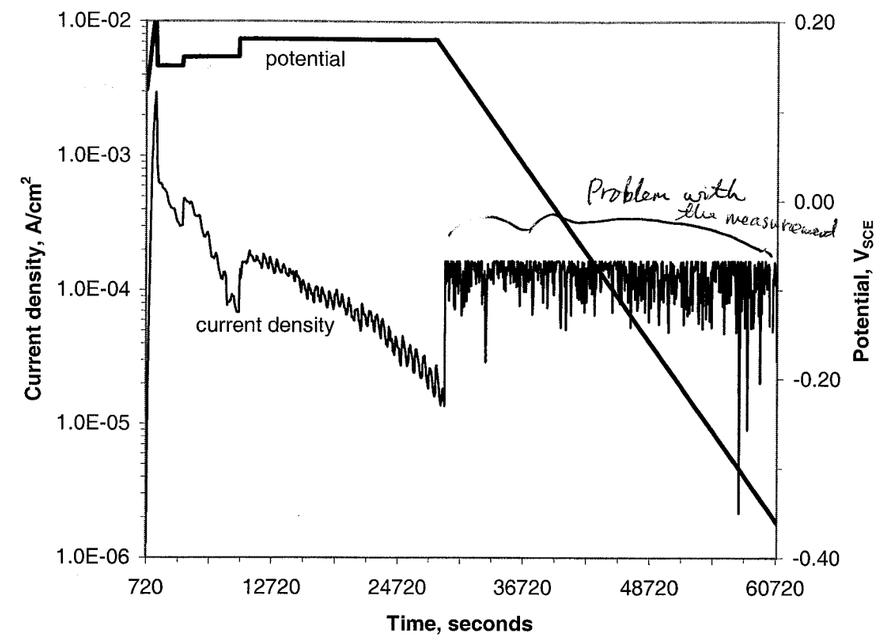
**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r305

**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)
**Specimen examination:**
Pitting corrosion and general corrosion outside of the creviced area

* CNWRA Drawing # 20.01402.571.006. X.H 11/7/05
Xihua He 1/18/05






C22r305
C-22 heat 2277-3-3266, mill annealed

6 M $MgCl_2$, 1 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0.2
125°C
Forward sweep rate 0.1 mV/s, Potentiostatic at 180 mV for 3 hours
Reverse sweep rate 0.0167 mV/s

Xihua He 1/21/05

Test results are invalid. See NCR 2005-06 for additional information.
X.H 4/21/05 See page #102 this notebook.
X.H 11/7/05

**Repassivation Potential Test**

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 mill annealed, Heat #: 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing.** Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torque to 50 in-oz.

** Drawing # 20.01402.571.006. X.H 1/7/05

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 03/03/05

**Initial Weight:** 41.19449 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 41.19222 g **CAL:** 11/10/04 **Due:** 05/10/05

**Solution:** 5M $MgCl_2$ + 1.5 M $Mg(NO_3)_2$
610 g $MgCl_2 \cdot 6H_2O$ · Lot # 042821 } + $H_2O$ Heat up to
230.8 g $Mg(NO_3)_2$ Lot # 037544 dissolve to form Gas solution

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 1/14/05 **Due:** 7/14/05

**Initial pH:**
**Final pH:** } not measured. Because solution is hot

**Test Temperature:** 1220C **Measured with Thermocouple SN:** 326
**Cal:** 07/23/04 **Due:** 01/23/05

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 8131148

**Gas:** 99.999% Nitrogen Gas

**Ecorr:** −224 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +507.3 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** SI1287 **SN:** 00148500

**DATA FILE:** ~~C22*~~ C22pot
X.H 1/19/2005

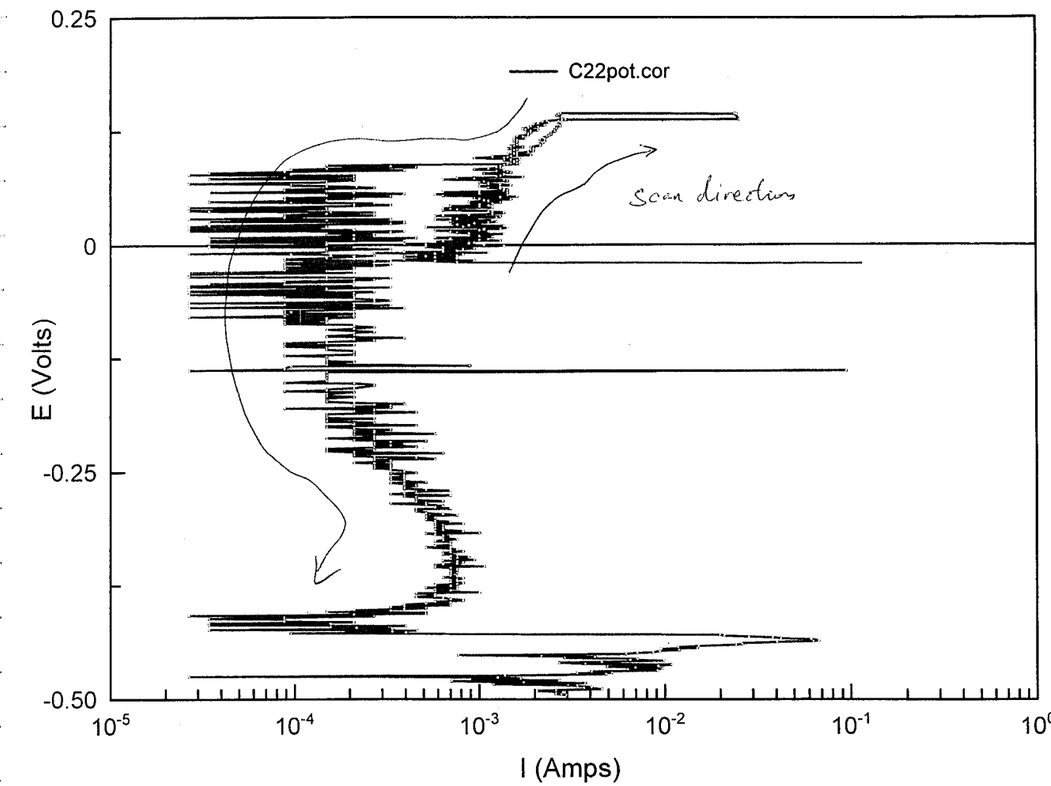
**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)
**Specimen examination:**

minor etching outside of the creviced area

* will Repolish for Further Testing
1/20/05

Xihua He 1/19/2005






Mostly the data is noise. Possible problem: bad reference electrode

Test results are invalid. See NCR 2005-06 for additional information. NCR is on Page # 102, this notebook. X.H 4/21/05

Xihua He 1/20/2005

## Repassivation Potential Test

**Objective:** same as pg #1 and #2

**Alloy/Specimen:** C22 mill annealed, Heat #: 2277-3-3266

**Specimen Preparation:** Specimen machined to dimensions specified in CNWRA Drawing*. Specimen surfaces polished to 600 Grit finish using SiC paper. Specimen cleaned in acetone and rinsed in DI water. PTFE crevice forming washers attached to specimen using insulated C-276 hardware. Hardware Torgue to 50 in-oz.

**Torque Screwdriver:** Snap-on USA **SN:** 1001200319
**Cal:** 09/03/04 **Due:** 03/03/05

**Initial Weight:** 41.19027 g **Model:** Sartorius Genius **SN:** 12809099
**Final Weight:** 41.11658 g **CAL:** 11/10/04 **Due:** 05/10/05

**Solution:** 5M $MgCl_2$ + 0.75M $Mg(NO_3)_2$
610 g $MgCl_2 \cdot 6H_2O$ Lot # 042821 } + $H_2O$ to 600ml
115 g $Mg(NO_3)_2 \cdot 6H_2O$ Lot # 037544

**Reagents measured with** **Model:** OHAUS **SN:** 2883
**Cal:** 1/14/05 **Due:** 7/14/05

**Initial pH:** } not taken, solution is concentrated and hot
**Final pH:**

**Test Temperature:** 122 C **Measured with Thermocouple SN:** 326
**Cal:** 07/23/04 **Due:** 01/23/05

**Counter Electrode:** Platinum Flag

**Reference Electrode:** Fisher 13-620-52 **SN:** 8131148

**Gas:** 99.999% Nitrogen Gas

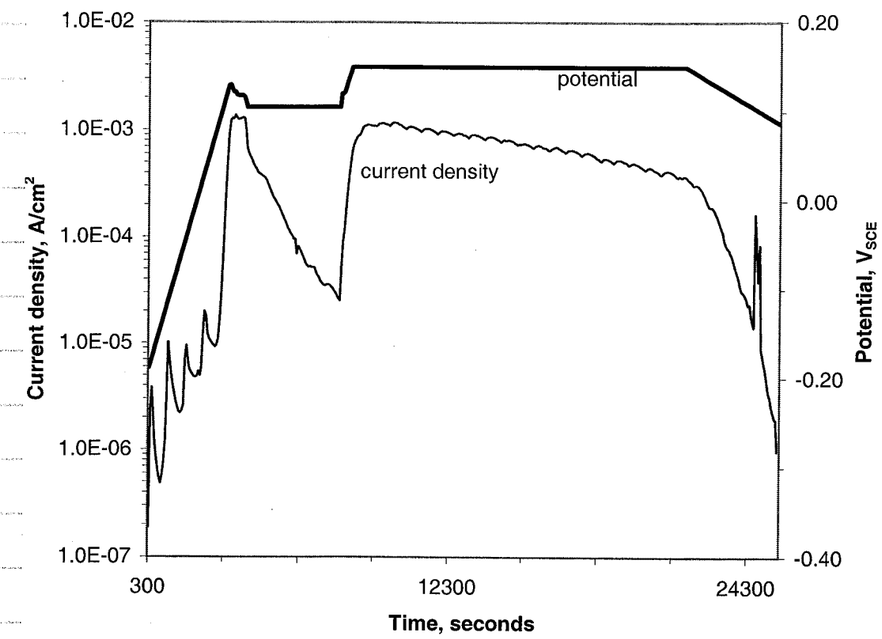
**Ecorr:** -195 mV **Model:** Keithley 614 **SN:** 0704934
**Ept:** +571.8 mV **Cal:** 7/12/04 **Due:** 7/12/05

**Potentiostat:** EG&G Model 273 **SN:** 41108

**DATA FILE:** C22r313

**Number of Crevice Corrosion Sites:** 0 /24 (24 max.)
**Specimen examination:**
Severe corrosion outside of the creviced area. The area in the crevice is protected.
* Drawing # 20.01402.571.006. X.H 11/7/05
Xihua He 1/20/2005






C22r313
C-22 heat 2277-3-3266, mill annealed

5 M $MgCl_2$, 0.75 M $Mg(NO_3)_2$, $[NO_3^-]/[Cl^-]$ =0.15
122°C
Forward sweep rate 0.1 mV/s, Potentiostatic at 150 mV for 3 hours
Reverse sweep rate 0.0167 mV/s
$i<10^{-5}$ at 99.4 mV
$i<2X10^{-6}$ at 90.3 mV
$i<10^{-6}$ at 88.3 mV

Xihua He 1/24/05

Test results are invalid. See NCR 2005-06 for additional information. NCR is on page #102 this notebook. X.H 11/7/05 X.H 4/21/05

# CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

## NONCONFORMANCE REPORT

**Project No.** 20.06002.01.322 **NCR No.** 2005-06

**PART 1: DESCRIPTION OF NONCONFORMANCE:**
The current measuring resistors used with two potentiostats were damaged from a current overload condition. Damage to the current measuring resistors results in significant errors in current measurements.

**Initiated by:** Darrell S. Dunn **Date:** 3/24/2005

**PART 2: PROPOSED DISPOSITION AND CORRECTIVE ACTION**

**Disposition:**
A total of 8 tests documented in Scientific Notebook 672 are affected by the out of tolerance condition.

**Basis of Disposition:**
Data obtained with the affected instruments was reviewed. A performance verification was conducted on 7/15/04 and is documented in Scientific Notebook 308. Results of tests conducted through 10/21/04 are consistent with previous tests under using similar material and test conditions. Data obtained in tests conducted after 10/21/04 is erratic. The unusual character of these results was documented in Scientific Notebook 672 at the time of the tests.

**Action to Correct Nonconformance:**
The current measuring resistors were replaced and checked with a calibrated multimeter (Model Fluke 87III, Serial Number 73980497, Asset Number 007646, Calibrated 1/17/05, Calibration Due: 1/17/06). Performance verifications (TOP-022) were conducted and documented in Scientific Notebook 308.

A notation will be included on each entry in Scientific Notebook 672 to indicate that the data is invalid. Each entry will reference NCR 2005-06. Data from these tests will not be used in any analyses or model.

Darrell S. Dunn He **Target date for completion:** 4/11/2005

**Proposed by:** Darrell S. Dunn and Xihua He **Date:** 3/25/2005

**PART 3: APPROVAL**

**Element Manager:** [signature] **Date:** 3/25/2005

**Director of QA:** [signature] **Date:** 3/28/2005

**Comments/Instructions:**

**PART 4: CLOSE OUT**

**Comments:** Notations have been placed in Scientific Notebook 672 on each of the 8 tests performed after Oct. 21, 2004. Each notation references this nonconformance report and indicates the data is not to be used.

**Verified by:** [signature] **Date:** 4/28/05

**Distribution:**

CNWRA FORM QAP 9-1

X. Hua He 11/1/05



I have reviewed this scientific notebook and find it in compliance with QAP-001. There is sufficient information regarding procedures used for conducting tests, acquiring and analyzing data so that another qualified individual could repeat the activity.

[signature] 11/07/05