EFFECTS OF CHEMISTRY AND OTHER VARIABLES ON CORROSION AND STRESS CORROSION CRACKING IN HANFORD DOUBLE-SHELL TANKS

Feng Gui, Colin Scott and Sean Brossia CC Technologies, Inc. for CH2M HILL Hanford Group, Inc. Richland, WA 99352 U.S. Department of Energy Contract DE-AC27-99RL14047

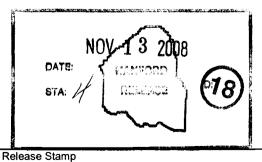
EDT/ECN: DRF Cost Center: B&R Code: UC: Charge Code: Total Pages:

B&R Code: Total Pages: علم المرابي العلم المحلم ال

Abstract: Laboratory testing was performed to develop a comprehensive understanding of the corrosivity of the tank wastes stored in Double-Shell Tanks using simulants primarily from Tanks 241-AP-105, 241-SY-103 and 241-AW-105. Additional tests were conducted using simulants of the waste stored in 241-AZ-102, 241-SY-101, 241-AN-107, and 241-AY-101. This test program placed particular emphasis on defining the range of tank waste chemistries that do not induce the onset of localized forms of corrosion, particularly pitting and stress corrosion cracking. This document summarizes the key findings of the research program.

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

Printed in the United States of America. To obtain copies of this document, contact: Document Control Services, P.O. Box 950, Mailstop H6-08, Richland WA 99352, Phone (509) 372-2420; Fax (509) 376-4989.



Approved For Public Release

EFFECTS OF CHEMISTRY AND OTHER VARIABLES ON CORROSION AND STRESS CORROSION CRACKING IN HANFORD DOUBLE-SHELL TANKS

September 2008

prepared by

CC Technologies, Inc. – A DNV Company 5777 Frantz Road Dublin, Ohio 43017-1386

prepared for

CH2M HILL Hanford Group, Inc.

EXECUTIVE SUMMARY

The Hanford reservation contains approximately 50-million gallons of liquid legacy radioactive waste from cold war weapons production that is stored in 177 underground storage tanks. Current plans call for vitrification of the waste and final disposal in a geologic repository at Yucca Mountain. The double-shelled carbon steel tanks presently used for storage will continue in operation until a vitrification plant is constructed and waste processing operations are completed. Due to various chemical reactions taking place inside the tanks, the waste chemistries will tend to change over time. Although the changes occur slowly, the waste compositions will be altered because of the current estimate for storage of waste, which goes beyond 2035.

In addition, the present chemistries for some of the tank waste types are no longer in specification with respect to corrosion mitigation (e.g., maintaining pH levels above 12). Thus, there is concern within the U.S. Department of Energy (DOE), oversight groups, and regulatory bodies that tank integrity may have been or may become compromised given these changes in chemistry. Furthermore, if tank integrity is potentially compromised, there is a need to define mitigation strategies. Additional resources would be required to mitigate potential leaks and conduct repairs. The objective of this work was to finalize the range of conditions where the tank steel is susceptible to localized corrosion and stress corrosion cracking (SCC) in the Double-Shell Tanks (DSTs) using primarily simulants of wastes stored in various tanks, in particular Tanks 241-AP-105, 241-SY-103 and 241-AW-105. The chemistries in these tanks cover a broad range of waste chemistries in the tank farm including low nitrate concentration wastes, low nitrite to nitrate ratio wastes, and wastes containing high halide concentrations. These tanks were specifically selected because they provide bounding compositions of aggressive ions. In addition, testing was conducted in simulants of wastes from Tank 241-AZ-102 and 241-SY-101 to test the impact of specific aggressive ions. Tank 241-AN-107 and Tank 241-AY-101 simulants were tested to complement results from previous corrosion studies with respect to carbonate SCC and pH impact on corrosion susceptibility, respectively. The work involved a series of cyclic potentiodynamic polarization (CPP), slow strain rate tests (SSRTs) and crack growth rate (CGR) tests in the waste simulants on a plate of American Association of Railways Tank Car (AAR TC) 128 Grade B steel, which is believed to have similar properties to the waste tanks.

Based on the work conducted, the key findings of the research are listed below.

- The SCC potency of the waste simulants for the three tanks studied followed the trends previously established for nitrate-based simulants. SCC only occurred at relatively high applied potentials (e.g., 0 mV vs. SCE) or at low nitrite/nitrate concentrations ratios.
- Limited CGR testing performed in AY-101 simulants indicated that stress intensity factors above 45 ksi√in were necessary for crack propagation to occur in the waste simulants tested.
- Though at current tank conditions the Present Supernate Composition (PSC) simulant for tank 241-AP-105 (AP-105-PSC) showed a low propensity for corrosion, the tank steel exposed to the Tank AP-105-PSC simulant at elevated temperatures and under anodically

polarizing conditions demonstrated a susceptibility to SCC and localized corrosion at the liquid/vapor interface. Long-term immersion tests indicated that the steel was susceptible to corrosion at the liquid/vapor interface even at open circuit potential (OCP), but the extent at room temperature was not as severe as at elevated temperatures (e.g., 50°C). The AP-105-PSC is the only simulant in which SCC was observed in a SSRT performed at OCP. Local chemistry changes (nitrite depletion or pH drop) may be responsible for the interfacial attack, though the precise mechanism is unclear at this time. The liquid/vapor interface attack indicates that localized corrosion is possible in simulants with high pH, and this should be considered in any future corrosion mitigation strategies.

- The Present Interstitial Liquid (PIL) for Tank 241-SY-103 (SY-103-PIL) simulant, which has the upper limit of chloride concentration of the DSTs, appears to be benign with respect to corrosion and SCC relative to the AP-105-PSC and previously tested Tank 241-AN-107 simulants and the PIL for Tank 241-AY-102 (AY-102PIL) simulant. Any possible corrosion liability associated with the high chloride content, appears to be offset by the relatively high nitrite content.
- The PIL for Tank 241-AW-105 (AW-105-PIL) simulant, which has the upper limit of fluoride concentration, also appears to be benign with respect to tank steel SCC. However, some localized corrosion has been observed at the liquid/vapor interface.
- The AZ-102 simulant, tested at the higher temperature of 77°C, appears to be benign with respect to SCC, confirming the inhibitory nature of nitrite. The AZ-102 simulant has a high nitrite/nitrate ratio of 8.4.

TABLE OF CONTENTS

1.0	INTE	RODUCTION AND BACKGROUND11	l
2.0	EXP	ERIMENTAL APPROACH14	4
	2.1	Materials and Specimens	
	2.2	Chemicals and Solutions	7
3.0	OPE	N CIRCUIT POTENTIAL MONITORING, POTENTIOSTATIC AND	
		LIC POTENTIODYNAMIC POLARIZATION TESTING	8
	3.1	Slow Strain Rate Testing	
	3.2	KthSCC and Crack Growth Rate Testing using Compact Tension Specimens20	
4.0	RES	ULTS AND DISCUSSION	2
	4.1	Electrochemical Polarization Behavior in Tank 241-AP-105 Based	
		Simulants	
		4.1.1 Cyclic Potentiodynamic Polarization Behavior	
		4.1.2 Liquid/Vapor Interfacial Corrosion in AP-105-PSC20	6
	4.2	Slow Strain Rate Testing in Tank 241-AP-105 Based Simulants4	1
	4.3	Electrochemical Polarization Behavior in Tank 241-SY-103-PIL Based	
		Simulants48	8
	4.4	Slow Strain Rate Testing in Tank 241-SY-103-PIL Based Simulants49	9
	4.5	Electrochemical Polarization Behavior in Tank 241-AW-105 Based	
		Simulants5	
	4.6	Slow Strain Rate Testing in Tank 241-AW-105 Based Simulants53	
	4.7	Slow Strain Rate Testing in Tank 241-AN-107 Based Simulants	9
	4.8	Electrochemical Polarization Behavior in Tank 241-AZ-102 Based Simulant	
	4.9	Slow Strain Rate Testing in Tank 241-AZ-102 Based Simulant	
		Electrochemical Polarization Behavior in Tank 241-SY-101 Based Simulant	
		Slow Strain Rate Testing in Tank 241-SY-101 Based Simulant	
	4.12	Electrochemical Polarization Behavior in Tank 241-AY-101-CSL Simulant	6
		Slow Strain Rate Testing in Tank 241-AY-101-CSL Based Simulant68	8
	4.14	Dynamic-K Testing in 5M NaNO ₃ and Tank 241-AY-101-PSC Based	
		Simulant	
	4.15	General Discussion of Results	5
5.0	SUM	IMARY OF KEY FINDINGS	0

LIST OF APPENDICES

Appendix A	_	Simulant Recipes, Certificates for Chemicals and QA Documents
Appendix B		Cyclic Potentiodynamic Polarization (CPP) Testing Data
Appendix C	_	Slow Strain Rate Test Data and Micrographs
Appendix D	-	Crack Growth Rate Test Data

LIST OF FIGURES

Figure 1. Photomicrographs of (a) the Microstructure of the AAR TC 128 Grade B
Tank Car Steel Used for the Current Work and Previous AY-102 and AP101
Work, and (b) the Microstructure of the ASTM A537 Class 2 Steel used for
Previous AN-105 and AN-107 Work15
Figure 2. Engineering Drawing of the Cyclic Potentiodynamic Polarization (CPP)
Specimen (Units in Inches)
Figure 3. Engineering Drawing of the Slow Strain Rate Test Specimen (Units in
Inches)
Figure 4. Engineering Drawing of the Crack Growth Rate Specimen (Units in Inches)
Figure 5. A Photograph of One of the CGR Specimens Following Side-Grooving17
Figure 6. The CPP Curve in Nitrogen Deaerated AP-105-PSC Simulant (T= 50°C and
pH>13)
Figure 7. CPP Curves in Nitrogen Deaerated AP-105 Mixed and Evaporated Simulants
at pH 14 and 50°C
Figure 8. CPP Curves Obtained in Nitrogen Deaerated AP-105 Evaporated and Mixed
with Nitrite-to-nitrate Concentration Ratio of 0.1 (pH 12+ and T=50°C)
Figure 9. A Comparison of CPP Curves in Nitrogen Deaerated AP-105-PSC Simulant at
Different Nitrite and Nitrate Concentrations (pH=13+, T=50°C)
Figure 10. Sample Appearance after CPP Testing in AP-105-PSC Simulant under
Quiescent Air Conditions (pH=13+, T=50°C)
Figure 11. The Change in the Current as a Function of Time when the Partially
• •
Immersed Sample Was Held at 0 mV vs. SCE (AP-105-PSC, pH>13, T=50°C, Ouiescent Air Conditions)
Figure 12. The Sample Appearance after 50 Hours of Potentiostatic Testing at 0 mV
vs. SCE in the AP-105-PSC Simulant (pH>13, T=50°C, Quiescent Air
Conditions)
Figure 13. Current as a Function of Time for Fully Immersed Sample Polarized at 0 mV
vs. SCE in AP-105-PSC Simulant (T=50°C, pH>13) Under Quiescent Air
Conditions
Figure 14. A Comparison of the Change in the Current as a Function of Time in the
Potentiostatic Tests Conducted in AP-105-PSC Simulants with Different Nitrite
Concentrations at 50°C and Quiescent Air Conditions
Figure 15. The Sample Appearance after Potentiostatic Test at 0 mV (vs. SCE) in the
AP-105-PSC Simulant with 0.6 M Nitrite for 50 Hours (Sample Partially
Immersed) at 50°C Under Quiescent Air Conditions
Figure 16. A Comparison of the Current Density as a Function of Time in the
Potentiostatic Tests Conducted at 0 mV (vs. SCE) in Quiescent and Nitrogen
Purged AP-105-PSC Simulants at 50°C
Figure 17. The Sample Appearance after Potentiostatic Test at 0 mV (vs. SCE) in
Nitrogen Deaerated AP-105-PSC Simulant for 50 hours (Sample Partially
Immersed) at 50°C
Figure 18. The Current Density as a Function of Time in the Potentiostatic Tests
Conducted at 0 mV (vs. SCE) in AP-105-PSC Simulants with the Head Space of
the Test Cell Purged with Nitrogen at 50°C

Figure 19. The Sample Appearance after the Potentiostatic Tests Conducted at 0 mV
(vs. SCE) in AP-105-PSC Simulants with the Head Space of the Test Cell
Purged with Nitrogen at 50°C
Figure 20. Current as a Function of Time in Potentiostatic Tests Conducted at Different
Temperature Levels and Quiescent Air Conditions
Figure 21. Current Density as a Function of Time in the Potentiostatic Tests Conducted
in AP-105-PSC Simulants Under Quiescent Air Conditions at (a) 0 mV (vs. SCE,
50°C) and 100 mV (vs. OCP, 50°C); (b) 50 mV (vs. OCP, Room Temperature)
and 0 mV (vs. SCE, Room Temperature)
Figure 22. Sample Appearance after 50 Hours Potentiostatic Testing in AP-105-PSC
Simulant at Different Potentials (Under Quiescent Air Conditions, Room
Temperature). (a) 0 mV vs. SCE; (b) 50 mV vs. OCP (-160 mV vs. SCE)
Figure 23. Corrosion Rate Calculated Based on Weight Loss for the Samples Partially
Immersed in the AP-105-PSC Simulants Under Freely Corroding Conditions for
More than Three Months (T=50°C Unless Noted Otherwise)
Figure 24. The Appearance of the Sample (a) and the Cross Section of a Corroded Site
(b) after Exposed in AP-105-PSC under Quiescent Air Conditions (Sample
Partially Immersed, T=50°, EL1196-83)
Figure 25. The Appearance of the Sample (a) and the Cross Section of a Corroded Site
(b) after Exposed in AP-105-PSC under Quiescent Air Conditions (Sample
Partially Immersed, Room Temperature, EL1196-97) at OCP
Figure 26. A Comparison of CPP Curves in Nitrogen Deaerated AP-105-PSC Simulant
at Different Nitrite and Nitrate Concentrations (pH=13+, T=50°C)
Figure 27. The Sample Appearance after CPP Testing in Nitrogen Deaerated AP-105-
PSC with No Nitrite and 3.85 M Nitrate (pH=13+, T=50°C)
Figure 28. A Comparison of the CPP Curves Obtained in the AP-105-PSC Simulant
under Different Aeration Conditions using Fully Immersed Samples
Figure 29. The Pit on the Sample Tested in the AP-105-PSC Simulant Under Quiescent
Air Conditions and at 50°C ($pH=13+$)
Figure 30. The Stress-Strain Behavior of Samples Tested in AP-105-PSC Based
Simulants at 0 mV vs. SCE and at OCP (-249 mV vs. SCE)
Figure 31. An Electron-Micrograph of a Secondary Crack in Test Sample SSRT-51
Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at OCP (-
249 mV vs. SCE)
Figure 32. A Stereo-Micrograph of the Test Sample from SSRT-51 Performed in
AP-105-PSC Standard Simulant at 50°C, pH 13+, and at OCP (-249 mV vs.
SCE)
Figure 33. A Stereo-Micrograph of the Test Sample from SSRT-60 Performed in
AP-105-PSC Standard Simulant at 50°C, pH 13+, and at OCP (-277 mV vs.
SCE). The test was stopped at the ultimate tensile strength
Figure 34. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-53
Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at 0 mV vs. SCE
Figure 35. Stereo-Micrograph of the Test Sample from SSRT-53 Performed in AP-105-
PSC Standard Simulant at 50°C, pH 13+, and at 0 mV vs. SCE
150 Stanuard Simulant at 50 C, pri 15^+ , and at $0 \text{ m} \neq 95$. SCE

Figure 36. Photograph of the Test Sample from SSRT-54 Performed in AP-105-PSC
Standard Simulant at 50°C, pH 13+, and at 0 mV vs. SCE
Figure 37. Photograph and Schematic of the Test Cell and Sample Indicating Regions
of Corrosion (Schematic Not To Scale)48
Figure 38. A CPP Curve in Deaerated SY-103-PIL Simulant (pH>13 and T=50°C)
Figure 39. The Stress-Strain Behavior of Samples Tested in SY-103-PIL Based
Simulants at 0 mV vs. SCE and at OCP (-424 mV vs. SCE)
Figure 40. Stereo-Micrograph of the Test Sample from SSRT-57 Performed in SY-103-
PIL Standard Simulant at 50°C, pH 14, at a Potential of 0 mV vs. SCE. The
yellow dashed circles indicate axial microcracks observed on the shaft of the
sample
Figure 41. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-57
Performed in SY-103-PIL Standard Simulant at 50°C, pH 14, at a Potential of 0
mV vs. SCE
Figure 42. A CPP Curve in Deaerated AW-105-PIL Simulant (pH>13 and T=50°C)
Figure 43. A CPP Curve in Deaerated AW-105-PSC Simulant (pH>13 and T=50°C)
Figure 44. Stress-Strain Behavior of Samples Tested in AW-105-PIL Based Simulants
at 0 mV vs. SCE and at OCP (-290 mV vs. SCE)
Figure 45. Stereo-Micrograph of the Test Sample from SSRT-56 Performed in
AW-105-PIL Standard Simulant at 50°C, pH 13+, at OCP (-290 mV vs. SCE).
The yellow dashed circles indicate axial microcracks observed on the shaft of the
sample
Figure 46. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-56
Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+, at OCP
(-290 mV vs. SCE)
Figure 47. Electron-Micrograph of an Axial Micro-Crack on the Shaft of Test Sample
from SSRT-56 Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+,
at OCP (-290 mV vs. SCE)
Figure 48. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-58
Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+, at 0 mV vs.
SCE
Figure 49. Stereo-Micrograph of the Shaft of Test Sample from SSRT-58 Performed in
AW-105-PIL Standard Simulant at 50°C, pH 13+, at 0 mV vs. SCE
Figure 50. Stress-Strain Behavior of Samples Tested in AW-105-PSC "6X" Simulant at
-50 and -100 mV vs. SCE
Figure 51. Photograph of the Test Sample from SSRT-74 Performed in AW-105-PSC
6X Simulant at 50°C, pH 13+, at a Potential of -100 mV vs. SCE
Figure 52. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-74
Performed in AW-105-PSC 6X Simulant at 50°C, pH 13+, at a Potential of -100
mV vs. SCE
Figure 53. Stereo-Micrograph of the Test Sample from SSRT-75 Performed in
AW-105-PSC 6X Simulant at 50°C, pH 13+, at a Potential of -50 mV vs. SCE
Figure 54. Stress-Strain Behavior of Samples Tested in AN-107 Based Simulants at
various potentials
various potentiais

Figure 55. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-48	
Performed in AN-107 Standard Simulant at 50°C, pH 11, at a Potential of -765	
mV vs. SCE	
Figure 56. CPP Curve in Deaerated AZ-102 Simulant (pH>12 and T=77°C)	1
Figure 57. The Stress-Strain Behavior of the Sample Tested in AZ-102 Simulants at	
OCP (-239 mV vs. SCE)	2
Figure 58. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-61	
Performed in AZ-102 Simulant at 77°C, pH 12+, at a Potential of -239 mV vs.	
SCE	3
Figure 59. CPP curves in deaerated SY-101 simulant at pH 13+ and 50°C	4
Figure 60. Stress-Strain Behavior of the Sample Tested in SY-101 Simulant at OCP	
(-206 mV vs. SCE)	5
Figure 61. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-67	
Performed in SY-101 Simulant at 50°, pH 13+, at a Potential of -206 mV vs.	
SCE	5
Figure 62. A Comparison of CPP Curves in the Deaerated AY-101-CSL Simulant at	-
Different pH Levels and Temperatures	7
Figure 63. Appearance of the Sample after CPP test in the Deaerated AY-101-CSL	
Simulant at 50°C and pH 11.8. (a) Before Cleaning; (b) After cleaning	7
Figure 64. The Appearance of the Sample after CPP Test in AY-101-CSL Simulant at	•
pH 12.3 and 50°C	8
Figure 65. Stress-Strain Behavior of the Sample Tested in AY-101-CSL Simulant at	Ŭ
OCP (-181 mV vs. SCE)	9
Figure 66. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-69	-
Performed in AY-101-CSL Simulant at 50°, pH 11.8, at a Potential of -181 mV	
vs. SCE	9
Figure 67. Plot of DCPD Calculated Crack Length as a Function of Time for CT-17	-
Performed in 5M NaNO ₃ at Open Circuit Potential. The Displacement was Held	
Constant Following Loading to a Nominal K ~ 25 ksi \sqrt{in}	1
Figure 68. Load as a Function of Time for CT-17 Performed in 5M NaNO ₃ at Open	T
Circuit Potential. The Displacement was Held Constant Following Loading to a	
Nominal K ~ 25 ksi√in	1
Figure 69. Plot of DCPD Calculated Crack Length as a Function of Time for CT-18	1
Performed in AY-101-PSC Simulant at 0 mV vs. SCE. The Displacement was	
	h
Held Constant Following Loading and Adjustment to a Nominal K ~ 45 ksi \sqrt{in}	Z
Figure 70. Load as a Function of Time for CT-18 Performed in AY-101-PSC Simulant	
at 0 mV vs. SCE. The Displacement was Held Constant Following Loading and	~
Adjustment to a Nominal K ~ 45 ksi \sqrt{in}	2
Figure 71. Electron-Micrograph of the Fracture Surface of Test Sample from CT-17	
Performed in 5M NaNO3 at 50°, at OCP (+107 mV vs. SCE). The sample was	
held at a constant displacement for ~80 days following a constant displacement	_
rate slow loading to a nominal K of 25 ksi√in	3
Figure 72. Electron-Micrograph of the Fracture Surface of Test Sample from CT-18	
Performed in AY-101 Simulant at 50°, at 0 mV vs. SCE. The sample was held at	
a constant displacement for \sim 150 days following a constant displacement rate	
slow loading to a nominal K of 45 ksi \sqrt{in} 7	4

Figure 73. Susceptibility of Materials to Pitting Corrosion as a Function of Nitrite and	
Nitrate Concentration. The Symbols Represent Various Simulant Chemistries	
Previously Studied.	77
Figure 74. Estimated CGR vs. Potential in the Investigated Simulants.	78
Figure 75. A Plot of Nitrite/nitrate Ratio vs. Applied Test Potential Indicating	
Conditions for SCC Susceptibility. Only Nitrate Based simulant Results Are	
Included	79

LIST OF TABLES

Table 1. A List of the Concentrations of the Main Constituents in Different Simulants	3
Table 2. Chemical Specifications for AAR TC128 Grade B Tank Car Steel14	1
Table 3. Mechanical Specifications for AAR TC128 Grade B Tank Car Steel	1
Table 4. The Concentrations of Chemicals Used in Preparation of the Simulants)
Table 5. A Summary of Electrochemical Tests Performed in AP-105-PSC Based	
Simulants. (2 sheets)	3
Table 6. The Bulk pH Values of the Simulant after the Long-Term Immersion Tests	3
Table 7. The Equilibrium Potential of Nitrite and Nitrate Redox Couple as a Function of	
Temperature at pH 13.5 (Nitrite=0.27M, Nitrate=3.58M))
Table 8. A Summary of Slow Strain Rate Tests Performed in AP-105 Based Simulants	2
Table 9. A Summary of Electrochemical Test Performed in SY-103-PIL Based	
Simulant)
Table 10. A Summary of Slow Strain Rate Tests Performed in SY-103-PIL Based	
Simulants	
Table 11. A Summary of Electrochemical Test Performed in AW-105 Based Simulant	l
Table 12. A Summary of Slow Strain Rate Tests Performed in AW-105 Based	
Simulants53	3
Table 13. A Summary of Slow Strain Rate Tests Performed in AN-107 Based	
Simulants)
Table 14. A Summary of Electrochemical Test Performed in AZ-102 Based Simulant	
Table 15. A Summary of Slow Strain Rate Tests Performed in AZ-102 Simulant	
Table 16. A Summary of Electrochemical Test Performed in SY-101 Based Simulant	
Table 17. Summary of Slow Strain Rate Tests Performed in SY-101 Simulants	1
Table 18. Summary of Electrochemical Test Performed in AY-101-CSL Based	
Simulant	
Table 19. A Summary of Slow Strain Rate Tests Performed in AY-101-CSL Simulant	
Table 20. A Summary of the Dynamic-K Tests Performed)
Figure B-17. A Comparison of the CPP Curves Obtained with and without Using a	
Crevice Former (AP105-PSC, pH>13, T=50°C)11	1
Table B-3. A Summary of Electrochemical Test Performed in SY103-PIL Based	
Simulant22	
Table B-4. A Summary of Electrochemical Test Performed in AW105 Based Simulant22	
Table B-5. A Summary of Electrochemical Test Performed in AZ102 Based Simulant23	
Table B-6. A Summary of Electrochemical Test Performed in SY101 Based Simulant	4
Table B-7. A Summary of Electrochemical Test Performed in AY101-CSL Based	
Simulant	5

LIST OF TERMS

Abbreviations and Acronyms

AAR TC	American Association of Railways Tank Car
ASTM	American Society for Testing and Materials
CGR	Crack Growth Rate
CPP	Cyclic Potentiodynamic Polarization
СТ	Compact Tension
DCPD	Direct Current Potential Drop
DI	Deionized
DOE	U.S. Department of Energy
K _{ISCC}	Stress intensity factor for stress corrosion cracking
K _{th}	Threshold stress intensity factor
K _{thSCC}	Threshold stress intensity factor for stress corrosion cracking
OCP	Open Circuit Potential
PIL	Present Interstitial Liquid
PSC	Present Supernate Composition
SCC	Stress Corrosion Cracking
SCE	Saturated Calomel Electrode
SEM	Scanning Electron Microscope
SSR	Slow Strain Rate
SSRT	Slow Strain Rate Test
TIC	Total Inorganic Carbon
Units	
°C	degrees Celsius
°F	degrees Fahrenheit
h	hour
in.	inch
ksi	kilopounds per square inch
ksi√in	ksi square root inch
Μ	molarity
mM	milli-molar
mV	millivolt
sec	second

1.0 INTRODUCTION AND BACKGROUND

The Hanford tank reservation contains approximately 50 million gallons of liquid legacy radioactive waste from cold war weapons production that is stored in 177 underground storage tanks. Current plans call for vitrification of the waste and final disposal in a geologic repository at Yucca Mountain. The carbon steel DSTs presently used for storage will continue in operation until a vitrification plant is constructed and waste processing operations are completed.

The waste chemistries in the storage tanks are grouped according to their main constituents, such as nitrite/nitrate-based and carbonate-based chemistries. Most of the wastes are highly alkaline in nature, typically with pH values between 12 and 14. Under alkaline conditions, carbon steels will tend to be passive and undergo relatively slow rates of uniform corrosion. However, carbon steels can become susceptible to localized corrosion (e.g., pitting) and SCC in the presence of certain aggressive constituents, such as chloride and nitrate, even in these passive conditions¹. The original Single-Shell Tanks (SSTs) at Hanford experienced some SCC failures because of the presence of high concentrations of nitrate in the waste and high residual stresses near the welds in the tanks. Research at Hanford and Savannah River Laboratories demonstrated that cracking could be prevented by post weld heat treating the tanks and maintaining the waste at a high pH (>13), which were practices incorporated into construction and operation of the tanks respectively. Although most wastes stored in the DSTs are currently within specification and will remain within specification for the next 20 years, there will be cases in which the chemistry will be out of specification (i.e., pH levels below 12). This transformation is a result of waste chemistries changing over time due to various chemical reactions taking place inside the tanks. These out of specification conditions could also develop during waste transfer and mixing operations. Thus, there is concern within DOE, oversight groups, and regulatory bodies that tank integrity could be compromised given these chemistry changes. If tank integrity is threatened, there is a need to define mitigation strategies. Additional resources would be required to mitigate potential leaks as well as conduct repairs.

Thus far, research has been conducted with waste simulants for Tanks 241-AN-107 (AN-107), 241-AN-102 (AN-102), 241-AY-101 (AY-101) and 241-AY-102 (AY-102) using the simulants developed for the wastes in these tanks. The AN-107, AN-102, and AY-101 simulants have nitrate-based chemistries with high concentrations of nitrite and nitrate (typically > 1.3M nitrate). The AY-102 stimulant has a carbonate-based chemistry as the carbonate concentration is considerably higher than the nitrite and nitrate concentrations (typically in the order of 1 M carbonate, vs. mM nitrate concentration).

Research conducted at CC Technologies in AN-107² simulants revealed that a nitrite concentration above 1M considerably reduced the susceptibility of carbon steel to pitting corrosion and SCC. Although the current pH value of the interstitial liquid in the salt cake/sludge in AN-107 is out of specifications (pH 11 rather than 13), the laboratory testing demonstrated that the pH did not have a significant impact on either localized corrosion or SCC

¹ R. N. Parkins, and R. Usher, *The Effect of Nitrate Solutions in Producing Stress Corrosion Cracking in Mild Steel*, Proceedings Frist International Congress on Metallic Corrosion. London, U.K.: Butterworths (1962): 296-302.

² Hanford Tanks 241-AN-107 and 241-AN-102: Effect of Chemistry and Other Variables on Corrosion and Stress Corrosion Cracking, CC Technologies Inc, September 8, 2006.

of carbon steel in the range of 10 to 13.5. SCC was commonly observed at an applied potential of -100 mV (vs. SCE) or above. This potential range is more positive than the OCP of the steel in the simulants. Furthermore, the concentration of the corrosion and SCC inhibitor nitrite is gradually increasing in the AN-107 waste from the initial concentration of 1.2M to 2.3M in the predicted endpoint chemistry. Thus, the tank chemistry in AN-107 is self-inhibiting owing to the increasing nitrite concentration with time. The implication of this research is that adjustments to the pH of the interstitial liquid in the salt cake/sludge to high levels is unnecessary (specifications stipulate pH between 12 and 14). Applications of these findings to interstitial liquid was immediate, but changes to control of the supernate liquid will only be possible if it can be shown that corrosion at the liquid/air interface and vapor space will be unaffected.

The work in AY-101³ and AY-102⁴ simulants indicated that these chemistries were largely benign with respect to localized corrosion. As with the AN-107 simulants, nitrite is a potent inhibitor to localized corrosion for these simulants. In nitrate-based AY-101, SCC was observed only at relatively high applied potentials (e.g., 0 mV vs. SCE). In carbonate-based AY-102, however, SCC was observed both at high potentials (0 mV vs. SCE) and at potentials near -800 mV vs. SCE where an active-passive transition was noted on CPP curves. Fortunately, corrosion potential monitoring of steel in the carbonate-based simulants suggested that the OCP of the steel will be far more positive than -800 mV vs. SCE. These results indicated the necessity to monitor the corrosion potential of the tank wall.

In the present work, the localized and SCC corrosion behavior of steel in waste simulants for Tanks 241-AP-105 (AP-105), 241-SY-103 (SY-103), 241-AW-105 (AW-105), 241-AZ-102 (AZ-102), 241-SY-101 (SY-101), AN-107 and AY-101 were investigated. The AP-105- PSC contains high nitrate (3.58 M) and low nitrite (0.27 M) concentrations. It has the lowest nitrite-to-nitrate concentration ratio among all simulants that have been investigated thus far. The SY-103 and AW-105 PILs (SY-103-PIL and AW-105-PIL) represent wastes with bounding chloride (0.5 M) and fluoride (0.58 M) levels, respectively. Chloride is known to contribute to pitting behavior in steels. Fluoride is expected to be detrimental to the tank steel as well. The AW-105 simulant has low nitrite (2.91 M) and nitrate (1.97 M). These differences are expected to have a significant influence on the corrosion and SCC behavior of the tank steel. The various chemistries of simulants investigated in this work are listed in Table 1 and compared with other chemistries studied previously.

The SY-101 simulant also has a low nitrite-to-nitrate concentration ratio and raised a concern for the susceptibility of the tank steel to localized corrosion and SCC. The AN-107 simulant was previously studied to examine its propensity for corrosion. The simulant was investigated to test susceptibility to carbonate SCC because of the high carbonate concentration of 1.4 M. The AZ-102 simulant represents a tank chemistry at the other extreme: the nitrite-to-nitrate ratio is a relatively high 8.4, with a nitrate content of 0.105 M and a nitrite content of 0.883 M. The

³ Hanford Tank AY-101: *Effect of Chemistry and Other variables on Corrosion and Stress Corrosion Cracking*, CC Technologies Inc, January 2008.

⁴ Hanford Tanks AY-102 and AP101: *Effect of Chemistry and Other Variable on Corrosion and Stress Corrosion Cracking*, CC Technologies, September 7th 2007.

supernate and interstitial liquid in Tank 241-AY-101 was investigated in previous programs. In this work, the condensate surface layer (CSL) in Tank AY-101 (AY-101-CSL), which has a relatively low nitrite-to-nitrate ratio (0.2), was studied.

This report summarizes the results obtained for the chemistries described above. The scope of the test program includes a series of CPP, SSRTs, and CGR tests on a plate of AAR TC 128 Grade B steel. AAR TC128 Grade B steel has similar properties to the steels used in constructing the DSTs.

The results from this work in conjunction with those obtained in other previous research programs for other tanks will help expand understanding of the roles of nitrite and nitrate (both absolute concentrations and ratio), and the roles of high chloride and fluoride in the corrosion process. Based on these results, strategies may be formulated about possible mitigation schemes.

Acronym	Simulant	AlO ₂ ⁻	SO4 ²⁻	NO ₂	NO ₃	TIC	Cľ	F	OH.	pН
AY-102-PIL	Present Interstitial Liquid	0.002	0.018	0.001	0.002	1.021	0.004	0.003	0.001	11
AP101-TSC	Transferred Supernatant Composition	0.31	0.029	0.98	2.13	0.47	0.05	0.09	2.61	14+
AY-102-CSC	Combined Supernatant Composition	0.29	0.028	0.938	1.967	0.477	0.046	0.084	2.42	14+
AY-102-ACS	Aged Combined Supernatant	0.29	0.028	1.27	1.635	1.118	0.046	0.084	1.24	14+
AY-102-AIL	Aged Interstitial Liquid	0.002	0.009	0.001	0.002	0.935	0.004	0.003	0.001	11
AY-102-ATL	Aged Total Liquid	0.37	0.027	1.20	1.532	1.242	0.043	0.079	0.96	14+
AY-101-PIL	Present Interstitial Liquid	-	0.305	0.847	0.057	1.842	0.011	0.068	0.001	11
AY-101-PSC	Present Supernatant Composition	0.107	0.020	0.205	1.33	0.201	0.018	0.014	0.71	13+
AP-105-PSC	Present Supernatant Composition	0.15	0.047	0.270	3.58	0.326	0.03	0.009	0.18	13+
SY-103-PIL	Present Interstitial Liquid	2.06	0.017	2.91	1.97	0.123	0.50	-	2.43	14
AW-105-PIL	Present Interstitial Liquid	0.02	0.014	0.12	0.42	0.097	0.01	0.58	0.45	13+
AP-105- Mixed	Mixed Simulant	0.195	0.04	0.413	2.857	0.274	0.039	0.026	0.95	13+
AP-105- Evaporated	Evaporated Simulant	0.347	0.072	0.736	5.087	0.489	0.069	0.047	1.67	14
AZ-102	AZ-102 Simulant	0.007	0.186	0.883	0.105	0.619	-	0.0520	-	12+
AW-105-PSC	Present Supernate Composition	0.0065	0.005	0.064	0.44	0.108	0.008	0.156	0.26	13+
SY-101	SY-101 Simulant	0.1407	0.02	0.203	0.931	0.133	0.023	0.028	0.66	13+
AY-101-CSL	Condensate Surface Layer	0.0153	0.002	0.037	0.181	0.147	0.006	0.002	0.005	11.82

 Table 1. A List of the Concentrations of the Main Constituents in Different Simulants.

2.0 EXPERIMENTAL APPROACH

2.1 MATERIALS AND SPECIMENS

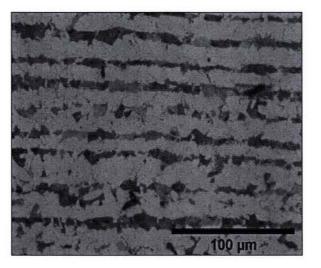
All test specimens were fabricated from a 2'×2'×1" as-supplied plate of AAR TC Grade B steel. This is similar in composition and mechanical properties to the A515 Grade 60 steel used in the Hanford AY-101 double-shelled underground storage tank construction. The plate was supplied to CC Technologies by ARES Corporation. Chemical and mechanical specifications for AAR TC 128 Grade B tank car steel are shown in Table 2 and Table 3, respectively; however, no efforts were made to confirm these values. Figure 1 (a) shows a photomicrograph of the AAR TC128 Grade B Tank Car Steel used in this investigation. This steel was also used in previous AY-102, AP101, and AY-101 work. For comparison, Figure 1 (b) shows the microstructure of the American Society for Testing and Materials (ASTM) A537 Class 2 steel used previously for Tank 241-AN-105 and AN-107 work. The most significant difference between the two microstructures is the presence of pearlite bands in the tank car steel which is commonly observed in hot rolled steels.

Element										
	С	Mn	P	S	Si	Cu	Fe			
Max.	0.50	1.35	0.040	0.05	0.30	0.35	balance			
Min.		-								

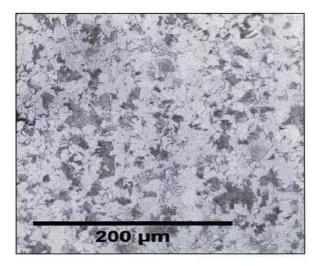
	Ultimate Tensile Strength (psi)	0.2% Offset Yield Strength (psi)	Elongation in 2" (%)		
Max.	101,000				
Min.	81,000	50,000	21.0		

Figure 1. Photomicrographs of (a) the Microstructure of the AAR TC 128 Grade B Tank Car Steel Used for the Current Work and Previous AY-102 and AP101 Work, and (b) the Microstructure of the ASTM A537 Class 2 Steel used for Previous AN-105 and AN-107 Work.

(a)



(b)



Three main specimen geometries were utilized in this work. A schematic representation of the CPP specimens, SSRT specimens, and CGR specimens are shown in Figure 2, Figure 3, and Figure 4, respectively. The specimens were fabricated by Metal Samples Company in Munford, AL and Metcut Research, Inc., in Cincinnati, Ohio. Material close to the flame cuts at the edges of the plates was avoided for specimen fabrication to ensure consistent microstructures. SSRT specimens were fabricated such that the longitudinal axis was aligned with the plate rolling direction (i.e., longitudinal orientation). Compact tension (CT) specimens were fabricated such that the pre-crack was in the plate rolling direction (i.e., transverse-longitudinal orientation).

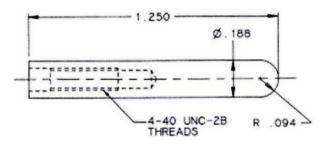


Figure 2. Engineering Drawing of the Cyclic Potentiodynamic Polarization (CPP) Specimen (Units in Inches).

SURFACE FINISH - APPROXIMATELY 8-16 RMS.

Figure 3. Engineering Drawing of the Slow Strain Rate Test Specimen (Units in Inches).

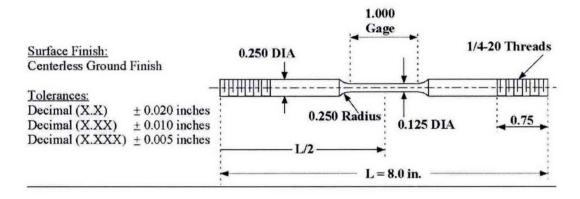
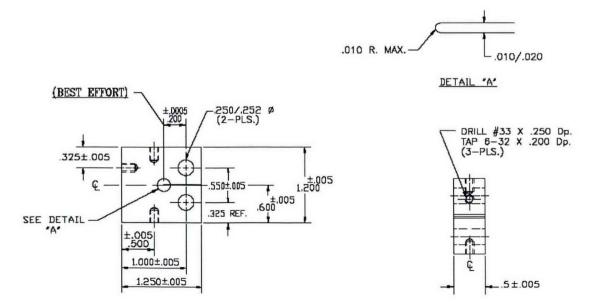
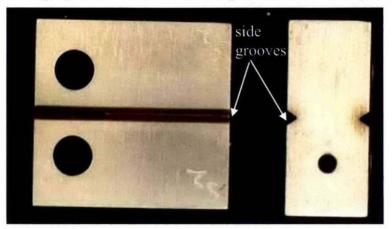


Figure 4. Engineering Drawing of the Crack Growth Rate Specimen (Units in Inches).



The dimensions of the CT specimens shown in the figure below are a standard size, and consistent with the dimensions used for CT samples in previous constant load experiments. Constant displacement rate tests previously used were again employed to determine the CGR and the threshold stress intensity for SCC (K_{thSCC}). All specimens were side-grooved (Figure 5) following the guidelines provided in ASTM E1820-06e1⁵ to ensure crack growth did not diverge significantly from the pre-crack direction and to promote plane strain conditions. This standard recommends a total reduction in cross-section of the crack plane of 20% of the width of the test sample, with an included angle of 90° or less, and a root radius of <= 0.02 \pm 0.01 in. Figure 5 shows a digital photograph of the CT sample machined with side-grooves.





2.2 CHEMICALS AND SOLUTIONS

The chemistries used in this work with AP-105, SY-103 and AW-105 were "present" chemistries. The aged chemistries for the tanks studied are not expected to be significantly different from the present chemistries due to the small concentration of organic carbon compounds (0.05M). That is, the oxidation of organic carbon compounds, when present at such low quantities, will not significantly alter the carbonate, hydroxide, nitrate, or nitrite concentrations. The presence and concentration of these species are believed to play critical roles in the corrosivity of the simulants.

As stated previously, the simulants that were chosen for evaluation were selected to bind the effects of various tank chemistry compositions, such as the effects of chloride, fluoride, and nitrite/nitrate ratio. All of the simulants are considered chemically stable and did not require continuous agitation prior to being used. The pH of each simulant was adjusted after initial mixing using either sodium hydroxide (Noah), or nitric acid (HNO₃) or acetic acid (CH₃COOH). If the difference between the measured pH and the target pH was large, nitric acid was favored over acetic acid; however, acetic acid was most commonly used because of the small adjustments that were typically required.

⁵ ASTM E1820-06e1, 2006, *Standard Test Method for Measurement of Fracture Toughness*, American Society for Testing and Materials, ASTM International, West Conshohocken, PA.

For each simulant a standard chemistry and several modified chemistries were often investigated. The standard chemistry was used to establish the baseline localized corrosion and SCC behavior. The modified chemistries were used to explore the role of certain species, such as nitrite, nitrate, and sulfate, on the localized corrosion and SCC behavior of the material. The chemicals used to mix the baseline simulants (i.e., without modifications) as well as the concentrations used are listed in Table 4. The rows containing some of the key species of interest are shaded. Note that in some cases simulants were mixed using the baseline chemistry, and then pH balanced. The pH balance will change the hydroxide concentration, and influence the proportions of carbonate and bicarbonate present in the solution.

3.0 OPEN CIRCUIT POTENTIAL MONITORING, POTENTIOSTATIC AND CYCLIC POTENTIODYNAMIC POLARIZATION TESTING

CPP testing was performed according to the guidelines set forth in ASTM G61-86e1.⁶ Samples were either fully immersed or partially immersed in the simulants. When the samples were partially immersed, a liquid/vapor interface was created so that the corrosion phenomena at the interface could be investigated.

Prior to testing, the specimens were prepared to a 600 grit surface finish, ultrasonically cleaned with isopropanol for five minutes, rinsed with DI water, and then dried with nitrogen. Prior to introducing the specimen to the test cell, the test solution was added. In cases where testing above room temperature was conducted, the solution was then heated to the desired temperature $(50^{\circ}C [122^{\circ}F] \text{ or } 77^{\circ}C [170^{\circ}F])$. The test solution was then purged with the desired test gas for approximately one hour prior to specimen introduction and testing unless the test was conducted under quiescent conditions. A saturated calomel electrode (SCE) was usually used as the reference electrode with a salt bridge to separate the reference electrode from the testing environment. This was done so that the reference electrode could be maintained at room temperature. In a few limited cases, a Ag/AgCl wire reference electrode was used. For tests where polarization was required, a platinized niobium wire was used as the counter electrode.

The OCP, CPP, and potentiostatic tests were performed under two different conditions – (1) quiescent in air conditions (i.e., no gas purging and the cell was open), (2) gas purging conditions (nitrogen, high purity Ar or compressed "zero" air containing no CO_2). In a set of long-term immersion tests to investigate the susceptibility of the steel to interfacial corrosion in the AP-105-PSC simulants, the head space of the cell was blanketed with compressed "zero" air (no CO_2), nitrogen or argon so that the mixing of the interface chemistry with the bulk solution could be minimized. The quiescent conditions and compressed air purging aimed to provide oxygen to the simulants, and in many cases were used to investigate the role of oxygen in both CPP and corrosion at the liquid/vapor interface. Nitrogen and argon purging were used to maintain deaerated conditions (i.e., the oxygen reduction reaction was minimized or eliminated). For the deaerated experiments the cathodic reactions were dominated either by other reducible species in the solution (i.e., nitrite or nitrate) or water reduction (assuming the potential was sufficiently negative).

⁶ ASTM G61-86e1, 2003, Standard Test Method for Conducting Cyclic Potentiodynamic Polarization Measurements for Localized Corrosion Susceptibility of Iron-, Nickel-, or Cobalt-Based Alloys, American Society for Testing and Materials, ASTM International, West Conshohocken, PA.

Chemical	Formula	AP-105- PSC Molarity	AP- 105- Mixed Molarity	AP-105- Evaporated Molarity (M)	SY-103- PIL Molarity	SY-101 Molarity	AW- 105-PIL Molarity	AW-105- PSC Molarity	AZ-102 Molarity	AY- 101- CSL Molarity
Sodium Aluminate	NaAlO ₂ .2H ₂ O	(M) 0.15	(M) 0.195	0.3470	(M) 2.06	(M) 0.1407	(M) 0.0160	(M) 0.0065	(M) 0.0070	(M) 0.0153
Sodium Chloride	NaCl	0.0308	0.039	0.0690	0.4960	0.0228	0.0102	0.0083	-	0.0064
Sodium Fluoride	NaF	0.0091	0.026	0.0470		0.0277	0.5810	0.156	0.0520	0.0015
Sodium Chromate	Na ₂ CrO ₄	0.0106	0.008	0.0140	0.0010	0.0021	0.0002	0.00004	0.0130	0.0003
Sodium Phosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	0.0301	0.03	0.0530	0.0275	0.0984	0.0032	0.0045	-	0.0059
Potassium Nitrate	KNO ₃	0.0133	0.13	0.23	0.1280	0.0069	0.2180	0.1444	0.0710	-
Sodium Sulfate	Na ₂ SO ₄	0.0472	0.04	0.072	0.0167	0.0196	0.0139	0.0053	0.1860	0.0021
Sodium Formate	NaHCOO	0.0100	0.0115	0.016	0.1880	-	0.0033	0.0021	-	-
Sodium Acetate Trihydrate	NaCH ₃ COO.3H ₂ O	0.0075	0.0105	_	0.0439	-	0.0062	0.0023	-	-
Sodium Oxalate	Na ₂ C ₂ O ₄	0.0075	0.0115	0.016	0.0044	0.0244	0.0032	0.0017	0.0170	0.0014
Sodium Nitrate	NaNO ₃	3.5644	2.727	4.857	1.8400	0.9244	0.2010	0.2956	0.0340	0.1810
Sodium Nitrite	NaNO ₂	0.2700	0.413	0.736	2.9100	0.2027	0.1240	0.0638	0.8830	0.0368
Sodium Carbonate	Na ₂ CO ₃	0.3260	0.274	0.489	0.1230	0.1328	0.0966	0.1076	0.6070	0.147
Glycolic Acid	C ₂ H ₄ O ₃	0.0075	0.0115	-	0.0334	-	-	0.0010	-	-
Sodium Hydroxide	NaOH	0.1761	0.952	1.67	2.43	0.6555	0.4502	0.2630	-	0.0051
Cobaltous Nitrate	Co(NO ₃) ₂	-	-	-	-	-	0.0000242	-	-	-
Nickel Nitrate	Ni(NO ₃) ₂	-	-	-	-	-	0.00007	-	-	-
Boric Acid	H ₃ BO ₃	-	-	-	-	0.0008	0.0006	0.0003	-	-
Potassium Molybdate	K ₂ MoO ₄	-	-	-	-	-	0.00003	0.00001	0.0005	-
Zirconyl Nitrate	$ZrO(NO_3)_2$	-	-	-	-	-	0.0000049	-	-	-
Tributyl phosphate	$C_{12}H_{27}O_4P$	-	-	-	-	·	0.0049	-	-	-
1-Butanol	C ₄ H ₉ OH	-	-	-	-	-	0.0125	-	-	-
Dibutyl Phosphate	$C_8H_{19}O_4P$	•	-	-	-	•	0.0125	-	-	-
Ammonium Acetate	NH ₄ CH ₃ COO	-	0.0040	0.008	-	-	-	-	-	-
Iron Nitrate, 9-Hydrate	$Fe(NO_3)_2.9H_2O$		-	0.00002	-	-	-	-	-	-
Zinc Nitrate, 6-Hydrate	$Zn(NO_3)_2.6H_2O$	-	-	0.00007	-	-	-	0.00003	-	-
Sodium Bicarbonate	NaHCO ₃	-	-	-	-	-	-	-	0.0120	-

Table 4. The Concentrations of Chemicals Used in Preparation of the Simulants.

Prior to CPP and potentiostatic testing, the OCP was monitored for 18 hours. The start potential for the CPP tests was -100 mV vs. OCP. The scan was reversed at 1V vs. SCE or if the current reached 1mA/cm^2 . A scan rate of 0.17mV/s (0.6 V/h) was used. For the potentiostatic testing, the sample was polarized to an anodic potential for the desired amount of time.

When a test was completed, the specimen was removed from the test solution, rinsed with deionized (DI) water, and then dried with nitrogen gas. If visible corrosion products were present on the specimen surface, the specimen was ultrasonically cleaned in acetone for five minutes, rinsed with DI water, and dried with nitrogen. The post-test appearance of the specimen was photographically documented to show any evidence of corrosion attack. In some cases, the test specimen was examined using a scanning electron microscope (SEM) in addition to examination using optical stereomicroscopy. Finally, the tested specimens were stored in separate specimen bags in a desiccator for possible further analysis.

3.1 SLOW STRAIN RATE TESTING

All SSRTs were performed according to the guidelines provided in ASTM G129-00⁷ using cylindrical tensile specimens at a constant extension rate of 10^{-6} in/in-s (unless otherwise noted). To perform the tests, the specimen was placed in a Teflon®⁸ test cell and the load was applied using grips that entered the cell through sliding seals. This assembly was then inserted into the load frame, after which the solution of interest was introduced and heated to 50 °C. Tests were conducted at open circuit or at an applied potential against a SCE reference electrode that was maintained at room temperature using a Luggin probe/salt bridge filled with the test solution. A platinum flag was used as a counter electrode. All of the SSRTs were performed under quiescent air conditions; i.e., exposed to air with no gas sparging.

The test specimens were pulled to failure. The stress-strain curves provided in the following results sections are for reference purposes. However, the time-to-failure and the strain-at-failure of the specimens did not always clearly indicate the presence of SCC. Also, the degree of SCC was not easily established from these parameters. Therefore, the occurrence of SCC was always confirmed by both visual inspection and SEM examination. Examination of the specimens after failure consisted of examination in a stereographic optical microscope at 10 - 63x, and a SEM. The fracture surface of each of the test samples was examined using the SEM to identify regions of intergranular fracture, indicative of high pH SCC.

3.2 K_{thSCC} AND CRACK GROWTH RATE TESTING USING COMPACT TENSION SPECIMENS

 K_{thSCC} and CGR tests were performed using pre-cracked $\frac{1}{2}$ -T (0.5 inch wide) CT specimens (Figure 5). The objective of these tests was to determine the K_{thSCC} for the steel in various

⁷ ASTM G129-00, 2006, Standard Practice for Slow Strain Rate Testing to Evaluate the Susceptibility of Metallic Materials to Environmentally Assisted Cracking, American Society for Testing and Materials, ASTM International, West Conshohocken, PA.

⁸ Teflon® is a registered trademark of DuPont in the United States and other countries.

simulants. The K_{thSCC} could then be related to the maximum K_I expected for a variety of flaw sizes in the tank. This would aid in the determination as to whether or not there is an integrity concern for the tank. The CGRs estimated in these tests can also be used to approximate the time for any growing flaw to go through-wall. The term K_{thSCC} refers to a "threshold." The term K_{ISCC} is not used because the test procedure utilized for this investigation does not satisfy the requirements of ASTM E1820. In particular, samples were not wide enough to ensure plane strain conditions, which are necessary for a valid K_{ISCC} determination.

Previous tank chemistry studies had been performed using a constant tensile load. Constant tensile load testing was not performed in the current investigation because of the difficulties associated with the determination of K_{thSCC} in tank waste simulants with this technique. Results from previous testing showed some inconsistencies in estimated K_{thSCC} from the different tests. In some cases, direct current potential drop (DCPD) indicated negative crack growth due to build up of corrosion product in the crack mouth. To avoid the difficulties, the approach was modified to a "dynamic-K" test. The dynamic K-tests were initiated with a constant displacement rate rather than a constant load. At the onset of cracking or a predefined K, the displacement was held constant for several weeks or months. Tests were concluded when evidence of crack growth and a declining K were observed or a sufficient length of time had elapsed (~5 months) to imply no cracking in the test sample. The advantage of the technique is that both K_{thSCC} and CGR can be estimated from the same test data, provided that some crack growth occurs during the test.

The dynamic-K tests were performed using the same loading frames as those used in the SSRTs. The dynamic-K tests were run at approximately 5×10^{-8} in/s, which was substantially slower than the nominal extension rate of 10^{-6} in/s used for SSRTs. The time frame for the dynamic load experiments ranged from several weeks to several months because of the slow loading rate to a specified K value and longer hold time. Comparatively, the constant load tests typically concluded within 30 days.

Dynamic-K experiments were conducted at 50°C in Teflon cells that contained the desired solutions. Tests were carried out either at open circuit or an applied potential. The OCPs were continuously monitored with a high impedance voltmeter and a reference electrode (SCE). The reference electrode was maintained at room temperature in a separate container that was connected to the test cell by means of a Luggin probe/salt bridge filled with the test solution. For the tests at applied potential, a platinum flag counter electrode was included in the test cell while a potentiostat was used to maintain the potential at the desired value.

The applied load and displacement for the test samples were monitored and recorded continuously throughout the experiments. Additionally, the DCPD was monitored as a means to estimate crack growth *in situ*. The DCPD technique involves the application of a constant current (in this case 20A) through the specimen while the potential drop across the two sides of the crack is recorded. Any crack propagation during the test will increase the resistance across the sample and this will be reflected by a change in potential drop. The increase in crack length is calculated from the potential drop and sample geometry using the Johnson equation⁹.

⁹ Johnson, H. H. "Calibrating the Electric Potential Method for Studying Slow Crack Growth," Materials Research and Standards, Volume 5, No 9, September 1965, pp 442-445.

To monitor crack propagation and growth, both the DCPD measurements and load measurements were used. A significant DCPD (beyond the noise in the data) was interpreted as crack growth. A reduction in the loading rate during loading or a reduction in load during the hold time was also interpreted as crack growth, as it indicates an increase in specimen compliance. Tests were carried out until cracking was detected by load and/or DCPD measurements or until a predefined limit of K was reached.

Following testing, the samples were sectioned longitudinally. Half of the sample was mounted and prepared for metallographic examination, while the other half of the sample was cooled in liquid nitrogen, and then overloaded to failure. The fracture surfaces were examined using the SEM for evidence of intergranular fracture features, which are indicative of SCC as described above for the SSRT specimens.

The morphology of the fracture surfaces observed in the SEM reveals whether crack growth has occurred. In particular, facture surfaces were examined for intergranular features, which are indicative of high pH SCC. Four types of fracture surfaces are expected during examination of the samples: transgranular fatigue (pre-crack), transgranular ductile (tearing during the test), intergranular (SCC), and transgranular brittle overload (fracture of the specimen in liquid nitrogen). From the inspection of the fracture surfaces, the known test conditions, and the load and DCPD data, estimates of both K_{thSCC} and CGRs are generated provided there was some crack propagation. If no crack propagation is observed, then it is known that K_{thSCC} is higher than the K applied in the test.

4.0 **RESULTS AND DISCUSSION**

4.1 ELECTROCHEMICAL POLARIZATION BEHAVIOR IN TANK 241-AP-105 BASED SIMULANTS

Table 5 summarizes the results of the electrochemical tests conducted in FY2008 AP-105-PSC based simulants, including standard AP-105-PSC simulants, AP-105-Evaporated simulants, and AP-105-Mixed simulants as well as their modified versions.

4.1.1 Cyclic Potentiodynamic Polarization Behavior

Figure 6 (a) is the CPP curve obtained with a fully immersed specimen in deaerated AP-105-PSC at 50°C and at pH above 13. This simulant contains 0.27 M nitrite ion and 3.58 M nitrate ion (nitrite-to-nitrate concentration ratio of 0.075). As shown in Figure 6 (a), the polarization curve showed a wide passive region before the increase in the current. This area of increased current is shown with more detail in Figure 6 (b). A small positive hysteresis loop was observed but no pitting corrosion was noted on the post-test sample. This implied that the increase in current at approximately 500 mV (vs. SCE) was not associated with localized corrosion but the oxidation of electro-active species in this simulant.

Base Chemistry	рН	NO ₂ ⁻ (M)	NO ₃ ⁻ (M)	TIC (M)	ОН ⁻ (М) [*]	Cl ⁻ (M)	F (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N_2 purging	CPP No pitting		54
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N ₂ purging	CPP Full immersion No pitting		60
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N ₂ purging	Potentiostatic at 0 mV	Potentiostatic at 0 mV No pitting	
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N ₂ purging	CPP Full immersion Crevice corros		64
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N ₂ purging	Potentiostatic at 0 mV	Crevice corrosion	65
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent Air	Potentiostatic at 0 mV, half immersion Severe attack at liquid/vapor interface		66
AP-105-PSC	>13	0.6	3.58	0.326	0.176	0.03	0.009	50	Quiescent Air	Potentiostatic at 0 mV, half immersion	Corrosion	72
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N ₂ purging	Potentiostatic at 0 mV, half immersion Corrosion		73
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent Air	CPP Corrosion		75
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent Air	Potentiostatic at 0 mV, half immersion Corrosion		76
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent Air	Potentiostatic at 100 mV vs. OCP, half immersion Corrosion		77
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent Air	CPP Full immersion No pitting		81
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	Potentiostatic at 0 mV Half immersion Minor corrosion		91
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Zero air purging	OCP Corrosion		84
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	High Purity Ar purging	OCP Corrosion		85
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N ₂ purging	OCP Corrosion		86
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	OCP Half immersion	Interface attack	83

 Table 5. A Summary of Electrochemical Tests Performed in AP-105-PSC Based Simulants. (2 sheets)

* This reflects the concentration prior to pH adjustment.

23

Base Chemistry	рН	NO ₂ ⁻ (M)	NO ₃ ⁻ (M)	TIC (M)	ОН ⁻ (М) [*]	Cl ⁻ (M)	F ⁻ (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent air	Potentiostatic at 50 mV vs. OCP Half immersion	Corrosion	92
AP-105-PSC	>13	0	3.85	0.326	0.176	0.03	0.009	50	N ₂ purging	CPP Full immersion	Pitting	93
AP-105-Mixed	>13	0.41 3	2.85 7	0.274	0.952	0.03 9	0.026	50	N ₂ purging	CPP Full Immersion	No pitting	98
AP-105-Evaporated	14	0.73 6	5.08 7	0.489	1.67	0.06 9	0.047	50	N ₂ purging	СРР	No pitting	99
AP-105-Evaporated (Nitrite/Nitrate=0.1)	14	0.51	5.08 7	0.489	1.67	0.06 9	0.047	50	N ₂ purging	CPP Full immersion	No pitting	105
AP-105-Mixed (Nitrite/Nitrate=0.1)	>13	0.28	2.85 7	0.274	0.952	0.03 9	0.026	50	N ₂ purging	CPP Full immersion	No pitting	106
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Zero air Blanket	OCP Half immersion	Minor corrosion	94
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	High Purity Ar blanket	OCP Half immersion	Minor corrosion	95
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N ₂ blanket	OCP Half immersion	Minor corrosion	96
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent air	OCP Half immersion	Interface attack	97
AP-105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	CPP Full immersion	Pitting	102

 Table 5. A Summary of Electrochemical Tests Performed in AP-105-PSC Based Simulants. (2 sheets)

* This reflects the concentration prior to pH adjustment.

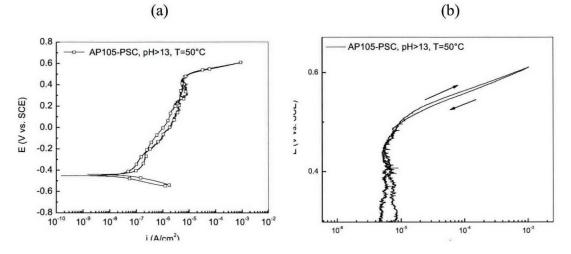


Figure 6. The CPP Curve in Nitrogen Deaerated AP-105-PSC Simulant (T= 50°C and pH>13).

Figure 7 shows a comparison of the CPP curves obtained in deaerated AP-105 mixed and evaporated simulants at 50°C. These simulants have a higher nitrite-to-nitrate ratio (0.14) than the standard AP-105 simulant (0.075). The CPP curves showed a tiny hysteresis loop. No pitting corrosion was observed on the sample after CPP testing. Similar to the observation in AP-105-PSC, therefore, the hysteresis loop was not associated with localized corrosion but most likely with the electrochemical oxidation and reduction of other electro-active species in the simulants.

Figure 8 is a comparison of the CPP curves obtained in the AP-105 evaporated and mixed simulants with nitrite-to-nitrate concentration ratio of 0.1. No clear positive hysteresis loops were noted in either CPP curves and the samples tested in both simulants did not show any indication of localized corrosion.

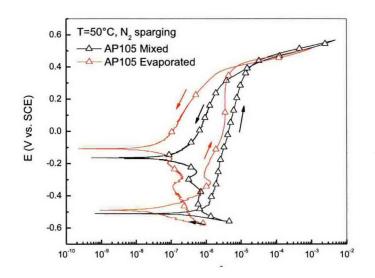
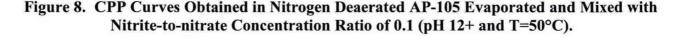
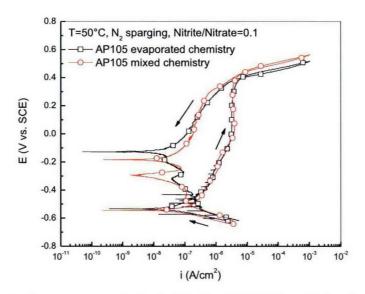


Figure 7. CPP Curves in Nitrogen Deaerated AP-105 Mixed and Evaporated Simulants at pH 14 and 50°C.





The lack of localized attack on the samples tested in the AP-105 based simulants was likely a result of relatively high hydroxide concentration and the combined inhibition from both nitrite and other inhibitory species. In the previous AN-107 program, at nitrite/nitrate ratio of 0.095, a value slightly higher than that in AP-105-PSC, severe pitting was noted and the repassivation potential was more negative than OCP. Although the nitrite/nitrate concentration ratio in the AP-105-PSC is lower than 0.095, the pH was significantly higher than the AN-107 simulant. Furthermore, other inhibitory species, such as aluminate, were present in the AP-105 simulant but not in the AN-107 simulants. The combined effect from all these differences very possibly caused the difference in the observed polarization behavior (i.e., different repassivation potential and the extent of localized attack). Similarly, although the nitrate concentration in the evaporated simulant is 5.087 M, a significantly higher value than other simulants investigated to date, no pitting corrosion was noted on the CPP specimen. Thus, it appears that nitrite, combined with other inhibitory species (e.g., hydroxide, aluminate), efficiently inhibited localized corrosion in the evaporated simulant.

4.1.2 Liquid/Vapor Interfacial Corrosion in AP-105-PSC

Figure 9 is a comparison of the CPP curves obtained in AP-105-PSC simulant when the specimen was partially immersed in quiescent air conditions and fully immersed in deaerated conditions. The sample was partially immersed to create a liquid/vapor interface that simulated the sample configuration in the SSRTs. In the SSRTs, which were all performed in quiescent air conditions, a liquid/vapor interface was present and severe attack at the interface was observed after polarizing to 0 mV vs. SCE at 50°C for approximately 60 hours in the AP-105-PSC simulant. Details of the SSRT results are discussed in the following section. Also, the investigation of corrosion at the interface could provide insight into the integrity evaluation of the waste storage tanks because a liquid/vapor interface will be present at the supernate level in the tank. As

mentioned above, a slightly positive hysteresis loop was observed when the sample was fully immersed in the deaerated simulant. However, the CPP curve for the partially immersed specimen in quiescent conditions exhibited a large hysteresis. The post-test inspection of the partially immersed sample revealed corrosion at the bottom of the sample, near the liquid/vapor interface, and the portion exposed to the vapor phase (Figure 10). The attack at the liquid/vapor interface was further investigated in a set of potentiostatic tests, as will be discussed below.

Figure 9. A Comparison of CPP Curves in Nitrogen Deaerated AP-105-PSC Simulant at Different Nitrite and Nitrate Concentrations (pH=13+, T=50°C).

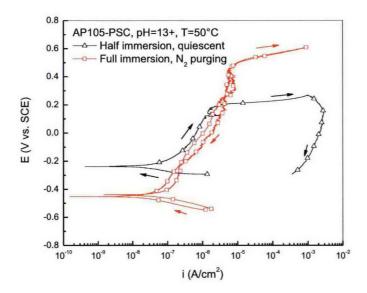


Figure 10. Sample Appearance after CPP Testing in AP-105-PSC Simulant under Quiescent Air Conditions (pH=13+, T=50°C).

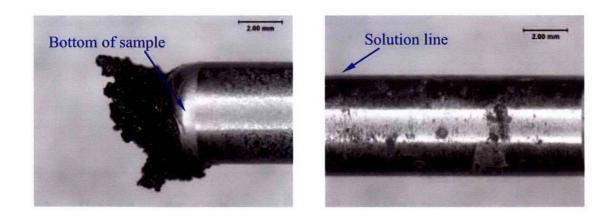


Figure 11 shows the current change as a function of time when a partially immersed sample was polarized at 0 mV vs. SCE for 50 hours (pH>13, T=50°C) in an AP-105-PSC simulant under quiescent conditions. The current measured in the potentiostatic test showed a sharp increase shortly after the potentiostatic test began. Severe corrosion attack was noted on the sample at the liquid/vapor interface, as shown in Figure 12 (a). Corrosion attack was also observed on the specimen areas that were above the liquid/vapor interface (Figure 12 (b)). The observed corrosion attack was similar to that observed on the SSRT sample when exposed to the same simulant under quiescent air conditions. In contrast, no corrosion was noted on a fully immersed sample in the same environment and conditions. The measured current density remained low indicating passive conditions throughout the test, as shown in Figure 13.

Figure 11. The Change in the Current as a Function of Time when the Partially Immersed Sample Was Held at 0 mV vs. SCE (AP-105-PSC, pH>13, T=50°C, Quiescent Air Conditions).

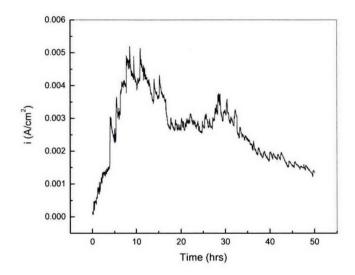
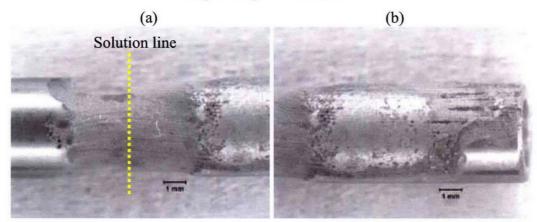


Figure 12. The Sample Appearance after 50 Hours of Potentiostatic Testing at 0 mV vs. SCE in the AP-105-PSC Simulant (pH>13, T=50°C, Quiescent Air Conditions).

(a) Corrosion at Liquid/vapor Interface; (b) Corrosion on the Portion above the Liquid/vapor Interface.



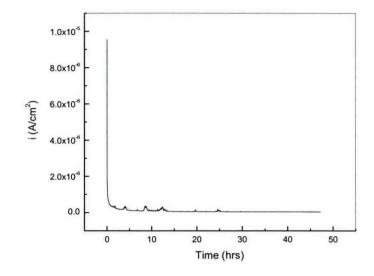


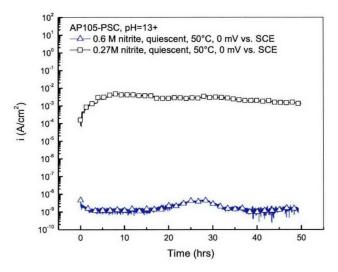
Figure 13. Current as a Function of Time for Fully Immersed Sample Polarized at 0 mV vs. SCE in AP-105-PSC Simulant (T=50°C, pH>13) Under Quiescent Air Conditions.

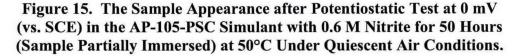
The contrasting results of severe corrosion attack for the partially immersed specimen and no corrosion attack for the fully immersed specimen are likely related to chemical reactions occurring at the interface. Typically, materials corrode more readily (at a higher rate) at a liquid/vapor interface than in the bulk in an aggressive environment. This is because oxygen is more readily available at the interface than in the bulk solution, allowing oxygen to contribute more significantly to the cathodic reaction (assuming oxygen reduction dominates the cathodic kinetics). However, when a sample is polarized to a noble potential (e.g., 0 mV vs. SCE as it was in these experiments), it is expected that all the cathodic reactions would be displaced to the counter electrode. This indicates that the fully immersed and partially immersed specimen should have similar cathodic reactions (as well as similar anodic reactions). Therefore, it is possible that some unknown reactions at the interface created a locally aggressive environment that resulted in severe corrosion attack of the partially immersed specimen.

While corrosion attack was noted at the liquid/vapor interface in quiescent air, the extent of corrosion attack was greatly decreased when the nitrite concentration was increased to 0.6M. The observed decrease in current density with the higher nitrite concentration is shown in Figure 14. Minimal corrosion attack was observed for this condition as shown in Figure 15.

Similarly, the current densities under deaerated conditions were lower than under quiescent conditions for the AP-105-PSC simulant with 0.27 M nitrite, as shown in Figure 16. The corrosion attack on the samples tested in deaerated simulants was also less severe than that observed under quiescent air conditions (see Figure 17). Additionally, the corrosion attack was noted to be less severe when the solution was actively sparged with nitrogen (Figure 16 and Figure 17). Note that in the test for the sample shown in Figure 17, though, the interface was actively disturbed and mixed with the bulk solution under the gas purging.

Figure 14. A Comparison of the Change in the Current as a Function of Time in the Potentiostatic Tests Conducted in AP-105-PSC Simulants with Different Nitrite Concentrations at 50°C and Quiescent Air Conditions.





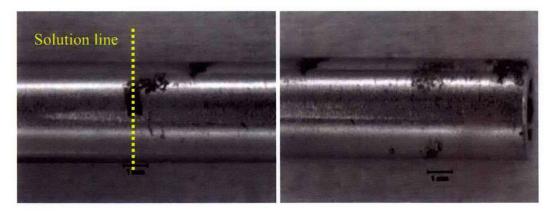


Figure 16. A Comparison of the Current Density as a Function of Time in the Potentiostatic Tests Conducted at 0 mV (vs. SCE) in Quiescent and Nitrogen Purged AP-105-PSC Simulants at 50°C.

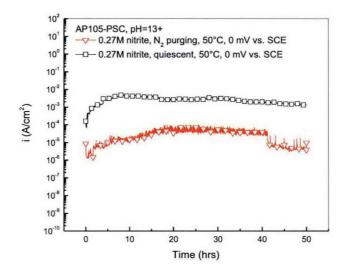
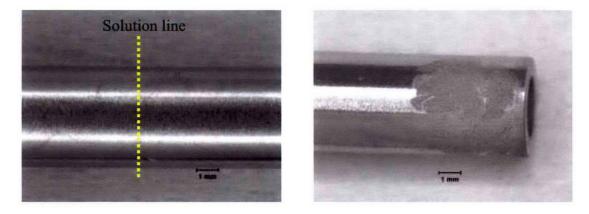


Figure 17. The Sample Appearance after Potentiostatic Test at 0 mV (vs. SCE) in Nitrogen Deaerated AP-105-PSC Simulant for 50 hours (Sample Partially Immersed) at 50°C.



Initially, it was thought that the rapid corrosion observed at the liquid/air interface was linked to the oxidation of nitrite in the presence of oxygen. However, corrosion at the interface was still observed in one test in which the head space of the test cell was purged with nitrogen to eliminate oxygen (i.e., the solution was not agitated). The current change as a function of time is shown in Figure 18 and the sample appearance after the potentiostatic test is shown in Figure 19. This demonstrated that the attack at the interface at 0 mV vs. SCE could still occur in the absence of oxygen. It also indicated that the role of nitrogen when actively purging the simulant was to primarily mix the bulk solution and the interface environment so that the local aggressive environment could be eliminated. Thus, it seems necessary to have a stable liquid/vapor interface to maintain the local chemistry at the interface in order to observe the corrosion attack as shown in Figure 12.

Figure 18. The Current Density as a Function of Time in the Potentiostatic Tests Conducted at 0 mV (vs. SCE) in AP-105-PSC Simulants with the Head Space of the Test Cell Purged with Nitrogen at 50°C.

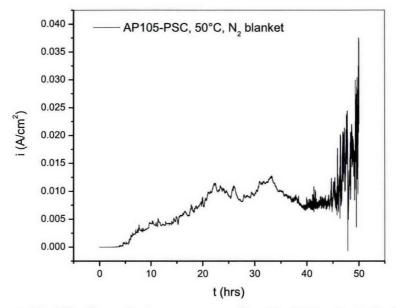
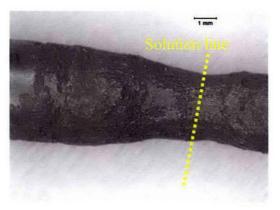


Figure 19. The Sample Appearance after the Potentiostatic Tests Conducted at 0 mV (vs. SCE) in AP-105-PSC Simulants with the Head Space of the Test Cell Purged with Nitrogen at 50°C.



The extent of corrosion attack at the liquid/vapor interface at a polarized potential decreased significantly with a decrease in temperature from 50°C to room temperature. Figure 20 shows a comparison of the current density as a function of time at room temperature (\sim 25°C) and 50°C at 0 mV vs. SCE with quiescent air in the head space. Although corrosion was noted when the solution was at room temperature and at 0 mV vs. SCE, the extent of corrosion was much less severe compared to 50°C and 0 mV vs. SCE (Figure 22 (a) vs. Figure 12). The current density at room temperature did increase dramatically after approximately 33 hours of exposure (Figure 20), while at a temperature of 50°C under the same conditions, the current increased within the first few hours, indicating the onset of corrosion.

The applied potential also had an impact on the onset of corrosion initiation at the liquid/vapor interface. Figure 21 shows that corrosion initiation took approximately 10 hours to appear at the interface when polarized to 100 mV vs. OCP (-204 mV vs. SCE) at 50°C and under quiescent air conditions. Comparatively, the current increased (i.e., corrosion initiated) within a few hours at 0 mV vs. SCE at 50°C in quiescent air conditions. A similar trend was observed at room temperature. In Figure 21 (b), the current did not increase within 50 hours of exposure at room temperature with an applied potential of 50 mV vs. OCP (-160 mV vs. SCE). However an increase in the current was noted after 33 hours at room temperature and an applied potential of 0 mV vs. SCE. Figure 22 (b) shows minimal corrosion attack at the interface for the 50mV vs. OCP potentiostatic polarization at room temperature and quiescent air conditions. As expected from the current transient data, the corrosion attack for the 0 mV vs. SCE, room temperature, quiescent air case (Figure 22 (a)) was more severe; however, the overall corrosion damage to both specimens was not substantial.

Figure 20. Current as a Function of Time in Potentiostatic Tests Conducted at Different Temperature Levels and Quiescent Air Conditions.

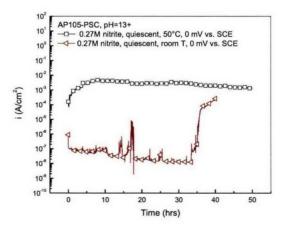
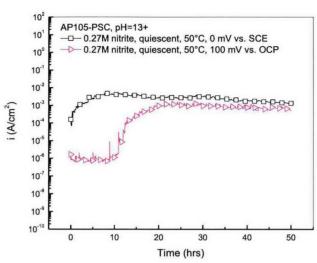


Figure 21. Current Density as a Function of Time in the Potentiostatic Tests Conducted in AP-105-PSC Simulants Under Quiescent Air Conditions at (a) 0 mV (vs. SCE, 50°C) and 100 mV (vs. OCP, 50°C); (b) 50 mV (vs. OCP, Room Temperature) and 0 mV (vs. SCE, Room Temperature).



(a)



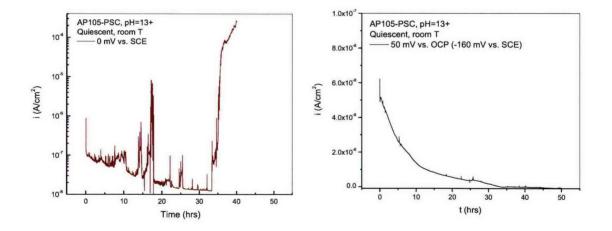
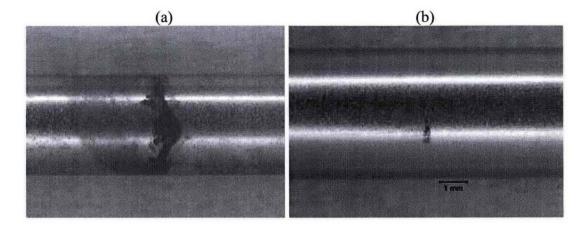
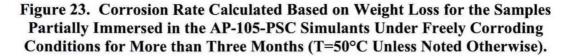


Figure 22. Sample Appearance after 50 Hours Potentiostatic Testing in AP-105-PSC Simulant at Different Potentials (Under Quiescent Air Conditions, Room Temperature). (a) 0 mV vs. SCE; (b) 50 mV vs. OCP (-160 mV vs. SCE).



To further investigate the corrosion attack at the liquid/vapor interface in the AP-105-PSC simulant, long-term immersion tests were performed with the samples partially immersed in the simulant to create a liquid/vapor interface. The effect of gas purging (through the bulk solution and the cell head space), temperature levels (room and 50°C), gas types (quiescent, compressed zero air, nitrogen and argon) on the interfacial corrosion susceptibility and extent were of particular interest. Figure 23 compares the corrosion rates of the samples that were partially immersed in the AP-105-PSC simulant at different conditions. It should be noted that the corrosion rate was calculated using the exposed surface area. This tends to underestimate the corrosion rate since the corrosion attack usually focused at the liquid/vapor interface or a few local sites. The samples exposed to the simulant open to the ambient air showed evident attack at the liquid/vapor interface (Figure 24 and Figure 25) and the extent of corrosion was less at room temperature. The corrosion rates at the other conditions (e.g., purged with nitrogen, argon and compressed zero air) did not differ from each other significantly. Additionally, the corrosion attack on the samples partially immersed in the actively sparged simulants were mainly located on the portion exposed to the vapor space region. Conversely, the corrosion was widely spread to the entire sample surface in cases where the solution remained stagnant or only the head space of the cell was purged with gases. These differences in the amount and mode of attack may suggest that the mixing of the bulk solution and the interface solution may have prevented the formation of a relatively aggressive environment adjacent to the sample surface.

It was also noted that the samples exposed to solutions with oxygen behaved differently. When the solution was open to the ambient air, the corrosion attack was more severe at an elevated temperature than at room temperature. In the case where the oxygen was introduced by actively purging the solution using zero air (i.e., air without CO₂), the corrosion was minor as the mixing of the interface with the bulk likely prevented the locally aggressive environment from forming. When the head space of the cell was purged with zero air, the corrosion attack was still not as severe as that in the solution open to the ambient air. Since the pH of the bulk solution did not change dramatically after the exposure, as shown in Table 6, it is not clear whether the local pH change at the interface played a significant role on the initiation of the attack at the interface.



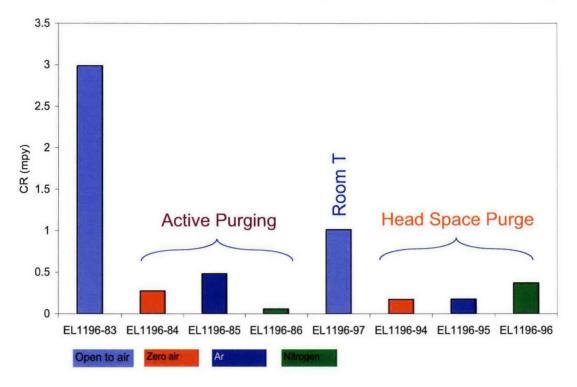


Figure 24. The Appearance of the Sample (a) and the Cross Section of a Corroded Site (b) after Exposed in AP-105-PSC under Quiescent Air Conditions (Sample Partially Immersed, T=50°, EL1196-83).

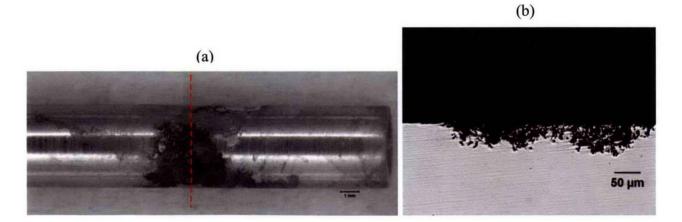


Figure 25. The Appearance of the Sample (a) and the Cross Section of a Corroded Site (b) after Exposed in AP-105-PSC under Quiescent Air Conditions (Sample Partially Immersed, Room Temperature, EL1196-97) at OCP.

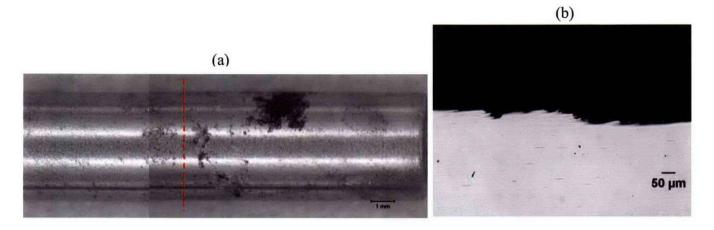


Table 6. The Bulk pH Values of the Simulant after the Long-Term Immersion Tests.

Exposed sample	Solution pH after test
EL1196-83	13.28
EL1196-84	13.23
EL1196-85	13.32
EL1196-86	13.21
EL1196-97	13.32
EL1196-94	13.4
EL1196-95	13.44
EL1196-96	13.38

The interfacial corrosion appears to be a complicated process and the exact mechanism is still uncertain without conducting a comprehensive investigation. Based on the results obtained to date in the present work, several mechanisms are possible, as discussed below.

(a). Nitrite depletion through oxidation at a polarized potential

Severe attack at the interface in deaerated AP-105-PSC simulants at polarized potentials above OCP may be able to convert the inhibitory nitrite locally to nitrate. Thus, a locally aggressive environment could be formed. It has been demonstrated above that the interfacial attack strongly depends on the applied potential. Typically, a more positive polarized potential led to more severe attack with a shorter initiation time. The depletion of nitrite could be linked to the oxidation of nitrite to nitrate via the electrochemical reaction below:

 $NO_2^- + H_2O \rightarrow NO_3^- + 2H^+ + 2e^-$

$E(NO_2^-/NO_3^-) = 0.835 - 0.000198TpH + 0.000099T \log([NO_3^-]/[NO_2^-])$

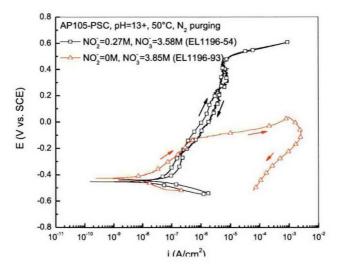
The equilibrium potential for this half reaction is listed in Table 7. Clearly, a polarization of 0 mV vs. SCE and 50 mV vs. OCP (-160 mV vs. SCE) are both sufficiently noble to oxidize nitrite to nitrate and the oxidation is still thermodynamically possible even at some OCPs. Although nitrite oxidation can occur anywhere on the immersed electrode surface, the local depletion can be compensated by the nitrite in the bulk solution through mass transport. At the liquid/vapor interface, however, the mass transport may be limited such that a local low nitrite environment can be maintained to form an aggressive environment.

Table 7. The Equilibrium Potential of Nitrite and Nitrate Redox Couple as a Function ofTemperature at pH 13.5 (Nitrite=0.27M, Nitrate=3.58M).

T (°C)	E (V vs. SCE)
25	-0.170
50	-0.235

To illustrate that the depletion of nitrite and a corresponding increase in nitrate concentration compared to the bulk AP-105-PSC simulant solution could lead to a more corrosive environment, a modified AP-105-PSC simulant was created in which the nitrite was removed and the nitrate concentration was increased to 3.85 M. This high nitrate content represents complete conversion of nitrite to nitrate. CPP testing showed an open hysteresis loop (Figure 26) with severe localized corrosion attack noted, as shown in Figure 27. Clearly, the depletion of nitrite can lead to a very aggressive environment. The CPP curve shows a repassivation potential more negative then the OCP, indicating that localized corrosion may occur at open circuit. This could be a plausible explanation for the observation of severe corrosion in the vapor phase and interfacial regions on some samples.

Figure 26. A Comparison of CPP Curves in Nitrogen Deaerated AP-105-PSC Simulant at Different Nitrite and Nitrate Concentrations (pH=13+, T=50°C).



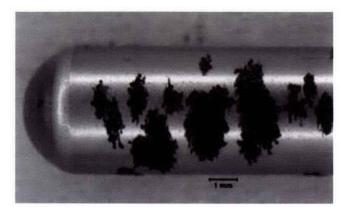


Figure 27. The Sample Appearance after CPP Testing in Nitrogen Deaerated AP-105-PSC with No Nitrite and 3.85 M Nitrate (pH=13+, T=50°C).

(b). Oxygen enhanced corrosion and possible nitrite depletion

In general, increased oxygen concentration results in higher corrosion rates. Furthermore, the role of oxygen is uncertain in the process of nitrite depletion. Oxygen may be a promoter for the nitrite depletion to aid in creating a more corrosive environment. As shown Figure 28, the CPP curve in AP-105-PSC simulant under quiescent air conditions and 50°C showed a positive hysteresis loop and the sample showed pitting corrosion (Figure 29). In the long-term immersion tests, however, the samples immersed in the simulants purged by compressed zero air (no CO_2) did not show appreciable corrosion attack. These observations seem to indicate that the presence of oxygen may have no strong influence on the liquid/vapor corrosion, and the lack of CO_2 and observable corrosion in the zero air (and nitrogen), suggests that CO_2 may be the controlling species in liquid/vapor corrosion process.

Figure 28. A Comparison of the CPP Curves Obtained in the AP-105-PSC Simulant under Different Aeration Conditions using Fully Immersed Samples.

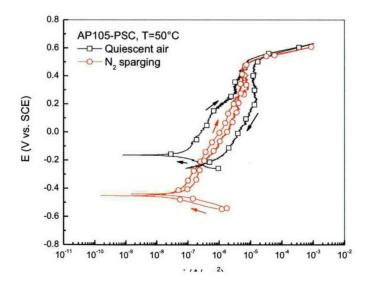




Figure 29. The Pit on the Sample Tested in the AP-105-PSC Simulant Under Quiescent Air Conditions and at 50°C (pH=13+).

(b). Local pH change causes an aggressive environment

In the long-term immersion tests, the samples immersed in the simulants under quiescent conditions (open to air) showed appreciable interface attack. However, when the solution or the cell head space was purged with zero air (compressed air without CO_2), the corrosion attack was minimal. This may indicate that the attack at the interface was due to a change in the interfacial pH resulting from reaction with CO_2 in the air.

The results of the four tests in which oxygen and carbon dioxide were both excluded from the test systems with the AP-105 simulant at 50 °C imply that one or both of these gases are required for rapid corrosion at the liquid air interface. The results of the two tests carried out with air from which carbon dioxide has been removed imply that the carbon dioxide content of air is the key factor in determining the rate of the interfacial corrosion process. Because in the absence of carbon dioxide the corrosion rate was low and since the bulk pH at the conclusion of these tests was observed to be similar, it seems that interfacial corrosion is a localized phenomena and that the rate of transport of hydroxide ion from the bulk solution to the corrosion site is insufficient to neutralize the acidic influence of carbon dioxide in unmixed solutions. However, no confirmatory chemical analysis has been performed to validate the proposed CO_2/pH reduction mechanism.

4.2 SLOW STRAIN RATE TESTING IN TANK 241-AP-105 BASED SIMULANTS

Table 8 summarizes the results of SSRTs performed in AP-105 based simulants. Variants include "mixed" and "evaporated" simulants. Tests were performed at 50°C, at potentials of 0 mV and -250 mV vs. SCE, and at OCP. In two cases the tests were stopped at the ultimate tensile strength of the steel, in order to study the role of the strain in the development of intergranular SCC in the gage sections of the samples. Replicate tests were conducted for some conditions.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
50	AP-105-PSC	13+	50	0	-242	15.0	41.6	Visual cracking	
51	AP-105-PSC	13+	50	ОСР	-249	22.3	62.1	Secondary Crack IG	1.3 x 10 ⁻⁷
52	AP-105-PSC	13+	50	OCP	-289	21.5	62.1	Ductile*	-
53	AP-105-PSC	13+	50	0	-259	16.3	49.2	Visual cracking	3 x 10 ⁻⁶
54	AP-105-PSC	13+	50	0	-287	19.4	53.8	Visual cracking	
59	AP-105- Evaporated	13+	50	ОСР	-510	21.2	59.0	Ductile	-
60	AP-105-PSC**	13+	50	OCP	-277	-	-	No cracking	-
62	AP-105- Evaporated (ratio 0.1)	13+	50	ОСР	-333	23.3	64.7	Ductile	-
63	AP-105-Mixed (ratio 0.1)	13+	50	OCP	-259	23.2	64.3	Ductile	
64	AP-105-Mixed	13+	50	ОСР	-312	21.7	60.3	Ductile	
65	AP-105-PSC**	13+	50	-250	-281	-	-	No cracking	-

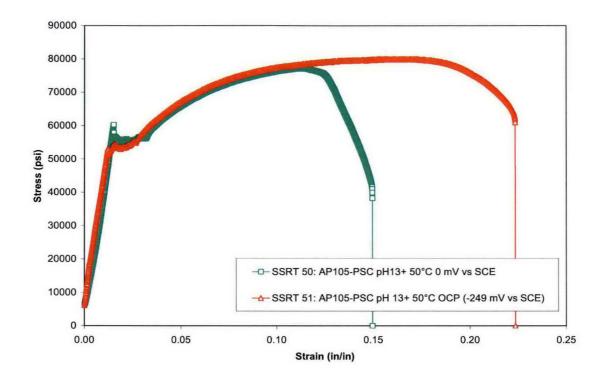
Table 8. A Summary of Slow Strain Rate Tests Performed in AP-105 Based Simulants.

*Secondary cracks were re-examined using the SEM, no apparent intergranular features

** Test was stopped at ultimate tensile stress

Figure 30 shows a plot of the stress-strain data from two of the slow strain rate tests, SSRT 50 and 51, performed in the AP-105-PSC base simulant. The specimens failed at 15.0 and 22.3 % strain. The former failure strain is lower than expected for this grade of steel, and is indicative of reduced cross-sectional area associated with severe corrosion attack during the testing. Visual and stereo-graphic examination of the test specimens indicated severe corrosion, though the nature of the corrosion was not typical of the corrosion that had been observed in previous testing.





A fracture surface examination of the samples tested at OCP (SSRT 51 and SSRT 52) indicated ductile failure. However, in SSRT 51, with an OCP of -249 mV vs. SCE, secondary crack examination showed intergranular features, indicative of high pH SCC (Figure 31). Similar behavior has been observed in previous testing, for example testing in modified AY-102 simulants with high nitrate contents when the specimen was polarized between -200 to -300 Mv vs. SCE. In addition, some tarnishing was seen on the shafts of samples as shown in Figure 32.

The intergranular features observed in the secondary cracks in the shaft of SSRT 51, tested in AP-105-PSC simulant at OCP, were unexpected. SCC has not been observed in any tests performed at OCP in waste simulants, including AN-107. One thought is that the sample may have been overly strained to enable the formation of the side cracks. This overly strained condition is unlikely to be relevant under normal tank operations. To investigate the role of strain, SSRT 60 was performed in AP-105-PSC simulant at OCP, but the test was stopped at the ultimate tensile strength. Post-test examination did not reveal any evidence of secondary cracking (Figure 33).

Figure 31. An Electron-Micrograph of a Secondary Crack in Test Sample SSRT-51 Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at OCP (-249 mV vs. SCE).

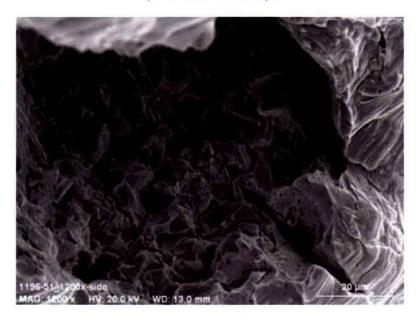


Figure 32. A Stereo-Micrograph of the Test Sample from SSRT-51 Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at OCP (-249 mV vs. SCE).

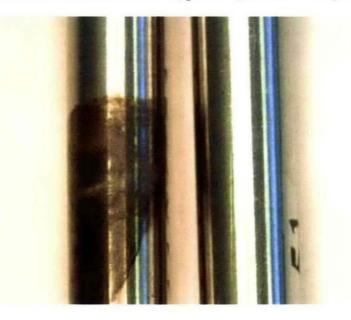


Figure 33. A Stereo-Micrograph of the Test Sample from SSRT-60 Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at OCP (-277 mV vs. SCE). The test was stopped at the ultimate tensile strength.



It was also noted that the OCP in SSRT 51 was -249 mV and the OCP in SSRT 52 was -289 mV vs. SCE. The test performed at the more noble potential was the one that had intergranular features. To determine if the more noble potential and/or the increased strain was primarily responsible for the SCC at OCP, SSRT 65 was performed in AP-105-PSC simulant at -250 mV vs. SCE, and stopped at the ultimate tensile strength. No secondary cracking was observed, indicating the SCC in SSRT 51 was most likely influenced by the high strain.

Examination of the fracture surface of the samples tested at 0 mV vs. SCE in the AP-105-PSC simulant showed intergranular features, indicative of high pH SCC (Figure 34). The observation of SCC at 0 mV vs. SCE is expected in a nitrate-based simulant, based on the results obtained in the previous testing programs. Previous testing had demonstrated that steels were susceptible to SCC in simulants containing high concentrations of nitrate and with low concentrations of inhibiting nitrite.

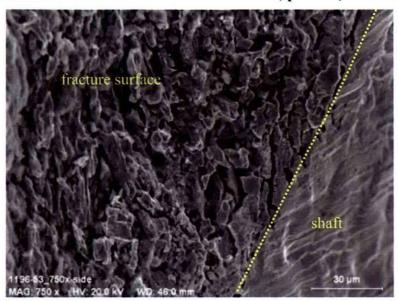


Figure 34. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-53 Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at 0 mV vs. SCE.

Visual examination of the samples tested under polarizing conditions (0 mV vs. SCE) also revealed severe corrosion on the sample above the gauge section (Figure 35 and Figure 36). A close examination of the SSRT cell indicated that the corroded section was at the liquid/vapor interface (Figure 37). Similar corrosion attack was observed in replicate tests. The discussion in the earlier section suggests the attack at the interface may be a result of the depletion of the inhibiting species (e.g., nitrite) or a reduction in the interfacial pH, both of which would result in the formation of a locally aggressive environment.

Significant corrosion has not been observed during SSR testing except under highly aggressive conditions in modified AN-107 simulants. Re-examination of the samples from testing in AN-107 with decreased nitrite concentrations showed severe corrosion along the entire length on the test sample, as opposed to just at the liquid/vapor interface. For those tests in the AN-107 program, however, the nitrite concentration was lower than 0.27 M while the simulant contained comparable amount of nitrate. Thus, the environment was sufficiently aggressive to attack the entire immersed portion. In the case of AP-105-PSC, it seems the nitrite concentration is near a threshold level below which localized corrosion could initiate. Therefore, the corrosion was observed at the liquid/vapor interface where even a slight decrease in nitrite or drop in pH could change its concentration to be below the threshold leading to an aggressive environment.

Corrosion attack was also seen near the base of several test samples. This attack was originally believed to be crevice corrosion associated with the seal between the test cell and sample. However, further examination indicated the corrosion was higher up on the sample than the test cell seal. Because a significant amount of corrosion product was observed at the interface (Figure 36), it was speculated that corrosion products may have accumulated at the base of the test cell and contributed to creating an occluded region. This hypothesis, however, was not studied further but is supported by the observation of corrosion products at the location of heavy corrosion. What is unclear is if the buildup of corrosion products is the cause or the result (or both) of the corrosion reaction at this location.

Figure 35. Stereo-Micrograph of the Test Sample from SSRT-53 Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at 0 mV vs. SCE.

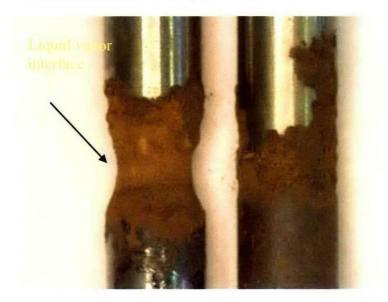
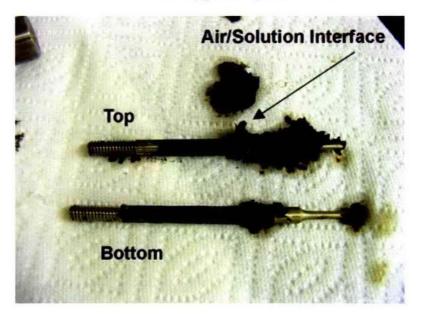


Figure 36. Photograph of the Test Sample from SSRT-54 Performed in AP-105-PSC Standard Simulant at 50°C, pH 13+, and at 0 mV vs. SCE.



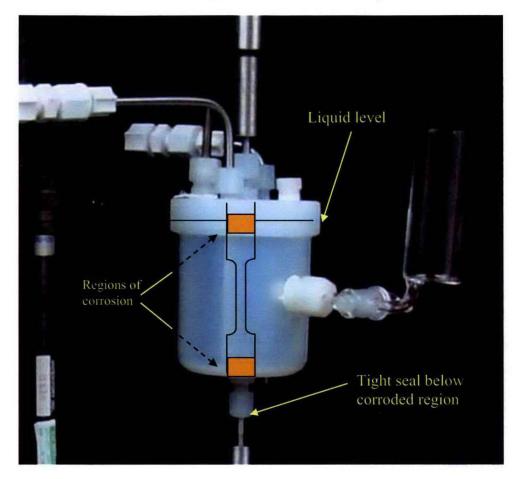


Figure 37. Photograph and Schematic of the Test Cell and Sample Indicating Regions of Corrosion (Schematic Not To Scale).

Tests performed in the AP-105 variants, that is mixed and evaporated simulants (SSRT 64 and SSRT 59, respectively), showed no evidence of SCC. These simulants have nitrite/nitrate ratios of ~0.14, so it was expected there may be SCC based on previous testing in the simulants with low nitrite contents. The simulants were modified to further decrease the nitrite/nitrate ratio to 0.1 to study the SCC sensitivity to the chemistry. SSRT 63 and SSRT 62, performed in mixed and evaporated simulants with a decreased nitrite content showed no evidence of SCC. Note that all of these tests were performed at OCP, and potentials were lower than potentials at which SCC has typically been observed.

4.3 ELECTROCHEMICAL POLARIZATION BEHAVIOR IN TANK 241-SY-103-PIL BASED SIMULANTS

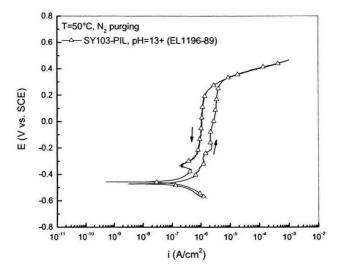
Table 9 summarizes the results of a CPP test conducted in the SY-103-PIL baseline simulant that investigated the susceptibility of the steel to localized corrosion in a simulant containing high chloride (0.5M). The chloride concentration in this simulant is the highest among the simulants that have been investigated thus far. No tests were performed in modified SY-103-PIL simulants.

Base Chemistry	pH	NO2 [*] (M)	NO3 ⁻ (M)	TIC (M)	OH ⁻ (M)	Cl ⁻ (M)	F (M)	T (°C)	Aeration condition	Visual	Sample ID (#EL1196-)
SY-103- PIL	>13	2.91	1.97	0.123	2.43	0.5	0	50	N ₂ purging	No pitting	89

Table 9. A Summar	of Electrochemical Test Performed in SY-103-PIL Based Simulant	t.

Figure 38 shows the CPP curve obtained in deaerated SY-103-PIL simulant at 50°C with a pH above 13. The CPP curve showed a negative hysteresis loop. No pitting corrosion was noted on the samples during post-test inspection. This phenomenon could indicate that there are other inhibiting species present in this simulant (e.g., 2.91 M nitrite in SY-103-PIL and/or pH 13), even though the chloride concentration in this simulant is high, 0.5 M.

Figure 38. A CPP Curve in Deaerated SY-103-PIL Simulant (pH>13 and T=50°C).



4.4 SLOW STRAIN RATE TESTING IN TANK 241-SY-103-PIL BASED SIMULANTS

Table 10 summarizes the results of the slow strain rate tests performed in SY-103-PIL simulants in quiescent air. Tests were performed at 50°C, and potentiostatically polarized to 0 mV vs. SCE or at OCP. Both tests were performed in the standard SY-103-PIL simulant. This simulant has high nitrate (1.97 M) and nitrite (2.91 M) concentrations, as well as a high chloride (0.5 M) concentration.

Table 10. A Summary	of Slow St	train Rate'	Tests Performe	d in SY-103-PI	L Based Simulants.
I dole IV. II Summer		LI MIII ILMEU	I COLO I CITOI IIIC		Daved Dimanator

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
55	SY-103-PIL	14	50	ОСР	-424	22.0	61.2	Ductile	-
57	SY-103-PIL	14	50	0	-477	22.4	62.2	Ductile	-

Figure 39 is a plot of the stress-strain data from the two tests. When polarized to 0 mV vs. SCE the SSRT specimen failed at 22.4% strain. The specimen that was tested at open circuit failed at 22.0% strain. No evidence of SCC was observed in either of the tests. Both stereoscopic (Figure 40) and electron microscopic (Figure 41) examinations displayed ductile fracture features. Examination of the secondary microcracks observed in the gauge section of the specimen indicated no intergranular features. These results are consistent with CPP results already discussed. That is, although chloride concentration is elevated in this simulant, other inhibiting chemicals may still be able to prevent SCC.

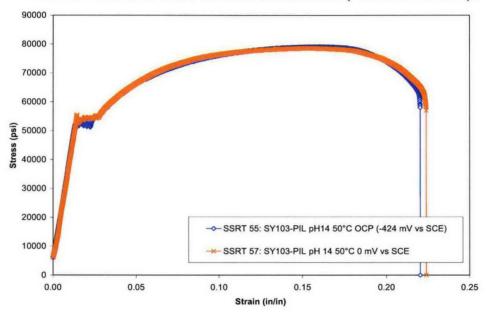
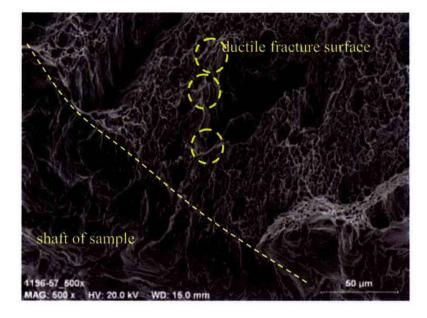


Figure 39. The Stress-Strain Behavior of Samples Tested in SY-103-PIL Based Simulants at 0 mV vs. SCE and at OCP (-424 mV vs. SCE).

Figure 40. Stereo-Micrograph of the Test Sample from SSRT-57 Performed in SY-103-PIL Standard Simulant at 50°C, pH 14, at a Potential of 0 mV vs. SCE. The yellow dashed circles indicate axial microcracks observed on the shaft of the sample.



Figure 41. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-57 Performed in SY-103-PIL Standard Simulant at 50°C, pH 14, at a Potential of 0 mV vs. SCE.



4.5 ELECTROCHEMICAL POLARIZATION BEHAVIOR IN TANK 241-AW-105 BASED SIMULANTS

Table 11 summarizes the CPP test conducted in the AW-105 baseline simulant. These tests were aimed at investigating the susceptibility of the steel to localized corrosion in simulants containing high fluoride concentrations (0.58M fluoride in the AW-105-PIL simulant) or a low nitrite-to-nitrate concentration ratio (Nitrite/nitrate of 0.145 in the AW-105-PSC simulant). No tests were performed using modified AW-105 simulants.

Table 11. A Summar	y of Electrochemical	Test Performed in AW-10	5 Based Simulant.
--------------------	----------------------	-------------------------	-------------------

Base Chemistry	pH	NO2 ⁻ (M)	NO3 ⁻ (M)	TIC (M)	ОН ⁻ (М)	Cl ⁻ (M)	F ⁻ (M)	Т (°С)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AW-105-PIL	>13	0.124	0.419	0.097	0.4502	0.01	0.58	50	N ₂ purging	CPP Full immersion	No pitting	90
AW-105-PSC	>13	0.0638	0.44	0.1076	0.2630	0.0083	0.156	50	N ₂ purging	CPP Full immersion	No pitting	108

Figure 42 shows the CPP curve obtained in deaerated AW-105-PIL simulant at 50°C with a pH above 13. The CPP curve showed a negative hysteresis loop and no pitting corrosion was noted on the samples during post-test inspection even though the fluoride concentration in this simulants is as high as 0.58 M. This indicates that either there are other inhibiting species present in these simulant (e.g., pH 13) or that the concentration of the aggressive species (e.g., nitrate at 0.42 M) is below a critical threshold above which localized corrosion would occur.

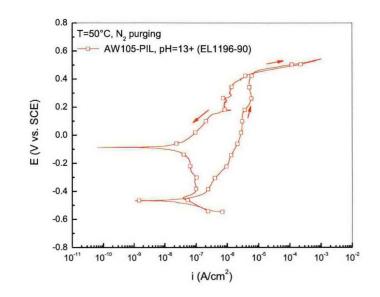
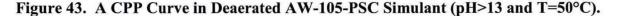
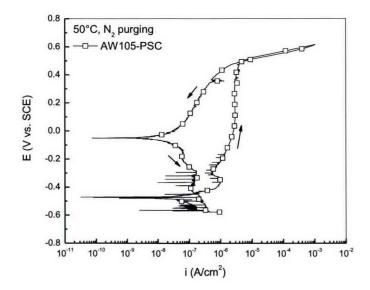


Figure 42. A CPP Curve in Deaerated AW-105-PIL Simulant (pH>13 and T=50°C).

Figure 43 is a CPP curves in deaerated AW-105-PSC simulant at 50°C. Again, no clear positive hysteresis loop was observed on the curve and the sample did not show any indication of localized corrosion. The lack of localized corrosion on the samples suggests that even though the nitrite/nitrate ratio in this simulants is lower than other simulants investigated before, other inhibitory species present in these simulants were able to efficiently prevent localized corrosion. Additionally, the benign nature of these simulants with respect to localized corrosion may be a result of the relatively low concentration of the aggressive nitrate.





4.6 SLOW STRAIN RATE TESTING IN TANK 241-AW-105 BASED SIMULANTS

Table 12 summarizes the results of the SSRTs performed in AW-105 based simulants. Tests were performed at 50°C and at OCP or potentiostatically polarized to 0 mV vs. SCE. Two tests were performed in the base AW-105-PIL simulant. This simulant has a low nitrate (0.42 M) and nitrite (0.12 M) concentration, as well as a high fluoride (0.58 M) content. Six tests were performed in AW-105-PSC or PSC-modified simulant. The PSC simulant has a low nitrate (0.44 M) and low nitrite (0.06 M) concentration. The PSC –modified tests were performed with either half the typical nitrite, or with three times the typical nitrite and six times the typical nitrate. These modifications were made to study the nitrite / nitrate ratio versus potential relationship.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
56	AW-105-PIL	13+	50	OCP	-290	22.3	62.0	Ductile	-
58	AW-105-PIL	13+	50	0	-193	21.7	60.3	Ductile	-
66	AW-105-PSC	13+	50	OCP	-235	21.3	61.9	Ductile	-
71	AW-105-PSC	13+	50	-100	-269	23.4	65.1	Ductile	-
72	AW-105-PSC	13+	50	-50	-210	21.9	60.8	Ductile	-
73	AW-105-PSC (half nitrite)	13+	50	-100	-217	22.5	65.4	Ductile	-
74	AW-105-PSC "6X"	13+	50	-100	-257	22.1	61.3	Ductile	-
75	AW-105-PSC "6X"	13+	50	-50	-270	8.5	23.6	Visible corrosion	

Table 12.	A Summary	of Slow Strain	n Rate Tests	S Performed in	n AW-105	Based Simulants.
A CONTRACT	I A NO WAAAAAAAAA	OR NAUTI NEL WIL	A ALCOLO A COCK	A CATOLANCE IN	A A A II AVE	

Figure 44 is a plot of the stress-strain data from the two tests performed in AW-105-PIL. When polarized to 0 mV vs. SCE, the SSRT specimen failed at 21.7% strain. The specimen that was tested at open circuit failed at 22.3% strain. Corrosion product was observed around axial microcracks along the shaft of the test sample that was performed at OCP (Figure 45). These microcracks have been observed in many of the previous test samples, and are attributed to grain boundary tearing. No intergranular features were observed during SEM examination, as shown in Figure 46 and Figure 47, though it is possible that such features corroded away prior to examination (though this seems unlikely given the nominally benign nature of this simulant) The test performed at 0 mV vs. SCE was also devoid of intergranular features on the fracture surface (Figure 48); however, there was some interfacial corrosion along the shaft of the test specimen at the liquid/vapor interface (Figure 49). Since the nitrite concentration in the AW-105-PIL is relatively low compared to other aggressive species, the attack at the interface may be due to a similar mechanism that led to the interface corrosion in the AP-105-PSC. That is, although the existing nitrite concentration was able to inhibit localized corrosion in the bulk solution, in the case that the nitrite concentration was decreased due to an unknown depletion mechanism at the interface, the environment could become aggressive to cause localized corrosion.

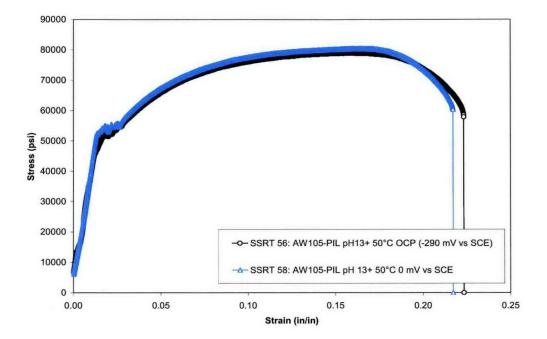


Figure 44. Stress-Strain Behavior of Samples Tested in AW-105-PIL Based Simulants at 0 mV vs. SCE and at OCP (-290 mV vs. SCE).

Figure 45. Stereo-Micrograph of the Test Sample from SSRT-56 Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+, at OCP (-290 mV vs. SCE). The yellow dashed circles indicate axial microcracks observed on the shaft of the sample.

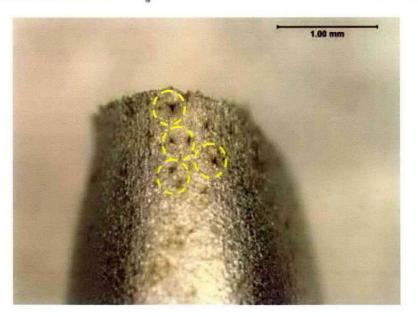


Figure 46. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-56 Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+, at OCP (-290 mV vs. SCE).

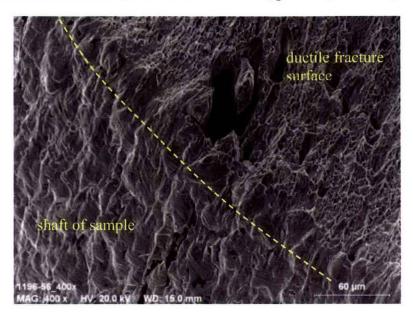


Figure 47. Electron-Micrograph of an Axial Micro-Crack on the Shaft of Test Sample from SSRT-56 Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+, at OCP (-290 mV vs. SCE).

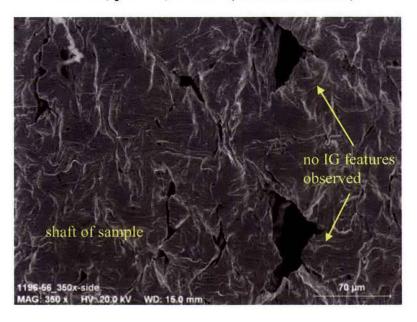


Figure 48. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-58 Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+, at 0 mV vs. SCE.

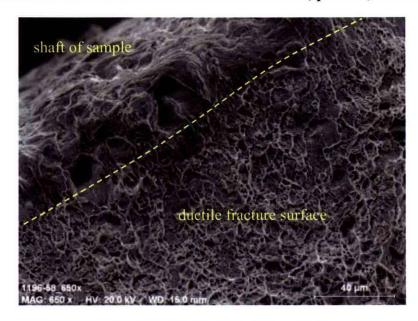
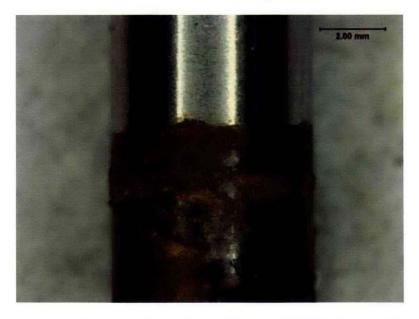
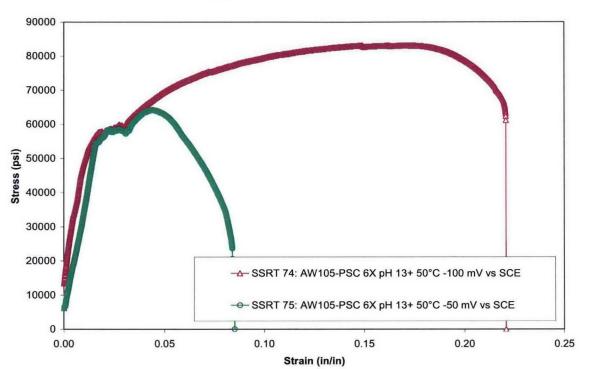


Figure 49. Stereo-Micrograph of the Shaft of Test Sample from SSRT-58 Performed in AW-105-PIL Standard Simulant at 50°C, pH 13+, at 0 mV vs. SCE.



Tests in AW-105-PSC base simulants showed no evidence of SCC when performed at OCP, -100 mV or -50 mV vs. SCE. Failure occurred between 21.3 and 23.4 %. Tests in the "6X" simulant were performed with the same nitrite/nitrate ratio as the "half nitrite" modified simulant, but with six times the absolute amounts of both nitrite and nitrate. This was done to explore the relations between nitrite / nitrate ratio and absolute nitrate content versus potential. Figure 50 is a plot of the stress-strain data from two of the tests performed in AW-105-PSC modified simulants. The test performed at -100 mV vs. SCE failed at 22.1 % strain. Corrosion was observed at the liquid/vapor interface, but no intergranular features were observed on the fracture surface during

SEM examination, see Figure 51 and Figure 52. The test performed at -50 mV vs. SCE failed at 8.5 % strain, and severe corrosion was observed on the fracture surface and along its gauge length, see Figure 53. The results suggest that there is a "critical" potential between -100 mV and -50 mV vs. SCE necessary for significant corrosion to occur in this modified simulant.



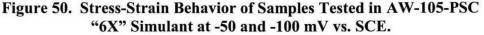


Figure 51. Photograph of the Test Sample from SSRT-74 Performed in AW-105-PSC 6X Simulant at 50°C, pH 13+, at a Potential of -100 mV vs. SCE.

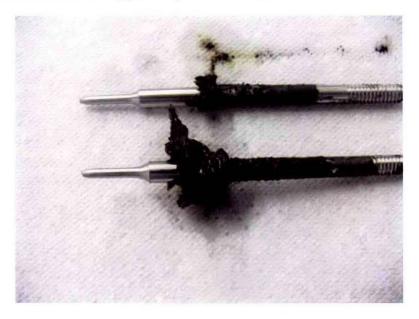


Figure 52. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-74 Performed in AW-105-PSC 6X Simulant at 50°C, pH 13+, at a Potential of -100 mV vs. SCE.

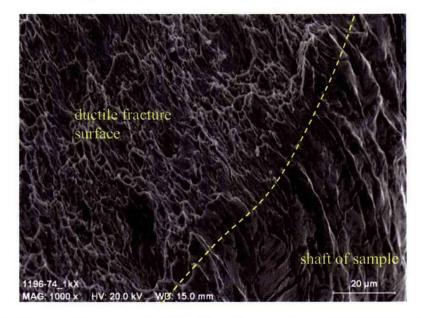
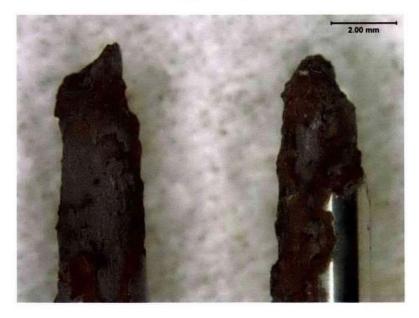


Figure 53. Stereo-Micrograph of the Test Sample from SSRT-75 Performed in AW-105-PSC 6X Simulant at 50°C, pH 13+, at a Potential of -50 mV vs. SCE.



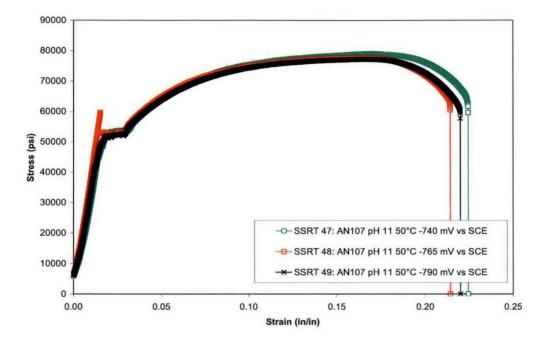
4.7 SLOW STRAIN RATE TESTING IN TANK 241-AN-107 BASED SIMULANTS

Table 13 summarizes the results of SSRTs performed in AN-107 simulants. Tests were performed at 50°C and potentiostatically polarized to potentials between -740 and -790 mV vs. SCE. The objective of these experiments was to test the propensity of carbonate cracking at low potentials since AN-107 simulant contains 1.4 M carbonate. Previous testing in AY-102-PIL simulants with high carbonate (1.021M) contents indicated cracking at low potentials -750 to -800 mV vs. SCE. These potentials correspond to the active-passive transition range observed in the AY-102-PIL CPP curve from previous studies.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
47	AN-107	11	50	-740	-315	22.5	62.9	Ductile	-
48	AN-107	11	50	-765	-296	21.4	61.6	Ductile	-
49	AN-107	11	50	-790	-274	22.0	61.1	Ductile	-

Table 13. A Summary of Slow Strain Rate Tests Performed in AN-107 Based	d Simulants.
-------------------------------------------------------------------------	--------------

Figure 54 is a plot of the stress-strain data from the three SSRTs. The samples all failed at strain from 21.4 to 22.5 %. No intergranular features were observed during SEM examination of any of these tests, suggesting the steel is not susceptible to cracking in AN-107 at potentials where carbonate cracking was observed in AY-102-PIL simulants, see example (Figure 55). It should be pointed out that the OCP of steel in the AN-107 simulants were generally much higher than the tested potentials above because the cathodic reactions were likely dominated by nitrite and/or nitrate reduction that occurred at potentials much more positive than -800 mV vs. SCE. In carbonate-based waste simulants, an active-passive transition associated with the formation of carbonate films was observed at potentials near -800 mV vs. SCE and was not observed on the CPP curves in the AN-107 simulants. Therefore, these tested potentials were selected similar to the potentials in AY-102-PIL where carbonate cracking was observed. Based on the observations in AY-102-PIL, the potential range for carbonate cracking was near -800 mV vs. SCE and fairly narrow. In the AN-107 simulants, the results above could indicate that cracking at these low potentials is not possible or the tested potentials may be away from any active/passive transition that may (or may not) be present. As mentioned above, because of the significant amount of nitrite and nitrate in AN-107 simulants, it is unlikely that the OCP of the tank steel would be anywhere near -800 mV vs. SCE and therefore the likelihood of the steel cracking at these low potentials is extremely small. Because of this, no further work was conducted to investigate the susceptibility of steel to carbonate cracking in AN-107 simulants.



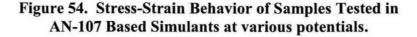
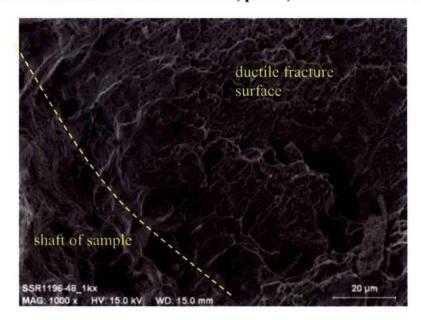


Figure 55. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-48 Performed in AN-107 Standard Simulant at 50°C, pH 11, at a Potential of -765 mV vs. SCE.



4.8 ELECTROCHEMICAL POLARIZATION BEHAVIOR IN TANK 241-AZ-102 BASED SIMULANT

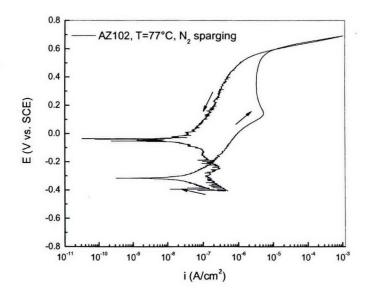
Table 14 summarizes the results of the CPP test conducted in the AZ-102 simulant that investigated the susceptibility of the steel to localized corrosion in simulants at a temperature level higher than 50°C. The test temperature for AZ-102 simulant was 77°C, which represents the upper bound of the temperature levels in all waste simulants. No tests were performed using modified AZ-102 simulants.

Table 14. A Summar	v of Electrochemical	Test Performed in	AZ-102 Based Simulant.
	j of Breet other mitter		

Base Chemistry	pН	NO2 ⁻ (M)	NO3 ⁻ (M)	TIC (M)	OH ⁻ (M)	Cl ⁻ (M)	F (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AZ-102	>12	0.883	0.105	0.619		-	0.052	77	N ₂ purging	CPP Full immersion	No pitting	103

Figure 56 is the CPP curve obtained in the deaerated AZ-102 simulant at 77°C. No clear positive hysteresis loop was observed and the sample did not show any indication of localized corrosion even at 77°C. The lack of localized corrosion on the sample is consistent with the inhibitory role of nitrite, since the nitrite concentration in this simulant is significantly higher than nitrate and other aggressive species (nitrite-to-nitrate concentration ratio of 8.4).

Figure 56. CPP Curve in Deaerated AZ-102 Simulant (pH>12 and T=77°C).



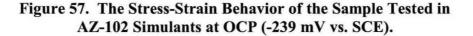
4.9 SLOW STRAIN RATE TESTING IN TANK 241-AZ-102 BASED SIMULANT

Table 15 summarizes the results of the slow strain rate test performed in the AZ-102 simulant. Only one test was performed, and it was at 77°C and at OCP. The standard AZ-102 simulant has high nitrite (0.88 M) and low nitrate (0.105 M) concentrations, and contains no halides.

Table 15. A Summary of Slow Strain Rate Tests Performed in AZ-102 Simulant.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
61	AZ-102	12+	77	OCP	-239	21.0	58.3	Ductile	-

The AZ-102 simulant has a very high nitrite/nitrate ratio (8.4) and no chlorides or fluorides, so no SCC or pitting was expected. In addition, the CPP curve exhibited no positive hysteresis. No localized corrosion was observed during post-test examination of the sample. The single SSRT in AZ-102 simulant failed at 21.0 % strain (Figure 57). No evidence of SCC was observed on the fracture surface of the test sample during SEM examination (see Figure 58). The SSRT result and CPP test results are consistent with previous test results in which nitrite was demonstrated to be inhibitory towards localized corrosion and SCC.



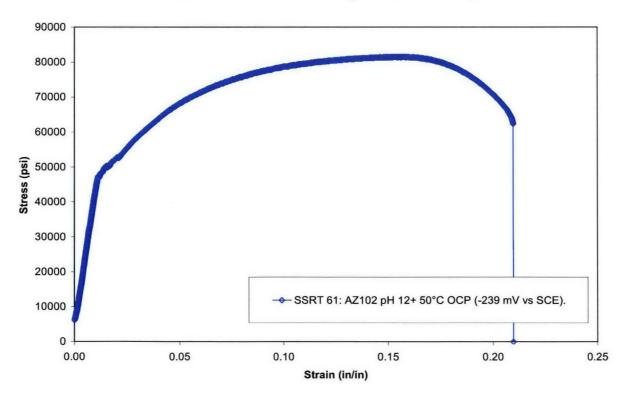
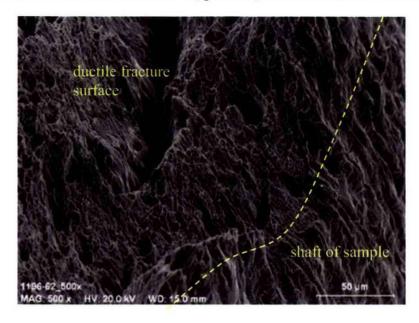


Figure 58. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-61 Performed in AZ-102 Simulant at 77°C, pH 12+, at a Potential of -239 mV vs. SCE.



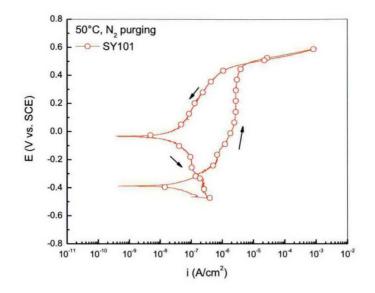
4.10 ELECTROCHEMICAL POLARIZATION BEHAVIOR IN TANK 241-SY-101 BASED SIMULANT

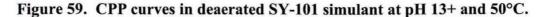
Table 16 summarizes the results of the CPP test conducted in the SY-101 simulant. The SY-101 simulant has a relatively lower nitrite-to-nitrate concentration ratio than other simulants being investigated. No tests were performed using modified SY-101 simulants.

Table 16. A Summary of Electrochemical Test Performed in SY-101 Based Simula	ant.
------------------------------------------------------------------------------	------

Base Chemistry	pH	NO2 ⁻ (M)	NO3 ⁻ (M)	TIC (M)	ОН ⁻ (М) [*]	Cľ (M)	F (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
SY-101	>13	0.2027	0.9313	0.1328	0.6555	0.0228	0.0277	50	N ₂ purging	CPP Full immersion	No pitting	109

Figure 59 is a CPP curve in deaerated SY-101 simulant at 50°C. No positive hysteresis loop was observed on the curve and the sample did not show any indication of localized corrosion. The lack of localized corrosion on the samples suggests that even though the nitrite/nitrate ratio in this simulant is lower than other simulants investigated before, other inhibitory species present in this simulants were able to efficiently prevent localized corrosion. Additionally, the benign nature of this simulant with respect to localized corrosion may be a result of the relatively low concentration of the aggressive species.





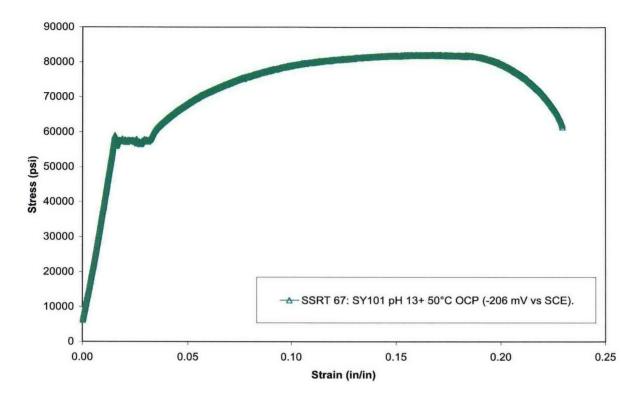
4.11 SLOW STRAIN RATE TESTING IN TANK 241-SY-101 BASED SIMULANT

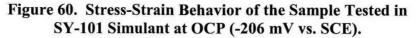
Table 17 summarizes the results of the slow strain rate tests performed in the SY-101 simulant. Only one test was performed, and it was at 50°C and OCP. This simulant has high nitrate (0.93 M) and low nitrite (0.20 M) concentrations.

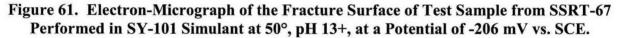
Table 17. Summary of Slow Strain Rate Tests Performed in SY-101 Simulants.

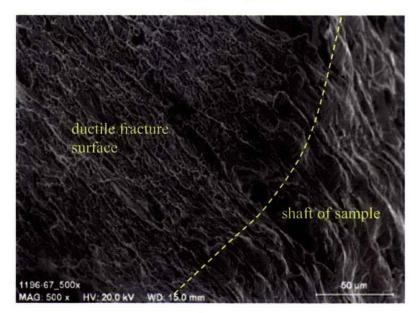
Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
67	SY-101	13+	50	OCP	-206	22.9	63.7	Ductile	-

The SY-101 simulant has a relatively low nitrite/nitrate ratio (0.18), so SCC or pitting was considered possible. However, no positive hysteresis was observed in the CPP curve and no localized corrosion was observed during post-test examination of the sample. The single SSRT performed in SY-101 simulant failed at 22.9 % strain (Figure 60). No evidence of SCC was observed on the fracture surface of the test sample during SEM examination (see Figure 61).









4.12 ELECTROCHEMICAL POLARIZATION BEHAVIOR IN TANK 241-AY-101-CSL SIMULANT

Table 18 summarizes the results of the CPP tests conducted in the standard AY-101-CSL simulants and the modified AY-101-CSL simulants. The tests performed in the standard AY-101-CSL simulants established the baseline of the susceptibility of the tank steel to localized corrosion whereas the tests in the modified AY-101-CSL simulants (with pH adjusted) were performed to understand the impact of pH on the localized corrosion susceptibility of the tank steel.

Base Chemistry	pН	NO ₂ ⁻ (M)	NO3 ⁻ (M)	TIC (M)	ОН ⁻ (М)*	Cl ⁻ (M)	F (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AY-101-CSL	11.8	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	50	N ₂ purging	CPP Full immersion	Pitting	111
AY-101-CSL	12.8	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	50	N ₂ purging	CPP Full immersion	No Pitting	112
AY-101-CSL	11.8	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	Room	N ₂ purging	CPP Full immersion	No Pitting	113
AY-101-CSL	12.3	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	50	N ₂ purging	CPP Full immersion	Pitting	115

Table 18.	Summary o	f Electrochemical	Test Performed	d in A'	Y-101-CSL	Based Simulant.

* This reflects the concentration prior to pH adjustment.

Figure 62 is a comparison of the CPP curves obtained in the AY-101-CSL simulants under different conditions. The CPP curve at pH 11.8 and 50°C showed an open loop with the passivation potential below the OCP. This is consistent with the observation of severe localized corrosion on the sample after the CPP test, as shown in Figure 63. At room temperature and pH 11.8, the CPP curve showed a negative hysteresis loop. The pitting corrosion noted at 50°C was not observed on the sample tested at the same pH but at room temperature. At pH 12.3 and 50°C, the CPP curve still exhibited an open loop even though the pitting potential was slightly higher than at pH 11.8. The sample showed severe localized corrosion after the CPP test, as shown in Figure 64. When the pH of the simulant was increased to 12.82, the CPP curve was similar to that at room temperature and pH 11.8 in that it showed a negative hysteresis loop. No pitting corrosion was noted at pH 12.8, even at 50°C. The testing results in the AY-101-CSL as a function of temperature and pH implied that the steel was susceptible to localized corrosion in this simulant at 50°C and pH 11.8 despite the relatively low concentration of aggressive species (such as nitrate = 0.181 M). The pitting corrosion at this pH, however, can be mitigated by decreasing the temperature. Furthermore, the results suggest that a threshold of pH exists above which pitting corrosion will not occur even at an elevated temperature (50°C). This threshold appeared to be between pH 12.3 and pH 12.8, but was not precisely determined with the limited experimental efforts conducted.

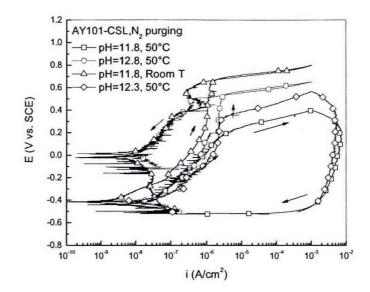
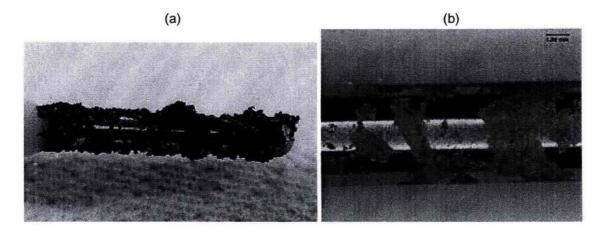


Figure 62. A Comparison of CPP Curves in the Deaerated AY-101-CSL Simulant at Different pH Levels and Temperatures.

Figure 63. Appearance of the Sample after CPP test in the Deaerated AY-101-CSL Simulant at 50°C and pH 11.8. (a) Before Cleaning; (b) After cleaning.



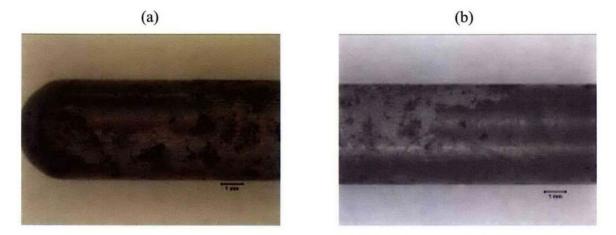


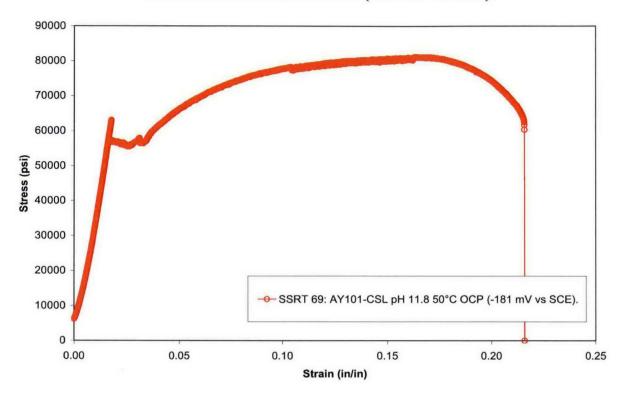
Figure 64. The Appearance of the Sample after CPP Test in AY-101-CSL Simulant at pH 12.3 and 50°C.

4.13 SLOW STRAIN RATE TESTING IN TANK 241-AY-101-CSL BASED SIMULANT

Table 19 summarizes the results of the slow strain rate tests performed in the AY-101-CSL simulant. Only one test was performed at 50°C and OCP. This simulant has low nitrate (0.181 M) and nitrite (0.0368 M) concentrations.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Failure Strain (%)	Failure Time (hrs)	SEM Surface Exam	Estimated CGR (mm/sec)
69	AY-101-CSL	11.8	50	OCP	-181	21.6	59.9	Ductile	-

The one SSRT sample failed at 21.9% strain, and showed no evidence of SCC during SEM examination (Figure 65 and Figure 66). The simulant has a relatively low nitrate content, and it may be that there was insufficient nitrate to cause SCC. A large positive hysteresis was noted in CPP curve provided by electrochemical testing in the AY-101-CSL simulant at pH 11.8 at 50°C. These results indicate that evidence of pitting is not necessarily indicative of SCC susceptibility. Note that the SSRT was performed at OCP, and the combination of potential and limited test time may not have been sufficient to allow any localized corrosion to initiate.



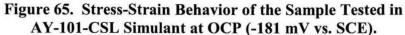
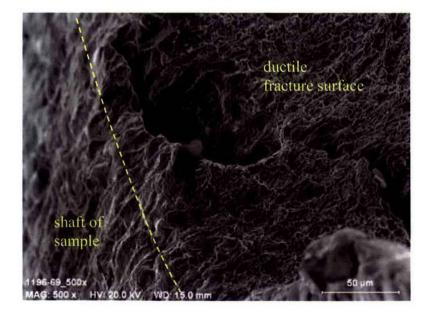


Figure 66. Electron-Micrograph of the Fracture Surface of Test Sample from SSRT-69 Performed in AY-101-CSL Simulant at 50°, pH 11.8, at a Potential of -181 mV vs. SCE.



4.14 DYNAMIC-K TESTING IN 5M NANO₃ AND TANK 241-AY-101-PSC BASED SIMULANT

Table 20 summarizes the details of the two dynamic-K tests performed during this test program. The objectives of the two K-tests were (1) to investigate the effect of a hold time on crack growth initiation; and, (2) to aid in the determination of K_{thSCC} by measuring the nominal K_I at which crack growth arrests under constant displacement conditions. With the test specimen geometry, both load and stress intensity reduce as a crack propagates under constant displacement conditions. A constant load during the test indicates the crack is not propagating. The crack's stability point and K_{thSCC} can then be calculated from the test parameters. Previous tests performed for this program were not held sufficiently long for this phenomenon to occur.

CT-17 was performed in 5 M NaNO₃ solution at OCP and at 50°C. This solution has previously been shown to cause severe cracking. The sample was loaded at a constant displacement rate until both DCPD and load measurements indicated cracking. The loading was stopped and the sample was held at constant displacement for approximately 80 days. DCPD (Figure 67) and load measurements (Figure 68) indicated continued cracking of the sample during the test. The maximum CGR for this sample was estimated as 4.5 inch / year (1.4×10^{-7} in/sec) based on DCPD data.

CT-18 was performed in AY-101-PSC simulant at 0 mV vs. SCE and at 50°C. Previous testing indicated no cracking in this environment for samples loaded to 40 ksi $\sqrt{10}$; however, the hold time was relatively short (approximately 30 days). The current investigation loaded the constant displacement sample to 45 ksi $\sqrt{10}$. DCPD (Figure 69) and load data (Figure 70) indicated that there may have been minor cracking in the sample, but it was not definitive because of the significant noise detected in the data. Note that a lower stress intensity (40 ksi $\sqrt{10}$) was accidently placed on the specimen for over a week near the onset of testing.

Test ID	Base Chemistry	pH	Temp (°C)	Pot (mV)	OCP (mV)	Test Type	Comments
17	5M NaNO ₃	11	50	OCP	+107	Load to above K _{thSCC} and hold 80 days	DCPD, load reduction and SEM examination indicated significant cracking
18	AY-101-PSC	11	50	0	-328	Load to 45 ksi√in and hold 150 days	DCPD and load reduction indicated possible minor cracking. Not confirmed by SEM examination

Table 20. A Summary of the Dynamic-K Tests Pe	erformed.
-----------------------------------------------	-----------

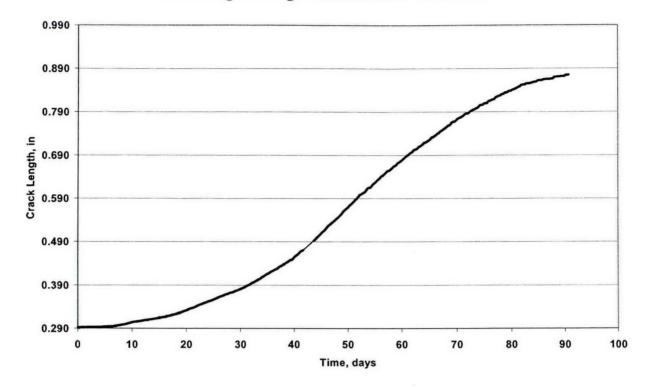
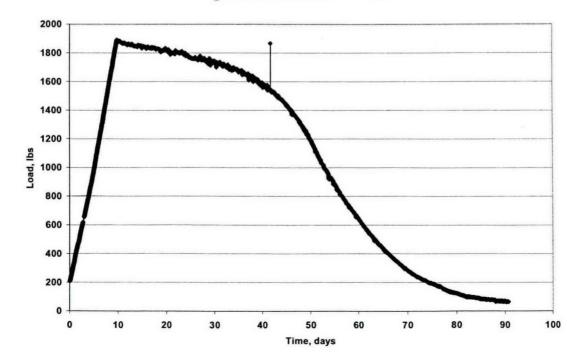
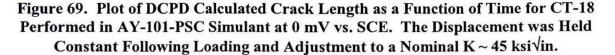


Figure 67. Plot of DCPD Calculated Crack Length as a Function of Time for CT-17 Performed in 5M NaNO₃ at Open Circuit Potential. The Displacement was Held Constant Following Loading to a Nominal K ~ 25 ksi√in.

Figure 68. Load as a Function of Time for CT-17 Performed in 5M NaNO₃ at Open Circuit Potential. The Displacement was Held Constant Following Loading to a Nominal K ~ 25 ksi√in.





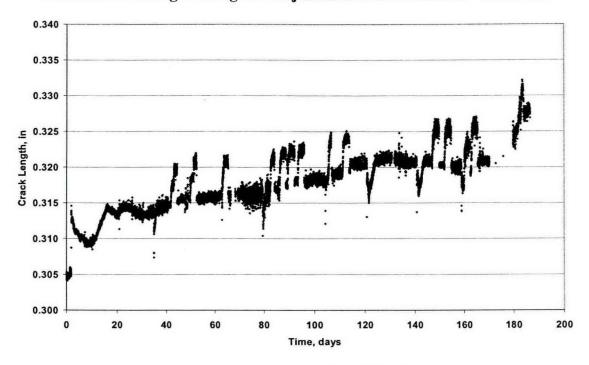
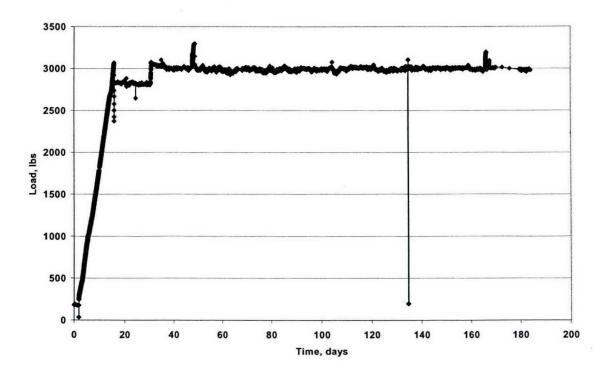


Figure 70. Load as a Function of Time for CT-18 Performed in AY-101-PSC Simulant at 0 mV vs. SCE. The Displacement was Held Constant Following Loading and Adjustment to a Nominal K ~ 45 ksi√in.



The fracture surfaces of the two K-test samples were examined using the SEM. Figure 71 is an electron-micrograph of the fracture surface of the test sample from CT-17, performed in 5M NaNO₃ solution. SCC was confirmed by the presence of intergranular features. Figure 72 is an electron-micrograph of the fracture surface of the test sample from CT-18, performed in the AY-101 simulant with an applied potential of 0 mV vs. SCE. No intergranular features were observed. This confirms the previous results, in which no SCC was detected in the AY-101 simulant loaded to 40 ksi \sqrt{in} and held for 30 days. This indicates that K_{thSCC} is over 45 ksi \sqrt{in} in this environment.

Figure 71. Electron-Micrograph of the Fracture Surface of Test Sample from CT-17 Performed in 5M NaNO3 at 50°, at OCP (+107 mV vs. SCE). The sample was held at a constant displacement for ~80 days following a constant displacement rate slow loading to a nominal K of 25 ksi√in.

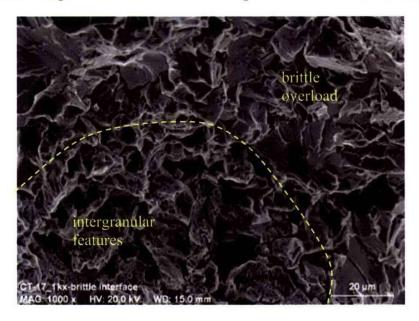
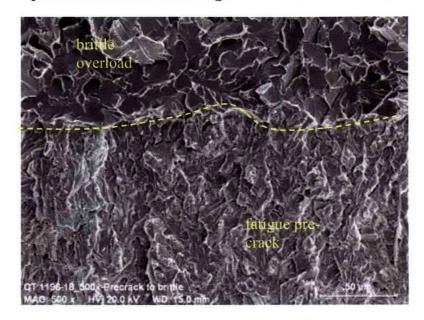


Figure 72. Electron-Micrograph of the Fracture Surface of Test Sample from CT-18 Performed in AY-101 Simulant at 50°, at 0 mV vs. SCE. The sample was held at a constant displacement for ~150 days following a constant displacement rate slow loading to a nominal K of 45 ksi√in.



The lack of intergranular features in test CT-18 was unexpected, given the apparent crack growth indicated by the DCPD measurements. Post-test analysis of the DCPD data indicated some drift in the applied DCPD current occurred over the course of the test, resulting in potential drop changes on the order of a few tens of millivolts. This explains the apparent crack growth from the DCPD data calculations. Another possibility is that there was some minor ductile tearing during the long-term hold.

The recent K-tests were performed using a constant displacement rate slow loading and a longterm hold. This technique was developed to try to eliminate some of the inconsistencies observed in data from tests that were performed using constant loads tests. However, it has not yet been confirmed that the test technique provided conservative values of K_{thSCC} . The technique relies on crack arrest following some SCC propagation. The K_{thSCC} calculation is then based on the final load and crack length values at arrest. To date, only one test (CT-17 performed in 5M NaNO₃ solution) has shown significant crack propagation and has been held for a long enough time to confirm crack arrest. Tests in various simulants have shown some minimal cracking, but not sufficient to provide a high level of confidence in the K_{thSCC} estimates. The effect of loading rate on K_{th} has also yet to be considered. Loading rate effects may influence the applied K at which SCC initiates, and the slower loading may produce artificially high K_{thSCC} estimates, though this would go against results typically observed in SSRTs. If this is the case then it is even more important to allow any growing cracks to arrest. The microstructural mechanisms involved in SCC crack initiation become an important consideration.

The dynamic-K test used in the current program shows promise as a test technique, but there are some issues still to be resolved. One limitation is that the tests must be run for a sufficient period of time for cracking to initiate and to arrest. This has only been done with the 5 M NaNO_3

solution. Given the low CGRs observed in some of the tests performed in waste simulants, tests would have to be performed for months, or years in some cases, in order to achieve the same results. A second limitation of the dynamic K-test is that it has not been validated that the test results are conservative. There are few comparisons that can be made between the current results and previous years' results, as the tests were performed under different conditions. Previous constant load testing in AN-107 simulant indicated a K_{thSCC} of approximately 20 ksi \sqrt{in} . However, the more recent dynamic K-test in AN-107 simulant implied a K_{thSCC} closer to 35 ksi \sqrt{in} , as crack growth was minimal when loaded to that level and held for 30 days. Note that in the latter test, the sample was not held for sufficient time for the crack to arrest. It is possible that the crack would have continued to propagate and eventually arrested at K nearer to 20 ksi \sqrt{in} . If so, the test techniques' results would have been self-consistent.

There are common features of the results of the constant load and dynamic-K tests that are encouraging. The CGRs measured in the waste simulant have been significantly less than those measured in the 5 M NaNO₃ solution. Consistent with this is the higher K_{thSCC} estimates in the waste simulants. Although the technique requires some further validation to ensure conservatism, the current qualitative indications are that the tests are providing useful information.

In previous work, crack growth in constant load tests was identified by DCPD, examination in the stereo-microscope and metallographically. Many of the tests showed a minimal amount of crack growth and visual observations become subjective. It is very difficult to distinguish between fatigue pre-crack, ductile tearing at the crack tip, and intergranular SCC. In some cases, the results were inconsistent between techniques, and in general the conservative result was reported. The difficulties in distinguishing microstructural features led to the use of the SEM in post test-examinations.

4.15 GENERAL DISCUSSION OF RESULTS

The purpose of this work was to examine the effects of different tank farm operational variables (chemistry, temperature) on the propensity for localized corrosion and stress corrosion cracking. To accomplish this goal, a range of tank chemistry simulants and variations thereof have been examined in an attempt to bound certain tank farm characteristics and to better elucidate the controlling mechanisms and processes that may compromise tank integrity from a materials degradation perspective. In the course of this work, nitrite has been found to inhibit both localized corrosion and SCC whereas nitrate promotes these degradation modes. In the present work, the localized and SCC corrosion behavior of steel in waste simulants for Tanks 241-AP-105 (AP-105), 241-SY-103 (SY-103), 241-AW-105 (AW-105), 241-AZ-102 (AZ-102), 241-SY-101 (SY-101), AN-107 and AY-101 were investigated to better examine the effects of low nitritenitrate concentration ratios, high bounding chloride and fluoride concentrations, and low and high absolute nitrite and nitrate concentrations. The AP-105-PSC simulant has a unique chemistry that includes 0.27 M nitrite and 3.58 M nitrate (nitrite/nitrate ratio of 0.075). Although the nitrite concentration is less than 10% of the nitrate concentration, this chemistry appears to be more benign than some of the previously investigated simulants (e.g., AN-107) at pH above 13 (assuming the nitrite concentration can be maintained). While this nitrite concentration seemed to play some inhibiting role, the previous discussion indicates that this concentration may be near a threshold of nitrite below which the nitrite will not be able to provide effective protection for the

steel. Severe corrosion was observed at the liquid/vapor interface where the nitrite may have become depleted to a concentration below the threshold level for efficient inhibition or alternatively the pH was suppressed below a critical value.

Corrosion attack at the liquid/vapor interface strongly depends on temperature, potential, and liquid/vapor interface stability. The results obtained thus far indicate that the extent of corrosion could be decreased relative to test conditions at potentials near OCP or at temperatures near room temperature. The corrosion initiation time generally increased significantly for these conditions. However, the long-term immersion tests revealed that the corrosion at the liquid/vapor interface is likely even at room temperature. It appears that the CO_2 present in the air may have played a role by changing the pH locally to create an aggressive environment locally at the liquid/vapor interface. No definitive conclusion can be drawn with respect to the initiation mechanism of the interfacial attack. Even though the experimental evidence indicated that potential, oxygen, and CO_2 may play certain roles, a comprehensive understanding of the initiation mechanism is lacking.

Figure 73 summarizes the susceptibility of the steel to pitting corrosion as a function of inhibiting species and aggressive species in various simulants. Open symbols indicate that no pitting corrosion was observed after CPP testing. For AN-107 simulants, pitting corrosion was observed in all cases. However, the difference of repassivation potential and the OCP was considerably larger in some cases and thus the safety margin was sufficiently wide to prevent pitting under freely corroding conditions. Therefore, the tests that showed a |Epit-OCP| greater than 500 mV are indicated with half-filled symbols, meaning that pitting corrosion was observed but a large safety margin (the difference between OCP and pitting potential) exists. Note that pitting corrosion was observed after polarizing to potentials higher than OCP during CPP testing. The conditions outlined in Figure 73 indicate that pitting *might* occur under the given environmental conditions. Therefore, Figure 73 should be used only as an illustrative tool to help understand the prospective roles of inhibiting and aggressive species.

Three zones are indicated in Figure 73: no pitting zone, pitting possible but unlikely zone, and pitting possible zone. AP-105-evaporated simulants were outliers that did not lead to localized corrosion at an extremely high nitrate concentration (5.087M). For illustrative purposes, dashed lines have been included in Figure 73 to qualitatively differentiate the pitting possible, pitting possible but unlikely, and no pitting regions. At each nitrate concentration level, there appears to be a critical nitrite level, above which the material was protected from localized corrosion.

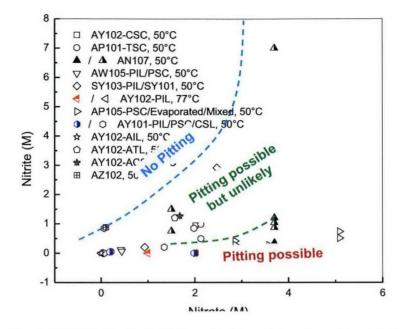


Figure 73. Susceptibility of Materials to Pitting Corrosion as a Function of Nitrite and Nitrate Concentration. The Symbols Represent Various Simulant Chemistries Previously Studied.

Figure 74 shows the estimated CGRs for tests that cracked as a function of applied potential in all simulants investigated. These data are primarily from SSRTs, with the one exception being the data point for the 5M NaNO₃ solution which was provided by a dynamic –K test. The new data obtained from the recent tests do not affect the general trend of the curve, which was developed using results from previous work. From previous testing, significant crack growth was only observed at potentials higher than -100 mV (vs. SCE) for the nitrate-based simulants (e.g., AY-101-PSC). Much slower CGRs were observed in carbonate-based simulants at potentials near -800 mV (vs. SCE). Similar slow CGRs were also observed in modified (increased nitrate) carbonate based simulants around -300 to -200 mV vs. SCE. The new data is seen in this third peak in the plot at -249 mV vs. SCE. This was generated from the one CGR experiment conducted in AP-105-PSC stimulant at OCP that showed cracking.

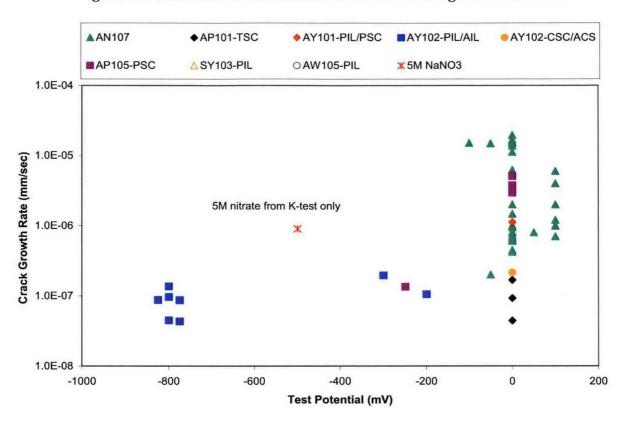
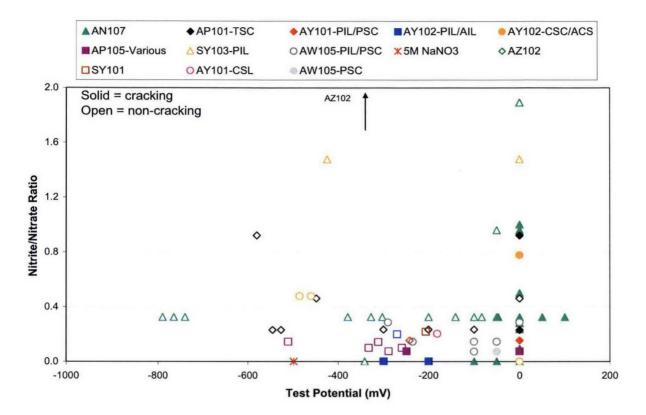


Figure 74. Estimated CGR vs. Potential in the Investigated Simulants.

Figure 75 is a plot of the nitrite/nitrate ratio vs. applied test potential. This data indicates conditions for SCC susceptibility. A similar plot was developed during previous work, and has been updated to include the new test data. SSRTs that showed cracking are indicated by solid symbols and tests that showed no cracking are indicated by open symbols. The general trend for the nitrate-based simulants is that SCC susceptibility tends to increase with increasing potential and decrease with increasing nitrite concentration. There is a transitional region of SCC behavior at low nitrite/nitrate ratios between potentials of -200 and -300 mV vs. SCE which remains poorly defined.

The results of the AP-105-PSC, SY-103-PIL and AW-105 testing are consistent with the results from previous tests programs, as can be seen from Figure 75. The AP-105-PSC simulant has a very low nitrite/nitrate ratio (0.075), and did show evidence of SCC, even at the relatively low OCP potential (-249 mV vs. SCE). The AW-105-PIL simulant has a slightly higher nitrite/nitrate ratio (0.29) and showed no evidence of SCC, at a comparable potential (-290 mV vs. SCE). These data help to further define the transitional region of the plot. The SY-103-PIL simulant has a much higher nitrite/nitrate ratio (1.47), and also shows no evidence of cracking, as the data in the Figure 75 would predict. The AW-105-PSC simulant and modified "6X" simulant data further defines the critical region in low nitrite/nitrate ratio and higher potential 0 mV to -100 mV vs. SCE region. Figure 75 indicates that SCC is possible in many of the simulants. However, it is important to realize that all but one of the two tests performed in AP-105-PSC at OCP that cracked. This is the only test that has shown evidence of cracking at OCP. This observation is important from a tank integrity perspective.

Figure 75. A Plot of Nitrite/nitrate Ratio vs. Applied Test Potential Indicating Conditions for SCC Susceptibility. Only Nitrate Based simulant Results Are Included.



An important conclusion that was drawn from this test program is that localized corrosion at liquid/vapor interfaces is possible at high pH. This indicates that the current requirements to maintain a high pH may not necessarily be sufficient to ensure long-term tank integrity. The interfacial corrosion is not currently well understood, and should be considered as a possible focus area for future work.

Based on the work conducted to date, it would seem that the risk of localized corrosion and SCC is relatively low under nominal tank operating conditions. There is, however, a possibility of SCC in achievable chemistries (these are chemistries similar to those already existing in the tank farm or those that may develop due to mixing/transfer operations) if a sufficiently noble potential is reached. This observation highlights the importance of the tank probe monitoring program. Also of significant note was the observation of rapid corrosion at the liquid/vapor interface which appears to be related to a drop in the interfacial pH due to the presence of CO_2 in the head space. Because the corrosion rates observed with some simulants were quite rapid, additional efforts to explore optimal mitigation strategies for this interfacial region are recommended.

5.0 SUMMARY OF KEY FINDINGS

Based on the work conducted, the key findings of the research are listed below.

- The SCC potency of the waste simulants for the three tanks studied followed the trends previously established for nitrate-based simulants. SCC only occurred at relatively high applied potentials (e.g., 0 mV vs. SCE) or at low nitrite/nitrate concentrations ratios.
- Limited GCR testing performed in AY-101 simulants indicated that stress intensity factors above 45 ksi√in were necessary for crack propagation to occur in the waste simulants tested.
- Though at current tank conditions the PSC for tank 241-AP-105 (AP-105-PSC) simulant of the tank showed a low propensity for corrosion. The tank steel exposed to the Tank AP-105-PSC simulant at elevated temperatures and under anodically polarizing conditions demonstrated a susceptibility to stress corrosion cracking (SCC) and localized corrosion at the liquid/vapor interface. Long-term immersion tests indicated that the steel was susceptible to corrosion at the liquid/vapor interface even at OCP, but the extent at room temperature was not as severe as at elevated temperatures (e.g., 50°C). The AP-105-PSC is the only simulant in which SCC was observed in a slow strain rate test (SSRT) performed at OCP. Local chemistry changes (nitrite depletion or pH drop) may be responsible for the interfacial attack, though the precise mechanism is unclear at this time. The liquid/vapor interface attack indicates that localized corrosion is possible in simulants with high pH, and this should be considered in any future corrosion mitigation strategies.
- The PIL for Tank 241-SY-103 (SY-103-PIL) simulant, which has the upper limit of chloride concentration of the DSTs, appears to be benign with respect to corrosion and SCC relative to the AP-105-PSC and previously tested Tank 241-AN-107 simulants and the PIL for Tank 241-AY-102 (AY-102PIL) simulant. Any possible corrosion liability associated with the high chloride content, appears to be offset by the relatively high nitrite content.
- The PIL for Tank 241-AW-105 (AW-105-PIL) simulant, which has the upper limit of fluoride concentration, also appears to be benign with respect to tank steel SCC. However, some localized corrosion has been observed at the liquid/vapor interface.
- The AZ-102 simulant, tested at the higher temperature of 77°C, appears to be benign with respect to SCC, confirming the inhibitory nature of nitrite. The AZ-102 simulant has a high nitrite/nitrate ratio of 8.4.

APPENDIX A

SIMULANT RECIPES, CERTIFICATES FOR CHEMICALS AND QA DOCUMENTS

AN-107 Supernate Simulant Recipe for a <u>2-Lifer Batch, pH = 11</u>
DADE OCH HERICAL A well PODE Manuface

	Balance Device ID No:	080	NIST Weight (10 g):	10.0000	Tracking #6
	Balance Device ID No:	018	NIST Weight (150 g):	749.7	
	Prepared By:	Nay Kelley	Date Prepared:	11/07	
Tare a <u>2-liter Vo</u>	lumetric Flask and then A	dd the Following, in	Order:		
Compound	Formula	Mass Required, grams	Actual Mass I grams	Jsed.	
Delonized Water	що	400.00		400	
Calcium Nilrate, 4-Hydrate	Ca(NO3)24440	6.96			
Cantum Nazate Casium Nitrate	Ca(NO3)2-6H2O	0.32	the second se		
Copper Nilrate, 2.5-Hydrate	Cu(NO1) 2.5H2O	0.22			-
Ferric Nilrate, 9-Hydrate	Fe(NO ₂) ₂ GH ₂ O Le(NO ₂) ₂ GH ₂ O	24.46	0:30		
Load Nikrate	Pb(NO ₁);	1.24	1.24	·	
Megnesium Nikate, 6-Hydrate	Mg(NOz)_ 6HzO	0.52	0,52		•
Manganous Chloride, 4-Hydrate Neodymium Nitrate, 6-Hydrate	MtrOk-4H2O Nd(NO2)26H2O	4.06	0.58	<u> </u>	
Nickel Nitrate, 6-Hydrate	NI(NO3)2.0H2O	5.26	Bidle		
Potassium Nitrate	KNO3 Sr(NO3)2	9.20	9.20	<u> </u>	
Zinc Nitrate, 6-Hydrate	Zn(NO ₂), dH ₂ O	0.032	0:41		
Ziroany/ Nikate	20(NO3), xH20	0.38	6:37		
EDTA, Ethylenediaminelat aecatete HEDTA, n-Hydraxyethylenediamine	HEDTA	14.52	<u></u>		
triacetate Sodium Gluconate	C.H.NaOr	4.32	7,87	<u> </u>	
Glycolic Ackt	CHO,	53.86	59.86		
Ciliric Acid Monotrydrate	C.H.O.H.O	18.88	18-88		
Nirlotriscetic Acid	CHUNOU HNICH2COOH)2	1.14	10/4		
Boric Acid	H,BO,	0.40	O:AQ		· .
Sodium Chloride	NaCi		<u> </u>	AL	
Sodium Chromate	NaF Ne ₂ Cr ₂ O ₄	0.58	1010		
Sodium Sulfate	Na ₂ SO ₄	24.40	ZArAD		
Potassium Mollodate	Kemool	0.18	0,18		
In a SEPARATE Container, Mix the F					
			30,50		
Aluminum Nilrale, 9-Hydrate	AI(NO3)2.9H2O	10.74	10:74		
Sodium Phosphele, 12-Hydrate Sodium Formate	NayPO4 12H2O	8.86	8-88 31.42		CA APPROVED
Sodium Acetale Tritydrate	NaCH_COO.3H_O	4.74	2.74		40
	Na ₂ C ₂ O ₄	2.52	3.52		NAME: Claum
	H ₂ O SUM	400.00	100		DATE: 1-2-08
Mix Thoroughly. Then Add this Solu					UAIC.
After the Addition to the Yolumetric					
	Ne ₂ CO ₈	296.50	296.5		initial pH 10.3
Mix Thoroughly		A			in nar pri 1013
Next, Mix the Following:					1
	NaNO,	594.56	\$14.60	2 1	En lak 11 ma
	NaiNO ₂ H ₂ O	165.58	165.60		Rinal pH 11.00
	Sum	200.00			•
Mix thoroughly and dilute to the 2-Li	er mark in the Volumetric	Fiesk.			
	SUM OF ALL	2350,46			-
		r		——)	1 AL
Record the Final Weight		Density:			(7)
Nexesture the pH 10-38					\mathbf{V}
Idjust the Final Solution to pH = 11 b HOROUGHLY after any addition of s			ide (NaOH) up to 20g. M	NX .	· .
				,	-
comments:					

AP105-PSC Base Solution 2007 Versio		Batch Size: pH:	. 4 13+	L AP105-PSC	1
Dase Outfield 2007 Tersit		pn:	134	AF 103-F3C	
Balance Device ID:	060	NIST Weigh		20,0000	
Balance Device ID:	018	NIST Weigh	t (500 g):	500.0	_
- · · · · /\/mu.	Kelley	Date: 11 (14) (
Technician: NOY	raley	Date:[[1]// 10		Tracking :68	-
Add DbA	2400 L mL DI water to	a haakar			
Insert Teflon stirbar and the					
Turn on heater and adjust to	60°C (±10°C).	unter / notplate.			
Add the following chemicals		ights:			
		Required	Actual		
Chemical	Formula	Mass (g)	Mass (g)	Comments	`
Sodium Aluminate	NaAlO2.2H20		0.71 70.71		1
Sodium Chloride	NaCl		7.20 1.20		4
Sodium Fluoride	NaF		<u>1.53 1.53</u>		1.
Sodium Chromate	Na _z CrO ₄		3.87 6.87		4
Sodium Sulfate	Na ₂ SO ₄		5.82 26.83	_ 	1
Sodium Phosphate, 12-Hydrate Sodium Formate	Na3PO4 12H2O		5.77 45+78	·	1
Sodium Acetate Trihydrate	NaHCOO		2.72 d. 72. 1.08 4.09		1
Sodium Oxalate	NaCH ₆ COO.3H ₂ O		1.02 1.00		1
Sodium Carbonate	Na ₂ C ₂ O ₄ Na ₂ CO ₃		321 138.2	+	1
Sodium Nitrate	NaNO3	1211			1
otassium Nitrate	KNO3		5.38 5.41		1
iodium Nitrite	NaNO ₂		1.52 74.5		1
Stycolic Acid	C,H403		3.23 9, 9	2	1
			18 19 19	<hr/>	1
Sodium fluoride is highly to djust total solution volume to djust solution temperature to	o 3 o 50°C to 60°C.	400 mL by adding DI v		6]
Sodium fluoride is highly to djust total solution volume to djust solution temperature to litter solution by vacuum thro linse beaker with approximately inse filter with approximately	dc. Handle with caution. 5 30°C to 60°C. 9 50°C to 60°C. 9 50°C mL of DI water 7 50 mL of DI water	400 mL by adding DI v landle with caution, h	1631.0 vater.	solution .]
Sodium fluoride is highly to djust total solution volume to djust solution temperature to litter solution by vacuum thro linse beaker with approximately ransfer final filtrate and rinse	dc. Handle with caution. 5 50°C to 60°C. 10gh medium glass filter. <i>I</i> tely 50 mL of DI water 50 mL of DI water 50 mL of DI water	1400 mL by adding DI v landle with caution, h with stir bar.	1631.0 vater.	solution.	
Sodium fluoride is highly to adjust total solution volume to djust solution temperature to lister solution by vacuum thro inse beaker with approximately ransfer final filtrate and rinse leasure and record initial pH	dc. Handle with caution. 5 50°C to 60°C. wigh medium glass filter. <i>H</i> tely 50 mL of Di water 50 mL of Di water 50 mL of Di water A L <u>16.35</u> 13,	1400 mL by adding DI v landle with caution, h with stir bar.	1631.0 vater.	solution.	
Sodium fluoride is highly to adjust total solution volume to djust solution temperature to lister solution by vacuum thro inse beaker with approximately ransfer final filtrate and rinse leasure and record initial pH	dc. Handle with caution. 5 50°C to 60°C. wigh medium glass filter. <i>H</i> tely 50 mL of Di water 50 mL of Di water 50 mL of Di water A L <u>16.35</u> 13,	1400 mL by adding DI v landle with caution, h with stir bar.	1631.0 vater.	b solution. QA APPRON NAME:Cedur	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to litter solution by vacuum thro linse beaker with approximately ransfer final filtrate and rinse leasure and record initial pH heck the pH to make sure it	dc. Handle with caution. $50 \times 10^{\circ}$ C to 60° C. 10° C.	1400 mL by adding DI v landle with caution, h with stir bar. <u>&{</u> 13+	b3 .0 vater. not and caustic	solution.	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to litter solution by vacuum thro linse beaker with approximately ransfer final filtrate and rinse leasure and record initial pH heck the pH to make sure it	dc. Handle with caution. $50 \times 10^{\circ}$ C to 60° C. 10° C.	1400 mL by adding DI v landle with caution, h with stir bar. <u>&{</u> 13+	b3 .0 vater. not and caustic	b solution. QA APPRON NAME:Cedur	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to liter solution by vacuum thro inse beaker with approximately ransfer final filtrate and rinse easure and record initial pH heck the pH to make sure it ransfer to volumetric flask ar	dc. Handle with caution. $50 \times 10^{\circ}$ C to 60° C. $100 \times 10^{\circ}$ C to 60° C to 10° W ter $100 \times 10^{\circ}$ C to 10°	1400 mL by adding DI v landle with caution, h with stir bar. <u>&{</u> 13+	b3 .0 vater. oot and caustic	b solution. QA APPRON NAME:Cedur	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to liter solution by vacuum thro inse beaker with approximately ransfer final filtrate and rinse easure and record initial pH heck the pH to make sure it ransfer to volumetric flask ar ljust final solution to volume	dc. Handle with caution. 0 3 0.50° C to 60°C. high medium glass filter. A tely 50 mL of DI water 0.50° C to 60°C. 0.01° C to 60°C.	1400 mL by adding DI v landle with caution, h with stir bar. &{ 13+ iter. Allow solution to ca L with DI water, and	b3 .0 vater. oot and caustic ool mix thoroughly.	6 solution QA APPRON NAME: Cedur DATE: (-2.01)	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to lise beaker with approximately inse tilter with approximately ransfer final filtrate and rinse easure and record initial pH heck the pH to make sure it ansfer to volumetric flask ar tjust final solution to volume Total chemicals (ta	dc. Handle with caution. 3 o 50°C to 60°C. rugh medium glass filter. <i>h</i> tely 50 mL of Di water o 50°L to 60°C. vgh medium glass filter. <i>h</i> y50 mL of Di water o solutions to large beaker $A \ge 14.35$ is $tl/4/7$. nd include rinse with DI water of 4 arget) 1630.9	1400 mL by adding DI v fandle with caution, fr with stir bar. & { 13+ iter. Allow solution to co L with DI water, and 18 g Total chemica	(b3).0 vater. not and caustic ool mix thoroughly. Nis (actual)	b solution. QA APPRON NAME:Cedur	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to liter solution by vacuum thro inse beaker with approximately ransfer final filtrate and rinse easure and record initial pH heck the pH to make sure it ransfer to volumetric flask ar ljust final solution to volume	dc. Handle with caution. 3 o 50°C to 60°C. ugh medium glass filter. <i>h</i> tely 50 mL of Di water solutions to large beaker $A \succeq A = 35$ $A \succeq A = 35$ is $h /A \lor A$ nd include rinse with DI water of 4 arget) 1630.9) 4	1400 mL by adding DI v fandle with caution, fr with stir bar. & { 13+ iter. Allow solution to co L with DI water, and 18 g Total chemica	[b3].0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual)	6 Solution QA APPHON NAME: Cedur DATE:	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to lister solution by vacuum thro inse beaker with approximately ransfer final filtrate and rinse easure and record initial pH heck the pH to make sure it ransfer to volumetric flask ar tjust final solution to volume JM Total chemicals (ta Total water (target	dc. Handle with caution. 3 o 50°C to 60°C. ugh medium glass filter. <i>h</i> tely 50 mL of Di water solutions to large beaker $A \succeq A = 35$ $A \succeq A = 35$ is $h /A \lor A$ nd include rinse with DI water of 4 arget) 1630.9) 4	1400 mL by adding DI v <i>landle with caution, h</i> with stir bar. <u>d{</u> 13+ Iter. Allow solution to c <u>L with DI water, and</u> 18 g Total chemica L Total water (a	[b3].0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual)	6 solution QA APPRON NAME: Cedur DATE:	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to liter solution by vacuum thro linse beaker with approximation ransfer final filtrate and rinse leasure and record initial pH heck the pH to make sure it ransfer to volumetric flask ar djust final solution to volume JM Total chemicals (ta Total water (target Target Specific De	dc. Handle with caution. o 3 o 50°C to 60°C. ugh medium glass filter. A tely 50 mL of DI water 3 750 mL of DI water 4 750 mL of DI water 4 arget) 1630.9) 4	1400 mL by adding DI w <i>landle with caution, h</i> with stir bar. <u>2</u> 13+ Iter. Allow solution to ca <u>L</u> with DI water, and B g Total chemica <u>L</u> Total water (a <u>L</u> Calculated de	(b3).0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual) insity	6 solution QAAPPHON NAME: Cedur DATE: 1-2-01 DATE: 1-2-01 TG31.0C ADOO TAI	•
Sodium fluoride is highly to djust total solution volume to djust solution by vacuum thro inse beaker with approximal inse filter with approximately ransfer final filtrate and rinse easure and record initial pH heck the pH to make sure it ansfer to volumetric flask ar ijust final solution to volume JM Total chemicals (ta Total water (target Target Specific De	dc. Handle with caution. o 3 o 50°C to 60°C. ugh medium glass filter. A tely 50 mL of DI water 3 750 mL of DI water 4 750 mL of DI water 4 arget) 1630.9) 4	1400 mL by adding DI v <i>landle with caution, h</i> with stir bar. <u>d{</u> 13+ Iter. Allow solution to c <u>L with DI water, and</u> 18 g Total chemica L Total water (a	(b3).0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual) insity	6 solution QAAPPHON NAME: Cedur DATE: 1-2-01 DATE: 1-2-01 TG31.0C ADOO TAI	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to litter solution by vacuum thro inse beaker with approximal inse filter with approximately ransfer final filtrate and rinse easure and record initial pH heck the pH to make sure it ansfer to volumetric flask ar tjust final solution to volume JM Total chemicals (ta Total water (target Target Specific De	dc. Handle with caution. o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o	1400 mL by adding DI w <i>landle with caution, h</i> with stir bar. <u>2</u> 13+ Iter. Allow solution to ca <u>L</u> with DI water, and B g Total chemica <u>L</u> Total water (a <u>L</u> Calculated de	(b3).0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual) insity	6 solution QAAPPHON NAME: Cedur DATE: 1-2-01 DATE: 1-2-01 TG31.0C ADOO TAI	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to litter solution by vacuum thro inse beaker with approximal inse filter with approximately ransfer final filtrate and rinse easure and record initial pH heck the pH to make sure it ansfer to volumetric flask ar tjust final solution to volume JM Total chemicals (ta Total water (target Target Specific De	dc. Handle with caution. o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o	1400 mL by adding DI w <i>landle with caution, h</i> with stir bar. <u>2</u> 13+ Iter. Allow solution to ca <u>L</u> with DI water, and B g Total chemica <u>L</u> Total water (a <u>L</u> Calculated de	(b3).0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual) insity	6 solution QAAPPHON NAME: Cedur DATE: 1-2-01 DATE: 1-2-01 TG31.0C ADOO TAI	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to litter solution by vacuum thro inse beaker with approximal inse filter with approximately ransfer final filtrate and rinse easure and record initial pH heck the pH to make sure it ansfer to volumetric flask ar tjust final solution to volume JM Total chemicals (ta Total water (target Target Specific De	dc. Handle with caution. o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o	1400 mL by adding DI w <i>landle with caution, h</i> with stir bar. <u>2</u> 13+ Iter. Allow solution to ca <u>L</u> with DI water, and B g Total chemica <u>L</u> Total water (a <u>L</u> Calculated de	(b3).0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual) insity	6 solution QAAPPHON NAME: Cedur DATE: 1-2-01 DATE: 1-2-01 TG31.0C ADOO TAI	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to litter solution by vacuum thro inse beaker with approximal inse filter with approximately ransfer final filtrate and rinse easure and record initial pH heck the pH to make sure it ansfer to volumetric flask ar tjust final solution to volume JM Total chemicals (ta Total water (target Target Specific De	dc. Handle with caution. o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o	1400 mL by adding DI w <i>landle with caution, h</i> with stir bar. <u>2</u> 13+ Iter. Allow solution to ca <u>L</u> with DI water, and B g Total chemica <u>L</u> Total water (a <u>L</u> Calculated de	(b3).0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual) insity	6 solution QAAPPHON NAME: Cedur DATE: 1-2-01 DATE: 1-2-01 TG31.0C ADOO TAI	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to litter solution by vacuum thro inse beaker with approximal inse filter with approximately ransfer final filtrate and rinse easure and record initial pH heck the pH to make sure it ansfer to volumetric flask ar tjust final solution to volume JM Total chemicals (ta Total water (target Target Specific De	dc. Handle with caution. o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o	1400 mL by adding DI w <i>landle with caution, h</i> with stir bar. <u>2</u> 13+ Iter. Allow solution to ca <u>L</u> with DI water, and B g Total chemica <u>L</u> Total water (a <u>L</u> Calculated de	(b3).0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual) insity	6 solution QAAPPHON NAME: Cedur DATE: 1-2-01 DATE: 1-2-01 TG31.0C ADOO TAI	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to litter solution by vacuum thro inse beaker with approximal inse filter with approximately ransfer final filtrate and rinse easure and record initial pH heck the pH to make sure it ansfer to volumetric flask ar tjust final solution to volume JM Total chemicals (ta Total water (target Target Specific De	dc. Handle with caution. o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o	1400 mL by adding DI w <i>landle with caution, h</i> with stir bar. <u>2</u> 13+ Iter. Allow solution to ca <u>L</u> with DI water, and B g Total chemica <u>L</u> Total water (a <u>L</u> Calculated de	(b3).0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual) insity	6 solution QAAPPHON NAME: Cedur DATE: 1-2-01 DATE: 1-2-01 TG31.0C ADOO TAI	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to liter solution by vacuum thro linse beaker with approximal inse filter with approximately ransfer final filtrate and rinse leasure and record initial pH heck the pH to make sure it ransfer to volumetric flask ar tjust final solution to volume UM Total chemicals (ta Total water (target Target Specific De	dc. Handle with caution. o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o	1400 mL by adding DI w <i>landle with caution, h</i> with stir bar. <u>2</u> 13+ Iter. Allow solution to ca <u>L</u> with DI water, and B g Total chemica <u>L</u> Total water (a <u>L</u> Calculated de	(b3).0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual) insity	6 solution QAAPPHON NAME: Cedur DATE: 1-2-01 DATE: 1-2-01 TG31.0C ADOO TAI	•
idjust total solution volume to djust solution temperature to litter solution by vacuum thro linse beaker with approximately ransfer final filtrate and rinse leasure and record initial pH heck the pH to make sure it ransfer to volumetric flask ar djust final solution to volume UM Total chemicals (ta Total water (target	dc. Handle with caution. o 3 o 50°C to 60°C. ugh medium glass filter. A tely 50 mL of DI water 3 750 mL of DI water 4 arget) 1630.9) 4 nskty 1 cord. p	1400 mL by adding DI w <i>landle with caution, h</i> with stir bar. <u>2</u> 13+ Iter. Allow solution to ca <u>L</u> with DI water, and B g Total chemica <u>L</u> Total water (a <u>L</u> Calculated de	(b3).0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual) insity	6 solution QAAPPHON NAME: Cedur DATE: 1-2-01 DATE: 1-2-01 TG31.0C ADOO TAI	•
Sodium fluoride is highly to djust total solution volume to djust solution temperature to liter solution by vacuum thro linse beaker with approximal inse filter with approximately ransfer final filtrate and rinse leasure and record initial pH heck the pH to make sure it ransfer to volumetric flask ar tjust final solution to volume UM Total chemicals (ta Total water (target Target Specific De	dc. Handle with caution. o 3 o 50°C to 60°C. ugh medium glass filter. A tely 50 mL of DI water 3 750 mL of DI water 4 arget) 1630.9) 4 nskty 1 cord. p	1400 mL by adding DI w <i>landle with caution, h</i> with stir bar. <u>2</u> 13+ Iter. Allow solution to ca <u>L</u> with DI water, and B g Total chemica <u>L</u> Total water (a <u>L</u> Calculated de	(b3).0 vater. oot and caustic ool mix thoroughly. ils (actual) ictual) insity	6 solution QAAPPHON NAME: Cedur DATE: 1-2-01 DATE: 1-2-01 TG31.0C ADOO TAI	•

1	4		

AP105-PSC Base Solution 2007 Version	Batch Size: pH:	2 L 13+	AP105-PSC	
Balance Device ID:	020 NIST Weight (20 g		20.0000	
Technician: Noy Kelley	Date: 19/12/07	y).	<u>300.0</u> Tracking :	73
7	DI water to a beaker. place on stirrer / hotplate.			F

Turn on heater and adjust to 60°C (±10°C).

Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	NaAlO ₂ .2H ₂ 0	35.35	35.36	
Sodium Chloride	NaCl	3.60	3.60	
Sodium Fluoride	NaF	0.76		
Sodium Chromate	Na ₂ CrO ₄	3.43	3.42	
Sodium Sulfate	Na ₂ SO ₄	13.41		
Sodium Phosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	22.88		
Sodium Formate	NaHCOO	1.36		
Sodium Acetate Trihydrate	NaCH ₃ COO.3H ₂ O	2.04		1
Sodium Oxalate	Na ₂ C ₂ O ₄	2.01	2.02	
Sodium Carbonate	Na ₂ CO ₃	69.11	19.20	
Sodium Nitrate	NaNO ₃	605.88		
Potassium Nitrate	KNO ₃	2.69		
Sodium Nitrite	NaNO ₂	37.26		
Stycolic Acid	C2H4O3	1.62	1062	
Sodium Hydroxide	NaOH	14.09		

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to

1700 mL by adding DI water.

.

AA APPROVED

AME: Cedur

ATE: 1-7-0r

<u>. . . .</u> . . . •

Adjust solution temperature to 50°C to 60°C. Filter solution by vacuum through medium glass filter. Handle with caution, hot and caustic solution .

Rinse beaker with approximately 50 mL of DI water

Rinse filter with approximately 50 mL of DI water

Transfer final filtrate and rinse solut	ions to large beaker with stir bar.
Measure and record initial pH	13.44
Check the pH to make sure it is	13+

Check the pH to make sure it is

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust fi	nal solution to volume of	2 L w	rith DI water, and mix thorough	ly
SUM	Total chemicals (target)	815.49 g	Total chemicals (actual)	815,62
	Total water (target)	2 L	Total water (actual)	2000
	Target Specific Density	1.41	Calculated density	7,41

Check final solution pH and record.

pH= 1340Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

Sodium Chloride NaCl 7.20 7.3 Sodium Fluoride NaF 1.53 1.53 1.53 Sodium Chromate Na2CO4 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87	
Balance Device ID: $Olds$ NIST Weight ($\pounds 00^\circ$): Technician: Noy Ke (ley Date: $I//(8/08)$ Add 2400 L mL DI water to a beaker. Insert Teffon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (410° C). Add the following chemicals and record their actual weights: Required Actual Chemical Formula Mass (g) Mass (g) Mass (g) Sodium Aluminate NaAlO ₂ .2H ₂ 0 70.71 $\gamma_{0.1}$ Sodium Choride NaF 1.53 1.53 1.53 Sodium Choride NaF 1.53 4.687 6.87 6.87 Sodium Choride NaF 1.53 4.687 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 6.87 <td< th=""><th>-<u>50 - ()</u> Tracking : <u>76</u> (g) Comments 371 </th></td<>	- <u>50 - ()</u> Tracking : <u>76</u> (g) Comments 371
Technician: Nay Ke (l ey Date: 1/18/08 Add 2400 L mL DI water to a beaker. Insert Teffon stirbar and thermocouple, and place on stirrer / hotplate. Turm on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights: Required Actual Chemical Formula Mass (g) Mass (g) Mass (g) Sodium Aluminate NaAlO2.2H20 70.71 70.71 70.72 Sodium Chloride NaF 1.53 1.53 1.53 Sodium Chloride NaF 1.53 1.53 1.53 Sodium Chloride NaF 1.53 1.53 1.53 Sodium Prosphate, 12-Hydrate Na2CPO4 26.62 46 Sodium Prosphate, 12-Hydrate Na2PO4.12H20 27.72 4.5 Sodium Prosphate, 12-Hydrate Na2PO4.12H20 27.72 4.5 Sodium Carbonate Na2CO3 138.21 75.38 5.77 4.5 Sodium Mitrate NaN03 Potastum Nitrate NaN03 121.76 16.1 176.1 174.5 174.5 174.5 174.5 174.5 174.5	Tracking : al (g) Comments 3→71 5→2
Add 2400 L mL DI water to a beaker. Insert Teffon stirbar and thermocoupie, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights: Chemical Formula Required Actual Sodium Aluminate NaAlO2.2H20 70.71 70.8 Sodium Choride NaCl 7.20 70.71 70.8 Sodium Choride NaCl 7.20 70.71 70.7 Sodium Choride NaCl 7.20 70.71 70.7 Sodium Choride NaF 1.53 1.53 1.53 1.53 Sodium Choride NaF 1.637 4.52 26.82 36 Sodium Suifate Na2CO0 2.72 d.6.87 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02 4.02<	al (g) Comments (a) 71 (a) 71 (a) 70 (a) 70
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights: Chemical Formula Mass (g) Mass (g) Sodium Aluminate NaAlO2,2H20 Sodium Chloride NaF Sodium Chloride NaF Sodium Chromate Na2CO4 Sodium Phosphate, 12-Hydrate Na2CO4 Sodium Acetate Trihydrate Na2CQ4 Sodium Acetate Trihydrate Na2CQ4 Sodium Carbonate Na2CQ4 Sodium Carbonate Na2CQ4 Sodium Carbonate Na2CQ4 Sodium Oxalate Na2CQ4 Sodium Nitrate NaNO2 Sodium Nitrate NaNO2 Sodium Ritrite NaNO2 Sodium Ritrite NaNO2 Sodium Ritrite NaNO2 Sodium Ritrite NaNO2 Sodium Hydroxide NaO4 Nasolution to volume to 3400 mL by adding DI water. Adjust solution to volume to 3400 mL by adding DI water. Adjust solution to volume to 12 a 4 S	(g) Comments 3; 71
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights: Chemical Formula Mass (g) Mass (Sodium Aluminate NaAlO ₂ .2H ₂ 0 70.71 70, Sodium Chloride NaF Sodium Chloride NaF Sodium Chromate Na ₂ CO ₄ 6.87 6, Sodium Suifate Na ₂ CO ₄ 26.82 % Sodium Phosphate, 12-Hydrate Na ₂ PO ₄ , 12H ₂ O Sodium Acetate Trihydrate Na ₂ CO ₄ 4.02 4. Sodium Acetate Trihydrate Na ₂ CO ₄ 4.02 4. Sodium Carbonate Na ₂ CO ₄ 4.02 4. Sodium Nitrate NaNO ₃ 1211.75 1% [] Potassium Nitrate NaNO ₃ 1211.75 1% [] Potassium Nitrate NaNO ₃ 74.52 7/4, Sodium fluoride is highly toxic. Handle with caution. Adjust total solution volume to So ⁺ C to 60°C. Filter solution temperature to 50°C to 60°C. Filter solution temperature to 5	(g) Comments 3; 71
Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights: Required Mass (g) Mass (g) Chemical Formula Mass (g) Actual Chemical Formula Mass (g) Actual Chemical Formula Mass (g) Mass (g) Actual Sodium Aluminate NaClo 2.2H20 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.71 70.70 6.8.87 7.20 7.72.0	(g) Comments 3; 71
ChemicalFormulaRequired Mass (g)Actual Mass (g)Sodium AluminateNaAIO2.2H20 70.711 70.3 Sodium ChlorideNaCI 70.711 70.3 Sodium ChlorideNaF 1.531 1.531 Sodium ChromateNa2CO4 6.87 $L.$ Sodium SuffateNa2S04 26.82 360 Sodium Phosphate, 12-HydrateNa2CO, $124,00$ 26.82 Sodium PromateNa2CO, $124,00$ 4.08 4.402 Sodium CarbonateNa2CO, $124,00$ 4.08 4.402 Sodium CarbonateNa2CO, $128,00$ 4.02 4.68 Sodium CarbonateNa2CO, $128,00$ 4.02 4.68 Sodium CarbonateNa2CO, 3.120 138.211 1736 Sodium NitrateNaNO3 1211.75 1.816 Potassium NitrateNaNO2 74.52 744 Sodium NitrateNaO4 28.18 5.5 Sodium Rodiu Addium NitriteNaOH 28.18 5.5 Sodium Rodiu Addium NitriteNaOH 28.18 5.5 Sodium HydroxideNaOH 28.18 5.5 Sodium Huoride is highly toxic. Handle with caution.Adjust total solution volume to 3400 mL by adding DI water.Adjust total solution volume to 3400 mL by adding DI water.Rinse Bitler with approximately 50 mL of DI water $13+1$ Transfer final filtrate and rinse solutions to large basker with stir bar.Measure and record initial pH $12/34$ $12/34$ $13+1$ Transfer	(g) Comments 3; 71
Chemical Formula Mass (g) Mass (g) Sodium Aluminate NaAlO2,2H20 70.71 70,3 Sodium Choride NaF 1.53 1 Sodium Provide NaF 1.53 1 Sodium Provide NaF 1.53 1 Sodium Suifate Na2CrO, 6.87 50 Sodium Prosphate, 12-Hydrate Na3PO, 12H20 45.77 4.5 Sodium Formate NaCH3CO, 4.08 4.02 Sodium Carbonate Na2CrO, 4.08 4.02 Sodium Carbonate Na2CQ, 4.08 4.02 Sodium Carbonate Na2CQ, 4.02 4.02 Sodium Nitrate NaNO3 1211.75 1.51 Potassium Nitrate NaNO3 5.38 5.7 Sodium Hydroxide NaO4 28.18 5.7 Sodium Hydroxide NaO4 28.18 5.7 Sodium Hydroxide NaO3 5.38 5.7 Sodium Hydroxide NaO4 28.18 5.7 Sodium Hydroxide NaO4 28.18 5.7 Sodium Hydroxide NaO4 28.18 5.7 Sodium Sutton to volume to 3400 mL of DI water 74.52 Rinse Biter with a	(g) Comments 3; 71
Sodium Aluminate NaAIO ₂ ,2H ₂ 0 70.71 70.8 Sodium Choride NaCl 7.20 4.8 Sodium Fluoride NaF 1.53 1.53 Sodium Chromate Na ₂ CO ₄ 6.87 6.87 6.87 Sodium Sulfate Na ₂ CO ₄ 26.82 36 Sodium Phosphate, 12-Hydrate Na ₂ CO ₄ 26.82 36 Sodium Acetate Trihydrate NaCH ₃ CO.3H ₂ O 4.08 4.4 Sodium Oxalate Na ₂ CO ₄ 4.02 4.2 Sodium Oxalate Na ₂ CO ₃ 138.21 138.21 Sodium Nitrate NaNO ₃ 1211.75 1.51 1.71 Potassium Nitrate NaNO ₃ 1211.75 1.58 5.7 Sodium Nitrate NaNO ₃ 1211.75 1.84 5.38 5.7 Sodium Nitrate NaNO ₃ 1211.75 1.84 5.8 5.8 5.7 Sodium Hydroxide NaNO ₃ 1211.75 1.84 5.8 5.8 5.7 Sodium Ruoride is highly toxic. Handle with caution. 3400 mL by adding DI water. Adjust total solution volume to 50°C to 60°C.	57 57 57 57 57 57 57 57 57 77 72
Sodium ChlorideNaCl7.207.3Sodium FluorideNaF1.531Sodium SulfataNa2CrO46.871Sodium SulfataNa3CQ426.8234Sodium Phosphate, 12-HydrateNa3PO4,12H2045.7745Sodium Acetata TrihydrateNaCH3COO,3H204.084.02Sodium OxalateNa2CQ3138.21138138.21Sodium CarbonateNa2CQ3138.211385Sodium NitrateNaNO31211.751.515Potassium NitrateNaNO31211.751.515Sodium NitrateNaNO31211.751.515Sodium NitrateNaNO31211.751.515Sodium NitrateNaNO31211.751.515Sodium NitrateNaNO31211.751.515Sodium NitrateNaNO31211.751.515Sodium HydroxideNaOH28.1833Sodium HydroxideNaOH28.1833Sodium HydroxideNaOH28.1833Sodium fluoride is highly toxic. Handle with caution.3400 mL by adding DI water.Adjust total solution volume to Adjust solution temperature to 50°C to 60°C.3400 mL by adding DI water.Rinse backer with approximately 50 mL of DI water134Rinse backer with approximately 50 mL of DI water134Transfer final filtrate and rinse solutions to large backer with stir bar.132Measure and record infitial pH123 <td>620 · 53 · 87 · 82 · · 82 · · 72 · 72</br></td>	620 · 53 · 87
Sodium FluorideNaF1.531Sodium ChromateNa2CrO46.87 μ_1 Sodium SulfateNa2CO46.87 μ_2 Sodium Prosphate, 12-HydrateNa4CO02.72 d_2 Sodium PromateNa4CO02.72 d_2 Sodium OxalateNa2CO3138.21 138.21 Sodium NitrateNaNO31211.75 d_2 Sodium NitrateNaNO31211.75 d_2 Potassium NitrateNaNO274.52 744 Sodium HydroxideNaOH28.18 28.18 Sodium HydroxideNaOH28.18 28.18 Sodium HydroxideNaOH28.18 28.18 * Sodium fluoride is highly toxic. Handle with caution.3400 mL by adding DI water.Adjust total solution volume to Rinse beaker with approximately 50 mL of DI water3400 mL by adding DI water.Rinse filter with approximately 50 mL of DI water13+Transfer final filtrate and rinse solutions to large beaker with stir bar. Measure and record initial pH 12345 Check the pH to make sure it is13+Transfer to volumetric flask and include rinse with DI water. Allow solution to coolAdjust final solution to volume of Total water (target)4Lwith DI water, and mix thorouSUMTotal chemicals (target) Total water (target)1630.98 g LTotal water (actual) Total water (actual)Total water (target)4LTotal water (actual)Target Specific Density1.41Calculated density	· 53 · 87 · 87 · 72 · 72
Sodium ChromateNa2CO46.87 J_{a} Sodium SulfataNa2SO426.8234Sodium Phosphate, 12-HydrateNa3PO4 12H2045.7745Sodium FormateNaHCOO2.72 d_{a} Sodium Acetate TrihydrateNa4CO34.08 A_{a} Sodium CarbonateNa2CO3138.21138.21Sodium NitrateNaNO31211.75 l_{a} Sodium NitrateNaNO274.5274Sodium NitrateNaNO274.5274Sodium NitrateNaNO274.5274Sodium NitrateNaNO274.5274Sodium NitrateNaNO274.5274Sodium HydroxideNaOH28.18 S^3 * Sodium Huoride is highly toxic. Handle with caution.3400 mL by adding DI water.Adjust total solution volume to3400 mL by adding DI water.Adjust total solution volume to3400 mL by adding DI water.Adjust solution temperature to 50°C to 60°C.Filter solution by vacuum through medium glass filter. Handle with caution, hot and cauRinse filter with approximately 50 mL of DI water13+Transfer to volumetric flask and include rinse with DI water. Allow solution to coolAdjust final solution to volume of4 LVital solution to volume of4 LTotal water (target)1630.98 gTotal water (target)4 LTotal water (target)1.41Calculated density	*87 **82 5*17 *72
Sodium SulfateNa2SO4Sodium Phosphate, 12-HydrateNa3PO4 12H20Sodium FormateNaHCOOSodium Acetate TrihydrateNaHCOOSodium OxalateNa2C2O4Sodium OxalateNa2C2O4Sodium OxalateNa2C2O4Sodium OxalateNa2C2O4Sodium OxalateNa2C2O4Sodium OxalateNa2C2O4Sodium OxalateNa2C2O4Sodium OxalateNa2C2O4Sodium NitrateNaNO3Potassium NitrateNaNO2Sodium NitrateNaNO2Sodium NitrateNaNO2Sodium HydroxideNaOHSodium HydroxideNaOH* Sodium HydroxideNaOH* Sodium fluoride is highly toxic. Handle with caution.Adjust total solution volume to3400 mL by adding DI water.Adjust solution temperature to 50°C to 60°C.Fifter solution by vacuum through medium glass filter. Handle with caution, hot and cauRinse filter with approximately 50 mL of DI waterTransfer final filtrate and rinse solutions to large beaker with stir bar.Measure and record initial pH12/2/4Check the pH to make sure it isTransfer to volumetric flask and include rinse with DI water. Allow solution to coolAdjust final solution to volume of4 LTotal water (target)Total water (target)Total water (target)Total water (target)Target Specific Density1.41Calculated density	6.82 5.17 ,72
Sodium Phosphate, 12-HydrateNa $_3PO_4$, 12H $_2O$ 45.7745Sodium FormateNaHCOO2.723.Sodium Acetate TrihydrateNaCH $_3COO_3H_2O$ 4.084.02Sodium OxalateNa $_2C_2O_4$ 4.024.02Sodium CarbonateNa $_2C_2O_4$ 138.21138.21Sodium NitrateNaNO $_3$ 1211.751.5Potassium NitrateNaNO $_2$ 74.52744Glycolic AcidC $_2H_4O_3$ 3.232.7Sodium HydroxideNaOH28.182.8* Sodium fluoride is highly toxic. Handle with caution.3400 mL by adding DI water.Adjust total solution volume to Rinse baaker with approximately 50 mL of DI water3400 mL by adding DI water.Rinse baaker with approximately 50 mL of DI water13.4Transfer final filtrate and rinse solutions to large baaker with stir bar.Measure and record initial pH 12.84 12.84 13.4 Transfer to volumetric flask and include rinse with DI water. Allow solution to coolAdjust final solution to volume of4Lwith DI water, and mix thorouSUMTotal chemicals (target) Total water (target)1630.98 g 1.41Total chemicals (actual) Target Specific Density	5.97 .78
Sodium Formate NaHCOO 2.72 J. Sodium Acetate Trihydrate NaCH3COO.3H2O 4.08 J. Sodium Carbonate Na2C2O4 4.02 J. Sodium Nitrate NaNO3 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 1211.75 134 1211.75 134 1211.75 134 1211.75 134 1211.75 134 1211.75 134 1211.75 134 1211.75 134 1211.75 134 138.21 148 134 1211.75 149 134 134 134 134 134 134 134 134 134 134 134 134 134 134 134 134	.72
Sodium Acetate TrihydrateNaCH3CO0.3H204.084.0Sodium OxalateNa2C2044.024.024.02Sodium CarbonateNa2C03138.21138.21138.21Sodium NitrateNaNO31211.751.511.51Potassium NitrateKNO35.385.7Sodium NitrateNaNO274.5274.52Potassium NitrateNaNO274.5274.52Sodium NitrateNaNO274.5274.52Sodium NitrateNaOH28.1828.18Sodium HydroxideNaOH28.1828.18Sodium HydroxideNaOH28.1828.18Sodium HydroxideNaOH28.1828.18Sodium HydroxideNaOH28.1828.18Sodium HydroxideNaOH28.1828.18Sodium HydroxideNaOH28.1828.18Sodium HydroxideSodium glass filter.Handle with caution.Adjust total solution volume to3400 mL by adding DI water.Adjust solution temperature to 50°C to 60°C.Filter solution by vacuum through medium glass filter.Hangle filter with approximately 50 mL of DI waterTransfer final filtrate and rinse solutions to large beaker with stir bar.Measure and record initial pH10.2 H SCheck the pH to make sure it is13.4Transfer to volumetric flask and include rinse with DI water.Adjust final solution to volume of4 LAdjust final solution to volume of4 LTotal chemicals (target)1630.98 gTot	
Sodium Oxalate Na ₂ C ₂ O ₄ 4.02 4. Sodium Carbonate Na ₂ CO ₃ 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 1211.75 1& 1211.75 1& 1211.75 1& 1211.75 1& 1211.75 1& 1211.75 1& 1211.75 1& 1211.75 1& 1211.75 1& 1211.75 1& 1211.75 1& 1211.75 1& 1211.75 1& 1211.75 1& 121 74 4 1211.75 1& 1211.75 1& 121 74 4 121.75 1& 121 121 74 4 121.75 1& 121 74 121 121 75 1& 123 121 121 </td <td>JOK 1</td>	JOK 1
Sodium Carbonate Na ₂ CO ₃ 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 138.21 1211.75 18.11 138.21 1211.75 18.11 138.21 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 1211.75 18.11 121.175 1211.75 <	
Socium Nitrate NaNO3 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 1211.75 </td <td>.08</td>	.08
Potassium Nitrate KNO3 5.38 5.7 Sodium Nitrite NaNO2 74.52 74.4 Stycolic Acid C2H4O3 3.23 3 Sodium Hydroxide NaOH 28.18 28.1 28.1 * Sodium fluoride is highly toxic. Handle with caution. 3400 mL by adding DI water. Adjust total solution volume to 3400 mL by adding DI water. Adjust solution temperature to 50°C to 60°C. Filter solution by vacuum through medium glass filter. Handle with caution, hot and cau Rinse beaker with approximately 50 mL of DI water Transfer final filtrate and rinse solutions to large beaker with stir bar. Measure and record initial pH 12.4 L 12.4 L 13+ Transfer to volumetric flask and include rinse with DI water. Allow solution to cool Adjust final solution to volume of 4 L With DI water, and mix thorou SUM Total chemicals (target) 1630.98 g Total chemicals (actual) Target Specific Density 1.41 Calculated density	
Sodium Nitrite NaNO2 74.52 74.62 Gtycolic Acid C2H4O3 3.23 3.23 Sodium Hydroxide NaOH 28.18 3.23 * Sodium fluoride is highly toxic. Handle with caution. 3400 mL by adding DI water. Adjust total solution volume to 3400 mL by adding DI water. Adjust solution temperature to 50°C to 60°C. Filter solution by vacuum through medium glass filter. Handle with caution, hot and cau Rinse beaker with approximately 50 mL of DI water Transfer final filtrate and rinse solutions to large beaker with stir bar. Measure and record initial pH 128.45 Check the pH to make sure it is 13+ Transfer to volumetric flask and include rinse with DI water. Allow solution to cool Adjust final solution to volume of 4 L SUM Total chemicals (target) 1630.98 g Total chemicals (actual) Target Specific Density 1.41 Calculated density	
Glycolic Acid C2H403 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23 3.23	
Sodium Hydroxide NaOH 28.18 28.18 * Sodium fluoride is highly toxic. Handle with caution. 3400 mL by adding DI water. Adjust total solution volume to 3400 mL by adding DI water. Adjust solution temperature to 50°C to 60°C. Filter solution by vacuum through medium glass filter. Handle with caution, hot and cau Rinse beaker with approximately 50 mL of DI water Transfer final filtrate and rinse solutions to large beaker with stir bar. Measure and record initial pH 10 a 4 5 Check the pH to make sure it is 13+ Transfer to volumetric flask and include rinse with DI water. Allow solution to cool Adjust final solution to volume of 4 L SUM Total chemicals (target) 1630.98 g Total chemicals (actual) Target Specific Density 1.41 Calculated density	
* Sodium fluoride is highly toxic. Handle with caution. Adjust total solution volume to 3400 mL by adding DI water. Adjust solution temperature to 50°C to 60°C. Filter solution by vacuum through medium glass filter. Handle with caution, hot and cau Rinse beaker with approximately 50 mL of DI water Rinse filter with approximately 50 mL of DI water Transfer final filtrate and rinse solutions to large beaker with stir bar. Measure and record initial pH <u>10° 45</u> Check the pH to make sure it is <u>13+</u> Transfer to volumetric flask and include rinse with DI water. Allow solution to cool Adjust final solution to volume of <u>4 L</u> with DI water, and mix thorou SUM Total chemicals (target) <u>1630.98 g</u> Total chemicals (actual) Target Specific Density <u>1.41</u> Calculated density	
Adjust total solution volume to 3400 mL by adding DI water. Adjust solution temperature to 50°C to 60°C. Filter solution by vacuum through medium glass filter. Handle with caution, hot and cau Rinse beaker with approximately 50 mL of DI water Rinse filter with approximately 50 mL of DI water Rinse filter with approximately 50 mL of DI water Transfer final filtrate and rinse solutions to large beaker with stir bar. Measure and record initial pH 10° 4 5 Check the pH to make sure it is 13+ Transfer to volumetric flask and include rinse with DI water. Allow solution to cool Adjust final solution to volume of 4 L SUM Total chemicals (target) Total water (target) 4 L Target Specific Density 1.41	5.25 aussovie, pracipitati
Transfer to volumetric flask and include rinse with DI water. Allow solution to cool Adjust final solution to volume of 4 L with DI water, and mix thorou SUM Total chemicals (target) 1630.98 g Total chemicals (actual) Total water (target) 4 L Total water (actual) Target Specific Density 1.41 Calculated density	NAME: Cldum
Transfer to volumetric flask and include rinse with DI water. Allow solution to cool Adjust final solution to volume of 4 L with DI water, and mix thorou SUM Total chemicals (target) 1630.98 g Total chemicals (actual) Total water (target) 4 L Total water (actual) Target Specific Density 1.41 Calculated density	
Adjust final solution to volume of 4 L with DI water, and mix thorou SUM Total chemicals (target) 1630.98 g Total chemicals (actual) Total water (target) 4 L Total water (actual) Target Specific Density 1.41 Calculated density	DATE: 2-5-08
SUM Total chemicals (target) 1630.98 g Total chemicals (actual) Total water (target) 4 L Total water (actual) Target Specific Density 1.41 Calculated density	
Total water (target) 4 L Total water (actual) Target Specific Density 1.41 Calculated density	ughly
Total water (target) 4 L Total water (actual) Target Specific Density 1.41 Calculated density	
Target Specific Density 1.41 Calculated density	4000 mL
	Teat
12 1/2 1/2	
Check final solution pH and record. pH=13.4 Readjust if significantly d	different from target.
Comments: record any difficulties or discrepancies	- V
	- •

	olution 2007 Version		Batch Size: pH:	4 L 13+	AP105-PSC	
Dolars		080	•			
	e Device ID: e Device ID:		NIST Weight (/C		10.0000	
Datance			NIST Weight (50	90 9):	<u>500.0</u>	
Technie	cia <u>n: Noy Ke(l</u>	<u>ey</u> Date	2/1/08		Tracking : 77	
	2400 eflon stirbar and thermocou	ple, and place on stirrer / ho				
	heater and adjust to 60°C (following chemicals and re		Required	Actual		
Chemic	al	Formula	Mass (g)	Mass (g)	Comments	
Sodium /	Aluminate	NaAlO2.2H20	70.71	90.70		
Sodium (Chloride	NaCl	7.20			
Sodium F	Fluoride	NaF	1.53	1, 55		
Sodium (Chromate	Na ₂ CrO ₄	6.87	6.84		
Sodium S	Sulfate	Na ₂ SO ₄	26.82	26.84		
Sodium F	Phosphate, 12-Hydrate	Na3PO4.12H2O	45.77	48.80		
Sodium F		NaHCOO	2.72	2.72		
	Acetate Trihydrate	NaCH3COO.3H2O	4.08	4:09		
Sodium C		Na ₂ C ₂ O ₄	4.02	4.02		
	Carbonate	Na ₂ CO ₃	138.21			
Sodium N		NaNO ₃	1211.75			
	m Nitrate	KNO3	5.38			
Sodium N		NaNO ₂	74.52	14.6		
Glycolic A	Acid	C ₂ H ₄ O ₃	3.23	2.37	Small precipitation	
	lydroxide n fluoride is highly toxic. Ha	NaOH	28.18	28.3	Dissovie after adving	sa
•	olution temperature to 50°C					
Adjust so Filter sol Rinse be Rinse filt Fransfer	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti	edium glass filter. <i>Handle w</i> mL of DI water L of DI water ons to large beaker with stir	,		A APPROVED	
Filter sol Rinse be Rinse filt Transfer Veasure	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti and record initial pH	edium glass filter. Handle w mL of DI water L of DI water ons to large beaker with stir $j_{\mathcal{R}}$, $\frac{4}{3}$,		A APPROVED	
Adjust so Filter sol Rinse be Rinse filt Fransfer Vleasure	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti	edium glass filter. <i>Handle w</i> mL of DI water L of DI water ons to large beaker with stir	,	L) N	A APPROVED AME: <u>Claur</u>	
Adjust so Filter sol Rinse be Rinse filt Transfer Measure Check th	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti and record initial pH	edium glass filter. <i>Handle w</i> mL of DI water L of DI water ons to large beaker with stir <u>12, 48</u> 13+	bar.	L) N	A APPROVED	
Adjust so Filter sol Rinse be Rinse filt Fransfer Measure Check th Fransfer	lution by vacuum through m eaker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti and record initial pH he pH to make sure it is	edium glass filter. <i>Handle w</i> mL of DI water Ons to large beaker with stir <u>12, 48</u> 13+ ude rinse with DI water. Allo	bar.	Ú N, D,	A APPROVED AME: <u>Claur</u>	
Adjust sc Filter sol Rinse be Rinse filt Fransfer Measure Check th Fransfer Adjust fir	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti e and record initial pH he pH to make sure it is to volumetric flask and incl hal solution to volume of	edium glass filter. <i>Handle w</i> mL of DI water Ons to large beaker with stir <u>12, 48</u> 13+ ude rinse with DI water. Allo	bar. w solution to cool DI water, and mix	() N; D; c thoroughty.	A APPROVED AME: <u>Claur</u> ATE: <u>2~5~08</u>	
Adjust sc Filter sol Rinse be Rinse filt Fransfer Measure Check th Fransfer Adjust fir	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti e and record initial pH he pH to make sure it is to volumetric flask and incl hal solution to volume of Total chemicals (target)	edium glass filter. <i>Handle w</i> mL of DI water ons to large beaker with stir <u>12, 48</u> 13+ ude rinse with DI water. Allo <u>4 L with</u> 1630.98 g	bar. w solution to cool <u>1 DI water, and mix</u> Total chemicals (i	() N; D; c thoroughly. actual)	A APPROVED AME: <u>Claur</u> ATE: <u>2-5-08</u>	
Adjust so Filter sol Rinse be Rinse filt Fransfer Measure Check th Fransfer	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti e and record initial pH ne pH to make sure it is to volumetric flask and incl nal solution to volume of Total chemicals (target) Total water (target)	edium glass filter. <i>Handle w</i> mL of DI water ons to large beaker with stir <u>12, 48</u> 13+ ude rinse with DI water. Allo <u>4 L with</u> 1630.98 g 4 L	bar. w solution to cool DI water, and mix Total chemicals (Total water (actua	() N, D, (thoroughly. actual) al)	A APPROVED AME: <u>Claur</u> ATE: <u>2-5-08</u> TE31.73 9 4000 ml	
Adjust so Filter sol Rinse be Rinse filt Fransfer Measure Check th Fransfer Adjust fir SUM	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti and record initial pH te pH to make sure it is to volumetric flask and incl nal solution to volume of Total chemicals (target) Total water (target) Target Specific Density	edium glass filter. <i>Handle w</i> mL of DI water ons to large beaker with stir <u>12, 48</u> 13+ ude rinse with DI water. Allo <u>4 L</u> with 1630.98 g 4 L 1.41	bar. w solution to cool DI water, and mix Total chemicals (Total water (actua Calculated densit	() N/ D/ actual) actual) al) y	A APPROVED AME: <u>Claur</u> ATE: <u>2~5~08</u> ATE: <u>2~5~08</u>	
Adjust so Filter sol Rinse be Rinse filt Fransfer Measure Check th Fransfer Adjust fir SUM	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti e and record initial pH ne pH to make sure it is to volumetric flask and incl nal solution to volume of Total chemicals (target) Total water (target) Target Specific Density nal solution pH and record.	edium glass filter. <i>Handle w</i> mL of DI water ons to large beaker with stir <u>12, 48</u> 13+ ude rinse with DI water. Allo <u>4 L</u> with 1630.98 g 4 L 1.41 pH= <u>12, 1</u>	bar. w solution to cool DI water, and mix Total chemicals (Total water (actua	() N/ D/ actual) actual) al) y	A APPROVED AME: <u>Claur</u> ATE: <u>2~5~08</u> ATE: <u>2~5~08</u>	
Adjust so Filter sol Rinse be Rinse filt Fransfer Measure Check th Fransfer Adjust fir SUM	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti and record initial pH te pH to make sure it is to volumetric flask and incl nal solution to volume of Total chemicals (target) Total water (target) Target Specific Density	edium glass filter. <i>Handle w</i> mL of DI water ons to large beaker with stir <u>12, 48</u> 13+ ude rinse with DI water. Allo <u>4 L</u> with 1630.98 g 4 L 1.41 pH= <u>12, 1</u>	bar. w solution to cool DI water, and mix Total chemicals (Total water (actua Calculated densit	() N/ D/ actual) actual) al) y	A APPROVED AME: <u>Claur</u> ATE: <u>2~5~08</u> ATE: <u>2~5~08</u>	
Adjust so Filter sol Rinse be Rinse filt Fransfer Measure Check th Fransfer Adjust fir SUM	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti e and record initial pH ne pH to make sure it is to volumetric flask and incl nal solution to volume of Total chemicals (target) Total water (target) Target Specific Density nal solution pH and record.	edium glass filter. <i>Handle w</i> mL of DI water ons to large beaker with stir <u>12, 48</u> 13+ ude rinse with DI water. Allo <u>4 L</u> with 1630.98 g 4 L 1.41 pH= <u>12, 1</u>	bar. w solution to cool DI water, and mix Total chemicals (Total water (actua Calculated densit	() N/ D/ actual) actual) al) y	A APPROVED AME: <u>Claur</u> ATE: <u>2~5~08</u> ATE: <u>2~5~08</u>	
Adjust so Filter sol Rinse be Rinse filt Fransfer Measure Check th Fransfer Adjust fir SUM	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti e and record initial pH ne pH to make sure it is to volumetric flask and incl nal solution to volume of Total chemicals (target) Total water (target) Target Specific Density nal solution pH and record.	edium glass filter. <i>Handle w</i> mL of DI water ons to large beaker with stir <u>12, 48</u> 13+ ude rinse with DI water. Allo <u>4 L</u> with 1630.98 g 4 L 1.41 pH= <u>12, 1</u>	bar. w solution to cool DI water, and mix Total chemicals (Total water (actua Calculated densit	() N/ D/ actual) actual) al) y	A APPROVED AME: <u>Claur</u> ATE: <u>2~5~08</u> ATE: <u>2~5~08</u>	
Adjust so Filter sol Rinse be Rinse filt Fransfer Measure Check th Fransfer Adjust fir SUM	lution by vacuum through m baker with approximately 50 ter with approximately 50 m final filtrate and rinse soluti e and record initial pH ne pH to make sure it is to volumetric flask and incl nal solution to volume of Total chemicals (target) Total water (target) Target Specific Density nal solution pH and record.	edium glass filter. <i>Handle w</i> mL of DI water ons to large beaker with stir <u>12, 48</u> 13+ ude rinse with DI water. Allo <u>4 L</u> with 1630.98 g 4 L 1.41 pH= <u>12, 1</u>	bar. w solution to cool DI water, and mix Total chemicals (Total water (actua Calculated densit	() N/ D/ actual) actual) al) y	A APPROVED AME: <u>Claur</u> ATE: <u>2~5~08</u> ATE: <u>2~5~08</u>	

AY101-PSC Base Solution 2007 Version		Batch Size: pH:	2 L >13	AY-101-PSC
Balance Device ID:	OBO	NIST Weight (/0	2a):	10.0000
Balance Device ID:	-018	NIST Weight (50		500.0
Technician: Noy Kell	ey Da	ne:2/1/08		Tracking: 78
Add 1200 Insert Tefion stirbar and thermocor Turn on heater and adjust to 60°C Add the following chemicals and re	uple, and place on stirrer / (±10°C).	hotplate.	, ,	
Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodinum Alumniate	NaAlO ₂ .2H ₂ 0	25.25		Comments
Sodium Chloride		·····		<u> </u>
Sodium Fluoride	NaCi	2.13		
Sodium Fluonde	NaF	1.16		├ ────────┤
Sodium Chromate		0.92		┟─────┤
	Na ₂ SO ₄	5.65	5,65	
Sodium Phosphate, 12-Hydrate	Na3PO412H2O	37.71		<u>↓</u>
Sodium Formate	NaHCOO	1.73		<u> </u>
Sodium Acetate Trihydrate	NaCH3COO.3H2O	2.41		
Sodium Oxalate	Na ₂ C ₂ O ₄	1.34		
Sodium Carbonate	Na ₂ CO ₃	42.61	Ad. 6.2	
Sodium Nitrate	NaNO ₃	226.07		<u></u>
Sodium Nitrite	NaNO ₂	28.29	38.30	
Sodium Silicate	Na ₂ SiO ₃ .9H ₂ O	0.99		Preapitation
Stycolic Acid	C₂H₄O ₃	1.60		ⁱ n
Sodium Hydroxide Sodium fluoride is highly toxic. Ha	NaOH	56.88	56.9	
Adjust total solution volume to Adjust solution temperature to 50°(Filter solution by vacuum through r	C to 60°C.	nL by adding DI wate e with caution, hot a		olution.
Rinse beaker with approximately 5 Rinse filter with approximately 50 r	0 mL of DI water nL of DI water		C	A APPROVED
Rinse beaker with approximately 5 Rinse filter with approximately 50 r ransfer final filtrate and rinse solu Measure and record initial pH	0 mL of DI water nL of DI water tions to large beaker with : 	stir bar.		A APPROVED
Rinse beaker with approximately 5 Rinse filter with approximately 50 r	0 mL of DI water nL of DI water	stir bar.		MA APPROVED
Rinse beaker with approximately 5 Rinse filter with approximately 50 r ransfer final filtrate and rinse solu Measure and record initial pH	0 mL of DI water nL of DI water tions to large beaker with s 12066 >13	stir bar.	non-standard	
Rinse beaker with approximately 5 Rinse filter with approximately 50 r ransfer final filtrate and rinse solu Measure and record initial pH Check the pH to make sure it is	0 mL of DI water nL of DI water tions to large beaker with s 130	stir bar.	non-standa fd	ME: Cedun
Rinse beaker with approximately 5 Rinse filter with approximately 50 r Fransfer final filtrate and rinse solu Measure and record initial pH Check the pH to make sure it is Fransfer to volumetric flask and inc	0 mL of DI water nL of DI water tions to large beaker with s 2000 >13 clude rinse with DI water. A 2 L v	stir bar. Allow solution to cool	non-standard D k thoroughly.	ME: Cedun
Rinse beaker with approximately 5 Rinse filter with approximately 50 r ransfer final filtrate and rinse solu Measure and record initial pH Check the pH to make sure it is ransfer to volumetric flask and inc udjust final solution to volume of Total chemicals (target	0 mL of DI water nL of DI water tions to large beaker with s 2000 >13 clude rinse with DI water. A 2 L v	stir bar. Allow solution to cool vith DI water, and mix Total chemicals (non-standard D k thoroughly. actual)	ME: <u>Cedum</u> ITE: <u>J-12-08</u>
Rinse beaker with approximately 5 Rinse filter with approximately 50 r ransfer final filtrate and rinse solu Measure and record initial pH Check the pH to make sure it is ransfer to volumetric flask and inc adjust final solution to volume of	0 mL of DI water nL of DI water tions to large beaker with s 2000 >13 clude rinse with DI water. A 2 L v 434.74 g 2 L	stir bar. Allow solution to cool vith DI water, and mix	non-standard k thoroughly. actual) al)	ME: <u>Cedun</u> /TE: <u>2-12-08</u>
Rinse beaker with approximately 5 Rinse filter with approximately 50 r ransfer final filtrate and rinse solu leasure and record initial pH Check the pH to make sure it is ransfer to volumetric flask and inc adjust final solution to volume of CM Total chemicals (target) Total water (target) Target Specific Density	0 mL of DI water nL of DI water tions to large beaker with s 2 13 clude rinse with DI water. A 2 L v 434.74 g 2 L 1.22	stir bar. Allow solution to cool with DI water, and mix Total chemicals (Total water (actu Calculated densit	non-standard k thoroughly. actual) al) ty	etME: <u>Cedun</u> /TE: <u>2-12-08</u> <u>434.91</u> <u>2000</u> 1.22 mi
Rinse beaker with approximately 5 Rinse filter with approximately 50 r ransfer final filtrate and rinse solu Measure and record initial pH Check the pH to make sure it is ransfer to volumetric flask and inc adjust final solution to volume of Total chemicals (target Total water (target) Target Specific Density Check final solution pH and record	0 mL of DI water nL of DI water tions to large beaker with s 120// >13 clude rinse with DI water. A 2 L v 434.74 g 2 L 1.22 pH= Č	stir bar. Allow solution to cool vith DI water, and mix Total chemicals (Total water (actu	non-standard k thoroughly. actual) al) ty	etME: <u>Cedun</u> /TE: <u>2-12-08</u> <u>434.91</u> <u>2000</u> 1.22 mi
Rinse beaker with approximately 5 Rinse filter with approximately 50 r ransfer final filtrate and rinse solu leasure and record initial pH Check the pH to make sure it is ransfer to volumetric flask and inc adjust final solution to volume of CM Total chemicals (target) Total water (target) Target Specific Density	0 mL of DI water nL of DI water tions to large beaker with s 120// >13 clude rinse with DI water. A 2 L v 434.74 g 2 L 1.22 pH= Č	stir bar. Allow solution to cool with DI water, and mix Total chemicals (Total water (actu Calculated densit	non-standard k thoroughly. actual) al) ty	etME: <u>Cedun</u> /TE: <u>2-12-08</u> <u>434.91</u> <u>2000</u> 1.22 mi
Rinse beaker with approximately 5 Rinse filter with approximately 50 r ransfer final filtrate and rinse solu Measure and record initial pH Check the pH to make sure it is ransfer to volumetric flask and inc adjust final solution to volume of Total chemicals (target Total water (target) Target Specific Density Check final solution pH and record	0 mL of DI water nL of DI water tions to large beaker with s 120// >13 clude rinse with DI water. A 2 L v 434.74 g 2 L 1.22 pH= Č	stir bar. Allow solution to cool with DI water, and mix Total chemicals (Total water (actu Calculated densit	non-standard k thoroughly. actual) al) ty	etME: <u>Cedun</u> /TE: <u>2-12-08</u> <u>434.91</u> <u>2000</u> 1.22 mi

.

AP105-PSC Base Solution 2007 Version		Batch Size: pH:	4 L 13+	AP105-PSC	
Balance Device ID:	020	NIST Weight (&		80.0000	
Balance Device ID:	0 18	NIST Weight (多	∞g):	300.0	
Technician: Noy Ke	<u>lley</u> c	ate:& / /4	108	_ Tracking : _	79
Add 240 Insert Teflon stirbar and thermoo Turn on heater and adjust to 60° Add the following chemicals and	C (±10°C).	/ hotplate.			
	-	Required	Actual		
Chemical	Formula	Mass (g)	Mass <u>(g)</u>	Comments	
Sodium Aluminate	NaAlO ₂ .2H ₂ 0	70.71			
Sodium Chloride	NaCl	7.20	1 7,20		
Sodium Fluoride	NaF	1.53	1.53		
Sodium Chromate	Na ₂ CrO ₄ .4H ₂ O	9.92			
Sodium Sulfate	Na ₂ SO ₄	26.82	26.82		
Sodium Phosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	45.77	1 19.83		
Sodium Formate	NaHCOO	2.72	2.73		
Sodium Acetate Trihydrate	NaCH ₃ COO.3H ₂ O	4.08	1 4.08		
Sodium Oxalate	Na ₂ C ₂ O ₄	4.02	4.03		
Sodium Carbonate	Na ₂ CO ₃	138.21	138.2		
Sodium Nitrate	NaNO ₃	1211.75			
Potassium Nitrate	KNO3	5.38			
Sodium Nitrite	NaNO ₂	74.52			
Glycolic Acid	C ₂ H ₄ O ₃	3.23			
Sodium Hydroxide	NaOH	28.18	28,31		

Sodium Hydroxide NaOH
* Sodium fluoride is highly toxic. Handle with caution.

1634.56

NAME: Claun

DATE:___

2-15-08

Adjust total solution volume to

3400 mL by adding DI water.

Adjust solution temperature to 50°C to 60°C.

Filter solution by vacuum through medium glass filter. Handle with caution, hot and caustic solution . Rinse beaker with approximately 50 mL of DI water **QA APPROVED**

13+

Rinse filter with approximately 50 mL of DI water

Transfer final filtrate and rinse solutions to large beaker with stir bar. Measure and record initial pH = 13.45Measure and record initial pH

Check the pH to make sure it is

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust f	inal solution to volume of	4L w	ly	
SUM	Total chemicals (target)	1634.03 g	Total chemicals (actual)	1624-56
	Total water (target)	4 L	Total water (actual)	2000
	Target Specific Density	1.41	Calculated density	1041

Check final solution pH and record.

pH=1345 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

AP105-PSC		Batch Size:	4 L		
Base Solution 2007 Versi	ion	pH:	13+	AP105-PSC	1
Balance Device ID:	020	NIST Weight	(A()a);	0.6M nitrite	
Balance Device ID:	018	NIST Weight	· •·	500.0	
Technician: Noy	Kelley Da	ne: 2/14/	08	Tracking :	80
Add	2400 L mL DI water to a beal	ker.			
Insert Teflon stirbar and the	ermocouple, and place on stirrer /				
Turn on heater and adjust	to 60°C (±10°C).	•			
Add the following chemical	s and record their actual weights:				
		Required	Actual		
Chemical	Formula	Mass (q)	Mass (g)	Comments	

Formula	Mass (g)	Mass (g)	Comments
NaAlO2.2H20		30.92	
NaCl	7.20		
NaF	1.53	1.53	
Na ₂ CrO ₄ .4H ₂ O	9.92	10.0	
Na ₂ SO ₄	26.82	26.83	
Na ₃ PO ₄ 12H ₂ O	45.77	15.78	· ·
NaHCOO	2.72		
NaCH ₃ COO.3H ₂ O	4.08	4109	
Na ₂ C ₂ O ₄	4.02	2,04	
Na ₂ CO ₃	138.21	138.2	
NaNO ₃	1211.75	1212	
KNO3	5.38	5.38	
NaNO ₂	165.60	16506	
C2H4O3	3.23	3,23	
NaOH	28.18	38,27	
	NaAlO ₂ .2H ₂ 0 NaCl NaF Na ₂ CrO ₄ .4H ₂ O Na ₃ SO ₄ Na ₃ PO ₄ .12H ₂ O NaHCOO NaCH ₃ COO.3H ₂ O Na ₂ Co ₃ NaNO ₃ KNO ₃ NaNO ₂ C ₂ H ₄ O ₃	NaAIO2.2H20 70.71 NaCi 7.20 NaF 1.53 Na2CrO4.4H2O 9.92 Na2SO4 26.82 Na3PO4.12H2O 45.77 NaHCOO 2.72 NaCH3COO.3H2O 4.02 Na2CO3 138.21 NaNO3 1211.75 KNO3 5.38 NaNO2 165.60 C2H4O3 3.23	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$

1725.59

QA APPROVED

2-15-08

NAME: Cedur

DATE:

3400 mL by adding DI water.

Adjust total solution volume to Adjust solution temperature to 50°C to 60°C.

Filter solution by vacuum through medium glass filter. Handle with caution, hot and caustic solution.

Rinse beaker with approximately 50 mL of DI water

Rinse filter with approximately 50 mL of DI water Transfer final filtrate and rinse solutions to large beaker with stir bar. Measure and record initial pH 12^{15} Measure and record initial pH 13+

Check the pH to make sure it is

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust fi	nal solution to volume of	4L w	ly	
SUM	Total chemicals (target)	1725.11 g	Total chemicals (actual)	1785.59 9
	Total water (target)	4 L	Total water (actual)	4000 mi
	Target Specific Density	1.43	Calculated density	1043

Check final solution pH and record.

pH= $\frac{1252}{R}$ Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

AP1	05-PSC				Batch Size:	4 L		
Base S	olution 2007 Ve	ersion			pH:	13+	AP105-PSC	
Balance	Device (D:		026		NIST Weight (&	5 a):	30,0000	
Balance	Device ID:		018		NIST Weight (5	÷.	500.0	
Technic	cian: Noy	Kelley	C	ate:	2/28/08		Tracking : 81	
Add	0	Ŭ		-				
	eflon stirbar and	2400 L thermocoup	mL DI water to a be le, and place on stirrer		nlate			
	heater and adju							
Add the	following chemi	cals and reco	ord their actual weights	:				
Chemic			Formula		Required	Actual Mass (g)	Comments	
	Aluminate		NaAlO2.2H20	1	<u>Mass (g)</u> 70.71	T		
Sodium (NaCl		7.20			
Sodium F			NaF		1.53	<u> </u>	┼───────────	
Sodium C					9.92		+	
Sodium S			Na ₂ CrO ₄ .4H ₂ O Na ₂ SO ₄		26.82		t	
	Phosphate, 12-Hy						+	
			Na3PO4,12H2O					
Sodium F					<u>2.72</u> 4.08	· · · · · · · · · · · · · · · · · · ·		
	Cetate Trihydrate		NaCH ₃ COO.3H ₂ O		4.08			
Sodium C								
	Carbonate		Na ₂ CO ₃		138.21		┥──────	
Sodium N			NaNO ₃				┼─────	
Potassiun			KNO3		5.38		ł	
Sodium N			NaNO ₂		74.52			
Glycolic A			C ₂ H ₄ O ₃		3.23		Stinall amount of	porcipita
Sodium H	lydroxide n fluoride is high		NaOH		28.18	28.19	all parcipitetion	J. · · · · · · · ·
Rinse be Rinse filt Fransfer	aker with appro er with approxin	ximately 50 r nately 50 mL rínse solutio			bar.			
	e pH to make s	•	13+		add	129 N	aoH to pl	H 13 +
Francfor	to volumotric fla	ek and inclu	le rinse with DI water.	Allow		Q	·	
						. the securably		
	al solution to vo	Jume of	4 L	with	DI water, and mi	x morougray.		
SUM	Total chemic:	als (target)	1634.03 g		Total chemicals ((actual)	1634:58	
	Total water (t	arget)	4 L		Total water (actu	ial)	4000	
	Target Specif	fic Density	1.41		Calculated densi	ty .	1.41	
				1200				
Check fin	al solution pH a	ind record.	pH=	1290	Readjust if signif	icantly differer	nt from target.	
Commen	its: record any of	difficulties or	discrepancies add)	19 9 01	1 Nool	+ to ae	t
	719		0000			<u> </u>	·	
- <u>-</u> [+						<u>ل</u>		
						-QA 7	APPROVE	┣
						NAM	E: CPOur	
						DATE	3-6-08	

د

Deless D	evice ID:	_	020	NIST Weight (#		\$0.0000	J	
Balance D	evice ID:	. —	018	NIST Weight (う	(<i>do</i> g):	500.0		
Technicia	n: Noy	Kelley	<u>D</u> a	te: <u>3 11/08</u>		Tracking :	82	
Add	0	2400 L m	L DI water to a beak	(e r				
	on stirbar and th		nd place on stirrer / I					
	ater and adjust			•				
Add the fol	llowing chemica	s and record th	neir actual weights:					
Chemical		r -		Required	Actual	Comments		
Sodium Alu	minoto		rmula AlO2.2H20	<u>Mass (g)</u>	Mass (g)	Comments		
Sodium Alu				70.71				
Sodium Chi Sodium Flux		Na Na		1.53				
Sodium Chr			<u></u> 2CrO ₄ .4H ₂ O	9.92		t —		
Sodium Sul			2SO4	26.82		1		
	sphate, 12-Hydra		3PO4 12H20	45.77		1		
Sodium Fon			HCOO	2.72				
Sodium Ace	tate Trihydrate		CH ₃ COO.3H ₂ O	4.08		1		
Sodium Oxa	late	Na	2C2O4	4.02	2 1.02			
Sodium Car	bonate	Na	2CO3	138.21	1 138.2			
Sodium Nitr	ate	Na	NO3	1211.75				
Potassium N	Nitrate	KN	O ₃	5.38				
Sodium Nitri			NO ₂	74.52		·		
Glycolic Acid		C2	4₄O₃	3.23				I
Sodium Hyd	uoride is highly		он	28.18	<u>8 </u>			
Adjust solu	-	e to 50°C to 60	°C. 1 glass filter. <i>Handle</i>	nL by adding DI wate		olution .	KEC	
Rinse beak Rinse filter Transfer fin Measure ar Check the p Transfer to	with approximat al filtrate and rin nd record initial pH to make sure volumetric flask	tely 50 mL of D nse solutions to oH^ a it is and include rin			I		QA APPROVE	NAME. COde
Rinse beak Rinse filter Transfer fin Measure ar Check the p Transfer to	with approximat al filtrate and rin nd record initial pH to make sure	tely 50 mL of D nse solutions to oH^ a it is and include rin	N water b large beaker with s <u>3, 15</u> 13+ nse with DI water. A				QA APPRO	NAMF. Codu
Rinse beak Rinse filter Transfer fin Measure ar Check the p Transfer to Adjust final	with approximal al filtrate and rin nd record initial pH to make sure volumetric flask solution to volu	tely 50 mL of D nse solutions to pH/ e it is and include ni me of	l water b large beaker with s <u>3, 15</u> 13+ nse with DI water. A <u>4 L w</u>	llow solution to cool rith DI water, and mi	ix thoroughly.	1632.917	QA APPRO	NAME COde
Rinse beak Rinse filter Transfer fin Measure ar Check the p Transfer to Adjust final SUM	with approximat al filtrate and rin nd record initial pH to make sure volumetric flask	tely 50 mL of D nse solutions to oH <u>}</u> it is and include rin me of (target)	N water b large beaker with s <u>3, 15</u> 13+ nse with DI water. A	llow solution to cool	ix thoroughly (actual)	1634.91	QA APPRO	NAME. Code
Rinse beak Rinse filter Transfer fin Measure ar Check the p Transfer to Adjust final SUM	with approximat all filtrate and rir nd record initial pH to make sure volumetric flask solution to volu Total chemicals	tely 50 mL of D nse solutions to pH <u>}</u> it is and include rin me of (target) get)	I water b large beaker with s 2,15 13+ nse with DI water. A 4 L w 1634.03 g	llow solution to cool hth DI water, and mi Total chemicals	ix thoroughly (actual) ual)	1632.91 4000 1.41	QA APPRO	NAME COde
Rinse beak Rinse filter Transfer fin Measure ar Check the p Transfer to Adjust final SUM	with approximal al filtrate and rir nd record initial pH to make sure volumetric flask solution to volu Total chemicals Total water (targ	tely 50 mL of D nse solutions to of	1 water b large beaker with s 3, 15 13+ nse with DI water. A 4 L w 1634.03 g 4 L 1.41 pH=	llow solution to cool hith DI water, and mi Total chemicals Total water (actu	ix thoroughly. (actual) ual) ity	4000 1•A1	QA APPRO	NAMF COdum

---·

SY103-PIL Base Solution 2008 Version		Batch Size: pH:	4 L 13+	SY103-PIL	
Balance Device ID:	0020	NIST Weight (🖧 g):			
Balance Device ID:	_0/18	NIST Weight (pccog):1000		
Technician: Enily		Date: 3/19/08		Tracking :	85

Add the following chemicals and record their actual weights:

			Required	Actual	
Chemical	Formula		Mass (g)	Mass (g)	Comments
In the first container measure		mL	DI water, heat to		hot-plate
Sodium Aluminate	Na ₂ AlO ₂		675.680	675.7	
Sodium Hydroxide	NaOH]	388.800	388.9	
In a separate container measure	1000	mL	DI water		
Copper Nitrate 2.5-hydrate	Cu(NO ₃) ₂ .2.5H ₂ O		0.186	0.183	
Ferric Nitrate 9-hydrate	Fe(NO3)3.9H2O		0.808	0.809	
Add the following Organics (to t	he second container)	•		•	
Sodium Acetate 3-hydrate	NaCH ₃ COO.3H ₂ O]	23.896	23.902	·
Sodium Formate	NaHCOO]	51.144	51.146	
Glycolic Acid	C ₂ H ₄ O ₃		14.39	14.38	
Sodium Oxalate	Na ₂ C ₂ O ₄		2.358	2,359	
Citric Acid 1-hydrate	C ₆ H ₈ O ₇ .H ₂ O		16.643	16.641	
Disodium EDTA	Na2C10H14O8.2H2O	1	13.103	13,103	
HEDTA	C10H18N2O7	1	4.897		
Nitrilotriacetic Acid	C ₆ H ₉ NO ₆		1.682	1.183	
Iminodiacetic Acid	C ₄ H ₇ NO ₂	1	10.542	10.544	T
Combine the two solutions into	one container, maintain	a ter	mperature of 50°C.	Add the remain	ining chemicals.
Boric Acid	H ₃ BO ₃		3.263	3.211	
Sodium Chromate	Na2CrO4 4H2O	1	0.936		
Potassium Molybdate	K2M0O4	1	1.714	1.714	
Potassium Nitrate	KNO3	1	51.712	51.703	1 -
Sodium Chloride	NaCl	1	115.945		1
Sodium Nitrate	NaNO ₃	1	625.600	625.6	
Sodium Nitrite	NaNO ₂	1	803.160	803.2	
Sodium Phosphate, 12-Hydrate	Na3PO4 12H2O		41.800	41.799	
Sodium Sulfate	Na ₂ SO ₄	}	9.486		
Sodium Carbonate	Na ₂ CO ₃		52.152		

Filter solution by vacuum through medium glass filter. *Handle with caution, caustic solution* . Rinse beaker with approximately 50 mL of DI water

Rinse filter with approximately 50 mL of DI water

Transfer final filtrate and rinse solutions to large beaker with stir bar.

Transfer to volumetric flask and include rinse with DI water.

Adjust fi	Adjust final solution to volume of 4 L with DI water, and mix thorou			ity
SUM	Total chemicals (targe	2910 g	Total chemicals (actual)	2910,091
	Total water (target)	4 L	Total water (actual)	4000
	Target Specific Densit	1.73	Calculated density	1173

Check final solution pH and record

 $pH=\frac{14.06}{100}$ Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

QA APPROVED adeur NAME:

_		8171						
Balance Devi		0020		_NIST Weight (2	g): 20 .000	·		
Balance Devi	ce ID:	0018		NIST Weight (/a	0.0001:{ 0			
Technician <u>×</u>	il f	e_	Date	: <u> 3-20 </u>		_ Tracking : _	86	
Add the follow	ving chemicals and red	cord their actual v	weights:	De midre d	A			
Chemical		Formula		Required Mass (g)	Actual Mass (g)	Comments		
	tainer measure	, outline	2400 mL	Di water, heat to				
Sodium Alumin	ate	Na ₂ AlO ₂			5.264			
Sodium Hydrox	ide	NaOH		72.032				
In a <u>separate</u> c	ontainer measure		1000 mL	DI water				
Cobaltous Nitra	te 6-hydrate	Co(NO3)2.6H2		0.028	0.029			
Nickel Nitrate 6	-hydrate	Ni(NO3)2.6H2C		0.081	0.083			
Add the follow	Ing Organics (to the se	cond container)						
Sodium Acetate		NaCH3COO.3H	20	3.369				
Sodium Format		NaHCOO		0.884				
Sodium Oxalate		Na ₂ C ₂ O ₄		1.726		_		
Tributyl Phosph	ate	C ₁₂ H ₂₇ O ₄ P			5/33			
1-Butanol		C4H9OH			3.706		<u> </u>	
Dibutyl Phospha	ate wo solutions into one c	C ₈ H ₁₉ O ₄ P		10.500			I	
Boric Acid	TO SORUCIONS INTO ONE C	H ₃ BO ₃	a temper			Cuenneals.		
Sodium Chroma		Na2CrO4.4H2O			6. 16 5		———————————————————————————————————————	
Potassium Moly		K2MoO4			,0292		·	
Potassium Nitra		KNO3		88.072	100.0			
Zirconyl Nitrate		ZrO(NO ₃) ₂ .H ₂ (5	0.005				
Sodium Chloride		NaCl		97,608	2362	+		
Sodium Fluoride Sodium Nitrate		NaF			1 68.0	<u> </u>		
Sodium Nitrite		NaNO ₃ NaNO ₂		34 224	34.3			1
Sodium Phosph	ate 12-Hydrate	Na ₃ PO ₄ 12H ₂ O			4,856			
Sodium Sulfate		Na ₂ SO ₄			7,883		¢	ן נ
Sodium Carbon	ate	Na ₂ CO ₃		40.958			——itr	1
Rinse beaker Rinse filter wit Fransfer final f	by vacuum through m with approximately 50 h approximately 50 m filtrate and rinse soluti fumetric flask and incl	mL of DI water L of DI water ons to large bea	ker with st	ir bar.		solution .	Maga 1	VAME: Com
Adjust final sol	ution to volume of		4 L wit	h DI water, and m	ix thoroughly.			y A
Tot	al chemicals (target) al water (target) get Specific Density	. 44	7.49 g 4 L 1.11	Total chemicals Total water (act Calculated dens	ual)	<u>447,46</u> 4000 _1.11		
	lution pH and record.		рН= <u>1</u> 3.	Readjust if signi	ficantly differe	ent from target.		
Comments: re	ecord any difficulties c	r discrepancies						

AP105-PSC Base Solution 2007 Version		Batch Size: pH:	4 L 13+	AP105-PSC 3.85M nitate,	no nitrite
Balance Device ID:	0020	NIST Weight (10 g): 10.0000 -		
Balance Device ID:	00 18	NIST Weight (50 g): 49.9999	<u> </u>	
Technician: Jesse Rhodes		Date: 4/1/08		Tracking :	87

Add 2400 L mL DI water to a beaker.

insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.

Turn on heater and adjust to 60°C (±10°C).

Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	NaAlO ₂ .2H ₂ 0	70.7	1 70.70	
Sodium Chloride	NaCl	7.3	20 7.203	
Sodium Fluoride	NaF	1.	1.530	
Sodium Chromate	Na ₂ CrO ₄ .4H ₂ O	9.9		
Sodium Sulfate	Na ₂ SO ₄	26.8	2 26,80	
Sodium Phosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	45.7		
Sodium Formate	NaHCOO		2 2 719	
Sodium Acetate Trihydrate	NaCH ₃ COO.3H ₂ O	4.0	8 4.081	
Sodium Oxalate	Na ₂ C ₂ O ₄	4.0	2 4,022	
Sodium Carbonate	Na ₂ CO ₃	138.2	1 138.20	
Sodium Nitrate	NaNO ₃	1211.	5 21.80	
Potassium Nitrate	KNO3	114.	57 114.60	
Sodium Nitrite	NaNO ₂	0.0		
Glycolic Acid	C ₂ H ₄ O ₃	3.2	23 3.241	
Sodium Hydroxide	NaOH	28.1	8 28.20	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to

3400 mL by adding DI water.

Adjust solution temperature to 50°C to 60°C.

Filter solution by vacuum through medium glass filter. Handle with caution, hot and caustic solution.

13+

Rinse beaker with approximately 50 mL of DI water

Rinse filter with approximately 50 mL of DI water

Transfer final filtrate and rinse solutions to large beaker with stir bar.

Measure and record initial pH 14.04 Check the pH to make sure it is

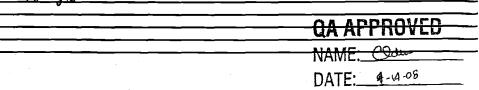
Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust fi	nal solution to volume of	4 L w	ith DI water, and mix thorough	ıly
SUM	Total chemicals (target)	1668.70 g	Total chemicals (actual)	1668.82
	Total water (target)	4 L	Total water (actual)	41
	Target Specific Density	1.42	Calculated density	1.42

Check final solution pH and record.

pH=1395Readjust if significantly different from target.

Comments: record any difficulties or discrepancies



AP105-PSC Base Solution 2007 Version		Batch Size: pH:	4 L 13+	AP105-PSC	
Balance Device ID:	0090	NIST Weight (10	g):	10.0000	
Balance Device ID:	0018	NIST Weight (50		49.9999	
Technician: Jesse Rhode6		Date: 4/2/08		Tracking : 88	3

Add 2400 L mL DI water to a beaker.

Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.

Turn on heater and adjust to $60^{\circ}C$ ($\pm 10^{\circ}C$). Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	NaAlO ₂ .2H ₂ 0		70.70	
Sodium Chloride	NaCi	7.20		
Sodium Fluoride	NaF	1.53		
Sodium Chromate	Na ₂ CrO ₄ .4H ₂ O	9.92		
Sodium Sulfate	Na ₂ SO ₄	26.82	26.80	
Sodium Phosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	45.77	45.80	
Sodium Formate	NaHCOO	2.72	2.7al	
Sodium Acetate Trihydrate	NaCH ₃ COO.3H ₂ O	4.08	4.078	
Sodium Oxalate	Na ₂ C ₂ O ₄	4.02	4.019	
Sodium Carbonate	Na ₂ CO ₃	138.21	138.20	
Sodium Nitrate	NaNO ₃	1211.75	1211.80	
Potassium Nitrate	KNO3	5.38	5.378	
Sodium Nitrite	NaNO ₂	74.52		
Glycolic Acid	C ₂ H ₄ O ₃	3.23	3.333	
Sodium Hydroxide	NaOH	28.18	3810	

* Sodium fluoride is highly toxic. Handle with caution.

3400 mL by adding DI water.

Adjust solution temperature to 50°C to 60°C.

Adjust total solution volume to

Filter solution by vacuum through medium glass filter. Handle with caution, hot and caustic solution .

Rinse beaker with approximately 50 mL of DI water

Rinse filter with approximately 50 mL of DI water

Transfer final filtrate and rinse solutions to large beaker with stir bar.

Measure and record initial pH 14,40 Check the pH to make sure it is

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust f	inal solution to volume of	<u> </u>	ith DI water, and mix thoroug	hly
SUM	Total chemicals (target)	1634.03 g	Total chemicals (actual)	1633.48
	Total water (target)	4 L	Total water (actual)	4L
	Target Specific Density	1.41	Calculated density	98 1.40 1.41

13+

Check final solution pH and record.

pH=14.19 Readjust if significantly different from target.

comments: record any difficulties or dis ६७३९६-<u>६</u>६९५ ब्रुट्	screpancies	·
		GA AFPROVED
	· · · ·	NAME: Cidu
		DATE: 4-14-08

AP105 - Mixed S Base Solution 2008 Versi	-	Batch Size: pH:	4 L 13+	AP105-Mixed Super
Balance Device ID: Balance Device ID;	030	NIST Weight (ఉంద్ర) NIST Weight (తిలంలిg		<u>do.0000</u>
Technician: Noy	Kelley	Date: 4/9/08		Tracking : 89
Add Insert Teflon stirbar and the	2400 L mL DI water to a armocouple, and place on st			

Turn on heater and adjust to 60° C ($\pm 10^{\circ}$ C). Add the following chemicals and record their actual weights:

Chemic	ai	Formula		Required Mass (g)	Actual Mass (g)	Comments
_	Aluminate	NaAlO22H2O	T	92.04		Cloundy then el
Sodium (NaCl	-	9.12		Clocker
Sodium F		NaF	-	4.37	4,99	<u>+</u>
	Chromate 4-hydrate	Na ₂ CrO ₄ .4H ₂ O	1	7.49		Yellow
Sodium S		Na2SO4	-	22.73		12000
	Phosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	-	45.61		
Sodium F		NaHCOO	-	3.13		<u> </u>
	Acetate Trihydrate	NaCH ₃ COO.3H ₂ O	-	5.72		<u>}</u>
Sodium (Na ₂ C ₂ O ₄	-	6.16		
	Carbonate	Na2CO3	-	116.17	116.2	cloundy
Sodium N		NaNO3	-1	927.07		
	m Nitrate	KNO3	-{	52.57	32.5	↓
Sodium N			-	113.99		<u>+</u>
			-			11/2 Poeci pitation
	Acid (70% solution)	C ₂ H₄O ₃	-	4.96		
	łydroxide im Acetate		╂	152.32		Clean al precipitat
	n fluoride is highly toxic. H	NH₄CH₃COO	<u> </u>	all analoun		uite chemical le gilter
		itions to large beaker wit	h stir	bar.		
Aeasure Check th	that intrate and rinse solu- e and record initial pH we pH to make sure it is to volumetric flask and in-	<u> </u>				
Measure Check th Transfer	and record initial pH apH to make sure it is	134 clude rinse with DI water	Allo		x thoroughly.	
Measure Check th Fransfer Adjust fin	and record initial pH to make sure it is to volumetric flask and in		. Allo with	w solution to cool	actual) al)	1565.28 g 4000 ml 1.39
Measure Check th Fransfer Adjust fin	and record initial pH te pH to make sure it is to volumetric flask and in <u>nal solution to volume of</u> Total chemicals (target Total water (target)		. Ailo	w solution to cool <u>DI water, and mi</u> Total chemicals (Total water (actu	actual) al) ty	4000 ml 1-39
Measure Check th Transfer Adjust fin SUM	and record initial pH te pH to make sure it is to volumetric flask and in- nal solution to volume of Total chemicals (target Total water (target) Target Specific Density		. Ailo	w solution to cool DI water, and mi Total chemicals (Total water (actu Calculated densi	actual) al) ty	4000 ml 1-39
Aeasure Check th Transfer adjust fin SUM	and record initial pH te pH to make sure it is to volumetric flask and in- nal solution to volume of Total chemicals (target Total water (target) Target Specific Density nal solution pH and record		. Ailo	w solution to cool DI water, and mi Total chemicals (Total water (actu Calculated densi	actual) al) ty	4000 ml 1-39
Aeasure Check th Transfer adjust fin SUM	and record initial pH te pH to make sure it is to volumetric flask and in- nal solution to volume of Total chemicals (target Total water (target) Target Specific Density nal solution pH and record		. Ailo	w solution to cool DI water, and mi Total chemicals (Total water (actu Calculated densi	actual) al) ty	4000 ml 1-39
Measure Check th iransfer adjust fin CUM	and record initial pH te pH to make sure it is to volumetric flask and in- nal solution to volume of Total chemicals (target Total water (target) Target Specific Density nal solution pH and record		. Ailo	w solution to cool DI water, and mi Total chemicals (Total water (actu Calculated densi Readjust if signif	actual) al) ty	4000 1-39 th from target.

Balance Device ID: 018 NIST We Technician: Noy Kelley Date: 4/// Add 2400 mL DI water to a beaker. Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights: Chemical Formula Mass (g) Sodium Aluminate Naci Sodium Choride Naci Sodium Choride Naci Sodium Choride Nag2CQ.44H2O Sodium Phosphate, 12-Hydrate Nag2CQ.4 Sodium Choride NaHCOO Sodium Choride Na2CQ.4 Sodium Suffate Na2CQ.4 Sodium Choride Na2CQ.4 Sodium Choride Na2CQ.4 Sodium Choride Na2CQ.4 Sodium Mitrate Na0A.3 Sodium Nitrate Na0A.3	d A		AP105-PSC <u>dv</u> . 000 <u>500</u> , 0 Tracking : Tracking : Clourd y -	90
Balance Device ID: 0 § NIST We Technician: N0 Y Kelley Date: 4 /// Add 2400 mL DI water to a beaker. Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights: Chemical Formula Mass (g) Sodium Aluminate NaAIO ₂ .2H ₂ O Sodium Chloride NaF Sodium Chromate Na ₂ CrO ₄ .4H ₂ O Sodium Suffate Na ₄ CO ₃ Sodium Phosphate, 12-Hydrate Na ₂ CrO ₄ .4H ₂ O Sodium Carbonate Na ₂ CcO ₄ Sodium Nitrate Na ₂ CcO ₃ Sodium Nitrate Na ₂ CoO ₃ Sodium Nitrate NaNO ₃ Potassium Nitrate NaNO ₃ Sodium Nitrite NaNO ₃ Sodium Hydroxide NaOH	d A 70.71 7.20 1.53 9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	Actual Mass (g) 70,70 9.22 1.56 9.96 9.96 9.96 9.96 9.96 9.96 9.84 4.09 1.58.4 1.09 1.58.4 1.58.4 1.58.4 1.8 0.40 7.4.5 2.84	Boo. o Tracking : Tracking : Clownd y 	90
Balance Device ID: Ø % NIST We Technician: N0 y Kelley Date: 4 /// Add 2400 mL DI water to a beaker. Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights: Chemical Formula Mass (g) Sodium Aluminate NaAIO ₂ :2H ₂ O Sodium Chloride NaF Sodium Fluoride NaF Sodium Suffate Na ₂ CO ₄ Sodium Phosphate, 12-Hydrate Na ₂ CO ₃ Sodium Catate Na ₂ CO ₃ Sodium Nitrate NaNO ₃ Potassium Nitrate KNO ₃ Sodium Nitrate NaNO ₃ Sodium Nitrate NaNO ₃ Sodium Nitrate NaOH Sodium Hydroxide NaOH	d A 70.71 7.20 1.53 9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	Actual Mass (g) 70,70 9.22 1.56 9.96 9.96 9.96 9.96 9.96 9.96 9.84 4.09 1.58.4 1.09 1.58.4 1.58.4 1.58.4 1.8 0.40 7.4.5 2.84	Boo. o Tracking : Tracking : Clownd y 	90
Technician: NOY Kelley Date: 4/// Add 2400 mL DI water to a beaker. Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights: Chemical Formula Mass (g) Sodium Aluminate NaAIO ₂ .2H ₂ O Sodium Chloride Sodium Fluoride NaF Sodium Chloride NaF Sodium Chloride Na2CO ₄ .4H ₂ O Sodium Suffate Na2SO ₄ Sodium Fluoride NaF Sodium Suffate Sodium Chloride Sodium Suffate Na2CO ₄ .4H ₂ O Sodium Chloride Sodium Suffate Sodium Chromate Na2CO ₄ .4H ₂ O Sodium Chloride Sodium Suffate Sodium Suffate Na2CO ₄ .4H ₂ O Sodium Chloride Sodium Suffate Sodium Chromate Na2CO ₄ .4H ₂ O Sodium Chloride Sodium Suffate Sodium Suffate Sodium Nutrate Na4CO ₃ Sodium NaClaste Sodium Suffate Sodium Suffate Sodium Suffate Sodium Nitrate NaNO ₃ Potassium Nitrate Sodium Suffate Sodium Suffate Sodium Suffate Sodium Suf	d A 70.71 7.20 1.53 9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	Actual Mass (g) 70,70 9.22 1.56 9.96 9.96 9.96 9.84 4.09 2.84 4.09 1.58.4 1.58.4 1.58.4 1.8 9.40 7.40 7.40 7.40 7.40 7.40 7.40 2.84	Tracking :	90
Add 2400 mL DI water to a beaker. Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights: Require Add the following chemicals and record their actual weights: Chemical maintee Sodium Aluminate NaAIO ₂ .2H ₂ O Sodium Choride NaF Sodium Choride NaF Sodium Choride NaF Sodium Choride NaF Sodium Suffate Na ₂ CO ₄ Sodium Phosphate, 12-Hydrate Na ₂ CO ₃ Sodium Choride NaHCOO Sodium Carbonate Na ₂ CO ₃ Sodium Carbonate Na ₂ CO ₃ Sodium Nitrate NaNO ₃ Potassium Nitrate NaNO ₂ Glycolic Acid C ₂ H ₄ O ₃ Sodium Hydroxide NaOH	d A 70.71 7.20 1.53 9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	Mass (g) 70,70 7.22 1.56 9.96 9.96 9.96 9.84 46.0 2.84 4.09 1.58.4 1.58.4 1.58.4 1.1.8 D.40 7.40 3.84	Comments Clound y " " " " " " " " " " " " " " " " " " "	90
Add 2400 mL DI water to a beaker. Insert Tefion stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights: Chemical Formula Sodium Aluminate NaAIO ₂ .2H ₂ O Sodium Choride NaF Sodium Chromate Na ₂ CrO ₄ .4H ₂ O Sodium Suffate Na ₂ CO ₄ .4H ₂ O Sodium Phosphate, 12-Hydrate Na ₂ CO ₃ .3 Sodium Chromate Na ₂ CO ₃ .3 Sodium Chromate Na ₂ CO ₃ .3 Sodium Chromate Na ₂ CO ₃ .3 Sodium Aluminate Na ₂ CO ₃ .3 Sodium Mitrate Na ₂ CO ₃ .3 Sodium Nitrate Na ₂ C ₂ O ₄ .3 Sodium Nitrate Na ₂ O ₃ .3 Sodium Nitrate Na ₂ O ₃ .3 Sodium Nitrate Na ₂ O ₃ .3 Sodium Mitrate Na ₂ O ₃ .3 Sodium Mitrate NaOH.3 Sodium Mitrate NaOH.3 Sodium Rudocide NaOH.3	70.71 7.20 1.53 9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	Mass (g) 70,70 7.22 1.56 9.96 9.96 9.96 9.84 46.0 2.84 4.09 1.58.4 1.58.4 1.58.4 1.1.8 D.40 7.40 3.84	Clound y 	
Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights: Require Add the following chemicals and record their actual weights: Chemical Sodium Aluminate Sodium Aluminate NaAIO ₂ .2H ₂ O Sodium Chorde NaF Sodium Fluoride NaF Sodium Chromate Na ₂ CO ₄ .4H ₂ O Sodium Suffate Na ₂ CO ₄ .4H ₂ O Sodium Phosphate, 12-Hydrate Na ₃ PO ₄ .12H ₂ O Sodium Chromate Na ₂ CO ₃ Sodium Chromate Na ₂ CO ₂ O ₄ Sodium Chromate Na ₂ CO ₃ Sodium Oxalate Na ₂ CO ₃ Sodium Nitrate NaNO ₃ Potassium Nitrate NaNO ₂ Glycolic Acid C ₂ H ₄ O ₃ Sodium Hydroxide NaOH * Sodium fluoride is highly toxic. Handle with caution.	70.71 7.20 1.53 9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	Mass (g) 70,70 7.22 1.56 9.96 9.96 9.96 9.84 46.0 2.84 4.09 1.58.4 1.58.4 1.58.4 1.1.8 D.40 7.40 3.84	Clound y 	
Add the following chemicals and record their actual weights: Require Chemical Formula Mass (g) Sodium Aluminate NaAIO ₂ .2H ₂ O	70.71 7.20 1.53 9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	Mass (g) 70,70 7.22 1.56 9.96 9.96 9.96 9.84 46.0 2.84 4.09 1.58.4 1.58.4 1.58.4 1.1.8 D.40 7.40 3.84	Clound y 	
Chemical Formula Mass (g) Sodium Aluminate NaAIO2.2H2O	70.71 7.20 1.53 9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	Mass (g) 70,70 7.22 1.56 9.96 9.96 9.96 9.84 46.0 2.84 4.09 1.58.4 1.58.4 1.58.4 1.1.8 D.40 7.40 3.84	Clound y 	
Chemical Formula Mass (g) Sodium Aluminate NaAIO2.2H2O Sodium Chloride NaCi Sodium Fluoride NaF Sodium Chromate Na2CrO4.4H2O Sodium Suffate Na2SO4 Sodium Phosphate, 12-Hydrate Na3PO4.12H2O Sodium Acetate Na4COO Sodium Acetate Na4COO Sodium Acetate Na2CQ4 Sodium Oxalate Na2CQ3 Sodium Nitrate NaNO3 Potassium Nitrate KNO3 Sodium Nitrite NaNO2 Glycolic Acid C2H4O3 Sodium Hydroxide NaOH	70.71 7.20 1.53 9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	Mass (g) 70,70 7.22 1.56 9.96 9.96 9.96 9.84 46.0 2.84 4.09 1.58.4 1.58.4 1.58.4 1.1.8 D.40 7.40 3.84	Clound y 	
Sodium Aluminate NaAIO2.2H2O Sodium Chloride NaCi Sodium Fluoride NaF Sodium Chromate Na2CrO4.4H2O Sodium Suffate Na2SO4 Sodium Phosphate, 12-Hydrate Na3PO4.12H2O Sodium Acetate Trihydrate Na4HCOO Sodium Acetate Trihydrate Na4CO Sodium Oxalate Na2CQ4 Sodium Oxalate Na2CQ3 Sodium Nitrate NaNO3 Potassium Nitrate NaNO2 Sodium Hydroxide NaO4 Sodium Hydroxide NaO4	70.71 7.20 1.53 9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	70,70 7.22 1.56 9.96 9.96 9.84 46.0 2.84 4.09 4.09 1.58.4 1.58.4 1.1.8 D.40 7.40 7.28 2.84	Clound y 	
Sodium Chloride NaCt Sodium Fluoride NaF Sodium Chromate Na2CrO4.4H2O Sodium Suffate Na2SO4 Sodium Phosphate, 12-Hydrate Na3PO4.12H2O Sodium Formate NaHCOO Sodium Acetate Trihydrate Na4HCOO Sodium Oxalate Na2CQ4 Sodium Oxalate Na2CQ4 Sodium Oxalate Na2CQ3 Sodium Nitrate NaNO3 Potassium Nitrate KNO3 Sodium Nitrite NaNO2 Gilycolic Acid C2H4O3 Sodium Hydroxide NaOH	7.20 1.53 9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	9.22 1.56 9.96 9.96 36.84 46.0 2.84 4.09 1.38.4 1.38.4 1.38.4 1.38.4 1.38.4 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1.40 1	v n n n v n v v v v v v v v v v v v v v v v v v	
Sodium Fluoride NaF Sodium Chromate Na2CrO4.4H2O Sodium Sulfate Na2SO4 Sodium Phosphate, 12-Hydrate Na3PO4.12H2O Sodium Formate NaHCOO Sodium Acetate Trihydrate Na4COO.3H2O Sodium Oxalate Na2C2O4 Sodium Carbonate Na2C2O3 Sodium Nitrate NaNO3 Potassium Nitrate NaNO2 Golium Nitrate NaNO3 Sodium Nitrate NaNO4 Sodium Nitrate NaO4 Sodium Hydroxide NaOH * Sodium fluoride is highly toxic. Handle with caution.	1.53 9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	1.56 9.96 36.84 46.0 2.84 4.09 1.38.4 1.8 1.8 1.8 1.8 1.8 1.8 1.8 2.40 1.40 1.40 1.45 2.84	P N N N N N N N N N N N N N	
Sodium Chromate Na2CrO4.4H20 Sodium Sutfate Na2SO4 Sodium Phosphate, 12-Hydrate Na3PO4.12H20 Sodium Formate NaHCOO Sodium Acetate Trihydrate NaCH3CO0.3H20 Sodium Oxalate Na2CQ4 Sodium Carbonate Na2CQ3 Sodium Nitrate NaNO3 Potassium Nitrate NaNO2 Glycolic Acid C2H4O3 Sodium Hydroxide NaOH	9.92 26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	9.96 36.84 46.0 2.84 4.09 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 139.40 139.40	н н н ц н н н н ц ц ц ц ц ц ц ц ц ц ц ц	
Sodium Sulfate Na2SO4 Sodium Phosphate, 12-Hydrate Na3PO4, 12H2Q Sodium Formate NaHCOO Sodium Acetate Trihydrate NaCH3CO0,3H2O Sodium Oxalate Na2CQ4 Sodium Carbonate Na2CQ3 Sodium Nitrate NaNO3 Potassium Nitrate NaNO2 Glycolic Acid C2H4O3 Sodium Hydroxide NaOH	26.82 45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	26.84 46.0 2.84 4.09 1.02 138.4 138.4 138.4 138.4 138.4 13.8 3.40 14.5 3.84	н н н ц н н н н ц ц ц ц ц ц ц ц ц ц ц ц	
Sodium Phosphate, 12-Hydrate Na_3PO_4, 12H_2O Sodium Formate NaHCOO Sodium Acetate Trihydrate NaCH_3COO.3H_2O Sodium Oxalate Na_2C_2O_4 Sodium Nitrate Na_2O_3 Sodium Nitrate NaNO_3 Potassium Nitrate KNO_2 Glycolic Acid C_2H_4O_3 Sodium Hydroxide NaOH	45.77 2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	460 2-84 4:09 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4	и 	
Sodium Formate NaHCOO Sodium Acetate Trihydrate NaCH3COO.3H2O Sodium Oxalate Na2C2O4 Sodium Carbonate Na2CO3 Sodium Nitrate NaNO3 Potassium Nitrate NaNO2 Gdium Nitrite NaNO2 Sodium Nitrate NaNO2 Sodium Nitrite NaNO2 Sodium Hydroxide NaOH	2.72 4.08 4.02 138.21 1211.75 5.38 74.52 3.23	2.84 4.09 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4 138.4		
Sodium Acetate Trihydrate NaCH3COO.3H2O Sodium Oxalate Na2C2Q4 Sodium Carbonate Na2C03 Sodium Nitrate NaNO3 Potassium Nitrate KNO3 Sodium Nitrate NaNO2 Glycolic Acid C2H4O3 Sodium Hydroxide NaOH	4.08 4.02 138.21 1211.75 5.38 74.52 3.23	4.09 1.02 138.4 211.8 D.40 74.5 D.84	<u>لا</u> ۲ ۲ ۲ ۲	
Sodium Oxalate Na2C2O4 Sodium Carbonate Na2CO3 Sodium Nitrate NaNO3 Potassium Nitrate KNO3 Sodium Nitrate NaNO2 Glycolic Acid C2H4O3 Sodium Hydroxide NaOH * Sodium fluoride is highly toxic. Handle with caution.	4.02 138.21 1211.75 5.38 74.52 3.23	1.02 138.4 138.4 1.8 D:40 11.5 3.84		
Sodium Carbonate Na2CO3 Sodium Nitrate NaNO3 Potassium Nitrate KNO3 Sodium Nitrite NaNO2 Glycolic Acid C2H4O3 Sodium Hydroxide NaOH * Sodium fluoride is highly toxic. Handle with caution.	138.21 1211.75 5.38 74.52 3.23	138.4 1211.8 1.40 14.5 3.84	4 4 2 2	
Sodium Nitrate NaNO3 Potassium Nitrate KNO3 Sodium Nitrite NaNO2 Glycolic Acid C2H4O3 Sodium Hydroxide NaOH * Sodium fluoride is highly toxic. Handle with caution.	1211.75 5.38 74.52 3.23	1211.8 D: 40 71.5 J. 24	1) V 2	
Potassium Nitrate KNO3 Sodium Nitrite NaNO2 Glycolic Acid C2H4O3 Sodium Hydroxide NaOH * Sodium fluoride is highly toxic. Handle with caution.	5.38 74.52 3.23	9,40 74.5 3.84	1) V 2	
Sodium Nitrite NaNO2 Glycollc Acid C2H4O3 Sodium Hydroxide NaOH * Sodium fluoride is highly toxic. Handle with caution.	74.52	7A.5 3.84	¥ 3	
Gtycolic Acid C2H4O3 Sodium Hydroxide NaOH * Sodium fluoride is highly toxic. Handle with caution.	3.23	3.84		
Sodium Hydroxide NaOH * Sodium fluoride is highly toxic. Handle with caution.				
* Sodium fluoride is highly toxic. Handle with caution.				
			ion clear wh	
Adjust solution temperature to 50°C to 60°C. Filter solution by vacuum through medium glass filter. <i>Handle with cautio</i> Rinse beaker with approximately 50 mL of DI water Rinse filter with approximately 50 mL of DI water Fransfer final filtrate and rinse solutions to Jarge beaker with stir bar.		nd caustic so QA		VED
		D 4 7		_
Check the pH to make sure it is 13+		DAI	E <u>4-18-</u>	08
Transfer to volumetric flask and include rinse with DI water. Allow solution	to cool			
Adjust final solution to volume of 4 L with DI water,	, and mix t	thoroughly.		
SUM Total chemicals (target) 1634.03 g Total che	emicals (ad	ctual)	1634.8 9	
(ter (actual	•	1634.8 9 1000 ma	2
	ed density		104	
Check final solution pH and record. $pH = \frac{\beta_1 8}{2}$ Readjust	if significa	antly differen	t from target.	
Comments: record any difficulties or discrepancies $SOUH'OV$	lourd	der 6	ut clear	when
	in cell		in hilter	NAAL
Filter. About 7.5 9 of white powder che		· ····································	<u>v. v. v- u</u>	<u></u>

Evaporated Supernate Base Solution 2008 Version		Batch Size: pH:	2 L 14	Evaporated Supernate
Balance Device ID: Balance Device ID:	0.30	NIST Weight (⅔ g): NIST Weight (ጛ⊘ g):		30.0000 500.0
Technician: Noy Kelley	Da	ate: 4/15/08		Tracking : 91

0 Add **1200** mL DI water to a beaker. Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weights:

	1700 to 60°C. Stir solution to o	mL by adding [81.89 8.06 3.95 6.55 20.45 40.29 2.18 4.29 103.66 825.59 46.51 101.57 133.60 1.23	1255 (g) 81.9 81.9 8.07 0.55 2017 2018 4.55 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 103.7 10.7 10.7 10.7 10	Comments
, 12-Hydrate , 12-Hydrate is highly toxic. Ha on volume to mperature to 50°C	NaCl NaF NagCrO4.4H2O Na2SO4 Na3PO4.12H2O NaHCOO Na2C2O4 Na2C2O4 Na2C2O4 Na2C2O4 Na2C2O4 NaACO NaACO3 NANO3 NANO2 NAOH NH4CH3COO ndle with caution. 1700 ndle with caution. 10 60°C. Stir solution to out is tic solution.	mL by adding I	8.06 3.95 6.55 20.45 40.29 2.18 4.29 103.66 825.59 46.51 101.57 133.60 1.23 DI water.	8:07 3:97 b:55 20:45 20:35 20:35 20:35 20:35 20:35 20:55 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 10 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 1030 10 10 10 10 10 10 1	kk 41isl08
, 12-Hydrate , 12-Hydrate is highly toxic. Ha on volume to mperature to 50°C	NaF Na ₂ CrO ₄ .4H ₂ O Na ₂ SO ₄ Na ₃ PO ₄ .12H ₂ O NaHCOO Na ₂ C ₂ O ₄ Na ₂ CO ₃ NaNO ₃ KNO ₃ NaNO ₂ NaOH NH ₄ CH ₃ COO ndle with caution. 1700 ndle with caution. to 60°C. Stir solution to out is the solution of the solution.	mL by adding I	3.95 6.55 20.45 40.29 2.18 4.29 103.66 825.59 46.51 101.57 133.60 1.23 DI water.	3.97 6.55 20.45 20.35 20.35 20.35 103.4 20.18 103.6 103.6 103.6 103.6 103.6 103.0 103.0 103.0 103.4	<u>kk 41i5108</u>
, 12-Hydrate , 12-Hydrate is highly toxic. Ha on volume to mperature to 50°C	Na2CrO4.4H2O Na2SO4 Na3PO4.12H2O NaHCOO Na2C2O4 Na2C03 NaNO3 KNO3 NaNO2 NaOH NH4CH3COO nde with caution. 1700 noise with caution. 10 60°C. Stir solution to custic solution.	mL by adding I	6.55 20.45 40.29 2.18 4.29 103.66 825.59 46.51 101.57 133.60 1.23 DI water.	6.55 20.45 20.34 2018 A.30 103.7 826.0 46.50 103.6 134.0 1024	kk 41isl08
, 12-Hydrate , 12-Hydrate is highly toxic. Ha on volume to mperature to 50°C	Na ₂ SO ₄ Na ₃ PO ₄ .12H ₂ O NaHCOO Na ₂ Co ₂ O ₄ Na ₂ CO ₃ NaNO ₃ KNO ₃ NaNO ₂ NaOH NH ₄ CH ₃ COO ndle with caution. 1700 noise with caution to custic solution to custic solution.	mL by adding I	20.45 40.29 2.18 4.29 103.66 825.59 46.51 101.57 133.60 1.23 DI water.	20.45 20.34 2018 4.30 10% 7 846.0 46.50 104.50 134.0 1024	<u>AK 41islo8</u>
is highly toxic. Ha on volume to mperature to 50°C	Na ₃ PO ₄ 12H ₂ O NaHCOO Na ₂ C ₂ O ₄ Na ₂ CO ₃ NaNO ₃ KNO ₃ NaNO ₂ NaOH NH ₄ CH ₃ COO ndle with caution. 1700 note with caution. to 60°C. Stir solution to existic solution.	mL by adding I	40.29 2.18 4.29 103.66 825.59 46.51 101.57 133.60 1.23 DI water.	20,34 2018 4.30 10%7 846.0 46.50 101.50 134.0 1024	<u>kk 41isto8</u>
is highly toxic. Ha on volume to mperature to 50°C	NaHCOO Na ₂ C ₂ O ₄ Na ₂ CO ₃ NaNO ₃ KNO ₃ NaNO ₂ NaOH NH ₄ CH ₃ COO ndle with caution. 1700 n it to 60°C. Stir solution to out its it c solution.	mL by adding I	2.18 4.29 103.66 825.59 46.51 101.57 133.60 1.23 DI water.	20,34 2018 4.30 10%7 846.0 46.50 101.50 134.0 1024	<u>+K 41isl08</u>
is highly toxic. Ha on volume to mperature to 50°C	Na2C2O4 Na2CO3 NaNO3 KNO3 NaNO2 NaOH NH4CH3COO ndle with caution. 1700 n it to 60°C. Stir solution to out its its solution.	mL by adding I	4.29 103.66 825.59 46.51 101.57 133.60 1.23 DI water.	A.30 103.7 816.0 46.50 101.50 134.0 1024	
is highly toxic. Ha on volume to mperature to 50°C	Na2CO3 NaNO3 KNO3 NaNO2 NaOH NH4CH3COO ndle with caution. 1700 n it to 60°C. Stir solution to outsitic solution.	mL by adding I	103.66 825.59 46.51 101.57 133.60 1.23 DI water.	10307 816.0 46.50 101.50 134.0 1024	
is highly toxic. Ha on volume to mperature to 50°C	NaNO3 KNO3 NaNO2 NaOH NH4CH3COO ndle with caution. 1700 n it to 60°C. Stir solution to out is the solution.	mL by adding I	825.59 46.51 101.57 133.60 1.23 DI water.	816.0 A6.50 101.50 134.0 1024	
is highly toxic. Ha on volume to mperature to 50°C	KNO3 NaNO2 NaOH NH4CH3COO ndle with caution. 1700 noise to 60°C. Stir solution to existic solution.	mL by adding [dissolve all che	46.51 101.57 133.60 1.23 DI water.	46.50 101.50 134.0 1024	
is highly toxic. Ha on volume to mperature to 50°C	NaNO2 NaOH NH4CH3COO ndle with caution. 1700 no to 60°C. Stir solution to exit solution.	mL by adding [dissolve all che	101.57 133.60 1.23 DI water.	46.50 101.50 134.0 1024	
is highly toxic. Ha on volume to mperature to 50°C	NaNO2 NaOH NH4CH3COO ndle with caution. 1700 no to 60°C. Stir solution to exit solution.	mL by adding [dissolve all che	133.60 1.23 DI water.	101.50 134.0 1024	
is highly toxic. Ha on volume to mperature to 50°C	NH ₄ CH ₃ COO note with caution. 1700 to 60°C. Stir solution to distic solution.	mL by adding [dissolve all che	1.23 DI water.	134.0 1024	
is highly toxic. Ha on volume to mperature to 50°C	NH ₄ CH ₃ COO note with caution. 1700 to 60°C. Stir solution to distic solution.	mL by adding [dissolve all che	1.23 DI water.	1024	
on volume to mperature to 50°C	ndle with caution. 1700 1 to 60°C. Stir solution to distic solution.	dissolve all che			· · ·
<i>ition, hot and cau</i> on to volume of			and mix th	horoughly,	
temperature to 50			QA A	NPPRC	IVED
nake sure it is	<u>14</u> ⁺ <u>14</u>		NAME	Cld	un
			DATE	4-1	8-08
chemicals (target) water (target) t Specific Density	1379.83 g 2 L 1.69	Total chem Total wate Calculated	r (actual)		1380.7 d000_m2 1.69
		A ⁺ Readjust if	f significa	ntly differen	t from target.
on pH and record.	pH= <u> </u> .				
		n pH and record. pH=1	n pH and record. pH= <u>14</u> ⁺ Readjust i	n pH and record. $pH=1/4^{+}$ Readjust if significa	

AY101-PSC Base Solution 2007 Version	Batch Size: 2 L pH: >13 AY-101-PSC	
Balance Device ID: C&C Balance Device ID: 0 { y	NIST Weight (₰० g):	
Technician: Noy Kelley	Date: 6 12/08 Tracking : 9	2
Add 1200 mL DI water to a the Insert Teflon stirbar and thermocouple, and place on stirre Turn on heater and adjust to 60°C (±10°C). Add the following chemicals and record their actual weight	r / hotplate.	

		Required	Actual	
Chemical	Formula	Mass (g)	Mass (g)	Comments
Sodium Aluminate	NaAlO ₂ .2H ₂ 0	25.25	25.31	
Sodium Chloride	NaCl	2.13	2.15	
Sodium Fluoride	NaF	1.16	1.17	
Sodium Chromate	Na2CrO4-4H2O	1.33	1.33	
Sodium Sulfate	Na ₂ SO ₄	5.65	5.65	
Sodium Phosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	37.71	37.41	· · ·
Sodium Formate	NaHCOO	1.73		
Sodium Acetate Trihydrate	NaCH ₃ COO.3H ₂ O	2.41	2.43	
Sodium Oxalate	Na ₂ C ₂ O ₄	1.34	1.36	
Sodium Carbonate	Na ₂ CO ₃	42.61	40.61	
Sodium Nitrate	NaNO ₃	226.07	224.0	
Sodium Nitrite	NaNO ₂	28.29	58.30	
Sodium Silicate	Na ₂ SiO ₃ .9H ₂ O	0.99	1.00	1*
Glycolic Acid	C ₂ H ₄ O ₃	1.60	1.60	
Sodium Hydroxide	NaOH	56.88		

>13

Adjust solution temperature to 50°C to 60°C.

Filter solution by vacuum through medium glass filter. Handle with caution, hot and caustic solution .

Rinse beaker with approximately 50 mL of DI water

Rinse filter with approximately 50 mL of DI water

Transfer final filtrate and rinse solutions to large beaker with stir bar. Measure and record initial pH 213

Check the pH to make sure it is

non-standard pH

 $\left(\right)$

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of		2 L w	ly	
SUM	Total chemicals (target)	435.15 g	Total chemicals (actual)	195.19
	Total water (target)	2 L	Total water (actual)	2000 mc
	Target Specific Density	1.22	Calculated density	1.22

Check final solution pH and record.

pH= $\frac{\gamma/3}{2}$ Readjust if significantly different from target.

Comme	nts: reco Pte	ord any difl というけんり	iculties ペo か	OCUSTC	ncies al	ter	ad	ing	Nazsio:	3.9140	but	dissorte
mose	afes	àddin	nor	NAOH	0			<u></u>				
		<u>* 19</u>	100	<u>solid</u>	jul_	10	n	filter				
		()	0	(•	0				
				,					QA A	PPROVE	0 ——	
									NAME	: Claun		
									DATE:	6-18-08		

AZ102 Base Solution 2008 Version		Batch Size: pH:	4 L 12	AZ102
Balance Device ID:	<i>0</i> 20	NIST Weight (& g):		20.0000
Balance Device ID:	018	NIST Weight (500 g):		500.0
Technician: Noy Kelleg	Da	te: 6/6/08		Tracking: 93

Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.

 Turn on heater and adjust to 60°C (±10°C).

 Add

 2400 mL DI water to a beaker or carboy as appropriate

Add the following chemicals and record their actual weights:

nate mate 4-Hydrate Nybdate de xxide e e	Formula NaAIO2 Na2CrO4.4H2O K2MOO4 KNO3 NaF NaOH NaNO3 NaNO2 Na2SO4 Na2CO3	Mass (g) 2.296 12.168 0.476 28.684 8.736 0.000 11.560 243.708 105.648		Comments
nate 4-Hydrate Ilybdate rate de xide 9 9 9	Na2CrO4.4H2O K2MOQ4 KNO3 NaF NaOH NaNO3 NaNO2 Na2SO4	12.168 0.476 28.684 8.736 0.000 11.560 243.708	12:176 0:481 28:696 8:756 0:00 11:571 243:70	
Nybdate rate de xide e e	K2MOO4 KNO3 NaF NaOH NaNO3 NaNO2 Na2SO4	0.476 28.684 8.736 0.000 11.560 243.708	0,281 28.696 8.756 0.00 11.571 243.70	
rate de xide e e	KNO ₃ NaF NaOH NaNO ₃ NaNO ₂ Na ₂ SO ₄	28.684 8.736 0.000 11.560 243.708	28.696 8.756 0.00 11.571 243.70	
de xide e nate	NaF NaOH NaNO ₃ NaNO ₂ Na ₂ SO ₄	8.736 0.000 11.560 243.708	8.756 0-00 11.571 243.70	
xide e nate	NaOH NaNO ₃ NaNO ₂ Na ₂ SO ₄	0.000 11.560 243.708	1.00 1.57 213.70	
e nate	NaNO ₃ NaNO ₂ Na ₂ SO ₄	11.560 243.708	11.57	
e nate	NaNO ₂ Na ₂ SO ₄	243.708	243.70	
e	Na ₂ SO ₄			
nate		105.648		
	INa.CO			
	11422003	257.368	assi y	
onate	NaHCO ₃	4.032	4.08	
te	Na ₂ C ₂ O ₄	9.112	9.122	
olution to volume of	4L v	with DI water, and mix	thoroughly.	
	683.79 g	•	•	194,295]
· • /		•	•	4000 mc
arget Specific Density	1.17	Calculated densit	у	617
plution pH and record.	pH=	Adjust to required	pH using Na	он
•	discrepancies			
olution pH and record. record any difficulties or	discrepancies			
•	discrepancies	Adjust to required		
•	discrepancies			
	a by vacuum through me with approximately 50 m filtrate and rinse solution olumetric flask and inclu- olution to volume of otal chemicals (target) otal water (target)	initial constraints initial constraints in temperature to 50°C to 60°C. initial constraints in temperature to constraints initial constraints in temperature to constraints initial constraints in temperature to constraints initial constraints in temperatur	$p_{1} = 2 \ge 24$ 3400 mL by adding DI water oblution volume to 3400 mL by adding DI water on temperature to 50°C to 60°C. a by vacuum through medium glass filter. Handle with caution, hot at r with approximately 50 mL of DI water $PH m_1^2$ filtrate and rinse solutions to large beaker with stir bar. $PH m_1^2$ olumetric flask and include rinse with DI water. Allow solution to cool olution to volume of 4 L with DI water, and mix 683.79 g Total chemicals (at get) otal water (target) 4 L Total water (actual	Integration 3400 mL by adding Di water. Integration volume to 3400 mL by adding Di water. Integration to the proximately 50 mL of DI water PH mitical (1) Intract and rinse solutions to large beaker with stir bar. Intract and rinse solutions to large beaker with stir bar. Intract and rinse solutions to large beaker with the solution to cool Intract and mix thoroughly. Intract and rinse solutions to large beaker with stir bar. Intract and mix thoroughly. Intract and rinse solutions to large beaker with DI water. Allow solution to cool Intract and mix thoroughly. Intract and rinse solution to volume of 4 L With DI water, and mix thoroughly. Intract and ringet) 683.79 g Total chemicals (actual)

CPP

QA APPROVED

NAME: claun DATE: 6-18-08

Evaporated Supernate Base Solution 2008 Version	Batch Size: pH:	2 L 14	Nitrite/Nitrate=0.1
Balance Device ID: CdO Balance Device ID: O19	NIST Weight (&♡g): NIST Weight (ℬ℗ց):		90.0000 B00.0
Technician: Noy Kelley Da	te: 5/12/08		Tracking : 94

Add 1200 mL DI water to a beaker.

Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.

Turn on heater and adjust to 60°C (±10°C).

Add the following chemicals and record their actual weights:

Chemical		Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Alur		NaAlO ₂ 2H ₂ O	81.89		
Sodium Chk		NaCl	8.06		<u> </u>
Sodium Fluc		NaF	3.95		<u> </u>
	omate 4-hydrate	Na ₂ CrO ₄ .4H ₂ O	6.55		<u>├────</u> ─
Sodium Sulf		Na ₂ SO ₄	20.45		<u>├────</u> ────────────
Sodium Pho	sphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	40.29		
Sodium For		NaHCOO	2.18		<u> </u>
Sodium Oxa		Na ₂ C ₂ O ₄	4.29		
Sodium Cart	Donate	Na ₂ CO ₃	103.66		
Sodium Nitra	nte	NaNO ₃	825.59	825.6	
Potassium N	litrate	KNO3	46.51	46.6	I
Sodium Nitri	te	NaNO ₂	70.38		
Sodium Hyd	roxide	NaOH	133.60		<u>├──</u> ─-
Ammonium		NH_CH3COO	1.23		<u> </u>
Adjust final	th caution, hot and cau solution to volume of	2L_w	ith DI water, and mit	k thoroughly.	
Maintain so	lution temperature to 50°	C to 60°C.			
Check the p	oH to make sure it is	14			
					A
	Total chemicals (target)	1348.64 g	Total chemicals (•	1349.73 3
	Total water (target)	2 L	Total water (actu	•	2000 ml
	Target Specific Density	1.67	Calculated densit	у У	1.67
Check final	solution pH and record.	рН= //	APReadjust if signifi	cantly differen	t from target.

Comments: record any difficulties or discrepancies

QA APPROVED

5

NAME: Cedun

DATE: 6-18-08

Evaporated Supernate	Batch Size:	1 L
Base Solution 2008 Version	pH:	12** No aluminate
Balance Device ID:	020NIST Weight (が g	11 + No NaOH
Balance Device ID:	NIST Weight (知):
Technician: Noy Kel	<u>1</u>	Tracking :95

0 Add 600 mL DI water to a beaker.

Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to $60^{\circ}C$ (±10°C).

Add the following chemicals and record their actual weights:

			Required	Actual	
Chemical	Formula		Mass (g)	Mass (g)	Comments
Sodium Aluminate	NaAlO ₂ 2H ₂ O		0.00	0.00	
Sodium Chloride	NaCl]	4.03	4.03	
Sodium Fluoride	NaF		1.97	1.97	
Sodium Chromate 4-hydrate	Na₂CrO₄ 4H₂O		3.28	3,28	
Sodium Sulfate	Na ₂ SO ₄]	10.23	0.23	
Sodium Phosphate, 12-Hydrate	Na3PO4,12H2O]	20.15	20-18	
Sodium Formate	NaHCOO		1.09	1.10	
Sodium Oxalate	Na ₂ C ₂ O ₄]	2.14	2.15	
Sodium Carbonate	Na ₂ CO ₃		51.83	51.84	
Sodium Nitrate	NaNO ₃		412.80	413,0	
Potassium Nitrate	KNO3		23.25	33,84	
Sodium Nitrite	NaNO ₂	1	51.06		
Sodium Hydroxide	NaOH	1	0.00	0.00	
Ammonium Acetate	NH ₄ CH ₃ COO	1	0.62	0.62	
* Sodium fluoride is highly toxic. I	landle with caution.				
Maintain solution temperature to t Check the pH to make sure it is	50°C to 60°C. (1 1 21	+ (E US714/ J	non-standard	рН
Klimited Samp	le use all s	am_	ple for	OCPa	CPP *
SUM Total chemicals (targe Total water (target) Target Specific Densit	t) 582.44 g _ 1 L		Total chemicals (Total water (actu Calculated densit	actual) al)	
Check final solution pH and recon	•		Readjust if signifi	cantly differen	t from target.
Comments: record any difficulties	No	S 	imple_le		
		_	QA	APPR(DVED

NAME: Cedure

DATE: 6-18-08

AP105 - Mixed Supernat Base Solution 2008 Version	Batch Size: pH:	2 L 13+	Nitrite/Nitrate=0.1
Balance Device ID:	NIST Weight (40 g): NIST Weight (50 g):		
Technician: Noy Kelley	Date: 5/13/08		Tracking :96

6 1200 mL DI water to a beaker. Add

Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.

Turn on heater and adjust to 60°C (±10°C).

Add the following chemicals and record their actual weights:

-	-	Required	Actual	
Chemical	Formula	Mass (g)	Mass (g)	Comments
Sodium Aluminate	NaAlO ₂ .2H ₂ O	46.02	46.06	
Sodium Chloride	NaCl	4.56	4.65	
Sodium Fluoride	NaF	2.18	2.18	
Sodium Chromate 4-hydrate	Na ₂ CrO ₄ .4H ₂ O	3.74	3.75	
Sodium Sulfate	Na ₂ SO ₄	11.36	11.58	
Sodium Phosphate, 12-Hydrate	Na3PO4,12H2O	22.81	22.80	
Sodium Formate	NaHCOO	1.56	1.58	
Sodium Acetate Trihydrate	NaCH ₃ COO.3H ₂ O	2.86	2.86	
Sodium Oxalate	Na ₂ C ₂ O ₄	3.08	3.10	
Sodium Carbonate	Na ₂ CO ₃	58.08	58.07	
Sodium Nitrate	NaNO ₃	463.54	A13.8	
Potassium Nitrate	KNO3	26.29	36.25	
Sodium Nitrite	NaNO ₂	38.64	38.63	
Glycolic Acid (70% solution)	C ₂ H ₄ O ₃	2.48	\$.50	Recipitation occon
Sodium Hydroxide	NaOH	76.16		·
Ammonium Acetate	NH ₄ CH ₃ COO	0.62	0.62	

* Sodium fluoride is highly toxic. Handle with caution.

1700 mL by adding DI water.

Adjust solution temperature to 50°C to 60°C.

Filter solution by vacuum through medium glass filter. Handle with caution, hot and caustic solution .

Rinse beaker with approximately 50 mL of DI water

Rinse filter with approximately 50 mL of DI water

Transfer final filtrate and rinse solutions to large beaker with stir bar. Measure and record initial pH

Adjust total solution volume to

Check the pH to make sure it is 13+ 14

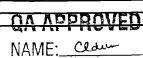
Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of		2 L with DI water, and mix thoroughly.				
SUM	Total chemicals (target)	763.98 g	Total chemicals (actual)	764.43 3		
	Total water (target)	2 L	Total water (actual)	2000 mi		
	Target Specific Density	1.38	Calculated density	1.38		

Check final solution pH and record.

pH= 2 & Readjust if significantly different from target.

Comments: record any difficulties or discrepancies



DATE. 6-1808

AW105 Supernate Base Solution 2008 Version		Batch Size: pH:	4 L 13+	AW105-PSC
Balance Device ID:	020	NIST Weight (& g):		80.000
Balance Device ID:	018	NIST Weight (500 g):		500 0
Technician: Noy Kelley	Date	5/27/08		Tracking : 97

2400 L mL DI water to a beaker. Add Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60°C (±10°C).

.

Add the following chemicals and record their actual weights:

Na2AIO2 2.799 sodium Aluminate Na0H 42.080 toric Acid H3BO3 0.079 sodium Chromate Na2Cr044H2O 0.037 totassium Molybdate K2MoO4 0.010 totassium Nitrate KNO3 58.338 inc Nitrate 6-hydrate Zn(NO3)2.6H2O 0.036 sodium Chloride NaCl 1.931 sodium Nitrate NaP 26.208 sodium Nitrate NaNO3 100.504 sodium Nitrate NaNO2 17.609 sodium Phosphate, 12-Hydrate Na2GO4 2.988 sodium Carbonate Na2CO3 45.622	
bric Acid H_3BO_3 0.079 0 odium Chromate $Na_2CrO_44H_2O$ 0.037 0 stassium Molybdate K2MoO4 0.010 0 stassium Nitrate KNO_3 58.338 0 nc Nitrate 6-hydrate Zn(NO_3)_2.6H_2O 0.036 0 idium Chloride NaCl 1.931 1 idium Fluoride NaF 26.208 2 idium Nitrate NaNO_3 100.504 0 idium Phosphate, 12-Hydrate Na ₃ PO ₄ .12H ₂ O 6.794 1 idium Sulfate Na ₂ SO ₄ 2.988 3	
Stodium Chromate Na2Cr04 4H2O 0.037 0 rod totassium Molybdate K2MoO4 0.010 0 rod 0 rod totassium Molybdate K2MoO4 0.010 0 rod	
totassium MolybdateK2MoO4totassium MolybdateK2MoO4totassium NitrateKNO3tinc Nitrate 6-hydrateZn(NO3)2.6H2Otodium ChlorideNaCltodium FluorideNaFtodium NitrateNaNO3todium NitrateNaNO2todium Phosphate, 12-HydrateNa ₃ PO4.12H2Otodium SulfateNa ₂ SO42.988 3_cO	
otassium Nitrate KNO3 58.338 $\widehat{O}6.9$ inc Nitrate 6-hydrate Zn(NO3)2.6H2O 0.036 $\emptyset.00$ iodium Chloride NaCl 0.1931 $i.eq$ iodium Fluoride NaF 26.208 $\&b_1$ iodium Nitrate NaNO3 100.504 $[0019]$ iodium Nitrate NaNO2 17.609 $[12.9]$ iodium Phosphate, 12-Hydrate NagO4, 12H2O 6.794 b_2 iodium Sulfate Na2SO4 2.988 3.0	
Inc Nitrate 6-hydrate Zn(NO ₃) ₂ .6H ₂ O 0.036 0 + 0 iodium Chloride NaCl 1.931 1 • 9 iodium Fluoride NaF 26.208 3 b ₂ iodium Nitrate NaNO ₃ 100.504 100 · 9 iodium Nitrate NaNO ₂ 17.609 1 · 2 iodium Phosphate, 12-Hydrate Na ₃ PO ₄ ,12H ₂ O 6.794 1 / 2 · 8 iodium Sulfate Na ₂ SO ₄ 2.988 3 c	
Image: Solution Chloride NaCl 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 1.931 <th1.931< th=""> 1.931 1.931</th1.931<>	
NaF 26.208 3/b, sodium Ritrate NaNO3 100.504 100,504 sodium Nitrate NaNO3 17.609 17.9 sodium Phosphate, 12-Hydrate Na3PO4,12H2O 6.794 10.8 sodium Sulfate Na2SO4 2.988 3.0	
NaNO3 100.504 100 vodium Nitrite NaNO2 17.609 17.9 vodium Phosphate, 12-Hydrate Na3PO4,12H2O 6.794 12.8 vodium Sulfate Na2SO4 2.988 3.0	
NaNO2 17.609 17.5 odium Nitrite NaNO2 6.794 1/2 odium Phosphate, 12-Hydrate NagPO4,12H2O 6.794 1/2 odium Sulfate Na2SO4 2.988 3.0	
Image: Non-State Na3PO4.12H2O 6.794 Image: Na3PO4.12H2O Image: Na3PO4.12H2O <th image:="" na3po4.1<="" td=""></th>	
Image: Non-State Na3PO4.12H2O 6.794 Image: Na3PO4.12H2O Image: Na3PO4.12H2O <th image:="" na3po4.1<="" td=""></th>	
odium Carbonate Na CO 45 622 4 C	
ilycolic Acid C2H4O3 0.437 0 4	
odium Acetate 3-hydrate NaCH3COO.3H2O 1.252	
odium Formate NaHCOO 0.558 0,5	
odium Oxalate Na2C2O4 0.884 0;8	
djust final solution to volume of 4 L with DI water, and mix thoroug	
UM Total chemicals (target) 308.17 g Total chemicals (actual) Total water (target) 4 L Total water (actual)	
Target Specific Density 1.08 Calculated density	
heck final solution pH and record. pH=Readjust if significantly dif	

DATE: 6-24-01

SY101 Base Solution 2008 Version		Batch Size: pH:	4 L 13+	SY101
Balance Device ID: Balance Device ID:	018	_NIST Weight (औg): _NIST Weight (5∞ g)	:	20,0000
Technician: Noy Kelley	Date	5/28/08		Tracking : 98

Add 2400 mL DI water to a beaker.

Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.

Turn on heater and adjust to 60°C (±10°C).

Add the following chemicals and record their actual weights:

		Neguneu	And Contract	
Chemical	Formula	Mass (g)	Mass (g)	Comments
Sodium Aluminate	NaAlO2.2H2O	66.41	66.42	
Sodium Chloride	NaCi	5.32	5.32	
Sodium Fluoride *	NaF	4.65	4.66	
Sodium Chromate	Na ₂ CrO ₄ .4H ₂ O	1.92	1.92	
Sodium Sulfate	Na ₂ SO ₄	11.16	11.16	
Sodium Phosphate, 12-Hydrate	Na3PO4 12H2O	149.54	149.6	·
Sodium Oxalate	Na ₂ C ₂ O ₄	13.08		
Sodium Carbonate	Na ₂ CO ₃	56.30		
Iron Nitrate, 9-hydrate	Fe(NO3)2.9H2O	0.04		
Zinc Nitrate, 6-hydrate	Zn(NO ₃) ₂ .6H ₂ O	0.08	0.08	
Calcium Nitrate	Ca(NO ₃) ₂ .4H ₂ O	0.50		
Sodium Nitrate	NaNO ₃	314.26	314.3	
Potassium Nitrate	KNO3	2.79		
Sodium Nitrite	NaNO ₂	55.95	35.95	
Sodium Hydroxide	NaOH	104.88	105.0	
Boric Acid	H₃BO₃	0.21	0.22	
* Sodium fluoride is highly toxic. I	landle with caution.	J <u>L</u>	787.45	·

3400 mL by adding DI water.

Required

Actual

Adjust solution temperature to 50°C to 60°C.

Filter solution by vacuum through medium glass filter. Handle with caution, hot and caustic solution .

Rinse beaker with approximately 50 mL of DI water

Rinse filter with approximately 50 mL of DI water

Transfer final filtrate and rinse solutions to large beaker with stir bar. Measure and record initial pH 13.30

Adjust total solution volume to

Check the pH to make sure it is 13+

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust fi	inal solution to volume of	4 L w	4 L with DI water, and mix thoroughly.		
SUM	Total chemicals (target) Total water (target) Target Specific Density	786.88 g 4 L 1.20	Total chemicals (actual) Total water (actual) Calculated density	787,45 g 1000 mc 1.20	
	inal solution pH and record. ents: record any difficulties or discre about X 0.5 9 01 Boot		30Readjust if significantly diff		
	·		QA A	PPROVED	
	· · · ·		NAME DATE	6-11-01	

AY101-CSL Base Solution 2008 Version		Batch Size: pH:	4 L 11.82	AY101-CSL
Balance Device ID: Balance Device ID:	080	NIST Weight (∂0 g): NIST Weight (∤0 ¤ g)		19,9999
Technician: Noy K	elley	Date: 3/29/08		Tracking :99

Add 2400 mL DI water to a beaker.

Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.

Turn on heater and adjust to 60°C (±10°C).

Add the following chemicals and record their actual weights:

		Required	Actual	
Chemical	Formula	Mass (g)	Mass (g)	Comments
Sodium Aluminate	NaAlO ₂ .2H ₂ O	7.2	2 7.22	
Sodium Chloride	NaCl	1.5	0 1.49	
Sodium Fluoride	NaF	0.2	5 0.25	
Sodium Chromate	Na2CrO4.4H2O	0.2	8 0.28	
Sodium Sulfate	Na ₂ SO ₄	1.1	9 1.20	
Sodium Phosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	8.9		
Sodium Oxalate	Na ₂ C ₂ O ₄	0.7	5 0.75	
Sodium Carbonate	Na ₂ CO ₃	62.4	9 62.29	
Sodium Nitrate	NaNO ₃	6.1	5 6.15	
Sodium Nitrite	NaNO ₂	10.1	6 10. 6.	
Sodium Hydroxide	NaOH	0.8	2 0.82	

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to Adjust solution temperature to 50°C to 60°C. 3400 mL by adding DI water.

Filter solution by vacuum through medium glass filter. Handle with caution, hot and caustic solution.

Rinse beaker with approximately 50 mL of DI water

Rinse filter with approximately 50 mL of DI water

Transfer final filtrate and rinse solutions to large beaker with stir bar.

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of		4 L with DI water, and mix thoroughly.			
SUM	Total chemicals (target)	99.78 g	Total chemicals (actual)	99,81	
	Total water (target)	4 L	Total water (actual)	4000	
	Target Specific Density	1.02	Calculated density	1,02	

Check final solution pH and record.

pH= #%SReadjust if significantly different from target.

Comments: record any difficulties or discrepancies

QA APPROVED

NAME: Claun

DATE: 6-18-08

AY101-CSL Base Solution 2008 Version	Batch Size: pH: 11.	4 L 82 AY101-CSL
Balance Device ID:	<u>ØՁ∅</u> NIST Weight (): <u>Ø[8</u> NIST Weight (_ <i> 0</i> ∞_g):	0
Technician: Noy Kelley	Date: 6/16/08	Tracking : 100

Add 2400 mL DI water to a beaker.

Insert Tefion stirbar and thermocouple, and place on stirrer / hotplate.

Turn on heater and adjust to 60°C (±10°C).

• ,

Add the following chemicals and record their actual weights:

Chemical	Formula	Required M <u>a</u> ss (g)	Actual Mass (g)	Comments
Sodium Aluminate	NaAlO2.2H2O	7.2		
Sodium Chloride	NaCl	1.5		1
Sodium Fluoride	NaF	0.2		
Sodium Chromate	Na2CrO4-4H2O	0.2	8 0:28	
Sodium Sulfate	Na ₂ SO ₄	1.1	9 1.19	
Sodium Phosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	8.9	7 9.00	
Sodium Oxalate	Na ₂ C ₂ O ₄	0.7	5 0.75	1
Sodium Carbonate	Na ₂ CO ₃	62.4	9 62.49	1
Sodium Nitrate	NaNO ₃	61.5	3 61.55	t
Sodium Nitrite	NaNO ₂	10.1	6 10.16	1
Sodium Hydroxide	NaOH	0.8		<u> </u>

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to

to 3400 mL by adding DI water.

Adjust solution temperature to 50°C to 60°C.

Filter solution by vacuum through medium glass filter. Handle with caution, hot and caustic solution.

Rinse beaker with approximately 50 mL of DI water

Rinse filter with approximately 50 mL of DI water

Transfer final filtrate and rinse solutions to large beaker with stir bar.

Transfer to volumetric flask and include rinse with DI water. Allow solution to cool

Adjust final solution to volume of		4 L_ w	ith DI water, and mix thorough	ly
SUM	Total chemicals (target)	155.16 g	Total chemicals (actual)	155.28 g
	Total water (target)	4 L	Total water (actual)	2000 mc
	Target Specific Density	1.04	Calculated density	1.04

Check final solution pH and record.

pH= ||&Readjust if significantly different from target.

Comments: record any difficulties or discrepancies

QA APPROVED

NAME: Oldun

DATE: 6-18-0r

RPP-RPT-37505, Rev. 0

AW105 Supernate Base Solution 2008 Version		Batch Size: pH:	2 L 13+	AW105-PSC
Balance Device ID:	020	NIST Weight (& g):		20.0000
Balance Device ID:	018	NIST Weight (100 g)	:	100.0
Technician: Noy Kelley		Date: 7 8 08		Tracking: 102

Add 1200 L mL DI water to a beaker.

Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.

Turn on heater and adjust to 60°C (±10°C).

Add the following chemicals and record their actual weights:

		Required	Actual	
Chemical	Formula	Mass (g)	Mass (g)	Comments
Sodium Aluminate	Na ₂ AlO ₂ 2H ₂ O	1.529		
Sodium Hydroxide	NaOH	21.040		
Boric Acid	H ₃ BO ₃	0.040	0.05-	
Sodium Chromate	Na ₂ CrO ₄ 4H ₂ O	0.019	0.03 /	
Potassium Molybdate	K2MoO4	0.005		1
Potassium Nitrate	KNO3	29.169	29.169	1
Zinc Nitrate 6-hydrate	Zn(NO ₃) _{2.} 6H ₂ O	0.018	0.022-	1
Sodium Chloride	NaCl	0.965	0.967	1
Sodium Fluoride	NaF	13.104		
Sodium Nitrate	NaNO ₃	50.252	20,25	1
Sodium Nitrite	NaNO ₂	8.804	8,88 -	
Sodium Phosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	3.397	3.39 -	
Sodium Sulfate	Na ₂ SO ₄	1.494		
Sodium Carbonate	Na ₂ CO ₃	22.811	22.83	
Glycolic Acid	C ₂ H ₄ O ₃	0.219	0.287	
Sodium Acetate 3-hydrate	NaCH ₃ COO.3H ₂ O	0.626	0.629	
Sodium Formate	NaHCOO	0.279	0.281	
Sodium Oxalate	Na ₂ C ₂ O ₄	0.442	0,455	
Rinse filter with approximately 50 Transfer final filtrate and rinse sole Transfer to volumetric flask and in	utions to large beaker with			ME: <u>Claun</u> TE: <u>8-20-08</u>
Adjust final solution to volume of	2 L v	with DI water, and mix		E
SUM Total chemicals (targe	t) 154.21 g	Total chemicals (actual)	54.498 3
Total water (target)	2 L	Total water (actu	•	2000 ml
Target Specific Densit	y 1.08	Calculated densit	•	1.08
Check final solution pH and record	i. pH= <u>j</u>	<u> 차구</u> Readjust if signifi	cantly differen	t from target.
Comments: record any difficulties	or discronancies'			
comments. record any dimedities	or discrepancies			
an an air an				
	승규는 것 같은 것 같은 것 같아. 것			
	en substantia de la completa de la c			the same the second and the second

RPP-RPT-37505, Rev. 0

AY101-CSL Base Solution 2008 Version		Batch Size: pH:	2 L 12.82	AY101-CSL
Balance Device ID: Balance Device ID:	020	NIST Weight (20 NIST Weight (200		- 30.0000 (10.0
Technician: Noy Kelley		Date: 7 8 08		Tracking : 103

Add 1200 mL DI water to a beaker.

Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate.

Turn on heater and adjust to 60°C (±10°C).

Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	NaAlO ₂ .2H ₂ O	3.6	3.66	1
Sodium Chloride	NaCl	0.7		
Sodium Fluoride	NaF	0.13		
Sodium Chromate	Na2CrO4.4H2O	0.14	1 0.142	
Sodium Sulfate	Na ₂ SO ₄	0.60	0.68.	
Sodium Phosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	4.4	4.901	/
Sodium Oxalate	Na ₂ C ₂ O ₄	0.3	3 0.37	
Sodium Carbonate	Na ₂ CO ₃	31.2	31.27,	
Sodium Nitrate	NaNO ₃	30.7	30.80 -	
Sodium Nitrite	NaNO ₂	5.08		
Sodium Hydroxide	NaOH	0.4		

* Sodium fluoride is highly toxic. Handle with caution.

Adjust total solution volume to

Adjust solution temperature to 50°C to 60°C.

1700 mL by adding DI water.

Filter solution by vacuum through medium glass filter. Handle with caution, hot and caustic solution .

Rinse beaker with approximately 50 mL of DI water

Rinse filter with approximately 50 mL of DI water

Transfer final filtrate and rinse solutions to large beaker with stir bar.

instead 11-84QA APPROVED

NAME: cedum

2+2+2

Fransfer to volumetric flask and include rinse with DI water. Allow solution to cool	
--------------------------------------------------------------------------------------	--

	Fred solution to us have of	DATE: 8-20-04-		
Adjust	final solution to volume of	2 Lwi	th DI water, and mix thoroughly.	
SUM	Total chemicals (target) Total water (target) Target Specific Density	77.58 g 2 L 1.04	Total chemicals (actual) Total water (actual) Calculated density	97.79 2000 mi 1.04

Gheck final solution pH and record.

•••

Ĩ.

pH= 10.8 Readjust if significantly different from target.

Comments: record any difficulties or discrepancies	And	x	A	9	α	Nach	to
adjust pH to 12.83				-0-	0		

AW105 Supernate Base Solution 2008 Version	Batch Size: 2 L pH: 13+	0.032M Nitrite AW105-PSC
Balance Device ID: 0010 Balance Device ID: 0010	NIST Weight (北 g): NIST Weight (20 g):	19.9999 20.1 g
Technician: Noy & Enn	Date: 7/23/08	Tracking: 103
Add 1200 L mL DI water to a b	beaker.	a all at
Insert Teflon stirbar and thermocouple, and place on stirre	er / hotplate.	() ** ()
Turn on heater and adjust to 60°C (±10°C).	·	

Add the following chemicals and record their actual weights:

	-	·	Required	Actual	
Chemica	al	Formula	Mass (g)	Mass (g)	Comments
Sodium A	Vuminate	Na ₂ AlO ₂ 2H ₂ O	1	.529 1,529	۱
Sodium H	lydroxide	NaOH	21	.040 21.0558	
Boric Acid	<u> </u>	H ₃ BO ₃	0	0.0400.0397	
Sodium C	hromate	Na2CrO44H2O		0.019 0 .019 3	
Potassiun	n Mołybdate	K2MoO4		0.005 (), 00 59	
Potassiun	n Nitrate	KNO3	29	1.169 29.170	7
Zinc Nitra	te 6-hydrate	Zn(NO3)2.6H2O		0.018 0.015	f
Sodium C	hloride	NaCl		965 0.990	
Sodium F	luoride	NaF	13	1.104 13.115	
Sodium N	litrate	NaNO ₃	50	1.252 50,264	9
Sodium N	litrite	NaNO ₂	4	416 4.420	2
Sodium P	hosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O		3.397 3.2995	5
Sodium S	ulfate	Na ₂ SO ₄		494 1.5171	
Sodium C	arbonate	Na ₂ CO ₃	22	2.811 22.822	外
Glycolic A	cid	C ₂ H ₄ O ₃		1.219 0.2900	
Sodium A	cetate 3-hydrate	NaCH ₃ COO.3H ₂ O		0.626 0.6489	}
Sodium Fo	ormate	NaHCOO	C).279 0	5 Q2606 FW 7/23/08
Sodium O	xalate	Na ₂ C ₂ O ₄	7 [0	1.442 0.457	
Filter solu Rinse bei Rinse filte	ution by vacuum through aker with approximately er with approximately 50	n medium glass filter. <i>Har</i> 50 mL of DI water 5 mL of DI water	dle with caution,	hot and caustic	ĨĂ [#] ĂPPROVED
Transfer	final filtrate and rinse so	lutions to large beaker wi	th stir bar.	Ν	JA APPROVED
Transfer 1 Transfer 1	final filtrate and rinse so	lutions to large beaker wi nclude rinse with DI wate	th stir bar. r. Allow solution to	۲ دەمە	
Transfer Transfer Adjust fin	final filtrate and rinse sol to volumetric flask and in	lutions to large beaker wi nclude rinse with DI wate	th stir bar. r. Allow solution to with DI water, an	cool d mix thoroughly.	IAME: Claum
Transfer 1 Transfer 1	final filtrate and rinse sol to volumetric flask and in	lutions to large beaker with nclude rinse with DI wate	th stir bar. r. Allow solution to with DI water, an	cool d mix thoroughly.	IAME: Claum
Transfer Transfer Adjust fin	final filtrate and rinse sol to volumetric flask and in al solution to volume of	lutions to large beaker with nclude rinse with DI wate	th stir bar. r. Allow solution to with DI water, an g Total chemi-	cool Id mix thoroughly. cals (actual)	VAME: <u>Cldun</u> DATE: <u>8-20-08</u>
Transfer Transfer Adjust fin	final filtrate and rinse sol to volumetric flask and in al solution to volume of Total chemicals (targe	lutions to large beaker winclude rinse with DI wate 2 L 2 t) 149.82 2 L	th stir bar. r. Allow solution to with DI water, an g Total chemi Total water	cool Id mix thoroughly: cals (actual) (actual)	VAME: <u>Cldum</u> DATE: <u>8-20-08</u>
Transfer Transfer Adjust fin SUM	Total chemicals (target) Total water (target)	lutions to large beaker winclude rinse with DI wate 2 L at) 149.82 2 L 149.82 1 L 149.82 1 L 1 L 1 L 1 L 1 L 1 L 1 L 1 L	th stir bar. r. Allow solution to with DI water, an g Total chemi- Total water	cool d mix thoroughly. cals (actual) (actual) density	VAME: <u>Cldum</u> DATE: <u>8-20-08</u> <u>150-16726</u> <u>2000</u> 1.0753
Transfer Transfer Adjust fin SUM	al solution to volume of Total chemicals (target Total water (target) Target Specific Densit	lutions to large beaker with nclude rinse with DI wate 2 L et) 149.82 2 L ty 1.0 d. pH	th stir bar. r. Allow solution to with DI water, an g Total chemi Total water 7 Calculated o	cool d mix thoroughly. cals (actual) (actual) density	VAME: <u>Cldum</u> DATE: <u>8-20-08</u> <u>150-16726</u> <u>2000</u> 1.0753
Transfer Transfer Adjust fin SUM	final filtrate and rinse sol to volumetric flask and in al solution to volume of Total chemicals (targe Total water (target) Target Specific Densit	lutions to large beaker with nclude rinse with DI wate 2 L et) 149.82 2 L ty 1.0 d. pH	th stir bar. r. Allow solution to with DI water, an g Total chemi Total water 7 Calculated o	cool d mix thoroughly. cals (actual) (actual) density	VAME: <u>Cldum</u> DATE: <u>8-20-08</u> <u>150-16726</u> <u>2000</u> 1.0753
Transfer Transfer Adjust fin SUM	al solution to volume of Total chemicals (target Total water (target) Target Specific Densit	lutions to large beaker with nclude rinse with DI wate 2 L et) 149.82 2 L ty 1.0 d. pH	th stir bar. r. Allow solution to with DI water, an g Total chemi Total water 7 Calculated o	cool d mix thoroughly. cals (actual) (actual) density	VAME: <u>Cldum</u> DATE: <u>8-20-08</u> <u>150-16726</u> <u>2000</u> 1.0753
Transfer Transfer Adjust fin SUM	al solution to volume of Total chemicals (target Total water (target) Target Specific Densit	lutions to large beaker with nclude rinse with DI wate 2 L et) 149.82 2 L ty 1.0 d. pH	th stir bar. r. Allow solution to with DI water, an g Total chemi Total water 7 Calculated o	cool d mix thoroughly. cals (actual) (actual) density	VAME: <u>Cldum</u> DATE: <u>8-20-08</u> <u>150-16726</u> <u>2000</u> 1.0753
Transfer Transfer Adjust fin SUM	al solution to volume of Total chemicals (target Total water (target) Target Specific Densit	lutions to large beaker with nclude rinse with DI wate 2 L et) 149.82 2 L ty 1.0 d. pH	th stir bar. r. Allow solution to with DI water, an g Total chemi Total water 7 Calculated o	cool d mix thoroughly. cals (actual) (actual) density	VAME: <u>Cldum</u> DATE: <u>8-20-08</u> <u>150-16726</u> <u>2000</u> 1.0753
Transfer Transfer Adjust fin SUM	al solution to volume of Total chemicals (target Total water (target) Target Specific Densit	lutions to large beaker with nclude rinse with DI wate 2 L et) 149.82 2 L ty 1.0 d. pH	th stir bar. r. Allow solution to with DI water, an g Total chemi Total water 7 Calculated o	cool d mix thoroughly. cals (actual) (actual) density	VAME: <u>Cldum</u> DATE: <u>8-20-08</u> <u>150-16726</u> <u>2000</u> 1.0753
Transfer Transfer Adjust fin SUM	al solution to volume of Total chemicals (target Total water (target) Target Specific Densit	lutions to large beaker with nclude rinse with DI wate 2 L et) 149.82 2 L ty 1.0 d. pH	th stir bar. r. Allow solution to with DI water, an g Total chemi Total water 7 Calculated o	cool d mix thoroughly. cals (actual) (actual) density	VAME: <u>Cldum</u> DATE: <u>8-20-08</u> <u>150-16726</u> <u>2000</u> 1.0753
UM COM COM COM COM	al solution to volume of Total chemicals (target Total water (target) Target Specific Densit	lutions to large beaker with nclude rinse with DI wate 2 L et) 149.82 2 L ty 1.0 d. pH	th stir bar. r. Allow solution to with DI water, an g Total chemi Total water 7 Calculated o	cool d mix thoroughly. cals (actual) (actual) density	VAME: <u>Cldum</u>)ATE: <u>8-20-08</u> <u>150.6726</u> <u>2000</u> 1.0753

RPP-RPT-37505, Rev. 0

AY101-CSL Base Solution 2008 Version		Batch Size: pH:	2 L 12.3	AY101-CSL
Balance Device ID:	020	NIST Weight (dØ g):		pH=12.3
Balance Device ID: Technician: Noy / Keyu M	0	NIST Weight (<i> 00</i> g) 8/ <i>X\0</i> 8):	<u>(00 \ 0</u> Tracking : 105
Technician: NOY [Kevin	Date			Tracking: 105

Add

Ú 1200 mL DI water to a beaker.

Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to $60^{\circ}C$ (±10°C).

Add the following chemicals and record their actual weights:

Chemical	Formula	Required Mass (g)	Actual Mass (g)	Comments
Sodium Aluminate	NaAlO2.2H2O		61 3.6130	
Sodium Chloride	NaCl	0.	75 - 7517	
Sodium Fluoride	NaF	0.	13 .1248	
Sodium Chromate	Na ₂ CrO ₄ .4H ₂ O	0.	14 .1430	
Sodium Sulfate	Na ₂ SO ₄	0.	60,6026	
Sodium Phosphate, 12-Hydrate	Na ₃ PO ₄ 12H ₂ O	4.	49 4.4895	
Sodium Oxalate	Na ₂ C ₂ O ₄	0.	38 . 3801	
Sodium Carbonate	Na ₂ CO ₃	31.	25 31.2491	
Sodium Nitrate	NaNO ₃		17 30.7680	
Sodium Nitrite	NaNO ₂		08 5.0814	
Sodium Hydroxide	NaOH		41 .3918	

* Sodium fluoride is highly toxic. Handle with caution.

	otal solution volume to		L by adding DI water.	
Filter so Rinse b Rinse fil	solution temperature to 50°C to 60°C olution by vacuum through medium g eaker with approximately 50 mL of E Iter with approximately 50 mL of DI v r final filtrate and rinse solutions to la	lass filter. <i>Handle</i>)I water vater	- · · ·	11.7 QA APPROVED NAME: <u>Cedum</u>
•	r to volumetric flask and include rins nal solution to volume of		llow solution to cool	DATE 8-20-08
SUM	Total chemicals (target) Total water (target) Target Specific Density	77.58 g 2 L 1.04	Total chemicals (actual) Total water (actual) Calculated density	4.61 9 2000 mc 1.04
Check fi	nal solution pH and record.	рН= <u>(</u> 2	30Readjust if significantly diff	erent from target.
Comme 	nts: record any difficulties or discre yusting pH from 11.76	pancies to pH 18.5	so with NaoH	
				5

AW105 Supernate Base Solution 2008 Version		Batch Size: pH:	 6X AW105-PSC
Balance Device ID: Balance Device ID:	020	NIST Weight (dv g): NIST Weight (dv g)	\$0.0000
Technician: Noy Kelley	Dat	e: 816108	Tracking: 106

Add 1200 L mL DI water to a beaker.

Insert Teflon stirbar and thermocouple, and place on stirrer / hotplate. Turn on heater and adjust to 60° C (±10°C).

Add the following chemicals and record their actual weights:

.				Required	Actual	-	
Chemic		Formula	-n 1	Mass (g)	Mass (g)	Comme	nts
	Aluminate	Na2AIO2.2H2O	4 4		1.5289		
	Hydroxide	NaOH	-		21.0791		
Boric Ac	id	H ₃ BO ₃	JL	0.040	.0402		
Sodium (Chromate	Na2CrO4.4H2O		0.019	.0192		
Potassiu	m Molybdate	K2MoO4] [.0664		
Potassiu	m Nitrate	KNO3] [29.169	2.1610	1	
Zinc Nitra	ate 6-hydrate	Zn(NO ₃) _{2.} 6H ₂ O		0.018	-0180		
Sodium (Chloride	NaCl	1 [0.965	.9651		
Sodium F	Fluoride	NaF	7 F	13.104	18.1042		
Sodium I	Nitrate	NaNO ₃	7 F	424.252	424.3		
Sodium f	Nitrite	NaNO2] [26.496	26,4957		
Sodium I	Phosphate, 12-Hydrate	Na3PO4 12H2O] [3.3169		
Sodium S	Sulfate	Na ₂ SO ₄] [1.4939		
Sodium (Carbonate	Na ₂ CO ₃	7 [22.811	22.8106	T —	
Glycolic /	Acid	C ₂ H ₄ O ₃	7.[0.219	-2189		
Sodium A	Acetate 3-hydrate	NaCH ₃ COO.3H ₂ O	7. r	0.626	.6264		
Sodium F	Formate	NaHCOO]^ [0.279	.2786		
eeu an							
Sodium (Na ₂ C ₂ O ₄] [d/e w/	0.442 th caution, hot a	· · · · · · ·	Q/MioA.	
Sodium (Filter sol Rinse be Rinse fill Transfer	Dvalate Jution by vacuum through eaker with approximately ter with approximately 50 r final filtrate and rinse sol r to volumetric flask and ir	medium glass filter. <i>Han</i> 50 mL of DI water mL of DI water utions to large beaker wit	hstir b	th caution, hot a	and caustic	NAME:	Claun
Sodium (Filter sol Rinse be Rinse fill Transfer Transfer	lution by vacuum through eaker with approximately ter with approximately 50 r final filtrate and rinse sol	medium glass filter. <i>Han</i> 50 mL of DI water mL of DI water utions to large beaker wit clude rinse with DI water	h stir b . Allow	th caution, hot a	nd caustic	NAME:	
Sodium (Filter sol Rinse be Rinse fill Transfer Transfer	lution by vacuum through eaker with approximately 50 final filtrate and rinse sol to volumetric flask and ir nal solution to volume of Total chemicals (targe	medium glass filter. <i>Han</i> 50 mL of DI water mL of DI water utions to large beaker wit nclude rinse with DI water 2 L 2 L	h stir b Allow	th caution, hot a par. v solution to cool DI water, and mix Total chemicals (and caustic	NAME: DATE:	Cldur 8.20.23
Sodium (Filter sol Rinse be Rinse fill Transfer Transfer Adjust fil	lution by vacuum through eaker with approximately 50 final filtrate and rinse sol to volumetric flask and ir nal solution to volume of Total chemicals (targe Total water (target)	medium glass filter. <i>Han</i> 50 mL of DI water mL of DI water utions to large beaker wit include rinse with DI water 2 L 2 L	h stir b Allow	th caution, hot a par. v solution to cool DI water, and mix Total chemicals (Total water (actua	and caustic thoroughly. actual)	NAME: DATE:	Cldur 8.20.23
Sodium (Filter sol Rinse be Rinse fill Transfer Transfer Adjust fil	lution by vacuum through eaker with approximately 50 final filtrate and rinse sol to volumetric flask and ir nal solution to volume of Total chemicals (targe	medium glass filter. <i>Han</i> 50 mL of DI water mL of DI water utions to large beaker wit include rinse with DI water 2 L 2 L	h stir b Allow	th caution, hot a par. v solution to cool DI water, and mix Total chemicals (and caustic thoroughly. actual)	NAME: DATE:	Cldur 8.20.23
Sodium (Filter sol Rinse be Rinse fill Transfer Transfer Adjust fil SUM	lution by vacuum through eaker with approximately 50 final filtrate and rinse sol to volumetric flask and ir nal solution to volume of Total chemicals (targe Total water (target) Target Specific Densit	medium glass filter. <i>Han</i> 50 mL of DI water mL of DI water utions to large beaker wit clude rinse with DI water 2 L (t) 545.90 g 2 L y 1.27	h stir t Allow with t	th caution, hot a par. solution to cool DI water, and mix Total chemicals (Total water (actual Calculated densit	and caustic (thoroughly. actual) al) y	NAME: DATE:	<u>Cldurv</u> 8·20 v 8
Sodium (Filter sol Rinse be Rinse fill Transfer Transfer Adjust fil SUM	lution by vacuum through eaker with approximately 50 final filtrate and rinse sol to volumetric flask and ir nal solution to volume of Total chemicals (targe Total water (target)	medium glass filter. <i>Han</i> 50 mL of DI water mL of DI water utions to large beaker wit clude rinse with DI water 2 L (t) 545.90 g 2 L y 1.27	h stir t Allow with t	th caution, hot a par. solution to cool DI water, and mix Total chemicals (Total water (actua Calculated densit	and caustic (thoroughly. actual) al) y	NAME: DATE:	<u>Cldurv</u> 8·20 v 8
Sodium (Filter sol Rinse be Rinse filt Transfer Transfer Adjust fil SUM	lution by vacuum through eaker with approximately 50 final filtrate and rinse sol to volumetric flask and ir nal solution to volume of Total chemicals (targe Total water (target) Target Specific Densit	medium glass filter. <i>Han</i> 50 mL of DI water mL of DI water utions to large beaker wit clude rinse with DI water 2 L t) 545.90 g 2 L y 1.27 d. pH=	h stir t Allow with t	th caution, hot a bar. solution to cool DI water, and mix Total chemicals (Total water (actua Calculated densit AL \$/7108 Readjust if signifi	and caustic (thoroughly. actual) al) y	NAME: DATE:	<u>Cldurv</u> 8·20 v 8
Sodium (Filter sol Rinse be Rinse filt Transfer Transfer Adjust fil SUM	lution by vacuum through eaker with approximately 50 r final filtrate and rinse sol to volumetric flask and ir nal solution to volume of Total chemicals (targe Total water (target) Target Specific Densit	medium glass filter. <i>Han</i> 50 mL of DI water mL of DI water utions to large beaker wit clude rinse with DI water 2 L t) 545.90 g 2 L y 1.27 d. pH=	h stir t Allow with !	th caution, hot a bar. solution to cool DI water, and mix Total chemicals (Total water (actua Calculated densit AL \$/7108 Readjust if signifi	and caustic (thoroughly. actual) al) y	NAME: DATE:	<u>Cldurv</u> 8·20 v 8

LOT ANALYSIS ITEM: 1099 SODIUM OXALATE, REAGENT (ACS)

LOT#: P568829

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min	PASS	101.8 %
2. Insoluble 0.005%	PASS	< 0.005 %
3. Loss on drying @ 105 C 0.01%	PASS	0.004 %
4. Neutrality - Pass Test	PASS	Passes Test
5. Chloride 0.002%	PASS	< 0.002 %
6. Sulfate 0.002%	PASS	< 0.002 %
7. Ammonium 0.002%	PASS	< 0.002 %
8. Heavy metals (Pb) 0.002%	PASS	< 0.002 %
9. Iron 0.001%	PASS	< 0.0001 %
10. Potassium 0.005%	PASS	< 0.002 %
11. Substances darkened by H2SO4 pass test	PASS	Passes Test

.

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Kenneth L. Shafer

Date: 9/15/2005

QC Supervisor: Joan Plowman

Retest Date: 9/15/2010

LOT ANALYSIS ITEM: 705 SODIUM CARBONATE, ANHYDROUS, POWDER, REAGENT (ACS)

LOT#: P675164

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min	PASS	100.00%
2. Insoluble 0.01%	PASS	0.004%
3. Loss on heating at 285 C 1.0% max	PASS	0.4%
4. Chloride 0.001%	PASS	0.0006%
5. Phosphate 0.001%	PASS	0.0003%
6. Silica 0.005%	PASS	0.001%
7. Sulfur compounds (as SO4) 0.003%	PASS	0.001%
8. Heavy metals (Pb) 0.0005%	PASS	0.0002%
9. Iron 0.0005%	PASS	0.0002%
10. Calcium 0.03%	PASS	0.005%
11. Magnesium 0.005%	PASS	0.002%
12. Potassium 0.005%	PASS	0.002%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Joan E Plowman

Date: 5/3/2006

QC Supervisor: Joan Plowman

Retest Date: 5/3/2011

LOT ANALYSIS ITEM: 1099 SODIUM OXALATE, REAGENT (ACS)

LOT#: P453301

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min	PASS	102.7%
2. Insoluble 0.005%	PASS	<0.005%
3. Loss on drying @ 105 C 0.01%	PASS	<0.01%
4. Neutrality - Pass Test	PASS	passes test
5. Chloride 0.002%	PASS	<0.002%
6. Sulfate 0.002%	PASS	<0.002%
7. Ammonium 0.002%	PASS	<0.002%
8. Heavy metals (Pb) 0.002%	PASS	<0.002%
9. Iron 0.001%	PASS	<0.001%
10. Potassium 0.005%	PASS	<0.005%
11. Substances darkened by H2SO4 pass test	PASS	passes test

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Daniel Merkoziaj

Date: 2/17/2004

QC Supervisor: Joan Plowman

Retest Date: 2/17/2006

LOT ANALYSIS ITEM: 656 SODIUM ACETATE, TRIHYDRATE, REAGENT (ACS)

LOT#: L350643

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0-101%	PASS	99.99%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 7.5-9.2 @ 25 C	PASS	8.0
4. Chloride 0.001%	PASS	<0.001%
5. Phosphate 0.0005%	PASS	<0.0005%
6. Sulfate 0.002%	PASS	<0.002%
7. Calcium 0.005%	PASS	<0.0005%
8. Magnesium 0.002%	PASS	<0.0001%
9. Heavy metals (as Pb) 0.0005%	PASS	<0.0005%
10. Iron 0.0005%	PASS	<0.0001%
11. Substances reducing permanganate - Pass Test	PASS	passes test
12. Potassium 0.005%	PASS	<0.0016%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Daniel Merkoziaj

Date: 10/1/2003

QC Supervisor: Joan Plowman

Retest Date: 24 Month after shipment

LOT ANALYSIS ITEM: 658 SODIUM NITRATE, REAGENT (ACS)

LOT#: L136875

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	99.7 %
2. pH of 5% solution 5.5-8.3 @ 25 C	PASS	5.9
3. Insoluble 0.005%	PASS	< 0.005 %
4. Chloride 0.001%	PASS	< 0.001 %
5. lodate 0.0005%	PASS	< 0.0005 %
6. Nitrite 0.001%	PASS	< 0.001 %
7. Phosphate 0.0005%	PASS	< 0.0005 %
8. Sulfate 0.003%	PASS	< 0.003 %
9. Calcium 0.005%	PASS	< 0.005 %
10. Magnesium 0.002%	PASS	< 0.002 %
11. Heavy metals (Pb) 0.0005%	PASS	< 0.0005 %
12. Iron 0.0003%	PASS	< 0.0003 %

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Kenneth L. Shafer

Date: 9/24/2001

QC Supervisor: Joan Plowman

Retest Date: 24 Month after shipment

.

LOT ANALYSIS ITEM: 658 SODIUM NITRATE, REAGENT (ACS)

.

LOT#: L137057

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	100.1 %
2. pH of 5% solution 5.5-8.3 @ 25 C	PASS	5.9
3. Insoluble 0.005%	PASS	< 0.005 %
4. Chloride 0.001%	PASS	< 0.001 %
5. lodate 0.0005%	PASS	< 0.0005 %
6. Nitrite 0.001%	PASS	< 0.001 %
7. Phosphate 0.0005%	PASS	< 0.0005 %
8. Sulfate 0.003%	PASS	< 0.003 %
9. Calcium 0.005%	PASS	< 0.0005 %
10. Magnesium 0.002%	PASS	< 0.0005 %
11. Heavy metals (Pb) 0.0005%	PASS	< 0.0005 %
12. Iron 0.0003%	PASS	< 0.0003 %

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Kenneth L. Shafer

Date: 9/26/2001

QC Supervisor: Joan Plowman

Retest Date: 24 Month after shipment

LOT ANALYSIS ITEM: 559 SODIUM NITRITE, REAGENT (ACS)

LOT#: P673156

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 97.0% min.	PASS	98.6%
2. Chloride 0.005%	PASS	< 0.005%
3. Sulfate 0.01%	PASS	< 0.01%
4. Calcium 0.01%	PASS	< 0.01%
5. Heavy metals (as Pb) 0.001%	PASS	< 0.001%
6. Iron 0.001%	PASS	< 0.001%
7. Potassium 0.005%	PASS	< 0.005%
8. Insoluble 0.01%	PASS	< 0.01%
9. pH of 5% solution 5.5-8.3 @ 25 C	PASS	7.2
10. Appearance - White to pale yellow	PASS	Pale Yellow

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Robert Kramer

Date: 2/28/2006

QC Supervisor: Joan Plowman

Retest Date: 2/28/2011

LOT ANALYSIS

ITEM: 559 SODIUM NITRITE, REAGENT (ACS)

LOT#: P676266

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 97.0% min.	PASS	97.3 %
2. Chloride 0.005%	PASS	< 0.005 %
3. Sulfate 0.01%	PASS	< 0.01 %
4. Calcium 0.01%	PASS	< 0.01 %
5. Heavy metals (as Pb) 0.001%	PASS	< 0.001 %
6. Iron 0.001%	PASS	< 0.001 %
7. Potassium 0.005%	PASS	< 0.005 %
8. Insoluble 0.01%	PASS	< 0.01 %
9. pH of 5% solution 5.5-8.3 @ 25 C	PASS	7.4
10. Appearance - White to pale yellow	PASS	pale yellow

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Kenneth L. Shafer

Date: 6/14/2006

QC Supervisor: Joan Plowman

Retest Date: 6/14/2011

LOT ANALYSIS

ITEM: 559 SODIUM NITRITE, REAGENT (ACS)

LOT#: P568476

.

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 97.0% min.	PASS	97.9 %
2. Chloride 0.005%	PASS	< 0.005 %
3. Sulfate 0.01%	PASS	< 0.01 %
4. Calcium 0.01%	PASS	< 0.001 %
5. Heavy metals (as Pb) 0.001%	PASS	< 0.001 %
6. Iron 0.001%	PASS	< 0.0005 %
7. Potassium 0.005%	PASS	< 0.001 %
8. Insoluble 0.01%	PASS	< 0.01 %
9. pH of 5% solution 5.5-8.3 @ 25 C	PASS	7.6
10. Appearance - White to pale yellow	PASS	pale yellow

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Kenneth L. Shafer

Date: 8/17/2005

QC Supervisor: Joan Plowman

Retest Date: 8/17/2010

LOT ANALYSIS ITEM: 2454 SODIUM SULFATE, ANHYDROUS, POWDER, REAGENT (ACS)

LOT#: P675142

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	99.75%
2. pH of 5% solution @ 25C 5.2-9.2	PASS	5.92
3. Insoluble matter 0.01%	PASS	0.003%
4. Loss on ignition 0.5%	PASS	0.22%
5. Chloride 0.001%	PASS	<0.0005%
6. Nitrogen compounds (as N) 0.0005%	PASS	<0.0003%
7. Phosphate 0.001%	PASS	<0.0005%
8. Calcium 0.01%	PASS	0.001%
9. Magnesium 0.005%	PASS	0.0005%
10. Heavy metals (as Pb) 0.0005%	PASS	<0.0003%
11. Iron 0.001%	PASS	<0.0005%
12. Potassium 0.01%	PASS	0.0015%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Nicholas E. Dangler

Date: 5/5/2006

QC Supervisor: Joan Plowman

Retest Date: 5/5/2011

LOT ANALYSIS ITEM: 2454 SODIUM SULFATE, ANHYDROUS, POWDER, REAGENT (ACS)

LOT#: P571317

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	100.3%
2. pH of 5% solution @ 25C 5.2-9.2	PASS	5.4
3. Insoluble matter 0.01%	PASS	< 0.01%
4. Loss on ignition 0.5%	PASS	< 0.5%
5. Chloride 0.001%	PASS	< 0.001%
6. Nitrogen compounds (as N) 0.0005%	PASS	< 0.0005%
7. Phosphate 0.001%	PASS	< 0.001%
8. Calcium 0.01%	PASS	< 0.01%
9. Magnesium 0.005%	PASS	< 0.005%
10. Heavy metals (as Pb) 0.0005%	PASS	< 0.0005%
11. Iron 0.001%	PASS	< 0.001%
12. Potassium 0.01%	PASS	< 0.01%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Robert Kramer

Date: 12/14/2005

Retest Date: 12/14/2010

QC Supervisor: Joan Plowman

LOT ANALYSIS ITEM: 1035 SODIUM PHOSPHATE, TRIBASIC, DODECAHYDRATE, REAGENT (ACS)

LOT#: P562445

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 98.0-102.0%	PASS	99.2%
2. Excess alkali (NaOH) 2.5%	PASS	1.8%
3. Insoluble 0.01%	PASS	0.005%
4. Chloride 0.001%	PASS	0.000 8%
5. Sulfate 0.01%	PASS	0.002%
6. Heavy metals (as Pb) 0.001%	PASS	0.000 5%
7. Iron 0.001%	PASS	0.000 3%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by:

QC Supervisor: Joan Plowman

Date: 1/27/2005

Retest Date: 1/27/2010

LOT ANALYSIS ITEM: 657 SODIUM CHLORIDE, REAGENT (ACS)

LOT#: P569640

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	100.0%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 5.0-9.0 @ 25 C	PASS	5.8
4. lodide 0.002%	PASS	<0.002%
5. Bromide 0.01%	PASS	<0.01%
6. Chlorate and nitrate (as NO3) 0.003%	PASS	<0.003%
7. Phosphate 0.0005%	PASS	<0.0005%
8. Sulfate 0.004%	PASS	0.004%
9. Barium - pass test	PASS	pass test
10. Heavy Metals (as Pb) 0.0005%	PASS	<0.0005%
11. Iron 0.0002%	PASS	<0.0002%
12. Calcium 0.002%	PASS	0.0003%
13. Magnesium 0.001%	PASS	<0.0001%
14. Potassium 0.005%	PASS	<0.005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Daniel Merkoziaj

QC Supervisor: Joan Plowman

Date: 10/9/2005

Retest Date: 10/9/2010

LOT ANALYSIS ITEM: 630 SODIUM HYDROXIDE, REAGENT (ACS)

LOT#: P569567

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 97.0% min	PASS	99.0%
2. Sodium carbonate 1.0% max	PASS	0.4%
3. Chloride 0.005%	PASS	<0.001%
4. Nitrogen compounds (N) 0.001%	PASS	<0.0003%
5. Phosphate 0.001%	PASS	<0.0002%
6. Sulfate 0.003%	PASS	0.0005%
7. Heavy metals (as Ag) 0.002%	PASS	<0.001%
8. Iron 0.001%	PASS	<0.0003%
9. Mercury 0.00001%	PASS	0.00001%
10. Nickel 0.001%	PASS	0.0001%
11. Calcium 0.005%	PASS	0.0003%
12. Magnesium 0.002%	PASS	0.002%
13. Potassium 0.02%	PASS	<0.01%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Joan E Plowman

Date: 10/5/2005

QC Supervisor: Joan Plowman

Retest Date: 10/5/2010

LOT ANALYSIS ITEM: 656 SODIUM ACETATE, TRIHYDRATE, REAGENT (ACS)

LOT#: L350643

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0-101%	PASS	99.99%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 7.5-9.2 @ 25 C	PASS	8.0
4. Chloride 0.001%	PASS	<0.001%
5. Phosphate 0.0005%	PASS	<0.0005%
6. Sulfate 0.002%	PASS	<0.002%
7. Całcium 0.005%	PASS	<0.0005%
8. Magnesium 0.002%	PASS	<0.0001%
9. Heavy metals (as Pb) 0.0005%	PASS	<0.0005%
10. Iron 0.0005%	PASS	<0.0001%
11. Substances reducing permanganate - Pass Test	PASS	passes test
12. Potassium 0.005%	PASS	<0.0016%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Daniel Merkoziaj

Date: 10/1/2003

QC Supervisor: Joan Plowman

Retest Date: 24 Month after shipment

LOT ANALYSIS ITEM: 1935 SODIUM ACETATE, TRIHYDRATE, BIO-REFINED

LOT#: P677274

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min.	PASS	99.7%
2. Substances reducing KMnO4 0.005%	PASS	<0.005%
3. pH (0.5M in water @ 20 deg. C) 7.5-9.0	PASS	8.3
4. Insoluble matter 0.005%	PASS	<0.005%
5. Chloride (CI) 0.0005%	PASS	<0.0005%
6. Phosphate (PO4) 0.0005%	PASS	<0.0005%
7. Sulfate (SO4) 0.002%	PASS	<0.0001%
8. Absorbance (0.50M in H2O) @ 260 nm <0.004	PASS	<0.004
9. Absorbance (0.50M in H2O) @ 280 nm <0.003	PASS	<0.003

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Joan E Plowman

Date: 7/26/2006

QC Supervisor: Joan Plowman

Retest Date: 7/26/2011

LOT ANALYSIS ITEM: 1935 SODIUM ACETATE, TRIHYDRATE, BIO-REFINED

LOT#: P460400

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min.	PASS	100.6 %
2. Substances reducing KMnO4 0.005%	PASS	< 0.005 %
3. pH (0.5M in water @ 20 deg. C) 7.5-9.0	PASS	8.5
4. Insoluble matter 0.005%	PASS	< 0.005 %
5. Chloride (Cl) 0.0005%	PASS	< 0.0005 %
6. Phosphate (PO4) 0.0005%	PASS	< 0.0005 %
7. Sulfate (SO4) 0.002%	PASS	0.0003 %
8. Absorbance @ 260nm/280nm (.5M in H2O)<0.004/<0.003	PASS	<0.001 / <0.001

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Kenneth L. Shafer

Date: 10/27/2004

QC Supervisor: Joan Plowman

Retest Date: 10/27/2009

LOT ANALYSIS ITEM: 655 POTASSIUM NITRATE, REAGENT (ACS)

LOT#: L346711

.

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min	PASS	99.7%
2. Insoluble 0.005%	PASS	< 0.00 5%
3. pH of 5% solution 4.5-8.5 @ 25C	PASS	5.8
4. Chloride 0.002%	PASS	<0.002%
5. lodate 0.0005%	PASS	<0.000 5%
6. Nitrite 0.001%	PASS	<0.001%
7. Phosphate 0.0005%	PASS	<0.000 5%
8. Sulfate 0.003%	PASS	<0.003%
9. Calcium 0.005%	PASS	<0.005%
10. Magnesium 0.002%	PASS	<0.002%
11. Heavy metals (as Pb) 0.0005%	PASS	<0.000 5%
12. Iron 0.0003%	PASS	<0.000 3%
13. Sodium 0.005%	PASS	<0.005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by:

Date: 3/28/2003

QC Supervisor: Joan Plowman

Retest Date: 24 Month after shipment

Fisher Scientific Company **Chemical Manufacturing Division**

Certificate of Analysis

Fisher Scientific's Quality System is Certified to ISO9002 (1994) standard by DNV Cert. # 96-HOU-AQ-8052

1 Reagent Lane

Fairlawn, NJ 07410

Phone: (201) 796-7100 Fax: (201) 796-1329

Catalog Number	S392	Report Date	8/4/03	Mfg. Date	7/23/03
Lot Number	035270	Sample ID	\$392.03	5270.CQS	
Description	SODIUM HYDROXIDE NF/F	CC/EP/BP/JP			

This is to certify that units of the above mentioned lot number were tested and found to comply with the specifications of the grade listed. Certain data have been supplied by third parties. Fisher Scientific expressly disclaims all warranties, expressed or implied, including the implied warranties of merchantability and fitness for a particular purpose. Unless otherwise stated, these products are not intended for dialysis, parenteral or injectable use without further processing. The following are the actual analytical results obtained:

Result Name	Specifications	Units	Test Value
APPEARANCE	White Pellets	REPORT	WHITE PELLETS
National Formulary Regul	rements:		
ASSAY	95.0 - 100.5	%	99.6000
ENDOTOXIN TESTING	Report	EU/g	<0.4
HEAVY METALS(AS Pb)	0.003 Maxmum	%	0.0020
IDENTIFICATION	Pass test	PASS/FAIL	PASS
INSOLUBLE SUBSTANCES & ORGANIC MATTER	Pass test	PASS/FAIL	PASS
POTASSIUM	Pass test	PASS/FAIL	PASS
SODIUM CARBONATE	3.0 Maximum	%	0.100
FCC Requirements:			
ARSENIC (As)	3 Maximum	mg/kg	3
ASSAY - FCC	95.0 - 100.5	%	99.6
CARBONATE (as Na2CO3)	3.0 Maximum	%	0,1
HEAVY METALS-FCC	0.002 Maximum	%	0.002
IDENTIFICATION - FCC	Pass test	PASS/FAIL	PASS
INSOL SUBT & ORG MAT	Pass test	PASS/FAIL	PASS
LEAD	10 Maximum	mg/kg	1
MERCURY (Hg)	0,1 Maximum	mg/kg	0.1

Lab Manager Fair Läwn	Lab Manager BPF	
Elan E Alen	Joel Baland	
CERTIFIED BY		

Note: The data listed is valid for all package sizes of this lot of product, expressed as a extension of the catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701

Fisher Scientific Company Chemical Manufacturing Division

Certificate of Analysis

Fisher Scientific's Quality System is Certified to ISO9002 (1994) standard by DNV Cert. # 96-HOU-AQ-8052

1 Reagent Lane

Fairlawn, NJ 07410

Phone: (201) 796-7100 Fax: (201) 796-1329

Catalog Number	\$392	Report Date	8/4/03	Mfg. Date	7/23/03
Lot Number	035270	Sample ID	\$392.03	5270.005	
Description	SODIUM HYDROXIDE NF/F	CC/EP/BP/JP			

This is to certify that units of the above mentioned lot number were tested and found to comply with the specifications of the grade listed. Certain data have been supplied by third parties. Fisher Scientific expressly disclaims all warranties, expressed or implied, including the implied warranties of merchantability and fitness for a particular purpose. Unless otherwise stated, these products are not intended for dialysis, parenteral or injectable use without further processing. The following are the actual analytical results obtained:

Result Name	Specifications	Units	Test Value
European Pharmacopoe	eia Requirements:		
APPEARANCE OF SOLN	Pass test	PASS/FAIL	PASS
ASSAY	97.0 - 100.5	%	98.8
CARBONATE	2.0 Maximum	%	0.6
CHLORIDE	50 Maximum	PPM	17
Bacterial Endotoxins	Report	EU/g	<0.4
HEAVY METALS	20 Maximum	PPM	7
IDENTIFICATION	Pass test	PASS/FAIL	PASS
IRON	10 Maximum	PPM	3
SULFATE	50 Maximum	PPM	13
British Pharmacopoeia	Requirements:		
APPEARANCE OF SOLN	Pass test	PASS/FAIL	PASS
ASSAY	97.0 - 100.5	%	98.8
CARBONATE	2.0 Maximum	%	0.6
CHLORIDE	50 Maximum	PPM	17
HEAVY METALS	20 Maximum	PPM	7
IDENTIFICATION	Pass test	PASS/FAIL	PASS
IRON	10 Maximum	PPM	3
SULFATE	50 Maximum	PPM	. 13
Jananese Pharmacopor	ia Requirements:		

Japanese Pharmacopoeia Requirements:

CERTIFIED BY	
Edan E Alan	Joel Baland
Lab Manager Fair Lawn	Lab Manager BPF
bloto: The data listed is valid for all package sizes of this	lot of product, ownerse and as a outprojon of the catalog

Note: The data listed is valid for all package sizes of this lot of product, expressed as a extension of the catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701

Fisher Scientific Company **Chemical Manufacturing Division**

Certificate of Analysis

Fisher Scientific's Quality System is Certified to ISO9002 (1994) standard by DNV Cert. # 96-HOU-AQ-8052

1 Reagent Lane Fairlawn, NJ 07410

Phone: (201) 796-7100 Fax: (201) 796-1329

Catalog Number	\$392	Report Date	8/4/03	Mfg. Date	7/23/03
Lot Number	035270	Sample ID	839203	5270.CQS	
Description	SODIUM HYDROXIDE NF/F	CC/EP/BP/JP			

This is to certify that units of the above mentioned tot number were tested and found to comply with the specifications of the grade listed. Certain data have been supplied by third parties. Fisher Scientific expressly disclaims all warranties, expressed or impled, including the implied warranties of merchantability and fitness for a particular purpose. Unless otherwise stated, these products are not intended for diatysis, parenteral or injectable use without further processing. The following are the actual analytical results obtained:

Result Name	Specifications	Units	Test Value
appearance of solution	Pass test	PASS/FAIL	PASS
ASSAY	95.0 Minimum	%	97.8
SODIUM CARBONATE	2.0 Naximum	%	1.6
CHLORIDE	0.050 Maximum	%	0.004
HEAVY METALS	30 Maximum	PPM	8
IDENTIFICATION	Pass test	PASS/FAIL	PASS
MERCURY	Pass test	PASS/FAIL	PASS
POTASSIUM	Pass test	PASS/FAIL	PASS

CERTIFIED BY	
Glan & Al	Joel Baland
Lab Manager Fair Lawn	Lab Manager BPF
Alatar The data listed is safed for all analysis along the	is int of manipulation and an a antenaion of the antalog

Note: The data listed is valid for all package sizes of this lot of product, expressed as a extension of the catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701

LOT ANALYSIS ITEM: 1031 SODIUM FLUORIDE, REAGENT (ACS)

LOT#: L239673

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99% min.	PASS	101.5%
2. Insoluble 0.02%	PASS	<0.02%
3. Loss on drying @ 150 C 0.3%	PASS	0.2%
4. Chloride 0.005%	PASS	<0.005%
5. Titrable acid 0.03 meq/g	PASS	<0.03 meq/g
6. Titrable base 0.01 meq/g	PASS	<0.01 meq/g
7. Sodium fluosilicate 0.1%	PASS	<0.1%
8. Sulfate 0.03%	PASS	<0.03%
9. Sulfite 0.005%	PASS	<0.005%
10. Heavy metals (as Pb) 0.003%	PASS	<0.003%
11. Iron 0.003%	PASS	<0.003%
12. Potassium 0.02%	PASS	<0.02%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by:

Date: 3/13/2002

QC Supervisor: Joan Plowman

Retest Date: 24 Month after shipment

LOT ANALYSIS

LOT#: P676271

TEST	PASS/FAIL	NUMERICAL RESULT
1. pH (@ 25 C) 10.00 +/- 0.01	PASS	10.01
2. NIST Traceable	PASS	As Stated

TRACEABLE TO N.I.S.T. (Y/N)? Y

ITEM: 682 BUFFER SOLUTION, pH 10.00

Comment: Reported by: Nicholas E. Dangler

Date: 6/20/2006

QC Supervisor: Joan Plowman

Retest Date: 6/20/2008

GFS Chemicals, Inc. Columbus, Ohio 43223

LOT ANALYSIS ITEM: 681 BUFFER SOLUTION, pH 7.00

LOT#: P678527

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Robert Kramer

Date: 10/3/2006

QC Supervisor: Joan Plowman

Retest Date: 10/3/2008

LOT ANALYSIS ITEM: 1031 SODIUM FLUORIDE, REAGENT (ACS)

.

LOT#: P676464

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99% min.	PASS	99.24%
2. Insoluble 0.02%	PASS	0.0057%
3. Loss on drying @ 150 C 0.3%	PASS	0.042%
4. Chloride 0.005%	PASS	0.003%
5. Titrable acid 0.03 meq/g	PASS	<0.03 meg/g
6. Titrable base 0.01 meq/g	PASS	0.004 meg/g
7. Sodium fluosilicate 0.1%	PASS	NIL
8. Sulfate 0.03%	PASS	0.02%
9. Sulfite 0.005%	PASS	0.0035%
10. Heavy metals (as Pb) 0.003%	PASS	0.0025%
11. Iron 0.003%	PASS	0.0024%
12. Potassium 0.02%	PASS	0.0049%

LOT ANALYSIS ITEM: 630 SODIUM HYDROXIDE, REAGENT (ACS)

LOT#: P780673

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 97.0% min	PASS	99.4%
2. Sodium carbonate 1.0% max	PASS	0.93%
3. Chloride 0.005%	PASS	<0.005%
4. Nitrogen compounds (N) 0.001%	PASS	<0.001%
5. Phosphate 0.001%	PASS	<0.001%
6. Sulfate 0.003%	PASS	<0.003%
7. Heavy metals (as Ag) 0.002%	PASS	<0.002%
8. Iron 0.001%	PASS	<0.0005%
9. Mercury 0.00001%	PASS	<0.000 01%
10. Nickel 0.001%	PASS	<0.0002%
11. Calcium 0.005%	PASS	<0.0005%
12. Magnesium 0.002%	PASS	<0.0002%
13. Potassium 0.02%	PASS	<0.02%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Robert Kramer

Date: 1/31/2007

QC Supervisor: Joan Plowman

Retest Date: 1/31/2012

LOT ANALYSIS ITEM: 705 SODIUM CARBONATE, ANHYDROUS, POWDER, REAGENT (ACS)

LOT#: P781010

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min	PASS	99.99%
2. Insoluble 0.01%	PASS	0.004%
3. Loss on heating at 285 C 1.0% max	PASS	0.2%
4. Chloride 0.001%	PASS	0.0004%
5. Phosphate 0.001%	PASS	0.0003%
6. Silica 0.005%	PASS	0.001%
7. Sulfur compounds (as SO4) 0.003%	PASS	0.0009%
8. Heavy metals (Pb) 0.0005%	PASS	0.0003%
9. Iron 0.0005%	PASS	0.0003%
10. Calcium 0.03%	PASS	0.005%
11. Magnesium 0.005%	PASS	0.002%
12. Potassium 0.005%	PASS	0.002%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Joan E Plowman

Date: 2/20/2007

QC Supervisor: Joan Plowman

Retest Date: 2/20/2012

LOT ANALYSIS ITEM: 1099 SODIUM OXALATE, REAGENT (ACS)

LOT#: P568829

TEST	IDACC/EAU	NUMERICAL RESULT
1. Assay 99.5% min	PASS	101.8 %
2. Insoluble 0.005%	PASS	< 0.005 %
3. Loss on drying @ 105 C 0.01%	PASS	0.004 %
4. Neutrality - Pass Test	PASS	Passes Test
5. Chloride 0.002%	PASS	< 0.002 %
6. Sulfate 0.002%	PASS	< 0.002 %
7. Ammonium 0.002%	PASS	< 0.002 %
8. Heavy metals (Pb) 0.002%	PASS	< 0.002 %
9. Iron 0.001%	PASS	< 0.0001 %
10. Potassium 0.005%	PASS	< 0.002 %
11. Substances darkened by H2SO4 pass test	PASS	Passes Test

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Kenneth L. Shafer

Date: 9/15/2005

QC Supervisor: Joan Plowman

Retest Date: 9/15/2010

LOT ANALYSIS ITEM: 658 SODIUM NITRATE, REAGENT (ACS)

LOT#: L136875

TEST	PASS/FAIL	NUMERICAL
1. Assay 99.0% min.	PASS	99.7 %
2. pH of 5% solution 5.5-8.3 @ 25 C	PASS	5.9
3. Insoluble 0.005%	PASS	< 0.005 %
4. Chloride 0.001%	PASS	< 0.001 %
5. lodate 0.0005%	PASS	< 0.0005 %
6. Nitrite 0.001%	PASS	< 0.001 %
7. Phosphate 0.0005%	PASS	< 0.0005 %
8. Sulfate 0.003%	PASS	< 0.003 %
9. Calcium 0.005%	PASS	< 0.005 %
10. Magnesium 0.002%	PASS	< 0.002 %
11. Heavy metals (Pb) 0.0005%	PASS	< 0.0005 %
12. Iron 0.0003%	PASS	< 0.0003 %

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Kenneth L. Shafer

Date: 9/24/2001

QC Supervisor: Joan Plowman

Retest Date: 24 Month after shipment

LOT ANALYSIS ITEM: 655 POTASSIUM NITRATE, REAGENT (ACS)

LOT#: L346711

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min	PASS	99.7%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 4.5-8.5 @ 25C	PASS	5.8
4. Chloride 0.002%	PASS	<0.002%
5. lodate 0.0005%	PASS	<0.000 5%
6. Nitrite 0.001%	PASS	<0.001%
7. Phosphate 0.0005%	PASS	<0.000 5%
8. Sulfate 0.003%	PASS	<0.003%
9. Calcium 0.005%	PASS	<0.005%
10. Magnesium 0.002%	PASS	<0.002%
11. Heavy metals (as Pb) 0.0005%	PASS	<0.000 5%
12. Iron 0.0003%	PASS	<0.000 3%
13. Sodium 0.005%	PASS	<0.005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by:

Date: 3/28/2003

QC Supervisor: Joan Plowman

Retest Date: 24 Month after shipment

LOT ANALYSIS ITEM: 704 SODIUM BICARBONATE, REAGENT (ACS)

LOT#: P459685

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay (dried basis) 99.7-100.3%	PASS	99.9 %
2. Insoluble 0.015%	PASS	< 0.015 %
3. Chloride 0.003%	PASS	< 0.003 %
4. Phosphate 0.001%	PASS	< 0.001 %
5. Sulfur compounds (as SO4) 0.003%	PASS	< 0.003 %
6. Ammonium 0.0005%	PASS	< 0.0005 %
7. Calcium 0.02%	PASS	0.004 %
8. Magnesium 0.005%	PASS	< 0.001 %
9. Heavy metals (as Pb) 0.0005%	PASS	< 0.0005 %
10. Iron 0.001%	PASS	0.0001 %
11. Potassium 0.005%	PASS	< 0.003 %

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Kenneth L. Shafer

Date: 9/29/2004

QC Supervisor: Joan Plowman

Retest Date: 9/29/2009

LOT ANALYSIS

ITEM: 559 SODIUM NITRITE, REAGENT (ACS)

LOT#: P677335

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 97.0% min.	PASS	98.2%
2. Chloride 0.005%	PASS	<0.005%
3. Sulfate 0.01%	PASS	<0.01%
4. Calcium 0.01%	PASS	<0.001%
5. Heavy metals (as Pb) 0.001%	PASS	<0.001%
6. Iron 0.001%	PASS	<0.001%
7. Potassium 0.005%	PASS	<0.001%
8. Insoluble 0.01%	PASS	<0.01%
9. pH of 5% solution 5.5-8.3 @ 25 C	PASS	8.0
10. Appearance - White to pale yellow	PASS	pale yellow

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Jon Brandon Kennedy

Date: 7/31/2007

QC Supervisor: Joan Plowman

Retest Date: 8/2/2011

LOT ANALYSIS ITEM: 2454 SODIUM SULFATE, ANHYDROUS, POWDER, REAGENT (ACS)

LOT#: P785319

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	99.1%
2. pH of 5% solution @ 25C 5.2-9.2	PASS	6.0
3. Insoluble matter 0.01%	PASS	< 0.01%
4. Loss on ignition 0.5%	PASS	< 0.5%
5. Chloride 0.001%	PASS	< 0.001%
6. Nitrogen compounds (as N) 0.0005%	PASS	< 0.0005%
7. Phosphate 0.001%	PASS	< 0.001%
8. Calcium 0.01%	PASS	< 0.001%
9. Magnesium 0.005%	PASS	< 0.0005%
10. Heavy metals (as Pb) 0.0005%	PASS	< 0.0005%
11. Iron 0.001%	PASS	< 0.0001%
12. Potassium 0.01%	PASS	0.001%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Robert Kramer

Date: 1/31/2008

Retest Date: 9/17/2012

QC Supervisor: Joan Plowman

LOT ANALYSIS ITEM: 1078 SODIUM CHROMATE, TETRAHYDRATE, REAGENT

LOT#: P568182

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0-102.0%	PASS	100.9%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 8.0-9.5	PASS	9.1
4. Chloride 0.005%	PASS	<0.005%
5. Sulfate 0.01%	PASS	<0.01%
6. Aluminum 0.002%	PASS	<0.002%
7. Calcium 0.005%	PASS	<0.005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Nicholas E. Dangler

Date: 1/31/2008

QC Supervisor: Joan Plowman

Retest Date: 8/16/2010

LOT ANALYSIS ITEM: 1035 SODIUM PHOSPHATE, TRIBASIC, DODECAHYDRATE, REAGENT (ACS)

LOT#: P678823

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 98.0-102.0%	PASS	101.4 %
2. Excess alkali (NaOH) 2.5%	PASS	1.0 %
3. Insoluble 0.01%	PASS	< 0.01 %
4. Chloride 0.001%	PASS	< 0.001 %
5. Sulfate 0.01%	PASS	< 0.01 %
6. Heavy metals (as Pb) 0.001%	PASS	< 0.001 %
7. Iron 0.001%	PASS	< 0.001 %

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Kenneth L. Shafer

QC Supervisor: Joan Plowman

Date: 1/31/2008

Retest Date: 10/22/2011

LOT ANALYSIS ITEM: 705 SODIUM CARBONATE, ANHYDROUS, POWDER, REAGENT (ACS)

LOT#: P784287

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.5% min	PASS	99.99%
2. Insoluble 0.01%	PASS	<0.01%
3. Loss on heating at 285 C 1.0% max	PASS	<1.0%
4. Chloride 0.001%	PASS	<0.001%
5. Phosphate 0.001%	PASS	<0.001%
6. Silica 0.005%	PASS	<0.005%
7. Sulfur compounds (as SO4) 0.003%	PASS	<0.003%
8. Heavy metals (Pb) 0.0005%	PASS	<0.0005%
9. Iron 0.0005%	PASS	<0.0005%
10. Calcium 0.03%	PASS	<0.03%
11. Magnesium 0.005%	PASS	0.005%
12. Potassium 0.005%	PASS	<0.005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

,

Comment: Reported by: Joan Plowman

Date: 2/1/2008

QC Supervisor: Joan Plowman

Retest Date: 7/24/2012



Certificateof Analysis

Product Name Product Number Product Brand CAS Number Molecular Formula Molecular Weight	Cerium (III) nitrate hexahydrate 99% (metals basis) 238538 Aldrich 10294-41-4 Ce(NO3)3 · 6H2O 434.22	2,
TEST	SPECIFICATION	LOT 06 703CC RESULTS
APPEARANCE	MOIST WHITE TO OFF- WHITE CRYSTALS AND/OR	MOIST WHITE CRYSTALS
TITRATION	96.5% - 103.5% (OR 31.1% - 33.4% CE)	32.2% CE (COMPLEXOMETRIC)
TRACE ANALYSIS, ICP		В 192 РРМ;
		MG 11.4 PPM; CA 6.5 PPM
ICP ASSAY	CONFIRMS CERIUM COMPONENT.	CONFIRMS CERIUM COMPONENT
SOLUBILITY	5% IN H2O; CLEAR, COLORLESS SOLUTION	5% IN H2O; CLEAR, COLORLESS SOLUTION
PURITY	PURITY BASED ON TRACE METALS ANALYSIS	>99% BASED ON TRACE METAL ANALYSIS
QUALITY CONTROL ACCEPTANCE DATE		MARCH, 2004

Brasban Lopen

Barbara Rajzer, Supervisor Quality Control Milwaukee, Wisconsin USA

LOT ANALYSIS ITEM: 619 SODIUM FORMATE, REAGENT (ACS)

LOT#: P673902

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	99.6%
2. Insoluble 0.005%	PASS	<0.005%
3. Chloride 0.001%	PASS	<0.001%
4. Sulfate 0.001%	PASS	<0.001%
5. Calcium 0.005%	PASS	<0.0005%
6. Heavy Metals (as Pb) 0.0005%	PASS	<0.0005%
7. Iron 0.0005%	PASS	<0.0005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Joan Plowman

QC Supervisor: Joan Plowman

Date: 2/4/2008

Retest Date: 3/24/2011

EMD

Certificate of Analysis

EMD Chemicals Inc. 480 S. Democrat Road Gibbstown, NJ 08027 Phone 856-423-6300 Fax 856-423-4389

Name: Sodium Aluminate, Hydrated Technical Item Number: SX0275/3 Lot Number: 44281541

Formula: NaAlO2XH2O

Formula Wt: 81.97* Data Order No: 000089319

CHARACTERISTIC	REQUI	REMENT	RESULTS	UNITS
	Min.	Max.		
Assay (complexometric)	65.0		78.5	%
Colar		1	White	
Form			Granular powder	

fiele the liter

Charles M. Wilson, Quality Assurance Manager Release Date: 10/13/2004

EMD Chemicals Inc. (Formerly EM Science, A Division of EM Industries, Inc.) An Affiliate of Merck KGaA, Darmstadt, Germany



Certificate of Analysis Sodium meta-Silicate, 9-Hydrate, Crystal BAKER ANALYZED® Reagent

Product No. 3868 Lot No. V38144

Formula Na₂SiO₃9H₂O F.W. 284 20

Release Date 09/28/2001

II-STSPECIFICATIONRESULTAppearancePasses TestPasses TestChloride (CI)0.01 % max.< 0.005 %</td> Sulfate (SO4) 0.01 % max. 0.005 % Heavy Metals (as Pb) Iron (Fe) 0.001 % max. < 0.0005 % < 0.003 % 0.005 % max. The following information is derived from testing completed after the original Certificate of Analysis was prepared. The information was added 06/25/2004.

Assay

Country of Origin:

> Phillipsburg, NJ 9003 Paris, KY 9002 Mexico City, Mexico 9002 Deventer, Holland 9001 Kaala Lompor, Malaysia 9002

USA

In Meber

Director of Total Quality

96.4 %

J. T. Baker - A.D. Henkin of Mallinckrodt Baker, Inc. - 222 Red School Lane - Philippburg, NJ 06986 - Phone: 906-859-2151 - Fax: 900-859 8005

Information Only %



CertificateorAnalysis

Product Name Product Number Product Brand CAS Number Molecular Formula Molecular Weight	Glycolic acid solution, technical grade, 70 wt. % in H; 420603 Aldrich 79-14-1 HOCH ₂ COOH 76.05	0
TEST	SPECIFICATION	LOT 10915KD RESULTS
APPEARANCE	COLORLESS TO AMBER LIQUID	COLORLESS LIQUID
PROTON NMR SPECTRUM	CONFORMS TO STRUCTURE	CONFORMS TO STRUCTURE.
VENDOR INFORMATION	70.0%-72.0% TOTAL ACID AS GLYCOLIC ACID *	70.80% TOTAL ACID AS GLYCOLIC ACID *
	3 GARDNER COLOR (MAXIMUM) *	0.798% FORMIC ACID *
	<1% FORMIC ACID *	1 GARDNER (COLOR) *
	800 PPM SO4 (MAXIMUM) *	111.2 PPM SULFATES *
	6.0 NTU (MAXIMUM) *	TURBIDITY: 0.55 NTU *
	* DUPONT SPECIFICATION	PRODUCT OF DUPONT
	REVISED FEBRUARY 15, 2005 RJM	PRODUCT OF DUPONT
	* DUPONT SPECIFICATION	*SUPPLIER DATA
	REVISED FEBRUARY 15, 2005 RJM	*SUPPLIER DATA
QUALITY CONTROL		SEPTEMBER 2005

ACCEPTANCE DATE

Ararban Lojan

Barbara Rajzer, Supervisor Quality Control Milwaukee, Wisconsin USA

LOT ANALYSIS ITEM: 624 ACETIC ACID, GLACIAL, REAGENT (ACS)

LOT#: P780790

TEST	PASS/FAIL	NUMERICAL RESULT
1. Assay 99.7% min.	PASS	101.3%
2. Color (APHA) 10 max	PASS	< 10
3. Dilution Test Pass test	PASS	Passed Test
4. Residue after evaporation 0.001%	PASS	0.0002%
5. Acetic Anhydride 0.01%	PASS	< 0.01%
6. Chloride 0.0001%	PASS	< 0.0001%
7. Sulfate 0.0001%	PASS	< 0.0001%
8. Heavy metals 0.00005%	PASS	< 0.00005%
9. Iron 0.00002%	PASS	< 0.00002%
10. Substances reducing dichromate-Pass test	PASS	Passed Test
11. Substances reducing permanganate-Pass test	PASS	Passed Test
12. Titrable base 0.0004 meq/g	PASS	< 0.0004 meq/g

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Robert Kramer

Date: 2/4/2008

QC Supervisor: Joan Plowman

Retest Date: 2/12/2012

LOT ANALYSIS

LOT#: P678527

2. NIST Traceable	PASS	As Stated
1. pH (@ 25 C) 7.00 +/- 0.01	PASS	7.01
TEST	PASS/FAIL	NUMERICAL RESULT

TRACEABLE TO N.I.S.T. (Y/N)? Y

ITEM: 681 BUFFER SOLUTION, pH 7.00

Comment: Reported by: Robert Kramer

Date: 2/4/2008

QC Supervisor: Joan Plowman

Retest Date: 10/3/2008

LOT ANALYSIS ITEM: 682 BUFFER SOLUTION, pH 10.00

LOT#: P676271

2. NIST Traceable	PASS	As Stated
1. pH (@ 25 C) 10.00 +/- 0.01	PASS	10.01
TEST	PASS/FAIL	NUMERICAL RESULT

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment: Reported by: Nicholas E. Dangler

Date: 2/4/2008

QC Supervisor: Joan Plowman

Retest Date: 6/20/2008

ARES Chem

LOT ANALYSIS

ITEM: 920 ETHYLENE GLYCOL, REAGENT

LOT#: P783656

/ ×

	PASS/	NUMERICAL
TEST	FAIL	RESULT
1. Boiling range 194-200 C	PASS	194-200 C
2. Specific gravity @ 20 C 1.115-1.116 g/ml	PASS	1.1151
3. Acidity (CH3COOH) 0.01%	PASS	0.00005
1. Water 0.2%	PASS	0.014
5. Residue 0.005%	PASS	<0.005
5. Chloride 0.0005%	PASS	0.00001
7. Iron 0.00002%	PASS	<0.00002

TRACEABLE TO N.I.S.T. (Y/N)? N

Comment:

Reported by: Silaja Nacharaju C/A Print Date: 3/14/08

QC Supervisor: Silaja Nacharaju Quality Assured to Retest Point: 60 months from shipment

Not for direct use in food, cosmetic or pharmaceuticals. Consult warranty limitations at www.gfschemicals.com/terms.asp. For resale by GFS authorized distributors only.

•

LOT ANALYSIS

ITEM: 658 SODIUM NITRATE, REAGENT (ACS)

LOT#: P786671

TEST	PASS/ FAIL	NUMERICAL RESULT
1. Assay 99.0% min.	PASS	100.7%
2. pH of 5% solution 5.5-8.3 @ 25 C	PASS	6.2
3. Insoluble 0.005%	PASS	<0.005%
4. Chloride 0.001%	PASS	<0.001%
5. Iodate 0.0005%	PASS	<0.0005%
6. Nitrite 0.001%	PASS	<0.001%
7. Phosphate 0.0005%	PASS	<0.0005%
8. Sulfate 0.003%	PASS	<0.003%
9. Calcium 0.005%	PASS	<0.005%
0. Magnesium 0.002%	PASS	<0.002%
1. Heavy metals (Pb) 0.0005%	PASS	<0.0005%
2. Iron 0.0003%	PASS	<0.0003%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Robert KramerC/A Print Date: 3/19/08QC Supervisor: Joan PlowmanQuality Assured to Retest Point: 60 months
from shipmentNot for direct use in food, cosmetic or pharmaceuticals.
Consult warranty limitations at www.gfschemicals.com/terms.asp.
For resale by GFS authorized distributors only.

LOT ANALYSIS

ITEM: 559 SODIUM NITRITE, REAGENT (ACS)

LOT#: P786739

TEST	PASS/ FAIL	NUMERICAL RESULT
1. Assay 97.0% min.	PASS	99.1 %
2. Chloride 0.005%	PASS	< 0.005 \$
3. Sulfate 0.01%	PASS	< 0.01 %
4. Calcium 0.01%	PASS	< 0.001 %
5. Heavy metals (as Pb) 0.001%	PASS	< 0.901 %
6. Iron 0.001%	PASS	< 0.001 %
7. Potassium 0.005%	PASS	< 0.001 %
8. Insoluble 0.01%	PASS	< 0.01 %
9. pH of 5% solution 5.5-8.3 @ 25 C	PASS	7.4
0. Appearance - White to pale yellow	PASS	As Stated

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer C/A Print Date: 3/19/08 QC Supervisor: Joan Plowman

Quality Assured to Retest Point: 60 months from shipment

LOT ANALYSIS

ITEM: 619 SODIUM FORMATE, REAGENT (ACS)

LOT#: P673902

	PASS/	NUMERICAL
TEST	FAIL	RESULT
L. Assay 99.0% min.	PASS	99.68
2. Insoluble 0.005%	PASS	<0.005%
3. Chloride 0.001%	PASS	<0.001*
I. Sulfate 0.001%	PASS	<0.001%
5. Calcium 0.005%	PASS	<0.0005%
. Heavy Metals (as Pb) 0.0005%	PASS	<0.0005%
7. Iron 0.0005%	PASS	<0.0005%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Joan Plowman

C/A Print Date: 3/19/08

QC Supervisor: Joan Plowman Quality

Quality Assured to Retest Point: 60 months from shipment

LOT ANALYSIS

ITEM: 1078 SODIUM CHROMATE, TETRAHYDRATE, REAGENT

LOT#: P568182

TEST	PASS/ FAIL	NUMERICAL RESULT
1. Assay 99.0-102.0%	PASS	100.9%
2. Insoluble 0.005%	PASS	<0.005%
3. pH of 5% solution 8.0-9.5	PASS	9.1
4. Chloride 0.005%	PASS	<0.005%
5. Sulfate 0.01%	PASS	<0.01%
5. Aluminum 0.002%	PASS	<0.002%
7. Calcium 0.005%	PASS	<0.005%

TRACEABLE TO N.I.S.T. (Y/N) 7 Y

Comment:

Reported by: Nicholas E. Dangler C/A Print Date: 3/19/08

QC Supervisor:	Joan	Plowman	Quality	Assured	to	Retest	Point:	60 p	nonths
-			•					from	shipment

ARES Chem

LOT ANALYSIS

ITEM: 920 ETHYLENE GLYCOL, REAGENT

LOT#: P783656

s ^

	PASS/	NUMERICAL
TEST	FAIL	RESULT
1. Boiling range 194-200 C	PASS	194-200 C
2. Specific gravity @ 20 C 1.115-1.116 g/ml	PASS	1.1151
3. Acidity (CH3COOH) 0.01%	PASS	0.00005
4. Water 0.2%	PASS	0.014
5. Residue 0.005%	PASS	<0.005
6. Chloride 0.0005%	PASS	0.00001
7. Iron 0.00002%	PASS	<0.00002

TRACEABLE TO N.I.S.T. (Y/N)? N

Comment:

Reported by: Silaja Nacharaju C/A Print Date: 3/14/08 QC Supervisor: Silaja Nacharaju Quality Assured to Retest Point: 60 months from shipment

LOT ANALYSIS

ITEM: 658 SODIUM NITRATE, REAGENT (ACS)

LOT#: P786671

	PASS/	NUMERICAL
TEST	FAIL	RESULT
	THID	ALDODI
1. Assay 99.0% min.	PASS	100.7%
2. pH of 5% solution 5.5-8.3 @ 25 C	PASS	6.2
3. Insoluble 0.005%	PASS	<0.005%
4. Chloride 0.001%	PASS -	<0.001%
4. Chioride 0.0018	PASS	(0.0018
5. Iodate 0.0005%	PASS	<0.0005%
6. Nitrite 0.001%	PASS	<0.001%
7. Phosphate 0.0005%	PASS	<0.0005%
8. Sulfate 0.003%	PASS -	<0.003%
0. Buildle 0.003%	PADD	20.005%
9. Calcium 0.005%	PASS	<0.005%
10. Magnesium 0.002%	PASS	<0.002%
11. Heavy metals (Pb) 0.0005%	PASS	<0.0005%
12 Tron 0 00028		-0.0028
12. Iron 0.0003%	PASS	<0.0003%

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Robert KramerC/A Print Date: 3/19/08QC Supervisor: Joan PlowmanQuality Assured to Retest Point: 60 months
from shipmentNot for direct use in food, cosmetic or pharmaceuticals.

.

RPP-RPT-37505, Rev. 0

G F S CHEMICALS, INC. Columbus, Ohio 43222

.

LOT ANALYSIS

ITEM: 559 SODIUM NITRITE, REAGENT (ACS)

LOT#: P786739

TEST	PASS/ FAIL	NUMERICAL RESULT
1. Assay 97.0% min.	PASS	99.1 %
2. Chloride 0.005%	PASS	< 0.005 %
3. Sulfate 0.01%	PASS	< 0.01 %
4. Calcium 0.01%	PASS	< 0.001 %
5. Heavy metals (as Pb) 0.001%	PASS	< 0.001 %
6. Iron 0.001%	PASS	< 0.001 %
7. Potassium 0.005%	PASS	< 0.001 %
8. Insoluble 0.01%	PASS	< 0.01 %
9. pH of 5% solution 5.5-8.3 @ 25 C	PASS	7.4
10. Appearance - White to pale yellow	PASS	As Stated

TRACEABLE TO N.I.S.T. (Y/N)? Y

Comment:

Reported by: Kenneth L. Shafer QC Supervisor: Joan Plowman

C/A Print Date: 3/19/08

Quality Assured to Retest Point: 60 months from shipment

Potentiodynamic/Potentiostatic Polarization							
Test Information Form							
Project Name:	ARES		Project#:	8	81170134		
Test Type:	Cyclic Potentiodynamic Polarization		Date Start: 11/14107				
Specimen ID:	ELligb-54		Time Start: 12200pm				
Data Files:	OCP: ELIGO-SU-OCP. DTA						
	CPP: ELIGE-SU-OCP.DTA						
	l 						
Solution:	APIOS-PSr		osphere:		Nitrogen pu		
Temperature:	<u></u>		erence Electro	de:	SCE		
initial pH:	>13	Fina	al pH:		₽₿		
		$ \downarrow$					
Starting Potential:	Vvs. OCP		Reversal Potent		+	S. SCE	
Scan Rate:	0.17 mV/s	니브	inal Potential:		-0.10 ve	B. OCP	
Reverse Current	4.79 mA*						
Somela Longth			amula Diamat		0.48	cm	
Sample Length:	$\frac{7.18}{tc-79}$ cm ²		ample Diamet	BI.	10.00		
Sample Area:	4-79 cm ²						
ARES AY102 Solutio	on Batch ID: APIO5 - PSc Tracking#		68				
Potentiostat:	Barry Rot 600						
Potentiostat ID:	1437						
Totendostat ID.	143/-1						
Comments:							
Test Performed by:	Feng Gui		Home Pho	ne:	614-777-9	599	
Project Manager:	Sean Brossia				12		
Date end:	11/15/07		Time end:		13:00 Pi	<u>~</u>	

QA APPROVED

NAME: <u>Cloum</u> DATE: <u>4-18-08</u>

Potentiodynamic/Potentiostatic Polarization							
Test Information Form							
Project Name:	ARES		Project#:	31170134			
Test Type:	Cyclic Potentiodynamic Polarization		Date Start:	1			
Specimen ID:	ELIM6-60		Time Start:	[2:00P	<u>^</u>		
Data Files:	OCP: EL196-60 - 0 CP . DT		-				
	CPP: ELIGE-60-CPP-DT	A					
		-					
Solution:	Apios-pse		osphere:		Nitrogen purging		
Temperature:	<u> </u>	Refe	erence Electro	de:	SCE		
Initial pH:	>13	Fina	l pH:		>13		
Starting Potential:	- 0\ V vs. OCP		eversal Potent	tial:	V vs. SCE		
Scan Rate:	mV/s	F	inal Potential:		- 0.1 V vs. OCP		
Reverse Current	⊄`.78mA*						
Sample Length:	<u>3,17</u> cm	S	ample Diamete	er:	Old cm		
Sample Area:	<u>4-78</u> cm ²						
		_					
ARES AY102 Solutio	APIOS-PSC Pit on Batch ID: Trackingま、しる	3 					
Potentiostat:	Gamry Ref 600						
Potentiostat ID:	1437						
Comments:							
Test Performed by:	Feng Gui		Home Pho		614-777-9599		
Project Manager:	Sean Brossia			10.	014-111-0088		
Date end:	(2/04/27		Time end:		Buropm		
	<u>-/···/-</u>	1	I fillio olla.		12 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		

QA AP	PROVED
NAME:	Cldun
DATE:	4-18-08

Potentiodynamic/Potentiostatic Polarization							
	Test Information Form						
Project Name:	ARES		Project#:		81170135		
Test Type:	Potentiosto	5170	Date Start:	012/1	7/2007		
Specimen ID:	EL1196-63		Time Start:	12:	nopm		
Data Files:	OCP: ELII96.	63-0CP.mpr -63-PS.mpr					
	CPP: ELIG6	-63-PS.mpr					
		<u> </u>					
Solution:	APIOS-PSC	Atmosphere:			No purging		
Temperature:	<u>50 °C</u>	Reference Electrode			SCE		
Initial pH:	213	Final pH:					
Starting Potential:	Via OCD	Reversal Potentia			AI /A V vs. SCE		
Scan Rate:	AVA V vs. OCP	Final Potential:	<u>. </u>		V vs. OCP		
	11 111/5	Applied potential	for potentios	atic			
Reverse Current	<i>N</i> /A _{mA*}	test:	for potentioo		O V vs. SCE		
Sample Length:	3.18 cm	Sample Diameter			only cm		
Sample Area:	4-79 cm ²	Sample initial/fin	N/A N/Ag				
Solution Batch ID:		AP 105-PSC	PH>	13			
Potentiostat:	VMP3 568						
Potentiostat ID:	568						
Comments: Apivs-psc. pH >13.							
Test Performed by:	Fong Cru	ì	Home Pho	one <u>:</u>	<u> -225 - 229</u>		
Project Manager: Date end:	Sean Brossia 12/20/2017		Time end:		(2=vvp~		

ROVED
Idun
4-18-08

	Potentiod	vnamic/Potentie		tic Polarizati	ion		
Potentiodynamic/Potentiostatic Polarization Test Information Form							
Project Name:	ARES 2008			Project#:		1170135	
Test Type:	CPP			Date Start:	01/21/2	800	
Specimen ID:	#EL196-64			Time Start:	12200		
Data Files:	OCP: #ELIO	16-64 - OCP.	mp	ř			
Data Thes.		6-66-0P.					
	. – 1	- τ-					
Solution:	API05-PSZ		Atm	osphere:		Nitrogen purging	
Temperature:	50 .	<u>c</u>		erence Electro	de:	SCE	
Initial pH:	>13		Fina	al pH:		>13	
Starting Potential:	-01	V vs. SCE	- H-	Reversal Poten	tial:	V vs. SCE	
Scan Rate:	0.17	mV/s	L F	inal Potential:		Vvs. SCE	
Reverse Current	4.79	mA*				ļ	
						0-68 cm	
Sample Length:	3-18	cm		ample Diamet	er:	Crick cm	
Sample Area:	4.79	cm ²				l	
ARES AY102 Solutio	n Batch ID:	plor-psc 7 plb13		,			
Potentiostat:	OCP LVMP						
	1 - 10						
i otentiostat ib.	1300						
Comments:	revice w	as from	ed	using	n P	TFE	
tuping)	ection '						
				<u>. </u>		- 	
Test Performed by:	Feng Gui			Home Pho	ne:	614-777-9599	
Project Manager:	Sean Brossia	<u>.</u>		↓ ↓			
Date end:	01/22/200	<u>ð</u>		Time end:		4= sopm	
	1					•	

QA APPROVED

NAME: <u>Claun</u> DATE: 4-16-08

	Potentiodynamic/F	Potentios	tatic Polarizati	on	
		ormation			
Project Name:	ARES 2008		Project#	8	1170135
Test Type:	Potentiostatic @	Omuli	E Date Start:	101/23/2	2027
Specimen ID:	EL196-65		Time Start:	12:00	pm
Data Files:	OCP: EL1196-65	-ocp.	mpi		l
	ELIG6-6!	5 - ps.	mpr		
			•	· · ·	
Solution:	AP105- PSC		mosphere:		Nitrogen purging
Temperature:			eference Electroc	te:	<u>SCE</u>
Initial pH:	<u>>B</u>	· Fi	nal pH:		713
Starting Potential:	N/A VV	s. SCE	Reversal Potent	ial:	N/A V vs. SCE
Scan Rate:	NA	mV/s	Final Potential:		V vs. SCE
Reverse Current	· · · · · · · · · · · · · · · · · · ·	mA*			
Sample Length:	3-18	cm	Sample Diamete	ər:	0.48 cm
Sample Area:	6.80	cm ²	10 A.		
ARES AY102 Solutio	on Batch ID: APIOS-P	king #	76		
Potentiostat:	VMP3	·	··		
Potentiostat ID:					
<u> </u>					
Comments:	potentis sta	tre -	test-e	Omi	vs. sce
w/ap	rFE Tupà	1 50	petrin o	~\\$	Crevia
former					
Test Performed by:	Fena Gui		Home Pho		614-777-9599
Project Manager:	Sean Brossia				
Date end:	01/25/2002		Time end:		12=00Pin

DATE: <u>4-18-08</u>

	Potentio	lynamic/Potent			ion		
		Test Informat	ion Fo	orm			
Project Name:	ARES 2008	·		Project#:		31170135	
Test Type:	Bitcutiostatic @ OMV SEE Date Start: 1/31/08						
Specimen ID:	EL1196-66			Time Start:	A 11.00	<u> </u>	
Data Files:		6-66-0CP.r					
	2PP: EL 119	6-16- ps. r	npr				
			· ·			open aig	
Solution:	AP 105 - PS	C 175	Atmo	osphere:		Nitrogen purg	ing 🗡
Temperature:	60	°C	Refe	rence Electro		SCE	
Initial pH:	<u>} 13</u>	·	Final	pH: 13.4	L5		
			\downarrow				
Starting Potential:		V vs. SCE		eversal Poten		NA Vvs.	
Scan Rate:	NA	mV/s	Fi	nal Potential:		/A Vvs.	SCE
Reverse Current	·	mA*	┤┝			· ·	
<u> </u>	9 14		$ \vdash$			01 1 Gr	
Sample Length:	3018	<u>cm</u>		ample Diamet	:er:	0.48	cm
Sample Area:	4.80	cm ²					
		AP 105 - PS Tracking	# =				
Potentiostat:	UMP3					<u> </u>	·
Potentiostat ID:	1568						
rotentiostat iD.	1500						
Comments:	1 1 1 1	1 1		anali	119. 9	<u>~</u>	[
10	Len fitstat	re lest	æ	Onto	V3. 0	E	1
agebres Edi	s integace	ne lest on cpp	Sa	mple			
							<u> </u>
Foot Derfermed here	For Out			Liense Die		614 777 05	
Test Performed by: Project Manager:	Feng Gui Sean Brossia			Home Pho	one:	614-777-959	
			{			9:00 AN	
Date end:	&1A108			Time end:		HIN HIN)

QA APPROVED NAME: <u>Oldun</u> DATE: <u>4-14-08</u>

	Potentiodynamic/Potenti			ion		
	Test Informat	ion F	<u>orm</u>			
Project Name:	ARES 2008		Project#:	8/15108	31170135	
Test Type:	Potentiostatic @ Omv/	SCE	Date Start:			
Specimen ID:	EL 1196 - 74 2/16/08 AL		Time Start: 9:00 A M			
Data Files:	OCP. [EL 1196 72 OCP.	mpr	<u> </u>			
	CPP:					
		_			open air	
Solution:	AP105-PSC # 80	Atm	osphere:		Nitrogen purging	
Temperature:	50 °C	-	erence Electro	de:	SCE	
Initial pH:	13.52		ipH: 13、			
Starting Potential:	N/A Vvs. SCE		eversal Poten	tial:	NA VVS. SCE	
Scan Rate:	mV/s	-1 H	inal Potential:		V vs. SCE	
Reverse Current	nTA mA*	1 Ė				
		1 🗖				
Sample Length:		1 5	ample Diamet	er:	0.48 cm	
Sample Area:	20916 cm ²	1 🖻				
		1 1			L	
ARES AY102 Solutio	on Batch ID: PH 13,52					
Potentiostat:	VMP 3					
Potentiostat ID:	1568			· · ·		
Comments: Pote	18 hos (1/2 coupon	0	0 mV/	SCF		
		9			expose to	
OCP 100	18 hos (/2 Coupon	in	solu tion	3 2.5	min apen o	
0					1	
·						
Test Performed by:	Feng Gui		Home Pho	one:	614-777-9599	
Project Manager:	Sean Brossia					
Date end:	2 19/08		Time end:		11:00 AM	

QA APPROVED

NAME: <u>Claum</u> DATE: <u>4-14-08</u>

	Potent	iodynamic/Potenti	osta	tic Polarizati	ion	
		Test Informati				
Project Name:	ARES 2008			Project#:	8	1170135
Test Type:	Poten tioste	atic @ O-mv/s	SCÊ	Date Start:	2/15/08	
Specimen ID:	FL 196-1			Time Start:	9100 A N	0
Data Files	OCP: EL	1196-73 AT 2/15	10 %	·		
Data Flies.	CPP:					
	·					
Solution:	AP 105-	PSC# 99 pH 13,45	Atn	nosphere:	·	Nitrogen purging
Temperature:	50	°C	<u> </u>	erence Electro	de:	SCE
Initial pH:	19045			al pH: 13.2		
• • • • • • • • • • • • • • • • • • •					<i>4</i>	
Starting Potential:		V vs. SCE		Reversal Poten	tial:	ALA VVS. SCE
Scan Rate:	A+A	mV/s		inal Potential:		NA VVS. SCE
Reverse Current	- NA-	mA*				
Sample Length:	1.5	r cm		Sample Diamet	er:	0148 cm
Sample Area:	do	5886 cm ²				
	·					
ARES AY102 Solutio	on Batch ID:	AP-105 PSC PH 13.52	य ।	• 8 ₅₀ °		
Potentiostat:	VMP3					
Potentiostat ID:	1568					
Comments: Pote	n tio stat	ic test @ OCP for 1	0 a 1	my/SC	E	, ,
a corpore	(II)ESSION		U V	16.0 4	nm expo	se to air
		v				
•						
Test Performed by:	Feng Gui			Home Pho	one:	614-777-9599
Project Manager:	Sean Brossia					
Date end:	2/19/08			Time end:		11:00 A.M
				•		

QA APPROVED NAME: <u>cedum</u>

DATE: 4-14-08

Test Information FormProject Name:ARES 2008Project#:81170135Project Mame:CPPDate Start: $d \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$		Potentiod	ynamic/Potent	iostatic Pola	arizati	on			
Test Type: CPP Date Start: $d \ Molo \ g$ Specimen ID: $EL \ 1(9L - 75$ Time Start: $d \ Molo \ g$ Data Files: OCP : $EL \ 1(9L - 75$ OCP . MPROpen Air OPP : $BL \ 1(9L - 75$ OPP . OPP .Solution: $AP \ 105 - P3C \ \pm 79$ Atmosphere: $OPPM \ Air$ Temperature: $50 \ c$ $Reference Electrode:$ SCEInitial pH: 13.45 $CPP \ Reference Electrode:$ SCEStarting Potential: $-\sigma.1$ $Vs.SCE$ Scan Rate: $or.1 \ Vs.SCE$ Reversal Potential: $I \ Vs.SCE$ Sample Length: $1.60 \ cm$ $Sample Diameter:$ $0.4\% \ cm$ Sample Area: $d.41 \ cm^2$ $Sample Diameter:$ $0.4\% \ cm$ ARES AY102 Solution Batch ID: $AP \ 105 - P3C \ \pm 79 \ CPP \ fas \ d.73$ $Ide 73 \ cm$ Potentiostat: $CCP \ VmP \ 3 \ CPP \ fas \ d.73$ $Ide 73 \ cm$ Cornements: $\frac{1}{2} \ Cop \ mRe \ Sample Diameter:$ $Ide 73 \ cm$ $\frac{1}{2} \ Cop \ mN \ P3 \ cm \ Sample \ d.73 \ cm$ $Ide 73 \ d.73 \ d.$									
Test Type: CPP Date Start:d $AOOO's$ Specimen ID:EL 140 - 75OCP: IPL 140 - 75OCP: MPROPEM AIT:ITime Start:III.00 AITDate Files:OPEM AIT:OPEM AIT:Solution:Atmosphere:OPEM AIT:OPEM AIT:OPEM AIT:Temperature:SO< *C	Project Name:			Project	#:		8117013	5	_
Specimen ID: βL $119L - 75$ Time Start: 11.00 $6 m$ Data Files:OCP: βL $119L - 75$ OCP. mPROpen AirOpen AirSolution: AP $105 - PSC$ # 79Atmosphere:Nttrogen purgingTemperature: 50 °CReference Electrode:SCEInitial pH: $19:45$ Final pH: $19:90$ Starting Potential: -0.1 Vys. SCEScan Rate: 0.17 mV/sReverse Current 3.41 mA*Sample Length: 1.60 cmSample Length: 1.60 cmARES AY102 Solution Batch ID: $P105 - PSC$ # 49CT suckturing #t) $p14$ 13.45 Potentiostat: $0CP$ fas 413 Opten Air 13.45 134.7 Comments: 3 000 3 CPP fas 413 000 $1005 - PSC$ # 49CT suckturing #t) $p14$ $13.AS$ 134.7 Comments: 3 000 3 000 1000 3 000 1000 3 000 1000 3 000 1000 3 000 1000 44.7 1000 3 1000 44.1 0000 44.1 0000 3 00000 3 000000 44.1 $000000000000000000000000000000000000$	Test Type:	CPP							
Data Files:OCP.EL 114L-75OCP. mpRCPP: PL 114L-75 CPP . corrSolution: PP PL 114L-75 CPP . corrSolution: PP PL 114L-75 CPP . corrTemperature: 30 \circ Reference Electrode:Scan Rate: $0 \cdot 1$ $Vvs.SeE$ Scan Rate: $0 \cdot 1$ $Vvs.SeE$ Scan Rate: $0 \cdot 1$ $Vvs.SeE$ Scan Rate: $0 \cdot 1$ $Vvs.SeE$ Reverse Current $d.A1$ mA^* Sample Length: $1 \cdot 40$ cmSample Length: $1 \cdot 40$ cmSample Area: $d.A1$ cm^2 ARES AY102 Solution Batch ID: $P14$ $13.A5$ Potentiostat: OCP $VmP 3$ CPP fas $d.73$ CPP fas $d.73$ CPP fas $d.73$ CPP on 134.7 Comments: Vg $Oupo n$ Vg $Oupo n$ $mmersidnQPPonPax d.73CPPon134.7Comments:VgQupo nVgQupo nmmersidnQPPonPax d.73CPPonAft d.779599roject Manager:See BrossiaSee Berformed by:Feng Guiroject Manager:See BrossiaSee Berformed by:Feng GuiHome Phone:614.777.9599$	Specimen ID:	EL 1196-75	2	Time Start: 11.00 AM				-	
CHARTNOS:CPP: EL (19L - 45 CPP: COTTSolution:AP 105 - PSC # 99Atmosphere:Nthrogen purging:Temperature:90 °CReference Electrode:SCEInitial pH:19:45Final pH: 19:30SCEStarting Potential:-0.1 V vs. SCEReversal Potential:1 V vs. SCEScan Rate:0.17mV/sFinal pH: 19:30Starting Potential:-0.1 V vs. SCEReversal Potential:1 V vs. SCEScan Rate:0.17mV/sFinal Potential:-0.1 V vs. SCESample Length:1 · b0cmSample Diameter:0.4% cmSample Length:1 · b0cmSample Diameter:0.4% cmSample Area:d.41cm²Sample Diameter:0.4% cmARES AY102 Solution Batch ID:P1413.45134.7Potentiostat:CCPVMP 3CPPfas d.f3Potentiostat:CCPom VMP 3134.7Comments:1/2Qupo nimmersion1/2Qupo nimmersion134.7Comments:1/2Qupo nimmersion1/2Qupo nimmersion134.7Comments:1/2Qupo nimmersion1/2Qupo nimmersion104.777.9599cop onN/M 2.5104.777.9599104.04	Data Files	OCP: EL 1196	-75 OCP. W	IPR					
Solution:AP $\{05 - PSC \pm 49\}$ Atmosphere:Open airTemperature: $50 \ ^{\circ}C$ Reference Electrode:SCEInitial pH: 19.45 Final pH: 19.30 Starting Potential: -0.1 $Vvs.see$ Scan Rate: 0.14 mV/sReverse Current $d.41$ mA*Sample Length: 1.40 cmSample Length: 1.40 cmSample Area: $d.41$ cm²ARES AY102 Solution Batch ID: $P16 105 - PSC$ ± 49 CT sacking ± 1 Potentiostat: CCP $VWP 3$ CPPfas ± 13 Potentiostat: CCP $VWP 3$ CPPfas ± 13 Comments: $\frac{1}{2}$ $\frac{1}{2}$ $Qupo M$ immersion QCP $OM P3$ CPP $OM P3$ C	Data Files:	CPP: EL 119	- 15 CPP.	<u></u>			_		
Solution: $AP 05 - P3C # 79$ Atmosphere:Nthrogen purgingTemperature: 30 °CReference Electrode:SCEInitial pH: 13.45 Final pH: 13.30 Starting Potential: -0.1 V vs. SCEReversal Potential: 1 V vs. SCEScan Rate: 0.17 mV/sReversal Potential: 1 V vs. SCESample Length: 1.40 cmSample Diameter: 0.48 cmSample Length: 1.40 cmSample Diameter: 0.48 cmSample Area: $d.41$ cm² mA^2 Sample Diameter: 0.48 cmARES AY102 Solution Batch ID: $P14$ 13.45 $P24$ CT sacking #) $P14$ 13.45Potentiostat: CCP VMP 3 CPP fax $d.13$ $P24$ TComments: $\frac{1}{2}$ Gupo n immersion 124.3 124.3 Correndo stat ID: $IEV8$ $I24.3$ $I24.3$ CPP on VMP 3 CPP fax $d.13$ $I24.3$ CPP on Pax $d.73$ $P1000$ fax $d.73$ CPP on Pax $d.73$ $I0000$ for Manager:Sean Brossia $I00000$ for Manager:Sean Brossia $I00000$ for Manager:Starting Potential Provides $I00000$ for Pax $I00000$ Starting Potential Provides $I000000$ for Pax $I0000000$ Starting Potential Provides $I000000000000000000000000000000000000$							(DPe A	n a	ir.
Temperature: 30 "CReference Electrode:SCEInitial pH: $13: A5$ Final pH: $13: A5$ SCEStarting Potential: -0.1 $Vvs. SCE$ Reversal Potential: $1 Vvs. SCE$ Scan Rate: 0.1 'f'mV/sReversal Potential: -0.1 $Vvs. SCE$ Reverse Current $d. A1$ mA*Sample Length: -0.1 $Vvs. SCE$ Sample Length: $1 \cdot b0$ cmSample Diameter: 0.4 %cmSample Area: $d.41$ cm²Sample Diameter: 0.4 %cmARES AY102 Solution Batch ID:AP 105 - PSC# 49 CT sack ing #) $pi+ 13, A5$ $pi+ 13, A5$ Potentiostat:CCPVMP 3CPP fas $d+3$ 20 Comments: $\sqrt{2}$ Cupo n immersion $124 - 3$ $\sqrt{2}$ Cupo n immersion $124 - 3$ CPPon $Pa + 3 + 3$ 20 CPPon $Pa + 3 + 3$ Comments: $\sqrt{2}$ 0.000 $\sqrt{2}$ Cupo n immersion 0.021 </td <td>Solution:</td> <td>AP 105 - PS</td> <td>c #79</td> <td>Atmosphere</td> <td></td> <td></td> <td></td> <td></td> <td></td>	Solution:	AP 105 - PS	c #79	Atmosphere					
Initial pH: $13:A5$ Final pH: $13:A5$ CCP Starting Potential: -0.1 V vs. SCE Reversal Potential: 1 V vs. SCE Scan Rate: 0.17 mV/s Reversal Potential: 1 V vs. SCE Reverse Current $d.A1$ mA* Final PH: 2.01 V vs. SCE Sample Length: 1.60 cm Sample Diameter: 0.48 cm Sample Area: $d.A1$ cm² Sample Diameter: 0.48 cm ARES AY102 Solution Batch ID: $P105 - PSC$ # 49 $CT sack ung #)$ $p1+$ $13, A5$ Potentiostat: CCP CPP $Pas & 473$ $Dat 7$ Comments: $\frac{1}{2}$ $Oupo n$ $immerside M$ $Dat 7$ Correntiostat ID: 1568 1347 $Dat 7$ Corrents: $\frac{1}{2}$ $Oupo n$ $immerside M$ $Dat 7$ corrents: $\frac{1}{2}$ $Oupo n$ $immerside M$ $Dat 7$ corrents: $\frac{1}{2}$ $Oupo n$ $Pat 3 + 3$ $Dat 7$ coref on VIMP 3	Temperature:					le [.]			9.19
Starting Potential: -0.1 Vvs. SCEScan Rate: 0.1 $Vvs. SCE$ Reversal Potential: 1 $Vvs. SCE$ Reverse Current $d.41$ mA^* rmV/s Final Potential: -0.1 $Vvs. SCE$ Sample Length: 1.60 cm Sample Diameter: 0.48 cm Sample Area: $d.41$ cm^2 Sample Diameter: 0.48 cm ARES AY102 Solution Batch ID: AP $105 - PSC$ $# 49$ $CT sack/wg$ $#$ Potentiostat: OCP $VmP 3$ CPP fas $d.47$ Potentiostat: OCP $VmP 3$ CPP fas $d.47$ Comments: Vg $Oupo n$ immersion om Vg $Oupo n$ $immersion$ om $d.473$ Corr $Pha x d.73$ $d.73$ $d.473$	Initial pH:	13:45	<u> </u>					<u>.</u>	
Starting Potential: -0.1 $Vvs. See$ Reversal Potential: I $Vvs. Sce$ Scan Rate: 0.17 mV/s $Final Potential:$ I $Vvs. Sce$ Reverse Current $d.41$ mA^* $and *$ $and *$ Sample Length: $I \cdot b0$ cm $Sample Diameter:$ 0.4% cm Sample Area: $d.41$ cm^2 $Sample Diameter:$ 0.4% cm ARES AY102 Solution Batch ID: $AP \ 105 - PSC$ $# 49 \ Cloacking \ #)$ $pI4 \ 13. AS$ Potentiostat: $CCP \ VMP \ 3$ $CPP \ Pas \ 843$ $134 \ 3$ Potentiostat: $CCP \ VMP \ 3$ $CPP \ Pas \ 843$ $134 \ 3$ Comments: $d_2 \ 0 \ VMP \ 3$ $CPP \ Pas \ 843$ $134 \ 3$ Somments: $d_2 \ 0 \ VMP \ 3$ $CPP \ Om \ Pas \ 3 \ 7$ $104 \ 7$ Sean Brossia $Home Phone:$ $614-777.9599$ roject Manager:Sean Brossia $0 \ 0 \ 0 \ 0 \ 0$		1	mr.s	·			+		
Scan Rate: 0.17 mV/sFinal Potential: -0.1 V vs. SOEReverse Current $d.41$ mA*Sample Length: 1.60 cmSample Area: $d.41$ cm²ARES AY102 Solution Batch ID: $P105 - PSC$ $# 49$ $P17$ 13.45 Potentiostat: CCP $VMP 3$ CPP fas $# 13$ Potentiostat ID: 1668 1047 Comments: $VMP 3$ CPP $VarPar< 373CPPOMP 3CPPCPPOMP 3CPPCPPOMP 3CPPCPPOMP 3CPPCPPOMP 3CPPCPPOMP 3CPPCPPOMP 3CPPCPPOMP 3CPPCPPOMP 3CPPCPPOMP 3CPPCPPOM 7ar 373$	Starting Potential:	-0.1			Potent	ial:	1	V vs	SCF
Reverse Current d. 41 mA* Sample Length: $1 \cdot b0$ cm Sample Length: $1 \cdot b0$ cm Sample Area: $d. 41$ cm² ARES AY102 Solution Batch ID: AP 105 - PSC # 49 CToacking #) Pit 13, AS Potentiostat: OCP VMP 3 CPP fas & 43 Potentiostat ID: IE68 I34 3 Somments: 12 Qupo n immersibn 12 Qupo n immersibn Immersibn 13 Qupo n Immersibn Immersibn 13 Qupo n Immersibn Immersibn 13 Qupo n Immersibn Immersibn 10 Part of 3 Qupo n <td></td> <td>0.17</td> <td></td> <td></td> <td></td> <td></td> <td>-0.1</td> <td></td> <td></td>		0.17					-0.1		
Sample Length: $1 \cdot 60$ cmSample Diameter: 0.4% cmSample Area: $d.41$ cm^2 Sample Diameter: 0.4% cmARES AY102 Solution Batch ID:AP 105 - PSC# 49 CToacking #)Potentiostat:OCPVMP 3CPPfas $d.13$ Potentiostat ID:IE6%I34 3Comments: 3 CPPfas $d.13$ 20 oupon immersionCCPon VMP 3CPPon VMP 3CPPCPPon Pax $d.73$ est Performed by:Feng GuiHome Phone:Orget Manager:Sean BrossiaOutput Manager:Sean Brossia	Reverse Current	2. AI					1		
Sample Area: $d.41$ cm^2 ARES AY102 Solution Batch ID:AP 105 - PS C# 49 CT sacking #)Potentiostat:OCP VMP 3CPP fas d #3Potentiostat:OCP VMP 3CPP fas d #3Potentiostat ID:1868134 3Potentistat: $dupo n$ immersion M Coupo n immersion $cmP 3$ CPP on VMP 3 $cpP on Pax d # 3$ Comments: $dupo n restoredM Coupo n restoredrestored = 1000CPP on Pax d # 3restored = 1000CPP on Pax d # 3restored = 1000CPP on Pax d # 3restored = 1000COP Con Pax d # 3restored = 1000CPP on Pax d # 3restored = 10000CPP on Pax d # 3restored = 10000CPP on Pax d # 3restored = 100000CPP on Pax d # 3restored = 100000000000000000000000000000000000$		T	<u>.</u>				1		
Sample Area: $d.41$ cm^2 ARES AY102 Solution Batch ID:AP 105 - PS C# 49 CT sacking #)Potentiostat:OCP VMP 3CPP fas d #3Potentiostat:OCP VMP 3CPP fas d #3Potentiostat ID:1868134 3Potentistat: $dupo n$ immersion M Coupo n immersion $cmP 3$ CPP on VMP 3 $cpP on Pax d # 3$ Comments: $dupo n restoredM Coupo n restoredrestored = 1000CPP on Pax d # 3restored = 1000CPP on Pax d # 3restored = 1000CPP on Pax d # 3restored = 1000COP Con Pax d # 3restored = 1000CPP on Pax d # 3restored = 10000CPP on Pax d # 3restored = 10000CPP on Pax d # 3restored = 100000CPP on Pax d # 3restored = 100000000000000000000000000000000000$	Sample Length:	1.60	cm	Sample D	iamete	r:	0.4	8	cm
ARES AY102 Solution Batch ID:AP 105 - PS C $# 49$ CToacking $#$)Potentiostat:OCP VMP 3CPP fas $& 139$ Potentiostat ID:18681347Potentiostat ID:19681347Comments:12471/2Coupon immersionOCP on VMP3CPP on Par $& 173$ CPP on Par $& 173$ Home Phone:614-777-9599614-777-9599		2.41					1		
Potentiostat ID: 1868 1347 Comments: ½ Coupon immersion OCP on VMP3 CPP on Pax 273 est Performed by: Feng Gui roject Manager: Sean Brossia	ARES AT 102 Solutio	P Batch ID:	19.45						
Potentiostat ID: IB68 1347 Comments: ½ Coupon immersion OCP on VMP3 CPP on Pax 273 est Performed by: Feng Gui roject Manager: Sean Brossia	Potentiostat	TOUR VODE		CPP P		13			
Comments: 2 Oupoin immersion OCP on VMP3 OPP on Pax 273 est Performed by: Feng Gui roject Manager: Sean Brossia Comments: Sean Brossia Commersion Home Phone: 614-777-9599 Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Commersion Comm									
2 Oupon immersion OCP on VMP3 OPP on Pax 273 est Performed by: Feng Gui roject Manager: Sean Brossia Galage: Sean Brossia	Potentiostat ID.	1008				<u>۲</u>			
est Performed by: Feng Gui roject Manager: Sean Brossia									<u>.</u>
roject Manager: Sean Brossia			; 273	Hom			614-7	77-95	99
			· · · - · ·				+	11-00	
							- Q0. N	AM	

QA APPROVED NAME: <u>claun</u>

DATE: 4-14-08

	Potentiodynamic/Potent	iostatic Polarizat	tion		
	Test Informat				
Project Name:	ARES 2008	Project#:		1170135	
Test Type:	Potentiostic (e) o mu/	SCF Date Start:			
Specimen ID:	EL 196 - 70	Time Start:	12:00		
Data Files:	OCP: EL1196-76 OCP-M	IPR			
Data Files.	CPP:				
				open ais	
Solution:	AP 105 - PSC # 79	Atmosphere:		Nitrogen purging	
Temperature:	Room temperatore.	Reference Electro	ode:	SCE	
Initial pH:	130 45	Final pH: 13	16.		
		· · · · · · · · · · · · · · · · · · ·			
Starting Potential:	NA Vvs. SCE	Reversal Poter	ntial:	NA V vs. SCE	
Scan Rate:	mV/s	Final Potential		V vs. SCE	
Reverse Current	mA*	1			
Sample Length:	2.42 cm	Sample Diame	ter:	0.48 cm	
Sample Area:	3.65 cm ²				
	on Batch ID: PH 13.45				
Potentiostat:	ICCP VMP3	· · ·			
Potentiostat ID:	1568				
	· · · · · · · · · · · · · · · · · · ·				
Comments: Pol	entiostast @ c m	visce a	et Rom	temperature	
OCP f	entiostast @ c m os 18 has 7.6 mm	expose to	air at	room tempesar	
Test Performed hu	Eand Cui	Home Dh		614-777-9599	
Test Performed by:		Home Ph	one:	614-777-9599	
Test Performed by: Project Manager: Date end:	Feng Gui Sean Brossia 2) สรีเชว	Home Ph		614-777-9599	

ua api	PROVED
NAME:	Cldun
DATE:	4-14-08

			formatio		ic Polarizat			
Destant Marca		iest in	ormatio			F	81170135	
Project Name:	ARES 2008	totic Ta	100	vel	Project#:	802510		
Test Type: Specimen ID:	EL 1196 - 7		10 10	"art	Time Start:	11:00 A	m	{
	OCP: ELI		OCP.Y	me		1 1 1 00 1		
Data Files:	SPP: ELI	191-77 -	· Pe r	nor				
	I-DI JEFI	<u> </u>	10.	<u> </u>			open	NA
Solution:	AP 105 - F	SC A1	9-1	Atm	osphere:		Nitrogen pl	
Temperature:	50	• <u>°</u>	<u> </u>		rence Electro	ode:	SCE	
Initial pH:	13.45				1 pH: 13.3			
	1				•]
Starting Potential:	NA	V	vs. SCE	R	eversal Poter	ntial:		s. SCE
Scan Rate:			mV/s	F	nal Potential	:	<u> </u>	s. SCE
Reverse Current	N/A		mA*			_ <u>.</u>		
	ļ							
Sample Length:	1.28		_ <u>cm</u>	S	ample Diame	ter:	0.48	<u> </u>
Sample Area:	1.9	3	cm ²				_ _	<u> </u>
	VMP 3 1568							
Potentiostat: Potentiostat ID: Comments: Potention OCT	1568 entronsta	atic i 18 hi	at 1 os at	.00	mv V? 50°C	5 OCF	D Reoto	HOSIOE - BO .
Potentiostat ID: Comments: Pote OCI	1568 entionsta P gos imeasion	atic o 18 hr coupon	at 1 ss at 19.	.00 T ! (m	50°С 1т <i>е</i> хро	se to	air	
Potentiostat ID: Comments: Pote OC 2	1568 entronsta P gos imeosion Feng Gui	atic o 18 hr coupon	at 1 es at 19.	.00 T	mν VS 50 č 1m <i>e</i> ×ρο Home Ph	se to	air 614-777-5	
Potentiostat ID: Comments: Pote OCY /2 Fest Performed by: Project Manager:	1568 entronsta P foc imersion Feng Gui Sean Brossia	atic o 18 ho coupon	at 1 ss at 19.	.000 T 1 T 1 T	50°C	se to	ai'r 614-777-6)599 (č.
Potentiostat ID: Comments: Pote OCY Za Test Performed by: Project Manager:	1568 entronsta P gos imeosion Feng Gui	atic o 18 hr coupon	at 1 ss at 19.	.000 T	50°С 1т <i>е</i> хро	se to	air)599 (č.
Potentiostat ID: Comments: Pote OC 2	1568 entronsta P foo imession Feng Gui Sean Brossia Rias los	18 hr	19.	(m	BOC Im Expo Home Pho Time end	se to	ai'r 614-777-6)599 /%/
Potentiostat ID: Comments: Pote (OC) /2 Test Performed by: Project Manager: Date end: Set a value such that	1568 entronsta P foo imession Feng Gui Sean Brossia Rias los	18 hr	ss æt 19, ty is 1m	(m 	50 c 1 m expo Home Ph Time end 2; 2 2 2 2 2 2 2 2 2 2 2 2 2	se to one:	air 614-777-6 91.00 At	9599 (A) N
Potentiostat ID: Comments: Pote (OC) /2 Test Performed by: Project Manager: Date end: Set a value such that	1568 entronsta P foc imersion Feng Gui Sean Brossia Riag log the reversal c	18 hr	ss æt 19, ty is 1m	(m 	BOC IM EXPO Home Phy Time end 2; CAT	se to one: : :	air 614-777-6 9:00 Ar PROVED	9599 (A) N

	Poten	tiodynamic/Poten	tiosta	tic Polarizat	ion		
		Test Informa					
Project Name:	ARES 2008			Project#:		81170135	-1
Test Type:	Date Start: 3/3/08						
Specimen ID:	EL 1196-	81		Time Start: 11:00 BM			
Data Files:	OCP: FL	1196-81 OCp. 1	mpr				
Data Files.	CPP: EL						
						open ait	-1
Solution:	AP 105 - 1	3C # 81	Atm	osphere:		Nitrogen purging	
Temperature:	Room Tem			erence Electro		SCE	4
Initial pH:	13.38	100000		I pH: 13.0		+	
<u></u>	1	91910* 200 (9)(0*				<u>├</u> ───	
Starting Potential:	-0.1	V vs. See		eversal Poten	tial:	1 V vs. SC	FK
Scan Rate:	0.17			inal Potential:		- 0 1 V vs. SG	E o/
Reverse Current	1. 716	mA*					ΞPC
			-1 1-			1	
Sample Length:	3.17	cm		ample Diamet	er:		m
Sample Area:	4.71			anipio prantoti			<u> </u>
			- <u> </u> _		_		
ARES AY102 Solutio		Isacking		81 81			
Potentiostat:	VMP3	Pao 273 CCPP)				
Potentiostat ID:	1568	1347	· · ·				
	2P 100	18 his. op	nen	to air	r foll	coupon	
OC imates on	V	•			-		
OC imates on	V	•			-		
OC imates on	V	•			-		
OC imates on	V	18 his. op Pas 273			-		
OC imates on	V	•			-		
OC imates on	V	•			-		
OC imession CF	V	•			you im		
OC imession CF est Performed by:]	pp on	•		n au's	you im	ersi'on	

QA APPROVED NAME: <u>Cedun</u> DATE: <u>A-14-08</u>

Potentiodynamic/Potentiostatic Polarization										
· ·	Test Information Form									
Project Name:	ARES		Project#:	811	70135					
Test Type:	CPP		Date Start:	03/24/0	<u>8</u>					
Specimen ID:	#EL1196-89		Time Start:	1:00pm						
Data Files:		-89-000. mp	>r							
	CPP: HELIGH	-89-CPP. COI								
		· · · · · · · · · · · · · · · · · · ·								
Solution:	SY103-DIL	Atmosphere:			No purging					
Temperature:	'50 °C	Reference Electrode	<u>):</u>		SCE					
Initial pH:	<u>13t</u>	Final pH:			<u>B4</u>					
Starting Potential:	-o`l Vvs. OCP	Reversal Potentia			I V vs. SCE					
Scan Rate:		Final Potential:	<u></u>		<u>v vs.sce</u> • (Vvs.OCP					
Joan Mate.	0.17 mV/s	Applied potential	for potentiost		5 1 V VS. OCF					
Reverse Current	U.77 mA*	test:	tor potentioot		A Vvs.SCE					
			-							
Sample Length:	3-18 cm	Sample Diameter	:	Ú	<i>⊳-{C}</i> cm					
Sample Area:	4.77 cm ²	Sample initial/fination	al weight:	3.5	³⁰ g/ _ g					
	•									
	ARE	5 Sylo3-PI	-							
Solution Batch ID:	Tre	ctime # PT								
		10 P II 1 2 J								
Potentiostat:	VMP3 COCPS	DAR >>	31COPS							
Potentiostat ID:	1578									
	D0		7							
Comments: full	immersion				·					
full	(mmersion									
1										
				<u></u>						
Test Performed by:	tons Gui		Home Pho	ne:	77-9599					
Project Manager:	Sean Brossia				Q > 1 C = P =					
Date end:	03/27/28		Time end:		x=40Am					
	/									

QA APPROVED

NAME: Clotum

DATE: 4-14-08

	Potentiodyn	amic/Potentiostat	ic Polarization				
		est Information Fo					
Project Name:	ARES		Project#:		81170135		
Test Type:	CPP		Date Start:	03/2K/al			
Specimen ID:	#FUM6-90-		Date Start: D3/21/08 Time Start: (= 00 pm)		i vo pm		
Data Files:	OCP: #EUM	6-93-0CP. m	-90-0CP, mpr				
CPP: #EL496- 90 - Cpp. Cor							
Solution:	AWINS- DIL	1 A 4			N. purging		
Temperature:	50 °C	Atmosphere:			SCE		
Initial pH:	13+	Final pH:			134		
					<u> </u>		
Starting Potential:	Vvs. OCP	Reversal Potentia	al:		/ V vs. SCE		
Scan Rate:	017 mV/s	Final Potential:			Vvs. OCP		
Reverse Current	4-75 mA*	Applied potential test:	for potentiostati	с 	A V vs. SCE		
Sample Length:	> to cm	Sample Diameter			JEF cm		
Sample Area:	(-75 cm ²	Sample initial/fina			3.545/g/ g		
Solution Batch ID: ARES AW105-PIL Tracking#86							
Detentiontel	VIII COCO	OA(2273 (CPP	<u>.</u>			
Potentiostat: Potentiostat ID:	VMP3 (OCP)		12/17				
Potentiostat ID:	1568	C					
Comments: Juli	immersion						
Test Performed by:	Feng Gui		Home Phone):	->>2-9579		
Project Manager:	Sean Brossia						
Date end:	03/26/38		Time end:		8-Jo Ame		

	QA APPROVED
	NAME: <u>Cedum</u>
¢, '	DATE: 4-14-08

	Potentiodyr	amic/Potentiostat	tic Polarizati	on			
		est Information F					
Project Name:	ARES			81170135			
Test Type:	Potentiospotic	Potentionatic		03/27/08			
Specimen ID:	EL1196-91	EL1196-91		10×30m			
Data Files:		-91-00p. mpr					
	CPP						
<u></u>	1			quiescent			
Solution:	Apios-psc		Atmosphere:				
Temperature:	<u>., ro °C</u> 3+	1	eference Electrode:				
Initial pH:	157	Final pH:		13+			
Starting Potential:	MA Vvs. OCP	Reversal Potentia	al:	1/A V vs. SCE			
Scan Rate:	mV/s	Final Potential:		<u>/// V vs. OCP</u>			
Reverse Current	N/A mA*	Applied potential test:	for potentiost	atic D V vs. SCE			
Sample Length:	3.17 cm	Sample Diameter					
Sample Area:	0-48 cm ²	Sample initial/fin		3.1230 g/ g			
Solution Batch ID:	T	acking# : 8	ک				
Potentiostat: VMP3 Potentiostat ID: 1368							
Comments: Potentiostatic @ O mu us. SCE, quiescent, Johnour; Check weight WSS, half immension. O.81" expose of							
Check wè	ynt WSS , 0.81'	haif i exposed	immersi	· · · ·			
	0.81'	' exposed					
Test Performed by:	D.81'	hait exposed	im mer sin				
	0.81'	hait exposed		ne: ראך לילק			

NAME: <u>cedum</u> DATE: <u>4-14-08</u> ŧ

	Potentiod	ynamic/Potentiostat	ic Polarizati	on
		Test Information F		
Project Name:	ARES		Project#:	81170135
Test Type:	Dotentiester	n C	Date Start:	03/27/28
Specimen ID:	EL196-	92	Time Start:	10-gon m
Data Files:	OCP: ELII9	1-92-000. mpr		
	CPP:			
				_
Solution:	Apros-pse	Atmosphere:		quiescent
Temperature:	Roomec	Reference Electrode		SCE
Initial pH:	3+	Final pH:		131
	<u> </u>			
Starting Potential:			al:	- N/A V vs. SCE V vs. OCP
Scan Rate:	/V/A mV/		· · · · · · · · · · · · · · · · · · ·	Vvs. OCP
Reverse Current	N/A mA	Applied potential	for potentiost	atic to vs. OCP
TOTOLOG OUTAIL		<u>lest.</u>		VIS. BUE
Sample Length:	3.17 cm	n Sample Diameter	•	cm (
Sample Area:	\$\ 68 cm			g/ g
Solution Batch ID:	T	105-psc rackig#= 82	-	
Potentiostat:	VMP3			
Potentiostat ID:	1768			
	<u> </u>			
Comments: Pote	intio static	(a + siomer mersion, 5	vs. 00	p. roum T.
mascon			U Man	د
v	•	1		
0-	DT" Expos	(red		·]
	1.			1
Test Performed by:	tang En		Home Pho	ne: 172-9579
Project Manager:	Sean Brossia			
Date end:	\$\$/31/08		Time end:	g. Jon

AAAPPROVED
NAME: Cedun
DATE: 4-14-08

Sample Length: 3.17 cm Sample Diameter: 0.43 cm Sample Area: 4.7 6 cm ² Sample initial/final weight: 3.5295 g/ cm Solution Batch ID: AP105-PSC No NU2 ⁻ Potentiostat: VmP5 (OCP) Potentiostat ID: 151%		Potentiody	namic/Potentiosta	tic Polarizati	on		
Test Type: CPP Date Start: $Odd/st/gl Specimen ID: #EU196-93 Time Start: 3 \cdot Cep^m Data Files: OCP: #EU196-93 Time Start: 3 \cdot Cep^m Data Files: OCP: #EU196-93 OCP. mPr Repertence Prove Manager: 3 \cdot Cep^m 3 \cdot Cep^m No Nitrite, 3 \cdot Sfm Nitrite, 3 \cdot Cep^m Solution: PP: No Nitrite, 3 \cdot Sfm Initial pit: +13 Final Potential: No Scen Starting Potential: - 0.1 V vs. OCP Reversal Potential: V vs. SCE Starting Potential: - 0.1 V vs. OCP Final Potential: V vs. SCE Reverse Current 4.7 6 mA* Est: V vs. SCE Sample Length: 3.17 cm Sample Diameter: 0.4C# cn Sample Area: 4.7 1 cm² Sample Diameter: 0.4C# cn Solution Batch ID: Troc King #1 87 3.85 m No5 Pr1 13* Potentiostat: VmP3 (CCP > Potential: 777-95?9 Somments: Sea Brossia Home $							
Specimen ID: #EU196-93 Time Start: 3× 0 a pm Data Files: OCP: #EU196-93 - OCP. mpr Mo Nitrite, 5.85 M Nitreta Solution: AP195-PSC Atmosphere: Nitrite, 5.85 M Nitreta Nitritea Solution: AP195-PSC Atmosphere: Nitritea Science Initial pH: +13 Final pH: Image: Science Science Starting Potential: - 0.1 V vs. OCP Reversal Potential: - 0.1 V vs. Science Scan Rate: 0.1 mV/s Reversal Potential: - 0.1 V vs. OCP Starting Potential: - 0.1 V vs. OCP Reversal Potential: - 0.1 V vs. OCP Starting Potential: - 0.1 V vs. OCP Reversal Potential: - 0.1 V vs. OCP Starting Potential: - 0.1 V vs. OCP Reversal Potential: - 0.1 V vs. OCP Starting Potential: - 0.1 V vs. OCP Sample Dotential for potentiostatic V vs. Science Sample Length: 3.17 cm Sample Diameter: 0.02 for -0.1 Vs. Science Solution Batch ID: ISA Trac Kring # 87 3-85 m N03 Pr1 13 for Potentiostat: VMP3 (CCP) -	Project Name:			Project#:			
Data Files: OCP: $\pm ELI196-93 = 0CP.$ mpr No Nitrite. 3.85M Nitrite. Solution: P105-P5C Atmosphere: N. Spare Initial pH: ± 13 Final pH: Science Science Science Starting Potential: -0.1 Vvs. OCP Reversal Potential: 1 Vvs. Science Vvs. Science Vvs. Science Scan Rate: 0.1 Vvs. OCP Reversal Potential: -0.1 Vvs. OCP Reversal Potential: -0.1 Vvs. OCP Sample Length: 3.17 cm Sample Diameter: $0.4C3$ cm Solution Batch ID: $Troc I Cring #1 g ? 3.87 M N_3^{-1} Pr1 13 \pm 13 + 13 + 13 + 13 + 13 + 13 + 13 $				Date Start:	O₹4,/	अ/of	
Volume	Specimen ID:				3.4	copm	
Solution: AP 195-PSC Atmosphere: N1 Spare Temperature: C0 °C Reference Electrode: SCE Initial pH: +13 Final pH: SCE SCE Starting Potential: -01/Vvs. OCP Reversal Potential: 1 Vvs. SCE Starting Potential: -01/Wvs. OCP Reversal Potential: -01/Vvs. OCF Scan Rate: 01/7 <mv s<="" td=""> Final Potential: -01/Vvs. OCF Reverse Current 4/3 f mA* Eest: Vvs. SCE Sample Length: 3/17 cm Sample Diameter: 0 0 Sample Area: 0/1 / cm² Sample Initial/final weight: 3/5215 g/ cm Solution Batch ID: Trocking #1 & 7 3-85 m. N05 Pr1 13* Potentiostat: V/mp3 (0CP) Potentiostat: Solution Potential: 7/2-9.57.9 Potentiostat ID: 15/8 Solution Solution Potential: 7/2-9.57.9 Potentiostat ID: 15/8 Solution Solution Solution Solution Solution Batch ID: 15/8 Solution Solution Solution</mv>	Data Files:	CPP:					
Temperature: Co °C Reference Electrode: SCE Initial pH: +13 Final pH: +13 Final pH: 1 Vvs. SCE Starting Potential: -01/Vvs. OCP Reversal Potential: 1 Vvs. SCE Scan Rate: 01/7 mV/s Reversal Potential: -01/Vvs. OCF Reverse Current 4/7 6 mA* Final Potential: -01/Vvs. OCF Sample Length: 3/17 cm Sample Diameter: 0.463 cm Sample Area: 0/2/6 cm² Sample Initial/final weight: 3.5215 g/g/g/g/g/g/g/g/g/g/g/g/g/g/g/g/g/g/g/		No.	Narite, 3.851	V NHALL			
Initial pH: -+13 Final pH: Starting Potential:			Atmosphere:			N ₂ S	pare
Starting Potential: - • 1 V vs. OCP Scan Rate: • 1 mV/s Scan Rate: • 1 mV/s Reverse Current 4.7 6 mA* Sample Length: 3.17 cm Sample Length: 3.17 cm Sample Length: 3.17 cm Sample Length: 3.17 cm Sample Area: 4.7 6 cm² Sample Diameter: 0.428 cm Solution Batch ID: Applo5- PSC Troc I <ing #1="" g?<="" td=""> 3.85 m NU3⁻ Potentiostat: VMP3 (0CP) Potentiostat: VMP3 (0CP) Potentiostat ID: 15/2 Comments: 15/2</ing>			Reference Electrod	a:		SCE	
Scan Rate: 0.17 mV/s Final Potential: -0.1 V vs. OCF Reverse Current 4.7 6 mA* Applied potential for potentiostatic V vs. SCE Sample Length: 3.17 cm Sample Diameter: 0.428 cm Sample Area: 4.7 6 cm² Sample Diameter: 0.428 cm Sample Area: 4.7 6 cm² Sample initial/final weight: 3.5215 g/ c Solution Batch ID: API05-PSC NO NU2 Pri 13+ Potentiostat: V MP3 (0CP) Pri 13+ 2.85 M Pri 13+ Potentiostat: V MP3 (0CP) Potentiostat ID: 15/4 Comments: Issue Com Home Phone: 777-9.51 %	Initial pH:	+13	Final pH:				
Scan Rate: 0.17 mV/s Final Potential: ,1 V vs. OCF Reverse Current 4.7 6 mA* Applied potential for potentiostatic V vs. SCE Sample Length: 3.17 cm Sample Diameter: 0.428 cm Sample Area: 4.7 6 cm² Sample Diameter: 0.428 cm Sample Area: 4.7 6 cm² Sample initial/final weight: 3.5215 g/ c Solution Batch ID: APIoS-PSC NO NU2 ⁻ Pri 13 ⁺ Potentiostat: V MP3 (0CP) Pri 13 ⁺ 3.85 M Pri 13 ⁺ Potentiostat: V MP3 (0CP) Potentiostat: 2.527.9 J Comments: 15/4 Image: Sean Brossia Home Phone: 777-9.57.9 J	Starting Detertic					<u> </u>	
Reverse Current 4.7 6 mA* Applied potential for potentiostatic V vs. SCE Sample Length: 3.17 cm Sample Diameter: 0.4C# cm Sample Area: 4.7 6 cm² Sample initial/final weight: 3.5295 g/ c Solution Batch ID: Appliod potential for potentiostatic V vs. SCE Potentiostat: V/V.p3 (2CP) NO NU2 ⁻ Potentiostat: V/MP3 (2CP) Potentiostat ID: 15/4 Comments: Home Phone: 772-9.51 9 Project Manager: Sean Brossia				ar:			
Sample Area: (L_2) cm² Sample initial/final weight: $3 \cdot 5^2 15 \text{ g/}$ g Solution Batch ID: $(AP_1) \cdot 5^- PS^ N \circ N \cdot U_2^-$ Trocking #1 & 7 $3 \cdot 85 \text{ m} \cdot N \cdot y_3^ Pri \cdot 13^+$ Potentiostat: $V \cdot MP_3 \in OCP_3$ $Potentiostat ID:$ $15 \cdot k_2^-$ Comments: $V \cdot MP_3 \in OCP_3$ $Pri \cdot 13^+$ Potentiostat: $V \cdot MP_3 \in OCP_3$ $Pri \cdot 13^+$ Potentiostat ID: $15 \cdot k_2^ 15 \cdot k_2^-$ Comments: $V \cdot MP_3 \in OCP_3$ $Pri \cdot 13^+$ Potentiostat ID: $15 \cdot k_2^ 15 \cdot k_2^-$ Comments: $V \cdot P_3 \in OV_3^-$ Home Phone: $777 - 9 \cdot 57$ Project Manager: Sean Brossia $V \cdot P_3 = V \cdot P_3 \cdot P_3 \cdot P_3$ $V \cdot P_3 = V \cdot P_3 \cdot P_3 \cdot P_3$	Reverse Current		Applied potential	for potentiost	atic		
Sample Area: $(4.)$ cm² Sample initial/final weight: 3.5215 g/ g Solution Batch ID: $(AP) \circ 5 - PSC$ $N \circ NU^2$ $Pri 13^+$ Solution Batch ID: $Troc King #1 & 7$ $3.85 m NU^2$ $Pri 13^+$ Potentiostat: $VmP_3 (CCP)$ $VmP_3 (CCP)$ Potentiostat ID: $13h$ Comments: $VmP_3 (CCP)$ Potentiostat: $VmP_3 (CCP)$ Potentiostat ID: $13h$ Potentiostat: $VmP_3 (CCP)$ Potentiostat: $VmP_3 (CP) = 0.577 - 9.579$	Sample Length:	3.17 cm	Sample Diameter			63.0	
Solution Batch ID: AP105-PSC NO NU2 Tracking # 87 3-85 m NU3 Pr1 13+ Potentiostat: VMP3 (OCP) Potentiostat ID: 13/2 Comments: Isla Test Performed by: F=Enc. Project Manager: Sean Brossia	Sample Area:		Sample initial/fin	al weight:		3-5295 0/	
Potentiostat ID: 151% Comments: est Performed by: デモルミー Cかく: Home Phone: フラフータックタ	Solution Batch ID:	Tro		3-85 M	n Nog	- pri	13+
Comments: est Performed by: デモルミ Cかく: Home Phone: フラフータックタ Project Manager: Sean Brossia	Potentiostat:	VMPS (OCP	<u> </u>	·			
rest Performed by: Files Cかく Home Phone: ファータックタ	Potentiostat ID:	1568					
Project Manager: Sean Brossia	Comments:						
				Home Pho		9-26	599
				nome Pho			- 11

·.,

QA APPROVED

NAME: <u>Claun</u> DATE: <u>4-14-08</u>

1	Poter	ntiodyn	nar	nic/Potentiostat	ic Polarizati	ion		_
				t Information Fo				
Project Name:	ARES				Project#:	1	31170135	
Test Type:	CPP				Date Start:	119108		
Specimen ID:	# EL 119	6-98			Time Start:	13.00		
Data Files:	OCP: 🔭	FL 119	16	-98 . mpr coop	·)			
	CPP: EL	1196-	90	BCPP . DAR DT	A AK A	111108		
<u> </u>	140105.0	10	1.00	t/			N. Por	nin
Solution:	50 °C	ked size		tmosphere:			<u> </u>	4
Temperature: Initial pH:	13+		+	eference Electrode	<u>ः</u> ३१ —		SCE 13t	
	- 10	_		inalipH: 1	<u> </u>		1.5.	
Starting Potential:	-0,1 VV	s. OCP		Reversal Potentia	d:		V vs.	SCE
Scan Rate:	0.17	mV/s		Final Potential:			-0: V vs.	OCP
Reverse Current	4.76	mA*]	Applied potential	for potentios	atic test:	V vs.	SCE
Sample Length:	3017	cm		Sample Diameter:	<u> </u>		0.48	cm
Sample Area:	4.76	cm ²	а. С	Sample initial wei	ght:		3.5230	g
Solution Batch ID:		Toac		5 Mixed Sul mg #89	PH 7 13			
Potentiostat:	VMP 3	(OCP)	5		HINCOS HOCCPR) Gar	N \$24	
Potentiostat ID:	11568	00.				140		
Comments:	l immers	ion			·			
Test Performed by:	Amnoyporn				Home Pho	Dne:	614-889-75	
Test Performed by: Project Manager:	Amnoyporn I Sean Brossia				Home Pho	one:	614-889-75	980

QA APPROVED NAME: <u>Cedun</u>

DATE: 8-7-08

		Test Information Form	
Project Name:	ARES	Project#:	81170135
Test Type:		C @ O MV VS SCE Date Start:	4/11/08
Specimen ID:	EL 1196-99	Time Start:	<u>1:00 PM</u>
Data Files:	OCP: EL 1196	99 OCP. Mpr	
	CPP: EL 1196	-99 PS. mpr	
Solution:	AP-105 PSC # 90		N2 at ha
Temperature:	50 °C	Reference Electrode:	SCE
Initial pH:	19.10	Final pH: 13,47	
Starting Potential:	UII Vvs. OCP	Reversal Potential:	NUA VVS. SCE
Scan Rate:	N/A mV/s		V vs. SCE V vs. OCF
		Applied potential for potentiost	atic
Reverse Current	N/A mA*	test:	<u> </u>
	· ·		· · ·
Sample Length:	1.52 cm		0:48 cm
Sample Area:	<u>4.3 cm²</u>	Sample initial/final weight:	3.5A3 g/ g
- - F	18 hos oc Ditentiostati	Usiging above head space P C Q O MV 50 h OM 16.5 mm expose to a	55
Test Performed by: Project Manager: Date end:	Noy Relievy Sean Brossia 41/8/08		
Set a value such that	it the reversal curren	nt density is 1mA/cm ² ;	
		Originia prolos with	the state of the set
r Coordsion P	'soduct pluck	lugging probe wh	in phisney

NAME: Cloum

DATE:___

8-2-08

· · · · · · · · · · · · · · · · · · ·	Potentiodyn	amic/Potentiostat	ic Polarizati	on	· _ · · · · · · · · · · · · · · · · · ·
-		est Information F		<u> </u>	
Project Name:	ARES		Project#:	8	1170135
Test Type:	CPP		Date Start:	415108	
Specimen ID:	EL 1196-100		Time Start:	1:00 PM	
Data Files:	OCP: EL 1196-1	DO. OCP. DAA A	+X Alistos		
Data Flies:	CPP: FL 196.	100 CPP. DTA			
· ·					
Solution:	Evaporate Superal	Atmosphere:			N ₂
Temperature:	60 °C	Reference Electrode			SCE
Initial pH:	14	Final pH: 14,	05		
Starting Potential:	- 0 • V vs. OCP	Reversal Potentia	al:		V vs. SCE
Scan Rate:	0.17 mV/s	Final Potential:]	-0.1 V vs. OCP
Reverse Current	4076 mA*	Applied potential	for potentiost	atic test:	N/A V vs. SCE
			<u></u>		
Sample Length:	3.14 cm	Sample Diameter	•		0-48 cm
Sample Area:	4076 cm ²	Sample initial we			3.527 g
		····	<u>.</u>		
Solution Batch ID:	PH	posate Super 12	nate 180	acking :	NK 4/16/08
Detentiontet:	(OCP) Games		p) Gamey		
Potentiostat:	1408	(0)	LAON -	<u> </u>	
Potentiostat ID:	1400		400		
Comments: Full	immesion; (OCP 100 18 h	185.		
CP	P @ ± 0.	I VS EOC	QA	APPRO	VED
			NAM	E: Clau	~~
			-	E: 8-7)-69
			DAT	E	
Test Performed by:	Amnoyporn Kelley		Home Phe	one:	614-889-7980
Project Manager:	Sean Brossia				
Date end:	A117/08		Time end	:	31.00 PM

- Solution Cloundy when start experiment but turn clear after our ocp Ores night (Top part) - when finish own CPP saturated chemical settle down in the bottom of the cell

	Potentiodyn	namic/Potentiosta	tic Polarizat	ion		
		Fest Information F	orm			
Project Name:	ARES		Project#:	8	1170135	
Test Type:	CPP		Date Start:	4117108		
Specimen ID:	EL1196-101		Time Start:	2:00 PI	η	
Data Files:	OCP: FL 1196 -1	of OCP. DTA				
	CPP: EL 1196.	101 CPP.DTA				
Solution:	AP LOS #86	Atmosphere:			Nai	n sol
Temperature:	Room °C	Reference Electrod			SCE	<u>v 34</u>
Initial pH:	13.95	Final pH:	ie		13,50	
	12/13					
Starting Potential:	-01 Vvs. OCP	Reversal Potenti	ial:		t Vvs.	SCE
Scan Rate:	0.17 mV/s				-0, (V vs.	OCP
Reverse Current	4.76 mA*	Applied potentia	al for potentios	tatic test:	V vs.	SCE
Sample Length:	3.17 cm	Sample Diamete	r:		0.48	cm
Sample Area:	4.76 cm ²	Sample initial w	eight:		8.5393	g
Solution Batch ID:	Ap	105 PSC TO		187 3	85 M N	
	Ap	· · · · ·		187 3	85 M N	
Solution Batch ID:	Ар РН	105 PSC Tro 19.95	ncking *	*87 3	85 M N	
Solution Batch ID: Potentiostat:	AP PH OCP Gamey	105 PSC TO	acki'ng # Gamsy	*87 9	85 M N	
Solution Batch ID:	Ар РН	105 PSC Tro 19.95	ncking *	*87 9	85 M N	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full	AP PH OCP Gamey 1408 immesib41	105 PSC Tro 19.95	acki'ng # Gamsy	*87 9	85 M N	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full	AP PH OCP Gamey 1408	105 PSC Tro 19.95	acki'ng # Gamsy	*87 9	85 M N	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full	AP PH OCP Gamey 1408 immesiban immesiban	105 PSC Tro 19.95	acki'ng # Gamsy	*87 9	85 M N	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full - OCP	AP PH OCP Gamey 1408 immesiban immesiban	105 PSC Tro 19.95	acki'ng # Gamsy	*87 9	85 M N	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full - OCP	AP PH OCP Gamey 1408 immesiban immesiban	105 PSC Tro 19.95	acki'ng # Gamsy	*87 9	85 M N	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full - OCP	AP PH OCP Gamey 1408 immesiban immesiban	105 PSC Tro 19.95	acki'ng # Gamsy	*87 9	85 M N	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full - OCP	AP PH OCP Gamey 1408 immesiban immesiban	105 PSC Tro 19.95	acki'ng # Gamsy	*87 9	85 M N	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full - OCP	AP PH OCP Gamey 1408 immesiban immesiban	105 PSC Tro 19.95	acki'ng # Gamsy		85 M N	Tsai
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full - OCP - CP	AP PH OCP Gamey 1408 immesiban 18 his. P	105 PSC Tro 19.95	Camsy 608			* tsair

No cossosion product

QA APPROVED NAME: Cedur

DATE: 8-7-08

· · · · · · · · · · · · · · · · · · ·	Potentiodyn	amic/Potentiostat	ic Polarizati	on	
		est Information F			
Project Name:	ARES		Project#:	8	1170135
Test Type:	CPP		Date Start:	4/18/08	5
Specimen ID:	FL 1196-102		Time Start:	10:00 A	<u>γη</u>
Data Files:	OCP: FL 1196-				
	CPP: EL 1196 -	IDA CPP.DTA			
Solution:	AP los psc	Atmosphere:			open to air
Temperature:	50 °C	Reference Electrode	»:		SCE
Initial pH:	19.18	Final pH:			13.20
Starting Potential:	-0-1 V vs. OCP		al:		1.0 V vs. SCE
Scan Rate:	0:17 mV/s	Final Potential:			-O.I V vs. OCP
Reverse Current	mA*	Applied potential	for potentiost	atic test:	N/A V vs. SCE
		 	<u> </u>		A. 11 12
Sample Length:	3.17 cm	Sample Diameter	•		0.4 8 cm
Sample Area:	A.76 cm ²	Sample initial we	ight:		3.524 g
Solution Batch ID:	рн	105 - PSC; it	acking	4 9 <i>0</i>	
·	AX 4/1810				. <u> </u>
Potentiostat:	OCP NINP3		CPP GO		
Potentiostat ID:	<u> </u>	568	140	<u> </u>	
Comments: - Full	immession				
- OC	CP 18 hrs				
- C	PP				
		· · · · · · · · · · · · · · · · · · ·			
Test Performed by:	Amnoyporn Kelley		Home Pho	one:	614-889-7980
Project Manager:	Sean Brossia				
Date end:	4/21108		Time end:		\$100 AM

QA APPROVED NAME: <u>Cedum</u> DATE: <u>8-7-00</u>

	Potentiody	namic/Potentiostatic Polariza	tion	
		Test Information Form		
Project Name:	ARES	Project#:		81170135
Test Type:	CPP	Date Start:	517/08	
Specimen ID:	EL 1196-103		9:00 AN	<u>າ</u>
Data Files:	OCP: EL1196	-103 OCP.mpr		
Data Files.	CPP: E1 1196	-103 CPP. DTA		
Solution:	AZ 102 PI+12	Atmosphere:		Na Rogi
Temperature:	77 °C	Reference Electrode:		
Initial pH:	12.25	Final pH:		12.16
Starting Potential:	-0:1 V vs. OCP	Reversal Potential:		V vs. SCE
Scan Rate:	0.17 mV/s			- 0- 1 V vs. OCP
Reverse Current	4:76 mA*	Applied potential for potentio	static test:	N/A Vvs. SCE
<u> </u>				
Sample Length:	3017 cm			0.48 cm
Sample Area:	1.76 cm ²			1 % 144
Solution Batch ID:	A	Z 102 Tracking #	93 6	9,533 g
	A		93 6	
Solution Batch ID:	A (E	z 102 Tracking # 0H 12.25)	93 p	
Solution Batch ID:	A (E OCP VMP3	Z 102 Tracking # OH 12.25) CPP Gamry	93 0	
Solution Batch ID:	A (E	z 102 Tracking # 0H 12.25)	93 (
Solution Batch ID: Potentiostat: Potentiostat ID:	A (F OCP VMP3 1568	Z 102 Tracking # OH 12.25) CPP Gamry		DH 18
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: Full At 77°C	A (F OCP VMP3 1568 immed Sion end off CPP	Z 102 Tracking #)H 12.25) <u>CPP Gambey</u> 1408 , OCP Jos 18 his	and the	DH 18

QA APPROVED NAME: <u>Claun</u> DATE: <u>8-2-06</u>

	Potentiodyn	amic/Potentiostat	ic Polarizati	on		
	T	est Information Fo	orm			
Project Name:	ARES		Project#:	8	1170135	
Test Type:	CPP		Date Start:	51141	08	AK 116
Specimen ID:	EL 1196-104		Time Start:	1:30 PA	n	
Data Files:	OCP: EL 1196.1	OA OCP. mpr				
	CPP: EL 1196 -	100 CPP				
Solution:	Evaposate Supesha	Atmosphere:			Na	Pusqu'r
Temperature:	50 °C	Reference Electrode			s	CE 0
Initial pH:	14	Final pH:				
Starting Potential:	- 0.1 V vs. OCP	Reversal Potentia	ut:			V vs. SCE
Scan Rate:	0.17 mV/s	Final Potential:				Vvs. OCP
Reverse Current	4.76 mA*	Applied potential	for potentios	tatic test:	NA	V vs. SCE
Sample Length:	3.17 cm	Sample Diameter	.		0,1	
Sample Area:	4.76 cm ²	Sample Initial we	ight:		3.53	<u> </u>
Potentiostat:	OCP (UMP3)	·				
Potentiostat ID:	1568					
Sample	P 18 hos full immes	stion $= T = B$	o'C N	, Purg	ing	
X Ra the t	n out a est; resun	of Ng the test or	not beo	.ble t.	0 001	-105 j
Test Performed by:	Amnoyporn Kelley		Home Ph			89-7980
Project Manager:	Sean Brossia	<u> </u>			101-0	
	00011 0103310		1 1			

QA APPROVED
NAME: adum
DATE: 8-7-08

·

	Potentiodyn	amic/Potentiostat	ic Polarizati	ion			
	T	est Information Fo	orm				
Project Name:	ARES		Project#:	8	3117013	35	
Test Type:	CPP		Date Start:	1119100	8		
Specimen ID:	EL 1196 - 105		Time Start:	21:00	301		
Data Files:	OCP: EL 1196 -	105 OCP. MPT		· · ·			_
Data Files.	CPP: EL 1196 -	105 OCP. DTA					
						_	
Solution: Eva	posate Supernak	Atmosphere:			N		sq iv
Temperature:	50 °C	Reference Electrode				SCE	0
Initial pH:	14	Final pH:			14.	16	
				-			
Starting Potential:	-0.1 V vs. OCP	Reversal Potentia	d:		1	V vs.	SCE
Scan Rate:	017 mV/s	Final Potential:			0.1	Vvs.	OCP
Reverse Current	A. 75 mA*	Applied potential	for potentiost	tatic test:	NA	Vvs.	SCE
	AK.						
Comula Length:	9.17 cm	Sample Diameter			Ø	.48	cm
Sample Length:							
			ight:		3.	325	g
Sample Length: Sample Area:	4.75 cm ²	Sample initial wei		14 : Fra	·		9 94
	4.75 cm ²			14; Геси	·		
Sample Area: Solution Batch ID:	A.75 cm ² AX Evia	Sample initial wei	ate; pH	14; Геси	·		
Sample Area: Solution Batch ID: Potentiostat:	A.75 cm ² AX Evia	Sample initial wei povale Supern	ate; pH	1.4 ; TECU	·		
Sample Area: Solution Batch ID:	A.75 cm ² AX Evia	Sample initial wei	ate; pH	14 ; rsa	·		
Sample Area: Solution Batch ID: Potentiostat: Potentiostat ID: Comments: . Foll - OC for a c P	A.75 cm ² AX Evia	Sample initial wei povale Supers M CPP Dam 1408	ate; pH	14 ; rsa	·		
Sample Area: Solution Batch ID: Potentiostat: Potentiostat ID: Comments: . Foll - OC for a c P	A+75 cm ² HX Evia COCP (UMP3) 1568 immession pos 18ha o c Na Amnoyporn Kelley	Sample initial wei povale Supers M CPP Dam 1408	ate; pH				94
Sample Area: Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - CP - CP - 5	Aoto cm² Ar Evia Cocp (UMP3) 1568 immession pos 18ha o c Na	Sample initial wei povale Supers M CPP Dam 1408	ate; pH		614	19 #	94

* Set a value such that the reversal current density is 1mA/cm²;

•

.

QA APPROVED				
NAME: <u>cloum</u>				
DATE: 8-7-08				
4				

	Potentiodyr	namic/Potentiostat	tic Polarizat	ion		
		Test Information F	orm			
Project Name:	ARES		Project#:	8	31170135	
Test Type:	CPP		Date Start:	SILALO	k	
Specimen ID:	EL 1196-106		Time Start:	9:00 A	m)	
Data Files:	OCP: EL1196-	106 OCP. mpr.				
		LOG CPP				
	31	uppernabe				
Solution:	TAP 105 Mixed	Atmosphere:			Na	pursqu
Temperature:	50 °C	Reference Electrode	e:		I SCE	- 0
Initial pH:	13+	Final pH:			13+	
Starting Potential:	-0,1 Vvs. OCP		al:			. SCE
Scan Rate:	0.17 mV/s	Final Potential:			- 0.1 V vs	
Reverse Current	4.75 mA*	Applied potential	for potentios	tatic test:	NA VVS	. SCE
	L	┥┠━━━━			L	
Sample Length:	3.17 cm	Sample Diameter			0.48	
Sample Area:	4.75 cm ²	Sample initial we	ight:		3.528	g
Solution Batch ID:		105 Mixed 1 13t	supernat	e trac	King #	9,6
Solution Batch ID:			Supernat	e trac	King #	96
Solution Batch ID:		† 13 ⁺		e tsac	King #	96
	pi-	+ 13 + CPP (Supervat	e trac	Kuhney #	96
Potentiostat:	-19 (1900) eqmu	+ 13 + CPP (Gamsy)	e tsac	Kinney #	96
Potentiostat: Potentiostat ID:	P1- UMP3 COCP) 1068	CPP (Gamsy) 408		Kinney #	96
Potentiostat: Potentiostat ID:	P1- UMP3 COCP) 1068	+ 13 + CPP (Gamsy) 408		Kinney #	96
Potentiostat: Potentiostat ID:	P1- UMP3 COCP) 1068	CPP (Gamsy) 408		Kinner #	9,6
Potentiostat: Potentiostat ID:	P1- UMP3 COCP) 1068	CPP (Gamsy) 408		King #	9,6
Potentiostat: Potentiostat ID:	P1- UMP3 COCP) 1068	CPP (Gamsy) 408		King #	96
Potentiostat: Potentiostat ID:	P1- UMP3 COCP) 1068	CPP (Gamsy) 408		King #	96
Potentiostat: Potentiostat ID:	P1- UMP3 COCP) 1068	CPP (Gamsy) 408		King #	96
Potentiostat: Potentiostat ID: Comments:Rull OC f	UMP3 COCP) 1668 immersion; ound CE	CPP (Camsy) 408 Purqi'n	aj		
Potentiostat: Potentiostat ID:	UMP3 COCP) 1668 immersion; ound CE	CPP (Gamsy) 408	aj	King #	

QA AP	PROVED
NAME:_	Claun
DATE:	8-2-08

	Potentiody	namic/Potentiosta		ion		
		Test Information I	Form			
Project Name:	ARES		Project#:		31170135	
Test Type:	CPP		Date Start:	<u> </u>		
Specimen ID:	FL 1196-107		Time Start:	11:00 A (<u>n</u>	
Data Files:	OCP: E1 19	-107 OCP. mpr				
		107 CPP . DTA	·			
	APIOS	· · · · · · · _				
Solution:	Evaposate Supes	Atmosphere:			[Na i	UM
Temperature:	50 °C	Reference Electroc	le:		SCE	0
Initial pH:	11.0	Final pH:			11,47	
					1.0 AX	
Starting Potential:	-0, Vvs. OC	Reversal Potent	ial:		GT Vvs.	
Scan Rate:	0.17 mV/				- 0.0 V vs. (_
Reverse Current	4.76 mA	* Applied potentia	al for potentios	tatic test:	NA VVS.	SCE
		_				
					0148	
Sample Length:	<u>3.17 cm</u>		er:			cm
Sample Length: Sample Area: Solution Batch ID:	A:76 cm		eight:	ieking NaAld	3.519	<u>9</u>
Sample Area:	A:76 cm APIPSEN PH	2 Sample initial w aposale Super 11-0; No N	eight: snate;Tro aott;Ng		3.519	
Sample Area:	A:76 cm APPSEN PH VMP3	2 Sample initial w aposale Super 11.0; No N	eight:		3.519	
Sample Area: Solution Batch ID: Potentiostat:	A:76 cm APPSEV PH VMP3 OCP (MUP3	2 Sample initial w aposale Super 11.0; No N	eight: s Ma K; Tro a OH; Ng CPP C Gar		3.519	
Sample Area:	A:76 cm APPSEN PH VMP3	2 Sample initial w aposale Super 11.0; No N	eight: snate;Tro aott;Ng		3.519	
Sample Area: Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full - OC	A:76 cm APPSEN PH VMP3 OCP (MOP 1568 impression P and CI	2 Sample initial w aposale Super 11-0; No N 27 AK	eight: s Ma K; Tro a OH; Ng CPP C Gar		3.519	
Sample Area: Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full - OC - N - 5	A:76 cm APPSEN PH VMP3 OCP (MUP3 1568 impression P and C1 y Purging O C	2 Sample initial w aposale Super 11-0; No N 27 AK	eight: snate; Tro a0H; Ng CPP CGar 1A08	moy)	3.519 4 95 X H ₀ O	9
Sample Area: Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full - OC - N - 5	A:76 cm APPSEN PH VMP3 OCP (MAP3 1568 immession P and C1 A Pusquing O C	2 Sample initial w aposale Super 11-0; No N 27 AK	eight: s Ma K; Tro a OH; Ng CPP C Gar	moy)	3.519	9
Sample Area: Solution Batch ID: Potentiostat: Potentiostat ID: Comments: - Full - OC - N - 5	A:76 cm APPSEN PH VMP3 OCP (MUP3 1568 impression P and C1 y Purging O C	2 Sample initial w aposale Super 11-0; No N 27 AK	eight: snate; Tro a0H; Ng CPP CGar 1A08	ms:y)	3.519 4 95 X H ₀ O	

٠

QA APPROVED NAME: _____

DATE: 9-7-08

	Potent	tiodyna	amic/Potentiostat	ic Polarizati	on		
			est Information F				
Project Name:	ARES			Project#:		31170135	
Test Type:		CPP			5/29/0	78	
Specimen ID:	BL 1196 - 1			Time Start:	3:00 P	r M	
Data Files:			28 OCP. mpr				
Data 1 1163.	CPP: FL	1196-1	08 CPP- DTA				
	· · ·		<u>د </u>				
Solution:		Scroond	Atmosphere:			Na purg	this
Temperature:	50 °C	-	Reference Electrode	e:		SCE	
Initial pH:	13:02		Final pH:			13.14	
Starting Potential:	- 0.1 V vs.	. OCP	Reversal Potentia	al:		<u> </u>	SCE
Scan Rate:	0.17	mV/s	Final Potential:			-0, V vs.	
Reverse Current	4074	mA*	Applied potential	for potentlost	atic test:	<u> </u>	SCE
Sample Length:	3,17	cm	Sample Diameter	•		0.48	cm
Sample Area:	4074	cm ²	Sample initial we	ight:		3.543	g
			· · · · · · · · · · · · · · · · · · ·				
Solution Batch ID:	,	AM PH	105 Supern 13 ⁺	ate; Trac	king .	17	
	1	05		<u> </u>			
Potentiostat:	OCP (UM	101		(Gamey)			
Potentiostat ID:	1568		IAOS				
Comments: OCP 18 hrs - CPP - 30°C; No Pusging Solution - Full immession							
Test Performed by:	Amporport			Home Pho		614-889-79	
Project Manager:	Amnoyporn Ke Sean Brossia	elley	······			014-003-19	00
	5/28/08			Time and		18:00 P	m
Date end:	2100108			Time end:		10.001	<u>''/</u>

No concision product

QA APPROVED

NAME: <u>Cedum</u>

DATE: 9-7-08

	Potentiodyr	namic/Potentiosta	tic Polarizati	on	`
		lest Information F		<u></u>	
Project Name:	ARES		Project#:		81170135
Test Type:	CPP		Date Start:	518810	78
Specimen ID:	EL1196-109		Time Start:	12:00 F	om
Data Files:	OCP: BL196-1	09 OPP. MPR	·		
Data rises.	CPP: EL 1196 -1				
Solution:	134101	Atmosphere:			Na
Temperature:	50 °C	Reference Electrod	e:		SCE
Initial pH:	1230	Final pH:			13.50
					AF 5188108
Starting Potential:	-0+1 Vvs. OCP	Reversal Potenti	al:		OF V VS. SCE
Scan Rate:	0.17 mV/s	Final Potential:			AF\$.O.IV vs. OCP
Reverse Current	4.76 mA*	Applied potentia	l for potentios	atic test:	V vs. SCE
Sample Length:	0,14 cm	Sample Diamete	r:		0.48 cm
Sample Area:	4.76 cm ²	Sample initial we	eight:		3,509 g
Solution Batch ID:	ye _	101; pH 13+	, racking	14 (d	
Potentiostat:	OCP (DMP3)	CPP	(Gamsy)		
Potentiostat ID:	1568		<u>g</u>		
rotentiostat iD.	1.000		<u> </u>		
-	OCP 18 his CPP at BOZ N Full 1'mmessi	Ū	5		
Test Performed by:			Home Ph	one:	614-889-7980
Project Manager:	Sean Brossia				
Date end:	5189108	· ·	Time end		15:00 PM

Not cossoded

QA APPROVED

NAME: <u>claun</u>

DATE: 8-2-08

_	Potentiodyn	namic/Potentiostat	ic Polarizati	ion			
		Test Information Fo					
Project Name:	ARES	Project#:		3117013	5		
Test Type:	CPP		Date Start:	518910			
Specimen ID:	EL 1196-110		Time Start:	11:00 AT	n		
Data Files:	OCP: EL 196-11	O OCP. MPr					_
Data Files:	CPP: EL1196.	110 CPP. DTA					
Solution:	AY 101 - CSL	Atmosphere:			No	Risq	in
Temperature:	50 °C	Reference Electrode				SCE	,
Initial pH:	11,85	Final pH:			10.1	0	
						<u> </u>	
Starting Potential:	-O. Vvs. OCP	Reversal Potentia	al:		1.0	V vs.	SCE
Scan Rate:	0017 mV/s	Final Potential:			-0.1	Vvs.	OCP
Reverse Current	4076 mA*	Applied potential	for potentios	tatic test:	nA	V vs.	SCE
Sample Length:	3017 cm	Sample Diameter	:		001	f8	cm
					1 1	175	
		Sample initial we $ 0 - CSL'_{3}$ 1 85		1 # 9.	<u> </u>		<u> </u>
Sample Area:				1 # 9.	<u> </u>		<u> </u>
Solution Batch ID:	AY P1-	101 - CSL 's 1 11.85	Trackino		<u> </u>		9
		101 - CSL 's 1 11.85			<u> </u>		
Solution Batch ID:	АУ р1- оср (VmP3)	101 - CSL 's 1 11.85	P (Gamse		<u> </u>		
Solution Batch ID: Potentiostat: Potentiostat ID: Comments:	AY PI- OCP (VMP3) 1568 OCP 18 V	101 - CSL '5 1 11.85 CP	P (Gamse		<u> </u>		
Solution Batch ID: Potentiostat: Potentiostat ID: Comments:	AY p1- 0CP (VMP3) 1568	101 - CSL '5 1 11.85 CP	P (Gamse		<u> </u>		
Solution Batch ID: Potentiostat: Potentiostat ID: Comments:	AY PI- OCP (VMP3) 1568 OCP 18 V	101 - CSL '5 1 11.85 CP	P (Gamse		<u> </u>		
Solution Batch ID: Potentiostat: Potentiostat ID: Comments:	AY PI- OCP (VMP3) 1568 OCP 18 V CPP - Full i'm me	101 - CSL '5 1 11.85 CP	P (Gamse		<u> </u>		
Solution Batch ID: Potentiostat: Potentiostat ID: Comments:	AY PI- OCP (VMP3) 1568 OCP 18 V CPP - Full imme - BOC	101 - CSL '5 1 11.85 CP	P (Gamse HOB		<u> </u>		
Solution Batch ID: Potentiostat: Potentiostat ID: Comments:	AY PI- OCP (VMP3) 1568 OCP 18 V CPP - Full imme - BOC	101 - CSL 's 1 11.85 CP	P (Gamse HOB		<pre>4</pre>		
Solution Batch ID: Potentiostat: Potentiostat ID: Comments:	AY PI- OCP (VMP3) 1568 OCP 18 V CPP - Full imme - BO'C - Ng PUsg	101 - CSL 's 1 11.85 CP	Гбасита <u>Р (Gamse</u> 1408 1408		eq 		80

٠

QA APPROVED

NAME: cedum

DATE: 8-2-08

	Potentiodyn	namic/Potentiostat	tic Polarizati	on	
		est Information F			
Project Name:	ARES		Project#:		1170135
Test Type:	CPP		Date Start:	611670	8
Specimen ID:	EL 1196-111		Time Start:	91,00	P.M
Data Files:	OCP: EL 1196	-111 ORP. MPY			
Data riles:	CPP: EL 1196	ILL CPP, DTA			_
Solution:	AY 101 - CSL	Atmosphere:			No Rigin
Temperature:	50 °C	Reference Electrode	ə:		SCE
Initial pH:	11.82	Final pH:			11.90
Starting Potential:	- O.I Vvs. OCP	Reversal Potentia	al:		1.0 Vvs. SCE
Scan Rate:	0.17 mV/s	Final Potential:			-Ool Vvs. OCP
Reverse Current	4.76 mA*	Applied potential	for potentiost	atic test:	NA Vvs. SCE
Sample Length:	3.17 cm	Sample Diameter	•.		0.48 cm
Sample Area:	4.76 cm ²	Sample initial we	ight:		3,518 g
	·		.		·¥
Solution Batch ID:		101-CSL Pt 140 mg # 100	1 (1.00		
Potentiostat:	OCP UMP3	СРР			
Potentiostat ID:	1568	<u>/</u>	108		
-	DCP los 18 CPP Jos 18 50°C	hes. * (Dossosiion o	п сопро	en 6
- () - F	la Pusqing Ull immession	n			
Test Performed by:		<u>.</u>	Home Pho	ne:	614-889-7980
Project Manager:	Sean Brossia				· · · ·
Date end:	6/17/08		Time end:	·	(2)00 PM.

QA APPROVED	
NAME: cedur	_
DATE: 8-7-0	-

	Potentiody	namic/Potentiosta	tic Polarizati	on		
		Test Information F				
Project Name:	ARES		Project#:		81170135	
Test Type:	CPP	Date Start:	7100	K		
Specimen ID:	FL 1196 - 112		Time Start:	411108		
Data Files:		12 OCP. DTA				
	CPP: EL 1196.	112 CPP. DTD				
Solution:	AY 101- C82	Atmosphere:			No PUBE SCE	212
Temperature:	50 °C	Reference Electrod	e:			
Initial pH:	18.82	Final pH:			18.90	
Starting Potential:	- 00 V vs. OCP	Reversal Potenti	<u>al:</u>		<u>1 V vs.</u>	
Scan Rate:	0:17 mV/s				-0; (V VS.	
Reverse Current	<u>A.76</u> mA*	Applied potentia	l for potentiost	atic test:	NA VVS.	SCE
	2 10	┨┝━━━━━━				
Sample Length:	3017 cm		<u>r:</u>		0.48	
Sample Area:	A.76 cm ²	Sample Initial we	ight:		3.538	g
Potentiostat:	OCP Gamiy		CPP GAM	154		
Potentiostat ID:	1408		1408			
Comments:	8 hrs 00	P then c	pp			
			()			
- []	& Pusging					
-	0 0					
- Fi	Ill immersion	1				
	<u> </u>	·				
Test Performed by:	Amnoyporn Kelley		Home Pho	<u></u>	614-889-79	80
Project Manager:	Sean Brossia			<u> </u>	014-008-13	
Date end:	7/11/09		Time end		11:00	
JALO DIN.	1 1 1 8 6 7 9		i i i i i i i i i i i i i i i i i i i	•		

coupon not avoide

QA APPROVED NAME: Cedur

DATE: 8-7-02

	Fole			nic/Potentiostat		ion			
	<u> </u>		res	t Information F					
Project Name:	ARES				Project#:	61.00	8117013	35	
Test Type:	CPP			Date Start:	4123				
Specimen ID:	EL 1196-113 OCP: EL 196-113 OCP. mpr			_Time Start: _	(0:00	(A1Y)			
Data Files:	OCP: EL	196-1	13	OCP. mpr					
	CPP: EL	196-1	19	CPP. DTA				1421 2	
	-						AF 1	10908	
Solution:	A7101-C		A	tmosphere:			Open	10 0	? 1
Temperature:	Room fe	mp=	R	eference Electrode			' 8	SCE	
Initial pH:	11.82	•	Fi	inal pH:			11.97	<u>ب</u>	
Starting Potential:	-001 VV	s. OCP		Reversal Potentia	al:		1.0	V vs.	SCE
Scan Rate:	0.17	mV/s		Final Potential:		_	-0.1	V vs. (OCF
			11	Applied potential	for potentios	atic			
Reverse Current	A076	mA*		test:				V vs.	SCE
······································									
Sample Length:	3,18	icm.		Sample Diameter	<u> </u>		Orts		СП
Sample Area:	4.76	cm ²		Sample initial/fina	al weight:		3.592	g/	Ş
Solution Batch ID:				ol- CSL .#		11.82			
Solution Batch ID:						11.83			
	I VMP3 CC	AY		01-CSL #	100 PH				
Potentiostat:	UMPB (C	AY		01-CSL #	100 PH	10 1			
Solution Batch ID: Potentiostat: Potentiostat ID:		AY		01-CSL #	100 PH	10 1			
Potentiostat: Potentiostat ID: Comments: O	1568 CP {00	Any xp>	{	01-CSL #	100 PH	8 8 1 8			
Potentiostat: Potentiostat ID: Comments: - O - C	1568 CP 606	Ary acps (s h	{	01-CSL #	100 PH PP Comm 140	8 8 1 8			
Potentiostat: Potentiostat ID: Comments: - O - C	1568 CP 606	Ary acps (s h	{	01-CSL #	100 PH PP Comm 140	8 8 1 8			
Potentiostat: Potentiostat ID: Comments: _ O _ C _ (1568 CP {06 PP Vz PU59	Ary 2P> (8 h	{(01 - CSL # - Room	100 PH PP Comm 140	8 8 1 8			
Potentiostat: Potentiostat ID: Comments: _ O _ C _ (1568 CP {06 PP Vz PU59	Ary 2P> (8 h	{(01 - CSL # - Room	100 PH PP Comm 140	8 8 1 8			
Potentiostat: Potentiostat ID: Comments: _ O _ C _ (1568 CP 606	Ary 2P> (8 h	{(01 - CSL # - Room	100 PH PP Comm 140	8 8 1 8			
Potentiostat: Potentiostat ID: Comments: _ O _ C _ (1568 CP {06 PP Vz PU59	Ary 2P> (8 h	{(01 - CSL # - Room	100 PH PP Comm 140	8 8 1 8			
Potentiostat: Potentiostat ID: Comments: - O - C - I - F	1568 CP {06 PP Vz PU59	Ary 2P> (8 h	{(01 - CSL # - Room	100 PH PP Comm 140	ature			
Potentiostat: Potentiostat ID: Comments: _ O _ C _ (1568 CP {06 PP Vz PU59	Ary ceps (s h je vessio	{(01 - CSL # - Room	100 PH PP Goim 1409 Fempers	ature			

coupon net cossode

PROVED
Oldun
8-7-08

. .^{*}

		amic/Potentiostat		on		
	T	est Information F	orm			
Project Name:	ARES		Project#:		8117013	35
Test Type:	CPP		Date Start:	7/31		
Specimen ID:	EL 1196 - 114		Time Start:	7:00	AM	
Data Files:	OCP: EL 196-					
	CPP: EL 1196-1	14 CPP. DAT				
<u> </u>						2
Solution:	AY 101 - CSL +100					SCE
Temperature:	50 °C	Reference Electrode	e: A. 33		<u> </u>	
Initial pH:	12.34	Final pH:	a. 99			
Starting Potential:	-0.1 V vs. OCP	Reversal Potentia	al:		1.0	
Scan Rate:	0.17 mV/s	Final Potential:			- 0:1	V vs. OC
	1.21	Applied potential	for potentiost	atic		V
Reverse Current	4.76 mA*	test:		· ·		V vs. SC
Sample Longth:	3.17 cm	Sample Diameter			0.	48 ci
						a/
Sample Area:		Sample initial/fination				g/
Sample Area:	I YA	101 - CSL # 10	0	18.30	pes (8	
	I YA		0	18.30	pes (g	
	I YA	01-CSL # 10 sting ph form	0 11.82 to	18.30	pes (g	
Solution Batch ID:	Ay l adju:	01-CSL # 10 sting ph form	0	18.30	pes (g	
Solution Batch ID: Potentiostat: Potentiostat ID:	AY ladju: OCP (UMP3) 1568	CPP C	0 11.8d to Coamry)		pes (8	
Solution Batch ID: Potentiostat: Potentiostat ID:	AY ladju: OCP (UMP3) 1568	CPP C	0 11.8d to Coamry)		pes (8	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: Area	AY 1 adju OCP (UMP3) 1568 Solution f	on - CSL # 10 sting ph from CPP c	0 11.8d to Coamry)		pes (8	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: A rea - T 5	Ay 1 adjuint 1568 Solution f 0°C	CPP C	0 11.8d to Coamry)		pes (g	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: A rea - T 5 - OCF	Ay i adjuint 1568 Solution f 0°C 2 Job 18 hi	CPP C	0 11.8d to Coamry)		pes (g	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: Area - T 5 - C P	Ay 1 adju: 1568 solution f 0°C 2 job 18 his	CPP C	0 11.8d to Coamry)		pes (8	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: Area - T 5 - C P	Ay i adjuint 1568 Solution f 0°C 2 Job 18 hi	CPP C	0 11.8d to Coamry)		pes (8	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: A rea - T 5 - OCF - C P - Ful	Ay 1 adju: 0CP (UMP3) 1568 3014:000 f 0°C Joo 18 hs P 1 immession	CPP C	0 11.8d to Coamry)		pes (8	
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: A rea - T 5 - OCF - C P - Ful	Ay 1 adju: 1568 solution f 0°C Joo 18 hs 1 immession Ausging	CPP C	0 11.8d to Coamry)			eng)
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: A rea - T 5 - OCF - C P - Ful	Ay 1 adjuint 1568 Solution f 0°C 100 18 hs 1 immession Pusging Noy Kelley	CPP C	0 11.8d to Coamry)	84		
Solution Batch ID: Potentiostat: Potentiostat ID: Comments: A rea - T 5 - OCF - C P - Ful - Ng	Ay 1 adju: 1568 solution f 0°C Joo 18 hs 1 immession Ausging	CPP C	0 11.8d to <u>Coamry</u>) 	84	882	eng)

QA AP	PROVED
NAME:_	Cldum
DATE:	8-7-08

Potentiodynamic/Potentiostatic Polarization						
Project Name:	ARES		Project#:		81170135	
Test Type:	CPP		Date Start:		108	
Specimen ID:	BL 1196-115	Cip	Time Start:	rs :	00 PM	
Data Files:		110 10111	\$15108			
Data i nes.	CPP: EL 1196	-115 CPP. DAT				
Solution:	Ay 101 - CSL	Atmosphere:			112	
Temperature:	<u>50 °C</u>	Reference Electrode	ə:		SCE	
Initial pH:	18.30	Final pH:			12.40	
Starting Potential:	- O · V vs. OCP	Reversal Potentia	al:		1.0 Vvs.	
Scan Rate:	0.12 mV/s	Final Potential: Applied potential	for potentical	atic	<u>~0 Vvs.</u>	UCP
Reverse Current	4.76 mA*	test:	tor potentios	auc	V vs.	SCE
Sample Length:	3. 17 cm	Sample Diameter			0.48	cm
Sample Area:	4.76 cm2	Sample initial/fin			3.5294	g
Solution Batch ID:						
CCP (Gamey)						
Potentiostat:	OCP (Gamsy	1408)		1408		
Potentiostat ID: 408						
Comments: Aves solution AY 102 - CSL pH 12.30 Tracking #105 - Ny progring - 50°C						
- Full immersion						
- OCP for 18 hrs.						
- CCP after OCP						
Test Performed by:	Nort Keller	·	Home Pho		889-19	80
Project Manager:	Sean Brossia					
Date end:	Sean Brossia (<u>ــــــــــــــــــــــــــــــــــــ</u>	Time end:		TA:00 P	M
	-17100	· · · · ·		·		
Set a value such the	t the reversal curren	t density is 1mA/cm	2			

sample associe after CPP

QA APPROVED

NAME: <u>Ceaun</u>

DATE: 8-7-08

 $\cdots \cdots x^{k^{n}} = t_{n-1} \cdots t_{n-1}$

RPP-RPT-37505, Rev. 0

Woi	Slow Strain Rate k Request/Test Information For	m
Special Hazards: CAUSTIE	THE DOWN Sh (Date/Time):11-5-07 7:15	Home Phone: 740 548 7747 Project Name: ARES JOO7 Project Number: 8/1 2013 9
Material ID#://96 Ex	TEST PARAMETERS st #: //96-47 tension Rate: //5-6 ain Rate: //E-6	
	DATA ACQUISITION ip Chart Scale: ip Chart Speed:	Data Acquisition Computer #: LVDT or Dial Gage ID#:87
Initial pHtT	SAMPLE ENVIRONMENT s:	Reference Electrode: <u>SCF</u> Free Corrosion Potential: <u>315</u> mV Applied Potential: <u>740</u> mV
Gage Mark Length: <u>1,819</u> in. De Gage Diameter: <u>0,1255</u> in.	SPECIMEN DIMENSIONS asurement Device: CAL TPEKS vice ID #: 1497 chined Gage Length: 1,000 in.	Final Overall Length: in. Gage Mark Distance: 2,038 in. Gage Diameter: 081 in. Cross Sectional Area: 005153 in. ²
	RESULTS & CALCULATIONS Load 778 lbs. Load 105153 in. ² = 2(1, 9, 5, 8	Time to Failure: 62.89 hrs. Time to Failure: 226405 sec. duction in Area (1067218) $\times 100 = 58.34$
Machined Gage Longth $(1,000)$ UTS = $\frac{Max. Load}{Initial Cross Section Area} = \frac{(278)}{(2371)} = \frac{79}{29}$		
Visual: Low Power (30X): Metallographic:	CRACKING	Crack Mode: Max_Crack Depth:mm Crack Velocity:mm/sec
Comments: 100 A ResisTor PSTA # 2090 Toutialler 10	260 TC # 1532	
Project Leader's Signature: QA 009-SSR Specimens, Tests, & Evaluation Revision 2	Page 11 DATE:	Approved: September 2004 7-08-

		i est Sneet Addendum	
Test # Sample # Filar Eye Piece	1196 - 47 SR 1196-47 CCT # 0224	Readings 86 '5	
Magnification inches/graduation	30 K ,00 (Avg. Reading, * inches/ = Final Diameter graduations graduation in. \Im^{1} , \Im^{0}	, 3
G -			-

Test Sheet Addendum

	Slow Strain Rate Work Request/Test Information For	m
Person Performing Test: <u>JOE</u> Special Hazards: <u>CAUSTIC</u> Filled Cell Start (Date/Time): <u>11-2-07</u> 8:15	61 ERST TAKE DOW Finish (Date/Time)://-5-07 7:15	Home Phone: 7415487747 Project Name: ARES 2007 Project Number: 81170134
Material: <u>AART 128</u> GIA & E Material ID#: <u>1196</u> Sample #: <u>458 1196 - 48</u>	TEST PARAMETERS	SSR System #: RPM:/7{{
Data File Name: <u>1196-48.DAT</u> Data Channels: <u>15416</u>	DATA ACQUISITION Strip Chart Scale: Strip Chart Speed:	Data Acquisition Computer #: 3
Test Solution: ANID7 Initial pH: // Final pH: /0.88	SAMPLE ENVIRONMENT Gas: Temperature: Pressure:	
$\begin{tabular}{lllllllllllllllllllllllllllllllllll$	SPECIMEN DIMENSIONS Measurement Device: <u><i>LALTIELS</i></u> Device ID #: <u>1497</u> Machined Gage Length: <u>/ d0 c0</u> in.	FinalOverall Length:in.Gage Mark Distance: $/.997$ Gage Diameter: 0.79 0.79 0.820 in.Cross Sectional Area: 004902 in. ²
Pre-Load: 75 lbs. Elongation = $\frac{1.997 - 1.772}{6}$ in.	<i>a</i>	٣
<u> </u>	$x 100 = \underline{x x c} \\ \text{MReduction} = \frac{1}{\text{Initial C}}$	duction in Area $\frac{(1007569)}{(1012770)} \times 100 = 60,69\%$ ix $10^{-3} = 535,79$ MPa
visual No	CRACKING	····
Visual: 10,0 Low Power (30X): N Metaflographic:		Crack Mode:mm Max, Crack Depth:mm Crack Velocity:mm/sec
comments: 100 N Resistor PSTAT # 2088 TCONTROL	ler#1269 TC# 1538	
Project Leader's Signature: 2A 009-SSR Specimens, Tests, & Evaluation Revision 2	Pogo 11	Approved: September 2004 7-08 Approved: September 2004 Written By: J. Gerst & C. Durr

Test Sheet Addendum

Test #	<u>1196-48</u>	Readings	
Sample #	<u>SSR 1196-48</u>	99	
Filar Eye Plece	CCT # 0224	20	
Magnification inches/graduation	30	Avg. Reading, * inches/ graduations graduation	= Final Diameter, in. .079

RPP-RPT-37505, Rev. 0

Person Performing Test: TOE GI	ERST	Home Phone: 790 5 98 7797
Special Hazards: <u>Coust.</u> Fillect (P) Start (Date/Time): <u>11-7-07</u> 8:15	Finish (Date/Time): 11507 7:15	Project Name:
Start (Date/Time): 11- (-01 8, 13	Finish (Date/Time): 11507 7:15	Project Number:
	TEST PARAMETERS	(-
Material: AART 128 Grade B		SSR System #:
Material ID#:	Extension Rate: 1 F · 6 in/sec	RPM://?
Sample #: <u>SSR 1196 - 49</u>	Strain Rate: <u>[E-G</u> sec ⁻¹	
	DATA ACQUISITION	
Data File Name: 1196-49, DAT	Strip Chart Scale:	Data Acquisition Computer #:
Data Channels: $9+15$	Strip Chart Speed:	LVDT or Dial Gage ID#: 530
	SAMPLE ENVIRONMENT	
Test Solution: AN 107	Gas: No~ア	Reference Electrode: \underline{SCE}
Initial pH:	Temperature: 50°C	Free Corrosion Potential: -27/ m
Final pH: 10.88	Pressure: Room	Applied Potentiat - 790 m
	SPECIMEN DIMENSIONS	
<u>Initial</u> Overall Lenoth: \$€0 in	Measurement Device: CALTERS _	<u>Final</u> Overall Length: 8,2 i
······································	Device ID #:1497	1 A) /
Gage Mark Length: 1, 505 in.		·
Gage Diameter 0.126 in.	Machined Gage Length: 1000 in.	Gage Diameter: <u>007</u> in Cross Sectional Area: <u>007657</u> in
Cross Sectional Area: <u>01247</u> Din. ²		Cross Sectional Area: 200 (B-2 / In
7	RESULTS & CALCULATIONS	C 1 1 3
Pre-Load: 15 lbs.	Max. Load 963lbs.	Time to Failure: <u>220050</u> hrs.
$E \log a f l n = \frac{1}{2} \frac{1}{2$	Reduction in Area: $.012470004157$ in. ²	Time to Failure: 220050 sec.
Elongation (,2(3)	$x 100 = 2/.3$ % % Reduction = $\frac{\text{Red}}{\text{Initial C}}$	function in Area $(2067873) - x100 - 62.65$
$K = \text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.2(3))}{(.200)}$		ross Section Area (,012470)
963		C20 118
$JTS = \frac{1}{(102)} = \frac{1}{(102)} = \frac{1}{(102)}$	77227 psi 77227 psi x 6.895	x 10-3 =MPa
	•	
	CRACKING	
/isual:		Crack Mode:
ow Power (30X):		Max. Crack Depth:m
Metallographic:		Crack Velocity:mm/se
comments: N 100 Resist		
PSTAT # 2115 Ter	introller#1325 TC	1524
I STILL TOTIS ICO	M	
A-		TOVED 1/7/0
Project Leader's Signature:	NAME C	Oate:Approved: September 20

Test Sheet Addendum

Test # Sample # Filar Eye Piece	<u>1 196-49</u> <u>SSR 119-49</u> CCT # 0224	Readings 78 l	_
Magnification inches/graduation	.00 (30X	Avg. Reading, * inches/ graduations graduation	= Final Diameter, in.
ل -		77,001	_07)

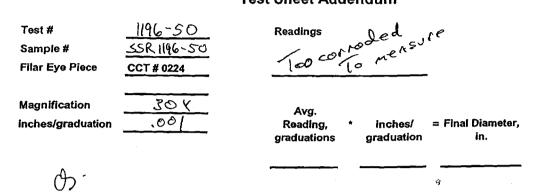
Comments

Ð

Slow Strain Rate Work Request/Test Information Form Gerst 7405487747 Joe Person Performing Test Home Phone: ARES 2007 Special Hazards: <u>CAUS</u> Filled CP/I Start (Date/Time): <u>//-26'07</u> AUSTic Project Name: TAKE low a Finish (Date/Time): 11-29-07 81170134 1:30 Project Number TEST PARAMETERS Material: AART (28 Grade B 1196-50 6 Test #: SSR System # 1196 174 Material ID#: IE-6 Extension Rate RPM in/sec SR 1196-50 IE-6 Sample #: Strain Rate: sec¹ DATA ACQUISITION 1196-50, DAT Data File Name ٣ Strip Chart Scale Data Acquisition Computer # Data Channels 9+15 ଽୖଽ୰ Strip Chart Speed: LVDT or Dial Gauge ID# Tracking 68 SAMPLE ENVIRONMENT APINS PSC Nore SCE Test Solution: Gas Reference Electrode Initial pH:/3 50°C Free Corrosion Potential: m٧ Temperature: 3.77 ROOM Final pH: Applied Potential Pressure: ۳v Initial C.U SPECIMEN DIMENSIONS <u>Final</u> Measurement Device: CALIPENS Overall Length Overall Length Gauge Mark Length: 1168 Device ID #: Gauge Mark Distance: coind Gauge Diameter: 4/25 PAS Gauge Diameter: 1.000 in. Machined Gauge Length: Cross Sectional Area: 10/23-7 Cross Sectional Area **RESULTS & CALCULATIONS** 41.58 955 Pre-Loa Max, Load Time to Fallu 0/A 49670 Reduction in An (,158) 100= 15, % Elon 1.000 (955) 7.7/91_ psi × 6.895 10" = 532127 MPa ITS (201237 Initial Cross Section Area CRACKING NO Visual: Crack Mode: Ľ Low Power (30X): Max. Crack Depth mm Metallographic: Crack Velocity: mm/sec PSTAT 152 comments: 100 A Resistor toller 2115 132 co, QA Project Leader's Signature QA 009 Revision #3 SSR Specimens, Tests, & Byelling Date Approved: April 2006 Prepared By: C. Scott adian DATE: 1-7-08

Test Sheet Addendum

4

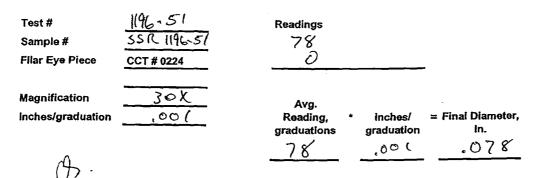


Comments

	Slow Strain Rate Work Request/Test Information For	m
Person Performing Test: <u>J& C</u> Special Hazards: <u>CAUST</u> ; <u>C</u>	Geist	Home Phone: 740 5487747 Project Name: ARES 2007
Special Hazards: <u>CAUST</u> ; F:11+d cell Start (Date/Time): <u>/2-3_74()</u>	TANE 16:21 Finish (Date/Time):12:7-07 8:00	Project Number: 8/170134
Material: <u>AART 128 GNAde B</u> Material ID#: <u>1196</u> Sample #: <u>SSR 1196 - S1</u>	TEST PARAMETERS Test #: //96 ~ 57 Extension Rate: / £ ~ 6 Strain Rate: / £ ~ 6	SSR System # RPM:
	DATA ACQUISITION	
Data File Name: 1196-51, DAT	Strip Chart Scale:	Data Acquisition Computer #:
Data Channels: 15 +16	Strip Chart Speed:	LVDT or Dial Gage ID#: <u>939</u>
Tracki~5 5668 Test Solution: <u>AP 105 PSC</u> Initial pH: <u>13,22</u> Final pH: 13,77	SAMPLE ENVIRONMENT Gas: Nowe Temperature: 50	Reference Electrode: $5CE$ Free Corrosion Potential: -249 m
Final pH: / S < / /	Pressure: ROOM	Applied Potential:mV
Initial Overall Length: $\mathcal{G}_1 \mathcal{O}$ in. Gage Mark Length: $1, 6, 3, 8$ in. Gage Diarneter: $\mathbf{v}_1 \mathcal{Q} \mathcal{S}$ in. Cross Sectional Area: 012273 in. ²	SPECIMEN DIMENSIONS Measurement Device: <u>CALEPELS</u> Device ID #: <u>1497</u> Machined Gage Length: <u>L. OOU</u> in.	Final Overall Length: 8'.2 in Gage Mark Distance: 1.8'.4'7 in Gage Diameter: 078 in Cross Sectional Area: 004779 in
Pre-Load: 75 lbs. Elongation = $\frac{75}{1.638}$ in. % Elongation = $\frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.209)}{(1.000)}$	RESULTS & CALCULATIONS Max. Load <u>982</u> bs. Reduction in Area: $\frac{111273 - 004779}{m^2}$ bs. x 100 = 20:9 % Reduction = Red initial C	Time to Failure: $62,06$ hrs. Time to Failure: 223419 sec. Auction in Area $(.007494)$ (.012273) x $100 = 61.06$
UTS = $\frac{Max. Load}{Initial Cross Section Area} = \frac{(982)}{(.0(2.2.73))} =$	80015 psi 80015 psix 6.895	x 10 ⁻³ = <u>551.71</u> MPa
	CRACKING	
Visual:		Crack Mode:
Low Power (30X): <u> </u>		Max. Crack Depth:mr
Metallographic:		Crack Velocity: mm/se
	#1325 TC 1528	
	#1325 TC 1528	
	QA APP	ROVED edun Date: 1/7/8

Slow Strain Rate





	Slow Strain Rate Work Request/Test Information For	rm
Person Performing Test: Joe C	erst	Home Phone: 740 548 7747
Special Hazards: <u>CAUSTIC</u> Filled Cell Start (Date/Time): <u>/2-10-07</u> /1:15		Project Name: SH ARES 2007
Start (Date/Time): 12-10-07 11:15	Finish (Date/Time): <u>12-13</u>	Project Number. 8/1 7013 4
Material: <u>AAAT 128 GMd + B</u> Material ID#: <u>1196</u> Sample #: <u>SSR 1196</u> -	TEST PARAMETERS Test #: //96-52 Extension Rate: / E-6	
	DATA ACQUISITION	
Data Fite Name: //96 .DAT	Strip Chart Scale:	Data Acquisition Computer #:
Data Channels: 15+16	Strip Chart Speed:	LVDT or Diał Gage ID#:939
Tracking $L8$ Test Solution: <u>AP 105 PSC</u> Initial pH: <u>13.02</u> Final pH: <u>13.75</u>	SAMPLE ENVIRONMENT Gas:	Reference Electrode: SCE Free Corrosion Potential: 289 mV Applied Potential:mV
Initial	SPECIMEN DIMENSIONS	Final
Overall Length: ど、う in.	Measurement Device: CAlipers	Overall Length: & ~ in.
Gage Mark Length: 1.6 28 in.	Device ID #: 1497	Gage Mark Distance: 1.844 in.
Gage Diameter:125 in.		Gage Diameter: ,076 in.
Cross Sectional Area: 012273 in.2	Machined Gage Length: 1,000 in.	Cross Sectional Area: 10457 3 in.2
Pre-Load: 75 Elongation = $\frac{1}{16}$ 8/4/-1,628 in. % Elongation = $\frac{1}{16}$ Elongation = $\frac{1}{16}$ (1.000) WTS = $\frac{1}{10}$ Max Load = $\frac{1}{10}$ (977) UTS = $\frac{1}{10}$ Initial Cross Section Area = $\frac{1}{10}$ (977) = $\frac{1}{10}$		Time to Failure: $61, 24$ hrs. Time to Failure: 220465 sec. duction in Area $(.007736)$ x $100 = £3.03$ % Cross Section Area $(.012273)$ x $100 = £3.03$ % $5x 10^{-3} = 548190$ MPa
	CRACKING	
Visual:NO		Crack Mode:
Low Power (30X):		Max. Crack Depth:mm
Metallographic:		Crack Velocity:mm/sec
Comments: TCONTroller	1203 TC 1528	
Project Leader's Signature:	Page 11 DATE: (Date: // //()



= Final Diameter,

in. .076

1196-52 Readings 상〇 Test # 55R Sample # 1196-5 ų Filar Eye Piece CCT # 0224 30 r Magnification Avg. Reading, inches/graduation inches/ 00 graduations graduation ,001 76

ط

Wor	Slow Strain Ra rk Request/Test Infor		n	
Person Performing Test: <u>Joe Ge</u> Special Hazards: <u>Caustic</u> Filled Cell Start (Date/Time):/ <u>2-10-07</u> [[1]5 Fini	ish (Date/Time): <u>12-13</u>	(Home Phone: <u>740 548 774</u> Project Name: <u>84 A</u> RES 20 Project Number: <u>8/1 7013 9</u>	17 07
Material ID#: Ex	TEST PARAMETE st #: /96 - 5-3 tension Rate: /E-1 rain Rate: /E-1		SSR System # RPM:/74	
A LIG	DATA ACQUISITIO		Data Acquisition Computer #:	
17 50	SAMPLE ENVIRONN s:	e 'c	Reference Electrode: SCE Free Corrosion Potential: -259 Applied Potential: O	_mV _mV
Gage Mark Length: 1.720 in. Dev Gage Diameter:	SPECIMEN DIMENS asurement Device: <u>CA</u> vice ID #: <u>1497</u> chined Gage Length: <u>/</u>	ipers	Final Overall Length: 8, 2 Gage Mark Distance: 1, 900 Gage Diameter: , 095 Cross Sectional Area: , 007089	in. in. in.
1000 1200	RESULTS & CALCULA Load <u>17</u> 3 Inction in Area; 012273-, 007	fbs.	122774	hrs. sec.
% Elongation = $\frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(180)}{(1000)} \times 100$				<u>24</u> %
UTS = $\frac{Max \text{ Load}}{\text{Initial Cross Section Area}} = \frac{(973)}{(273)} = -797$	<u>282 psi 7928</u>	<u>くて</u> psi_x 6.895x 1	σ ³ = <u>546,65</u> μp ₈	
	CRACKING			
Visual:YCS			Crack Mode:	
Low Power (30X): 7965			Max. Crack Depth:	mm
Metallographic:		<u> </u>	Crack Velocity:mm	vsec
comments: 100 N ResisTOR PS	STAT 2115	TCONTIG	Iler 1325 TC 1:	<u>53</u>
Project Leader's Signature:	QA NAN Page 11 DAT		Written By: J. Gerst & (

Test # Sample # Filar Eye Piece	<u> 196 -53</u> SR 1196-53 CCT # 0224	Readings 100 		
Magnification inches/graduation	30 X .00 (Avg. Reading, * inches/ = Final Diameter, graduations graduation in. 95,001,095		

Test Sheet Addendum

	Slow Strain Rate Work Request/Test Information For	rm.
Person Performing Test: Jo C (Special Hazards: <u>CAUSTic</u> Filled Cell Start (Date/Time): 2-1-08/230	Serst. Hot	Home Phone: <u>740548</u> 774 Project Name: <u>81170135</u> Project Number:
Material: <u>AART 128 Grade L</u> Material ID#: <u>118 G</u> Sample #: <u>SR 1196 - 54</u>	3 TEST PARAMETERS 4 1196-54 5 Extension Rate: 1E-6 5 Strain Rate: 1E-6	SSR System #: RPM: (승 역 니
Data File Name: 1196-59, D) Data Channels: 172	DATA ACQUISITION	Data Acquisition Computer #:
Test Solution: AP 10.5 Initial pH: 12,98 Final pH: 13,10	SAMPLE ENVIRONMENT Gas: Nowe Temperature: 50°C Pressure: Room	Reference Electrode: SCE Free Corrosion Potential: -287 Applied Potential: OmV
$\begin{array}{c} \underline{Inttial} \\ \text{Overall Length:} & \underline{\$} & \underline{\circlearrowright} & \circlearrowright$	Device ID #: 1497	Final Overall Length: 8, 2 Gauge Mark Distance: To corroded Gauge Diameter: To corroded Cross Sectional Area: To corroded
Pre-Load: 75 lbs. Elongation = $.187$ in. % Elongation = Elongation = $(.187)$ Machined Gage Length = $(.187)$	Reduction in Area:in. ²	Time to Failure: $53,78$ f Time to Failure: 193606 so tion in Area (?) x100 = ?
8	$\frac{78118}{78118}$ psi $\frac{78118}{78118}$ psi × 6.895 1	s Section Area (2012175)
Visual: Low Power (30X): Metallographic:	CRACKING	Crack Mode: Max. Crack Depth: Crack Velocity:mm/
comments: 100 Resistor Scribed X ON Fred	PSTATE 2090 Toortrolle. of specimen that	#1260 TC#1528 with be Top
Project Leader's Signature:	SSR Specimens, Tests, & Evaluation Page TIATE: 2-5-c	Date: 2/5/08. Date Approved: April Prepared By: C.

A-134

	Slow Strain Rate Work Request/Test Information Fo	rm		
Person Performing Test: Joe Special Hazards: Costic Start (Date/Time): <u>2-25-08</u> 910	Gers T TAKE ROWN Finish (Date) Time): 3-2807 7:20	Home Phone: 740 548 7747 Project Name: <u>ARES</u> Project Number: <u>8(17013 5</u>		
Material: <u>AART 128</u> G RAD e E Material ID#: <u>//9,6</u> Sample #: <u>SSR /19(55</u> , 1	TEST PARAMETERS Test #: //96-55 Extension Rate: 16-6 Strain Rate: 16-6			
Data File Name: <u>1196:55.04</u> T Data Channels: <u>91-65</u>	DATA ACQUISITION Strip Chart Scale:	Data Acquisition Computer # LVDT or Dial Gauge ID#:530		
Test Solution: <u>SY103</u> PIC Initial pH: <u>14</u> ,0 Final pH: <u>13</u> + W	SAMPLE ENVIRONMENT Gas: <u>No ッ て</u> Temperature: <u>50 ⁶C</u> Pressure: <u>Ro の 〜</u>	Reference Electrode: <u>SCE</u> Free Corrosion Potential: <u>- 424</u> mV Applied Potential: mV		
Initial Overall Length: 8,0 in. Gauge Mark Length: 1,6,7 in. Gauge Diameter: 1,255 in. Cross Sectional Area: .012370 in.2	SPECIMEN DIMENSIONS Measurement Device: <u>Calipers</u> Device ID #: <u>1497</u> Machined Gauge Length: <u>1.000</u> in.	Final Overall Length: 8.2 in. Gauge Mark Distance: 1.888 in. Gauge Diameter: 0.75 in. Cross Sectional Area: 004418 in. ²		
Pre-Load: 75 Elongation = $1.88\% - 1.667$ in. % Elongation = Elongation (1.000) Machined Gage Length (1.000)	RESULTS & CALCULATIONS Max. Load (79) lbs. 3012370,004415 in. ² Reduction in Area: (004415) in. ² x100 = 22.1 % %Reduction = Rec initial C	Time to Failure: 61.18 hrs. Time to Failure: 220237 sec. Iucion in Area $(.007952) \times 100 = 69.28$ ress Section Area $(.917370)$		
$\text{UTS} = \frac{\text{Max. Load}}{\text{initial Cross. Section Area}} = \frac{(479)}{(2012370)} = \frac{79142}{\text{psi}} \qquad 79142 \text{psi} \times 6.895 \ 10^{-3} = \frac{545.68}{545.68} \text{Area}$				
Visual:NONC	CRACKING	Crack Mode:		
Low Power (30X): Metallographic:		Max. Crack Depth:mm Crack Velocity:mm/sec		
Comments: JEMp Controlle	~#1205 TC #1670)		
Project Leader's Signature:	QA	APPROVED		
QA 009 Revision #3	SSR Specimens, Tests, & Evaluation AN Page 11 DAT	Column Date Approved: April 2006 Prepared By: C. Scott Prepared By: C. Scott		

Test # Sample #	1196-55 SSR 1196-55	Readings <i>公</i> 기		
Filar Eye Piece	CCT # 0224	12		
Magnification	30X	75 Avg.		
inches/graduation	.00[Reading, * graduations	inches/ graduation	= Final Diameter, in.
		75	,001	,075

Test Sheet Addendum

Comments

Person Performing Test: Jor	Greist	Home Phone: 740 548 7747
•		Project Name: ARES
Special Hazards: f (1+d cert Start (Date/Time): 1-25-08, 95	5 Finish (Date Time): 3-28-07 720	Project Number: 8/1170/35
Material: <u>AART (28 Grade B</u> Material ID#://96 Sample #: <u></u> (196 - 5 (6	TEST PARAMETERS Test #: ////////////////////////////////////	
Data File Name: 1/96-56 . DA T	DATA ACQUISITION	~ ~ ~
Data File Name: <u>1116-56, 54 (</u> Data Channels: <u>(5 + (6</u>	Strip Chart Scale:	Data Acquisition Computer #: LVDT or Dial Gauge ID#:434
Test Solution: AW 105 PIL Initial pH:/3 c b Final pH:/3 +	SAMPLE ENVIRONMENT Gas: <u>Non 7</u> Temperature: <u>SO</u> Pressure: ROOM	Reference Electrode: <u>SCF</u> Free Corrosion Potential: <u>290</u> mV Applied Potential: mV
<u>Initial</u> Overall Length: ど、〇	SPECIMEN DIMENSIONS	Final
	in. Device ID #: (497)	- Overall Length: <u>8</u> . C. in. Gauge Mark Distance: <u>1,870</u> in.
Gauge Diameter: 1255 Cross Sectional Area: 012370	n. 2 Machined Gauge Length: /.000 in	Gauge Diameter: +076 in.
Pre-Load 75 lbs.	RESULTS & CALCULATIONS Max. Load fbs.	Time to Failure: 62.04 hrs.
Elongation = $\frac{1.870 - 1.653}{1.000}$ in.	Reduction in Area: <u>#13370 004537</u> in. ²	Time to Failure: <u>223341</u> sec.
$% Elongation = \frac{3600}{Machined Gape Length} = \frac{(.2)7}{(1.000)}$	$\frac{1}{2} \times 100 = \frac{21.7}{100} \text{ % Reduction} = \frac{\text{Red}}{1000}$	rduction in Area $(.007833)$ Cross Section Area $(.012370)$ x 100 = 63.32
UTS = $\frac{Mex. Load}{Initial Cross. Section Area} = \frac{(977)}{(1012370)}$	= <u>78980</u> psi 78980 psi×6.89	5 10- = <u>544,57</u> MPa
	CRACKING	
/isual:	<u></u>	Crack Mode:
ow Power (30X):2	-	, Max, Crack Depth: mm
/letallographic:		Crack Velocity:mm/sec
omments: Temp Controller	#1236 7C#16	68
pitting in corros	ion nound in con	ick like Areas
and correction prode	not in solution remo	ved from cell
roject Leader's Signature:	QA A	PPROVED
4 009 evision #3	SSR Specimens, Tests, & Evaluator E	Oldun Date Approved: April 2006 Prepared By: C. Scott

÷.,

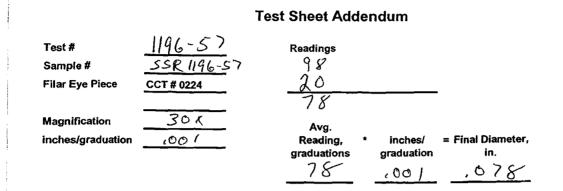
Test	Sheet	Addend	dum
------	-------	--------	-----

Test # Sample # Filar Eye Piece	1196-56 35R 1196-36 CCT # 0224	Readings 8 5		
Magnification inches/graduation	30x ,00(Avg. Reading, * graduations 76	inches/ graduation	= Final Diameter, in. , ०२६

Person Performing Test: Joe C	Tara	Home Phone: 740548774>
. 1		ARECIME
Special Hazards; <u>CAUSTIC</u> Filled ell Start (Date/Time): <u>920</u> 4208	Finish (Date Time): 4-5 6:30	Project Name:///2.5 2008 Project Number:///0135
Material: AART 128 Grade 13	TEST PARAMETERS Test #: 196-57	2
		SSR System #: <u>(X</u>
Material ID#:/96	Extension Rate: / E b in/sec	RPM:
Sample #: <u>SSR / 196~S7</u>	Strain Rate: Sec ⁻¹ sec ⁻¹	
	DATA ACQUISITION	2
Data File Name: 1196-57, DAT	Strip Chart Scale:	Data Acquisition Computer #:
Data Channels:15 + 16	Strip Chart Speed:	LVDT or Dial Gauge ID#:
Tracking 85	SAMPLE ENVIRONMENT	
Test Solution: SY 103 PIC	Gas: NON-P	Reference Electrode: <u>SCE</u>
Initial pH: 13 +	Temperature: 12 Rac - 50 C	Free Corrosion Potential:m
Final pH: 13 +	Pressure: Roo	Applied Potential:
Initial	SPECIMEN DIMENSIONS	<u>Final</u>
Overall Length: <u><u>y</u>, <u>O</u> in.</u>	Measurement Device: <u>C4(ipels</u>	Overall Length: 8.2 in
Gauge Mark Length: 1,728 in.	Device ID #: _ / 9 9 7	Gauge Mark Distance: 1, 9 4 5 ir
Gauge Diameter: <u>e / 25</u> in.	1.000	Gauge Diameter. <u>678</u> ir
Cross Sectional Area: 012272 in.2	Machined Gauge Length: /, 000 in.	Cross Sectional Area: .004779_ in.
	RESULTS & CALCULATIONS	
Pre-Load:75ibs.	Max Load _ 9 (c (ibs.	Time to Failure: 62.21 hrs.
Elongation = 1,945 - 1,728 in	Reduction in Area:	Time to Failure: 223954 sec.
· · · · · · · · · · · · · · · · · · ·		
$K = \text{Elongation} = \frac{\text{Elongation}}{(1, 2, 2, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3,$	(100 = 21.7) % Reduction = Reduction = Reduction =	colon in Area $\frac{(.007493)}{(.007493)} \times 100 = \frac{61.06}{00}$ se Sectión Area $\frac{1}{00} \times 100 = \frac{100}{00}$
Machined Gage Longth (/ VO V)	tnittaì Cro	se Section Area (O(2272)
ITS = Max. Load (964)	78554 poi 78554 poi×6.895	
Initial Cross Section Area (,0[2272) =-	<u>2 0 1 psi 2 0 1 psi 6.895</u>	10 = <u>1 1 1 1 2 1 1 2 2 1 2 2 2 2 2 2 2 2 2 </u>
······		
/isual: No	CRACKING	Caraly Made
ow Power (30X):		Crack Mode:
fetallographic:		
		Crack Velocity: mm/sec
omments:		
<u> </u>		
		· · · · · · · · · · · · · · · · · · ·
roject Leader's Signature	- A 14/08 . UA APP	RUVEU
roject Leader's Signature:	<u>4/14/08</u> . UA APP	RUV_Date Cotum Date Approved: April 200

1

.



	Slow Strain Rate Work Request/Test Information For	m
Person Performing Test. Joe G	erst	Home Phone: 7405487747
Special Hazards: CAUSTIC		Project Name: ARES 2008
Special Hazards: <u>Caustic</u> Filed Cell Start (Date/Time): <u>4</u> 708 940	Finish (Date/Time): 4-7-08 7:20	Project Number: <u></u>
Material: <u>APRT 128 Grade 13</u> Material ID#: <u>1196</u> Sample #: <u>SSR 1196-58</u>	TEST PARAMETERS Test #: 1/96-58 Extension Rate: /€-6 Strain Rate: /£-6	
	DATA ACQUISITION	
Data File Name: <u>//16-S8, DAT</u> Data Channels: <u>9+</u> 15	Strip Chart Scale:	Data Acquisition Computer #1
Tracking 86	SAMPLE ENVIRONMENT	SCE
Test Solution: <u>AW 105 PIC</u>	Gas: Non P	Reference Electrode:
Initial pH: <u>13 +</u> Final pH:13 +-	Temperature: <u>fR cos 4 SOC</u>	Free Corrosion Potential: 7 > mV
Final pH:13	Pressure:K © 6 1 1	Applied Potential: 0,0 mV
Initial Overall Length: 8,0 in. Gauge Mark Length: 1/036 in. Gauge Diameter: 12.5 in. Cross Sectional Area: 1012272n.²	SPECIMEN DIMENSIONS Measurement Device: <u>Colipers</u> Device ID #: <u>1497</u> Machined Gauge Length: <u>COO</u> in.	Final Overall Length: 8.2 in. Gauge Mark Distance: 1.838 in. Gauge Diameter: .079 in. Cross Sectional Area: .004902 in. ²
Pre-Load: 75 lbs. Elongation = $\frac{1.838}{1000}$ - $\frac{1.636}{1000}$ in.	RESULTS & CALCULATIONS Max. Load 98 for the second	Time to Failure: <u>217022</u> hrs. Time to Failure: <u>217022</u> sec.
$\text{\% Bongation} = \frac{\text{Bongation}}{\text{Machined Gage Length}} = \frac{(.202)}{(/.000)}$		$\frac{uction in Area}{cose Section Area} \frac{(1007370)}{(1000)} \times 100 = \frac{60.06}{5}\%$
UTS = $\frac{Max, Load}{Initial Cross Section Area} = \frac{(988)}{(012272)} =$	80509 poi \$0509 poi × 6.895	10 ⁻³ = <u>555, 11</u> MPa
11	CRACKING	
Visual:		Crack Mode:
Low Power (30X):		Max. Crack Depth: mm
Metallographic:		Crack Velocity:mm/sec
Comments:	·	
Project Leader's Signature:	4/14/08 QA AP	PROVED
QA 009 Revision #3	SSR Specimens, Tests, & Evaluation E	CADu Date Approved: April 2006 Prepared By: C. Scott
	 	4-14-08



Test # Sample # Filar Eye Piece	1196-58 SSR 1196-58 CCT # 0224	Readings 89 10		
Magnification inches/graduation	<u>30 X</u> .00 (Avg. Reading, * graduations	Inches/ graduation	= Final Diameter, in. . 079

.....

	Slow Strain Rate Work Request/Test Information Fo	mo
Person Performing Test: Jo Special Hazards: <u>AU</u> Filled Coll 4-15-08	e Gerst	Home Phone: 740548779> Project Name: 81170135
Material: \underline{AART} $\underline{I28GI}$ Material: $\underline{D#}$: $\underline{I19G}$ Sample #: \underline{SSR} $\underline{I19G}$ $\underline{S9}$	TEST PARAMETERS	
Data File Name: Data Channels: +(6	DATA ACQUISITION Strip Chart Scale: Strip Chart Speed:	Data Acquisition Computer #: 3
TrAchi's 91 Test Solution: EUAporated Sup Initial pH: 14 t Final pH: 14 t	ervale Gas: NON P Temperature: SO C Pressure: RCOM	Reference Electrode: <u>SCE</u> Free Corrosion Potential: <u>-S/O</u> mV Applied Potential: mV
	SPECIMEN DIMENSIONS in. Measurement Device: <u>CAlepers</u> in. Device ID #: <u>1497</u> in. in. in.	Final Overall Length: 8, 2 in. Gauge Mark Distance: i . 87 (in. Gauge Diameter: 107 8 in. Cross Sectional Area: .00477 9 in. ²
Pre-Load: 75 bb Elongation = <u>1,876 ~ (,667</u> in. Bonation (,70	Reduction in Area: <u>012272~,00477</u> 1in. ²	Time to Failure: 58.96 hrs. Time to Failure: $2(2265)$ sec.
% Elongation = $\frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(, 20)}{(1, 00)}$ $\text{UTS} = \frac{\text{Max. Load}}{\text{Initial Cross, Section Area}} = \frac{(, 4, 6, 7)}{(, 0, 1, 2, 2, 7, 2)}$	$\frac{1}{10} \times 100 = \frac{20}{10} \times 100 = \frac{20}{10} \times 100 = \frac{100}{1000} \times 100 = \frac{100}{10000} \times 100 = \frac{100}{100000} \times 100 = \frac{100}{1000000} \times 1000 = \frac{100}{10000000} \times 10000 = \frac{100}{100000000000000000000000000000000$	$\frac{(.00.7493)}{(.01.7272)} \times 100 = 61.06 \text{ s}$ $\frac{(.01.7272)}{(.01.7272)} \times 100 = 61.06 \text{ s}$ $5 \ 10^{-3} = 543.31 \text{ MPa}$
113	QA APPAROVED	
Visuat	- NAME: Cloum	Crack Mode:
Low Power (30X):/UU	DATE: 4-18-08	Max. Crack Depth:mm
comments: TCONTroller	#1236 TC #16-	Crack Velocity: 7() when I dropped it is
Project Leader's Signature:	A	Date: 4/18/08
QA 009 Revision #3	SSR Specimens, Tests, & Evaluation Page 11	Date Approved: April 2006 Prepared By: C. Scott

Slow Strain Rate Work Request/Test Information Form 405487 Gers Person Performing Test Home Pho ARE Special Hazards: (F. ((C) C C C) Start (Date/Time): 11 : 50 C ۶ A. Τe Project Name TAKE DOWN Finish (Date/Time): 5-7:08 X1170 5.08 ۴, 7:00 A. Moroject Number TEST PARAMETERS Material: AART (28 Grade B -60 Test # SSR System 1196 74 Material ID#: Extension Rate in/sec RPM: Sample #: 55R / 1196 60 Strain Rate: G sec⁻¹ DATA ACQUISITION Data File Name: 1196-60, PAT Data Acquisition Computer Strip Chart Scale: 34 Data Channels: 15+16 LVDT or Dial Gauge ID# Strip Chart Speed:_ 90 Trackins SAMPLE ENVIRONMENT Test Solution: AP105-PSC Non Reference Electrode Gas 13+ ٥ Initial pH: C Free Corrosion Potential ٣V Final pH: 13+ 00 0 Applied Potential Pressure: m٧ measured with catigers SPECIMEN DIMENSIONS Initial Final 8.0 Measurement Device: CALIPEIS 8. Overall Length: **Overall Lengt** 144 Device (D #: Gauge Mark Length; . <u>7</u>0 Gauge Mark Distances 26 Gauge Diameter: 1 Gauge Diameter: • 8 Cross Sectional Area: , 01246 % in.2 Machined Gauge Length: /.000 Cross Sectional Area: ,00937 in. in.2 **RESULTS & CALCULATIONS** RUNNIUS 977 25 38.85 Pre-Load Time to Eally RUNNIS Time to Fally Max. Load lhs Elongation = 1:816-1,702 139862 Reduction in Area: 012464-1010437in.2 $=\frac{(.114)}{(1.000)} \times 100 = 11.$ Reduction in Area (,001532) x 100 = 12.2%at Cross Section Area (,01246%)% Elonga (977) 78354 psi × 6.895 10" = 540,25 78354 UTS = Initial Cross Section Area (012469) CRACKING Jone Visual Crack Mode: Low Power (30X); NE Max. Crack Depth: mm Metallographic: Crack Velocity:_ mm/sec 38.8 Topk A hos Comments 7. ANO 1e SOMP corros ion At interface JAME: 30 Clow 16 70 12 controlle ~ DATE: 6-18-04 Project Leader's Signature 6/5/08 QA 009 SSR Specimens, Tests, & Evaluation Date Approved: April 2006 Prepared By: C. Scott Revision #3 Page 11

	Slow Strain Rate Work Request/Test Information For	m
Person Performing Test: 100	Gerst	Home Phone: 740548774>
Special Hazards: (AUST, C		Project Name: ARES 2008
Fistart (DaterTime): 5408 7:15	Take Nown Finish (Date/Time):5-12-08 7:15	Project Number: 8/117013_5
Material ID#:	TEST PARAMETERS JA Test #:)//6 ~ 6 6 6 Extension Rate: / E · 6 in/sec Strain Rate: / E - 6 sec ¹	SSR System # RPM:/ 7 '(
	DATA ACQUISITION	7
Data File Name: 1146-60 DAT	Strip Chart Scale:	Data Acquisition Computer #:
Data Channels: 15+(6	Strip Chart Speed:	LVDT or Dial Gauge ID#:
Indering 93	SAMPLE ENVIRONMENT	34
Test Solution: <u>AZ102</u>	Gas: NONC	Reference Electrode: <u>SCF</u>
Initial pH:	Temperature: 77° C	Free Corrosion Potential: <u>239</u> mV
Final pH:	Pressure: <u><u><u>Roo</u></u></u>	Applied Potential: FCP mV
<u>Initial</u> Overall Length: どいつ in	SPECIMEN DIMENSIONS Measurement Device: CALEPERS	<u>Final</u> Overall Length: <u> </u>
Gauge Mark Length: 1,593 in.	Device ID #:/ 4 4 7	Gauge Mark Distance: 1,802 in.
Gauge Diametert 1 2 5 in.		Gauge Diameter:078in.
Cross Sectional Area: ,012272 in.2	Machined Gauge Length: 1.000 in.	Cross Sectional Area:
	RESULTS & CALCULATIONS Max Load /000 lbs.	Time to Failure: 58,25 hrs.
	Reduction in Area: <u>012272-,00477</u> m ²	Time to Failure: 209715 sec.
% Elongation = $\frac{\text{Elongation}}{\text{Machined Gags Length}} = \frac{(,209)}{(,1e^{000})} x$	$100 = 20 \cdot 9 \% \qquad \text{%Reduction} = \frac{\text{Red}}{\text{initial Crit}}$	$\frac{(.007493)}{(.017272)} \times 100 = (.06\%)$ cases Section Area $(.017272)$
$JTS = \frac{Max. Load}{Max. Cross. Section Area} = \frac{(1000)}{(1012272)} = \frac{8}{5}$	81487 psi 81487 psi×6.895	10"= <u>561,85</u> mpa
	CRACKING	
/isual:ND		Crack Mode:
.ow Power (30X):		Max. Crack Depth:mm
letallographic:	·	Crack Velocity: mm/sec
omments: T controller#123	6 TC+1670 QA	APPROVED
	NAN	1E: Claum
d	DAT	F. 6-1808
roject Leader's Signature:	6/5/08	Date:
1 009		

Test	Sheet	Adden	dum
------	-------	-------	-----

Test #	1196-61	Readings		
Sample #	SSR 1196-61	90		
Filar Eye Piece	CCT # 0224	12		
		78		
Magnification	<u> </u>	Avg.		
inches/graduation	.001	Reading,	* inches/	= Final Diameter,
		graduations	graduation	in.
		78	.001	.078

.

.

	Work Request/Test Information For	
	persi	Home Phone: 740 548 770
Special Hazards: <u>Crustic</u> Filled cert Start (Date Time): <u>11510</u> <u>5</u> .12-08	·	Project Name: <u>ARES 20</u> Brief Number 8/1/7013
Start (Date/Time): 11:10 5-12-08	Finish (Date/Time):	Project Number: 8117015
ADDTIDIO 1 D	TEST PARAMETERS)
Material: AART128 Grade B	Test#	SSR System #:
Material ID#: [196	Extension Rate: 16-5 in/sec	RPM:/? У
Sample #: <u>SSR 1146 - 62</u>	Strain Rate:/ E `_ 6 sec'1	
1101-62-005	DATA ACQUISITION	
Data File Name: 1(96 - 62.0AT	Strip Chart Scale:	Data Acquisition Computer #:
Data Channels:5+(C	Strip Chart Speed:	LVDT or Dial Gauge ID#
Euoporated Supervate TA	SAMPLE ENVIRONMENT	500
Test Solution: HZ TO	Gas: NONE	Reference Electrode: SCE
Initial pH:/4,0	Temperature: 50°C	Free Corrosion Potential: -3.32
Final pH:14_+	Pressure: ROOM	Applied Potential:FCA
initial	SPECIMEN DIMENSIONS	Cinal .
Overall Length: &, O	Measurement Device CALOPS	Overall Length: 8, 2
1104	Device ID #: /497	/072
a a 19 u		
Gauge Diameter: <u>0129</u> in. Cross Sectional Area: <u>012076</u> in. ²	Machined Gauge Length: 1.00 0 in.	Gauge DiameterO [/ Cross Sectional Area: (00 465)
	RESULTS & CALCULATIONS	
	Max Load 993 tos.	Time to Failure: 69.67
Elongation = $1.933 - 1.689$ in.	Reduction in Area: <u>.012076~.004657</u> in.2	Time to Failure: 232813
Bongation (,244)	່. ໃນໄປເຮັດ Redu	ration in Area (10077419) /
X Elongation = $\frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(, 244)}{(, 200)} x$	$100 = \frac{24.4}{100} \text{ % Reduction} = \frac{\text{Reduction}}{100} = \frac{100}{100}$	$\frac{1}{1000} \frac{1}{1000} \frac{(.007419)}{1000} \times 100 = \frac{1}{2}$
94.7		
$\pi S = \frac{Max Load}{Initial Cross Section Area} = \frac{(11.5)}{(1012.076)} = \frac{5}{2}$	2227 psi 82227 psi × 6.895	10" = 566,96 MPa
		<u> </u>
A] _	CRACKING	
/isual:N0	· · ·	Crack Mode:
ow Power (30X): N Ə		Max. Crack Depth:
letallographic:		Crack Velocity:n
omments: TCO~ TAO 11er# 12	36 TC#1670	QA APPROVED
·····	· · · · · · · · · · · · · · · · · · ·	NAME Odum
		DATE .
oject Leader's Signature:	(11-10)	DATE:
The M	1-615/08	
009	SSR Specimens, Tests, & Evaluation	Date Approved: A

Test S	Sheet	Adder	ndum
--------	-------	-------	------

Test #	1196-62	Readings		
Sample #	<u>SSR 1196-62</u>	87		
Filar Eye Piece	CCT # 0224			_
		77		-
Magnification	30 X	Avg.		
inches/graduation	.001	Reading, graduations	* inches/ graduation	= Final Diameter, in.
		77	,00 (.077

	Slow Strain Rate Work Request/Test Information For	m
Person Performing Test <u>JG</u> Special Hazards: <u>CAUST</u> Fill fel CPII Start (Date/Time): <u>S-14-08</u> /:44	Gerst	Home Phone: 740 548 774 Project Name: ARES Project Number: 811 70 13 S
Material: AART 128 Grade 1 Material ID#: Sample #: SSR _1196 - 6 - 3	TEST PARAMETERS	SSR System #:5 RPM:694
Data File Name: //96-63,07 Data Channels: 97/6	DATA ACQUISITION	Data Acquisition Computer #:/C
Trackitus 96 Test Solution: <u>AP 105</u> Initial pH:13 r.S Final pH:13 t	SAMPLE ENVIRONMENT Gas: NONC Temperature: 50°C Pressure: Room	Reference Electrode: <u>SCE</u> Free Corrosion Potential: <u>-300</u> n Applied Potential: <u>FCP</u> n
Initial Overall Length: 8.0 in Gauge Mark Length: 1.105(in Gauge Diameter: 1.24 in Cross Sectional Area: 0.12076 in. ²	1 (14)	Final Overall Length: §, Z Gauge Mark Distance: 1.897 Gauge Diameter: 077 Cross Sectional Area: 004657
Pre-Load: 75 ibs. Elongation = <u>1,897 - 1,656 in</u> .	RESULTS & CALCULATIONS Max. Load 996 Ibs. Reduction in Area: 012076004657 in.2	Time to Failure: 64.33 hrs Time to Failure: $23/595$ sec
	$\frac{1}{2} \times 100 = \frac{24 \cdot 1}{100} \% \% \text{Reduction} = \frac{\text{Reduction}}{1000 \text{ km start Crit}}$ $= \frac{82476}{2000} \text{ poi} \qquad 82476 \text{ poi} \times 6.895$	
Visual:NO Low Power (30X):NC) Metallographic:	CRACKING	Crack Mode:n Max. Crack Depth:n Crack Velocity:mm/s
comments: TController #	-1264 70#1301	QA APPROVED
		DATE: C-18-08

ţ

|--|

Test #	1196-63	Readings		
Sample #	SSR 1196-63	84		
Filar Eye Piece	CCT # 0224	7		
		77		
Magnification inches/graduation	.00 (30X	Avg. Reading, * graduations	inches/ graduation	= Final Diameter, in.
		77	,001	.077

	Slow Strain Rate Work Request/Test Information Fo	m
Person Performing Test: Joe	berst.	Home Phone: 740 548 7747
Special Hazards: CAUSTIC		Project Name: ARES
Special Hazards: <u>Crustic</u> Filled ce (1 Start (Date/Time): <u>57/6-08</u> 11:25	Finish (Date/Time): 5-19-08 7:20	Project Number: 81170135
Material: <u>AART 128 Grade 13</u> Material ID#: <u>119 6</u> Sample #: <u>SSR 1196 - 6 4</u>	TEST PARAMETERS Test #: //96-64 Extension Rate: /6-6 Strain Rate: /6-6	
	DATA ACQUISITION	2
Data File Name: 1196 - 64	Strip Chart Scale:	Data Acquisition Computer #:
Data Channels: 15+16	Strip Chart Speed:	LVDT or Dial Gauge ID#: <u>434</u>
Tracking 89	SAMPLE ENVIRONMENT	
Test Solution: <u>AP105</u> Aixed	Gas:NONE	Reference Electrode: SCE
Initial pH:/3 +	Temperature: <u>50°C</u>	Free Corrosion Potential: -324 mV
Final pH:737	Pressure: <u><u><u></u><u></u><u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u></u></u>	Applied Potential: FCP mV
Initial	SPECIMEN DIMENSIONS	<u>Final</u>
Overall Length: S , O in.	Measurement Device: CAL PES	Overall Length: <u>8,</u> 2in.
Gauge Mark Length: 1.660 in.	Device ID #: 1497	Gauge Mark Distance: 1.876 in.
Gauge Diameter: 1/2-4 in.		Gauge Diameter
Cross Sectional Area: 2012076 in.2	Machined Gauge Length: 1,00 () in.	Cross Sectional Area: . 004537 in.2
Pre-Load: 75 lbs. Elongation = $1.876 - 1.660$ in. % Elongation = Borgation Machined Gage Length = $(.216)$ (1.000) JTS = Max. Load Initial Cross Section Area = $(.879)$ (.812076) = -		Time to Failure: $60, 27$ hrs. Time to Failure: 216466 sec. rotion in Area (2007540) x 100 = $62,43$ w to 3 = 564.67 MPa
4.1.	CRACKING	
visual:		Crack Mode:
.ow Power (30X):		Max. Crack Depth: mm
fetallographic:		Crack Velocity:mm/sec
omments: TController #12	36 7C # 1670	QA APPROVED
	· · · · · · · · · · · · · · · · · · ·	NAME: cean
roject Leader's Signature:	/	DATE: 6-18-08
1 009 vision #3	SSR Specimens, Tests, & Evaluation Page 11	Date Approved: April 2006 Prepared By: C. Scott

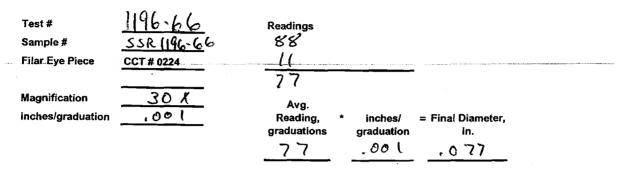


Test #	1196-64	Readings	
Sample #	SSR 1196-64	91	
Filar Eye Piece	CCT # 0224	15	
	<u> </u>	76	
Magnification	<u>30K</u>	Avg.	
inches/graduation	.001	Reading, * graduations g	inches/ = Final Diameter, raduation in.
		Jh 00 76 _	.076

1

	v Strain Rate Test Information Form
Person Performing Test. Joe Gers T	Home Phone: 7405487747
Special Hazards: CANESTIC	Project Name: ARES
F: [[e4 cell Start (Date/Time): 5-78-0-7 [];00 Finish (Date/Time): Project Number:8/170135
	PARAMETERS A (96~65) SSR System #: A 16~6 sc RPM: 174 16-6 scc ¹ Image: State St
Data File Name: 1196-65.047 Strip Chart Scale: Data Channels: 15 + 1 C Strip Chart Speed	
	ENVIRONMENT
	0 ~ · · · · · · · · · · · · · · · · · ·
Initial pH:/3,0/ Temperature:	50 °C Free Corrosion Potential: mV
Final pH:13_+Pressure:	Room Applied Potential: -250 mV EN DIMENSIONS MEASUred with calipers -
Gauge Mark Length: 1,760 in Device ID #: Gauge Diameter: 1,245 in	vice: $CA(ipels)$ Overall Length: $3 \cdot 2$ in. $/ 497$ Gauge Mark Distance: $1,888$ in. Gauge Diameter: 1175 in. Length: 1000 in. Cross Sectional Area: 010844 in. ²
Pre-Load: Nos. Max Load	E CALCULATIONS $\frac{85}{100}$ tos. Time to Failtone: 41.69 hrs. $\frac{12.04^{-}.010844}{10.02}$ time to Failtone: 150072 sec.
% Elongation = $\frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(128)}{(100)} \times 100 = \frac{12.8}{100}$	$ \frac{1}{100} \text{ % Reduction} = \frac{\text{Reduction in Area}}{\text{initial Cross Section Area}} \frac{(001330)}{(012174)} \times 100 = 10192\% $
UTS = $\frac{Max. Load}{Initial Cross. Section Area} = \frac{(485)}{(1012174)} = \frac{80911}{pai}$	& D9 [[psi x 6.895 10 ⁻³ = <u>557,88</u> MPa
	RACKING
Visual:NO	Crack Mode:
Low Power (30X):	Max. Crack Depth: mm
Metallographic:	Crack Velocity:mm/sec
comments: Toor troller 1325 T	C 1301 PSTAT 2115
1000 N Resistor	QA APPROVED
stopped AT 7:30 A.M. 98	85 165 -250 NAME: Ceam
Project Leader's Signature: 1-9-1508	Date: 6-18-02-
	is, Tests, & Evaluation Date Approved: April 2006 Page 11 Date Approved: April 2006 Prepared By: C. Scott

Person Performing Test: Jee	Gerst	Home Phone: 740 548 774
	· · · ·	Project Name: ARES
Special Hazards: <u>CAUS</u> Fille(1 Ce)(Start (Date/Time): <u>6-3-58</u> 230	AKA MANUAL	Project Number: 8117013 S
yya chasa chamina commo	TEST PARAMETERS	<u></u>
Material: AART 128 Grade 1	S Test #: 1196-66	SSR System #:
Material ID#:/ 196	Extension Rate: 15-6 in/sec	с RPM:724
sample #:SSR 1196-66	Strain Rate: 15-6sec ^{**}	1
	DATA ACQUISITION	2
Data File Name: 1196-66, 0.41	Strip Chart Scale:	Data Acquisition Computer #:
Data Channels:5+/6	Strip Chart Speed:	LVDT or Dial Gauge ID#: 7.5
Tracking 97	SAMPLE ENVIRONMENT	
Test Solution: AW 105 SuperNAT	Gas: None	Reference Electrode: <u>5C.5</u>
Initial pH: 13 +	Temperature: <u>50°C</u>	Free Corrosion Potential:
Final pH:13 +	Pressure: <u><u><u>Room</u></u></u>	Applied Potential:
. Initial	SPECIMEN DIMENSIONS	Final
Overall Length: 6. 0 in.	Measurement Device: CALIPENS	- Overall Length: 8,2
Gauge Mark Length: 1:672 in.	Device ID #:/ 497	Gauge Mark Distance: 1.885
Gauge Diameter: 0/245 in.		Gauge Diameter:577
Cross Sectional Area: 012174 in.2	Machined Gauge Length: / . UUU in.	Cross Sectional Area:
Pre-load: 75 he	RESULTS & CALCULATIONS	Time to Failure: 61,87
1005 1177	Max Load <u>18</u> (nos. Reduction in Area: 012174 ~ ,00 4657 in. ²	Time to Failure: 222716
% Elongation = $\frac{\text{Elongation}}{\frac{1}{2}} = \frac{(,213)}{(,213)}$	$x100 = 21.5$ % % Reduction = $\frac{Re}{Initial}$	$\frac{\text{duction in Area}}{(.007517)} \times 100 = 61.$
Machined Gage Length (7,000)	initial (Cross Section Area (, UIZI/ 7)
UTS = (987) _	<u>81075 psi 81075 psi×6.89</u>	5 10°= 559,01 MPa
Initial Cross Section Area (012174)	par x 0.00	
	QALAPPROVED)
VisualNO	NAME: Claun	Crack Mode:
ow Power (30X):?		Max. Crack Depth:
Vetallographic:	DATE: 8-20-08	
comments: Tcontroller 13	R25 TC 1670	
	ſ	
		Date: 8/4/08
roject Leader's Signature:	•	Date: 94/08

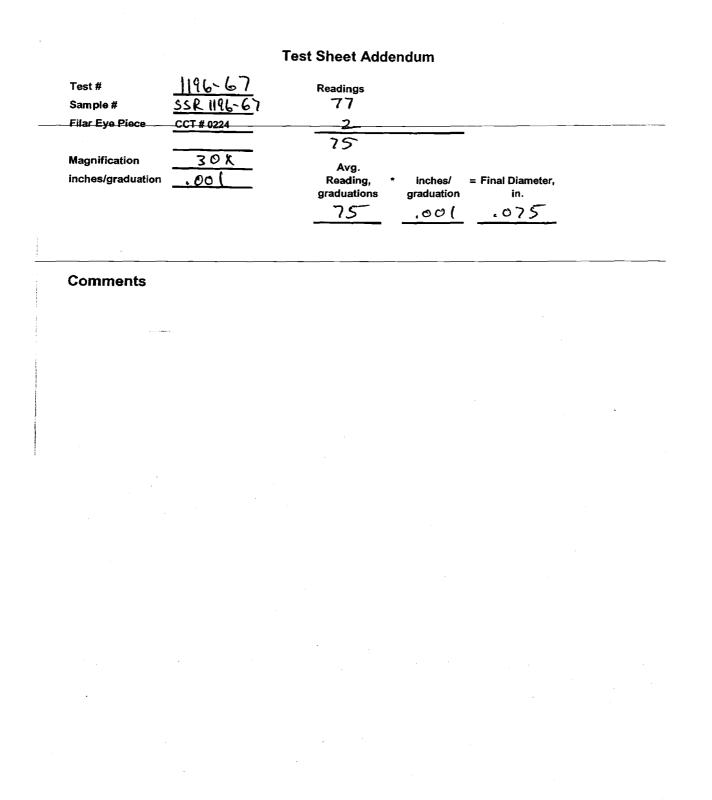


Test Sheet Addendum

Comments

ς.

	Slow Strain Rate Work Request/Test Information For	rm
Person Performing Test. Job (Special Hazards: CAUS Filled Cell: Start (Date Time): 6-4-08 410	tic	Home Phone: 740 548 7747 Project Name: ARES Project Number: 81170135
Material: <u>AART128 614d e</u> Material ID#: <u>1196</u> Sample #: <u>SSR 1196-67</u>	TEST PARAMETERS B Test #. //16 · 6 7	
Data File Name: 1/16-67,047 Data Channels: 11_F(Z	DATA ACQUISITION Strip Chart Scale:	Data Acquisition Computer #:/ LVDT or Dial Gauge ID#:2_9_
Tracking 98 Test Solution: 54 /01 Initial pH: 13 + Final pH: (3 +	SAMPLE ENVIRONMENT Gas: Temperature: Pressure: Moo	Reference Electrode: <u>SC</u> Free Corrosion Potential: <u>206</u> mV Applied Potential: mV
Initial Overall Length: 0 Gauge Mark Length: 1, 676 Gauge Diameter: , 1245 Cross Sectional Area: 022174	Device ID #:/ 497	Final Overall Length: 3.2 in. Gauge Mark Distance: 1.900 in. Gauge Diameter: .07.5 in. Cross Sectional Area: .00.441.8 in.2
Pre-Load: 75 ibs. Elongation = $1.900 - 1.676$ in.	RESULTS & CALCULATIONS Max. Load /000 lbs. Reduction in Area: 01217100411/Bin.2	Time to Failure: <u>63.70</u> hrs. Time to Failure: <u>274328</u> sec.
-	$\frac{1}{2} \times 100 = \frac{22.4}{5} \times \frac{100}{5} = \frac{22.4}{5} \times \frac{100}{5} = \frac{22.4}{5} \times \frac{100}{5} = \frac{100}{5} \times \frac{100}{5} \times \frac{100}{5} = \frac{100}{5} \times \frac{100}{5}$	
<u></u>	UA APPROVED	
Visual: <u>NO</u>	NAME: <u>Claun</u>	Crack Mode:
Low Power (30X):C	DATE: 8-20-08	Max. Crack Depth:mm Crack Velocity:mm/sec
	260 TC 1538	
nı.S	· · · · · · · · · · · · · · · · · · ·	als/al
Project Leader's Signature:	SSR Specimens, Tests, & Evaluation Page 11	Date: <u>844708</u> Date Approved: April 200 Prepared By: C. Sco



RPP-RPT-37505, Rev. 0

Slow Strain Rate Work Request/Test Information Form 614-413-8128 Person Performing Test: Home Phone ARES 2008 Special Hazards Project Name 81170135 Start (Date/Time):06 -10 -08 6-13-08 Project Number: Finish (Date/Time): FILLED CALL 10.30 ARAMETERS Y TEST Material: AART 128 Grade B Test # SSR System 90 Material ID# F Extension Rate in/sec RPM Sample #: 6 E ~ Strain Rate: sec⁻¹ DATA ACQUISITION 11 6-68 Data File Nam Strip Chart Scale: Data Acquisition Computer # 0 Data Channels LVDT or Dial Gauge ID#: Strip Chart Speed: 94 Tracking SAMPLE ENVIRONMENT CEYIOI CSL A None Test Solution: Gas Reference Electro -180 11.89 50°C IZ2°F Initial pH: 7 m٧ Free Corrosion Potential Temperature 2 Ó Roon Final pH: Pressure: Applied Potential mV. SPECIMEN DIMENSIONS [nitial Final 70Measurement Device: CALIPERS Overall Length: Overali Length in. 149 6340 Device ID #: Gauge Mark Length: in Gauge Mark Distance Gauge Diamete 124 07 Gauge Diameter: Machined Gauge Length: / 000 Cross Sectional Area: 004657 Cross Sectional Area: 012076 in.2 in. in.² **RESULTS & CALCULATIONS** 4.00 1004 Pre-Loa ihs Max. Load 230402 ,63 860 Elong Reduction in Area: .0(2076-.004657in.2 226 22 % Ela (100 = Area (,012076 (1004) (.01207G) 83138 peix 6.895 10" = 573.24 MPa 83138 UTS Initial Cross Se **QA APPROVED** Ø Visual: Crack Mode: NAME: Claum 2 Low Power (30X): Max. Crack Depth mm Metallographic: DATE Crack Velocity: 8-20-06 mm/sec 60 \mathcal{O} Comments hr 335 hrs 44.636 0 8/4 Project Leader's Signature Date: QA 009 SSR Specimens, Tests, & Evaluation Page 11 Date Approved: April 2006 Prepared By: C. Scott Revision #3

Test # Sample # - Filar Eye Piece	1196-68 SSR 1196-68 CCT # 0224	Readings 94 17 77
Magnification inches/graduation	,00 (30X	Avg. Reading, * inches/ = Final Diameter, graduations graduation in.

Test Sheet Addendum

- · · · · ·

T	Work Request/Test Information For	
Person Performing TestO_C	Gerst	Home Phone: 740 5487787
Special Hazards: <u>CAUSTIC</u> F.: [led cell Stat [Date/Time]: 7:45 6-17-08	TAKEDOWN	4/1 70/35
f: [led cell 7:45 6-17-08 start (Date/Time): 7:45 6-17-08	TAKE DOUN Finish (Date/Time): 7.20-08	Project Number. 811 7013 3
ANTION O IL P	TEST PARAMETERS	4
Material: AART 128 Grade B	Test #: //96-69	SSR System #:
Material ID#:	Extension Rate: /E-6in/sec	RPM:0_/ 7
Sample #:	Strain Rate: /E-Gsec ⁻¹	
	DATA ACQUISITION	. 11
Data File Name: 1196-69, DAT	Strip Chart Scale:	Data Acquisition Computer #:
Data Channels:	Strip Chart Speed:	LVDT or Dial Gauge ID#:
Tracking 100	SAMPLE ENVIRONMENT	
Test Solution: AY 101 CSL	Gas: None	Reference Electrode: SCE
Initial pH://_82	Temperature: 50°C	Free Corrosion Potential:
Final pH: /2.16	Pressure: <u><u><u></u><u><u></u><u><u></u><u></u><u><u></u><u></u><u></u><u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u></u></u></u></u></u>	Applied Potential: <u>FCP</u> m
nitial	SPECIMEN DIMENSIONS	
Overall Length: どい in.	Measurement Device: Calipers	Overall Length:
Gauge Mark Length: /. 656 _ in.	Device 1D # 1487	Gauge Mark Distance: 1. 460 ir
1245		Gauge Diameter:
Gauge Diameter: 12 3 in. Cross Sectional Area: 012179 in. ²	Machined Gauge Length: $1,000$ in.	Cross Sectional Area: <u>004418</u> in.
	RESULTS & CALCULATIONS	
Pre-Load: 75 ibs.	Max. Load 988 Ibs.	Time to Failure: 59.45 hrs.
	Reduction in Area: 012174 ~ 004418 in.2	Time to Failure: 215807 sec.
% Elongation = $\frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(, 204)}{(, 000)}$	$x 100 = \frac{20}{100} \frac{10}{100} \frac{10}{100} \frac{100}{100} \frac{100}{100}$	$\frac{1007750}{100} \times 100 = \frac{(.007750)}{(.012174)} \times 100 = \frac{63.71}{(.012174)}$
Machined Gage Langth (12000)		
UTS =	81157 psi 81157 psi x 6.895	10"=559,58 MPa
Initial Cross Section Area (812 (74)		
Visual: No~e	QA APPROVED	Crack Mode:
Low Power (30X):?	NAME: Claun	Max. Crack Depth: m
Metallographic:	DATE. 8-20-08	Crack Velocity:mm/se
comments: T Centrollier /	264 TC 1538	
Comments: Certre (1978]		
· · · ·		
<u></u>	<u>ŧ</u>	Sala Stalas
Project Leader's Signature: (M		Date: <u>0/4/00</u>
QA 009 Revision #3	SSR Specimens, Tests, & Evaluation Page 11	Date Approved: April 20 Prepared By: C. So

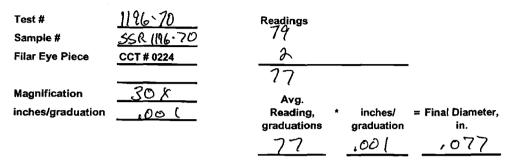
Sample # Filar Eye Piece Magnification Inches/graduation	<u>SSR 1196-69</u> <u>CCT # 0224</u> <u>30 X</u> 00 (3 75 Avg. Reading, graduation 75	* inches/ s graduation , 80 (= Final Diameter, in. 	
Comments					
	•				
•					

Test Sheet Addendum

	Work Request/Test Information F	
Person Performing Test: <u>Jo</u> Special Hazards: <u>Cous</u> Filled cell 9:50 7-9 Start (Date/Time): <u>1:50 7-9</u>	e Gerst t.c Trihen (DaterTime): 7-13-08 9:0	Home Phone: <u>740 548 7747</u> Project Name: <u>ARES</u> Project Number: <u>8//70/35</u>
Material: <u>AART 128 Groat</u> Material ID#: <u>119 G</u> Sample #: <u>SS R 119 G ~ 7</u>	Extension Rate: 1E-G in/s	
Data File Name: <u>1196-70</u> Data Channels: <u>15 + 1</u> 0		Data Acquisition Computer #:3
Tracking 102 Test solution: <u>Aw 105 52</u> Initial pH: <u>13,17</u> Final pH: <u>13-4</u>	SAMPLE ENVIRONMENT	Reference Electrode: <u>5CF</u> Free Corrosion Potential: <u>269</u> m ⁻ Applied Potential: <u>-100</u> m ⁻
Initial Overall Length: 8:0 Gauge Mark Length: 1.73 Gauge Diameter: 2.12 Cross Sectional Area: 0.12		Einal Overall Length: 8. 2
Pre-Load:75 Elongation = <u>1,953 - 1,733</u>	RESULTS & CALCULATIONS Ibs.	Time to Failure: <u>67.78</u> .hrs. Time to Failure: <u>244019</u> sec.
% Elongation = $\frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{1}{1000}$ UTS = $\frac{\text{Max. Load}}{\text{Max. Load}} = \frac{1000}{1000}$		Reduction in Area at Cross Section Area $(,0074]9)$ x $100 = 6(.4)$ at Cross Section Area $(,00276)$ x $100 = 6(.4)$ 895 $10^{4} = 666$ MPa
Visual:	OA APPROVED NAME: Claum	Crack Mode: Max. Crack Depth: mr
Visual:	OA APPROVED NAME: <u>Claun</u> <u>DATE: 8-20-00</u> <u>IContisller</u> 1325 did Not Ac	Max. Crack Depth:m Crack Velocity:mm/see STAT 21(5 TC/6) VA (YZ.Y
Visual:	10 QA APPROVED NAME: Claum DATE: 8-20-08 I Controller 1325 P	Max. Crack Depth:m Crack Velocity:mm/see STAT 21(5 TC/6) VA (YZ.Y

,





:

	Slow Strain Rate Work Request/Test Information For	m
Person Performing Test: Joe G Special Hazards: Crost. (Home Phone: 740 548 774	
Special Hazards: <u>CAOSEC</u> Start (Date/Time): <u>7-14</u> <u>11:10</u>	Finish (Date/Time): 7-17	Project Number: 81/70135
AART 128 Grade 15 Material: 191746 Material ID#: 196 Sample #: SSR 1196-71	TEST PARAMETERS Test #: //96 ~ 7 / Extension Rate: / E ~ 6 Strain Rate: / E ~ 6	
Data File Name: <u>1196-71.0AT</u> Data Channels: <u>154/6</u>	DATA ACQUISITION Strip Chart Scale:	Data Acquisition Computer #:3
TrAckins 102	SAMPLE ENVIRONMENT	
Test Solution: <u>AW 105 Supervice</u> Initial pH: <u>13:17</u> Final pH:13:4[Gas: No NO Temperature: <u>50°C</u> Pressure: Rod	Reference Electrode: <u>SCE</u> Free Corrosion Potential: <u>-36 Z</u> mV Applied Potential: <u>10 C</u> mV
Initial Overall Length: <u>4,0</u> in. Gauge Mark Length: <u>1,665</u> in. Gauge Diameter: <u>7,72,95</u> in. Cross Sectional Area: <u>012174</u> in. ²	SPECIMEN DIMENSIONS Measurement Device: Califers Device ID #: 1997 Machined Gauge Length: 1,000 in.	$\begin{array}{c} \underline{Final} \\ \hline \\ \text{Overall Length:} \underbrace{\$, 2}_{i} \\ \hline \\ \text{Gauge Mark Distance:} \underbrace{1, 895}_{i} \\ \text{in.} \\ \hline \\ \text{Gauge Diameter:} \underbrace{0, 28}_{i} \\ \hline \\ \text{Cross Sectional Area:} \underbrace{0, 0, 4779}_{i} \\ \text{in.} \\ \end{array}$
Pre-Load: 75 lbs. Elongation = <u>1.898~1,665 in.</u>	RESULTS & CALCULATIONS Max. Load /00 / Ibs. Reduction in Area:	Time to Failure: ムジ、〇8 Time to Failure: 234298 sec.
$K = \text{Elongation} = \frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(230)}{(200)}$ $JTS = \frac{\text{Max. Load}}{\text{Initial Cross Section Ares}} = \frac{(650\%)}{(70\%)} = \frac{1}{2}$		$\frac{40073957}{100855} \times 100 = \frac{60.75}{100} $
Initial Cross Section Area (/OO (,)		
Aisual:No	QA APPROVED NAME <u>: Claun</u>	Crack Mode:mm
Metallographic:	DATE: 8-20 08	_ Crack Velocity:mm/sec
comments: 1000 A PST	AT 2115 T.Co. Tro	(ler 1325 T(167
roject Leader's Signature:		Date: 8/4/08
A 009 evision #3	SSR Specimens, Tests, & Evaluation Page 11	Date Approved: April 2006 Prepared By: C. Scott

A-164



Test #	1196-71	Readings		
Sample #	<u>SSR [196-7]</u>	81		
Filar Eye Piece	CCT # 0224	3		
		78		-
Magnification	308	Avg.		
inches/graduation	.001	Reading, graduations	 inches/ graduation 	= Final Diameter, in.
		_78	,001	.078

	Slow Strain Rate Work Request/Test Information Fo	m
Person Performing Test: Joe Special Hazards: CAUST Start (Date/Time): 7-7206 9	Gerst ti C 1:00 Take Down 2-2508 2:10	Home Phone: 740 548 77 Project Name: ARES Project Number: 81 (70 (3 S
Material: <u>AART</u> 128 GrAd Material ID#: <u>1196</u> Sample #: <u>SR 1196-7</u>	Extension Rate: 16-6 in/sec	
Data File Name: <u> { 6 - 72 , ⊅</u> Data Channels: 15 + 1 <_	Strip Chart Speed:	Data Acquisition Computer #:3
Tracking #10 Test Solution: AW 105 Super Initial pH: 13+ Final pH: 13,37		Reference Electrode: SCE Free Corrosion Potential: -2/0 m Applied Potential: -50 m
Initial Overall Length: K.O Gauge Mark Length: //637 Gauge Diameter: O_ [25 Cross Sectional Area: <u>C[277</u>	SPECIMEN DIMENSIONS in. Measurement Device: Califers in. Device ID #: / 417 in. in. in. in.^2 Machined Gauge Length: /.000in.	Gauge Diameter:
Pre-Load: 75 Elongation = $\frac{1.862 - 1.637}{\text{Elongation}}$ in % Elongation = $\frac{\text{Elongation}}{\text{Machined Gage Length}} = \frac{(.23)}{(/c00)}$	Reduction in Area: $0 \circ 7 = 7 = 7 = 7 = 7 = 7 = 7 = 7 = 7 = 7$	Time to Failure: 60.79 hrs. Time to Failure: $2/8846$ sec. GIST soluction in Area $(,007547464 \times 100 = 62.00)$ Cross Section Area $(,012272)$
UTS = $\frac{Max. Load}{Initial Cross Section Area} = \frac{(977)}{(10)(227)}$	$\frac{1}{2} = \frac{79613}{2}$ psi $7\frac{9613}{100}$ psi x 6.85	35 10° = <u>548, 9 J</u> AIPa
Visual: Low Power (30X):? Metallographic: Comments:/OOD_N_Re ?	QA APPROVED NAME: <u>Claum</u> DATE: 8-2008 Sictor BTAT #2/15	Crack Mode:m Max. Crack Depth:m Crack Velocity:mm/se Tcoutroller#1325
Project Leader's Signature:	£	Date: 8/4/08
		Date Approved: April 20

. •

Test Sheet Addendum

Test #	196-72	Readings		
Sample #	SSR 1196-72	82		
Filar Eye Piece	CCT # 0224	5		
		77		
Magnification	_30x	Avg.		
inches/graduation		Reading, * graduations	inches/ graduation	= Final Diameter, in.
		77	,00 (,077

. -

	Slow Strain Rate Work Request/Test Information For	m
Person Performing Test Joe G Special Hazards: AUST Start Categories 7-25-05 830	erst	Home Phone: 740 548 774 Project Name: ARES 2008
Start (Date/Time): 7-25-08 830 Material: <u>ART</u> 128 GAA	TEST PARAMETERS	SSR System #
Data File Name: <u>1196-73, D4</u> 7 Data Channels: <u>15716</u>	Strip Chart Speed:	Data Acquisition Computer #:
TRACKENG 103.0324 Test Solution 1733 AW 1055 Initial pH: 13.32 Final pH: 13 H	PervAlesample Environment Gas:	Reference Electrode: <u>SCE</u> Free Corrosion Potential: <u>217</u> mV Applied Potential: <u>700</u> mV
Initial Overall Length: 8,0 in. Gauge Mark Length: 1,634 in. Gauge Diameter: 12,7 in. Cross Sectional Area: 12,68 in. ²	SPECIMEN DIMENSIONS Measurement Device: <u>Calipers</u> Device ID #: <u>/997</u> Machined Gauge Length: <u>/c000</u> in.	Final Overall Length: $S_1 \ge 2$ in. Gauge Mark Distance: $1 \times S_2 \le 5$ in. Gauge Diameter: $Q_2 = 7 \ge 2$ in. Cross Sectional Area: $1 \times 0 \times 6 \le 7$ in.
Pre-Load: 75 ibs. Elongation = $1.885 - 1.634$ in. % Elongation = Elongation = $(,201)$	RESULTS & CALCULATIONS Max. Load /0/0 lbs. Reduction in Area: $\frac{512668-004657}{2}$ in. ² $\frac{1}{2} \times 100 = \frac{20 e}{2} \times \frac{8}{2}$ WReduction = Reduction = Red	Time to Failure: 62.43 hrs. Time to Failure: $22474/$ sec. suction in Area $(.009011)$ $\times 100=63.24\%$
•)	
Visual:	QA APPROVED	Crack Mode:
Low Power (30X):	NAME: Cedur	Max. Crack Depth:mm
Metallographic:	DATE 8-20-08	Crack Velocity:mm/sec
comments: 1000 Resisto	R PStat #2115 1 contr	coller #1325 TC 1670
Project Leader's Signature:	<i>t</i>	Date: 8/20/8
QA 009 Revision #3	SSR Specimens, Tests, & Evaluation Page 11	Date Approved: April 2006 Prepared By: C. Scott

Test #	1196-73	Readings			
Sample #	SSR 1196-73	85			
Filar Eye Piece	CCT # 0224	<u>۲</u>			
		77			
Magnification inches/graduation	.30 .00 [Avg. Reading, graduations	*	inches/ graduation	= Final Diameter, ín.
		77	_	001	.077

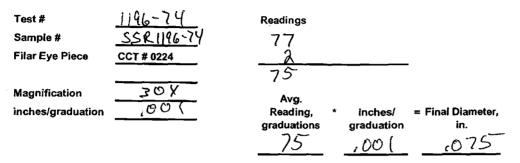
Test Sheet Addendum

RPP-RPT-37505, Rev. 0

,

	Slow Strain Rate Work Request/Test Information For	m
Person Performing Test: Joe G Special Hazards: CAUS (Start (Date/Time): 8-7-08 /0; 15	erst	Home Phone: 740 548 774 Project Name: ARES
Stair (Date/Time): 8-7.08_10, 15 Material: AART (128 Grade) Material ID#: 1196 Sample #:	TEST PARAMETERS	SSR System #: RPM:74
Data File Name: 1196-74, DAT Data Channels: 15416	DATA ACQUISITION Strip Chart Scale:	Data Acquisition Computer #:
VIOS FGE TRACK rest solution: 500 sullow Lot Initial pH: 13,32 Final pH: 13 t	Gas: Nove Gas: Sove Temperature: <u>50°</u> Pressure: <u>Roon</u>	Reference Electrode: <u>SC.F.</u> Free Corrosion Potential: <u>257</u> mV Applied Potential: <u>700</u> mV
$\begin{array}{c c} & \underline{Inttial} \\ \hline \\ Overall Length: & \underline{S} & \underline{O} \\ \hline \\ Gauge Mark Length: & \underline{I} & \underline{C} & \underline{S} \\ \hline \\ Gauge Diameter: & \underline{I} & \underline{C} & \underline{C} \\ \hline \\ Cross Sectional Area: & \underline{0} & \underline{12} & \underline{4} & \underline{6} \\ \hline \\ \end{array}$	SPECIMEN DIMENSIONS Measurement Device: <u>Califers</u> Device ID #: <u>/ 997</u> Machined Gauge Length: <u>/ 1000</u> in.	Gauge Mark Distance: <u>1.83</u> in. Gauge Diameter: <u>0.75</u> in.
Pre-Load:	RESULTS & CALCULATIONS Max. Load / 0 / 2 ibs. Reduction in Area: 012469-,004418 in. ²	
•	$\frac{1}{2} \times 100 = \frac{20.4}{100} \text{ %} \text{ %} \text{Reduction} = \frac{\text{Re}}{100} \text{ meas}$ $= \frac{\$1161}{\$100} \text{ psi} \qquad \frac{\$1161}{\$100} \text{ psi} \times 6.89$	$\frac{44(1500 \text{ in Area}}{27055 \text{ Section Area}} = \frac{(, 6 \text{ C} \text{ y} \text{ (} \text{)})}{(, 0 \text{ 2} $
Visual:ND Low Power (30X): Metallographic: Comments: 1000 JL Accisto	QA APPROVED NAME: <u>Claun</u> DATE: 8-20-08 DATE: 1325	Crack Mode:
l'ABE ANOUNT of corr. A Project Leader's Signature:	naterial at interface	And creatice core. At fillin Date: 8/20/8
QA 009 Revision #3	SSR Specimens, Tests, & Evaluation Page 11	Date Approved: April 2006 Prepared By: C. Scot





		Slow Strain Rate Work Request/Test Information For	n
	Person Performing Test: <u>///ARK</u> Special Hazards: <u>CAUS</u> (1) F { (CAUSE) [/ (00 %)4.0 % Start (Date/Time): / (00 %)4.0 %	/ JOE <u>C</u> Finish (Date/Time): <u>8-15-08</u> 4:45	Home Phone: $l_0/4 - 403 - 8620$ Project Name: $ARES 2008$ Project Number: 81170135
	Material: <u>AART</u> 128G114 <u>6</u> Material ID#: <u>119G</u> Sample #: <u>55R 1196-75</u>	TEST PARAMETERS Test #: $//96 - 7S$ Extension Rate: $/E^-G$ in/sec Strain Rate: $/E^-G$ sec ¹	SSR System #: <u>BADE 4</u> 2 RPM:7 4
	Data File Name: <u>119 6-75, DAT</u> Data Channels: <u>15 +16</u>	DATA ACQUISITION Strip Chart Scale: Strip Chart Speed:	Data Acquisition Computer # LVDT or Dial Gauge ID#:
1	ГАС Кай 9 1103/06 СХ Test Solution: <u>AW IOS Superwal</u> Initial pH: <u>13+</u> Final pH: <u>13+</u>	SAMPLE ENVIRONMENT Gas: NOY P Temperature: 50 ° C Pressure: ROOM	Reference Electrode: <u>SCF</u> Free Corrosion Potential: <u>270</u> mV Applied Potential: <u>50</u> mV
	Initial Overall Length: <u>8</u> (Q)in. Gauge Mark Length: <u>1, 6 4 4 5</u> in. Gauge Diameter: <u>125</u> in. Cross Sectional Area: <u>011111</u> in. ²	SPECIMEN DIMENSIONS Measurement Device: <u>A (+ P + S</u> Device ID #: <u>/ 4 9 7</u> Machined Gauge Length: <u>/ 000</u> in.	Final Overall Length: 8.1 Gauge Mark Distance: To corrected. Gauge Diameter: To MEASURE in. Cross Sectional Area:
₽⁄A	Pre-Load: 7.5 bs. Elongation = 07.4 in. % Elongation = Elongation Machined Gage Length = $\frac{(, 074)}{(/_{c}000)}$		Time to Failure: 23.63 hrs. Time to Failure: 85080 sec. Action in Area $()$ coss Section Area (-012272) $x 100 =%$
	UTS = $\frac{Max. Load}{Initial Cross Section Area} = \frac{(183)}{(1012272)} = -$	<u>63723</u> psi <u>6372</u> <u>a</u> si × 6.895	10*= <u>\$139.37</u> MPa
		QA AP prov ed	
	Visual: Low Power (30X): Metallographic:	NAME: <u>Rdun</u> DATE: <u>8-20-08</u>	Crack Mode: Max. Crack Depth: mm Crack Velocity: mm/sec
-	comments: 100 N RESISTOR Severe corrosion NO Final Dian-ten		
	NO Firal Diameter	ior ending gauge a	Date: 8/208
	QA 009 Revision #3	SSR Specimens, Tests, & Evaluation Page 11	Date Approved: April 2006 Prepared By: C. Scott

A-172

ARES AN 107		wth Test	ing fr	Don T.			16 CT - 17			Project Name ARES 20
- 1	196 CT	-[[#S-1841	oller #1	315	Lab Computer		F17,0AT	-	Project Number 8/1170/3
Frame			TCONIN	# 15		File Name Setup File		2008		Run at FCP
Load Cell	2181	l		•	-			6.5 ch P	4941	Material AART128GIAG
LVDT	1219			Batch	2-12-			6.5 pH		Material ID # 1196
								PSTAT	V Drep apross	Specimen Isolated All Leads
Date	Time	Temp. C	Load, Ibs.	Disp. In	Current Amps	Pot Drop V	Control PD V	Pot V SCE	Resistor, V	Comments
2-12-08	9:00	Room	328		20,01	,000317	,000298	~	FEP	Dry
2-17-08	1250	50	210	,2707	19.98	1000312	100290		+ 107mv	Filled cell 9:30
2-14-08	950	50	478	.2799	19,97	,000312	,000289	~	~ 48	
2-15.08	400	50	671	12843	19,96	2000 311	,000 289	-	+ 22	
2-18-08	655	50	1118	12908	19.98	,000 308	1000284		- 69	
2-19-08	230	50	1367	129.18	19.99	.000311	,000285	-	- 70	
2-20-08	305	50	1560	12979	19.99	.000315	.000 287		- 85	
2-21-08	715	50	1690	1300 1	19.98	000315	,000286		-72	ON APPROVED
2-22-08	730	50	1890	13033	19.98	1000318	1002 285		-78	GITTITIOTED
2-29-08	715	50	1834	13033	20,01	,000336	,000286		-112	NAME: cedum
3-3-08	825	50	1831	,3032		1000350	,000287			DATE: 8-25-08
3-5-08	1740	50	1795		20,03	1000359	1000285	1	-110	
3.7.08	715	50	1789	,3032	20,03	1750001	,000287	<u> </u>	- 96	<u></u>
3-10.08	and the second s	50	17.66	13032		,000387	000285	ļ	-11/2	added HO to Luger
3-13-08	200	50	+	13031	20,03		1000 289	<u> -</u>	- 125	<u> </u>
3-18-08	925	50	1685	,3030	20,02		+		-128	
3-20.08	110	50	1652	13028	20,02		1000285		- 131	
3-24-08	930	50	1565	1.3027	20.03	.000506	00289			
3-27-08		50	1481	,3025	20,03		2000286		- 122	D/A PD's were not
	230	50	1436	13025	20.02	1000 566	,000287		-111	
3-31.08		50	1322		20,03	1000 611	1000287		- 073	
4-3-08	1945	150	11137	13016	20,02	1.00 675	7,000 292	.}	-096	

 \sim

A-173

				i	10 1	(si =	2783	3 Lbs	· · · · · · · · · · · · · · · · · · ·	Pagel
ARES AN 107			ting	#-		Test# (T-18	······		Project Name ARES 200
Specimen	196 CT-	18	PSTAT	- # 20'	10	Lab Compute			FCP	Project Number 81170135
Frame	# #	<u> </u>		#120		File Name	1196CT.		-328 MV SCE	Applied Potential Or
Load Cell	2178		TC	Test Soluti		Setup File	ACES 2 Starting pH	13 +		Material AART 128 Gride
LVDT	181			Batch	Tracking	# 78	Ending pH	127		Material ID # 1/96
								PSTAT	V Drop across	specimen Isolated All Leads conductive
Date	Time	Temp. C	Load, Ibs.	Disp. In	Current Amps	Pot Drop V	Control PD V	Pot V SCE	(<u>⊿⊘</u> ohm Resistor, V	Comments
12-12-08		Roon			20,00	.000289	,000230	- SCE		Dry
2-12-08		50	182		20.00	1000 307	.000242	0,0	, 232	Filled cell 8:05
2-14-08		50	100		20.00	1000 309	1000241	0,0	,0042	cell leaked had
Renou			ON AN		1 +		Re Appl	, had	PSTAT of	Temporarily
Solution	1	1 .	AS N		A	specine	1 1 10 1 1			
2-14-02			252	13474	the second s	2000319	cooc 244	0	10042	Transmiller overshot
2-15-08		50	463	,3486	20,01	,000 3 14	,000241	0	,0056	
2-18-09		50	1024		20.00	.000312	r0002411	\overline{O}	,0060	OA APPROVED
2-19-03		50	1233	3634	19,99	000312	000241	0	10032	
2.20.08		580	1435	.3665	19.99	the second s	0.000241	1001	· 0037	NAME: C.Laur
2-21-08	715	50	1559.	,3683	20,00	1000312	,00241	0	,0028	DATE: 8-250r
2-22-08		50	1768	13714	20,00	1000317	0450001	0	,0025	
2.26-08	and the second	50	2677	14129	20,00	1000315	1000241	0	,0015	Added solution to Lugen
2.28-08		50		,3874.	2000	316	24($\overline{\mathcal{O}}$	10012	stopped unlunded to 27
	+	1	<u> </u>					<u> </u>		
2:29.00	715	50	2827	13856	20,00	1000318	,000242	6	10012	
3-3-00		50	2836	<u>}</u>	20,00			0	10012	
8:5-08		50	2810	,3856	20,00	1000315			.0012	Added 200 ml of solution
5 7 - 7 - C S	7 15	50	2819	3856	19,99	1000 316		0	,0009	ON 3-4
3-W-C	811:00	50	2825	13858	19,99	1000316	,000240		,000 8	1
3-13-0	8200	50	2817	13856	19,99	,00031(1	1000232	80	8000,	
3-14-0	8725	50	2821	,3856	19.99	1000 317	1000241	0	1000 8	
Projec	t Manager _	dis	<i>∦</i> .							Date 8/21/8

A-174

Project Mahager

Date <u>8/2(/8</u>

RES AN 107			ting		-		CT-18			Project Name <u>ARIES 2001</u>		
pecimen <u>[[</u>	46 CT	18				Lab Compute	r			Project Number <u>81310135</u>		
rame		L				File Name Setup File						
oad Cell				Test Soluti			Starting pH	······		Material		
VDT				Batch			Ending pH		Material ID #			
Date	Time	Temp. C	Load, Ibs.	Disp. In	Current Amps	Pot Drop V	Control PD V	PSTAT Pot V SCE	V Drop across / <u>O O</u> ohm Resistor, V	Comments		
3-11 Re	LoAd	Ŧo	J		Lbs							
3-18-08	930	50	3041	,3877	19.99	,000 318	,000242	0	.0007	Added solution		
3-20-08	110	50	3022	13875	19.99	,000 316	,000 241	0	,0012			
3-24-08	930	50	3000	,3879	20.00	,000318	,000 242	U	:0021			
1-27-08	650	50	3000	,3879	19,99	,000 319	.000238	J	2166,			
1-31-08	715	50	3017	13878	20.00	10 00319	1002242	0	10015	Added solution		
-31-08	10 05	PRO	3188	13873	20.00	1000 307	000230	O	10012	TCONTIN 11pr. MALFUNCTIC		
	Rep	LAC	ed	Tem	per	sture	Contr	oller	#1260 W	th #12043		
1-1-08	330	29	3297	13870	20,00	,000 299	,000 223	Ċ	,0031	ja ja		
	MDer		the second s	troller	Fai	led	Replacing	cable	+ TC	NEW TCH/669		
<u>4-3-08</u>	940	49	2983	,3880	20,00	,000318	,000238	0	10014			
9-4-08	720	49	3007	,3881	19,99	1000 317	,000 236	0	10019	OA APPROVED		
4-7-08	730	49	3003	13876	19,99	1000317	10002411	0	,0013	NAME: Claure		
4-9.08	755	49	2010	13877	20,01	1000318	1)25000,	0	.0017			
4-11-08	105	49	3019	13878	20,01	1000318	,000240	<u></u>	,0047	DATE: A.25-0		
1-14-08		199	2964	13883	20,01	1000318	1000240	U	,0010			
9.15.08	1200	49	2978			,000318	1000 241	0	10010	Added 60 mls		
4-17-08		╅╌┶╌╄╍	2970	138811	20,00	1,000 321)	000 239	0	85001			
4-21-06		49	2972	,3882	20,00	,000 317	1000 239	0	,0011	computer down		
4.22.08	┉┧╍╍┥┹┈╍	49	2994	13882	20,00	000 319	1.000241	<u> </u>	.0013	computer down ASA		
4-23-08		50	3008	+	10,01	1000 317	1000239	0	10014	computer dour		
1-25-08	730	50	2986	13883	20,01	.000 319	,000 240	<u> </u>	10009	<u> </u>		

RPP-RPT-37505, Rev. 0

ARES AN 10 Specimen _ Frame _			ting			Test # Lab Compute File Name Setup File	<u> </u>			Project Name Project Numbe	<u>ARES 200</u> or <u>8/176(35</u>
Load Cell _		······		Test Solut	ion		Starting pH			Material	
LVDT	·····		·····	Batch			Ending pH	PSTAT	V Drop across	Material ID #	
Date	Time	Temp. C	Load, Ibs.	Disp. In	Current Amps	Pot Drop V	Control PD V	Pot V SCE	ohm Resistor, V	C	comments
5-1-08	715	50	2954	13884	20.00	,000 319	,000241	Q	,0008		
5-2-08	855	50	2989	3883	20,00	,000319	,000 2.41	υ	,0011	Added	80 nl ot solu
5.5.08	705	50	2956	,3883	20.00	,000 319	,000 241	Ø	,0009		
5-6-08	330	50	2997	,3882	20,00	1000319	,000 236	0	.0010		·
5-8-08	850	50	3003	,3882	20,00	,000 318	,000 239	0	.0046	QA AI	PROVED
5-13-08	720	50	2955	,3883	20,00	1000320	1000 236	Û	.0005	NAME	Claum
5-14-08	805	50	2991	,3883	20.01	1000320	,000236	0	10014		
5-16-08	00 []	49	3003	,3882	20,01	,000319	1000 239	0	10006	DATE:	
5-19-0.8	350	50	2977	13885	20,01	,000320	.000240	0	,0007		
5.27-08	700	50	3018	3883	20,01	000321	1000241	0	,0 39	Addo	Tulos In Das
5-27-08	-710	40	3066	3880	20,01	1000310	1000235	U	37		
5-30-08	730	150	2962	13885	20,00	1000 322	1000 241	0	,0007	A	
6.3-08	1	50	3006	,3882	20.00	1000322	142000141	0	,0012		
6-9-08	the second s	SU	3010	3886	20,03	1000323	,000241	0	10007		
6-13-0		50	3018		20,00	2000323	1000 241	<u> </u>	,0008	Added	solution
6-17-0	- 740	50	2976	,3889	20,01	,000324	1000 2YZ	0	,0005		
6-18-0	655	50	2959	,3889	20,00	.000324	,000 241	0	,000 Y		
6-23	705	50	2981	13891	20,01	1000322	1000 240	0	1,000.4		
6-24	730	50	2979	,3891	20,01	1250001	1000 241	0	,0005		
6-27	705	50	3014	,3887	20.01	.000323	1000 240	σ	10013	Power osts	ON 25 + 26 +1
6-30	640	50	3019			1000 323	000241	0	,000 5		
7-1	1100	50	3001	3888	20,02	323	240	D	10005		
Projec	t Manager	ahi	£.						-	Dat	e <u>8/2(/8</u>

Date 8/2//8

A-176

ARES AN 107 Specimen Frame	Crack Gro 196 <u>C</u> T 1	wth Tes 18	sting			Test # Lab Compute File Name	<u>CT 18</u> er		•	Project Name Project Numbel	ARES 200 81/70/3
Load Cell			·····	Test Solut Batch	ion	Setup File	Starting pH Ending pH			Material Material ID #	
Date	Time	Temp. C	Load, Ibs.	Disp. In	Current Amps	Pot Drop V	Control PD V	PSTAT Pot V SCE	V Drop across ohm Resistor, V	Co	mments
7-3.08	730	50	3010	,3889	20.02			0	0005		IJTion
7-8-08	300	50	2997	,3890	20,02	1000324	,000241	C	,000 4		
7-9-08	230	50	3005	,3889		1000325		0	,0007	······································	
7-14-08	815	50	2499	13888			,0002.YU	0	0005		······
7-17	635	52	3008	13889	20.03	,000322		Ś	2 0000		
7-21	1250	50	3020	.3888	20,02	,000317	1000241	Ú	10003		
7-25	720	50	2991	,3888	20,01	,000 323	1000 242	0	,000 5		
8-4	400	50	3013	13885	2,02	,000 323	1125 600	<u> </u>	,0002	computer Dov	n on sat Res
8-7	955	50	2999	3886	20,02	,000 323	,000240		,0005	Added	solution
8-11	1015	50	2986			.000 330	,000244	0	,0005		
8-13	730	50	2986	3886		,000329	,000212	0	,0005		
8-18	130	50	2979	3888	20,03	1000329	1420001	0	.000 5	TAKE	Down
					,	E 1	FR	~		·····	
			1p	51						QA AP	PROVED
		· · · ·	+7E			<u> </u>				NAME:	Cldun
										DATE:	8-23-02
							· · · · · · · · · · · · · · · · · · ·				
			<u> </u>								

RPP-RPT-37505, Kev. 0

١,

•

;

ł , .

APPENDIX B

CYCLIC POTENTIODYNAMIC POLARIZATION (CPP) TESTING DATA

Base Chemistry	рН	NO ₂ (M)	NO ₃ (M)	TIC (M)	OH ⁻ (M) [*]	Cl [°] (M)	F (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N ₂ sparging	CPP Full immersion	No pitting	54
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N ₂ sparging	CPP Full immersion	No pitting	60
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N ₂ sparging	Potentiostatic at 0 mV	No pitting	63
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N2 sparging	CPP Full immersion	Crevice corrosion	64
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N2 sparging	Potentiostatic at 0 <u>mV</u>	Crevice corrosion	65
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	Potentiostatic at 0 mV, half immersion	Severe attack at solution/vapor interface	66
AP105-PSC	>13	0.6	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	Potentiostatic at 0 mV, half immersion	Corrosion**	72
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	N ₂ sparging	Potentiostatic at 0 mV, half immersion	Corrosion**	73
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	CPP Half immersion	Corrosion	75
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent air	Potentiostatic at 0 mV, half immersion	Corrosion**	76
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	Potentiostatic at 100 mV vs. OCP, half immersion	Corrosion**	77
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent air	CPP Full immersion	No pitting	81
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	50	Quiescent air	Potentiostatic at 0 mV Half immersion	Minor corrosion	91
AP105-PSC	>13	0.27	3.58	0.326	0.176	0.03	0.009	Room	Quiescent air	Potentiostatic at 50 mV vs. OCP Half immersion	Corrosion	92
API05-PSC	>13	0	3.85	0.326	0.176	0.03	0.009	50	N ₂ sparging	CPP Full immersion	Pitting	93

Table B-1. A Summary of Electrochemical Tests Performed in
AP105-PSC Based Simulants.

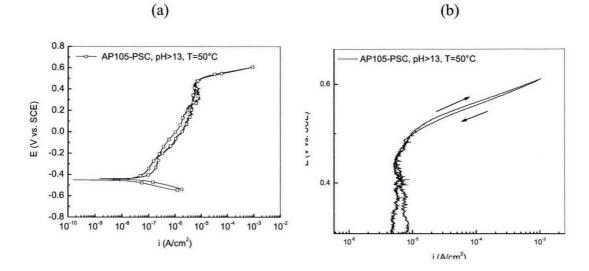
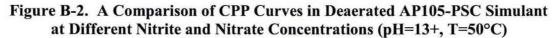


Figure B-1. The CPP Curve in Deaerated AP105-PSC Simulant (T= 50°C and pH>13).



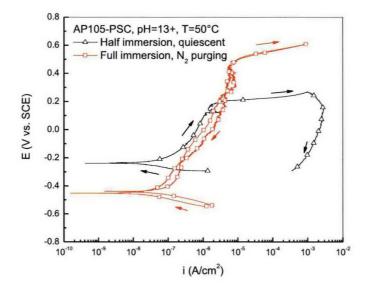


Figure B-3. Sample Appearance after CPP Testing in AP105-PSC Simulant at Quiescent Condition (pH=13+, T=50°C)

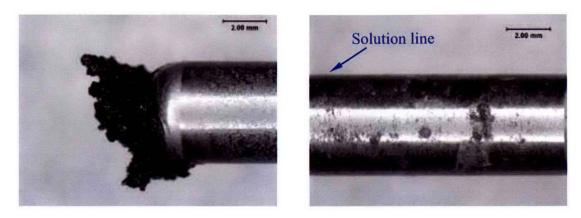


Figure B-4. The Current Density as a Function of Time when the Partially Immersed Sample Was Held at 0 mV vs. SCE (AP105-PSC, pH>13, T=50°C, Quiescent Condition).

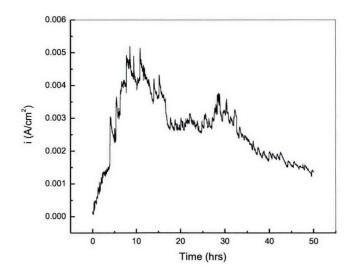
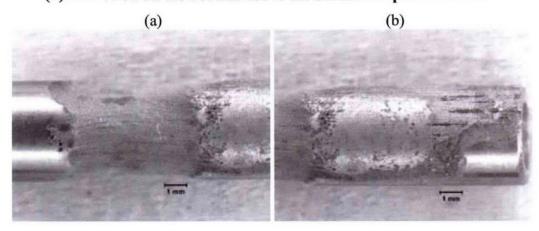


Figure B-5. The Sample Appearance after 50 Hours of Potentiostatic Testing at 0 mV vs. SCE in the AP105-PSC Simulant (pH>13, T=50°C, Quiescent Condition).
 (a) Corrosion at Solution/Vapor Interface;

(b) Corrosion on the Portion above the Solution/vapor Interface.



(b)

Figure B-6. The Current Density as a Function of Time When the Fully Immersed Sample Was Held at 0 mV vs. SCE in AP105-PSC Simulant (T=50°C, pH>13).

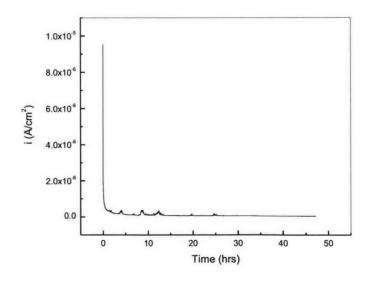


Figure B-7. A Comparison of the Current Density as a Function of Time in the Potentiostatic Tests Conducted in AP105-PSC Simulants with Different Nitrite Concentrations at 50°C and Quiescent Conditions.

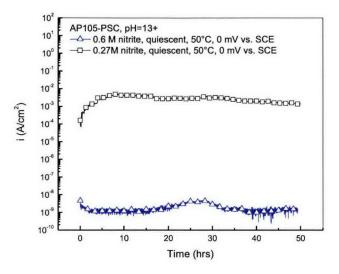


Figure B-8. The Sample Appearance After Potentiostatic Test at 0 mV (vs. SCE) in the AP105-PSC Simulant with 0.6 M Nitrite for 50 hours (Sample Partially Immersed) at 50°C.

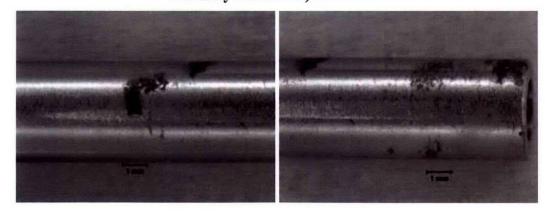


Figure B-9. A Comparison of the Current Density as a Function of Time in the Potentiostatic Tests Conducted at 0 mV (vs. SCE) in Quiescent and Nitrogen Purged AP105-PSC Simulants at 50°C.

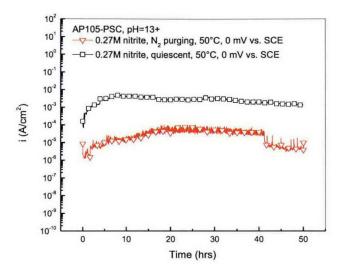


Figure B-10. The Sample Appearance after Potentiostatic Test at 0 mV (vs. SCE) in Deaerated AP105-PSC Simulant for 50 hours (Sample Partially Immersed) at 50°C.

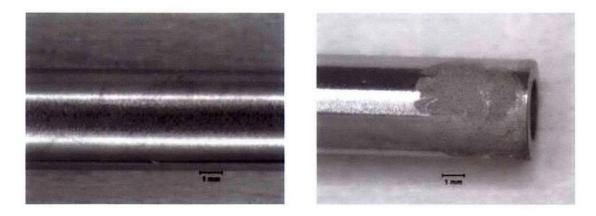


Figure B-11. A Comparison of the Current Density as a Function of Time in the Potentiostatic Tests Conducted in AP105-PSC Simulants at 0 mV (vs. SCE) and 100 mV (vs. OCP) (50°C, Quiescent Condition).

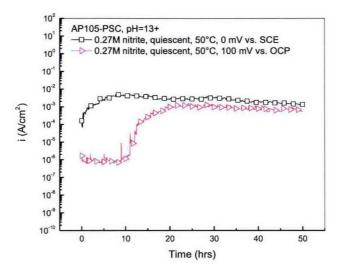
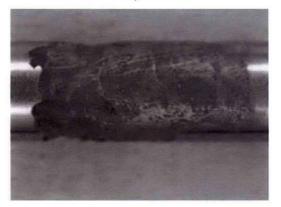
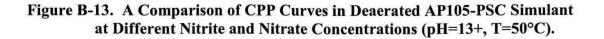


Figure B-12. The Sample Appearance after Potentiostatic Test at 100 mV (vs. OCP) in the AP105-PSC Simulant for 50 Hours (Sample Partially Immersed) at 50°C.



B-8



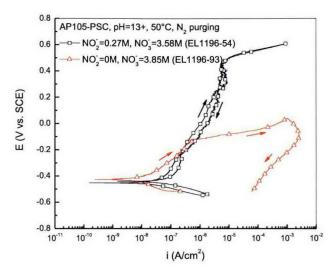


Figure B-14. The Sample Appearance after CPP Testing in Deaerated AP105-PSC with 0 M Nitrite and 3.85 M Nitrate (pH=13+, T=50°C).

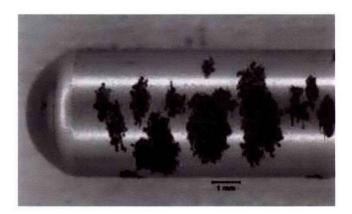
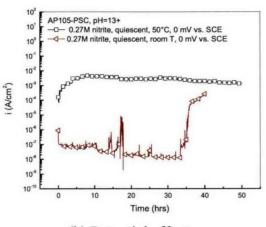
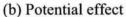


Figure B-15. A Comparison of the Current Density as a Function of Time in the Potentiostatic Tests Conducted in Different Conditions. (a) Room T vs. 50°C;

(b) 0 mV (vs. SCE) vs. 50 mV (vs. OCP) at Room T.

(a) Temperature effect





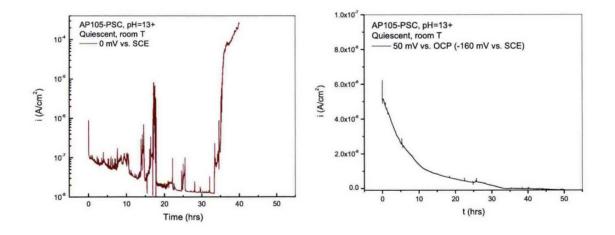


Figure B-16. A Comparison of the Sample Appearance after Potentiostatic Testing in AP105-PSC Simulant at Different Potentials (Under Quiescent Condition, Room Temperature). (a) 0 mV vs. SCE; (b) 50 mV vs. SCE (-160 mV vs. SCE).

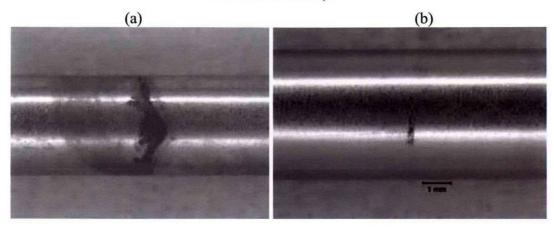
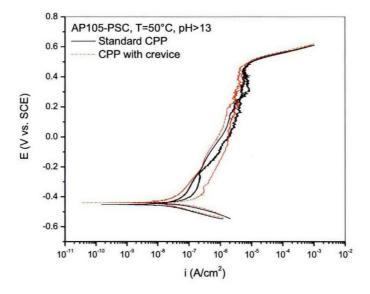
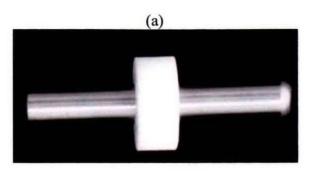


Figure B-17. A Comparison of the CPP Curves Obtained with and without Using a Crevice Former (AP105-PSC, pH>13, T=50°C)

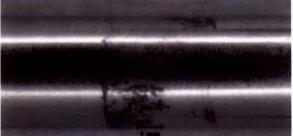


B-11

Figure B-18. The Crevice Assembly of the CPP Sample (a) and the Sample Appearance at the Crevice Section after CPP Testing in AP105-PSC Simulant (b) (pH>13, T=50°C).



(b)



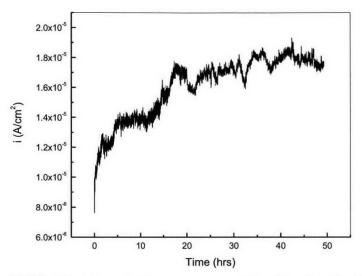
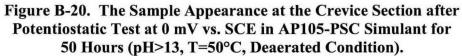
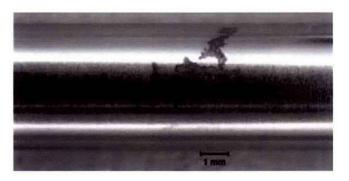
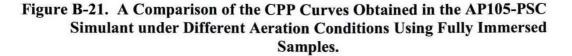


Figure B-19. The Current Density as a Function of Time When the Sample with a Crevice Former Was Polarized to 0 mV vs. SCE (AP105-PSC, pH>13, T=50°C, Deaerated Condition).







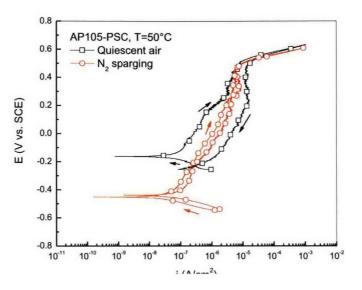
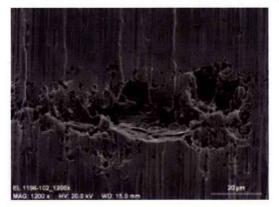
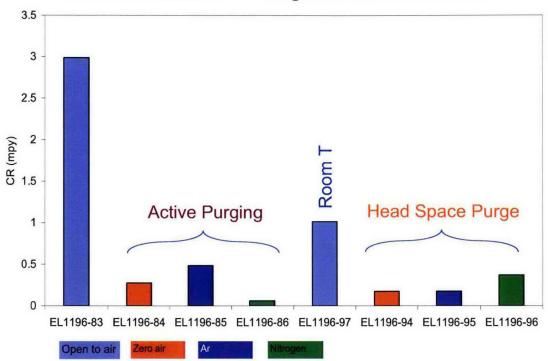


Figure B-22. The Pits on the Samples Tested in the AP105-PSC Simulant under Quiescent Conditions and at 50°C (Ph=13+).





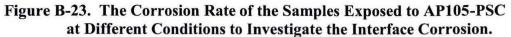
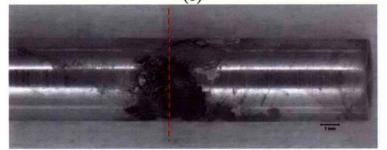


Figure B-24. The Appearance of the Sample (a, b) and the Cross Section of a Corroded Site (c) after Exposed in AP105-PSC at Quiescent Condition (Sample Partially Immersed, T=50°, EL1196-83).

(a)



(b)



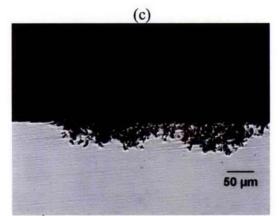
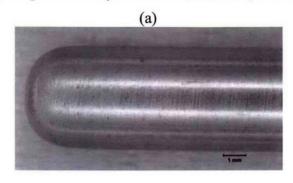


Figure B-25. The Appearance of the Sample after Exposed in AP105-PSC Purged with Zero Air (Sample Partially Immersed, No CO₂, T=50°, EL1196-84)



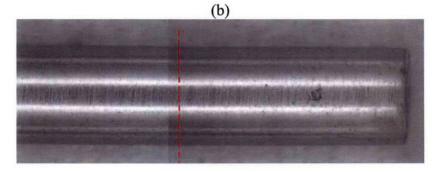
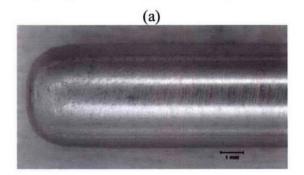


Figure B-26. The Appearance of the Sample after Exposed in AP105-PSC Purged with Ar (Sample Partially Immersed, T=50°, EL1196-85).



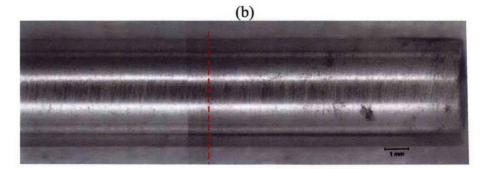
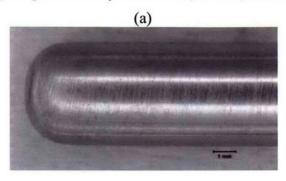
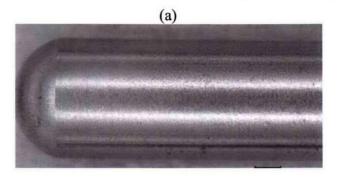


Figure B-27. The Appearance of the Sample after Exposed in AP105-PSC Purged with N₂ (Sample Partially Immersed, T=50°, EL1196-86).

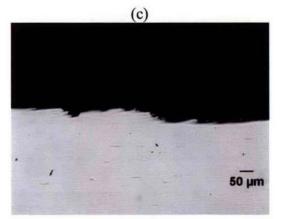


(b)

Figure B-28. The Appearance of the Sample (a, b) and the Cross Section of a Corroded Site (c) after Exposed in AP105-PSC at Quiescent Condition (Sample Partially Immersed, Room T, EL1196-97).

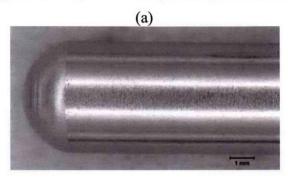


(b) 1 mm



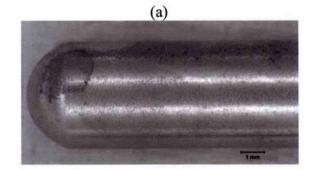
B-19

Figure B-29. The Appearance of the Sample after Exposed in AP105-PSC. The Head Space of the Cell Was Purged with Zero Air (No CO₂, Sample Partially Immersed, T=50°, EL1196-94).



(b)

Figure B-30. The Appearance of the Sample after Exposed in AP105-PSC. The Head Space of the Cell Was Purged with Ar (Sample Partially Immersed, T=50°, EL1196-95).





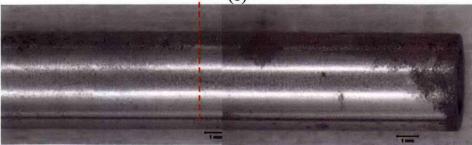


Figure B-31. The Appearance of the Sample after Exposed in AP105-PSC. The Head Space of the Cell Was Purged with N₂ (Sample Partially Immersed, T=50°, EL1196-96).

(a)





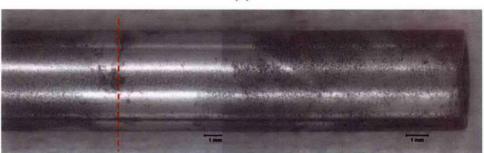


Table B-2. The pH Values of the Simulant after the Long Term Immersion Tests.

Exposed sample	Solution pH after test
EL1196-83	13.28
EL1196-84	13.23
EL1196-85	13.32
EL1196-86	13.21
EL1196-97	13.32
EL1196-94	13.4
EL1196-95	13.44
EL1196-96	13.38

Base Chemistry	pH	NO2 ⁻ (M)	NO3 ⁻ (M)	TIC (M)	ОН ⁻ (М) [*]	Cl ⁻ (M)	F (M)	T (°C)	Aeration condition	Visual	Sample ID (#EL1196-)
SY103-PIL	>13	2.91	1.97	0.123	2.43	0.5	0	50	N ₂ sparging	No pitting	89

Table D-3. A Summary of Electrochemical restriction med in Strug-111 Dased Simulant.	Table B-3. A Summary of	of Electrochemical Test Performed in SY103-PIL Based Simulant.
--------------------------------------------------------------------------------------	-------------------------	----------------------------------------------------------------

Figure B-32. A CPP Curve in Deaerated SY103-PIL Simulant (pH>13 and T=50°C).

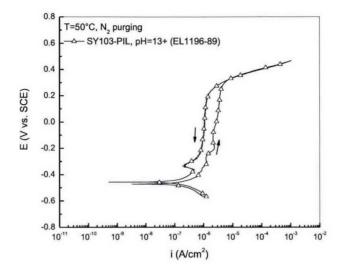


Table B-4. A Summary of Electrochemical Test Performed in AW105 Based Simulant.

Base Chemistry	pH	NO ₂ ⁻ (M)	NO3 ⁻ (M)	TIC (M)	ОН ⁻ (М) [*]	Cľ (M)	F ⁻ (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AW105-PIL	>13	0.124	0.419	0.097	0.4502	0.01	0.58	50	N ₂ sparging	CPP Full immersion	No pitting	90
AW105-PSC	>13	0.0638	0.44	0.1076	0.2630	0.0083	0.156	50	N ₂ sparging	CPP Full immersion	No pitting	108



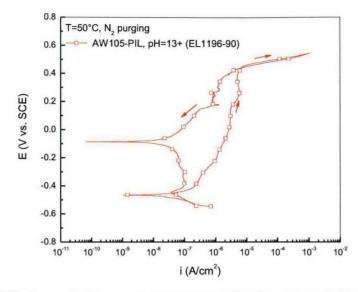


Figure B-34. A CPP Curve in Deaerated AW105-PSC Simulant (pH>13 and T=50°C).

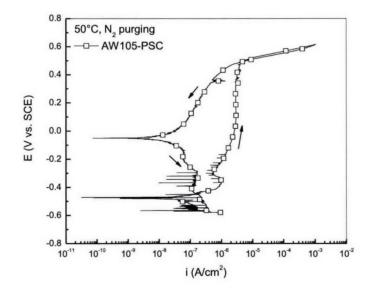
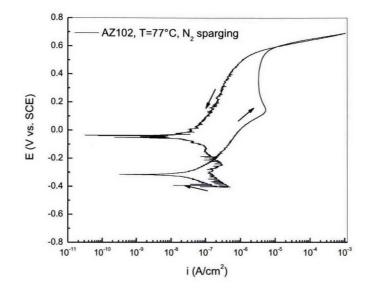


Table B-5. A Summary of Electrochemical Test Performed in AZ102 Based Simulant.

Base Chemistry	рН	NO2 ⁻ (M)	NO3 ⁻ (M)	TIC (M)	OH ⁻ (M) [*]	Cr (M)	F ⁻ (M)	Т (°С)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AZ102	>12	0.883	0.105	0.619	-	-	0.052	77	N ₂ sparging	CPP Full immersion	No pitting	103



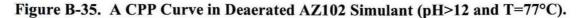
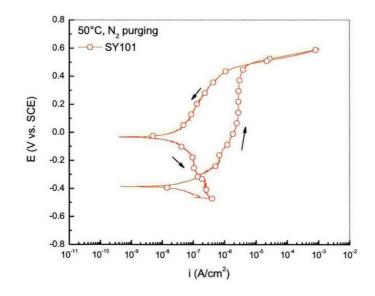


Table B-6. A Summary of Electrochemical Test Performed in SY101 Based Simulant.

Base Chemistry	pH	NO2 ⁻ (M)	NO ₃ ⁻ (M)	TIC (M)	OH ⁻ (M) [*]	Cl ⁻ (M)	F (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
SY101	>13	0.2027	0.9313	0.1328	0.6555	0.0228	0.0277	50	N ₂ sparging	CPP Full immersion	No pitting	109

Figure B-36. A CPP Curve in Deaerated SY101 Simulant at pH 13+ and 50°C.



Base Chemistry	pH	NO2 ⁻ (M)	NO3 ⁻ (M)	TIC (M)	OH ⁻ (M) [*]	Cr (M)	F (M)	T (°C)	Aeration condition	Testing type	Visual	Sample ID (#EL1196-)
AY101-CSL	11.82	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	50	N ₂ sparging	CPP Full immersion	Pitting	111
AY101-CSL	12.82	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	50	N ₂ sparging	CPP Full immersion	No Pitting	112
AY101-CSL	11.82	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	Room	N ₂ sparging	CPP Full immersion	No Pitting	113
AY101-CSL	12.3	0.0368	0.181	0.1474	0.0051	0.0064	0.0015	50	N ₂ sparging	CPP Full immersion	Pitting	115

Table B-7. A Summary of Electrochemical Test Performed in AY101-CSL Based Simulant.

Figure B-37. A Comparison of CPP Curves in the Deaerated AY101-CSL Simulant at Different pH and Temperature Levels.

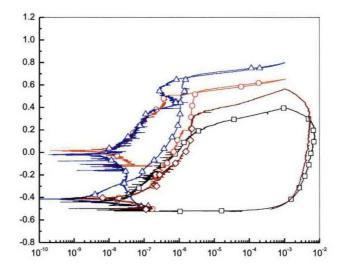


Figure B-38. The appearance of the sample after CPP test in the deaerated AY101-CSL simulant at 50°C and pH 11.82. (a) before cleaning; (b) after cleaning





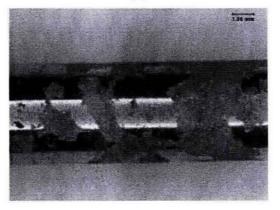
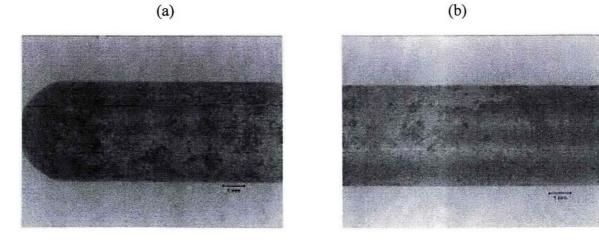


Figure B-39. The appearance of the sample after CPP test in AY101-CSL at pH 12.3 and 50°C.



APPENDIX C

SLOW STRAIN RATE TEST DATA AND MICROGRAPHS

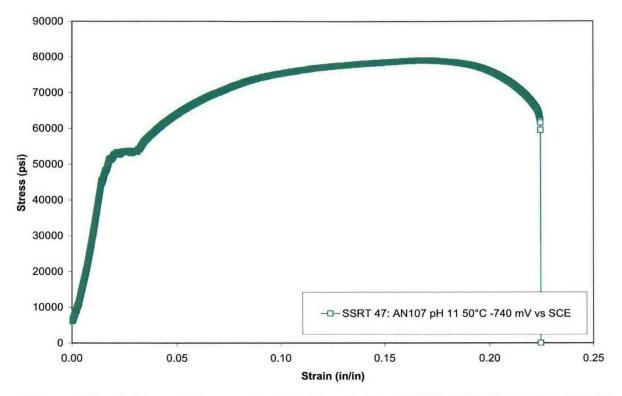
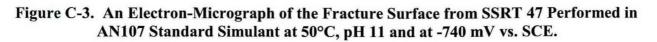
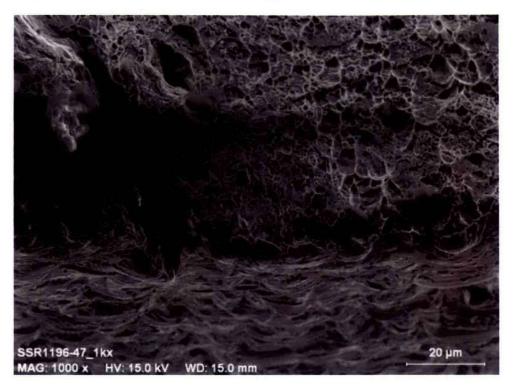


Figure C-1. The Stress-Strain Curve from SSRT 47 Performed in AN107 Standard Simulant at 50°C, pH 11 and at -740 mV vs. SCE.

Figure C-2. A Stereo-Micrograph of the Sample from SSRT 47 Performed in AN107 Standard Simulant at 50°C, pH 11 and at -740 mV vs. SCE.







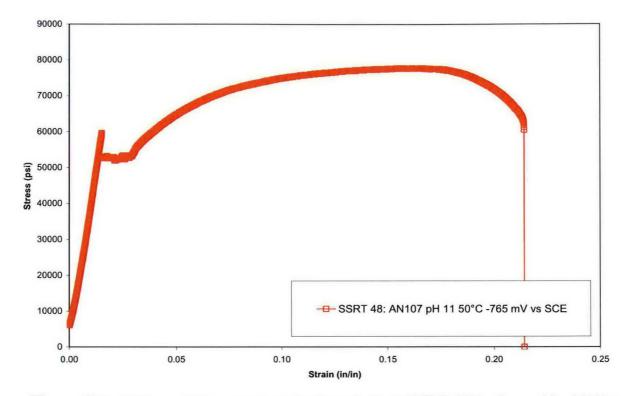


Figure C-4. The Stress-Strain Curve from SSRT 48 Performed in AN107 Standard Simulant at 77°C, pH 11 and at -765 mV vs. SCE.

Figure C-5. A Stereo-Micrograph of the Sample from SSRT 48 Performed in AN107 Standard Simulant at 77°C, pH 11 and at -765 mV vs. SCE.



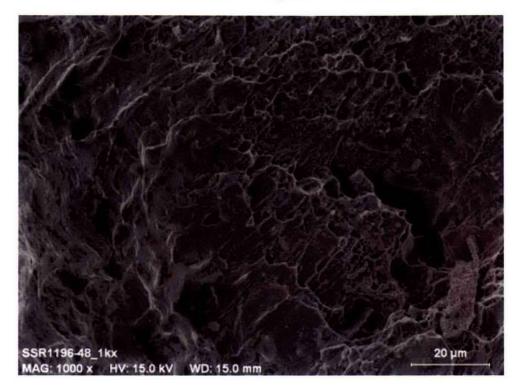
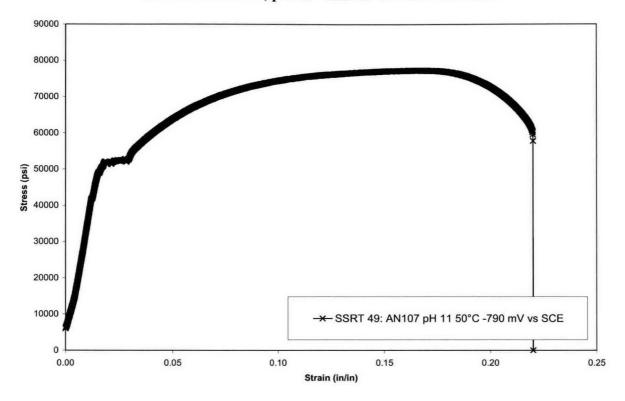


Figure C-6. An Electron-Micrograph of the Fracture Surface from SSRT 48 Performed in AN107 Standard Simulant at 77°C, pH 11 and at -765 mV vs. SCE.



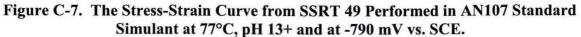


Figure C-8. A Stereo-Micrograph of the Sample from SSRT 49 Performed in AN107 Standard Simulant at 77°C, pH 13+ and at -790 mV vs. SCE.



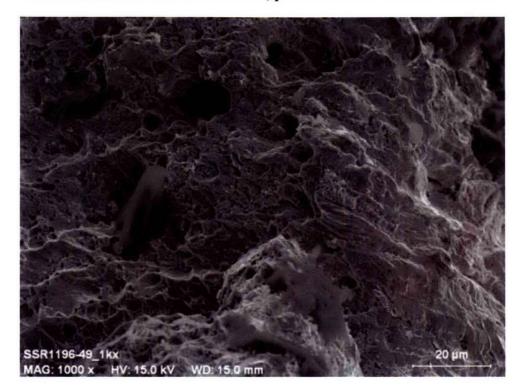
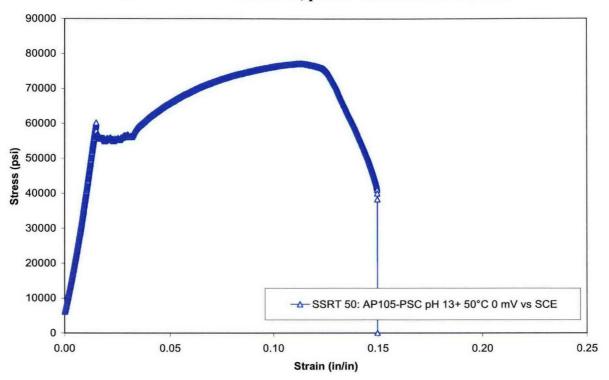


Figure C-9. An Electron-Micrograph of the Fracture Surface from SSRT 49 Performed in AN107 Standard Simulant at 77°C, pH 13+ and at -790 mV vs. SCE.



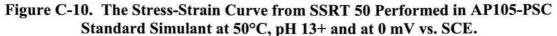


Figure C-11. A Stereo-Micrograph of the Sample from SSRT 50 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.



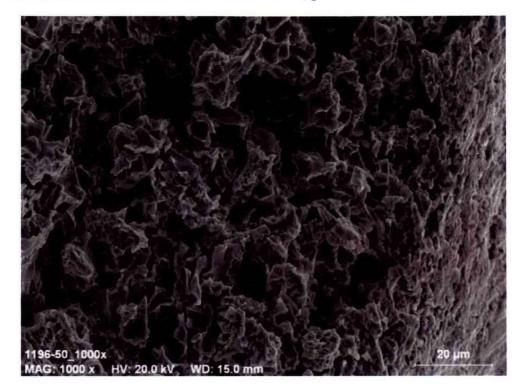


Figure C-12. An Electron-Micrograph of the Fracture Surface from SSRT 50 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

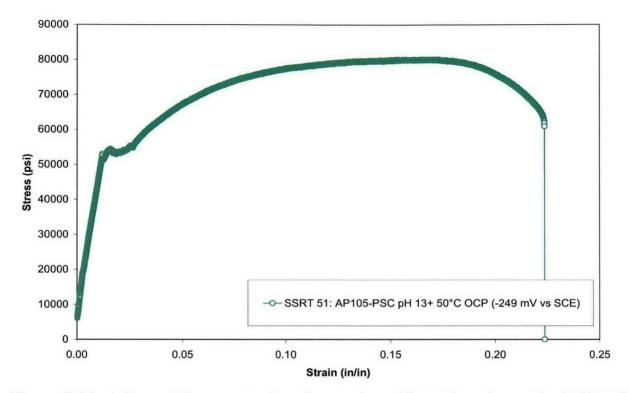


Figure C-43. The Stress-Strain Curve from SSRT 51 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at OCP (-249 mV vs. SCE).

Figure C-14. A Stereo-Micrograph of the Sample from SSRT 51 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at OCP (-249 mV vs. SCE).

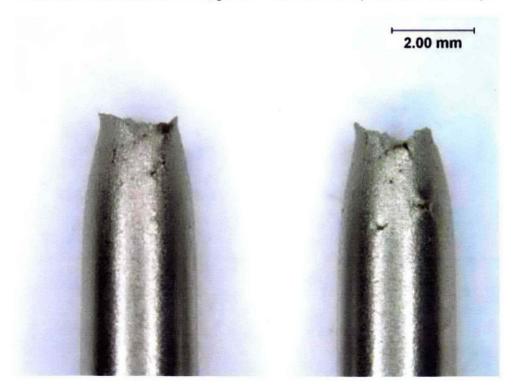
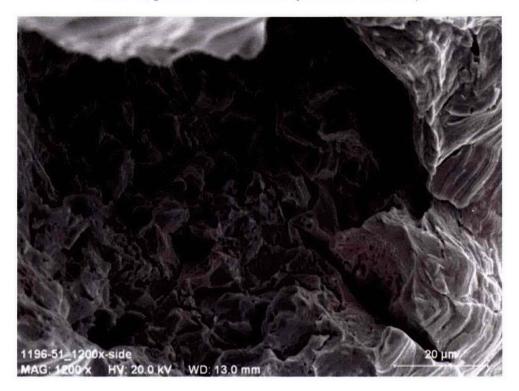
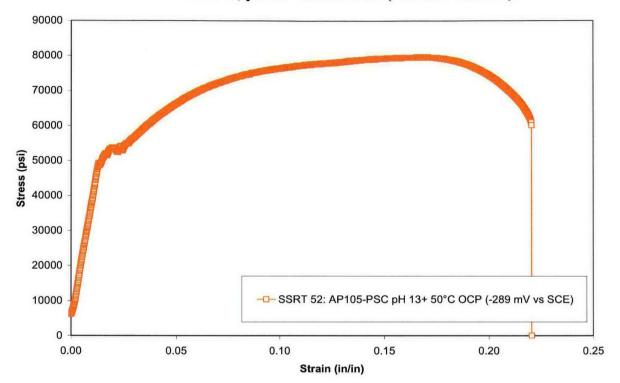


Figure C-15. An Electron-Micrograph of a Secondary Crack in the Shaft of SSRT 51 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at OCP (-249 mV vs. SCE).





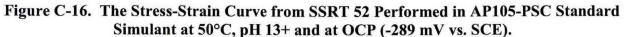
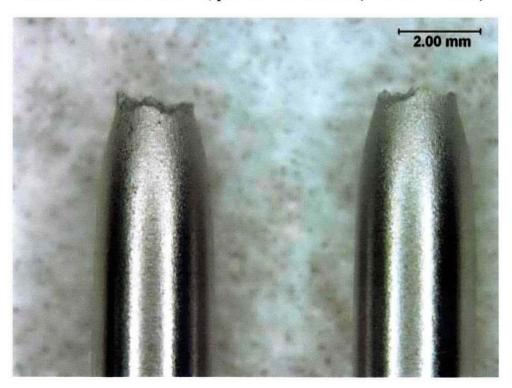


Figure C-17. A Stereo-Micrograph of the Sample from SSRT 52 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at OCP (-289 mV vs. SCE).



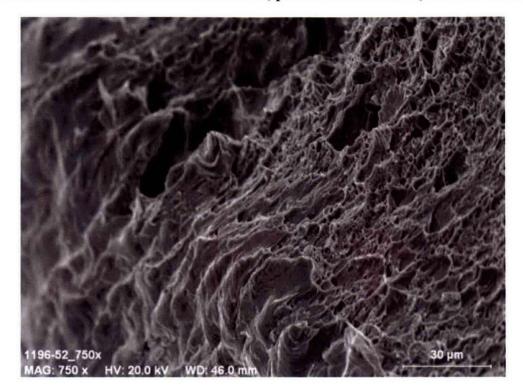


Figure C-18. An Electron-Micrograph of the Fracture Surface from SSRT 52 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at OCP (-289 mV vs. SCE).

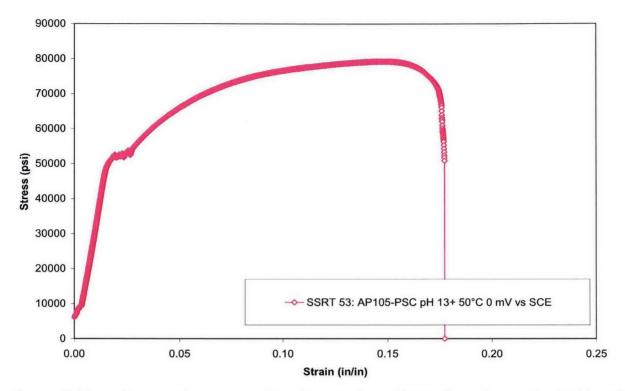
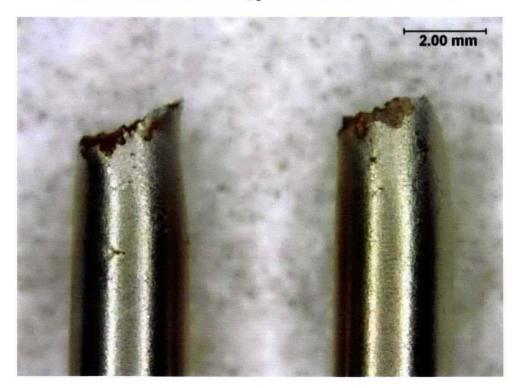


Figure C-19. The Stress-Strain Curve from SSRT 53 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.

Figure C-20. A Stereo-Micrograph of the Sample from SSRT 53 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.



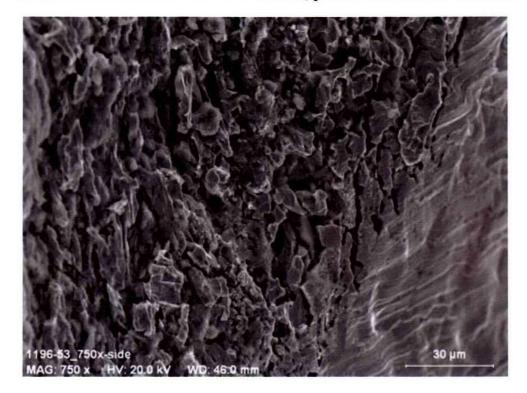
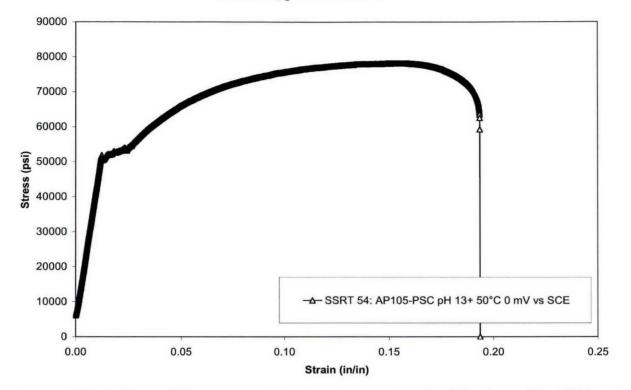


Figure C-21. An Electron-Micrograph of the Fracture Surface from SSRT 53 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.



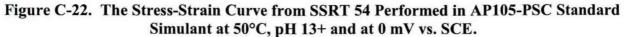
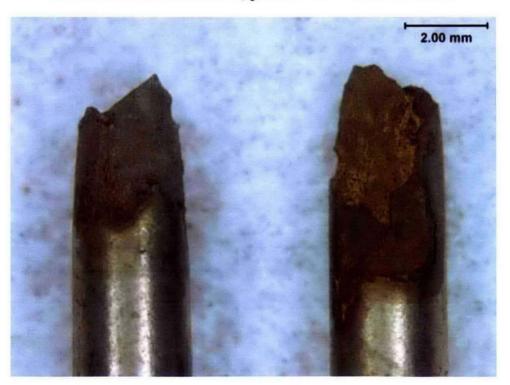


Figure C-23. A Stereo-Micrograph of the Sample from SSRT 54 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.



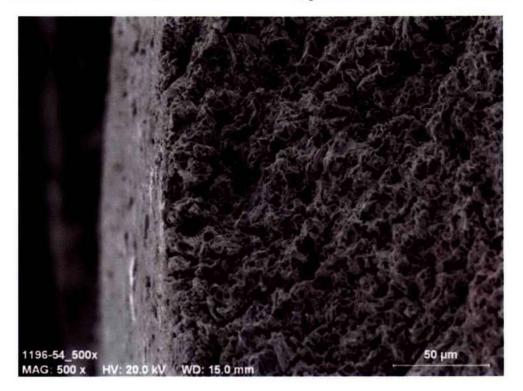
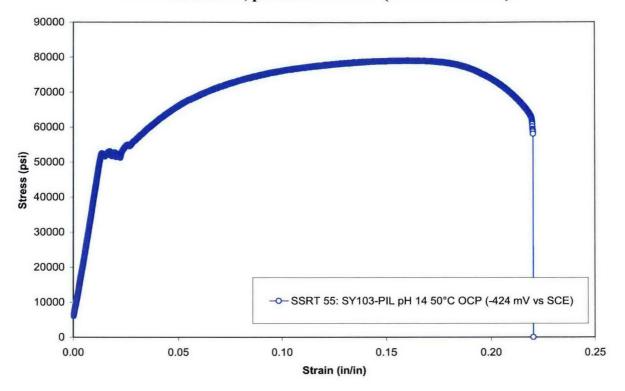


Figure C-24. An Electron-Micrograph of the Fracture Surface from SSRT 54 Performed in AP105-PSC Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.



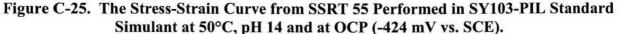
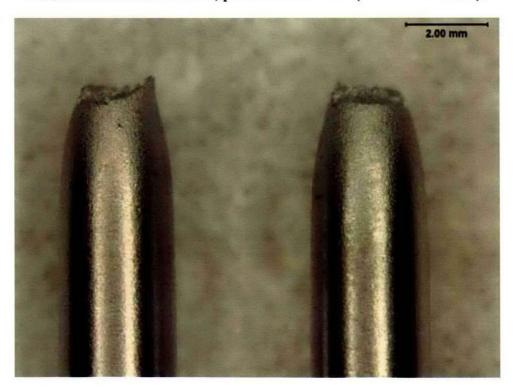


Figure C-26. A Stereo-Micrograph of the Sample from SSRT 55 Performed in SY103-PIL Standard Simulant at 50°C, pH 14 and at OCP (-424 mV vs. SCE).



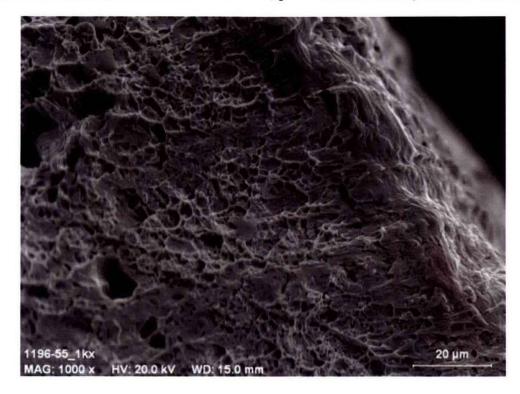
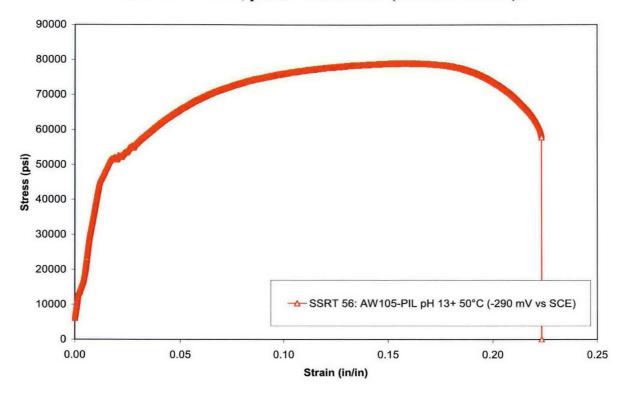


Figure C-27. An Electron-Micrograph of the Fracture Surface from SSRT 55 Performed in SY103-PIL Standard Simulant at 50°C, pH 14 and at OCP (-424 mV vs. SCE).



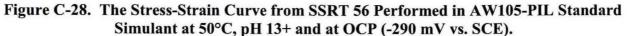
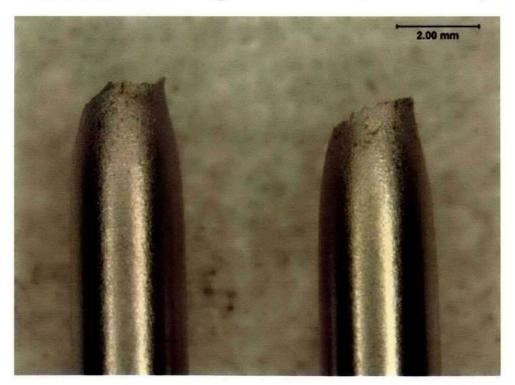


Figure C-29. A Stereo-Micrograph of the Sample from SSRT 56 Performed in AW105-PIL Standard Simulant at 50°C, pH 13+ and at OCP (-290 mV vs. SCE).



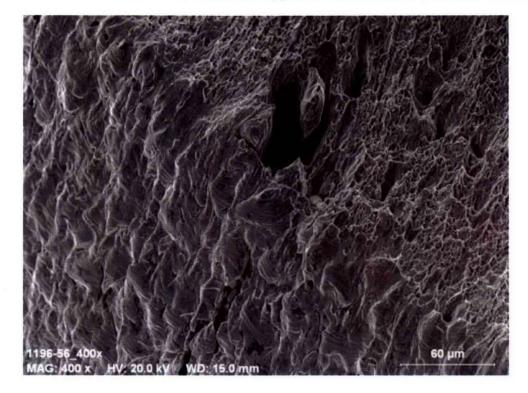
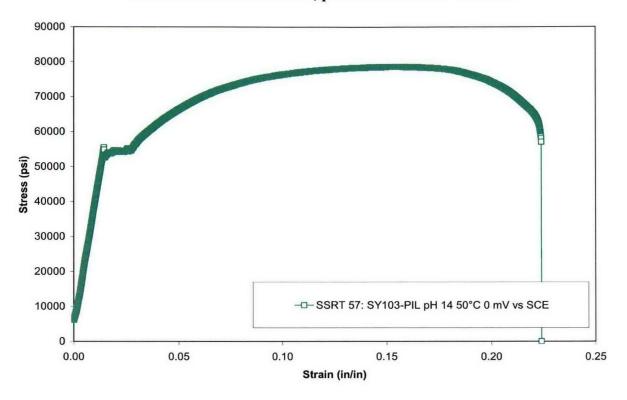
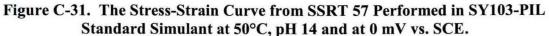
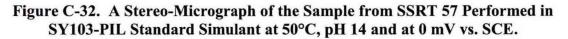


Figure C-30. An Electron-Micrograph of the Fracture Surface from SSRT 56 Performed in AW105-PIL Standard Simulant at 50°C, pH 13+ and at OCP (-290 mV vs. SCE).









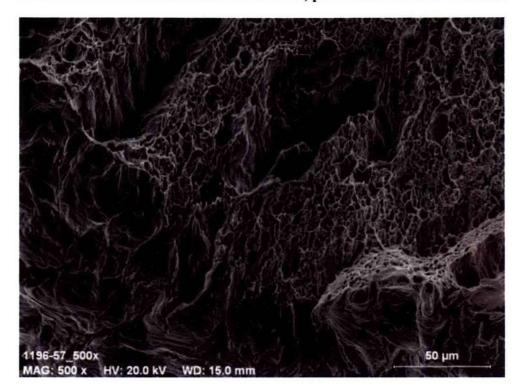
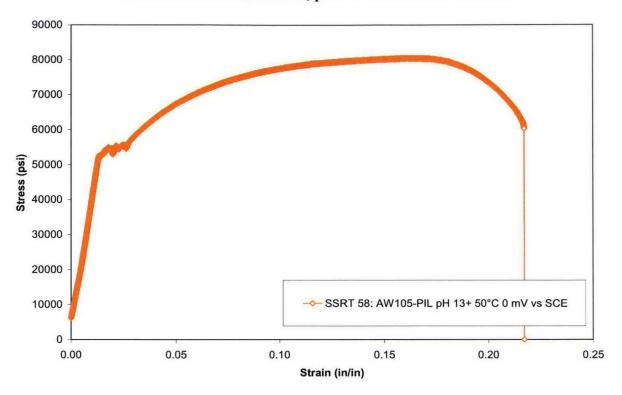
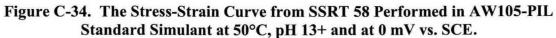
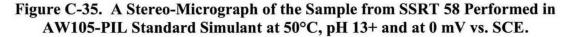
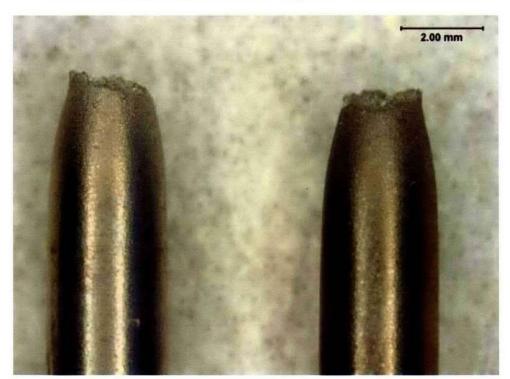


Figure C-33. An Electron-Micrograph of the Fracture Surface from SSRT 57 Performed in SY103-PIL Standard Simulant at 50°C, pH 14 and at 0 mV vs. SCE.









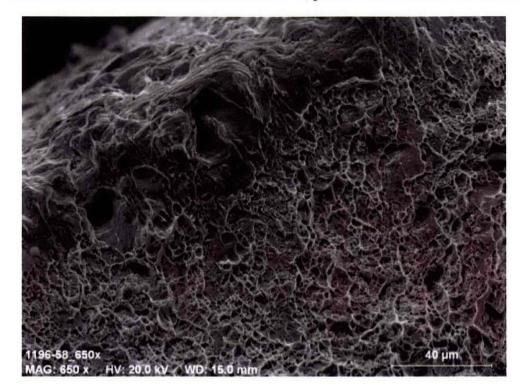
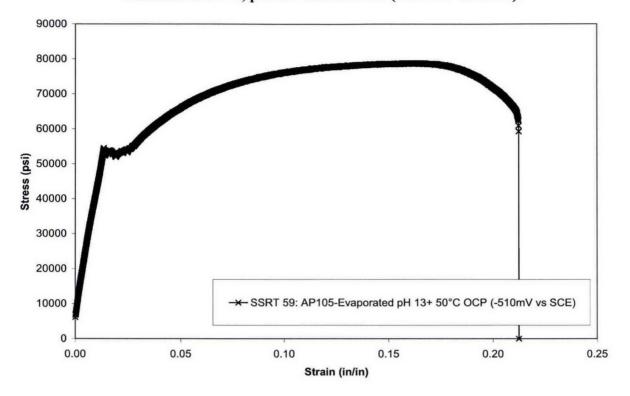


Figure C-36. An Electron-Micrograph of the Fracture Surface from SSRT 58 Performed in AW105-PIL Standard Simulant at 50°C, pH 13+ and at 0 mV vs. SCE.



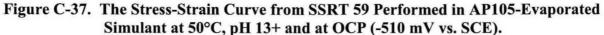
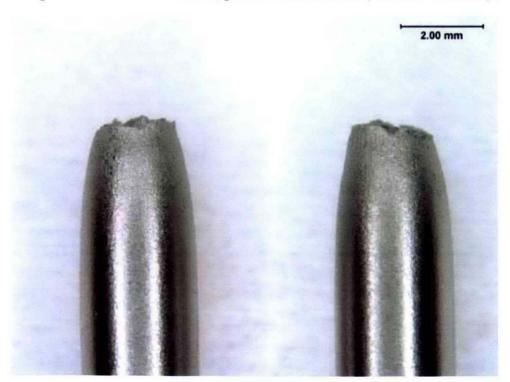


Figure C-38. A Stereo-Micrograph of the Sample from SSRT 59 Performed in AP105-Evaporated Simulant at 50°C, pH 13+ and at OCP (-510 mV vs. SCE).



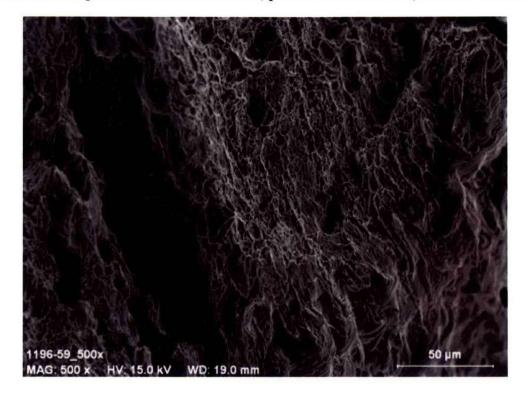
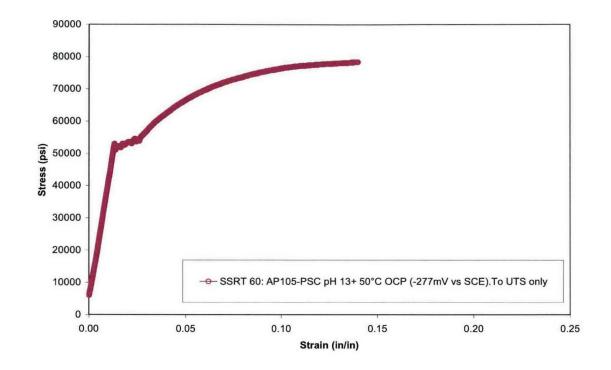


Figure C-39. An Electron-Micrograph of the Fracture Surface from SSRT 59 Performed in AP105-Evaporated Simulant at 50°C, pH 13+ and at OCP (-510 mV vs. SCE).



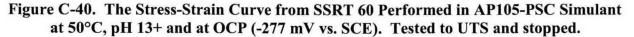
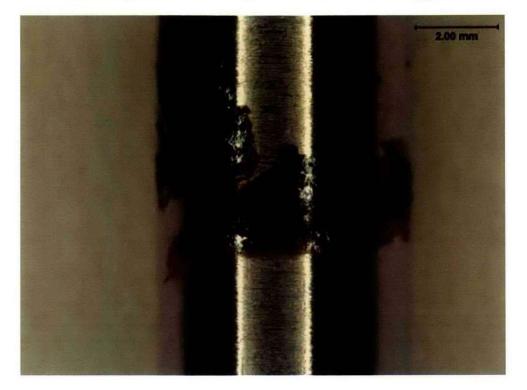
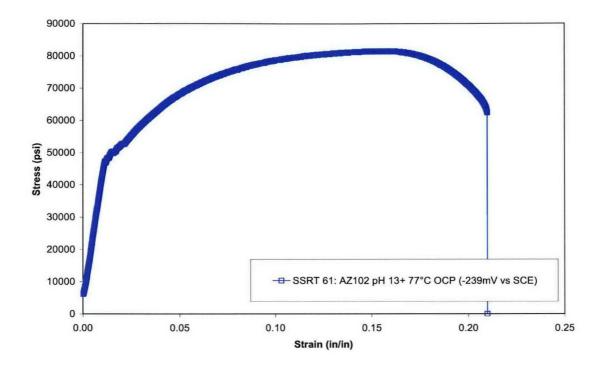


Figure C-41. A Stereo-Micrograph of the Sample from SSRT 60 Performed in AP105-PSC Simulant at 50°C, pH 13+ and at OCP (-277 mV vs. SCE). Tested to UTS and stopped.



Figure C-42. A Stereo Micrograph of the Liquid / Vapor Interface Region from SSRT 60 Performed in AP105-PSC Simulant at 50°C, pH 13+ and at OCP (-277 mV vs. SCE). Tested to UTS and stopped.





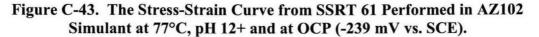
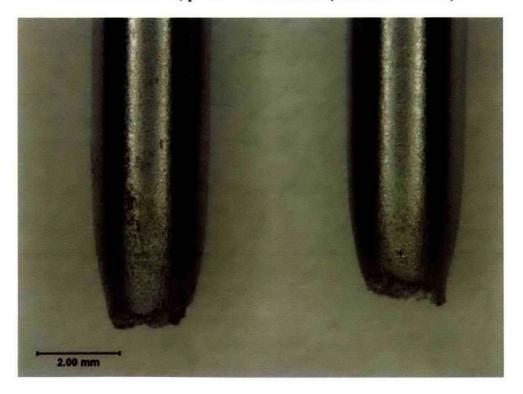


Figure C-44. A Stereo-Micrograph of the Sample from SSRT 61 Performed in AZ102 Simulant at 77°C, pH 12+ and at OCP (-239 mV vs. SCE).



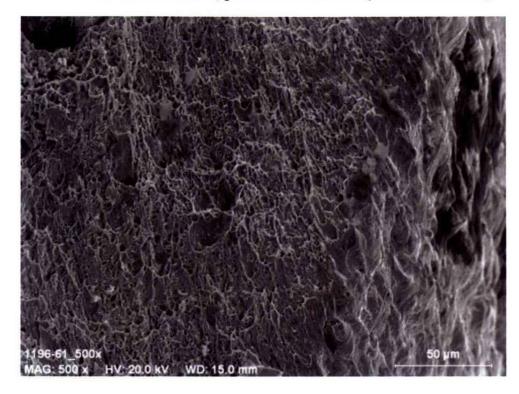
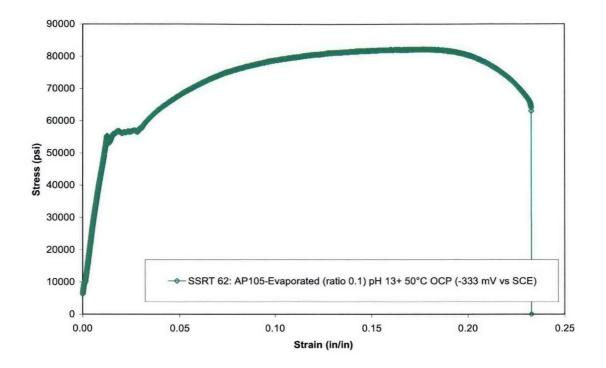
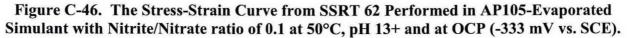
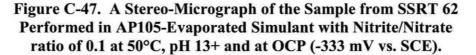


Figure C-45. An Electron-Micrograph of the Fracture Surface from SSRT 61 Performed in AZ102 Simulant at 77°C, pH 12+ and at OCP (-239 mV vs. SCE).







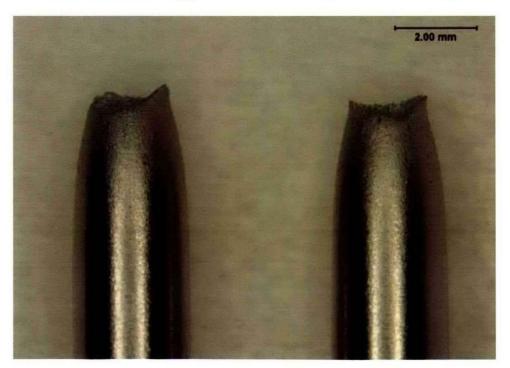
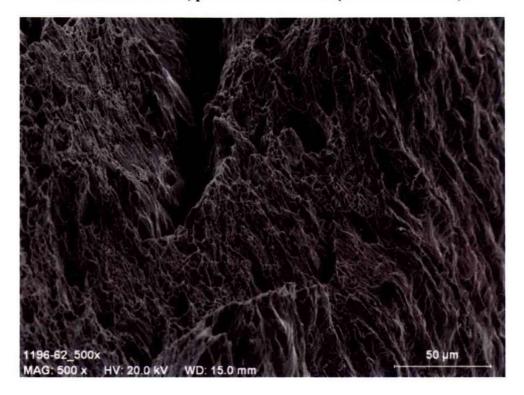
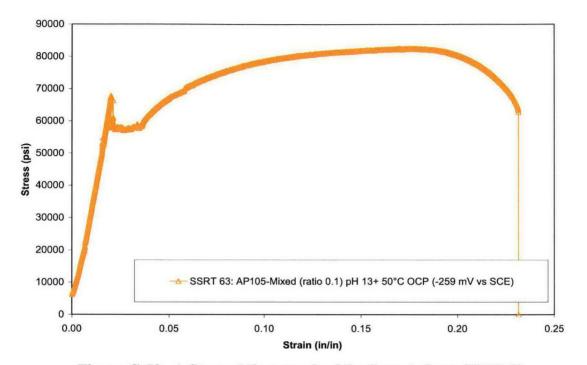


Figure C-48. An Electron-Micrograph of the Fracture Surface from SSRT 62 Performed in AP105-Evaporated Simulant with Nitrite/Nitrate ratio of 0.1 at 50°C, pH 13+ and at OCP (-333 mV vs. SCE).





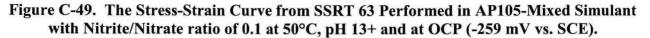


Figure C-50. A Stereo-Micrograph of the Sample from SSRT 63 Performed in AP105-Mixed Simulant with Nitrite/Nitrate ratio of 0.1 at 50°C, pH 13+ and at OCP (-259 mV vs. SCE).

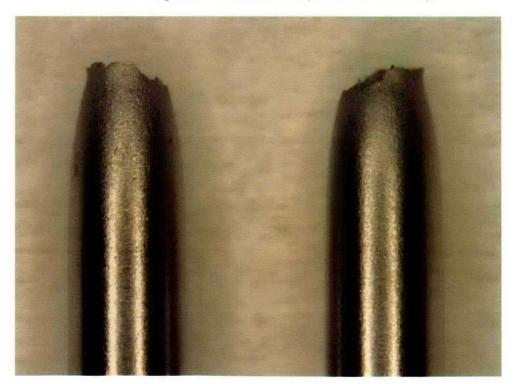
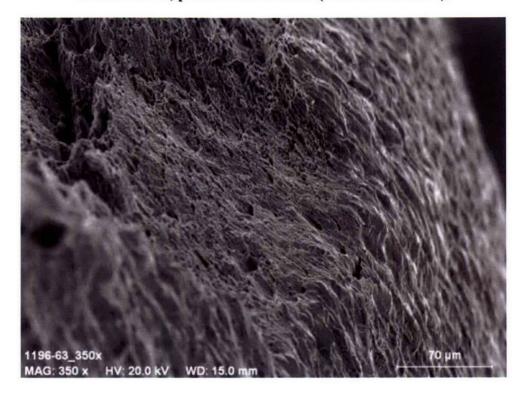
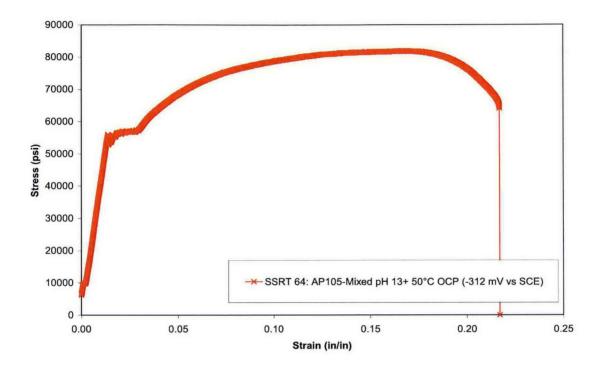
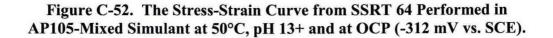
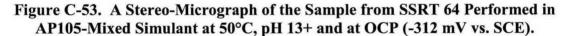


Figure C-51. An Electron-Micrograph of the Fracture Surface from SSRT 63 Performed in AP105-Mixed Simulant with Nitrite/Nitrate ratio of 0.1 at 50°C, pH 13+ and at OCP (-259 mV vs. SCE).









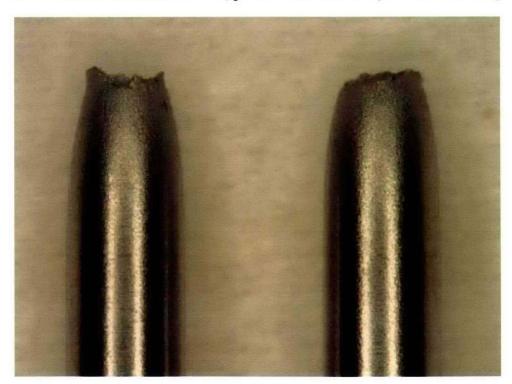
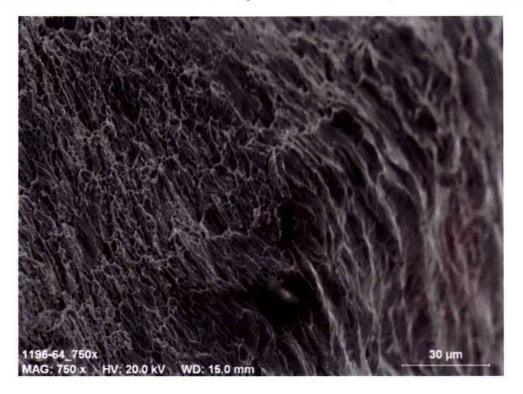


Figure C-54. An Electron-Micrograph of the Fracture Surface from SSRT 64 Performed in AP105-Mixed Simulant at 50°C, pH 13+ and at OCP (-312 mV vs. SCE).



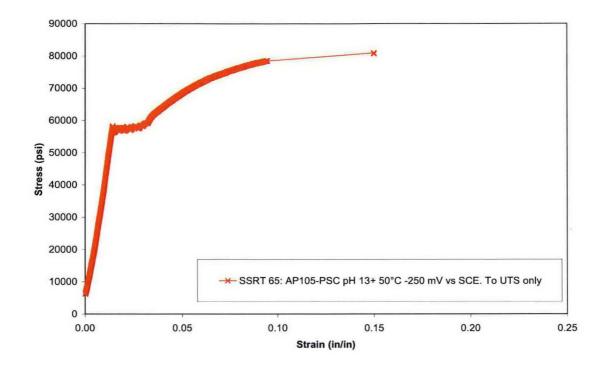
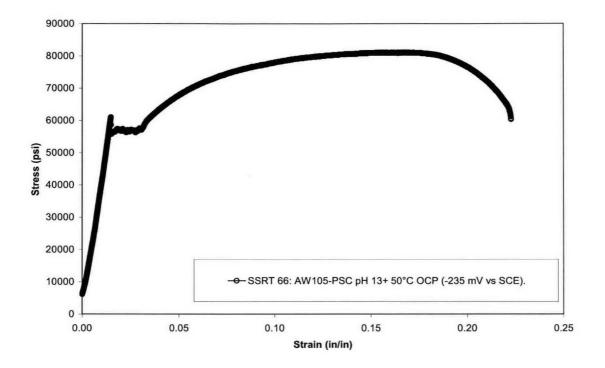


Figure C-55. The Stress-Strain Curve from SSRT 65 Performed in AP105-PSC Simulant at 50°C, pH 13+ and at -250 mV vs. SCE. Test stopped at UTS.

Figure C-56. A Stereo-Micrograph of the Sample from SSRT 65 Performed in AP105-PSC Simulant at 50°C, pH 13+ and at -250 mV vs. SCE. Test stopped at UTS.





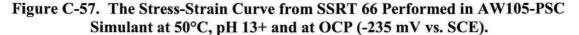
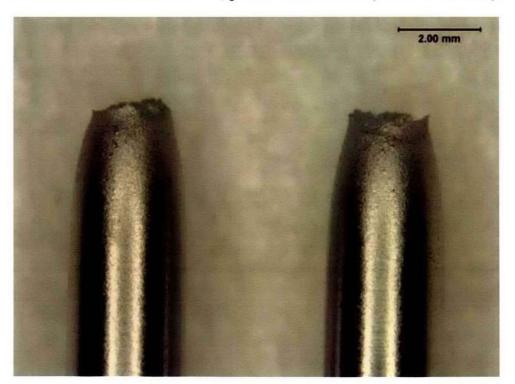


Figure C-58. A Stereo-Micrograph of the Sample from SSRT 66 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at OCP (-235 mV vs. SCE).



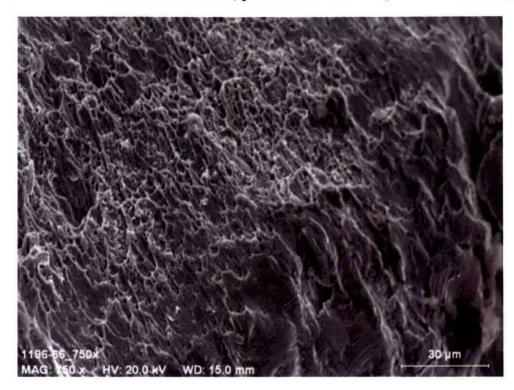
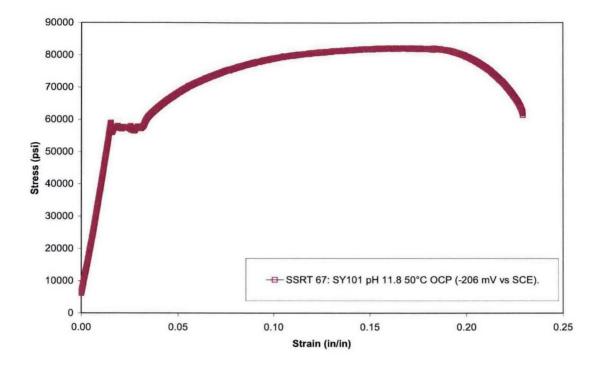


Figure C-59. An Electron-Micrograph of the Fracture Surface from SSRT 66 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at OCP (-235 mV vs. SCE).



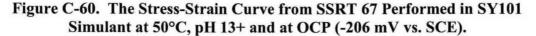


Figure C-61. A Stereo-Micrograph of the Sample from SSRT 67 Performed in SY101 Simulant at 50°C, pH 13+ and at OCP (-206 mV vs. SCE).

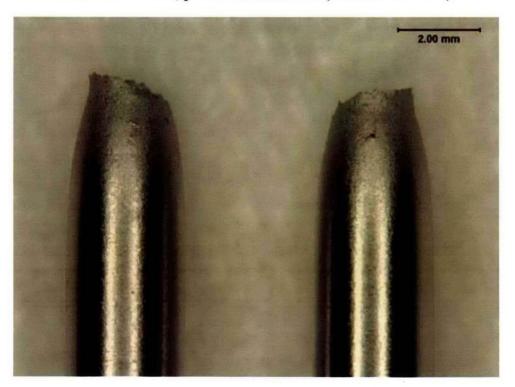
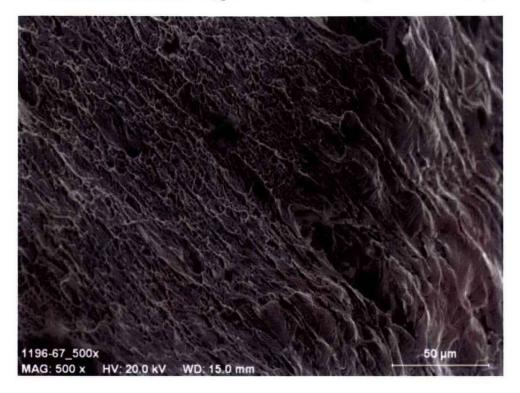
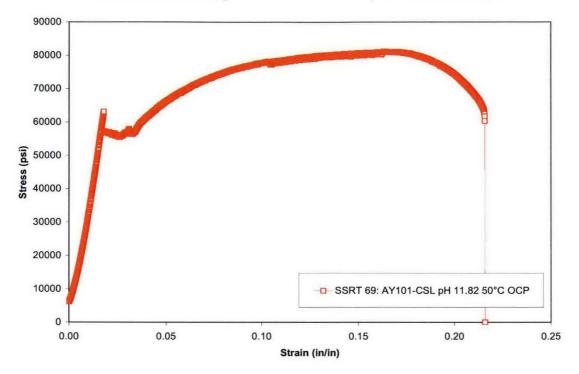
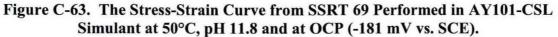
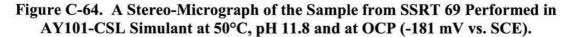


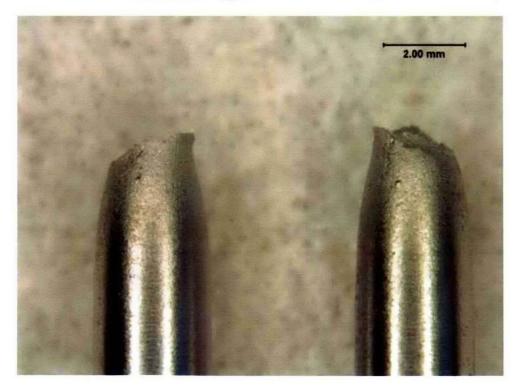
Figure C-62. An Electron-Micrograph of the Fracture Surface from SSRT 67 Performed in SY101 Simulant at 50°C, pH 13+ and at OCP (-206 mV vs. SCE).











C-43

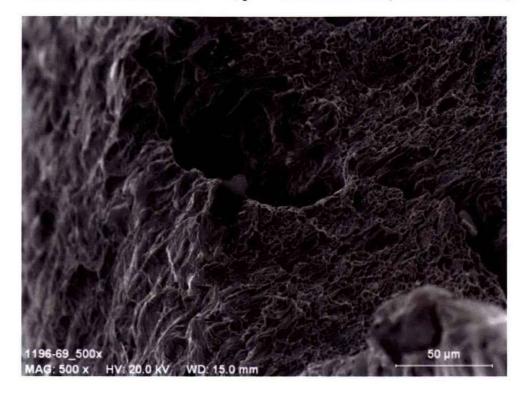
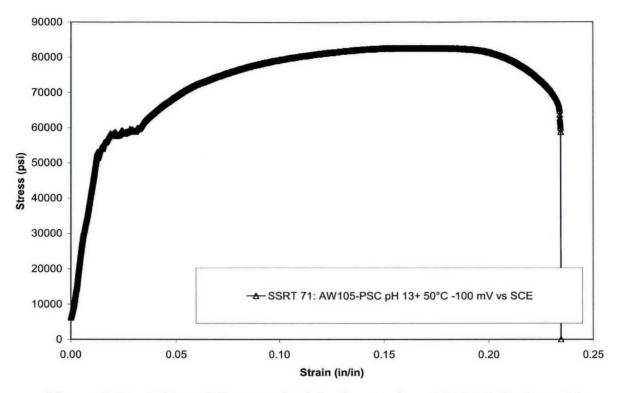


Figure C-65. An Electron-Micrograph of the Fracture Surface from SSRT 69 Performed in AY101-CSL Simulant at 50°C, pH 11.8 and at OCP (-181 mV vs. SCE).



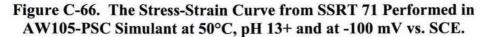
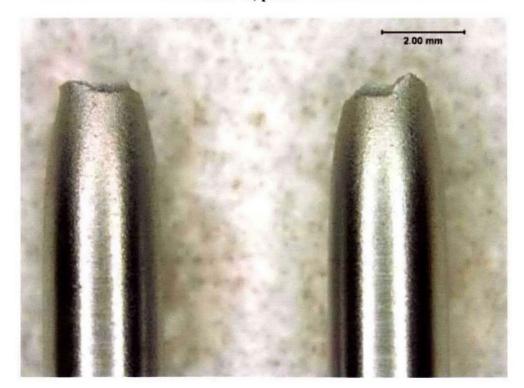


Figure C-67. A Stereo-Micrograph of the Sample from SSRT 71 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.



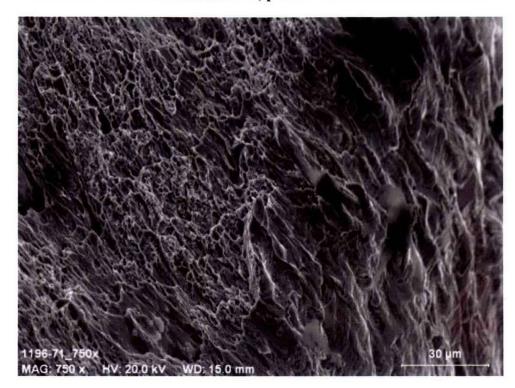
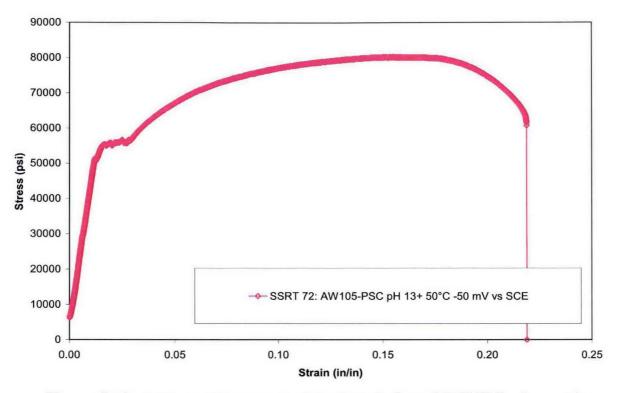


Figure C-68. An Electron-Micrograph of the Fracture Surface from SSRT 71 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.



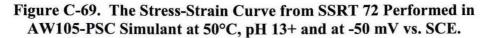
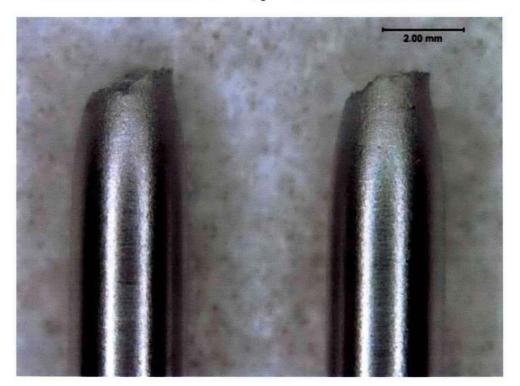


Figure C-70. A Stereo-Micrograph of the Sample from SSRT 72 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at -50 mV vs. SCE.



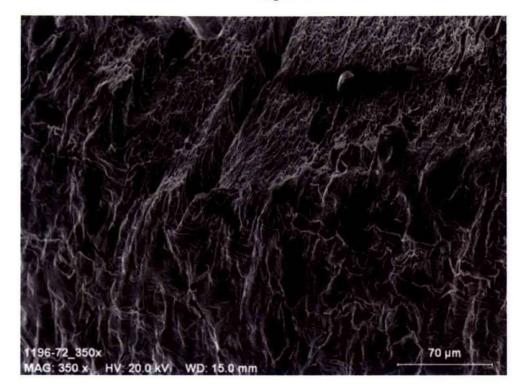
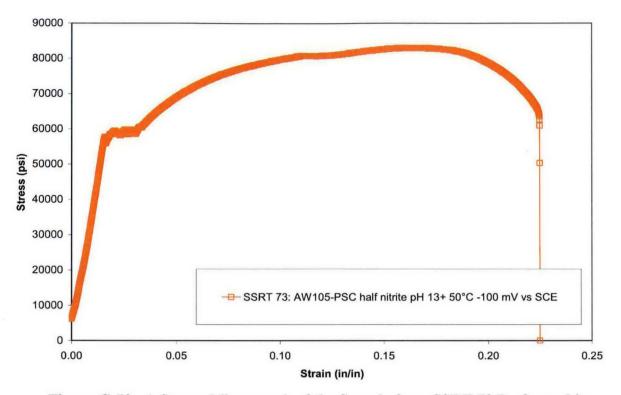
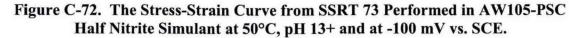
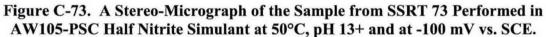
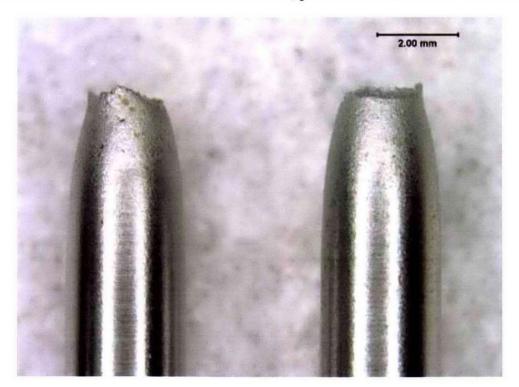


Figure C-71. An Electron-Micrograph of the Fracture Surface from SSRT 72 Performed in AW105-PSC Simulant at 50°C, pH 13+ and at -50 mV vs. SCE.









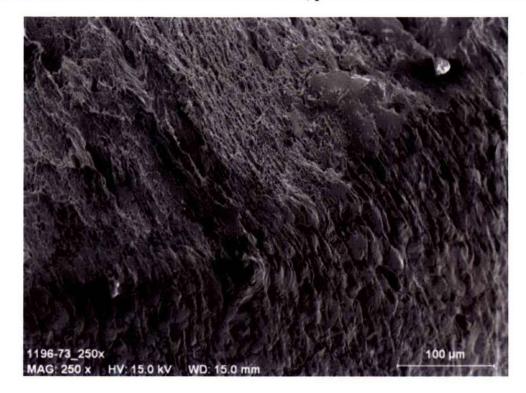
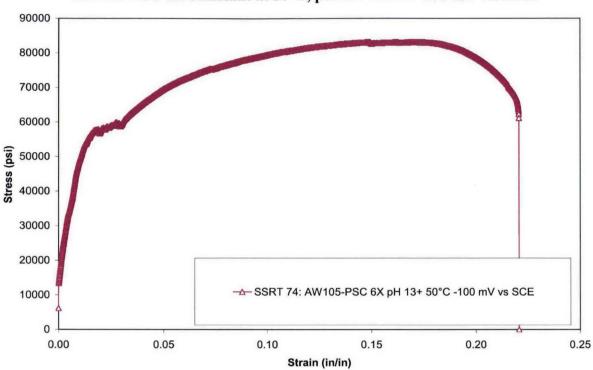


Figure C-74. An Electron-Micrograph of the Fracture Surface from SSRT 73 Performed in AW105-PSC Half Nitrite Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.



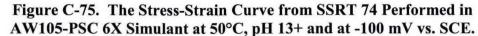
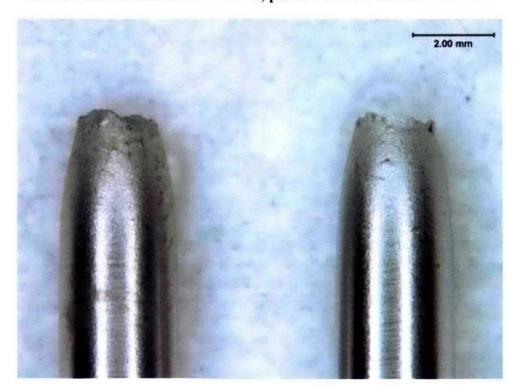


Figure C-76. A Stereo-Micrograph of the Sample from SSRT 74 Performed in AW105-PSC 6X Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.



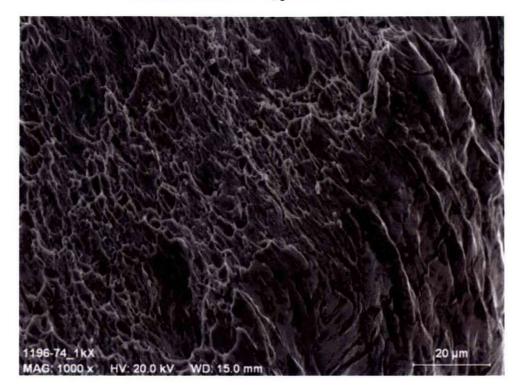


Figure C-77. An Electron-Micrograph of the Fracture Surface from SSRT 74 Performed in AW105-PSC 6X Simulant at 50°C, pH 13+ and at -100 mV vs. SCE.

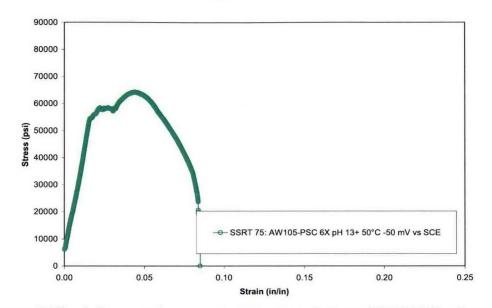


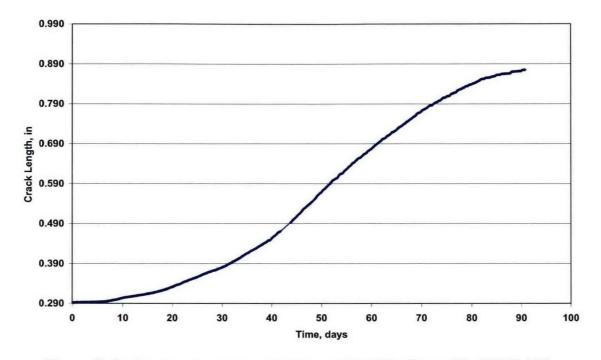
Figure C-78. The Stress-Strain Curve from SSRT 75 Performed in AW105-PSC 6X Simulant at 50°C, pH 13+ and at -50 mV vs. SCE.

Figure C-79. A Stereo-Micrograph of the Sample from SSRT 75 Performed in AW105-PSC 6X Simulant at 50°C, pH 13+ and at -50 mV vs. SCE.



APPENDIX D

CRACK GROWTH RATE TEST DATA



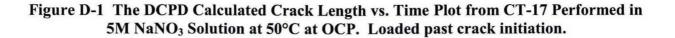
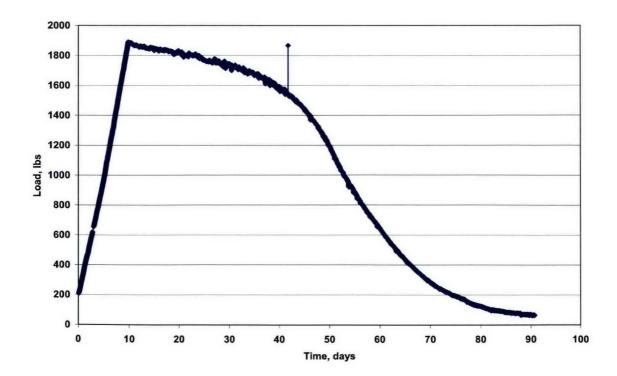


Figure D-2. The Load vs. Time Plot from CT-17 Performed in 5M NaNO₃ Solution at 50°C at OCP. Loaded past crack initiation.



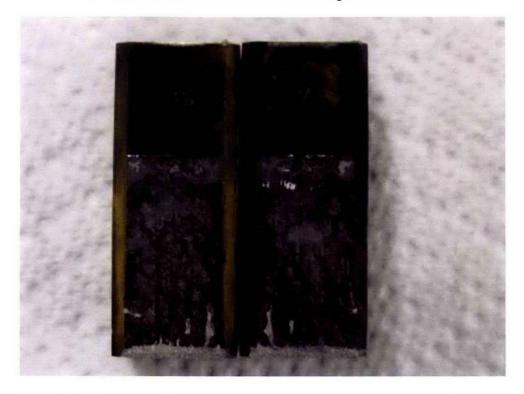
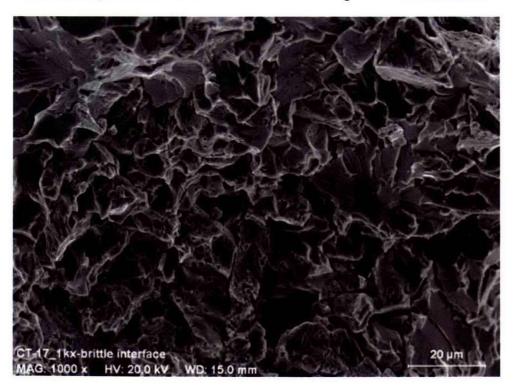


Figure D-3. A Stereo-Micrograph of the Test Sample from CT-17 Performed in 5M NaNO₃ Solution at 50°C at OCP. Loaded past crack initiation.

Figure D-4. An Electron-Micrograph of the Test Sample from CT-17 Performed in 5M NaNO₃ Solution at 50°C at OCP. Loaded past crack initiation.



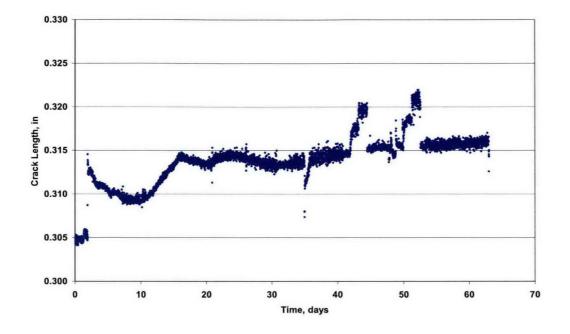


Figure D-3 The DCPD Calculated Crack Length vs. Time Plot from CT-18 Performed in AY101-PSC Standard Simulant at 50°C, pH 11 and at 0 mV vs. SCE. Loaded to K = 45 ksi√in.

Figure D-4. The Load vs. Time Plot from CT-18 Performed in AY101-PSC Standard Simulant at 50°C, pH 11 and at 0 mV vs. SCE. Loaded to K = 45 ksi√in.

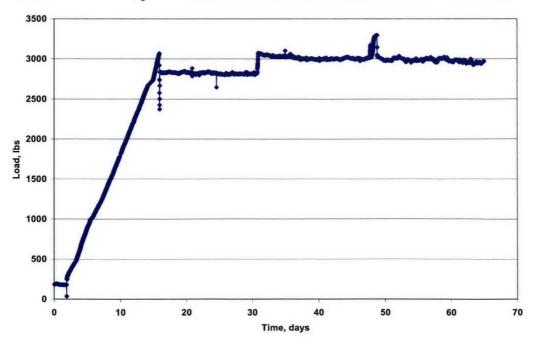


Figure D-5. An Electron-Micrograph of the Test Sample from CT-18 Performed in AY101-PSC Standard Simulant at 50°C, pH 11 and at 0 mV vs. SCE. Loaded to K = 45 ksi√in.

