308 - - - Q200402170001

Scientific Notebook No. 368: Development of corrosion and chemistry sensors for use under elevated temperatures under episodic solution flow conditions (09/22/1999 through 02/19/2003)

LABORATORY NOTEBOOK

CNWRA/SwRI

CORROSION SENSOR DEVELOPMENT

— 20-1402-661
— 20-1402-571

NOTEBOOK NO. _____

ISSUED TO S. BROSSIA SB — ESB

ON 9/22 **19** 99

DEPARTMENT DIV 20

RETURNED _____ **19** ____

CNWRA
CONTROLLED
COPY 368

Darrell Dunn DD

—SCIENTIFIC NOTEBOOK CO.—
2831 LAWRENCE AVE.
P.O. BOX 238
STEVENSVILLE, MI 49127
616-429-8285

INSTRUCTIONS

1. **The primary purpose of this notebook is to protect your and the Company's Patent-Rights by keeping records of all original work in a form acceptable as evidence if any legal conflict arises.**

2. • When starting a page, enter the title, project number, and book number.
   • Use ink for permanence -- avoid pencil.
   • Record your work as you progress, including any spur-of-the-moment ideas which may be developed later.
   • Avoid making notes on loose paper to be recopied.
   • Record your work in such a manner that a co-worker can continue from where you stop. You might be ill and to protect your priority it could be urgent that the work continue while you are absent.

3. • Give a complete account of your experiments and the results, both positive and negative, including your observations.
   • Record all diagrams, layouts, plans, procedures, new ideas, or anything pertinent to your work including the details of any discussions with suppliers, or other people outside the Company.
   • Do not try to erase any incorrect entries; draw lines deleting them, note the corrections, sign and date the changes. This extra care is worthwhile because of the necessity of original data to prove priority of new discoveries.

4. • After entering your data, sign and date the entries.
   • Explain your work to at least two witnesses who are not co-inventors, and have them sign and date the pages in the place provided.
   • Record the names of operators and witnesses present during any demonstration and have at least two witnesses sign the page. If no witnesses are present during an experiment of importance, repeat it in the presence of two witnesses.

5. Since computer programs can be patented these instructions apply to the development of computer software. In this case a description of the structure and operation of the program should be recorded in the notebook, together with a basic flow diagram which illustrates the essential features of the program. In the course of developing the code, the number of lines of code written each day should be recorded in the notebook, together with a statement of the portion of the flow diagram to which the section of code is directed.

6. This notebook and its contents are the exclusive property of the Company. It is confidential and the contents are not to be disclosed to anyone unless authorized by the Company. You must return it when completed, upon request, or upon termination of employment. It should be kept in a protected place. **If loss occurs, notify your supervisor immediately, and make a written report describing the circumstances of the loss.**

Copyright Harold Gallop

Initial Scientific notebook entry for Corrosion/Chemistry Sensor Studies.

Title: Development of corrosion and chemistry sensors for use under elevated temperatures under episodic solution flow conditions

Tests Performed by: Sean Brossia, Steve Clay, other personnel will be identified as they begin work on specific tests. - Oliver Moghissi

Objectives: Develop suitable sensors for monitoring/measuring corrosion potential, chloride concentration, pH, and other environmental and corrosion parameters of interest for use in simulated heater tests.

Equipment: Specific equipment lists provided in initial entries or in individual test entries. Equipment will be identified and calibrated prior to testing.

CSB 9/22/99

Materials: Will be identified through the course of the work.

FORCE INSTITUTE

Southwest Research Institute
6220 Culebra Road
P.O. Drawer 28510
San Antonio, TX 78238-5166
USA
Att.: S. Brossia/ Bldg. 57

Your ref. Purchase Order: 993360W
Our ref. B9-6759-4/OSK/sh
Division Materials and Chemical Analysis
Date 06-09-99

Re.: Your order for ERE 20 Reference Electrodes

Referring to your order of September 2nd 1999 from Robert Wolfe, we hereby send you 2 pcs. ERE 20 Reference Electrodes, each with 5 metres XLPE/PVC cable. The potentials measured for these electrodes are as follows:

5-R3352	09/99	170 mV SCE
5-R3353	09/99	170 mV SCE

NB! Please remember to remove the protection cap before use.

Operating instruction is enclosed together with our confirmation of order and invoice.

Yours sincerely
THE CONCRETE INSPECTION AND ANALYSIS DEPARTMENT

Sadie Heinecke
Sadie Heinecke

From Page No.

A Johnson Matthey Company
30 BOND STREET WARD HILL, MA 01835
EMERGENCY PHONE NUMBER 1-800-424-9300
D-U-N-S 09-907-9063
FEDERAL ID NO. 23-2543453

SHIP TO
Southwest Research Institute
Attn: PO#966727M
6220 Culebra Road
San Antonio TX 78238
TEL # 210-522-3265

990820

CUST# 56027609 DAB

DATE SHIPPED	SHIPPING CHARGES	
8-19		
SHIPPER	NO. OF PKGS.	GROSS WEIGHT
MD	1	

CUSTOMER ORDER NUMBER	DATE ENTERED	ALFA AESAR ORDER NUMBER	F.O.B. PLANT	PRINT DATE & TIME
966727M	8/19/99	457[illegible]76	WARD HILL	8/19/99 121214

TERMS	SHIP VIA
NET 30 DAYS /COL	FEDX PII 00

STOCK NUMBER	UNIT OF MEASURE	SHIP QTY	B/O QTY	ORDER QTY	SHIPPING DATA AND DESCRIPTION
10285-BY SA-FE-05 00716	[illegible]				Platinum wire, 1.0mm (0.04in dia, hard, 99.95% (metals basis)
10411-G1 06-06-03 00896					Tungsten wire, 1.0mm (0.04in dia, 99.95% (metals basis) C27H18 Lot C27H18
11466 32.04-OZ A11466					Silver wire, 1.0mm (0.04in) dia, Premion, 99.999% (metals basis) L10I16 Lot L10I16

*** Shipping Instructions ***
COLL [illegible] 901-4[illegible]
*** ORDER IS COMPLETE ***
THANK YOU FOR YOUR ORDER.

SALES TAX [illegible] .00

NOTE TO RECEIVER:
REPORT SHORTAGES OR ERRORS TO SALES SERVICE DEPARTMENT, JOHNSON MATTHEY. REPORT DAMAGE OF CONTENTS TO CARRIER IMMEDIATELY.

TÜV CERT ISO 9002

PACKING LIST

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
CSR	9/22/99	Recorded by	

From Page No.

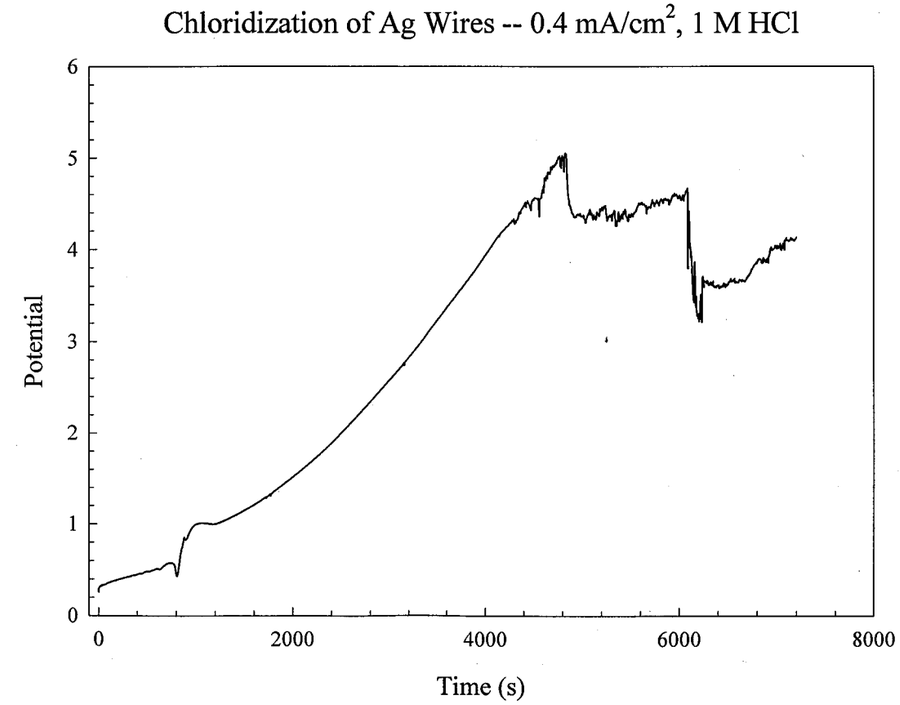
Tungsten wire, 1.0mm dia 99.95% (metals basis) AlfaAesar Lot# C27H18
Silver wire, 1.0mm dia, Premion 99.999% (metals basis) Alfa Aesar Lot # L10I16

Tungsten wire heat oxidized with propane torch

Silver wire oxidized using contant current in 1M → HCl
1M → HCl → 41ml / 500ml
8 wires @ depth of 1.25" in HCL solution held at constant
23mA for 2hours

Equipment used

VergaBath model 236 Fisher Scientific
Thermometer S/N 1238002 AN: 001430



To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by CSR	9/22/99

From Page No.

> using 27.5°C for initial tests to effectively maintain bath temperature

> using Keithley 2517A Electrometer to measure potentials

To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by SR 9/22/99

From Page No.

Test A

Temp

Cell 1 1mM NaCl → .117g / 2Lt use 500ml 972274
10mM HCl → .416ml / 500ml

Cell 2 1mM NaCl → .117g / 2Lt use 500ml 972274

Cell 3 1mM NaCl → .117g / 2Lt use 500ml 972274
20mM Na_2CO_3 → 1.0599g / 500ml

Cell 4 1M NaCl → 116.88g / 2Lt use 500ml 972274
10mM HCl → .416ml / 500ml

Cell 5 1M NaCl → 116.88 / 2Lt use 500ml 972274

Cell 6 1M NaCl → 116.88 / 2Lt use 500ml 972274
20mM Na_2CO_3 → 1.0599g / 500ml

Cell 7 10mM NaCl → 5ml of 1M NaCl to 495ml DI 972274

Cell 8 100mM NaCl → 50ml of 1M NaCl to 450ml DI 972274

To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by SR 9/22/99

Project No.
Book No.
TITLE

From Page No.

Results from evaluation of temp effects on pH & Cl^- sensitive wires on cont. temp both performed.

	-1- Time (h)	-2- 1 mM Cl vs Mn	-3- 1mM Cl vs SCE	-4- 10 mM Cl vs Mn	-5- 10 mM Cl vs SCE
1	4.3330	-84.0000	233.0000	-103.0000	116.0000
2	24.5833	-82.0000	140.0000	-106.0000	100.0000
3	29.4833	-82.0000	141.0000	-102.0000	104.0000
4	95.9333	-84.0000	139.0000	-105.0000	99.0000
5	99.6500	-41.0000	145.0000	-75.0000	99.0000
6	126.3166	-59.0000	149.0000	-82.0000	103.0000
7	172.4830	-66.0000	147.0000	-83.0000	104.0000

25°C

Data 1

	-6- 100 mM Cl vs Mn	-7- 100mM Cl vs SCE	-8- 1M Cl vs Mn	-9- 1M Cl vs SCE	-10-
1	-125.0000	46.0000	-158.0000	-6.0000	
2	-129.0000	47.0000	-157.0000	-6.0000	
3	-127.0000	47.0000	-158.0000	-6.0000	
4	-128.0000	47.0000	-158.0000	-6.0000	
5	-116.0000	46.0000	-161.0000	-6.0000	
6	-118.0000	46.0000	-161.0000	-5.0000	
7	-119.0000	47.0000	-166.0000	-5.0000	

Data 1

	-11-	-12-	-13-	-14-	-15- Cl concentratio
1	??	??			1.0000e-3
2	??	??			0.0100
3	??	??			0.1000
4	??	??			1.0000
5	??	??			
6	??	??			
7	??	??			
8	??	??			

Data 1

	-16- Avg E vs Mn	-17- Error vs Mn	-18- Avg E vs SCE	-19- Error vs SCE	-20-
1	-71.1429	16.5774	156.2857	34.0329	
2	-93.7143	13.1366	103.5714	5.9121	
3	-123.1429	5.3363	46.5714	0.5345	
4	-159.8571	3.1320	-5.7143	0.4880	

Data 1

	-21- pH	-22- E 1 mM sce	-23- sce error	-24- E 1 M vs SCE	-25- sce err
1	2.0000	78.0000	3.3000	-6.8500	1.1000
2	5.0000	156.2857	34.0329	-5.7143	0.4880
3	10.0000	161.0000	3.3000	-6.0000	0.6000

To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by | 10/25/99

TITLE
Project No.
Book No.

From Page No.

	-1- Time	-2- E vs Mn 100m	-3- E vs sce 100 ,M	-4- E vs Mn 1M	-5- E vs. SCE 1 M
1	0.0000	-114.0000	48.0000	-152.0000	-11.0000
2	17.0000	-123.0000	49.0000	-148.0000	-10.0000
3	17.3330	-124.0000	48.0000	-152.0000	-10.0000
4	19.7500	-129.0000	50.0000	-151.0000	-11.0000
5	42.0000	-130.0000	55.0000	-151.0000	-10.0000
6	94.0000	-127.0000	56.0000	-149.0000	-9.0000

50°C

Data 1

	-6-	-7- Temp	-8- AvgE Mn 100 m	-9- error 100 m	-10- AvgE SCE 100 m
1		25.0000	-123.1429	5.3363	46.5714
2		50.0000	-124.5000	5.8224	51.0000
3		85.0000			

Data 1

	-11- error sce 100 m	-12- AvgE Mn 1M	-13- error Mn 1M	-14- AvgE SCE 1M	-15- error sce 1M
1	0.5345	-159.8571	3.1320	-5.7143	0.4880
2	3.5777	-150.5000	1.6432	-10.1667	0.7528

To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by | 10/25/99

From Page No.

Data 1

	-1- Time	-2- E vs Mn 100m	-3- E vs sce 100 ,M	-4- E vs Mn 1M	-5- E vs. SCE 1 M
1	0.0000	-114.0000	48.0000	-152.0000	-11.0000
2	17.0000	-123.0000	49.0000	-148.0000	-10.0000
3	17.3330	-124.0000	48.0000	-152.0000	-10.0000
4	19.7500	-129.0000	50.0000	-151.0000	-11.0000
5	42.0000	-130.0000	55.0000	-151.0000	-10.0000
6	94.0000	-127.0000	56.0000	-149.0000	-9.0000

50°C

Data 1

	-6-	-7- Temp	-8- AvgE Mn 100 m	-9- error 100 m	-10- AvgE SCE 100 m
1		25.0000	-123.1429	5.3363	46.5714
2		50.0000	-124.5000	5.8224	51.0000
3		85.0000			

Data 1

	-11- error sce 100 m	-12- AvgE Mn 1M	-13- error Mn 1M	-14- AvgE SCE 1M	-15- error sce 1M
1	0.5345	-159.8571	3.1320	-5.7143	0.4880
2	3.5777	-150.5000	1.6432	-10.1667	0.7528

From Pag

25°C

	-1- Time	-2- avg E	-3- error	-4- time 50	-5- avg E 50
1	4.3330	202.8750	57.3696	0.0000	156.2500
2	24.5833	190.0000	35.3917	17.0000	159.0000
3	29.4833	189.1250	33.6895	17.3300	162.0000
4	95.9333	190.6250	35.2620	19.0000	162.0000
5	99.6500	179.7500	24.6098	42.7500	168.0000
6	126.3166	182.5000	24.6461	94.0000	169.2500
7	172.4830	187.2500	25.1950		

Data 1

	-6- error 50	-7- time 85	-8- avg E 85	-9- error 85	-10-
1	11.8427	0.3333	146.5000	21.5019	
2	19.1311	4.6333	149.2500	24.4455	
3	18.7794	22.5833	152.7500	26.0432	
4	20.9921	28.1333	153.7500	25.9021	
5	23.3524	47.2167	156.5000	24.1868	
6	19.7210	53.9000	137.5000	15.0000	
7		70.7833	138.2500	19.0329	
8		99.4500	133.2500	14.4539	
9		195.4167	131.0000	16.8325	

Data 1

	-11-	-12-	-13- 4.33	-14- 24.58	-15- 29.433
1			165.0000	178.0000	180.0000
2			165.0000	161.0000	170.0000
3			125.0000	127.0000	132.0000
4			131.0000	131.0000	129.0000

Data 1

	-16- 95.933	-17- 99.65	-18- 126.32	-19- 172.483	-20-
1	183.0000	183.0000	154.0000	160.0000	150.0000
2	168.0000	171.0000	146.0000	147.0000	140.0000
3	134.0000	137.0000	128.0000	129.0000	125.0000
4	130.0000	135.0000	122.0000	117.0000	118.0000

Data 1

	-21-
1	154.0000
2	133.0000
3	120.0000
4	117.0000

	-1- Time	-2- E vs Mn pH 6 10	-3- E vs sce pH 610	-4- E vs Mn pH 61M	-5- E vs. SCE pH 61
1	0.0000	-347.0000	-187.0000	-305.0000	-160.0000
2	17.0000	-353.0000	-177.0000	-280.0000	-140.0000
3	17.3330	-347.0000	-170.0000	-230.0000	-80.0000
4	19.7500	-356.0000	-175.0000	-234.0000	-89.0000
5	42.0000	-362.0000	-174.0000	-230.0000	-85.0000
6	94.0000	-358.0000	-172.0000	-199.0000	-78.0000

°C
25 °C
50 °C
85 °C

Data 1

	-6- E vs Mn pH 10 1	-7- E vs sce pH 10	-8- E vs mn pH10 1M	-9- E vs sce pH10 1	-10-
1	-635.0000	-482.0000	-630.0000	-488.0000	
2	-628.0000	-455.0000	-599.0000	-470.0000	
3	-628.0000	-445.0000	-574.0000	-440.0000	
4	-625.0000	-448.0000	-584.0000	-450.0000	
5	-615.0000	-435.0000	-590.0000	-447.0000	
6	-613.0000	-419.0000	-594.0000	-435.0000	

Data 1

	-11- Temp	-12- AvgE pH 6 100 m	-13- error pH6 100m	-14- AvgE pH 10 100	-15- error pH 10 100
1	25.0000	-118.4286	38.4831	-388.4286	15.4796
2	50.0000	-175.8333	5.9805	-447.3333	21.0776
3	85.0000				

Data 1

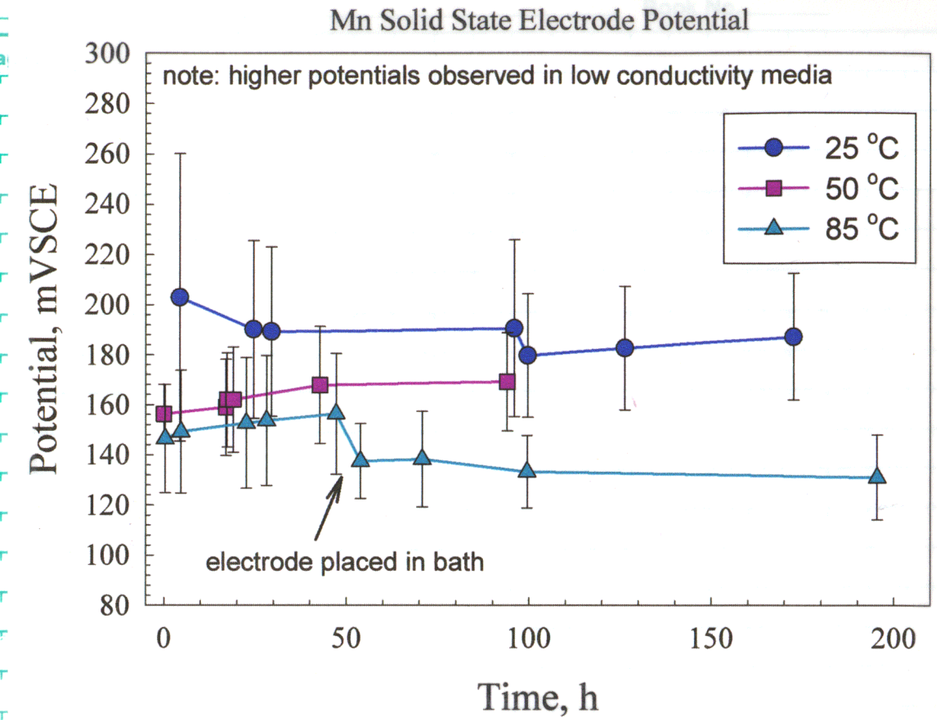
	-16- AvgE pH 6 1M	-17- error pH 61M	-18- AvgE pH 10 1M	-19- error pH 10 1 M	-20-
1	-97.7143	17.0462	-376.1429	5.9000	
2	-105.3333	35.3817	-455.0000	20.1395	

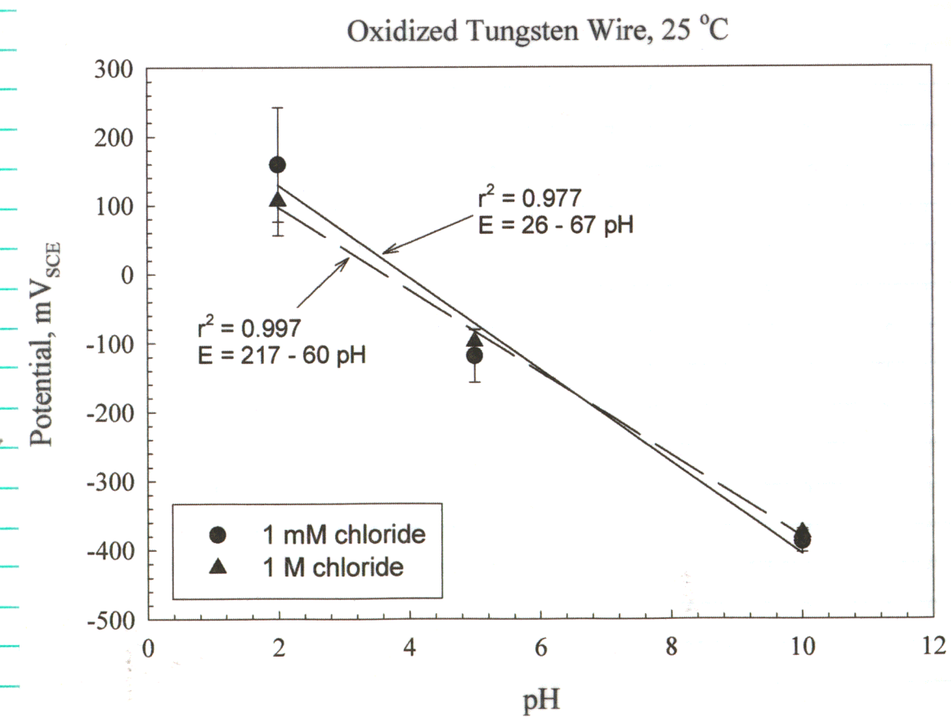
Data 1

	-21- pH	-22- E 100 mM Mn	-23- 100 m error	-24- E 100 mM sce	-25- error sce 100m
1	5.7000	-353.8333	6.0470	-175.8333	5.9805
2	11.0000				

Data 1

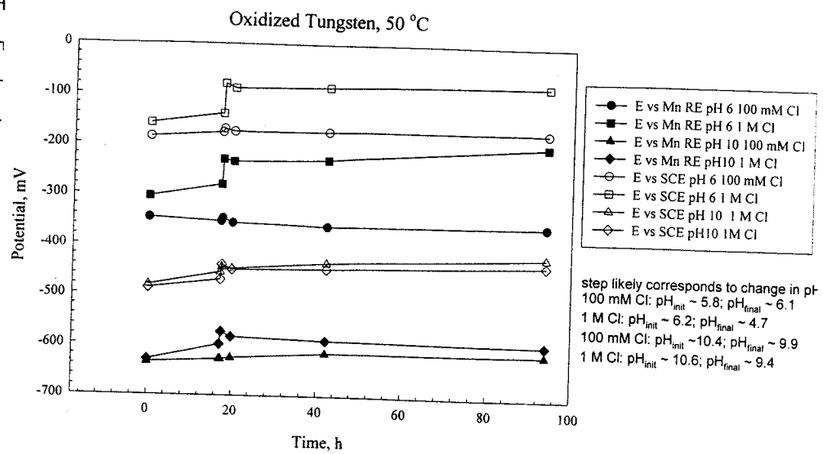
	-26- E 1 Mn	-27- error 1 M	-28- E 1 SCE	-29- error sce 1M	-30-
1					

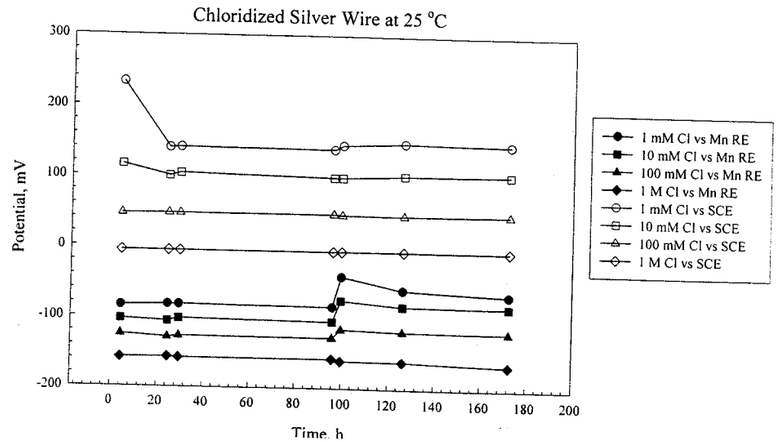


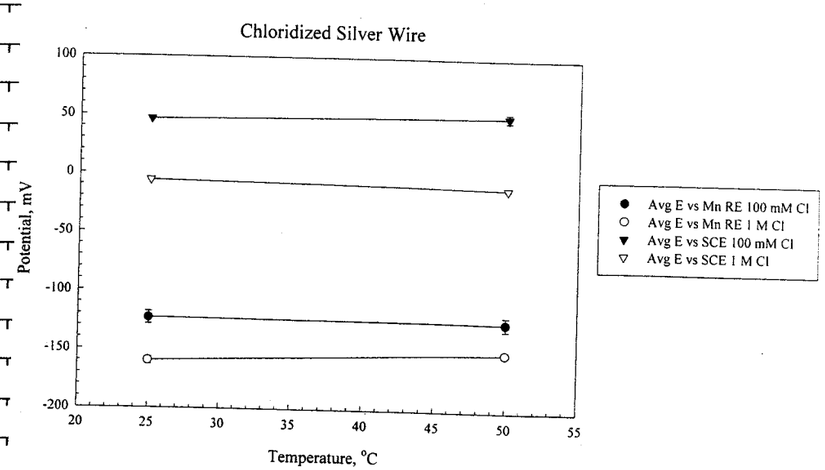


Project No.
Book No.
TITLE

From Page No.







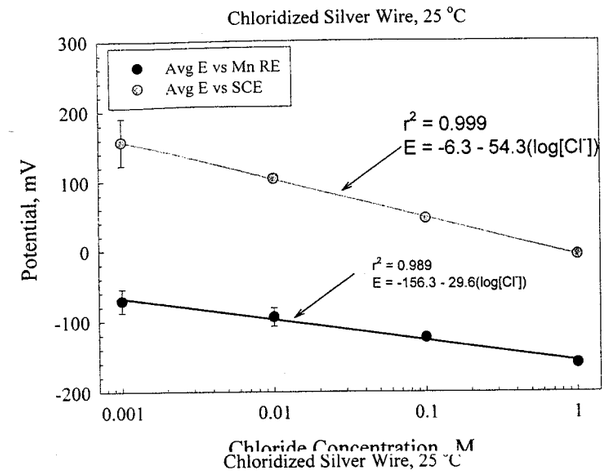
To Page No.

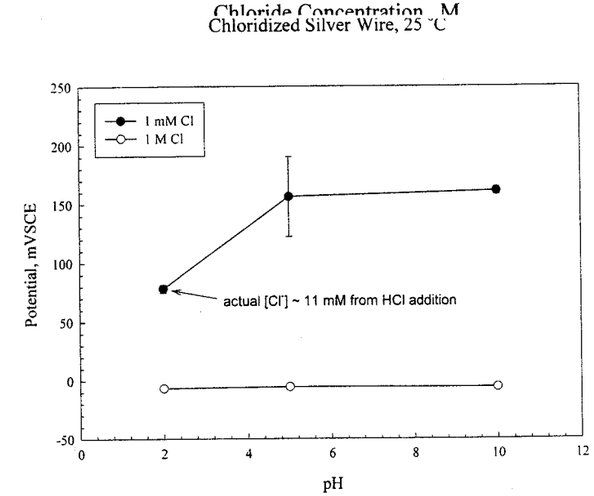
Witnessed & Understood by me, | Date | Invented by | Date
Recorded by SB | 10/25/99

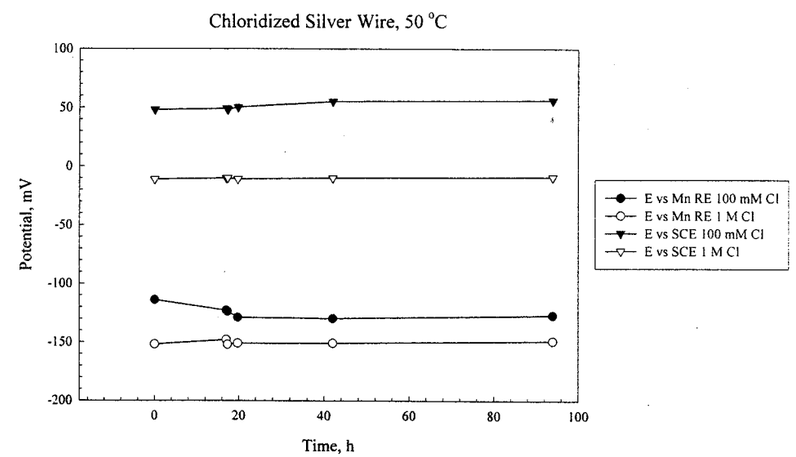
TITLE

From Page No.

Project No.





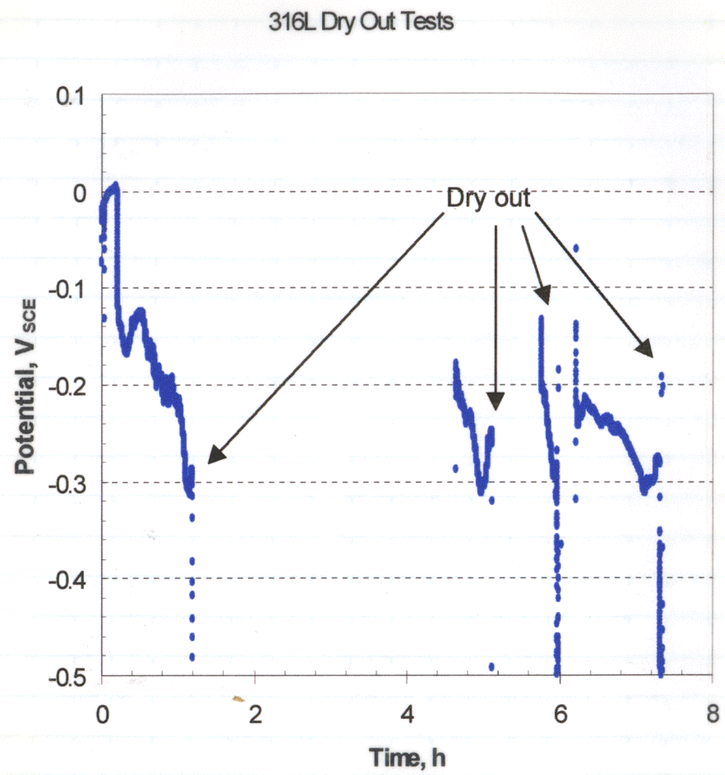


To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by SB | 10/25/99

From Page No.

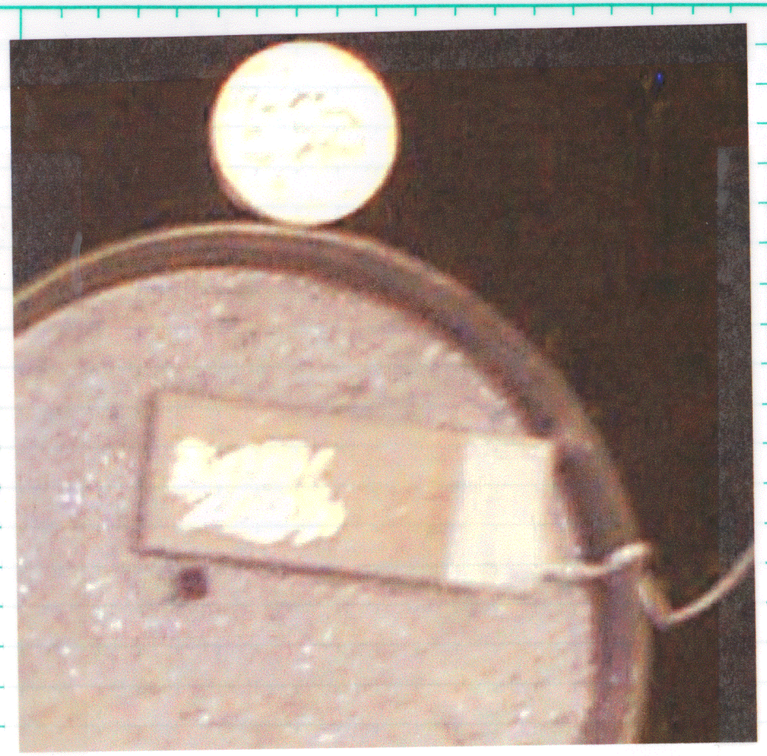
Tests ~~when~~ SB 8/16/2000 were initiated examining the performance of monitoring the ocp of 316L SS coupon during dry out periods when placed in a dish on a hot plate and 1 mM NaCl solution was poured on top and allowed to boil off. SCE was used w/ a luggin probe to eliminate adverse temp effects on SCE performance.

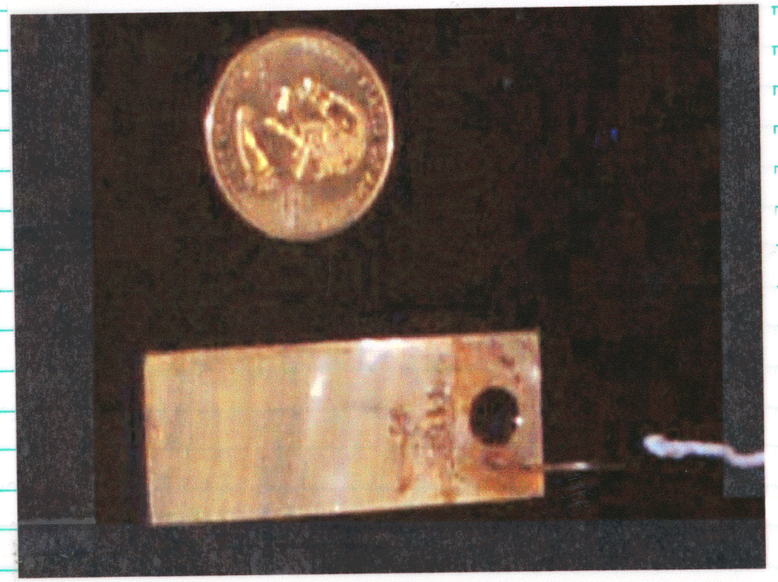


To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by SB | 10/29/99

From Page No.

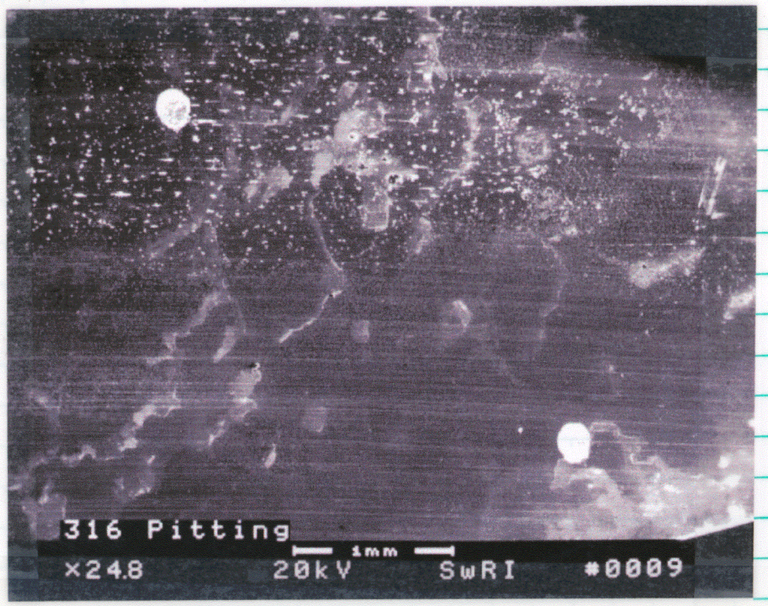




To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by SB | 10/29/99

From Page No.

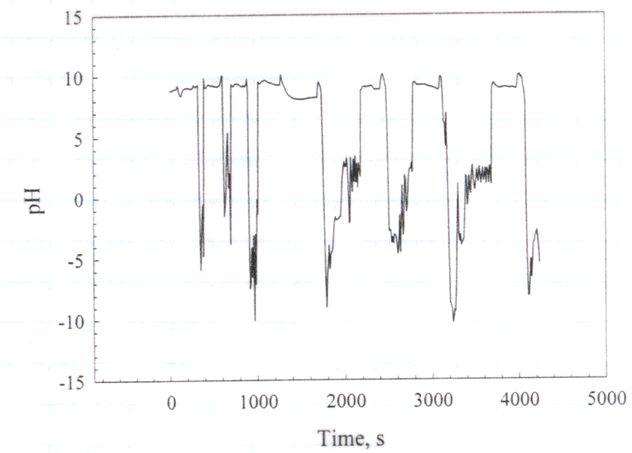


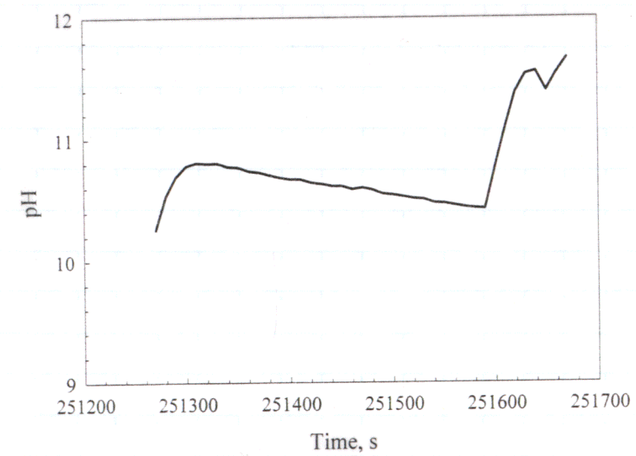
To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by S Brown | 10/29/99

From Page No.

Test modified to monitor potential of chloridized Ag for [Cl], oxidized W for pH, Pt for E_{redox}, 316 SS & C-22 SS ocp and MnO RE. 1mM NaCl dripped periodically onto above in a glass dish on a hot plate and allowed to dry out. Same set up as on p 14 except a syring pump was used to dispense solution (~7mL)

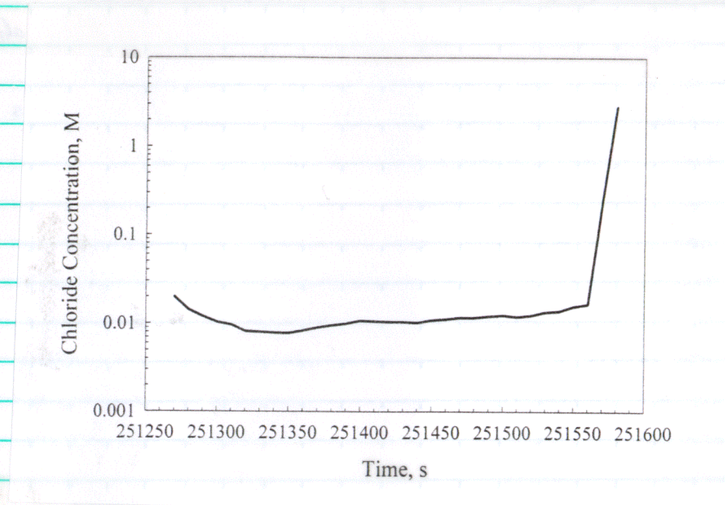


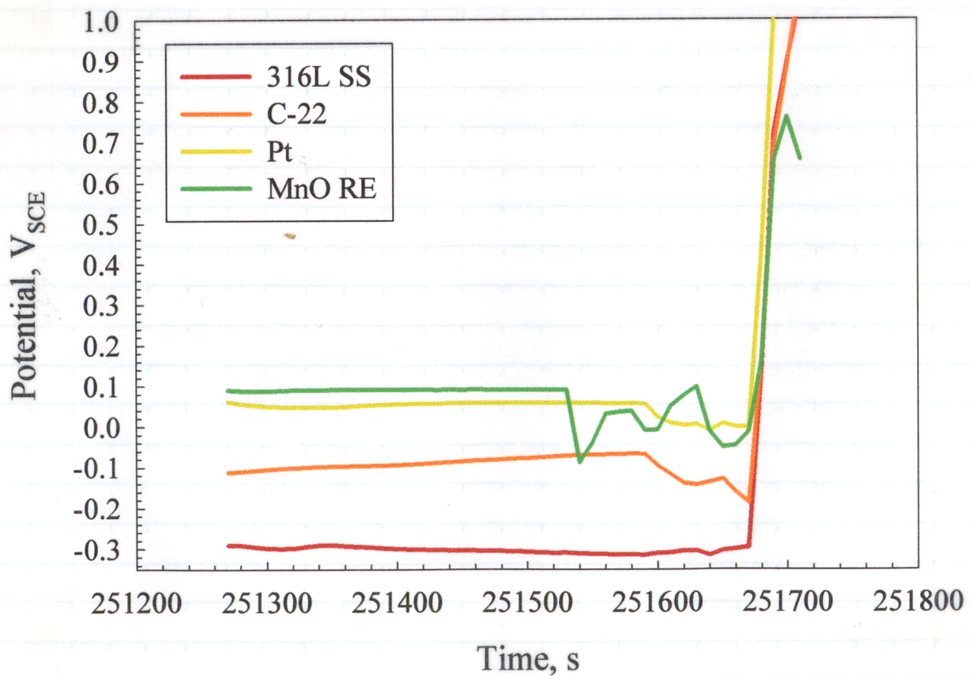


To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by S Brown | 1/20/00

From Page No.

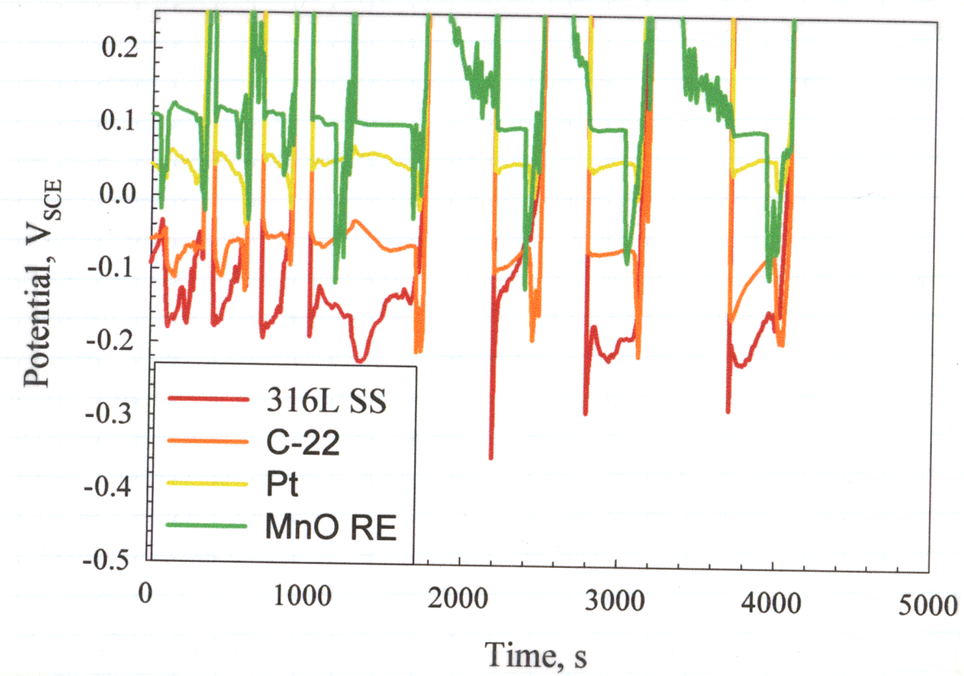




To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by SB | 1/20/00

From Page No.



To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by SB | 1/20/00

From Page No.____

Metal Samples
Corrosion Monitoring Systems

Metal Samples Corrosion Monitoring Systems
a division of Alabama Specialty Products, Inc.
152 Metal Samples Rd. P.O. Box 8
Munford, AL 36268
Phone: (256) 358-4202 Fax: (256) 358-4515
e-mail: benl@alspi.com Internet: www.alspi.com

Fax Transmission from Benjamin Lackey

Recipient [redacted]
Company Southwest Research Institute
Fax Number 1-210-522-5184
Subject [redacted]
Date 01/07/2000
Number of Pages (including cover) 15

Sean,

Following, are copies of the material certs supplied by Metal Samples Company with SwRI PO#'s 984139S and 951110J. I have also included copies of the original manufacturer certifications for each material.

SwRI PO# 984139S / Metal Samples order# 38276 (Coupons)
1) C22 – MS Heat# J244
2) A516Gr60 – MS Heat# F215
3) 316L – MS Heat# P012
4) C22 – MS Heat# J351
5) A516Gr60 – MS Heat# F215
6) 316L – MS Heat# P770
7) C22 – MS Heat# J351
8) A516Gr60 – MS Heat# F215
9) 316L – MS Heat# P770

Coupons #1-3 are 1/16" x 1/2" x 3", with a 3/16" diameter hole, 1/4" from one end.
Coupons #4-6 are 1/8" x 3/4" x 2", with a 1/4" diameter hole, 1/4" from one end.
Coupons #5-9 are the same size as #4-6, but with an autogenous weld added.

SwRI PO# 951110J / Metal Samples order# 37572 (Wires, 0.040" dia x 12" long)
1) TiGr7 – MS Heat# P914
2) C22 – MS Heat# H157
3) 316L – MS Heat# H405
4) ZR4 – MS Heat# D830

If you have any questions, or need anything else, please let us know.

Best regards,
Benjamin Lackey

To Page No._____

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	1/18/00

From Page No.____

CONAM KAWIN

194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P. O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P. O. # 50138
DESCR 01-25-00 PO# X94367X
REQ# 505956

REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 16 JOB NO: 2/1 #41

ASTM A516-64 WELDED A516 CARBON STEEL HEAT# MSF215/E44794

CHEMICAL ANALYSIS

Si	.25	Mn	1.05	C	.26
P	.017	S	.016	Ni	.03
Cr	.03	Mo	<.01	Cu	.01
Fe	BASE				

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ICP ;

QA INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

PAGE 16 OF 16

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

To Page No._____

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	1/18/00

Project No._____

Book No._____ TITLE _____

From Page No.____

To Page No._____

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by SB	5/15/00

TITLE _____

Project No._____

Book No._____

From Page No.____

To Page No._____

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by SB	5/15/00

CONAM KAWIN
194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P.O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P.O. # 50138

DESCR 01-25-00 PO# X94367X
REG# 505956

REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 15

JOB NO: 2/1 #40

ASTM A516-64 WROUGHT A516 CARBON STEEL HEAT# MSF215/E44794

CHEMICAL ANALYSIS

Si	.25	Mn	1.04	C	.29
P	.018	S	.015	Ni	.03
Cr	.04	Mo	.01	Cu	.01
Fe	BASE				

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ICP ;

GA INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

PAGE 15 OF 16

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

CONAM KAWIN
194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P.O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P.O. # 50138

DESCR 01-25-00 PO# X94367X
REG# 505956

REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 13

JOB NO: 02/02 #18

ASTM A240 WELDED 316L SS HEAT# MSJP770/B84438

CHEMICAL ANALYSIS

Si	.46	Mn	1.85	C	.030
P	.023	S	.001	Ni	10.29
Cr	16.42	Mo	2.31	N	.023
Fe	67.64				

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ICP ; ASTM E 354 ;

GA INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

PAGE 13 OF 16

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

CONAM KAWIN
194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P.O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P.O. # 50138

DESCR 01-25-00 PO# X94367X
REG# 505956

REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 12

JOB NO: 02/02 #17

ASTM A240 WROUGHT 316L SS HEAT# MSJP770/B84438

CHEMICAL ANALYSIS

Si	.49	Mn	1.93	C	.030
P	.034	S	.001	Ni	10.68
Cr	16.14	Mo	2.33	N	.023
Fe	67.47				

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ICP ; ASTM E 354 ;

QA INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

PAGE 12 OF 16

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

CONAM KAWIN
194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P.O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P.O. # 50138

DESCR 01-25-00 PO# X94367X
REG# 505956

REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 11

JOB NO:

ASTM A240 WROUGHT 316L SS HEAT# MSJP012/273854

CHEMICAL ANALYSIS

Si	.59	Mn	1.53	C	.006
P	.023	S	.014	Ni	10.67
Cr	16.58	Mo	2.17	Cu	.33
Co	.20	N	.040	Fe	67.54

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ICP ; ASTM E 354 ;

QA INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

PAGE 11 OF 16

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

CONAM KAWIN
194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P.O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P.O. # 50138
DESCR 01-25-00 PO# X94367X
REQ# 505956

REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 09
JOB NO: 02/10 #13

ASTM 575 WELDED ALLOY C22 HEAT# MSJ351/XX0680BQ

CHEMICAL ANALYSIS

Si	.05	Mn	.23	C	.013
P	.003	S	.001	Ni	BALANCE
Cr	20.12	Mo	15.80	V	.01
Co	.06	Fe	2.10	W	1.25

1/4 HR PT

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ICP ; ASTM E 354 ;

QA INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

PAGE 9 OF 16

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

CONAM KAWIN
194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P.O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P.O. # 50138
DESCR 01-25-00 PO# X94367X
REQ# 505956

REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 08
JOB NO: 02/10 #12

ASTM 575 WROUGHT ALLOY C22 HEAT# MSJ351/XX0680BQ

CHEMICAL ANALYSIS

Si	.06	Mn	.26	C	.009
P	.002	S	.001	Ni	BALANCE
Cr	20.20	Mo	15.66	V	.01
Co	.07	Fe	2.45	W	2.40

1/4 HR PT

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ICP ; ASTM E 354 ;

QA INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

PAGE 8 OF 16

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

From Page No.____

CONAM KAWIN

194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P.O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P.O. # 50138

DESCR 01-25-00 PO# X94367X
REG# 505956

REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 07

JOB NO: 02/10 #11

ASTM 575 WROUGHT ALLOY C22 HEAT# MSJ244/XX0604BK

CHEMICAL ANALYSIS

Si	.04	Mn	.25	C	.014
P	.002	S	.001	Ni	BALANCE
Cr	20.16	Mo	15.85	V	<.01
Co	.07	Fe	2.30	W	1.65

1/4 HR PT

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ICP ; ASTM E 354 ;

QA INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

PAGE 7 OF 16

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

To Page No._____

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by | 8/15/00

From Page No.____

Metal Samples
Corrosion Monitoring Systems

Metal Samples Corrosion Monitoring Systems
a division of Alabama Specialty Products, Inc.
152 Metal Samples Rd. P.O. Box 8
Munford, AL 36268
Phone: (256) 358-4202 Fax: (256) 358-4515
e-mail: benl@alspi.com Internet: www.alspi.com

Fax Transmission from Benjamin Lackey

Recipient [redacted]
Company Southwest Research Institute
Fax Number 1-210-522-5184
Subject [redacted]
Date 01/07/2000
Number of Pages (including cover) 15

Sean,

Following, are copies of the material certs supplied by Metal Samples Company with SwRI PO#'s 984139S and 951110J. I have also included copies of the original manufacturer certifications for each material.

SwRI PO# 984139S / Metal Samples order# 38276 (Coupons)
1) C22 – MS Heat# J244
2) A516Gr60 – MS Heat# F215
3) 316L – MS Heat# P012
4) C22 – MS Heat# J351
5) A516Gr60 – MS Heat# F215
6) 316L – MS Heat# P770
7) C22 – MS Heat# J351
8) A516Gr60 – MS Heat# F215
9) 316L – MS Heat# P770

Coupons #1-3 are 1/16" x 1/2" x 3", with a 3/16" diameter hole, 1/4" from one end.
Coupons #4-6 are 1/8" x 3/4" x 2", with a 1/4" diameter hole, 1/4" from one end.
Coupons #5-9 are the same size as #4-6, but with an autogenous weld added.

SwRI PO# 951110J / Metal Samples order# 37572 (Wires, 0.040" dia x 12" long)
1) TiGr7 – MS Heat# P914
2) C22 – MS Heat# H157
3) 316L – MS Heat# H405
4) ZR4 – MS Heat# D830

If you have any questions, or need anything else, please let us know.

Best regards,
Benjamin Lackey

To Page No._____

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by | 8/15/00

From Page No.____

CONAM KAWIN

194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P.O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P.O. # 50138

DESCR 01-25-00 PO# X94367X
REG# 505956

REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 06

JOB NO:

ASTM B350 ZIRCALOY-4 WIRE HEAT# MSD830/214450Q

CHEMICAL ANALYSIS

Cr	.11	Sn	1.57	Fe	.21
Zr	BALANCE				
Cb	.004				

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; CLASSIC WET ;

Q.A. INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

To Page No._____

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by SB	5/10/00

From Page No.____

CONAM KAWIN

194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P.O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P.O. # 50138

DESCR 01-25-00 PO# X94367X
REG# 505956

REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 14

JOB NO: 02/02 #19

ASTM A240 316L SS WIRE HEAT# MSH405/E77055

CHEMICAL ANALYSIS

Si	.48	Mn	1.60	C	.027
P	.011	S	.001	Ni	12.40
Cr	19.30/19.36	Mo	2.52	N	.039
Fe	63.14				

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ICP ; ASTM E 354 ;

QA INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

To Page No._____

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by SB	5/10/00

CONAM KAWIN
194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P. O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P. O. # 50138
DESCR 01-25-00 PO# X94367X
REQ# 505956
REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 04
JOB NO:

ASTM B265 GR 7 TI-GR 7 WIRE HEAT# MSP914/Z1812

CHEMICAL ANALYSIS

C	.07	Ti	REMAINDER	Fe	.05
H	23.2PPM	N	.0083	O	.12
Pd	.13				

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ASTM E1447 ; ASTM E 1409 ;

QA INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

PAGE 4 OF 16

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

CONAM KAWIN
194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P. O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P. O. # 50138
DESCR 01-25-00 PO# X94367X
REQ# 505956
REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 10
JOB NO: 02/02 #15

ASTM 575 ALLOY C22 WIRE HEAT# MSH157/227703270

CHEMICAL ANALYSIS

Si	.04	Mn	.29	C	.018
P	.002	S	.001	Ni	BASE
Cr	20.48	Mo	15.10	V	.12
Co	.60	Fe	4.90	W	2.75

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ICP ; ASTM E 354 ;

QA INSPECTOR

ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

PAGE 10 OF 16

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

Project No.
Book No. TITLE

From Page No.

Sensor Array construction

→ 2 Pt for conductivity
→ 316L ocp
→ C22 ocp
→ Ag/AgCl for Cl
→ W/WO_3 for pH
→ Luggin probe w/ SCE

- wires secured to glass inserts w/ high temp RTV (Automotive red)
- glass inserts secured to array cell w/ same high temp RTV

To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by SB 7/19/2000

TITLE
Project No.
Book No.

From Page No.

Bench test of prototype Array using conductivity meter S/N hot plate, syringe pump w/ 0.8 mL per cycle, and thermometer #

- initial solution used was from DI that was equilibrated w/ YM rock for ~5 months (samples taken for further analysis at a later date).

* Note: an old Ag/AgCl wire was ~~&~~ SB 7/24/2000 used to determine the effects of aging on its performance → it was non sensical! (23M)

- pH, conductivity and ocp measurements all seemed to work

* Conductivity measured using array is off by a factor of 2.2 x compared to a conductivity probe w/ a cell constant of 1.0.

files: array1a.asc — 7/24/00
array1b.asc — 7/25/00
array1c.asc — 7/26/00

To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by SB 8/1/00

Project No.
Book No. TITLE

From Page No.

Solution changed to 1000 ppm Cl^- (as KCl) w/o rinsing/washing precipitated residue in array cell from rock water

file: array2a.asc – 7/28/00

– again, conductivity, pH & ocp performed well. Cl measurements were nonsensical.

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by SB 7/29/00	

Project No.
TITLE Book No.

From Page No.

SB 8/9/00

2 new sensor arrays ~~and~~ were constructed w/ WO_3, Ag/AgCl, 316L, C-22, and 2 pt wires for use in heater test.

An interdigitated Ag – Carbon steel sensor supplied by D. Yunn will also be included.

Coupons that will be exposed: → used in as-rcvd w/o polish

	Coupon designation (stamped ID)		initial wt
carbon steel	A516-60 – 1		13.43783g
	A516-60 – 3		13.42184
	A516-60 – 4		13.40983
Type 316L (welded)	316LW – ~~3~~ 2	SB 8/9/00	22.93875
	316LW – ~~2~~ 3		22.70091
C-22 welded	C22W – 1		24.91087
	C22W – 2		24.88200

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by SB	8/9/2000

Project No.
Book No.
TITLE

From Page No.

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

SCIENTIFIC NOTEBOOK REVIEW CHECKLIST RECORD

Scientific Notebook No.: 368

Accomplished

yes ✓	1. Initial entries per QAP-001
yes ✓	2. Dating of entries
① no ✓	3. Corrections (crossed out, one line through w/initials/date)
yes ✓	4. White out not used
yes ✓	5. Page number visible on original notebook
yes ✓	6. In process entries per QAP-001
N/A ✓	7. Figure numbers present
yes ✓	8. Text visible
N/A ✓	9. Electronic Scientific Notebook changes initialed and dated
yes ✓	10. Permanent ink or type only
yes ✓	11. Signing of entries (not required on each page)
N/A ✓	12. Statement at the end of electronic Scientific Notebook print outs—"No original text removed"
N/A ✓	13. Electronic media in the scientific notebook properly labeled

Discrepancies have been identified. Yes ✓ No

Checker: [signature] Date: 8/16/00

The discrepancies identified in this Scientific Notebook Review Checklist have been addressed by:

[signature] Signature — 8/16/2000 Date

CNWRA Form QAP-01 (8/2000)

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by [signature]	8/16/2000

Project No.
Book No.
TITLE

From Page No.

Notebook copy sent to QA

pages 20-40

To Page No.

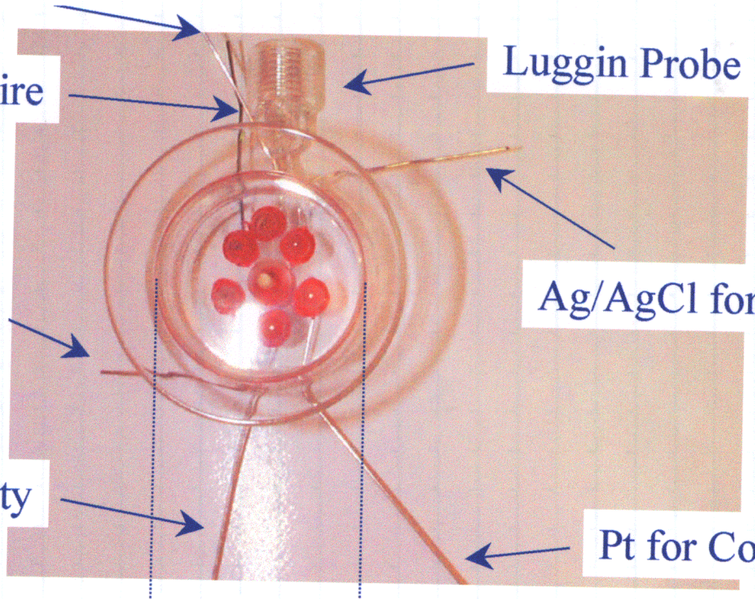
Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by [signature]	9/5/2000

Project No.
Book No.
TITLE

From Page No.

Simulated drift heater test – 2 sensor arrays, 1 galvanic sensor, plus coupons

Sensor Array Cell



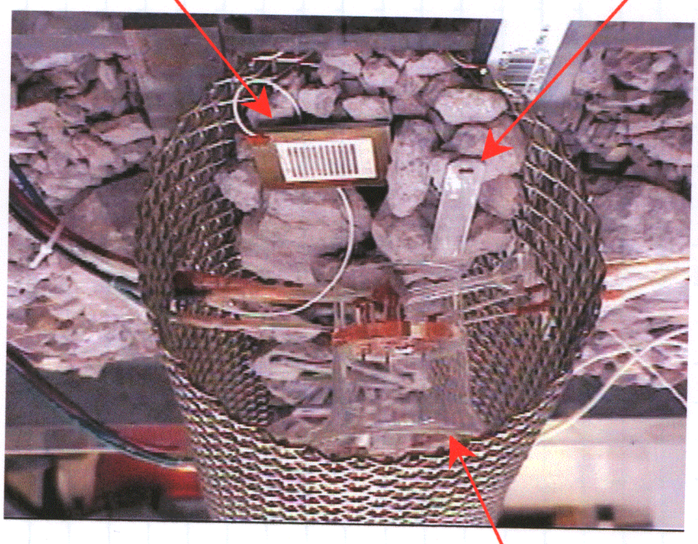
To Page No.

Witnessed & Understood by me,
Date
Invented by
Recorded by
Date
3/22/01

Project No.
Book No.
TITLE

Drift construction

From Page No.



To Page No.

Witnessed & Understood by me,
Date
Invented by
Recorded by
Date
3/22/01

From Page No.

Data measured at one sensor array during a brief wet period in which water was observed to be dripping onto sensor

To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by SB | 3/22/01

From Page No.

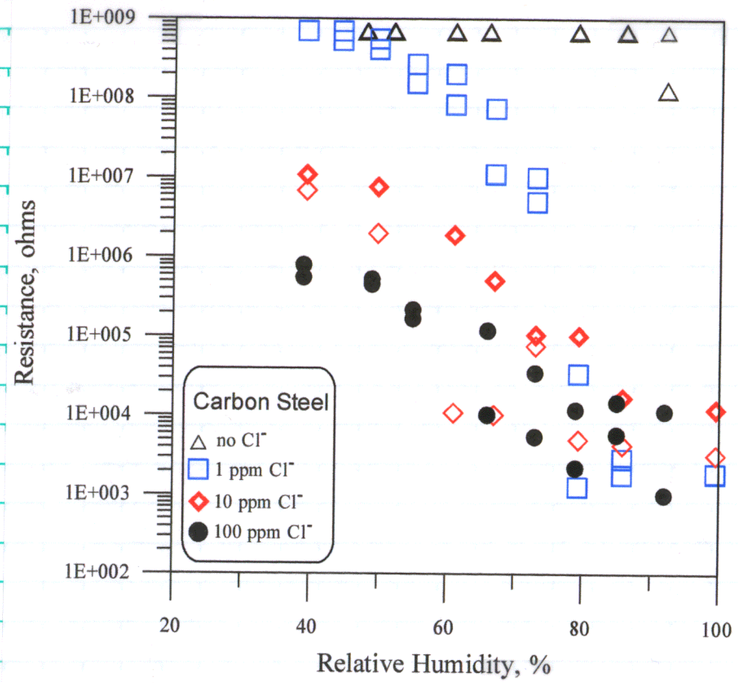
Galvanic couple sensor – Bench Top Tests

– Additional details and testing results can be found in S/N 366, Information is only contained here on this subject for completeness.

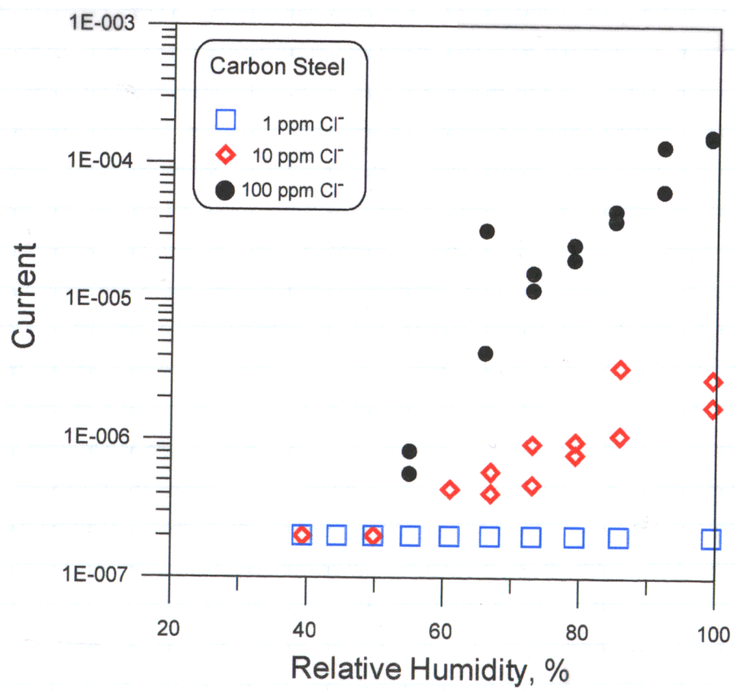
To Page No.

Witnessed & Understood by me, | Date | Invented by | Date
Recorded by SB | 3/22/01

From Page No.



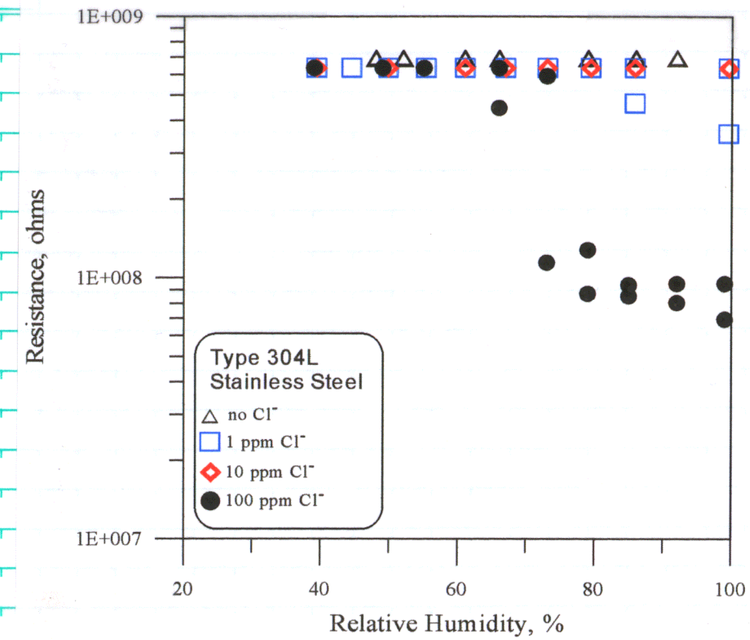
Carbon Steel Sensor

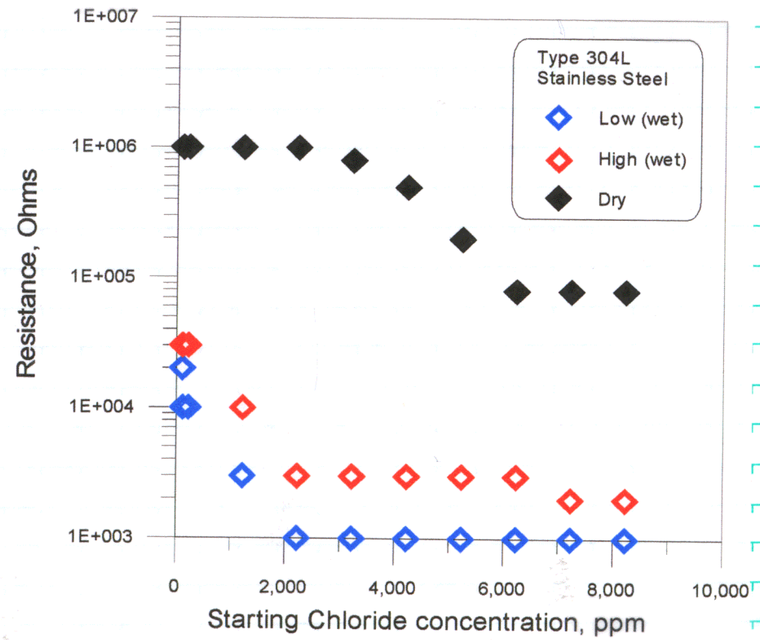


To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by SB	3/22/01

From Page No.





To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by SB	3/22/01

Project No.

Book No.

Water chemistry Analysis

TITLE

Results of chemical analyses of water samples sent to Div 01 (see p 100-104)

ICP analyses of major and minor cations and IC analyses of anions

All sample results are in mg/L

Sample label	Description or Location	Date collected	Solution temp C	Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Chromium	Cobalt
EQ1	Equilibrated with Topapah Spring lower lithophysal unit	12/5/00		<0.05	<0.015	<0.01	0.005	<0.005	<0.01	<0.05	<0.005	8.96	<0.005	<0.005
EQ2		12/5/00		<0.05	<0.015	<0.01	<0.005	<0.005	<0.01	<0.05	<0.005	8.96	<0.005	<0.005
EQ3		12/5/00		<0.05	<0.015	<0.01	0.005	<0.005	<0.01	<0.05	<0.005	8.96	<0.005	<0.005
EQ4	Equilibrated with Topapah Spring lower lithophysal unit and spiked with 10 ppm Cl using NaCl	12/5/00		<0.05	<0.015	<0.01	0.042	<0.005	<0.01	<0.05	<0.005	7.92	<0.005	<0.005
EQ5		12/5/00		<0.05	<0.015	<0.01	0.043	<0.005	<0.01	<0.05	<0.005	8.04	<0.005	<0.005
EQ6		12/5/00		<0.05	<0.015	<0.01	0.043	<0.005	<0.01	<0.05	<0.005	8.00	<0.005	<0.005
S2B	Below center of drift	1/8/01	24.8	<0.1	<0.03	<0.02	0.036	<0.01	<0.02	0.295	<0.01	31.9	<0.01	<0.01
S2C		1/24/01	25.2	<0.1	<0.03	<0.02	0.027	<0.01	<0.02	0.141	<0.01	21.9	<0.01	<0.01
S4	Adjacent to center of drift	12/19/00	30.7	<0.1	<0.03	<0.02	0.029	<0.01	<0.02	0.317	<0.01	36.4	<0.01	<0.01
S4B		1/8/01	31.1	<0.1	<0.03	<0.02	<0.01	<0.01	<0.02	0.145	<0.01	10.6	<0.01	<0.01
S4C		1/24/01	31.1	<0.1	<0.03	<0.02	<0.01	<0.01	<0.02	0.114	<0.01	9.93	<0.01	<0.01
S5	Adjacent to center of drift	12/19/00	30.4	<0.1	<0.03	<0.02	0.023	<0.01	<0.02	0.182	<0.01	25.5	<0.01	<0.01
S5B		1/8/01	30.9	<0.1	<0.03	<0.02	0.016	<0.01	<0.02	<0.1	<0.01	14.0	<0.01	<0.01
S5C		1/24/01	31.1	<0.1	<0.03	<0.02	0.012	<0.01	<0.02	<0.1	<0.01	17.6	<0.01	<0.01
S12C	Just off center and above drift	1/24/01	39	<0.1	<0.03	<0.02	0.041	<0.01	<0.02	0.571	<0.01	47.7	<0.01	<0.01
S14	Above and toward front of drift	12/19/00	37.2	0.055	<0.015	<0.01	0.053	<0.005	<0.01	0.840	<0.005	85.8	<0.005	<0.005
S14B		1/8/01	37.5	<0.1	<0.03	<0.02	0.015	<0.01	<0.02	0.327	<0.01	19.3	<0.01	<0.01
S14C		1/24/01	37.3	<0.1	<0.03	<0.02	<0.01	<0.01	<0.02	0.149	<0.01	13.0	<0.01	<0.01
S15	Above and slightly off center of drift	12/19/00	40.5	0.191	<0.015	<0.01	0.072	<0.005	<0.01	0.385	<0.005	75.2	<0.005	<0.005
S15C		1/24/01	43.6	<0.1	<0.03	<0.02	<0.01	<0.01	<0.02	<0.1	<0.01	13.9	<0.01	<0.01

Sample label	Copper	Iron	Lanthanum	Lead	Lithium	Magnesium	Manganese	Molybdenum	Nickel	Palladium	Phosphorus	Potassium	Selenium	Silicon	Silver	Sodium	Strontium	Sulfur	Thallium	Thorium	Tin
EQ1	<0.005	<0.025	<0.005	<0.005	0.038	0.575	<0.005	<0.005	<0.005	<0.01	<0.25	0.619	<0.01	11.6	<0.005	5.38	0.079	0.300	<0.005	<0.01	<0.005
EQ2	<0.005	<0.025	<0.005	<0.005	0.038	0.577	<0.005	<0.005	<0.005	<0.01	<0.25	0.632	<0.01	11.6	<0.005	5.28	0.079	0.296	<0.01	<0.01	<0.005
EQ3	<0.005	<0.025	<0.005	<0.005	0.038	0.572	<0.005	<0.005	<0.005	<0.01	<0.25	0.627	<0.01	11.6	<0.005	5.25	0.079	0.296	<0.01	<0.01	<0.005
EQ4	<0.005	<0.025	0.008	<0.005	0.039	0.508	<0.005	<0.005	<0.005	<0.01	<0.25	1.41	<0.01	11.2	<0.005	10.6	0.070	0.290	<0.01	<0.01	<0.005
EQ5	<0.005	<0.025	0.009	<0.005	0.039	0.521	<0.005	<0.005	<0.005	<0.01	<0.25	1.40	<0.01	11.3	<0.005	10.9	0.071	0.301	<0.01	<0.01	<0.005
EQ6	<0.005	<0.025	0.009	<0.005	0.038	0.518	<0.005	<0.005	<0.005	<0.01	<0.25	1.39	<0.01	11.3	<0.005	10.5	0.071	0.306	<0.01	<0.01	<0.005
S2B	<0.01	<0.05	<0.01	<0.01	0.250	2.14	0.014	<0.01	<0.01	<0.02	<0.5	2.54	<0.02	23.1	<0.01	34.2	0.293	4.45	<0.02	<0.02	<0.01
S2C	<0.01	<0.05	<0.01	<0.01	0.121	1.53	<0.01	<0.01	<0.01	<0.02	<0.5	8.29	<0.02	20.5	<0.01	26.1	0.202	1.56	<0.02	<0.02	<0.01
S4	<0.01	<0.05	<0.01	<0.01	0.172	2.46	<0.01	0.013	<0.01	<0.02	<0.5	9.07	<0.02	25.6	<0.01	44.0	0.336	5.24	<0.02	<0.02	<0.01
S4B	<0.01	<0.05	<0.01	<0.01	0.070	0.716	<0.01	<0.01	<0.01	<0.02	<0.5	2.13	<0.02	23.7	<0.01	28.7	0.098	1.52	<0.02	<0.02	<0.01
S4C	<0.01	<0.05	<0.01	<0.01	0.059	0.681	<0.01	<0.01	<0.01	<0.02	<0.5	5.73	<0.02	22.0	<0.01	25.0	0.093	1.06	<0.02	<0.02	<0.01
S5	<0.01	<0.05	<0.01	<0.01	0.100	1.76	<0.01	<0.01	<0.01	<0.02	<0.5	9.08	<0.02	23.8	<0.01	31.4	0.226	2.35	<0.02	<0.02	<0.01
S5B	<0.01	<0.05	<0.01	<0.01	0.045	1.00	<0.01	<0.01	<0.01	<0.02	<0.5	2.72	<0.02	20.9	<0.01	20.1	0.126	0.610	<0.02	<0.02	<0.01
S5C	<0.01	<0.05	<0.01	<0.01	0.031	1.41	<0.01	<0.01	<0.01	<0.02	<0.5	2.49	<0.02	16.8	<0.01	15.5	0.158	0.459	<0.02	<0.02	<0.01
S12C	<0.01	<0.05	<0.01	<0.01	0.267	2.19	<0.01	0.025	<0.01	<0.02	<0.5	13.7	<0.02	35.8	<0.01	145	0.444	4.82	<0.02	<0.02	<0.01
S14	0.009	<0.025	<0.005	<0.005	0.167	5.82	0.026	0.018	<0.005	<0.01	<0.25	107	<0.01	36.2	<0.005	73.4	0.731	8.71	<0.01	<0.01	<0.005
S14B	<0.01	<0.05	<0.01	<0.01	0.125	1.22	0.015	0.015	<0.01	<0.02	<0.5	4.73	<0.02	30.7	<0.01	62.8	0.173	3.58	<0.02	<0.02	<0.01
S14C	<0.01	<0.05	<0.01	<0.01	0.048	0.863	<0.01	<0.01	<0.01	<0.02	<0.5	3.82	<0.02	25.5	<0.01	22.7	0.116	1.39	<0.02	<0.02	<0.01
S15	0.007	0.062	0.008	<0.005	0.276	5.08	1.02	0.015	0.034	<0.01	<0.25	41.7	<0.01	34.9	<0.005	129	0.635	5.76	<0.01	<0.01	<0.005
S15C	<0.01	<0.05	<0.01	<0.01	0.066	1.05	<0.01	<0.01	<0.01	<0.02	<0.5	3.52	<0.02	19.0	<0.01	39.3	0.133	0.934	<0.02	<0.02	<0.01

Witnessed & Understood by me,

Date

Invented by

Recorded by

Date 3/22/01

Water chemistry Analysis

Project No.

TITLE

From Page No.

All sample results are in mg/L

Sample label	Bromide	Chloride	Fluoride	Nitrate-N	Nitrite-N	Phosphate-P	Sulfate	pH	Alkalinity in mg CaCO3/L
EQ1	0.441	0.669	0.238	0.140	<0.1	<0.1	0.814	6.88	54.67
EQ2	0.468	0.676	0.243	0.140	<0.1	<0.1	0.833	6.88	54.67
EQ3	0.445	0.687	0.231	0.131	<0.1	<0.1	0.759	6.88	54.67
EQ4	0.510	11.3	0.248	0.161	<0.1	<0.1	0.832	6.83	51.75
EQ5	0.462	11.3	0.270	0.535	<0.1	<0.1	0.860	6.83	51.75
EQ6	0.488	11.3	0.254	0.590	<0.1	<0.1	0.803	6.83	51.75
S2B	4.87	49.1	3.89	1.68	<0.1	<0.1	12.6	7.6	108.5
S2C	1.55	38.9	0.743	1.26	<0.1	<0.1	4.33	8.02	112.4
S4	6.57	89.7	2.01	2.57	<0.1	<0.1	13.9	7.96	114.2
S4B	1.10	27.3	1.18	0.948	<0.1	<0.1	4.13	8.06	78.1
S4C	0.591	28.9	0.801	2.00	<0.1	<0.1	2.81	8.23	64
S5	2.25	53.3	1.42	1.18	<0.1	<0.1	6.00	8.01	107
S5B	0.391	20.2	0.604	0.847	<0.1	<0.1	1.61	8.08	84.5
S5C	0.235	19.3	0.314	1.06	<0.1	<0.1	1.12	8.38	86.2
S12C	9.35	249	1.06	6.59	<0.1	<0.1	12.5	8.52	
S14	11.3	304	0.285	3.75	<0.1	<0.1	22.6	7.8	69.8
S14B	4.20	92.7	1.97	2.75	<0.1	<0.1	9.61	8.16	77
S14C	0.567	22.6	0.748	1.94	<0.1	<0.1	3.56	8.47	75.7
S15	9.84	209	1.57	2.54	<0.1	<0.1	15.0	7.78	
S15C	0.980	39.3	0.463	3.132	<0.1	<0.1	2.52	8.5	

Sample label	Titanium	Tungsten	Uranium	Vanadium	Yttrium	Zinc	Zirconium
EQ1	<0.005	<0.02	<0.1	<0.005	<0.005	<0.005	<0.005
EQ2	<0.005	<0.02	<0.1	<0.005	<0.005	<0.005	<0.005
EQ3	<0.005	<0.02	<0.1	<0.005	<0.005	<0.005	<0.005
EQ4	<0.005	<0.02	<0.1	<0.005	<0.005	0.035	<0.005
EQ5	<0.005	<0.02	<0.1	<0.005	<0.005	0.017	<0.005
EQ6	<0.005	<0.02	<0.1	<0.005	<0.005	0.018	<0.005
S2B	<0.01	<0.04	<0.2	<0.01	<0.01	0.011	<0.01
S2C	<0.01	<0.04	<0.2	<0.01	<0.01	0.015	<0.01
S4	<0.01	<0.04	<0.2	<0.01	<0.01	0.018	<0.01
S4B	<0.01	<0.04	<0.2	<0.01	<0.01	<0.01	<0.01
S4C	<0.01	<0.04	<0.2	<0.01	<0.01	<0.01	<0.01
S5	<0.01	<0.04	<0.2	<0.01	<0.01	0.010	<0.01
S5B	<0.01	<0.04	<0.2	<0.01	<0.01	<0.01	<0.01
S5C	<0.01	<0.04	<0.2	<0.01	<0.01	<0.01	<0.01
S12C	<0.01	<0.04	<0.2	0.012	<0.01	<0.01	<0.01
S14	<0.005	<0.02	<0.1	<0.005	<0.005	0.068	<0.005
S14B	<0.01	<0.04	<0.2	<0.01	<0.01	0.013	<0.01
S14C	<0.01	<0.04	<0.2	<0.01	<0.01	<0.01	<0.01
S15	<0.005	<0.02	<0.1	<0.005	<0.005	0.032	<0.005
S15C	<0.01	<0.04	<0.2	<0.01	<0.01	<0.01	<0.01

To Page No.

Witnessed & Understood by me,

Date

Invented by

Recorded by

Date 3/22/01

Project No.
Book No.
TITLE Anion Analysis

From Page No.

Results of chemical analyses of water samples sent to Div 01 (see p 100-104)

ICP analyses of major and minor cations and IC analyses of anions

All sample results are in mg/L

Sample label	Description or Location	Date collected	Solution temp C	pH	Alkalinity in mg CaCO3/L	Bromide	Chloride	Fluoride	Nitrate-N	Nitrite-N	Phosphate-	Sulfate
EQ1	Equilibrated with Topapah Spring lower lithophysal unit	12/5/00		6.88	54.67	0.441	0.669	0.238	0.140	<0.1	<0.1	0.814
EQ2		12/5/00		6.88	54.67	0.468	0.676	0.243	0.140	<0.1	<0.1	0.833
EQ3		12/5/00		6.88	54.67	0.445	0.687	0.231	0.131	<0.1	<0.1	0.759
EQ4	Equilibrated with Topapah Spring lower lithophysal unit and spiked with 10 ppm Cl using NaCl	12/5/00		6.83	51.75	0.510	11.3	0.248	0.161	<0.1	<0.1	0.832
EQ5		12/5/00		6.83	51.75	0.462	11.3	0.270	0.535	<0.1	<0.1	0.860
EQ6		12/5/00		6.83	51.75	0.488	11.3	0.254	0.590	<0.1	<0.1	0.803
S2B	Below center of drift	1/8/01	24.8	7.6	108.5	4.87	49.1	3.89	1.68	<0.1	<0.1	12.6
S2C		1/24/01	25.2	8.02	112.4	1.55	38.9	0.743	1.26	<0.1	<0.1	4.33
S4	Adjacent to center of drift	12/19/00	30.7	7.96	114.2	6.57	89.7	2.01	2.57	<0.1	<0.1	13.9
S4B		1/8/01	31.1	8.06	78.1	1.10	27.3	1.18	0.948	<0.1	<0.1	4.13
S4C		1/24/01	31.1	8.23	64	0.591	28.9	0.801	2.00	<0.1	<0.1	2.81
S5	Adjacent to center of drift	12/19/00	30.4	8.01	107	2.25	53.3	1.42	1.18	<0.1	<0.1	6.00
S5B		1/8/01	30.9	8.08	84.5	0.391	20.2	0.604	0.847	<0.1	<0.1	1.61
S5C		1/24/01	31.1	8.38	86.2	0.235	19.3	0.314	1.06	<0.1	<0.1	1.12
S12C	Just off center and above drift	1/24/01	39	8.52		9.35	249	1.06	6.59	<0.1	<0.1	12.5
S14	Above and toward front of drift	12/19/00	37.2	7.8	69.8	11.3	304	0.285	3.75	<0.1	<0.1	22.6
S14B		1/8/01	37.5	8.16	77	4.20	92.7	1.97	2.75	<0.1	<0.1	9.61
S14C		1/24/01	37.3	8.47	75.7	0.567	22.6	0.748	1.94	<0.1	<0.1	3.56
S15	Above and slightly off center of drift	12/19/00	40.5	7.78		9.84	209	1.57	2.54	<0.1	<0.1	15.0
S15C		1/24/01	43.6	8.5		0.980	39.3	0.463	3.132	<0.1	<0.1	2.52

To Page No.

Witnessed & Understood by me,
Date
Invented by
Recorded by SBrue
Date 3/22/01

TITLE
Project No.
Book No.

From Page No.

Copies sent to QA records.

SBrue 3/22/01

SBrue 9/5/02

To Page No.

Witnessed & Understood by me,
Date
Invented by
Recorded by
Date

Project No.
Book No.
TITLE

From Page No.

HEATER TEST DISASSEMBLY 2/19/2003

Metal coupons identified on page 39 and water collection sensor array cells on page 42 and the carbon steel galvanic sensor shown on page 43 & 45 were removed

Rock above the drift space was previously removed.

Sensor array cells filled with rock and water deposits

Galvanic sensor was obviously damaged by corrosion

Carbon steel specimens were severely corroded

316LW specimens had water deposits and some rust spots

C22W specimens had water deposits

None of the samples were reweighed water deposits and scales were not removed from the specimens.

Diagram on page 53 shows location of specimens as they were removed

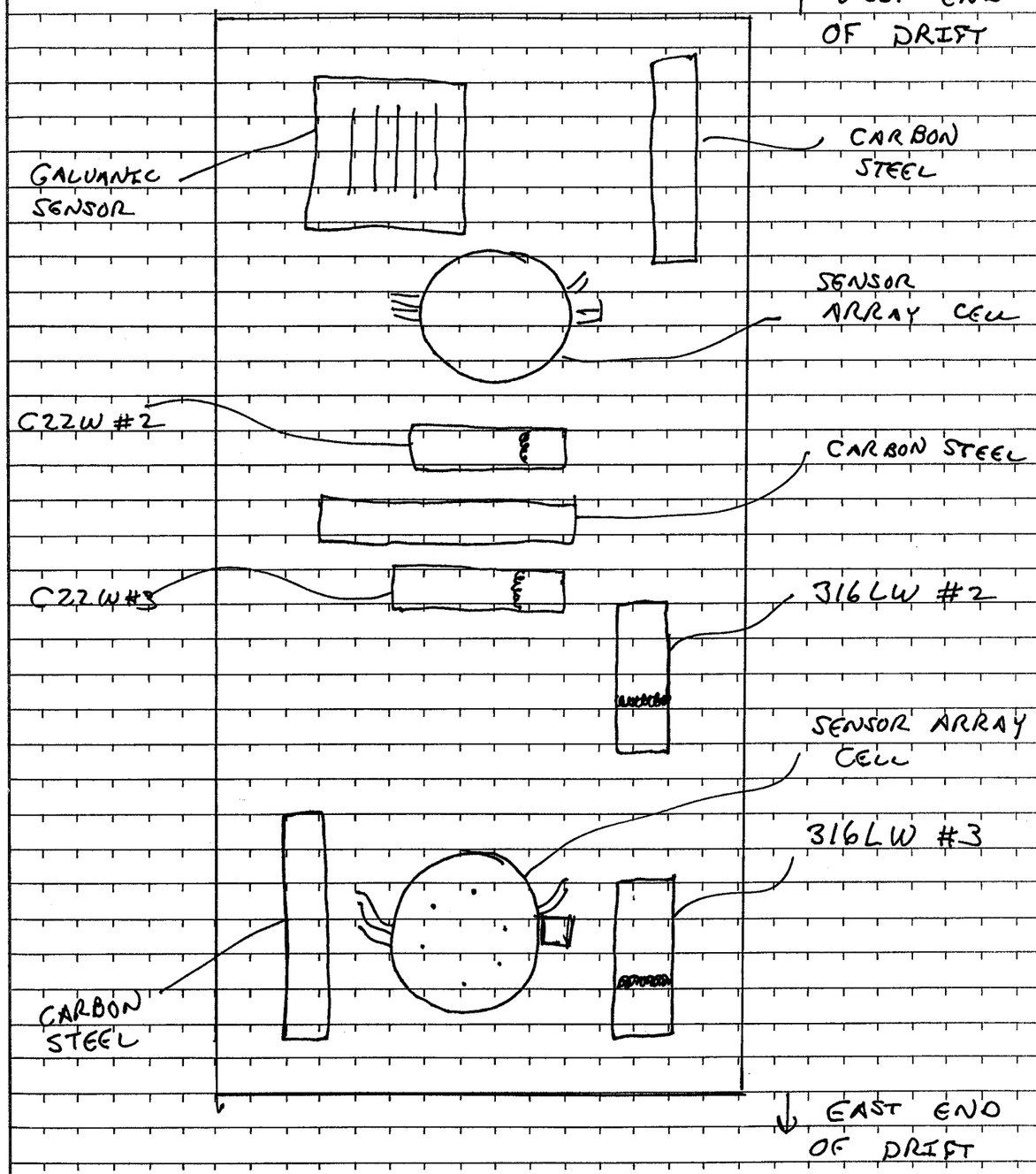
Identification of carbon steel specimens was not possible due to severe corrosion

To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by [signature]	2/19/03

Project No.
Book No.
TITLE

From Page No.



To Page No.

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by [signature]	2/19/03

Project No._____
Book No._____ TITLE_____

From Page No.____

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

2/16/04

To Page No._____

Witnessed & Understood by me,	Date	Invented by	Date
		Recorded by	