Field Season [redacted] 2010

Primary

Sea-Bird Electronics, Inc.
1808 136th Place NE, Bellevue, Washington 98005 USA
Website: http://www.seabird.com

Phone: (425) 643-9866
FAX: (425) 643-9954
Email: seabird@seabird.com

SBE Pressure Test Certificate

Test Date: **5/22/2008** Description **SBE-9Plus CTD**

Job Number: **47490** Customer Name **MD Marine Electric**

SBE Sensor Information:

Model Number: **09**
Serial Number: **0906**

Pressure Sensor Information:

Sensor Type: **DigiQuartz**
Sensor Serial Number: **107068**
Sensor Rating: **10000**

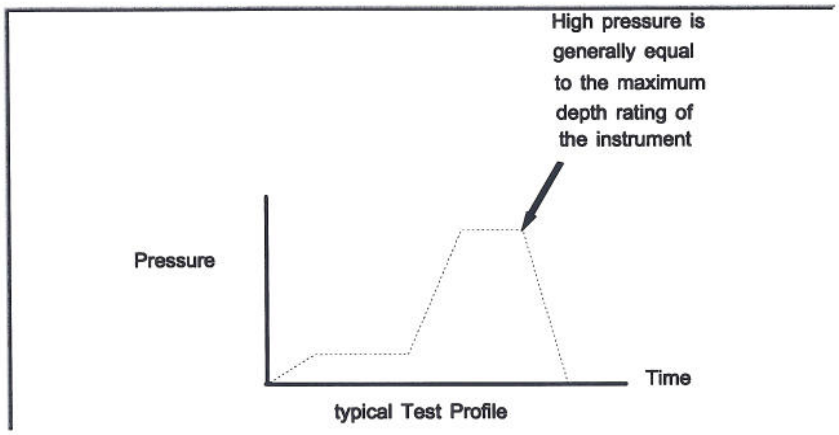
Pressure Test Protocol:

Low Pressure Test: **40** PSI Held For **15** Minutes

High Pressure Test: **10000** PSI Held For **15** Minutes

Passed Test: ☑

Tested By: ND



typical Test Profile

CALIBRATION COEFFICIENTS

PAROSCIENTIFIC
PRESSURE TRANSDUCER
Corrected coefficients for SBE-9plus, SN 0906.

Serial No: **107068**
Original Cal Date: 9/11/2007
Corrected Cal Date: 6/9/2008

MODEL:	PRESSURE RANGE:	TEMP. RANGE:	PORT:
410K-134	0 to 10000 psia	0 to 125 deg C	oil filled

PRESSURE COEFFICIENTS

U = temperature (deg C)

T = pressure period (µsec)

$C = C_1 + C_2U + C_3U^2$

$D = D_1 + D_2U$

$T_0 = T_1 + T_2U + T_3U^2 + T_4U^3 + T_5U^4$

pressure: (psia)

$P = C(1 - (T_0^2/T^2))(1 - D(1 - (T_0^2/T^2)))$

C1	*-45806.14*	*psia*
C2	*-3.898443E-01*	*psia/deg C*
C3	1.3305E-02	psia/deg C ^{2}
D1	0.032989	
D2	0	
T1	*30.25149*	*µsec*
T2	*-4.453719E-04*	*µsec/deg C*
T3	3.33012E-06	µsec /deg C^3
T4	6.10635E-09	µsec /deg C^3
T5	0	

Digiquartz Pressure Calibration Coefficients
Corrected at Sea-Bird Electronics on **09-Jun-2008**
as per Paroscientific Calibration and SBE dP/dT tests.

(Changed coefficients are posted in italics.)

CALIBRATION COEFFICIENTS

SERIAL NO : **107068**

PRESSURE TRANSDUCER

DATE : 09-11-2007

MODEL :	PRESSURE RANGE :	TEMP. RANGE :	PORT :
410K-134	0 to 10000 psia	0 to 125 deg C	oil filled

PRESSURE COEFFICIENTS

U = temperature (deg C)

$C = C_1 + C_2U + C_3U^2$

$D = D_1 + D_2U$

$T_0 = T_1 + T_2U + T_3U^2 + T_4U^3 + T_5U^4$

T = pressure period (μsec)

Pressure : (psia)

$$P = C\left(1 - \frac{T_0^2}{T^2}\right)\left(1 - D\left(1 - \frac{T_0^2}{T^2}\right)\right)$$

C_1	-45804.11	psia
C_2	-3.49118E-01	psia/deg C
C_3	1.33045E-02	psia/deg C^2

D_1	0.032989
D_2	0

T_1	30.25212	μsec
T_2	-4.32828E-04	μsec/deg C
T_3	3.33012E-06	μsec/deg C^2
T_4	6.10635E-09	μsec/deg C^3
T_5	0	

(09-11-2007)

HISTORY

PAROSCIENTIFIC, INC.
4500 148th AVENUE N.E.
REDMOND, WA. 98052

CUSTOMER : SEABIRD ELECTRONICS, INC.

PARO TEST 12

SALES ORDER : 24499 PREPARED BY : T.C.

CALIBRATION COEFFICIENTS

SERIAL NO : **107068**

PRESSURE TRANSDUCER

DATE : 09-11-2007

MODEL :	PRESSURE RANGE :	TEMP. RANGE :	PORT :
410K-134	0 to 10000 psia	0 to 125 deg C	oil filled

PRESSURE COEFFICIENTS AT FIXED TEMPERATURE

(only valid at specified temperature)

T = pressure period (μsec)

Pressure equation : (psia)

$$P = C\left(1 - \frac{T_0^2}{T^2}\right)\left(1 - D\left(1 - \frac{T_0^2}{T^2}\right)\right)$$

Temperature: 21.0 C

C (psia)	-45805.58				
D	0.032989				
T_0 (μsec)	30.24455				

(09-11-2007)

PAROSCIENTIFIC, INC.
4500 148th AVENUE N.E.
REDMOND, WA. 98052

CUSTOMER : SEABIRD ELECTRONICS, INC.

PARO TEST 12

SALES ORDER : 24499 PREPARED BY : T.C.

Primary

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 5023
CALIBRATION DATE: 29-May-08

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.39259975e-003
h = 6.39056784e-004
i = 2.21710408e-005
j = 2.04065077e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.68121248e-003
b = 5.96167618e-004
c = 1.51299775e-005
d = 2.04208808e-006
f0 = 3172.501

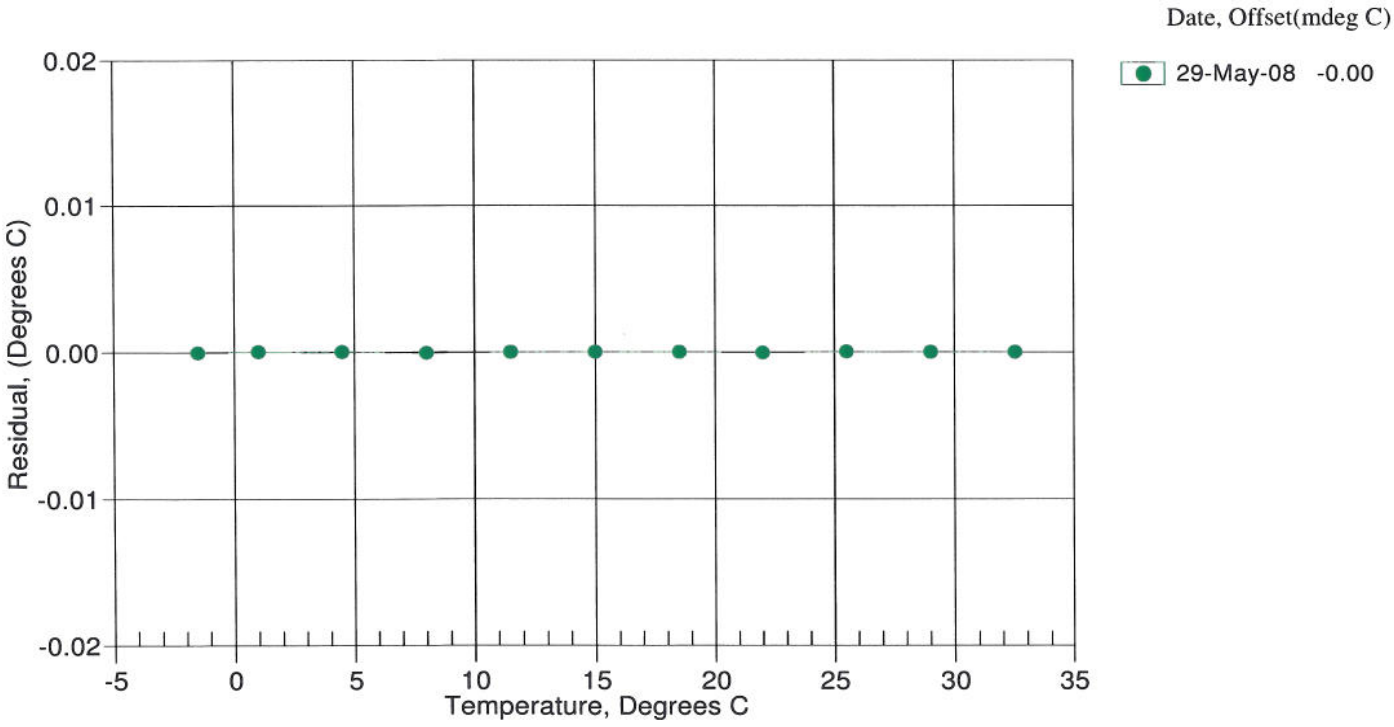
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	3172.501	-1.5000	-0.00001
1.0000	3356.581	1.0000	0.00001
4.5000	3627.111	4.5000	0.00003
8.0000	3912.978	8.0000	-0.00003
11.5000	4214.614	11.5000	-0.00000
15.0000	4532.417	15.0000	0.00001
18.5000	4866.783	18.5000	0.00001
22.0000	5218.093	22.0000	-0.00001
25.5000	5586.722	25.5000	0.00001
29.0000	5973.018	29.0000	0.00001
32.5000	6377.322	32.5000	-0.00001

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



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SBE Pressure Test Certificate

Test Date: **10/12/2007** Description **SBE-3 Temperature Sensor**

Job Number: **47490** Customer Name **MD Marine Electric**

SBE Sensor Information:

Model Number: **03**
Serial Number: **5023**

Pressure Sensor Information:

Sensor Type: **None**
Sensor Serial Number: **None**
Sensor Rating: **0**

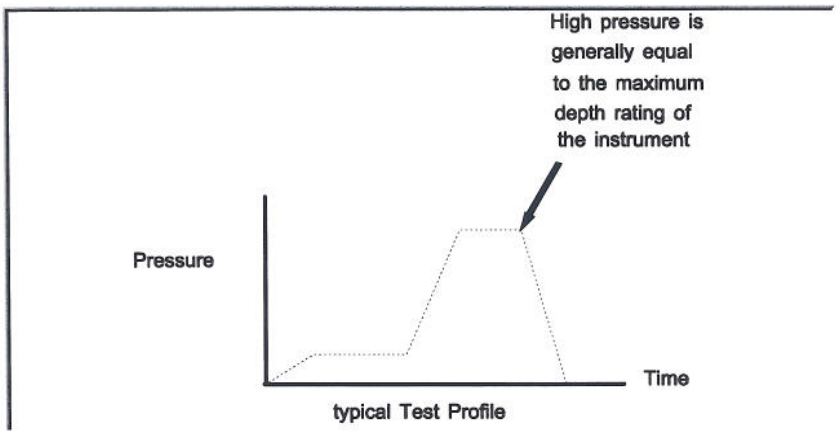
Pressure Test Protocol:

Low Pressure Test: **40** PSI Held For **15** Minutes

High Pressure Test: **10000** PSI Held For **15** Minutes

Passed Test: ☑

Tested By: FS



typical Test Profile

Secondary

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 5026
CALIBRATION DATE: 29-May-08

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.33081673e-003
h = 6.33607551e-004
i = 2.08477308e-005
j = 1.82929335e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.68121212e-003
b = 5.95759866e-004
c = 1.50644779e-005
d = 1.83069634e-006
f0 = 2882.648

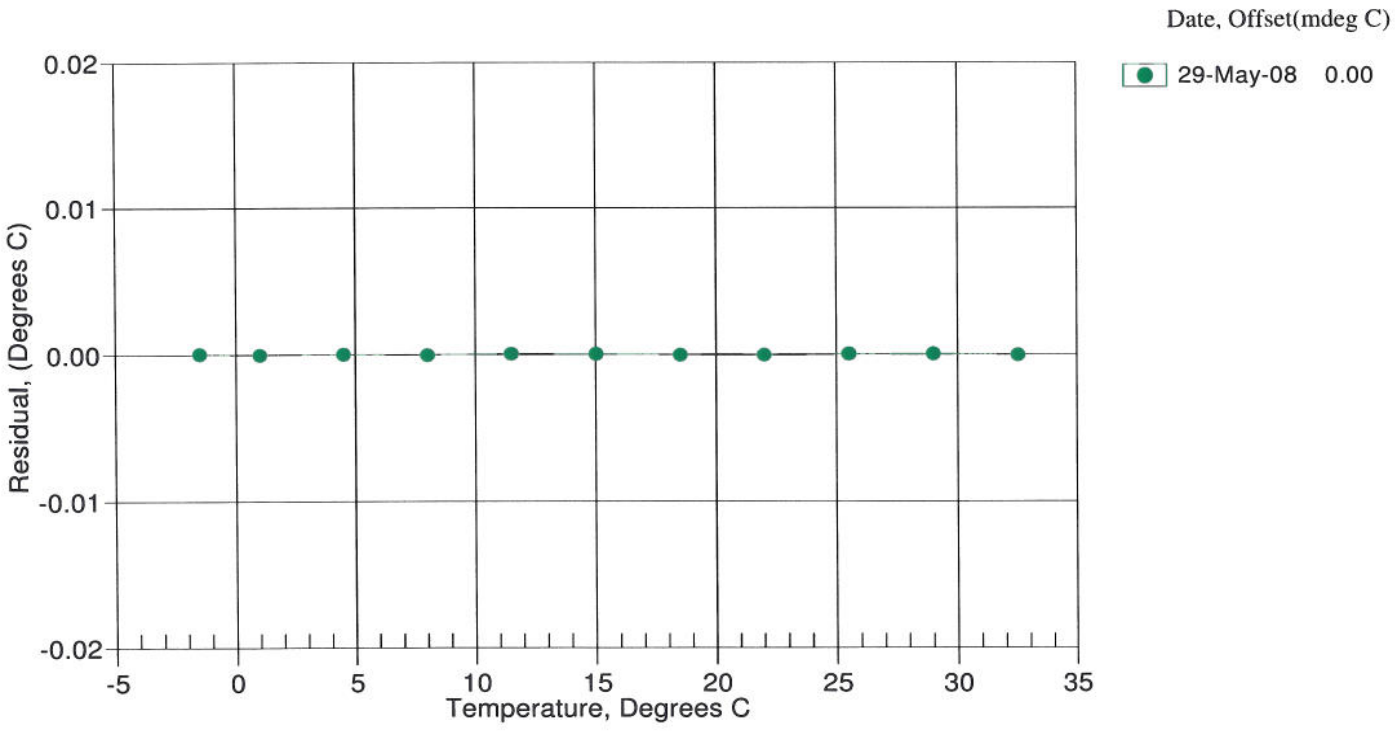
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2882.648	-1.5000	0.00001
1.0000	3050.023	1.0000	-0.00002
4.5000	3296.019	4.5000	-0.00000
8.0000	3555.981	8.0000	-0.00002
11.5000	3830.302	11.5000	0.00004
15.0000	4119.347	15.0000	0.00002
18.5000	4423.485	18.5000	-0.00002
22.0000	4743.073	22.0000	-0.00005
25.5000	5078.463	25.5000	0.00002
29.0000	5429.972	29.0000	0.00003
32.5000	5797.919	32.5000	-0.00001

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



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SBE Pressure Test Certificate

Test Date: **10/12/2007** Description **SBE-3 Temperature Sensor**

Job Number: **47490** Customer Name **MD Marine Electric**

SBE Sensor Information:

Model Number: **03**
Serial Number: **5026**

Pressure Sensor Information:

Sensor Type: **None**
Sensor Serial Number: **None**
Sensor Rating: **0**

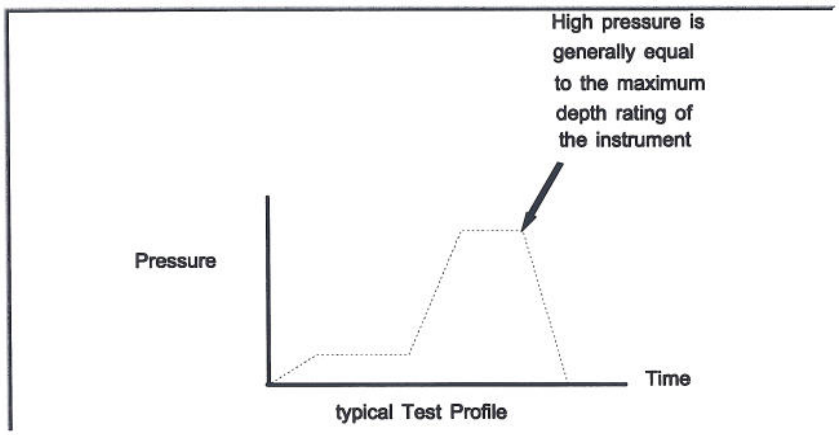
Pressure Test Protocol:

Low Pressure Test: **40** PSI Held For **15** Minutes

High Pressure Test: **10000** PSI Held For **15** Minutes

Passed Test: ☑

Tested By: FS



typical Test Profile

primary

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1808 136th Place N.E., Bellevue, Washington, 98005 USA
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SENSOR SERIAL NUMBER: 3455
CALIBRATION DATE: 03-Jun-08

SBE4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -1.00952036e+001
h =  1.56202306e+000
i = -2.33201013e-003
j =  2.64582197e-004
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  4.58306124e-007
b =  1.55598008e+000
c = -1.00835243e+001
d = -8.54917697e-005
m =  6.4
CPcor = -9.5700e-008 (nominal)
```

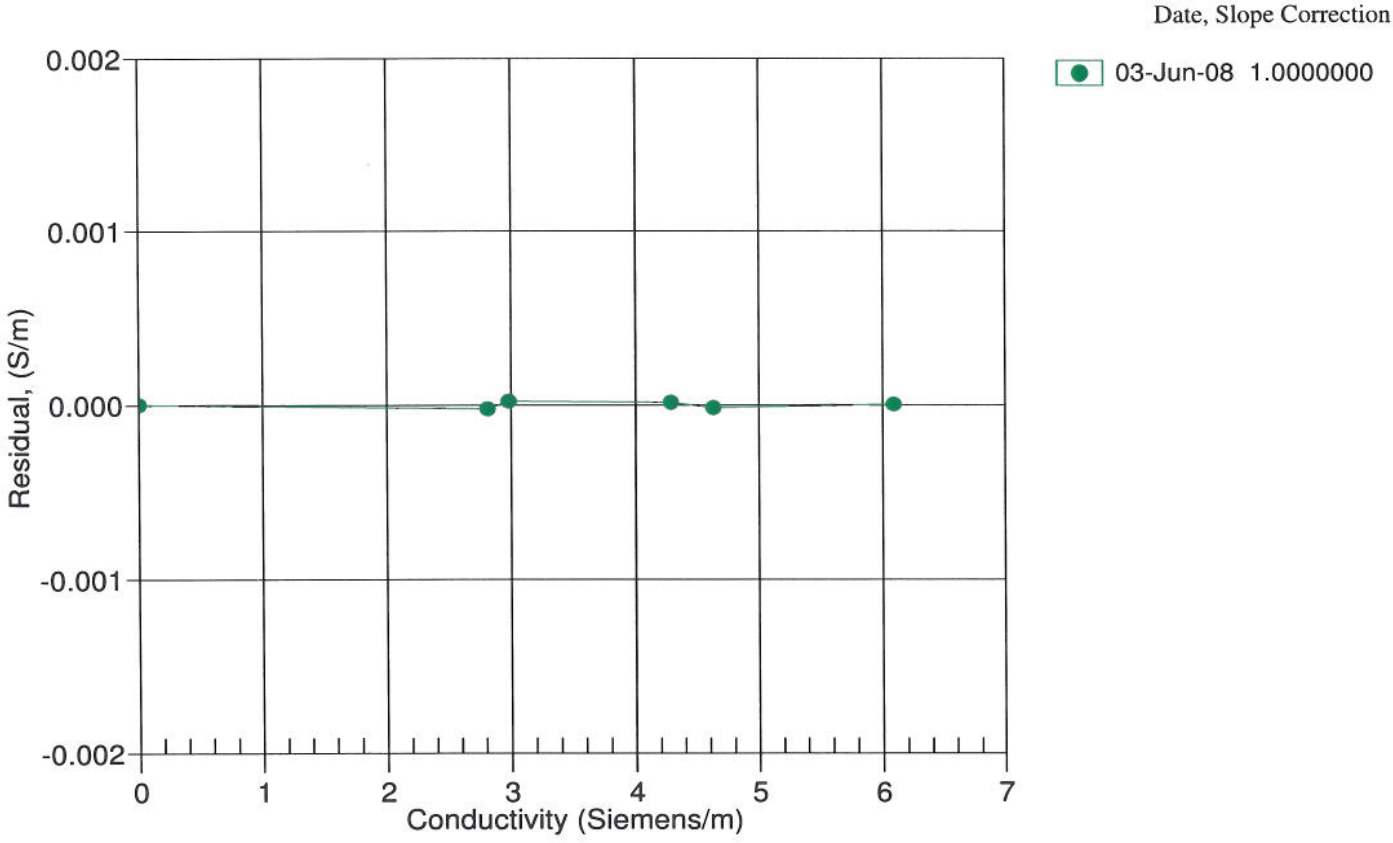
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.54567	0.00000	0.00000
-1.0000	34.9177	2.81198	4.95423	2.81196	-0.00002
1.0000	34.9177	2.98380	5.06436	2.98383	0.00002
15.0000	34.9182	4.28279	5.82947	4.28280	0.00001
18.5000	34.9174	4.63033	6.01755	4.63031	-0.00002
32.5000	34.9126	6.09088	6.75041	6.09088	0.00000

Conductivity = $(g + hf^2 + if^3 + jf^4) / 10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10 (1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



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SBE Pressure Test Certificate

Test Date: **6/25/2007** Description **SBE-4 Conductivity Sensor**

Job Number: **47490** Customer Name **MD Marine Electric**

SBE Sensor Information:

Model Number: **04**
Serial Number: **3455**

Pressure Sensor Information:

Sensor Type: **None**
Sensor Serial Number: **None**
Sensor Rating: **0**

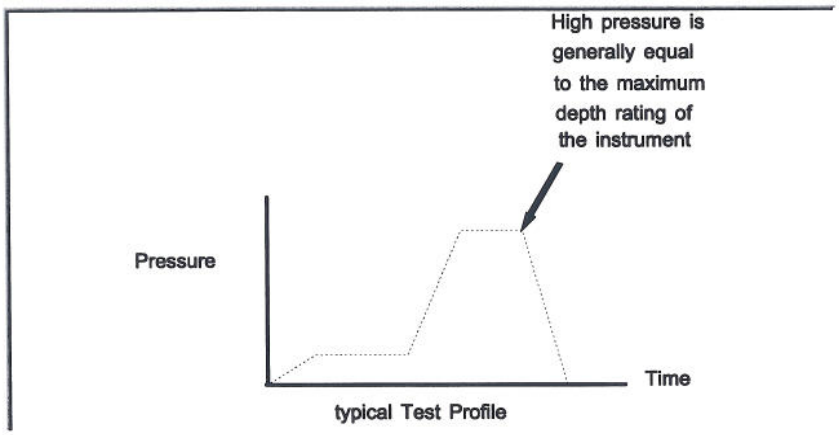
Pressure Test Protocol:

Low Pressure Test: **40** PSI Held For **15** Minutes

High Pressure Test: **10000** PSI Held For **15** Minutes

Passed Test: ☑

Tested By: FS



typical Test Profile

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1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 3456
CALIBRATION DATE: 03-Jun-08

SBE4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -9.95398347e+000
h =  1.51635985e+000
i = -2.16218587e-003
j =  2.50397387e-004
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  6.81351244e-007
b =  1.51081274e+000
c = -9.94337606e+000
d = -8.71621609e-005
m =  6.2
CPcor = -9.5700e-008 (nominal)
```

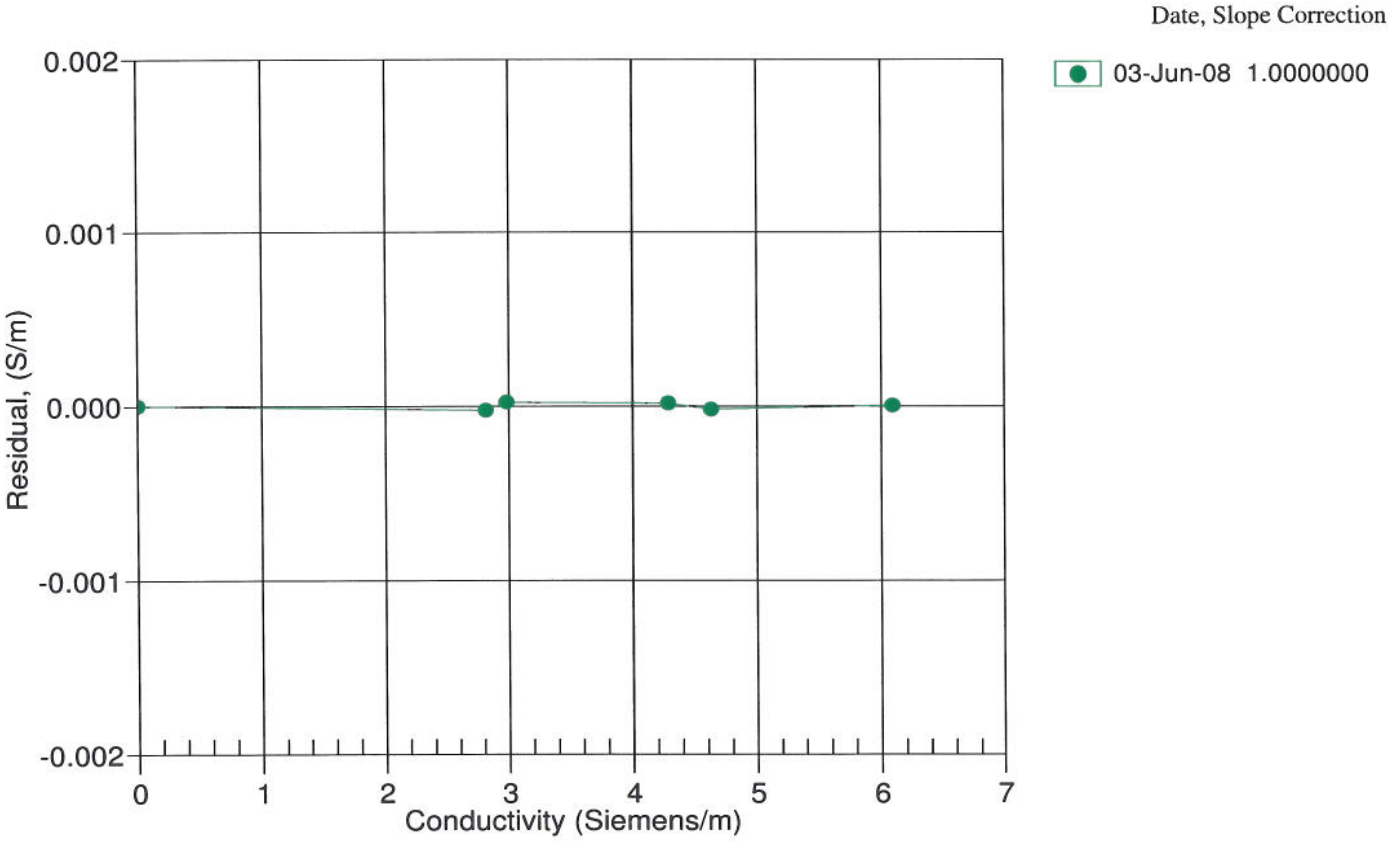
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.56541	0.00000	0.00000
-1.0000	34.9177	2.81198	5.01836	2.81196	-0.00002
1.0000	34.9177	2.98380	5.13032	2.98383	0.00002
15.0000	34.9182	4.28279	5.90784	4.28280	0.00002
18.5000	34.9174	4.63033	6.09893	4.63031	-0.00002
32.5000	34.9126	6.09088	6.84333	6.09088	0.00000

Conductivity = $(g + hf^2 + if^3 + jf^4) / 10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10 (1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



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Email: seabird@seabird.com

SBE Pressure Test Certificate

Test Date: **6/25/2007** Description **SBE-4 Conductivity Sensor**

Job Number: **47490** Customer Name **MD Marine Electric**

SBE Sensor Information:

Model Number: **04**
Serial Number: **3456**

Pressure Sensor Information:

Sensor Type: **None**
Sensor Serial Number: **None**
Sensor Rating: **0**

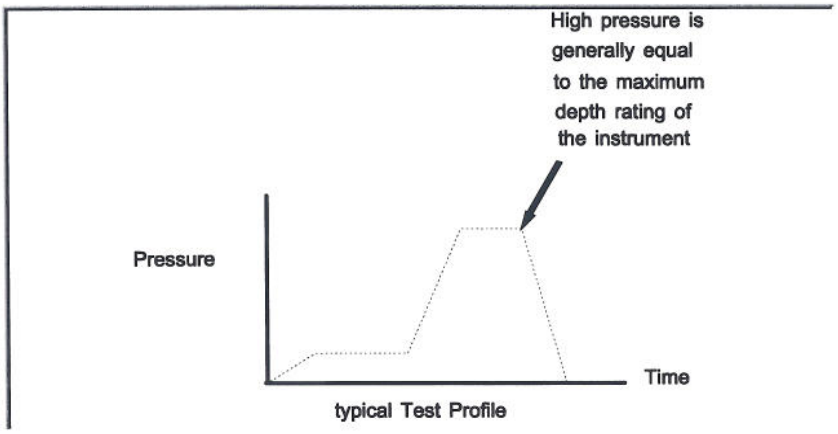
Pressure Test Protocol:

Low Pressure Test: **40** PSI Held For **15** Minutes

High Pressure Test: **10000** PSI Held For **15** Minutes

Passed Test: ☑

Tested By: FS



typical Test Profile

primary

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Email: seabird@seabird.com
Fax: (425) 643-9866

SBE 5T SUBMERSIBLE PUMP CONFIGURATION SHEET

Customer: MD Marine Electric
Delivery Date: 5/20/2008
Serial Number: 4974
MRP PN: 90543
Job Number: 47490

Pressure Case: 10,500 meters (titanium)

Pittman Motor Type:

- P/N 3711B113-R1, 18.02 ohms nominal (For applications up to 2000 RPM MAX) ☐
  - 5 Winding, low voltage input (jump P5 to P7) (80676 assy/3711B113-R1 motor) ☐
  - 5 Winding, standard voltage input (jump P5 to P6) (80676 assy/3711B113-R1 motor) ☐
- P/N 3711B112-R1, 7.40 ohms nominal (For applications up to 4500 RPM MAX) ☐
  - 3 Winding, low voltage input (jump P5 to P7) (80675 assy/3711B112-R1 motor) ☐
  - 3 Winding, standard voltage input (jump P5 to P6) (80675 assy/3711B112-R1 motor) ☐
- P/N 3711B112-R2, 3.55 ohms nominal (For applications up to 4500 RPM MAX) ☑
  - 3 Winding, low voltage input (jump P5 to P7) (801572 assy/3711B112-R2 motor) ☐
  - 3 Winding, standard voltage input (jump P5 to P6) (801572 assy/3711B112-R2 motor) ☑

Speed Adjust Range: Min: 930 RPM Max: 5010 RPM (@ 12 Vin/300mA load)

Final Speed Setting: 3000 RPM (TP1 = 100.0 Hz)

Low voltage pumps only:

Motor speed at 7.5 Vin with no load: 0 RPM (TP1 = 0.0 Hz)

Motor speed at 7.5 Vin with 200mA load: 0 RPM (TP1 = 0.0 Hz)

Motor dropout voltage: 9.3

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Email: seabird@seabird.com

SBE Pressure Test Certificate

Test Date: **5/12/2008** Description **SBE-5T Submersible Pump**

Job Number: **47490** Customer Name **MD Marine Electric**

SBE Sensor Information:

Model Number: **5T**
Serial Number: **4974**

Pressure Sensor Information:

Sensor Type: **None**
Sensor Serial Number: **None**
Sensor Rating: **0**

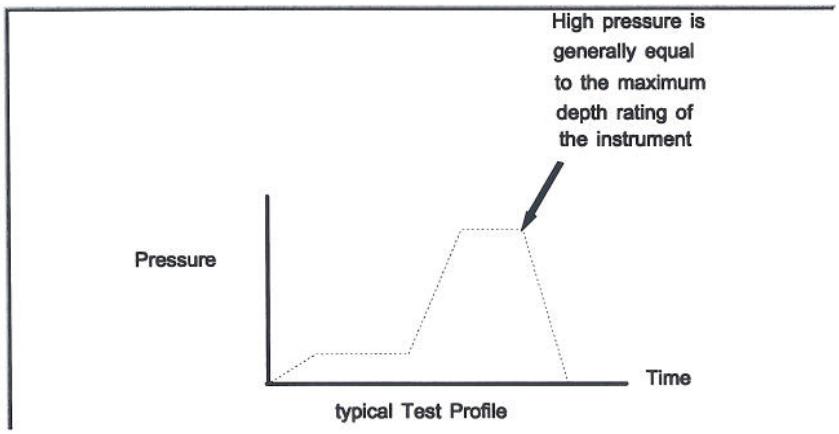
Pressure Test Protocol:

Low Pressure Test: **40** PSI Held For **15** Minutes

High Pressure Test: **10000** PSI Held For **15** Minutes

Passed Test: ☑

Tested By: FS



typical Test Profile

Secondary

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Website: http://www.seabird.com

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Email: seabird@seabird.com
Fax: (425) 643-9866

SBE 5T SUBMERSIBLE PUMP CONFIGURATION SHEET

Customer: MD Marine Electric
Delivery Date: 5/20/2008
Serial Number: 4975
MRP PN: 90543
Job Number: 47490

Pressure Case: 10,500 meters (titanium)

Pittman Motor Type:

P/N 3711B113-R1, 18.02 ohms nominal (For applications up to 2000 RPM MAX) ☐

- 5 Winding, low voltage input (jump P5 to P7) (80676 assy/3711B113-R1 motor) ☐
- 5 Winding, standard voltage input (jump P5 to P6) (80676 assy/3711B113-R1 motor) ☐

P/N 3711B112-R1, 7.40 ohms nominal (For applications up to 4500 RPM MAX) ☐

- 3 Winding, low voltage input (jump P5 to P7) (80675 assy/3711B112-R1 motor) ☐
- 3 Winding, standard voltage input (jump P5 to P6) (80675 assy/3711B112-R1 motor) ☐

P/N 3711B112-R2, 3.55 ohms nominal (For applications up to 4500 RPM MAX) ☑

- 3 Winding, low voltage input (jump P5 to P7) (801572 assy/3711B112-R2 motor) ☐
- 3 Winding, standard voltage input (jump P5 to P6) (801572 assy/3711B112-R2 motor) ☑

Speed Adjust Range: Min: 930 RPM Max: 5220 RPM (@ 12 Vin/300mA load)

Final Speed Setting: 3000 RPM (TP1 = 100.0 Hz)

Low voltage pumps only:

Motor speed at 7.5 Vin with no load: 0 RPM (TP1 = 0.0 Hz)

Motor speed at 7.5 Vin with 200mA load: 0 RPM (TP1 = 0.0 Hz)

Motor dropout voltage: 9.3

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FAX: (425) 643-9954
Email: seabird@seabird.com

SBE Pressure Test Certificate

Test Date: **5/12/2008** Description **SBE-5T Submersible Pump**

Job Number: **47490** Customer Name **MD Marine Electric**

SBE Sensor Information:

Model Number: **5T**
Serial Number: **4975**

Pressure Sensor Information:

Sensor Type: **None**
Sensor Serial Number: **None**
Sensor Rating: **0**

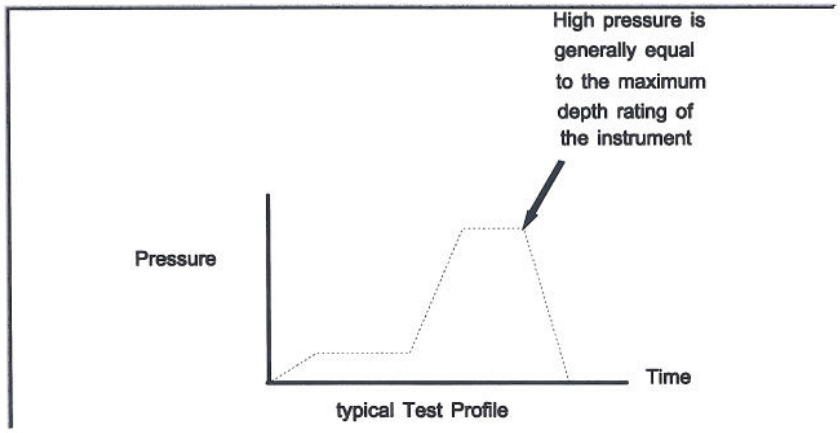
Pressure Test Protocol:

Low Pressure Test: **40** PSI Held For **15** Minutes

High Pressure Test: **10000** PSI Held For **15** Minutes

Passed Test: ☑

Tested By: FS



typical Test Profile