Sea-Bird Scientific
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SENSOR SERIAL NUMBER: 1443
CALIBRATION DATE: 04-Apr-24

SBE 9plus PRESSURE CALIBRATION DATA
10000 psia S/N 150911

DIGIQUARTZ COEFFICIENTS:

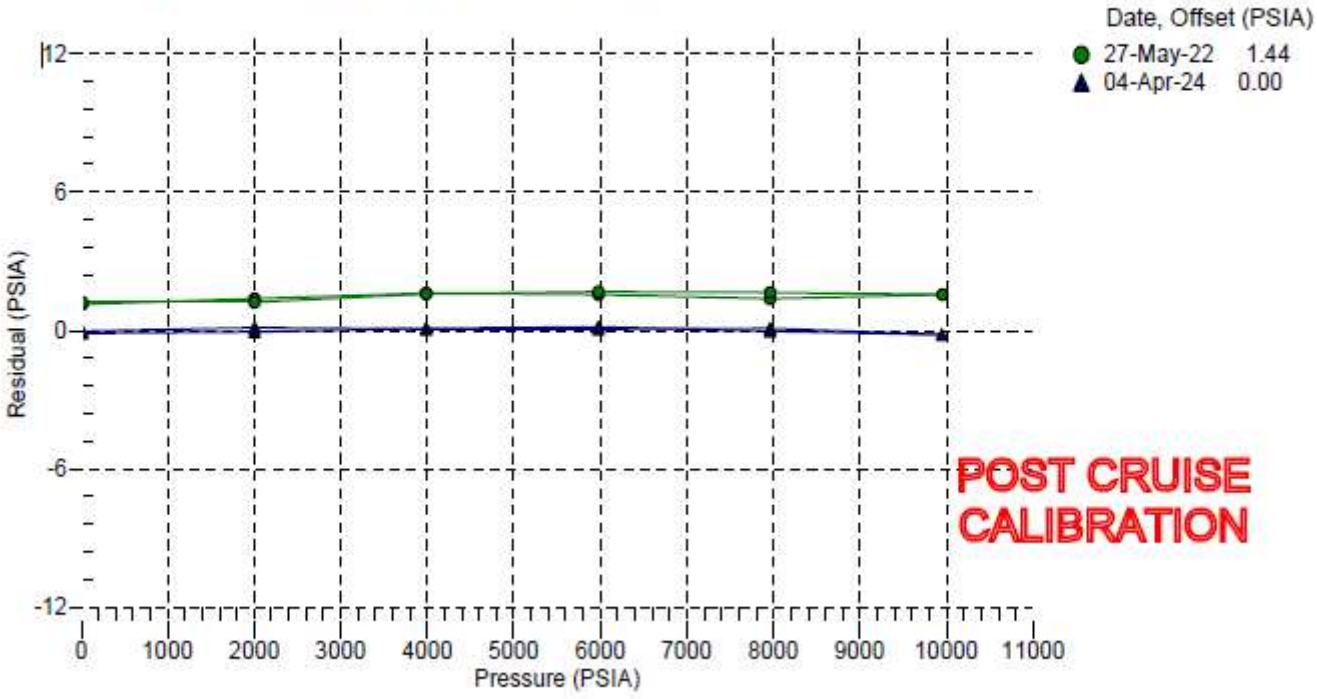
```
C1 =  -4.542941e+004
C2 =  -3.764250e-001
C3 =   1.292400e-002
D1 =   3.726000e-002
D2 =   0.000000e+000
T1 =   3.048710e+001
T2 =  -3.748600e-004
T3 =   4.012000e-006
T4 =   1.231040e-009
T5 =   0.000000e+000
```

AD590M, AD590B, SLOPE AND OFFSET:

```
AD590M =   1.28031e-002
AD590B =  -9.32441e+000
Slope  =   1.00002
Offset =  -0.5582 (dbars)
```

PRESSURE (PSIA)	INSTRUMENT OUTPUT (Hz)	INSTRUMENT TEMPERATURE (°C)	INSTRUMENT PRESSURE (PSIA)	CORRECTED PRESSURE (PSIA)	RESIDUAL (PSIA)
14.417	32813.40	23.9	15.175	14.366	-0.051
2000.410	33521.60	24.0	2001.286	2000.507	0.097
3987.702	34213.30	24.0	3988.501	3987.754	0.052
5974.811	34889.10	24.1	5975.587	5974.871	0.060
7962.082	35550.00	24.1	7962.834	7962.148	0.066
9949.954	36196.90	24.1	9950.403	9949.749	-0.205
7962.491	35550.10	24.1	7963.138	7962.452	-0.039
5975.317	34889.30	24.1	5976.180	5975.464	0.147
3988.208	34213.50	24.1	3989.038	3988.290	0.082
2001.090	33521.80	24.1	2001.799	2001.021	-0.069
14.418	32813.40	24.1	15.088	14.279	-0.139

Residual (PSIA) = corrected instrument pressure - reference pressure



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SENSOR SERIAL NUMBER: 1572
CALIBRATION DATE: 02-May-24

SBE 3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

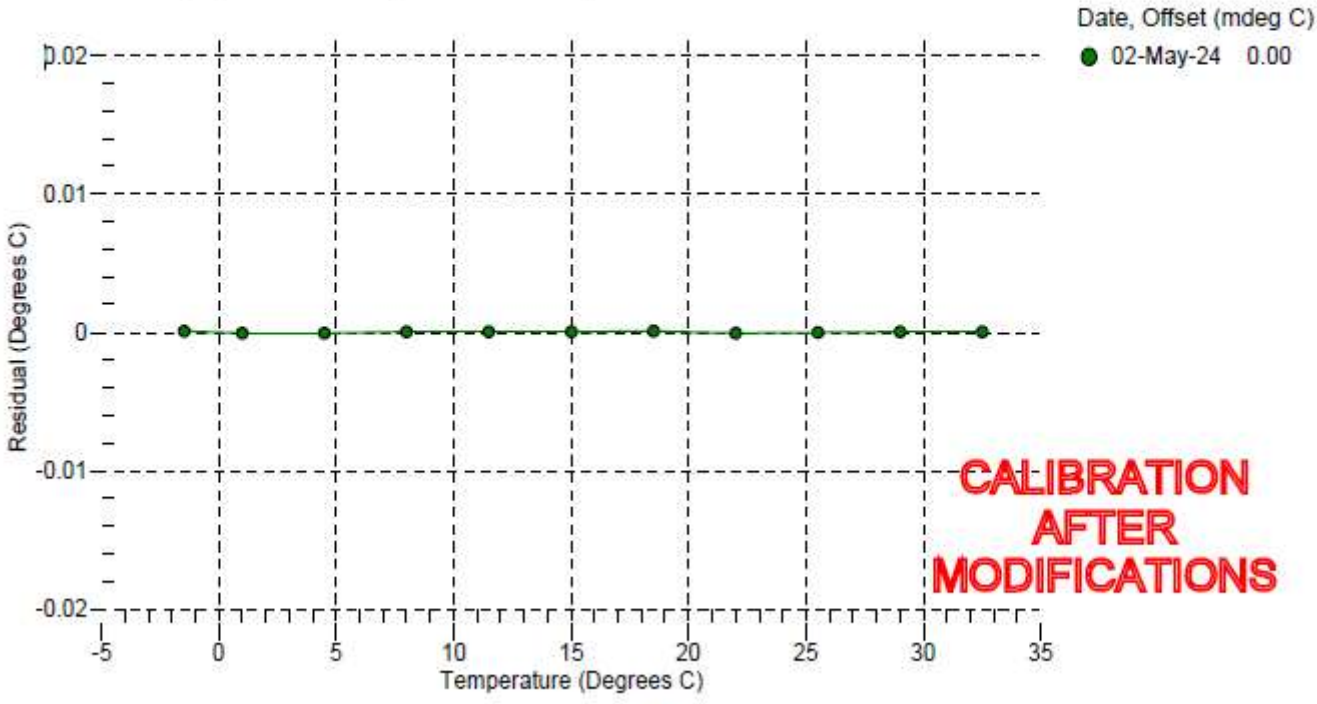
g = 4.32025883e-003
h = 6.40924838e-004
i = 2.20581115e-005
j = 1.99438491e-006
f0 = 1000.0

BATH TEMP (° C)	INSTRUMENT OUTPUT (Hz)	INST TEMP (° C)	RESIDUAL (° C)
-1.5000	2801.632	-1.4999	0.00005
1.0000	2962.580	0.9999	-0.00006
4.5000	3199.002	4.4999	-0.00005
8.0000	3448.693	8.0000	0.00004
11.5000	3711.998	11.5000	0.00003
15.0000	3989.271	15.0000	0.00001
18.5000	4280.856	18.5001	0.00005
22.0001	4587.070	22.0000	-0.00007
25.5001	4908.240	25.5001	-0.00003
29.0000	5244.655	29.0000	0.00001
32.5000	5596.623	32.5000	0.00001

f = Instrument Output (Hz)

Temperature ITS-90 (°C) = $1/\{g + h[ln(f0 / f)] + i[ln^2(f0 / f)] + j[ln^3(f0 / f)]\} - 273.15$

Residual (°C) = instrument temperature - bath temperature



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SENSOR SERIAL NUMBER: 4107
CALIBRATION DATE: 25-Apr-24

SBE 4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g =  -1.02004323e+001
h =   1.39992641e+000
i =  -1.37453591e-003
j =   1.74418114e-004

CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

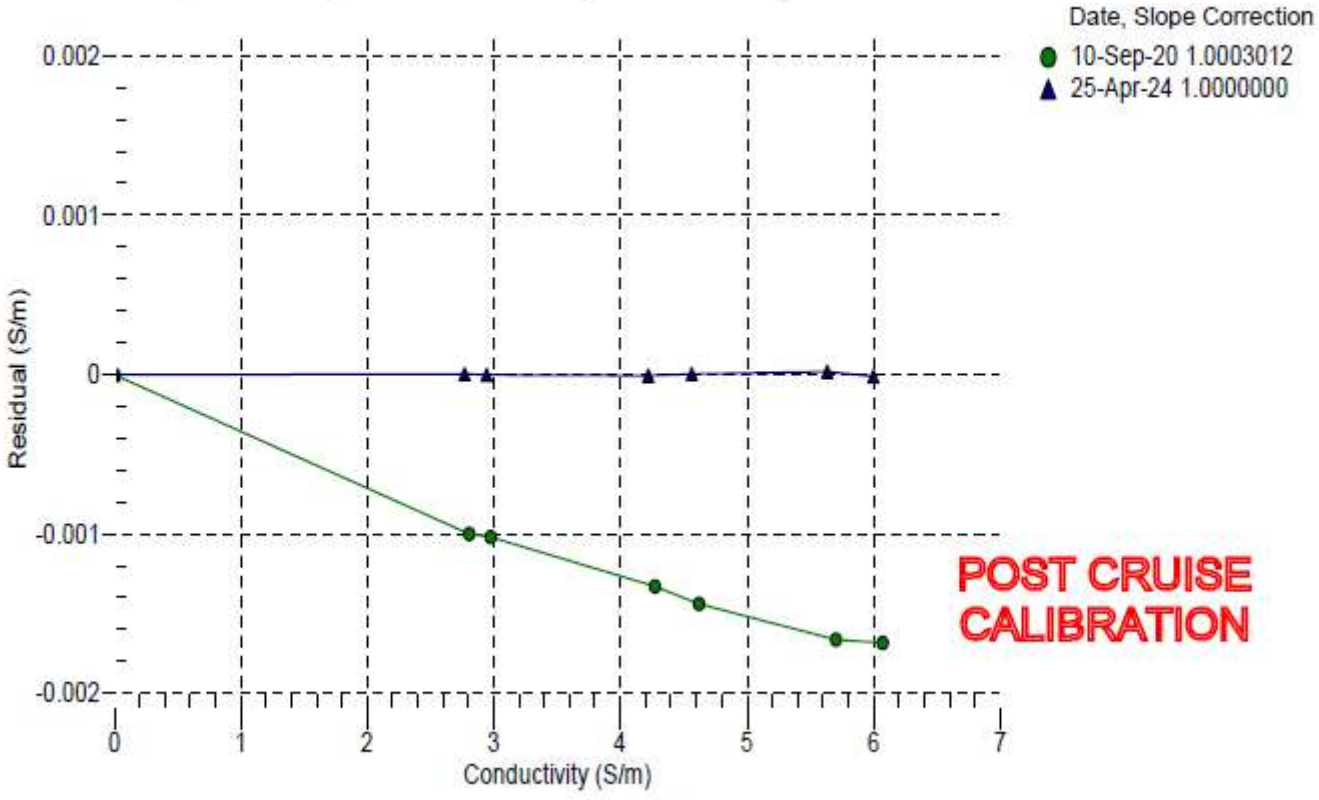
BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (kHz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
0.0000	0.0000	0.00000	2.70169	0.00000	0.00000
-1.0001	34.3582	2.77108	5.20844	2.77108	0.00000
1.0000	34.3588	2.94056	5.32350	2.94056	-0.00000
15.0000	34.3589	4.22139	6.12311	4.22138	-0.00001
18.4999	34.3576	4.56402	6.31976	4.56402	0.00000
29.0000	34.3500	5.63447	6.89774	5.63449	0.00002
32.4999	34.3266	6.00016	7.08426	6.00015	-0.00001

f = Instrument Output (kHz)

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

Conductivity (S/m) = $(g + h * f^2 + i * f^3 + j * f^4) / 10 (1 + \delta * t + \varepsilon * p)$

Residual (Siemens/meter) = instrument conductivity - bath conductivity



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SENSOR SERIAL NUMBER: 4267
CALIBRATION DATE: 22-May-24

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS:
Soc = 0.5415
Voffset = -0.5222
Tau20 = 1.06
A = -2.6160e-003
B = 9.5729e-005
C = -1.8003e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS
D1 = 1.92634e-4
D2 = -4.64803e-2
H1 = -3.300000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

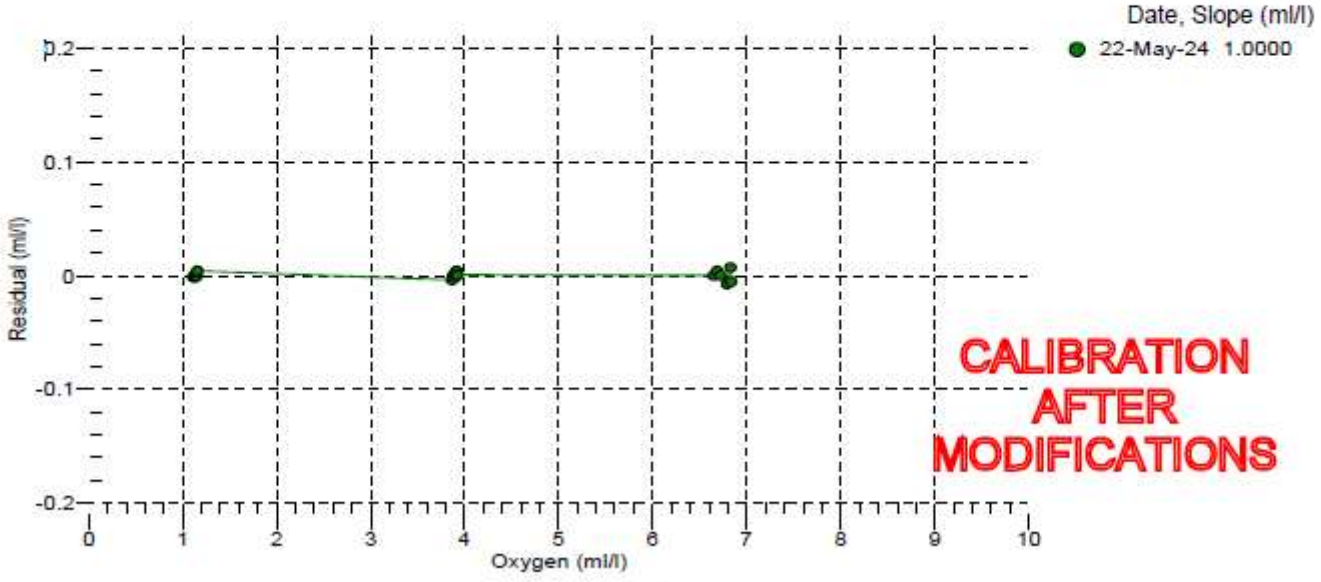
BATH OXYGEN (ml/l)	BATH TEMPERATURE (° C)	BATH SALINITY (PSU)	INSTRUMENT OUTPUT (volts)	INSTRUMENT OXYGEN (ml/l)	RESIDUAL (ml/l)
1.12	2.04	0.00	0.736	1.11	-0.00
1.12	6.00	0.00	0.763	1.12	-0.00
1.13	12.00	0.00	0.804	1.13	-0.00
1.14	20.00	0.00	0.862	1.14	-0.00
1.15	26.00	0.00	0.911	1.15	0.00
1.15	30.00	0.00	0.944	1.16	0.00
3.87	2.04	0.00	1.264	3.86	-0.00
3.88	6.00	0.00	1.355	3.88	-0.00
3.89	12.00	0.00	1.495	3.89	0.00
3.90	20.00	0.00	1.686	3.89	-0.00
3.91	26.00	0.00	1.842	3.92	0.00
3.92	30.00	0.00	1.949	3.92	0.00
6.65	2.04	0.00	1.799	6.65	0.00
6.68	6.00	0.00	1.958	6.69	0.00
6.72	12.00	0.00	2.203	6.72	0.00
6.79	20.00	0.00	2.550	6.79	-0.01
6.83	26.00	0.00	2.826	6.83	0.01
6.83	30.00	0.00	3.008	6.83	-0.01

V = instrument output (volts); T = temperature (°C); S = salinity (PSU); K = temperature (°K)

Oxsol(T,S) = oxygen saturation (ml/l); P = pressure (dbar)

$Oxygen\ (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T^2 + C * T^3) * Oxsol(T,S) * \exp(E * P / K)$

Residual (ml/l) = instrument oxygen - bath oxygen



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ECO Chlorophyll Fluorometer Characterization Sheet

Date: 4/12/2022 S/N: FLRTD-7511

Chlorophyll concentration expressed in µg/l can be derived using the equation:

CHL (µg/l) = Scale Factor * (Output - Dark Counts)

	Analog Range 1	Analog Range 2	Analog Range 4 (default)		Digital	
Dark Counts	0.048	0.019	0.011	V	48	counts
Scale Factor (SF)	6	13	25	µg/l/V	0.0076	µg/l/count
Maximum Output	4.97	4.97	4.97	V	16380	counts
Resolution	1.0	1.0	1.0	mV	1.0	counts

Ambient temperature during characterization 20.4 °C

Analog Range: 1 (most sensitive, 0–4,000 counts), 2 (midrange, 0–8,000 counts), 4 (entire range, 0–16,000 counts).

Dark Counts: Signal output of the meter in clean water with black tape over detector.

SF: Determined using the following equation: SF = x ÷ (output - dark counts), where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

Resolution: Standard deviation of 1 minute of collected data.

The relationship between fluorescence and chlorophyll-a concentrations *in-situ* is highly variable. The scale factor listed on this document was determined using a mono-culture of phytoplankton (*Thalassiosira weissflogii*). The population was assumed to be reasonably healthy and the concentration was determined by using the absorption method. To accurately determine chlorophyll concentration using a fluorometer, you must perform secondary measurements on the populations of interest. This is typically done using extraction-based measurement techniques on discrete samples. For additional information on determining chlorophyll concentration see "Standard Methods for the Examination of Water and Wastewater" part 10200 H, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation.

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C-Star Calibration

Date September 23, 2021 S/N# CST-2151 Pathlength 25 cm

	Analog output	Digital output	
V_{dark}	0.000 V	0 counts	
V_{air}	4.802 V	15784 counts	
V_{ref}	4.702 V	15455 counts	
Temperature of calibration water			23.4 °C
Ambient temperature during calibration			23.2 °C

Relationship of transmittance (Tr) to beam attenuation coefficient (c), and pathlength (x, in meters): $Tr = e^{-cx}$

To determine beam transmittance: $Tr = (V_{sig} - V_{dark}) / (V_{ref} - V_{dark})$

To determine beam attenuation coefficient: $c = -1/x * \ln(Tr)$

V_{dark} Meter output with the beam blocked. This is the offset.
V_{air} Meter output in air with a clear beam path.
V_{ref} Meter output with clean water in the path.
Temperature of calibration water: temperature of clean water used to obtain V_{ref}.
Ambient temperature: meter temperature in air during the calibration.
V_{sig} Measured signal output of meter.