Pressure Calibration Report
STS Calibration Facility

SENSOR SERIAL NUMBER: 1281
CALIBRATION DATE: 07-DEC-2021
Mfg: SEABIRD Model: 09P CTD Prs s/n: 136428

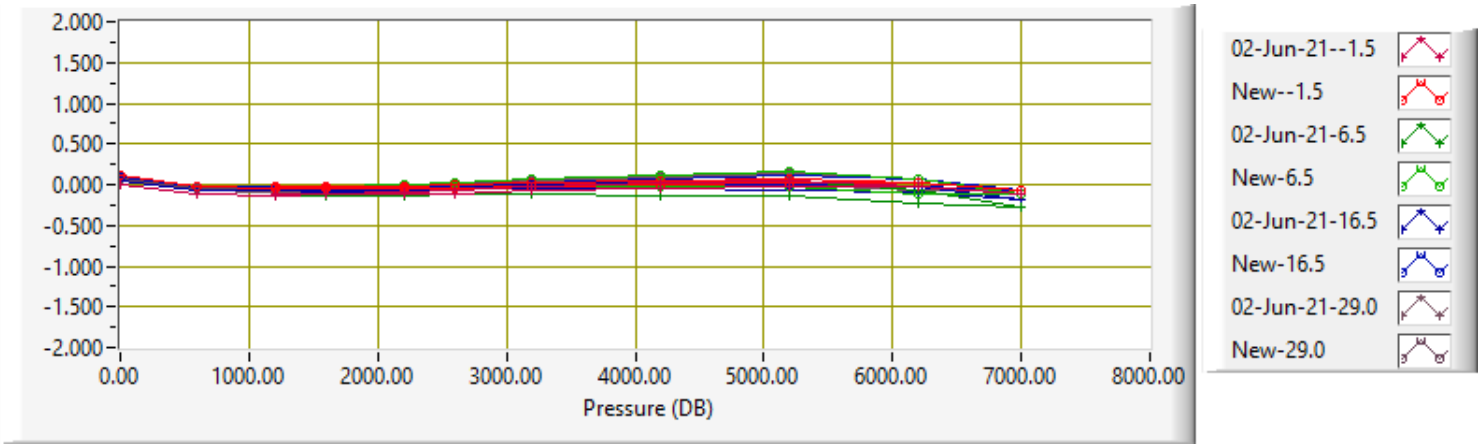
C1= -4.160481E+4
C2= -3.219786E-1
C3= 1.105909E-2
D1= 3.538794E-2
D2= 0.000000E+0
T1= 3.013965E+1
T2= -3.914456E-4
T3= 4.524706E-6
T4= -6.654717E-9
T5= 0.000000E+0
AD590M= 1.27846E-2
AD590B= -9.25586E+0
Slope = 1.00000000E+0
Offset = 0.00000000E+0

Calibration Standard: Mfg: FLUKE Model: P3125 s/n: 70856
t0=t1+t2*td+t3*td*td+t4*td*td*td
w = 1-t0*t0*f*f
Pressure = (0.6894759*((c1+c2*td+c3*td*td)*w*(1-(d1+d2*td)*w)-14.7)

Sensor Output	DWT	Sensor New_Coefs	DWT-Sensor Prev_Coefs	DWT-Sensor NEW_Coefs	PT-DegC	Bath_Temp
33184.484	0.27	0.15	-0.01	0.12	-0.79	-1.522
33529.461	600.32	600.33	-0.12	-0.01	-0.79	-1.523
33870.352	1200.35	1200.38	-0.13	-0.04	-0.79	-1.523
34095.434	1600.37	1600.41	-0.12	-0.04	-0.79	-1.523
34429.896	2200.40	2200.44	-0.11	-0.04	-0.78	-1.523
34650.800	2600.41	2600.46	-0.10	-0.04	-0.78	-1.523
34979.159	3200.48	3200.50	-0.08	-0.03	-0.78	-1.523
35518.611	4200.53	4200.53	-0.05	-0.01	-0.78	-1.523
36048.722	5200.59	5200.57	-0.02	0.02	-0.78	-1.523
36569.891	6200.60	6200.59	-0.02	0.02	-0.78	-1.523
36980.687	7000.60	7000.66	-0.11	-0.06	-0.78	-1.522
36569.868	6200.57	6200.54	-0.01	0.03	-0.78	-1.522
36048.668	5200.56	5200.48	0.04	0.08	-0.79	-1.522
35518.570	4200.53	4200.47	0.02	0.06	-0.79	-1.522
34979.128	3200.49	3200.46	-0.02	0.03	-0.79	-1.522
34650.795	2600.45	2600.45	-0.07	-0.01	-0.79	-1.522
34429.893	2200.42	2200.45	-0.09	-0.03	-0.79	-1.522
34095.434	1600.38	1600.41	-0.11	-0.03	-0.79	-1.522

Sensor Output	DWT	Sensor New_Coefs	DWT-Sensor Prev_Coefs	DWT-Sensor NEW_Coefs	PT-DegC	Bath_Temp
33870.344	1200.35	1200.38	-0.11	-0.02	-0.79	-1.523
33529.450	600.32	600.31	-0.10	0.01	-0.79	-1.523
33187.695	0.27	0.15	0.01	0.12	7.25	6.485
33532.691	600.32	600.34	-0.12	-0.02	7.25	6.485
33873.596	1200.35	1200.39	-0.13	-0.04	7.25	6.485
34098.690	1600.37	1600.41	-0.13	-0.04	7.25	6.485
34433.169	2200.41	2200.46	-0.14	-0.05	7.25	6.484
34654.079	2600.42	2600.46	-0.13	-0.04	7.25	6.484
34982.435	3200.45	3200.47	-0.11	-0.02	7.25	6.484
35521.908	4200.46	4200.49	-0.13	-0.03	7.25	6.484
36052.022	5200.46	5200.48	-0.13	-0.02	7.25	6.484
36573.272	6200.48	6200.59	-0.24	-0.11	7.25	6.484
36984.076	7000.51	7000.64	-0.28	-0.13	7.25	6.484
36573.222	6200.57	6200.50	-0.06	0.07	7.25	6.485
36051.999	5200.59	5200.43	0.05	0.16	7.25	6.485
35521.885	4200.57	4200.45	0.02	0.12	7.25	6.485
34982.416	3200.51	3200.44	-0.01	0.08	7.25	6.485
34654.069	2600.46	2600.45	-0.07	0.02	7.24	6.485
34433.161	2200.44	2200.44	-0.10	-0.01	7.24	6.485
34098.685	1600.39	1600.41	-0.11	-0.02	7.24	6.485
33873.587	1200.36	1200.38	-0.11	-0.02	7.24	6.485
33532.679	600.32	600.32	-0.10	-0.00	7.24	6.485
33190.832	0.27	0.18	0.04	0.09	17.23	16.491
33535.848	600.33	600.35	-0.07	-0.02	17.24	16.493
33876.777	1200.36	1200.39	-0.07	-0.03	17.25	16.492
34101.892	1600.39	1600.41	-0.06	-0.03	17.25	16.492
34436.397	2200.43	2200.45	-0.07	-0.03	17.26	16.492
34657.327	2600.44	2600.46	-0.06	-0.02	17.25	16.492
34985.713	3200.47	3200.48	-0.05	-0.00	17.26	16.491
35525.226	4200.48	4200.48	-0.05	-0.00	17.26	16.491
36055.397	5200.49	5200.50	-0.07	-0.01	17.26	16.491
36576.653	6200.53	6200.54	-0.10	-0.01	17.26	16.491
36987.507	7000.54	7000.62	-0.19	-0.08	17.26	16.491
36576.636	6200.57	6200.51	-0.03	0.06	17.26	16.491
36055.374	5200.57	5200.46	0.04	0.11	17.25	16.492
35525.205	4200.52	4200.46	0.01	0.07	17.23	16.492
34985.697	3200.49	3200.46	-0.01	0.03	17.23	16.492
34657.320	2600.45	2600.46	-0.05	-0.01	17.23	16.492
34436.391	2200.42	2200.45	-0.07	-0.03	17.23	16.492
34101.893	1600.38	1600.43	-0.08	-0.05	17.23	16.491
33876.773	1200.35	1200.39	-0.08	-0.04	17.23	16.491
33535.836	600.32	600.33	-0.05	-0.01	17.23	16.491
33193.464	0.27	0.19	-0.01	0.08	29.78	29.003
33538.531	600.33	600.37	-0.10	-0.04	29.78	29.002
33879.505	1200.36	1200.41	-0.10	-0.05	29.78	29.002
34104.652	1600.39	1600.44	-0.09	-0.05	29.78	29.002

Sensor Output	DWT	Sensor New_Coefs	DWT-Sensor Prev_Coefs	DWT-Sensor NEW_Coefs	PT-DegC	Bath_Temp
34439.199	2200.43	2200.47	-0.07	-0.04	29.78	29.002
34660.159	2600.44	2600.48	-0.05	-0.04	29.78	29.002
34988.587	3200.48	3200.49	-0.02	-0.02	29.78	29.002
35528.174	4200.49	4200.50	-0.01	-0.01	29.78	29.002
36058.400	5200.48	5200.49	0.01	-0.00	29.79	29.001
36579.741	6200.49	6200.56	-0.06	-0.07	29.79	29.000
36990.617	7000.49	7000.57	-0.07	-0.08	29.79	29.001
36579.691	6200.52	6200.46	0.07	0.06	29.79	29.001
36058.364	5200.55	5200.42	0.14	0.13	29.78	29.002
35528.137	4200.53	4200.44	0.10	0.09	29.78	29.003
34988.564	3200.49	3200.45	0.04	0.04	29.78	29.002
34660.145	2600.45	2600.45	-0.02	-0.00	29.78	29.002
34439.185	2200.42	2200.45	-0.05	-0.03	29.78	29.001
34104.645	1600.38	1600.43	-0.08	-0.05	29.78	29.001
33879.496	1200.35	1200.40	-0.09	-0.04	29.78	29.002
33538.512	600.32	600.33	-0.08	-0.01	29.78	29.001
33193.437	0.27	0.14	0.04	0.12	29.78	29.000



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SENSOR SERIAL NUMBER: 2569
CALIBRATION DATE: 17-Mar-22

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

COEFFICIENTS:

```
g =  -1.04574666e+001
h =   1.58020915e+000
i =   1.92446352e-003
j =  -2.24202625e-005

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

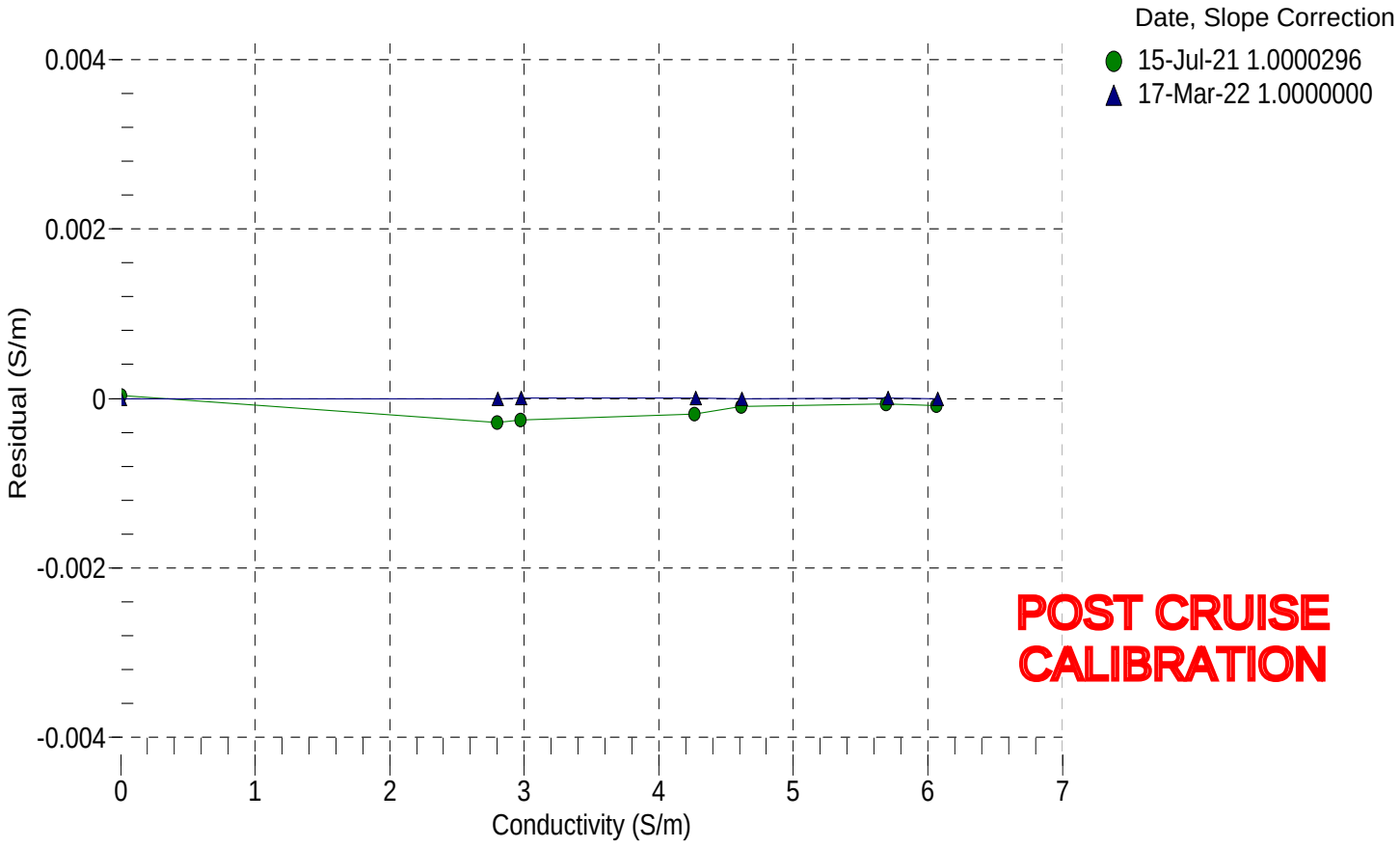
BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (kHz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
0.0000	0.0000	0.00000	2.56861	0.00000	0.00000
-1.0001	34.8352	2.80595	4.92316	2.80595	-0.00000
0.9999	34.8357	2.97746	5.03130	2.97746	0.00000
14.9999	34.8360	4.27376	5.78316	4.27377	0.00000
18.4999	34.8361	4.62070	5.96822	4.62070	-0.00000
29.0000	34.8319	5.70459	6.51234	5.70459	0.00001
32.5000	34.8212	6.07675	6.68888	6.07674	-0.00000

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: 3578
CALIBRATION DATE: 22-Mar-22

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

COEFFICIENTS:

```
g =  -9.47463002e+000
h =   1.14725777e+000
i =  -5.49238016e-004
j =   1.02257222e-004

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

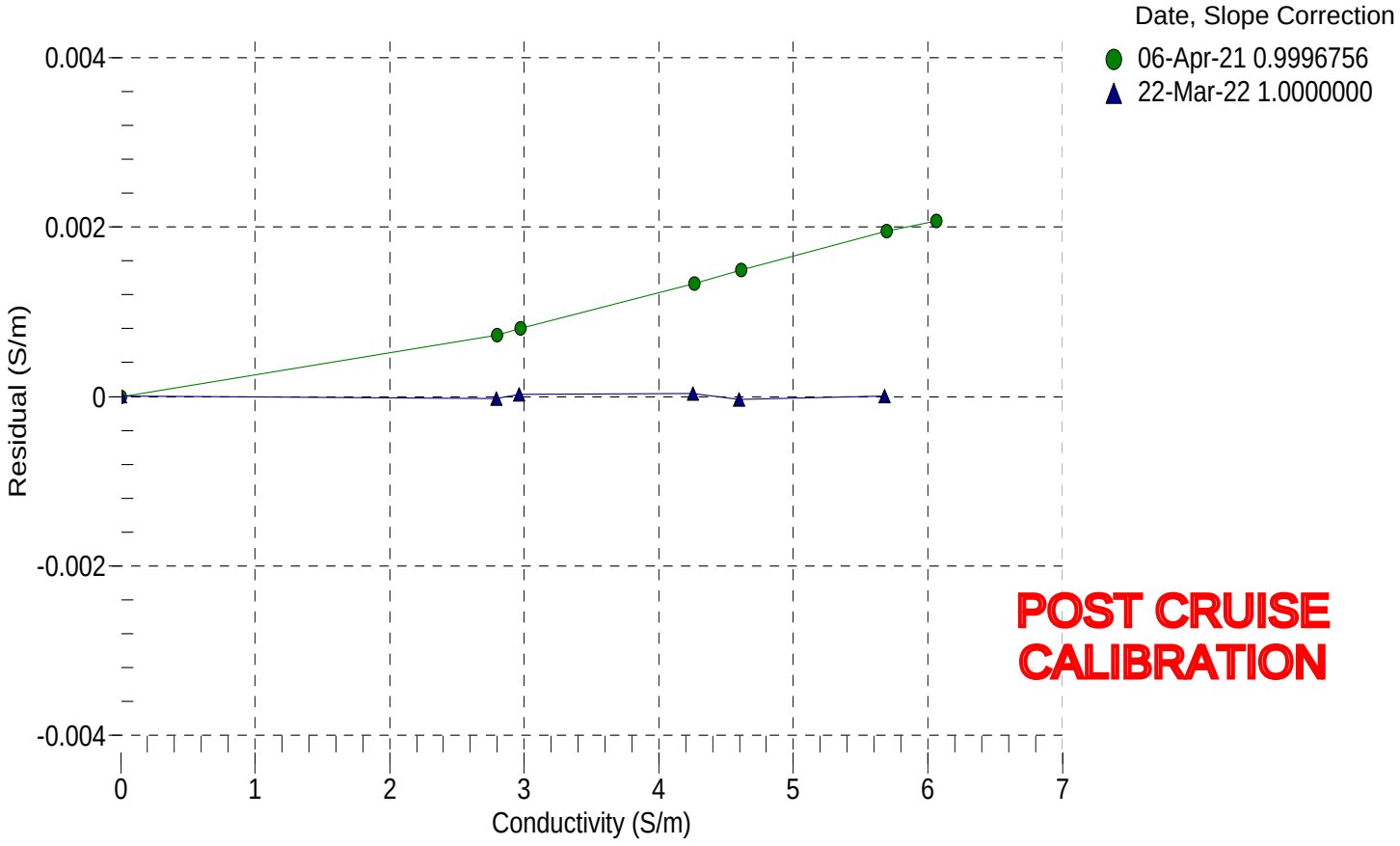
BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (kHz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
0.0000	0.0000	0.00000	2.87468	0.00000	0.00000
-1.0000	34.6472	2.79222	5.70884	2.79219	-0.00003
1.0000	34.6471	2.96288	5.83749	2.96290	0.00003
15.0000	34.6463	4.25296	6.73011	4.25299	0.00003
18.5001	34.6449	4.59809	6.94927	4.59805	-0.00004
29.0000	34.6383	5.67644	7.59308	5.67644	0.00001
32.5000	34.6230	6.04608	7.80118	6.04573	-0.00035

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



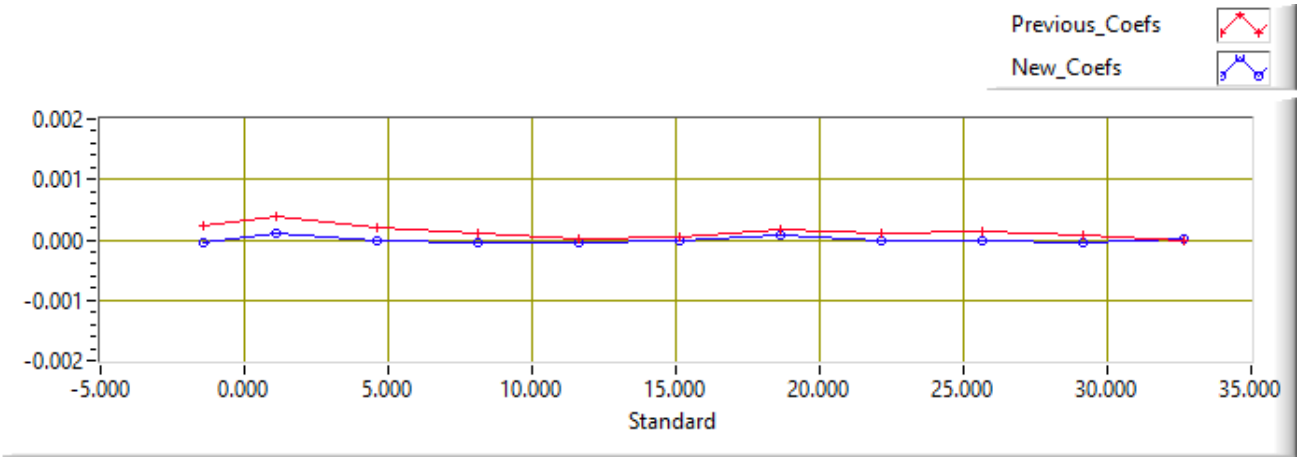
Temperature Calibration Report
STS Calibration Facility

SENSOR SERIAL NUMBER: 0105
CALIBRATION DATE: 15-Mar-2022
Mfg: SEABIRD Model: 35
Previous cal: 09-Feb-21
Calibration Tech: MVK

ITS-90_COEFFICIENTS
a0 = 6.524193824E-3
a1 = -1.849038085E-3
a2 = 2.569536069E-4
a3 = -1.400059014E-5
a4 = 2.909840456E-7
Slope = 1.000000 Offset = 0.000000
Calibration Standard: Mfg: Isotech Model: MicroK100 s/n: 291088-2

Calibration Standard: Mfg: Isotech Model: MicroK100 s/n: 291088-2
Temperature ITS-90 = 1/{a0+a1[ln(f)]+a2[ln2(f)]+a3[ln3(f)]+a4[ln4(f)} - 273.15 (°C)

SBE35 Count	SPRT ITS-T90	SBE35 ITS-T90	SPRT-SBE35 OLD_Coefs	SPRT-SBE35 NEW_Coefs
921181.3716	-1.4298	-1.4298	0.00024	-0.00006
823747.7314	1.0749	1.0748	0.00040	0.00011
705943.7767	4.5815	4.5815	0.00021	-0.00001
606521.2201	8.0900	8.0900	0.00010	-0.00004
522477.9212	11.5985	11.5986	0.00003	-0.00005
451384.5810	15.1014	15.1014	0.00004	-0.00002
390849.1226	18.6137	18.6136	0.00017	0.00009
339363.4042	22.1233	22.1233	0.00012	0.00000
295402.2109	25.6355	25.6355	0.00014	-0.00001
257832.7582	29.1445	29.1446	0.00008	-0.00004
225602.7730	32.6547	32.6547	-0.00000	0.00002



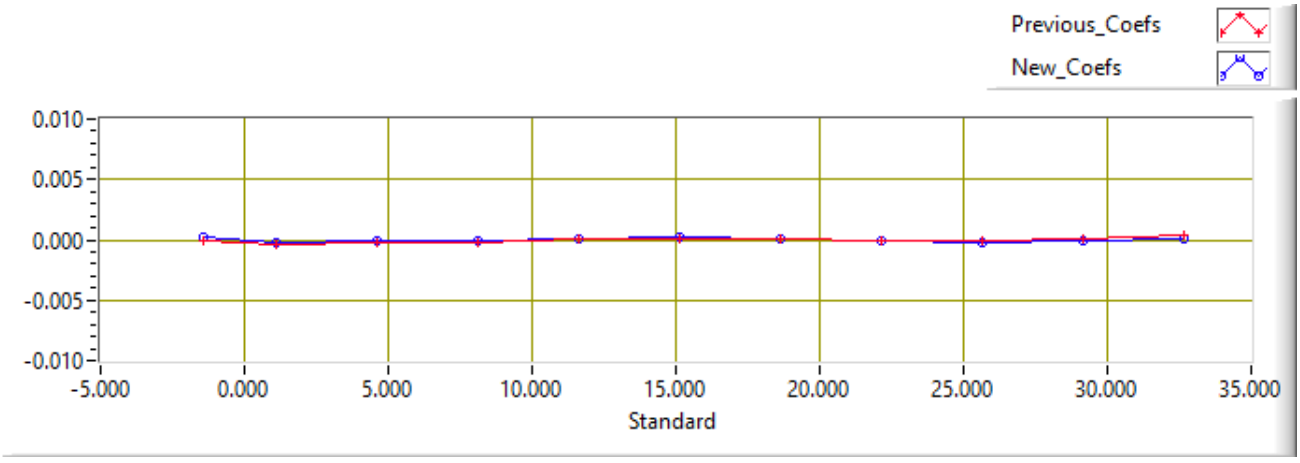
Temperature Calibration Report
STS Calibration Facility

SENSOR SERIAL NUMBER: 4138
CALIBRATION DATE: 17-Mar-2022
Mfg: SEABIRD Model: 03
Previous cal: 31-Aug-21
Calibration Tech: AJM

ITS-90_COEFFICIENTS	IPTS-68_COEFFICIENTS ITS-T90	
g = 4.32516790E-3	a = 4.32535573E-3	
h = 6.27336486E-4	b = 6.27540205E-4	
i = 2.00203041E-5	c = 2.00510291E-5	
j = 1.55382422E-6	d = 1.55518090E-6	
f0 = 1000.0	Slope = 1.0	Offset = 0.0

Calibration Standard: Mfg: Isotech Model: MicroK100 s/n: 291088-2
Temperature ITS-90 = 1/{g+h[ln(f0/f)]+i[ln2(f0/f)]+j[ln3(f0/f)]} - 273.15 (°C)
Temperature IPTS-68 = 1/{a+b[ln(f0/f)]+c[ln2(f0/f)]+d[ln3(f0/f)]} - 273.15 (°C)
T68 = 1.00024 * T90 (-2 to -35 Deg C)

SBE3 Freq	SPRT ITS-T90	SBE3 ITS-T90	SPRT-SBE3 OLD_Coefs	SPRT-SBE3 NEW_Coefs
2889.1750	-1.4300	-1.4302	-0.00002	0.00020
3058.7838	1.0742	1.0744	-0.00039	-0.00022
3308.2564	4.5810	4.5811	-0.00019	-0.00007
3572.2452	8.0890	8.0891	-0.00022	-0.00014
3851.2432	11.5994	11.5993	0.00007	0.00013
4144.7378	15.1008	15.1006	0.00014	0.00019
4454.8273	18.6132	18.6131	0.00005	0.00008
4780.7934	22.1234	22.1234	-0.00001	-0.00002
5123.3570	25.6352	25.6354	-0.00011	-0.00017
5482.4267	29.1442	29.1443	0.00002	-0.00013
5858.9713	32.6564	32.6562	0.00042	0.00015



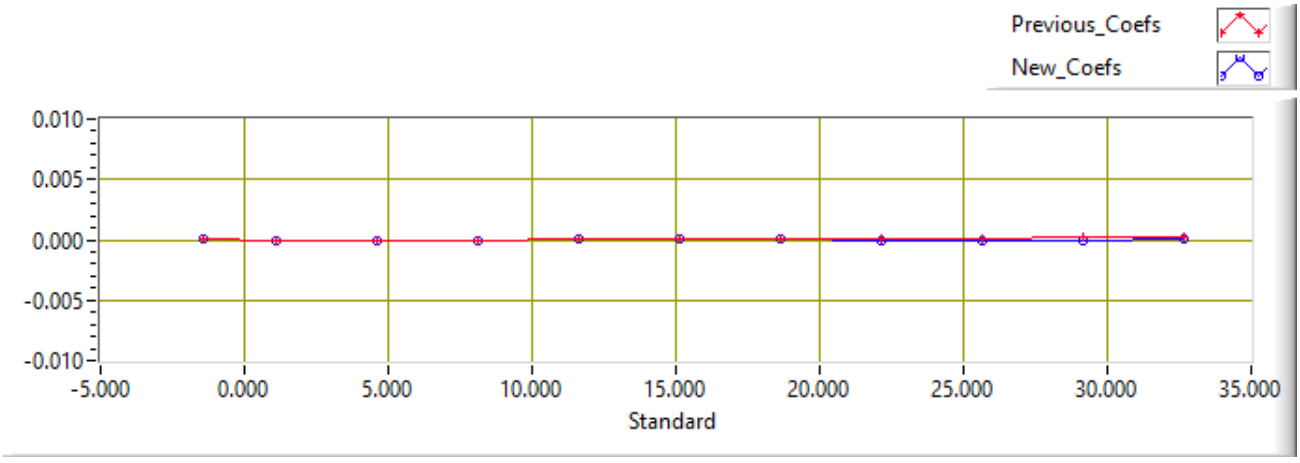
Temperature Calibration Report
STS Calibration Facility

SENSOR SERIAL NUMBER: 4941
CALIBRATION DATE: 09-Mar-2022
Mfg: SEABIRD Model: 03
Previous cal: 31-Aug-21
Calibration Tech: AJM

ITS-90_COEFFICIENTS	IPTS-68_COEFFICIENTS ITS-T90	
g = 4.36052717E-3	a = 4.36072637E-3	
h = 6.41687693E-4	b = 6.41898355E-4	
i = 2.28813698E-5	c = 2.29135945E-5	
j = 2.15275286E-6	d = 2.15425958E-6	
f0 = 1000.0	Slope = 1.0	Offset = 0.0

Calibration Standard: Mfg: Isotech Model: MicroK100 s/n: 291088-2
Temperature ITS-90 = 1/{g+h[ln(f0/f)]+i[ln2(f0/f)]+j[ln3(f0/f)]} - 273.15 (°C)
Temperature IPTS-68 = 1/{a+b[ln(f0/f)]+c[ln2(f0/f)]+d[ln3(f0/f)]} - 273.15 (°C)
T68 = 1.00024 * T90 (-2 to -35 Deg C)

SBE3 Freq	SPRT ITS-T90	SBE3 ITS-T90	SPRT-SBE3 OLD_Coefs	SPRT-SBE3 NEW_Coefs
3000.3682	-1.4293	-1.4293	0.00010	0.00005
3173.7371	1.0751	1.0751	-0.00000	-0.00003
3428.5184	4.5817	4.5818	-0.00009	-0.00010
3697.8770	8.0908	8.0908	-0.00001	-0.00001
3982.1314	11.6009	11.6008	0.00011	0.00010
4280.7697	15.1016	15.1016	0.00006	0.00003
4595.9846	18.6143	18.6143	0.00007	0.00001
4926.8615	22.1239	22.1240	0.00005	-0.00005
5274.2376	25.6360	25.6360	0.00014	-0.00001
5637.7164	29.1432	29.1433	0.00016	-0.00004
6018.7425	32.6565	32.6565	0.00029	0.00004



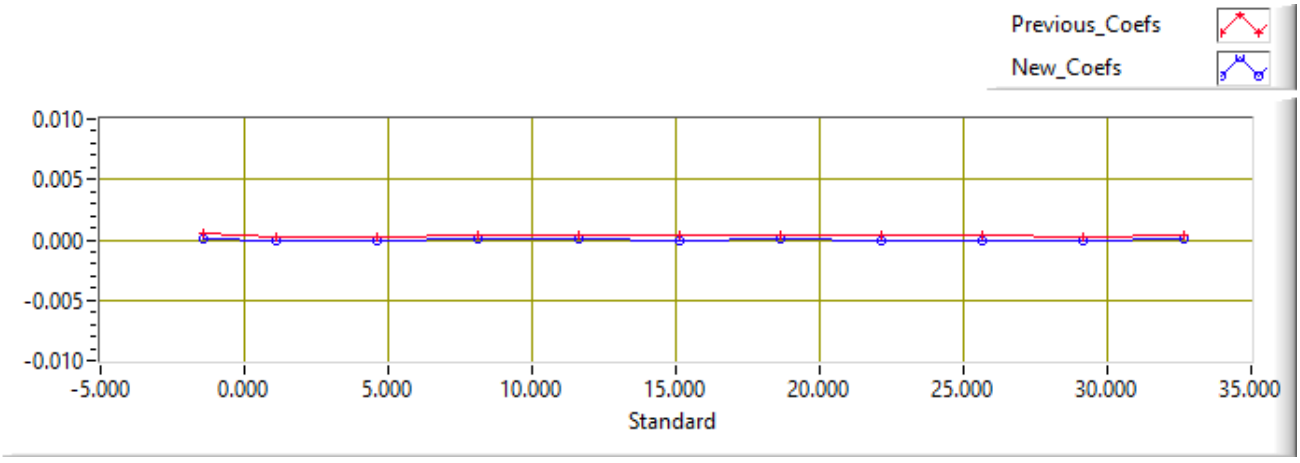
Temperature Calibration Report
STS Calibration Facility

SENSOR SERIAL NUMBER: 5046
CALIBRATION DATE: 02-Mar-2022
Mfg: SEABIRD Model: 03
Previous cal: 24-Feb-21
Calibration Tech: MVK

ITS-90_COEFFICIENTS	IPTS-68_COEFFICIENTS ITS-T90	
g = 4.41636859E-3	a = 4.41658635E-3	
h = 6.44196855E-4	b = 6.44412734E-4	
i = 2.26266614E-5	c = 2.26589816E-5	
j = 2.07106898E-6	d = 2.07252479E-6	
f0 = 1000.0	Slope = 1.0	Offset = 0.0

Calibration Standard: Mfg: Isotech Model: MicroK100 s/n: 291088-2
Temperature ITS-90 = 1/{g+h[ln(f0/f)]+i[ln2(f0/f)]+j[ln3(f0/f)]} - 273.15 (°C)
Temperature IPTS-68 = 1/{a+b[ln(f0/f)]+c[ln2(f0/f)]+d[ln3(f0/f)]} - 273.15 (°C)
T68 = 1.00024 * T90 (-2 to -35 Deg C)

SBE3 Freq	SPRT ITS-T90	SBE3 ITS-T90	SPRT-SBE3 OLD_Coefs	SPRT-SBE3 NEW_Coefs
3276.5574	-1.4290	-1.4291	0.00053	0.00008
3465.8594	1.0752	1.0752	0.00030	-0.00009
3744.0916	4.5827	4.5828	0.00026	-0.00007
4038.0594	8.0910	8.0909	0.00037	0.00004
4348.2547	11.6005	11.6004	0.00043	0.00008
4674.1811	15.1015	15.1015	0.00032	-0.00006
5018.1189	18.6143	18.6143	0.00044	0.00004
5379.1382	22.1246	22.1246	0.00043	0.00000
5757.8618	25.6350	25.6350	0.00042	0.00000
6154.5491	29.1447	29.1448	0.00027	-0.00009
6569.8498	32.6566	32.6565	0.00032	0.00006



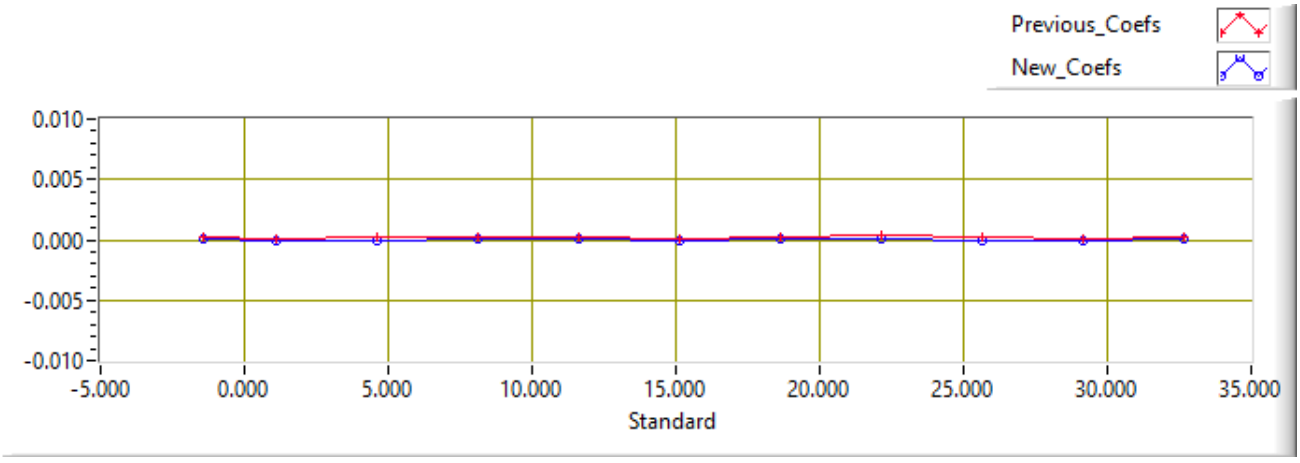
Temperature Calibration Report
STS Calibration Facility

SENSOR SERIAL NUMBER: 6018
CALIBRATION DATE: 02-Mar-2022
Mfg: SEABIRD Model: 03
Previous cal: 24-Feb-21
Calibration Tech: MVK

ITS-90_COEFFICIENTS	IPTS-68_COEFFICIENTS ITS-T90	
g = 4.36187980E-3	a = 4.36207948E-3	
h = 6.37713526E-4	b = 6.37923075E-4	
i = 2.21508074E-5	c = 2.21825746E-5	
j = 2.03138571E-6	d = 2.03284160E-6	
f0 = 1000.0	Slope = 1.0	Offset = 0.0

Calibration Standard: Mfg: Isotech Model: MicroK100 s/n: 291088-2
Temperature ITS-90 = 1/{g+h[ln(f0/f)]+i[ln2(f0/f)]+j[ln3(f0/f)]} - 273.15 (°C)
Temperature IPTS-68 = 1/{a+b[ln(f0/f)]+c[ln2(f0/f)]+d[ln3(f0/f)]} - 273.15 (°C)
T68 = 1.00024 * T90 (-2 to -35 Deg C)

SBE3 Freq	SPRT ITS-T90	SBE3 ITS-T90	SPRT-SBE3 OLD_Coefs	SPRT-SBE3 NEW_Coefs
3025.6386	-1.4290	-1.4291	0.00027	0.00006
3201.3846	1.0752	1.0752	0.00012	-0.00009
3459.8000	4.5827	4.5827	0.00018	-0.00003
3732.9699	8.0910	8.0909	0.00028	0.00006
4021.3636	11.6005	11.6004	0.00027	0.00004
4324.5238	15.1015	15.1016	0.00014	-0.00010
4644.5878	18.6143	18.6143	0.00028	0.00003
4980.7012	22.1246	22.1245	0.00036	0.00010
5333.4873	25.6350	25.6350	0.00023	-0.00002
5703.1694	29.1447	29.1448	0.00010	-0.00012
6090.3748	32.6566	32.6565	0.00023	0.00006



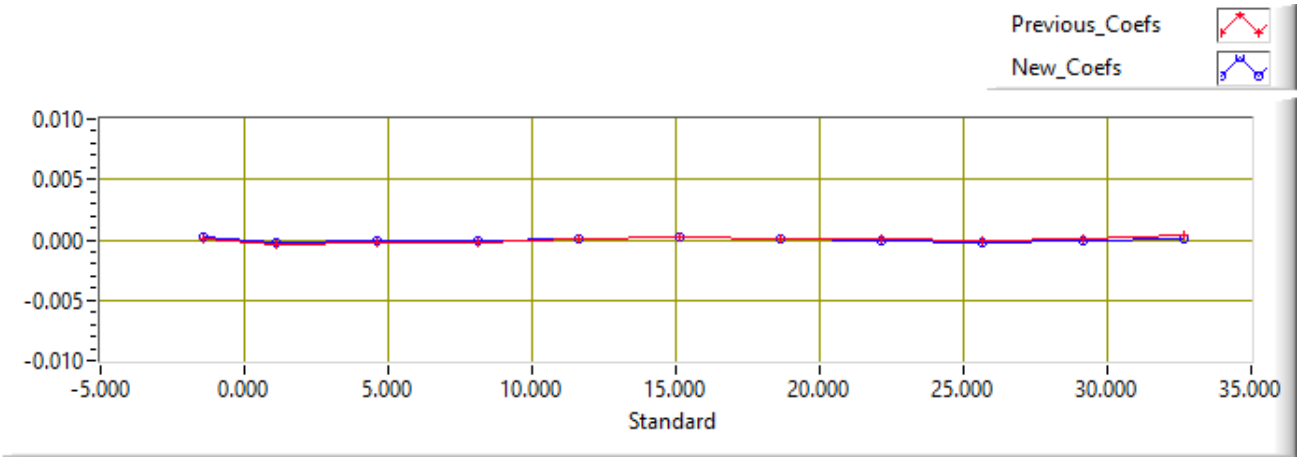
Temperature Calibration Report
STS Calibration Facility

SENSOR SERIAL NUMBER: 6049
CALIBRATION DATE: 17-Mar-2022
Mfg: SEABIRD Model: 03
Previous cal: 31-Aug-21
Calibration Tech: AJM

ITS-90_COEFFICIENTS	IPTS-68_COEFFICIENTS ITS-T90	
g = 4.31264709E-3	a = 4.31283085E-3	
h = 6.27365760E-4	b = 6.27568511E-4	
i = 1.99855976E-5	c = 2.00163145E-5	
j = 1.56729241E-6	d = 1.56865339E-6	
f0 = 1000.0	Slope = 1.0	Offset = 0.0

Calibration Standard: Mfg: Isotech Model: MicroK100 s/n: 291088-2
Temperature ITS-90 = 1/{g+h[ln(f0/f)]+i[ln2(f0/f)]+j[ln3(f0/f)]} - 273.15 (°C)
Temperature IPTS-68 = 1/{a+b[ln(f0/f)]+c[ln2(f0/f)]+d[ln3(f0/f)]} - 273.15 (°C)
T68 = 1.00024 * T90 (-2 to -35 Deg C)

SBE3 Freq	SPRT ITS-T90	SBE3 ITS-T90	SPRT-SBE3 OLD_Coefs	SPRT-SBE3 NEW_Coefs
2828.1534	-1.4300	-1.4302	0.00001	0.00020
2993.9491	1.0742	1.0744	-0.00033	-0.00020
3237.7958	4.5810	4.5811	-0.00018	-0.00010
3495.7969	8.0890	8.0891	-0.00018	-0.00012
3768.4416	11.5994	11.5993	0.00009	0.00012
4055.2179	15.1008	15.1006	0.00020	0.00021
4358.1828	18.6132	18.6131	0.00007	0.00006
4676.6220	22.1234	22.1234	0.00002	-0.00002
5011.2402	25.6352	25.6354	-0.00006	-0.00016
5361.9492	29.1442	29.1443	0.00004	-0.00014
5729.6864	32.6564	32.6562	0.00045	0.00015



Temperature Calibration Certificate

Model	:	ARO-CAV
Serial No.	:	0251
Date	:	December 21, 2015
Location	:	Production Section
Method	:	Calibration equation is determined from third order regression of samples of the reference temperature against instrument voltages. Samples are taken at approximately 3, 10, 17, 24, and 31 °C.

1. Equation

Instrument temperature[°C] = $A+B \times V+C \times V^2+D \times V^3$ V: Instrument voltage[V]

2. Coefficients

A = −5.275295e+00
B = +1.670109e+01
C = −2.172049e+00
D = +4.643500e−01

3. Calibration results

Reference temperature [°C]	Instrument voltage [V]	Instrument temperature [°C]	Residual error [°C]	Acceptance [°C]	OK/NG
3.176	0.53955	3.176	0.000	±0.020	OK
9.842	1.00891	9.841	−0.001	±0.020	OK
16.630	1.51318	16.632	0.002	±0.020	OK
24.180	2.07520	24.179	−0.001	±0.020	OK
31.348	2.58124	31.348	0.000	±0.020	OK

4. Verification

Criteria of judgement : Residual error of the instrument temperature at arbitrary point is within the acceptance value.

Reference temperature [°C]	Instrument temperature [°C]	Residual error [°C]	Acceptance [°C]	Judgement
19.921	19.923	0.002	±0.020	Passed

Examined K. Shimotsu

Approved A. Fukuoka

Dissolved Oxygen Calibration Certificate

Model	:	ARO-CAV
Serial No.	:	0251
Date	:	December 21, 2015
Location	:	Production Section
Method	:	Calibration is performed with the nitrogen gas (zero) and the oxygen saturated water (span) kept by air bubbling.
Film No.	:	151502B

1. Equation

DO[%] =G+H × P'

Here, P'[%] consists of the coefficients A-F determined by the initial calibration.

2. Coefficients

A =	-3.893493e+01	E =	+4.000000e-03
B =	+1.192391e+02	F =	+4.760000e-05
C =	-3.509264e-01	G =	+0.000000e+00
D =	+1.006600e-02	H =	+1.000000e+00

3. Verification

Criteria of judgement : Residual error of the instrument DO at arbitrary point is within the acceptance value. The test is performed 3 times.

Acceptance: ±0.5% of full scale

Test for DO 0 %

	Test condition		Instrument DO [%]	Residual error [%]	Acceptance [%]	Judgement
	Atm. pressure [hPa]	Reference DO [%]				
1st	1023.7	0.00	-0.04	-0.04	±1.00	Passed
2nd	1023.7	0.00	0.04	0.04	±1.00	Passed
3rd	1023.8	0.00	0.04	0.04	±1.00	Passed

Test for DO 100 %

	Test condition			Instrument DO [%]	Residual error [%]	Acceptance [%]	Judgement
	Water T. [°C]	Atm. pressure [hPa]	Reference DO [%]				
1st	25.1	1023.9	101.09	100.75	-0.34	±1.00	Passed
2nd	25.1	1023.9	101.09	100.54	-0.55	±1.00	Passed
3rd	25.1	1024.0	101.10	100.59	-0.51	±1.00	Passed

Examined R. Kashida

Approved A. Fukuoka

CALIBRATION CERTIFICATE

NAME	:	RINKO Ⅲ
MODEL	:	ARO-CAV
SERIAL No.	:	0296
Parameter	:	Temperature Dissolved Oxygen

JFE

JFE Advantech Co., Ltd.

Temperature Calibration Certificate

Model	:	ARO-CAV
Serial No.	:	0296
Date	:	April 07, 2017
Location	:	Production Section
Method	:	Calibration equation is determined from third order regression of samples of the reference temperature against instrument voltages. Samples are taken at approximately 3, 10, 17, 24, and 31 °C.

1. Equation

Instrument temperature[°C] = $A+B \times V+C \times V^2+D \times V^3$ V: Instrument voltage[V]

2. Coefficients

A = −5.305905e+00
B = +1.666857e+01
C = −2.142681e+00
D = +4.582805e−01

3. Calibration results

Reference temperature [°C]	Instrument voltage [V]	Instrument temperature [°C]	Residual error [°C]	Acceptance [°C]	OK/NG
2.437	0.49243	2.437	0.000	±0.020	OK
10.737	1.07715	10.735	−0.002	±0.020	OK
17.463	1.57825	17.466	0.003	±0.020	OK
24.123	2.07288	24.121	−0.002	±0.020	OK
31.105	2.56635	31.105	0.000	±0.020	OK

4. Verification

Criteria of judgement : Residual error of the instrument temperature at arbitrary point is within the acceptance value.

Reference temperature [°C]	Instrument temperature [°C]	Residual error [°C]	Acceptance [°C]	Judgement
20.068	20.086	0.018	±0.020	Passed

Examined R Kashida

Approved A. Fukuoka

Dissolved Oxygen Calibration Certificate

Model	:	ARO-CAV
Serial No.	:	0296
Date	:	April 10, 2017
Location	:	Production Section
Method	:	Calibration is performed with the nitrogen gas (zero) and the oxygen saturated water (span) kept by air bubbling.
Film No.	:	164312BA

1. Equation

DO[%] =G+H × P'

Here, P'[%] consists of the coefficients A-F determined by the initial calibration.

2. Coefficients

A =	−4.524084e+01	E =	+4.000000e−03
B =	+1.449377e+02	F =	+6.250000e−05
C =	−3.051590e−01	G =	+0.000000e+00
D =	+1.065300e−02	H =	+1.000000e+00

3. Verification

Criteria of judgement : Residual error of the instrument DO at arbitrary point is within the acceptance value. The test is performed 3 times.

Acceptance: ±0.5% of full scale

Test for DO 0 %

	Test condition		Instrument DO [%]	Residual error [%]	Acceptance [%]	Judgement
	Atm. pressure [hPa]	Reference DO [%]				
1st	1015.7	0.00	0.02	0.02	±1.00	Passed
2nd	1015.7	0.00	0.02	0.02	±1.00	Passed
3rd	1015.7	0.00	0.02	0.02	±1.00	Passed

Test for DO 100 %

	Test condition			Instrument DO [%]	Residual error [%]	Acceptance [%]	Judgement
	Water T. [°C]	Atm. pressure [hPa]	Reference DO [%]				
1st	25.1	1015.0	100.18	99.89	−0.29	±1.00	Passed
2nd	25.1	1015.0	100.18	99.94	−0.24	±1.00	Passed
3rd	25.1	1014.9	100.17	99.95	−0.22	±1.00	Passed

Examined M. TAKEISHI

Approved A. Fukuoka

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SENSOR SERIAL NUMBER: 0060
CALIBRATION DATE: 15-Mar-22

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS:
Soc = 0.5069
Voffset = -0.4968
Tau20 = 1.20

A = -4.5924e-003
B = 1.9638e-004
C = -2.9709e-006
E nominal = 0.036

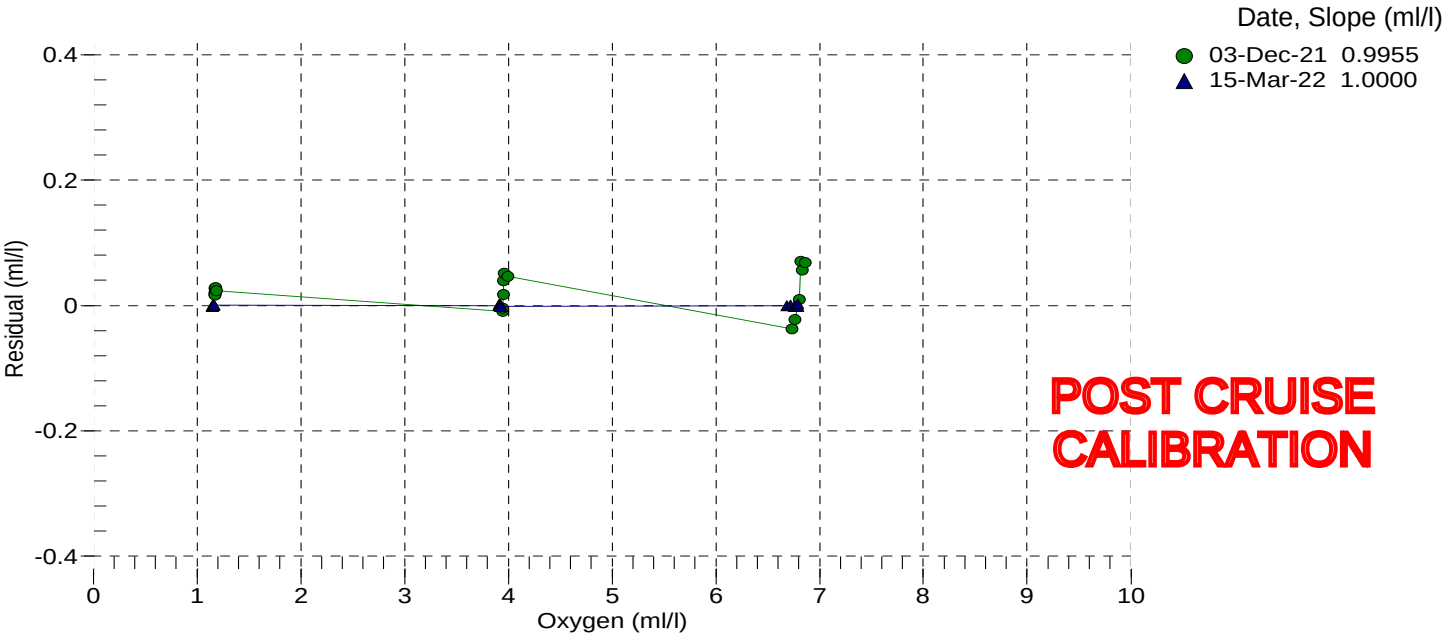
NOMINAL DYNAMIC COEFFICIENTS
D1 = 1.92634e-4
D2 = -4.64803e-2
H1 = -3.300000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

BATH OXYGEN (ml/l)	BATH TEMPERATURE (° C)	BATH SALINITY (PSU)	INSTRUMENT OUTPUT (volts)	INSTRUMENT OXYGEN (ml/l)	RESIDUAL (ml/l)
1.15	2.00	0.00	0.733	1.15	-0.00
1.15	6.00	0.00	0.763	1.15	0.00
1.15	12.00	0.00	0.808	1.15	-0.00
1.16	20.00	0.00	0.870	1.16	0.00
1.16	26.00	0.00	0.916	1.16	0.00
1.17	30.00	0.00	0.951	1.17	0.00
3.91	2.00	0.00	1.301	3.91	-0.00
3.91	6.00	0.00	1.403	3.92	0.00
3.92	20.00	0.00	1.759	3.92	0.00
3.92	30.00	0.00	2.023	3.92	0.00
3.92	12.00	0.00	1.557	3.92	0.00
3.92	26.00	0.00	1.915	3.92	-0.00
6.69	2.00	0.00	1.872	6.69	-0.00
6.72	6.00	0.00	2.052	6.72	0.00
6.76	12.00	0.00	2.323	6.76	-0.00
6.77	20.00	0.00	2.676	6.77	-0.00
6.79	30.00	0.00	3.137	6.79	-0.00
6.79	26.00	0.00	2.952	6.79	0.00

V = instrument output (volts); T = temperature (°C); S = salinity (PSU); K = temperature (°K)
Oxsol(T,S) = oxygen saturation (ml/l); P = pressure (dbar)

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

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



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SENSOR SERIAL NUMBER: 0185
CALIBRATION DATE: 15-Mar-22

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS:
Soc = 0.4772
Voffset = -0.5018
Tau20 = 1.54

A = -3.8659e-003
B = 1.6601e-004
C = -2.5194e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS
D1 = 1.92634e-4
D2 = -4.64803e-2

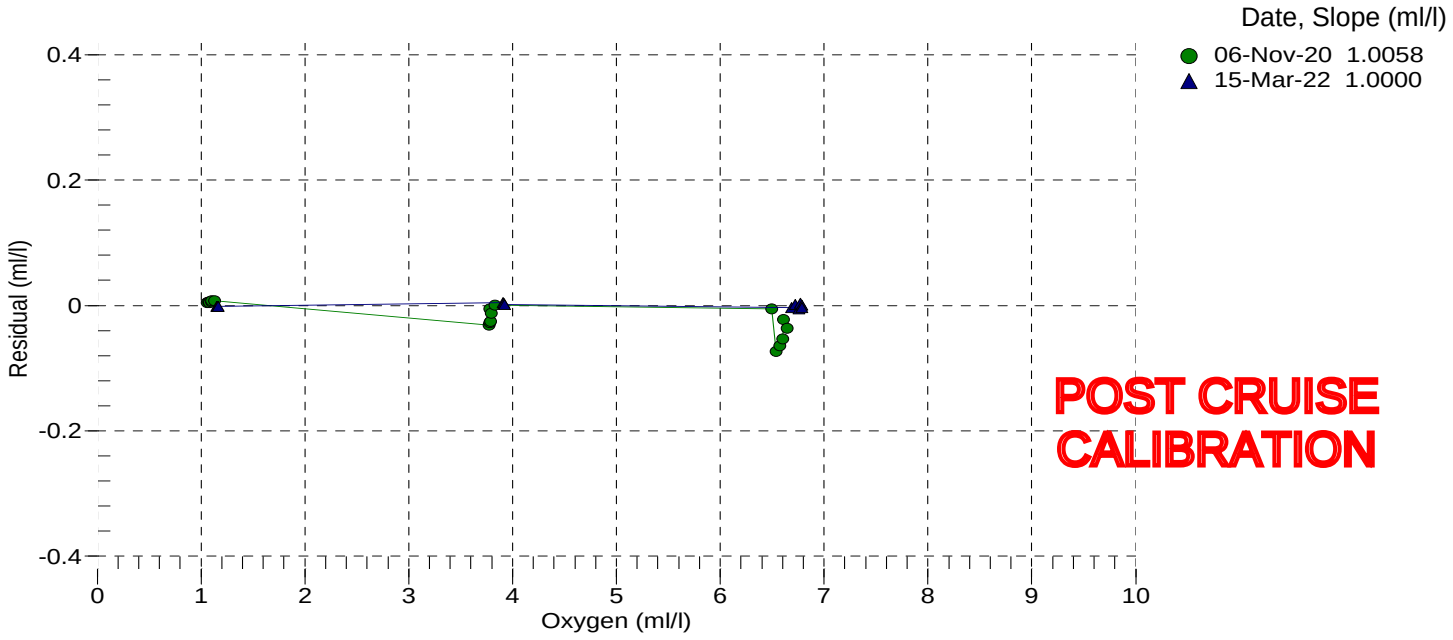
H1 = -3.300000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

BATH OXYGEN (ml/l)	BATH TEMPERATURE (° C)	BATH SALINITY (PSU)	INSTRUMENT OUTPUT (volts)	INSTRUMENT OXYGEN (ml/l)	RESIDUAL (ml/l)
1.15	2.00	0.00	0.752	1.15	-0.00
1.15	6.00	0.00	0.784	1.15	-0.00
1.15	12.00	0.00	0.831	1.15	-0.00
1.16	20.00	0.00	0.894	1.15	-0.00
1.16	26.00	0.00	0.944	1.16	-0.00
1.17	30.00	0.00	0.980	1.17	-0.00
3.91	2.00	0.00	1.355	3.91	0.00
3.91	6.00	0.00	1.461	3.92	0.00
3.92	20.00	0.00	1.835	3.92	0.00
3.92	30.00	0.00	2.112	3.92	0.00
3.92	12.00	0.00	1.623	3.93	0.00
3.92	26.00	0.00	2.000	3.93	0.00
6.69	2.00	0.00	1.960	6.68	-0.00
6.72	6.00	0.00	2.148	6.72	0.00
6.76	12.00	0.00	2.430	6.75	-0.01
6.77	20.00	0.00	2.804	6.77	0.00
6.79	30.00	0.00	3.288	6.79	0.00
6.79	26.00	0.00	3.091	6.79	-0.00

V = instrument output (volts); T = temperature (°C); S = salinity (PSU); K = temperature (°K)
Oxsol(T,S) = oxygen saturation (ml/l); P = pressure (dbar)

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

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



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SENSOR SERIAL NUMBER: 1508
CALIBRATION DATE: 08-Oct-21

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS:
Soc = 0.5690
Voffset = -0.5028
Tau20 = 1.45
A = -3.7769e-003
B = 1.3435e-004
C = -1.6085e-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

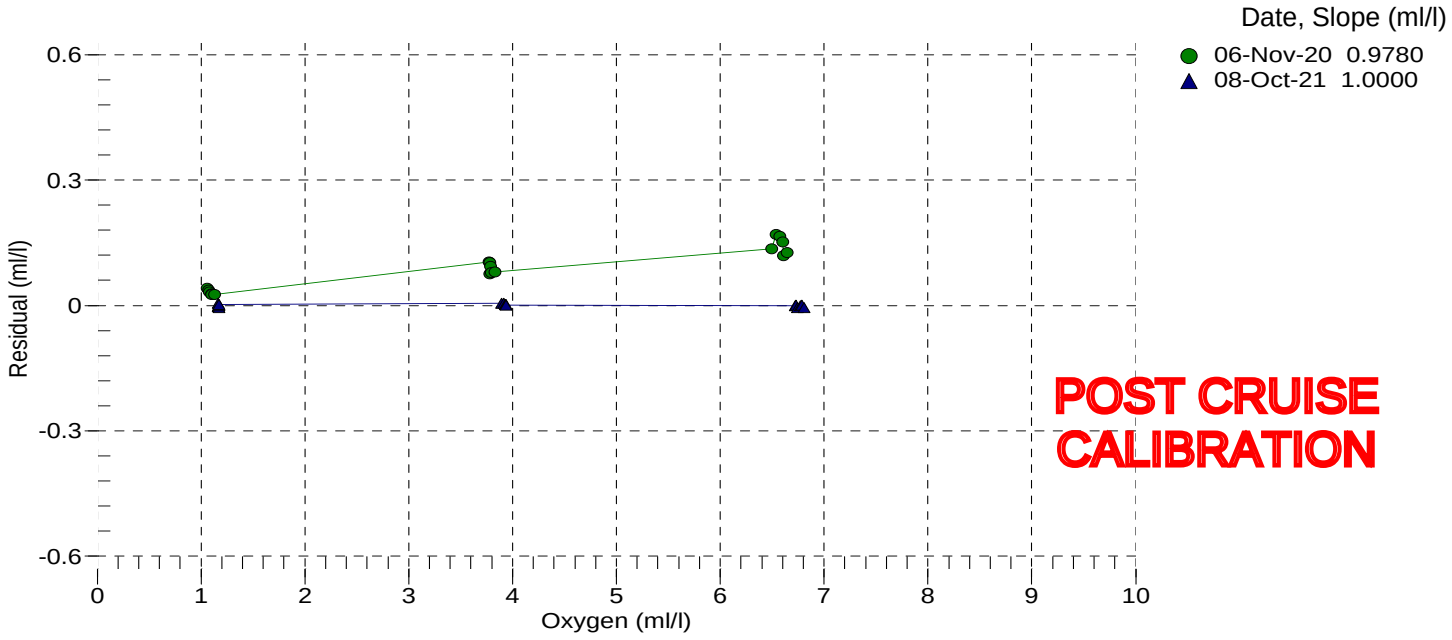
BATH OXYGEN (ml/l)	BATH TEMPERATURE (° C)	BATH SALINITY (PSU)	INSTRUMENT OUTPUT (volts)	INSTRUMENT OXYGEN (ml/l)	RESIDUAL (ml/l)
1.16	12.00	0.00	0.781	1.16	-0.00
1.17	30.00	0.00	0.907	1.17	0.01
1.17	6.00	0.00	0.742	1.17	-0.00
1.17	2.00	0.00	0.716	1.16	-0.01
1.17	20.00	0.00	0.838	1.17	-0.00
1.18	26.00	0.00	0.881	1.18	0.00
3.90	30.00	0.00	1.848	3.90	0.01
3.91	26.00	0.00	1.761	3.92	0.01
3.93	20.00	0.00	1.628	3.93	0.00
3.93	6.00	0.00	1.311	3.94	0.00
3.94	12.00	0.00	1.447	3.94	0.00
3.94	2.00	0.00	1.223	3.94	0.00
6.72	6.00	0.00	1.884	6.72	-0.00
6.73	2.00	0.00	1.733	6.73	0.00
6.74	30.00	0.00	2.824	6.74	-0.01
6.77	26.00	0.00	2.677	6.77	-0.00
6.78	12.00	0.00	2.131	6.78	0.00
6.81	20.00	0.00	2.449	6.80	-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)

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

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



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ECO Chlorophyll Fluorometer Characterization Sheet

Date: 1/7/2022 S/N: FLRTD-4334

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	0.060	0.031	0.017	V	45	counts
Scale Factor (SF)	7	13	26	µg/l/V	0.0079	µg/l/count
Maximum Output	4.97	4.97	4.97	V	16380	counts
Resolution	0.9	0.9	0.9	mV	1.0	counts

Ambient temperature during characterization 21.0 °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 January 5, 2022 S/N# CST-1873DR Pathlength 25cm

	Analog output	Digital output
V_d	0.008 V	0 counts
V_{air}	4.800 V	15729 counts
V_{ref}	4.700 V	15398 counts

Temperature of calibration water	21.9	°C
Ambient temperature during calibration	22.0	°C

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

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

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

$\mathbf{V_d}$ Meter output with the beam blocked. This is the offset.
$\mathbf{V_{air}}$ Meter output in air with a clear beam path.
$\mathbf{V_{ref}}$ 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.
$\mathbf{V_{sig}}$ Measured signal output of meter.

VALEPORT

This document certifies that the instrument detailed below has been calibrated according to Valeport Limited's Standard Procedures, using equipment with calibrations traceable to UKAS or National Standards.

Calibration Certificate Number:	43900
Instrument Type:	Altimeter
Instrument Serial Number:	53821
Calibrated By:	J.Harper
Date:	28/01/2016
Signed:	

Full details of the results from the calibration procedure applied to each fitted sensor are available, on request, via email. This summary certificate should be kept with the instrument.

Valeport Ltd | St Peter's Quay | Totnes | Devon | TQ9 5EW | UK
T: +44 (0) 1803 869292 | F: +44 (0) 1803 869293

Instrument Serial Number	53821
Sensor Type	500kHz Neptune
Altimeter Range (m)	100m
Certificate Number	43900

Stage 1

Test the assembled altimeter in a body of water to ensure a signal is recieved at the minimum range. Taking direct readings from the unit immerse the head till it is roughly 0.1m from the bottom, readings should come through - if not then the signal is being saturated and there is a problem

To inhibit spurious readings set using: #226;40

	Pass/Fail
Bench Test Min Range <0.1m	Pass

Stage 2

Using a mini SVS or similar, measure the average sound velocity for the water in the tow tank and input the value in the cell below.

Enter the SOS	1481.712

Input SOS value to the altimeter using: #830;1481.7120

Stage 3

Fit the altimeter into the calibration fixture and lower the assembly into the tank till it is about 0.5m down facing the far end of the tow tank and clamp in place. Using the distance markers on the wall align the front edge of the trolley with the datum line to set the front of the altimeter at stated distance from the wall.

To determine the Range Offset		
Distance m	Measured Range m	Measured Offset m
1	1.018	-0.018

Stage 4: Enter the Offset Correction
#828;-0.0180

Stage 5 - Range Check after Offset Correction			
Distance m	Measured Range m	Measured Offset m	Pass/Fail
1	0.998	0.002	Pass
5	5.003	-0.003	Pass

Stage 6: Reset the SOS
#830;1500

Stage 7: Reset maximum range to 105m		Stage 8: Reset spurious range
#823;105	(500kHz units)	#226;0

Calibrated by:	J.Harper	Date:	28/01/2016

ltimeter Build and Calibration Record

rument type	Altimeter
al number	53821
d rate set ex factory	115200

Calibration History:	Certificate	Date
	43900	28/01/2016

System Components	Original Manufacture Part (Blank=Not Fitted)	Iss	Serial Number	Range / Firmware	Modification Part (Blank=Not Fitted)	Iss	Serial Number	Range / Firmware	Modification Part (Blank=Not Fitted)	Iss	Serial Number	Range / Firmware	Modification Part (Blank=Not Fitted)	Iss	Serial Number	Range / Firmware
board	0430502	C	110929													
board	0430501	C	78627	ACTEL 0430707												
				ATMEL 0430704A13												
ducer Assembly	500kHz Neptune		31059	100m												
ure sensor	PAA - 10LX		N/A	N/A												
	Name			P Tremlett	Name				Name				Name			
	Date			28/01/2016	Date				Date				Date			
	Signed				Signed				Signed				Signed			