LMG 1110

Cape Sherriff Opening

Bucklin B-285-L

Warren B-393-L

Cruise Data Report

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Introduction

The LMG data acquisition systems continuously log data from a suite of instrumentation throughout the cruise. This document describes the format of that data and its location on the distribution CDs. It also contains important information that may affect how this data is processed such as instrument failures or other known problems with acquisition.

The data collected during this cruise is distributed on a CD-ROM written in ISO9660 level-1 format. This data format has very strict requirements on filenames and organization. However, it is readable by virtually every computing platform.

All of the data has been archived with the Unix “tar” command and/or compressed using Unix “gzip” compression. Tar files have a “.tar” extension and Gzipped files have a “.gz” extension. Tools are available on all platforms for uncompressing and de-archiving these formats. On Macintosh, Stuffit Expander with DropStuff will open a tar archive and uncompress gzipped and Unix compressed files. For Windows, WinZip, a shareware utility included on this CD (remember, it is shareware) will open these files.

In some cases to adhere to the ISO9660 format the .tar extension was removed. When we tarred the files then gzip the tar archive the name of the file became *File*.tgz. This name does not follow the 8.3 naming convention of the ISO9660 format. On Windows and Mac Platforms Winzip and Stuffit Expander handles this just fine. When they expand the *File*.gz the expanded file becomes *File*.tar, which both software packages can handle. On Unix platforms gunzip expands *File*.tgz but it does not append the .tar extension. So you may not recognize the file as a tar archive, but OS does recognize it as a tar archive. If you use the file command it will return saying it is a tar file. The below tar command will un-archive the file just fine.

IMPORTANT: Read the last section in this document, Acquisition Problems and Events, for important information that may affect the processing of this data.

Archive Data Extraction

It is often useful to know exactly how an archive was produced when expanding its contents. Tar files were created using the following commands:

```
tar cvf archive-file files-to-be-archived
```

To create a list of the files in the archive:

```
tar tvf  archive-file  > contents.list
```

To extract the files from the archive:

```
tar xvf  archive-file file(s)-to-extract
```

G-zipped files will have a ".gz" extension on the filename. These files can be decompressed after de-archiving, using:

```
gunzip filename.gz
```

CD Directory Structure

ADCP: ADCP.tar Cal: InstCoef.txt CTD: Ctd.tar Imagery: Imag.tar Maps: Process: JGOF.tar PCO2.tar PROC.tar QC.tar Report: Report.doc RVDAS: nav/ uw/ Salinity: Logsheet.pdf Salts.xls Science: Utility: Acrobat Winzip XBT: Xbt.tar XCTD: Xctd.tar		

Distribution Contents

ADCP

/Adcp/

This directory contains a tar file of gentoo's proc directory, which contains a database of the averaged ping data, Matlab m-files used in processing the data, and daily graphs of the currents. For more information contact Teri Chereskin at tchereskin@ucsd.edu .

Calibration

/Cal/

Refer to the InstCoef.txt file along with the specific instrument calibration sheets, both located in this directory, for information on how the RVDAS data was collected and processed.

Imagery

/Imagery/

This directory contains things such as ice imagery, isobar charts, sat imagery, wave and wind images, and weather reports.

Data and Science Report

/Report/

Copies of this report in MS Word, HTML, and text formats.

XBT

/XBT/

Contains a zip archive of XBT data generated for the Drake Transect by NOAA standard "AMVERSEAS" software. Non-Drake transect data may also be included, which will a combination of binary and ascii files generated by standard Sippican MK-21 software.

XCTD

/XCTD/

Contains binary and ascii data files as generated by standard Sippican MK-21 software.

Logsheets

/logsheet/

This directory contains logsheets for XBT, XCTD, air samples and TCO2 data. For further information on this data (TCO2), contact Tim Newberger at ***tnewberg@ldeo.columbia.edu*****.**

Salts

/Salinity/

This directory contains the log sheet for the Salt sample take during the Drake Transect Sampling, also a spreadsheet containing the Salt sample and TSG comparison. These samples were analyzed with the onboard AutoSal by the MST.

Science

/Science/

This directory, if populated, contains data specified by the on-board science party.

Maps

/Maps/

This directory maps and mapping data generated by the ship's MCIS and automated scripts, usually in JPEG or PostScript format, plus any maps provided for this purpose by the on-board science party.

QC Plots

/QC_PLOTS/

Postscript files of data stored each day on RVDAS for quality control analysis during the cruise. There are 3 types of files, named metXXX.ps, navXXX.ps, and oceanXXX.ps, where XXX is represents the Julian day. Met files are a summary of the data from the meteorological instruments, Nav files are a summary of navigational data, and Ocean files are a summary of the underway seawater and bathymetry data.

JGOFS Data Set

/JGOF/

The JGOFS data set consists of a single file produced each day named jg<julian_day>.dat.gz where <julian_day> is the day the data was acquired. The ".gz" extension indicates that the individual files are compressed before archiving. The daily file consists of 22 separate columnar fields in text format, which are described below. The JGOFS data set is obtained primarily by applying calibrations to raw data and decimating to whole minute intervals. However, several fields are derived measurements from more than a single raw input. *Note: Null, unused, or unknown fields are filled with 9's in the JGOFS data.*

Additionally, 3 separate QC plots are generated daily by the ET using the JGOFS data set. These plots include TSG and Bathymetry data, meteorological data, and navigation data. The files are called ocean<julian_day>.ps, met<julian_day>.ps, and nav<julian_day>.ps respectively.

Field	Data	Units
01	GMT date	dd/mm/yy
02	GMT time	hh:mm:ss
03	PCOD latitude (negative is South)	Ddd.dddd
04	PCOD longitude (negative is West)	Ddd.dddd
05	Ships speed	Knots
06	GPS HDOP	-
07	Gyro Heading	Degrees (azimuth)
08	Course over ground	Degrees (azimuth)
09	Mast PAR	μEinsteins/meters^2 sec
10	Sea surface temperature	°C
11	Not used	-
12	Sea surface salinity	PSU
13	Sea depth (uncorrected, calc. sw sound vel. 1500 m/s)	meters
14	True wind speed (port windbird)	meters/sec
15	True wind direction (port windbird)	degrees (azimuth)
16	Ambient air temperature	°C
17	Relative humidity	%
18	Barometric pressure	mBars
19	Sea surface fluorometry	volts (0-5 FSO)
20	Not used	-
21	PSP	W/m^2
22	PIR	W/m^2

TSG Data files

/TSG/tsgfl

RVDAS processes the ltsg.d### file, using the Seabird calibration. It produces a daily tsgfl.d### file with the below fields.

```
04+321:00:01:23.978 -00.070 -00.089 02.8042 33.75690 0.471306 4.341880
```

Field	Data	Units
1	RVDAS Time Tag	
2	Internal water temperature	°C
3	External water temperature	°C
4	Conductivity	S/cm
5	Salinity	PSU

Field	Data	Units
6	Transmissometer signal	Volts

RVDAS

/RVDAS/

RVDAS (Research Vessel Data Acquisition System) was developed at Lamont-Doherty Earth Observatory of Columbia University and has been used on the R/V Maurice Ewing for several years. It was adapted for use on the Nathaniel B. Palmer and her sister ship, the R/V Laurence M. Gould.

Below you will find detailed information on the data included. Be sure to read the "Significant Acquisition Events" section below for important information about data acquisition during this cruise.

Meteorological and Light Data

Measurement	File ID	Collect. Status	Rate	Instrument
Air Temperature	lmwx	continuous	1 sec	R. M. young 41372VC
Relative Humidity	lmwx	continuous	1 sec	R. M. young 41372VC
Wind Speed/Direction	lmwx	continuous	1 sec	Gill Ultrasonic
PAR, (Photosynthetically-Available Radiation)	lmwx	continuous	1 sec	BSI QSR-240
Barometer	lmwx	continuous	1 sec	R. M. young 61201
GUV	lguv	continuous	1 sec	GUV2511
PIR (LW radiation)	lmwx	continuous	1 sec	Eppley PIR
PSP (SW radiation)	lmwx	continuous	1 sec	Eppley PSP
Port Ultrasonic Wind Speed/Direction	lmwx	continuous	1 sec	Gill Wind Observer II

Navigational Data

Measurement	File ID	Collect. Status	Rate	Instrument
Trimble GPS	tgps	civilian mode	1 sec	Trimble 20636-00SM
Gyro	lgyr	continuous	0.2 sec	Anschutz Gyro
Garmin GPS	lgar	continuous	1 sec	Garmin 17
Seapath GPS	Lsep	Continuous	1 sec	Seapath 330

Geophysical Data

Measurement	File ID	Collect. Status	Rate	Instrument
Bathymetry	lknu	variable	Varies	Knudsen 320B/R
DUSH 11 Winch	lwn1	variable	varies	Markey DUSH 11
DUSH 5 Winch	lwn1	variable	varies	Markey DUSH 5
DUSH 4 Winch	lwn1	variable	varies	Markey DUSH 4

Oceanographic Data

Measurement	File ID	Collect. Status	Rate	Instrument
Salinity	utsg	continuous	1 sec	SeaBird 45
Sea Surface Temperature	Lrtm	continuous	1 sec	SeaBird 38
Fluorometry (digital)	lflr	continuous	1 sec	Turner 10-AU-005
Fluorometry (digital)	ldflr	continuous	1 sec	Wetlab ECO
ADCP, Speed Log	ladc	continuous	1 sec	RD Instruments
Oxygen	loxy	continuous	1 sec	
PCO2	lpco2	continuous	2.5 min	

Data File Names and Structures

RVDAS data is divided into two broad categories, ***Underway*** and ***Navigation***. The groups are abbreviated “uw” and “nav”. Thus, these two tar files, lmguw.tar and lmgnav.tar exist under the top-level rvdas directory. The instruments are broken down as shown. Each data file is g-zipped to save space on the distribution. Not all data types are collected everyday or on every cruise.

RVDAS data files are named following the convention: LMG[FileID].dDDD.

- The FileID is a 4-character code representing the system being logged, for example: lmet (for meteorology)
- DDD is the Julian day of the data collection

Underway Data	File ID
Meteorological - Cambell	lmwx
Knudsen	lknu
microTSG	utsg
Digital Remote Temperature	lrtm
Fluorometer – Wetlab ECO	ldfl
ADCP	ladc
Sound Velocity Probe	lsvp
GUV & PUV	lguv
PCO2 System	lpco
Oxygen	loxy
Wet Wall Flows	lsea
Winches: Dush4,5,&11	lwn1
Net Depth Sensor	lnds

Navigation Data	File ID
Gyro Compass	lgyr
P-CODE GPS	tgps
Garmin 17 GPS	lgar
Seapath 330 GPS	lsep

Data is received by the RVDAS system via RS-232 serial connections. The data files that comprise the rvdas data set are described below. A time tag is added to each line of data received and the data is written to disk.

```
YY+DDD:HH:MM:SS.SSS [data stream from instrument]
```

Where, YY: two-digit year, DDD: Julian Day, HH: 2 digit hours, MM: 2 digit minutes SS.SSS: seconds. All times are UTC.

The delimiters used to separate fields in the raw data files are usually spaces and commas, but other delimiters are used (::, =, @) and occasionally there is no delimiter. Care should be taken when reprocessing the data that the fields separations are clearly understood. An example data

lknu – Knudsen Sonar

```
08+024:07:36:36.245 HF,00.00, 000,0,LF,448.9,-026,1
```

Field	Data	Units
1	RVDAS Time Tag	
2	HF – high frequency header (12 kHz)	
3	HF - depth to surface	meters
4	HF - Echo Strength	
5	HF – Depth Valid Flag	
6	LF – low frequency header (3.5 kHz)	
7	LF - depth to surface	meters
8	LF - Echo Strength	
9	LF – Depth Valid Flag	

lnds – Net Depth Sensor

```
99+099:00:18:19.775 V01 00199.8
```

Field	Data	Units
1	RVDAS Time Tag	
2	V01 – Sensor 1	label
3	Depth	meters

lwn1 - Winches

```
08+033:11:27:50.673 RD,DUSH-5,00111.63,00000000,-0000012,1938
```

Field	Data	Units
1	RVDAS Time Tag	
2	Record Identifier, RD=Remote Data	
3	Winch Indentifier, DUSH-X where X is 4, 5, or 11	
4	Tension	lbs
5	Speed	Meters/minute
6	Payout	meters
7	Checksum	

lmwx - Campbell Meteorological DAS

```
08+034:13:52:14.216 PUS,A,356,002.15,M,+332.28,+000.97,60,08
```

Field	Data	Units
1	RVDAS Time Tag	
2	PUS tag – Port UltraSonic Anemometer	
3	Unit Identification, A-Z	
4	Port Wind Direction, degrees relative to Bow	deg
5	Port Wind Speed	m/s
6	Units, M=meters per second	
7	Sound Speed	m/s
8	Sonic Temperature	°C
9	Status, 0=ok, 60=Heating Enabled & ok, Other value mean a fault	
10	Check Sum	

```
08+034:13:52:14.216 SUS,A,356,002.15,M,+332.28,+000.97,60,08
```

Field	Data	Units
1	RVDAS Time Tag	
2	SUS tag – Starboard UltraSonic Anemometer	
3	Unit Identification, A-Z	
4	Port Wind Direction, degrees relative to Bow	deg
5	Port Wind Speed	m/s
6	Units, M=meters per second	
7	Sound Speed	m/s
8	Sonic Temperature	°C
9	Status, 0=ok, 60=Heating Enabled & ok, Other value mean a fault	
10	Check Sum	

```
08+034:13:52:14.454 MET,12.22322,44.25706,-75,-25,-363.6365,2.332982,-0.08215196,278.6845,
279.2192,854.6198
```

Field	Data	Units
1	RVDAS Time Tag	
2	MET tag	
3	Power Supply Voltage	Volts
4	Enclosure Relative Humidity	%
5	Air Temp	°C
6	Air Relative Humidity	%
7	PAR	mVolts
8	PSP Thermopile	mVolts
9	PIR Thermopile	mVolts
10	PIR Case Temperature	°K
11	PIR Dome Temperature	°K
12	Barometer	mBars

utsg – microTSG, Thermosalinograph

For further information on this data, check www.seabird.com for SBE 45 MicroTSG Thermosalinograph

```
08+037:13:45:57.596   2.6470,  3.03853,  33.8129, 1459.351
```

Field	Data	Units
1	RVDAS Time Tag	
2	Internal water temperature	°C
3	Conductivity	S/m
4	Salinity	psu
5	Sound Velocity	m/s

lrtm – digital Remote Temperature

For further information on this data, check on www.seabird.com on SBE38 Digital Thermometer

08+037:13:47:17.841 2.2527

Field	Data	Units
1	RVDAS Time Tag	
2	External water temperature	°C

ldflr – Fluorometer, Wetlab ECO

```
08+037:13:55:08.434 99/99/99    99:99:99        0.00     2585     73       543
```

Field	Data	Units
1	RVDAS Time Tag	
2	Fluorometer Date	mm/dd/yy
3	Fluorometer Time	hh:mm:ss
4	Chlorophyll Signal	μg/l
5	Reference	λq
6	Counts – Chlorophyll Signal	Count
7	Thermistor	

Ioxy - Oxygen

For further information on this data, contact Tim Newberger at ***tnewberg@ldeo.columbia.edu***

```
04+117:23:57:23.504 MEASUREMENT        3830     380  Oxygen:           309.95      Saturation:
83.48   Temperature:        -1.35      DPhase:             33.41      BPhase:            32.22
        RPhase:              0.00      BAmp:      262.09      BPot:      163.00      RAmp:
0.00    RawTem.:           694.92
```

Field	Data	Units
1	RVDAS Time Tag	
2-4	Measurement ID, Model Number, Serial Number	alphanumeric
5	Oxygen heading	text
6	Oxygen Reading	Raw numeric
7	Saturation heading	text
8	Saturation Reading	Raw numeric
9	Temperature heading	text
10	Water Temperature	ºC
11	Dphase heading	text
12	Dphase	Raw numeric
13	Bphase heading	text
14	BPhase	Raw numeric
15	Rphase heading	text
16	Rphase	Raw numeric
17	Bamp heading	text
18	Bamp	Raw numeric
19	Bpot heading	text
20	Bpot	Raw numeric
21	Ramp heading	text
22	Ramp	Raw numeric
23	RawTem heading	text
24	RawTemp	Raw numeric

Ipco – PCO2 system

For further information on this data, contact Tim Newberger at ***tnewberg@ldeo.columbia.edu***

```
02+319:23:59:13.748 2002319.99851    7154.27     26.49    1033.6     325.79      6.74     329.3
53.76     0   Equil
```

Field	Data	Units
1	RVDAS Time Tag	
2	Julian date file string	Julian
3	IR voltage reading	mV
4	Cell temperature	°C
5	Barometer	millibars
6	VCO2	mL
7	Equilibrator temperature	°C
8	PCO2	millibars
9	Gas flow	mL/min
10	Solenoid position ID	number
11	Valve Position ID	number
12	Measured gas	name

Lguv – Biospherical GUV

08+037:14:17:59.211 020608 141758 -.000099 1.307E0 7.24E0 1.316E1 2.609E1 3.285E1 3.505E1 8.075E-2 38.993 17.985

GUV only

Field	Data	Units
1	RVDAS Time Tag	
2	GUV Computer Date	mmddyy
3	GUV Computer Time	hhmmss
4	Ed0Gnd - GUV	Volts
5	Ed0305 - GUV	µW/cm^{2}nm
6	Ed0313 - GUV	µW/cm^{2}nm
7	Ed0320 - GUV	µW/cm^{2}nm
8	Ed0340 - GUV	µW/cm^{2}nm
9	Ed0380 - GUV	µW/cm^{2}nm
10	Ed0395 - GUV	µW/cm^{2}nm
11	Ed0PAR - GUV	µE/cm^{2}sec
12	Ed0Temp - GUV	°C
13	Ed0VIn	Volts

GUV and PUV

Field	Data	Units
1	RVDAS Time Tag	
2	GUV Computer Date	mmddyy
3	GUV Computer Time	hhmmss
4	EdZGnd -PUV	Volts
5	EdZ305 -PUV	µW/cm^{2}nm
6	EdZ313 -PUV	µW/cm^{2}nm
7	EdZ320 -PUV	µW/cm^{2}nm
8	EdZ395 -PUV	µW/cm^{2}nm
9	EdZ340 -PUV	µW/cm^{2}nm
10	EdZPAR -PUV	µE/cm^{2}sec
11	LuZChl -PUV	µE/srm^{2}sec
12	EdZ380 -PUV	µW/cm^{2}nm
13	WTemp -PUV	°C
14	Depth -PUV	m
15	EdZTemp -PUV	°C
16	LuZTemp -PUV	°C
17	Tilt -PUV	Degrees
18	Roll -PUV	Degrees
19	Ed0Gnd - GUV	Volts
20	Ed0305 - GUV	µW/cm^{2}nm
21	Ed0313 - GUV	µW/cm^{2}nm
22	Ed0320 - GUV	µW/cm^{2}nm
23	Ed0340 - GUV	µW/cm^{2}nm
24	Ed0380 - GUV	µW/cm^{2}nm
25	Ed0395 - GUV	µW/cm^{2}nm
26	Ed0PAR - GUV	µE/cm^{2}sec
27	Ed0Temp - GUV	°C
28	Ed0VIn	Volts

lsvp - Sound Velocity Probe in ADCP Transducer Well

```
00+348:01:59:52.128  1539.40
```

Field	Data	Units
1	RVDAS Time Tag	
2	Sound velocity	m/s

ladc – ADCP Speed Log

```
00+019:23:59:59.099 $PUHAW,UVH,-1.48,-0.51,250.6
```

Field	Data	Units
1	RVDAS Time Tag	
2	$PUHAW	
3	UVH (E-W, N-S, Heading)	
4	Ship Speed relative to reference layer[1] velocity[2], East vector	knots
5	Ship Speed relative to reference layer[1] velocity[2], North vector	knots
6	Ship heading	degrees

[1]The reference layer is an average velocity measured in a number of depth “bins”. On the LMG, the bins are eight meters deep and bins 3-10 define the reference layer. Hence, the reference layer is the water column from 16-80 meters beneath the ship.

[2]The speed ouput is water velocity relative to the ship’s hull and is therefore opposite of the actual movement of the ship. For example, if the ship’s heading is due north, the North/South reference layer velocity is likely to be negative (southerly).

lgyr - Gyro

```
02+315:23:59:58.194 $PASVW,00.1,A*1D
02+315:23:59:58.414 $IIVHW,287.7,T,,M,,N,,K*71
02+315:23:59:58.616 $HEHDT,287.7,T*25
02+315:23:59:58.821 $HEROT,001.6,A*2C
02+315:23:59:58.984 $HCHDT,,T*07
```

HDT: True Heading

```
01+083:00:00:02.893 $HEHDT,246.3,T*2C
```

Field	Data	Units
1	RVDAS Time Tag $HEHDT	
2	Heading XXXXX = ddd.d	degrees
3	T flag for true heading, checksum	

ROT: Rate of Turn

```
01+083:00:00:03.093 $HEROT,-006.3,A*03
```

Field	Data	Units
1	RVDAS Time Tag $HEROT	
2	Rate of turn	degrees/min
3	Status: A = data valid, checksum	

Isep – Seapath 330 GPS

INZDA: Time and Date Data

10+351:23:59:58.142 $INZDA,235958.08,17,12,2010,,*78

Field	Data	Units
1	RVDAS Time Tag	
2	$INZDA Tag	
3	time	hhmmss.ss
3	day	dd
4	month	mm
5	year	yyyy
6	(blank)	
7	Check sum	hexadecimal

INGGA: Global Positioning Fix Data

10+351:23:59:58.142 $INGGA,235958.07,6118.168460,S,06008.089527,W,1,12,0.7,22.57,M,17.79,M,,*46

Field	Data	Units
1	RVDAS Time Tag	
2	$INGGA Tag	
3	Time (UTC)	hhmmss.ss
3	Latitude in degrees with decimal minutes	ddmm.mmm
4	{NIS} (latitude is north or south)	
5	Longitude in degrees with decimal minutes	ddmm.mmm
6	{EIW} (longitude is east of west)	
7	GPS quality indicator: 0 = invalid position, 1 = GPS SPS used, 2 = DGPS used, 3 = GPS PPS used, 4 = GPS RTK used, 5 = GPS float RTK used, 6 = dead reckoning	
8	Number of Satellites in use (00-99)	
9	HDOP	
10	Height above ellipsoid in meters	m.mm
11	M	
12	Age of DGPS corrections in seconds	ss.ss
13	M	
14	(blank)	
15	*Check sum	hexadecimal

INRMC: Recommended Minimum Specific GNSS Data

10+351:23:59:58.200 $INRMC,235958.07,A,6118.168460,S,06008.089527,W,12.8,331.22,171210,11.3,E,A*1C

Field	Data	Units
1	RVDAS Time Tag	
2	$INRMC Tag	
3	UTC of position	hhmmss.ss
4	Status A = Data Valid, V = Navigation Receiver Warning	
5	Latitude in degrees with decimal minutes	ddmm.mmm
6	North (N) or South (S)	
7	Longitude in degrees with decimal minutes	ddmm.mmm
8	East (E) or West (W)	
9	Speed Over Ground, knots	knots
10	Course Over Ground, degrees True	degrees
11	Date	ddmmyy
12	Magnetic Variation, degrees E/W	degrees

Field	Data	Units
13	Mode Indicator E= Estimated Mode	
14	*Check sum	

PSXN,20: Data Quality

10+351:23:59:58.200 $PSXN,20,1,2,0,0*38

Field	Data	Units
1	RVDAS Time Tag	
2	$PSXN Tag	
3	20 (PSXN identifier)	
3	Horizontal position and velocity quality: 0 = normal, 1 = reduced performance, 2 = invalid data	
4	Height and vertical velocity quality: 0 = normal, 1 = reduced performance, 2 = invalid data	
5	Heading quality: 0 = normal, 1 = reduced performance, 2 = invalid data	
6	Roll and pitch quality: 0 = normal, 1 = reduced performance, 2 = invalid data	
7	*Check sum	hexadecimal

PSXN,23: Roll, Pitch, Heading and Heave

10+351:23:59:58.213 $PSXN,23,0.02,-0.76,330.56,*0B

Field	Data	Units
1	RVDAS Time Tag	
2	$PSXN Tag	
3	23 (PSXN identifier)	
3	Roll in degrees. Positive with port side up.	d.dd
4	Pitch in degrees. Positive with bow up.	d.dd
5	Heading in degrees true	d.dd
6	Heave in meters. Positive is down	m.mm
7	*Check sum	hexadecimal

lgar - Garmin GPS

GGA: Global Positioning Fix Data

08+034:12:26:06.131 $GPGGA,122607,6446.4733,S,06403.4455,W,1,11,0.9,-193.4,M,9.7,M,,*5A

Field	Data	Units
1	RVDAS Time Tag	
2	$GPGGA Tag	
3	UTC of position	hhmmss.ss
4	Latitude in degrees with decimal minutes	ddmm.mmm
5	North (N) or South (S)	
6	Longitude in degrees with decimal minutes	ddmm.mmm
7	East (E) or West (W)	
8	GPS quality (1=GPS 2=DGPS)	
9	Number of GPS satellites used	
10	Horizontal dilution of precision (HDOP)	
11	Antenna height above/below mean-sea-level (geoid)	meters
12	Units for antenna height (M = Meters)	
13	Geoidal Separation[1]	
14	Units for Geoidal Separation (M = Meters)	meters
15	Age of differential GPS data, number of seconds since last SC104 Type 1 or 9	
16	Differential reference station ID	

[1]Geoidal Separation: the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid). A negative value represents mean-sea-level below ellipsoid.

GLL: Geographic Position – Latitiude/Logitude

```
08+034:12:26:06.211 $GPGLL,6446.4733,S,06403.4455,W,122607,A
```

Field	Data	Units
1	RVDAS Time Tag	
2	$GPGLL Tag	
3	Latitude	ddmm.mmm
4	North (N) or South (S)	
5	Logitude	ddmm.mmm
6	East (E) or West (W)	
7	UTC of position	hhmmss.ss
8	Status: A = Data Valid, V =Data Not Valid	

VTG: Track Made Good and Speed over Ground

```
08+034:12:26:06.211 $GPVTG,167,T,151,M,000.0,N,0000.0,K
```

Field	Data	Units
1	RVDAS Time Tag	
2	$GPVTG Tag	
3	Track, degrees true	degrees
3	T flag for True	
4	Track, degrees magnetic	degrees
5	M flag for Magnetic	
6	Speed over Ground	knots
7	N flag for Knots	
8	Speed over Ground	kmhr
9	K flag for km/hr	

tgps – Trimble Centurion GPS

GGA: Global Positioning Fix Data

08+034:12:26:06.131 $GPGGA,122607,6446.4733,S,06403.4455,W,1,11,0.9,-193.4,M,9.7,M,,*5A

Field	Data	Units
1	RVDAS Time Tag	
2	$GPGGA Tag	
3	UTC of position	hhmmss.ss
4	Latitude in degrees with decimal minutes	ddmm.mmm
5	North (N) or South (S)	
6	Longitude in degrees with decimal minutes	ddmm.mmm
7	East (E) or West (W)	
8	GPS quality (1=GPS 2=DGPS)	
9	Number of GPS satellites used	
10	Horizontal dilution of precision (HDOP)	
11	Antenna height above/below mean-sea-level (geoid)	meters
12	Units for antenna height (M = Meters)	
13	Geoidal Separation[1]	
14	Units for Geoidal Separation (M = Meters)	meters
15	Age of differential GPS data, number of seconds since last SC104 Type 1 or 9	
16	Differential reference station ID	

[1]Geoidal Separation: the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid). A negative value represents mean-sea-level below ellipsoid.

GLL: Geographic Position – Latitiude/Logitude

`08+034:12:26:06.211 $GPGLL,6446.4733,S,06403.4455,W,122607,A`

Field	Data	Units
1	RVDAS Time Tag	
2	$GPGLL Tag	
3	Latitude	ddmm.mmm
4	North (N) or South (S)	
5	Logitude	ddmm.mmm
6	East (E) or West (W)	
7	UTC of position	hhmmss.ss
8	Status: A = Data Valid, V =Data Not Valid	

VTG: Track Made Good and Speed over Ground

`08+034:12:26:06.211 $GPVTG,167,T,151,M,000.0,N,0000.0,K`

Field	Data	Units
1	RVDAS Time Tag	
2	$GPVTG Tag	
3	Track, degrees true	degrees
3	T flag for True	
4	Track, degrees magnetic	degrees
5	M flag for Magnetic	
6	Speed over Ground	knots
7	N flag for Knots	
8	Speed over Ground	kmhr
9	K flag for km/hr	

RMC: Recommended Minimum Specific GNSS Data

08+034:13:17:26.627 $GPRMC,131726.605,A,6446.4820,S,06403.3075,W,000.0,094.4,030208,16.3,E

Field	Data	Units
1	RVDAS Time Tag	
2	$GPRMC Tag	
3	UTC of position	hhmmss.ss
4	Status A = Data Valid, V = Navigation Receiver Warning	
5	Latitude in degrees with decimal minutes	ddmm.mmm
6	North (N) or South (S)	
7	Longitude in degrees with decimal minutes	ddmm.mmm
8	East (E) or West (W)	
9	Speed Over Ground, knots	knots
10	Course Over Ground, degrees True	degrees
11	Date	ddmmyy
12	Magnetic Variation, degrees E/W	degrees
13	Mode Indicator E= Estimated Mode	

LMG Sensors

Shipboard Sensors

Sensor	Description	Serial #	Cal. Date	Status
Port Anemometer	Gill Ultrasonic Wind Observer II	840019	N/A	Collected
Starboard Anemometer	Gill Ultrasonic Wind Observer II	71738	N/A	Collected
Barometer	R.M. Young 61201	BP0873	28-Jul-2010	Collected
Humidity/Wet Temp	RM Young 41372LC	06720	11-Feb-2010	Collected
PAR for Mast	Biosph. Inst. QSR-240P	6393	31-Aug-2010	Collected
PIR	Eppley PIR	28903F3	13-Oct-2010	Collected
PSP	Eppley PSP	28933F3	9-Sept-2010	Collected
GUV (Mast)	Biosph. Inst. GUV-2511	25110805127	17-May-2010	Collected
Transmissometer	WET Labs C-Star 25 cm deep	CST-553DR	26-Aug-2010	Collected
MicroTSG	Sea-Bird 45	243	21-Jul-2010	Collected
Digital Remote Temp	Sea-Bird 38	324	26-Jan-2010	Collected
Fluorometer	WET Labs ECO-FL	FLRTD-399	15-Sep-09	Collected

CTD Sensors

Sensor	Description	Serial #	Cal. Date	Status
CTD Fish	Seabird SBE9Plus	0232	01-Apr-10	Collected
Primary Temperature	Seabird SBE3	2470	28-Apr-11	Collected
Secondary Temperature	Seabird SBE3	2205	28-Apr-10	Collected
Primary Conductivity	Seabird SBE4	2048	01-Apr-11	Collected
Secondary Conductivity	Seabird SBE4	2065	21-Apr-10	Collected
Primary Dissolved Oxygen	Seabird SBE43	0182	03-May-11	Collected
Secondary Dissolved Oxygen	Seabird SBE43	0201	06-Jul-11	Collected
Fluorometer	Wet Labs ECO	FLRTD-1735	14-Apr-11	Collected
PAR	Biosph. Inst. QSP-2300	4722	19-May-10	Collected
Transmissometer	Wet Labs C-Star	CST-406DR	22-Mar-11	Collected

MOCNESS Sensors

Sensor	Description	Serial #	Cal. Date	Status
Pressure	MOCNESS Depth Sensor	156	N/A	Collected
Temperature	Seabird SBE3	1619	20-Mar-09	Collected
Conductivity	Seabird SBE4	2293	04-Mar-11	Collected
Transmissometer	Wet Labs C-Star	CST-407DR	22-Mar-11	Collected

Underway Calibration Sheets

Note: Embedded pdf files can be opened with a right-click, Acrobat Document Object, Open

Remote Temperature

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0324
CALIBRATION DATE: 26-Jan-10

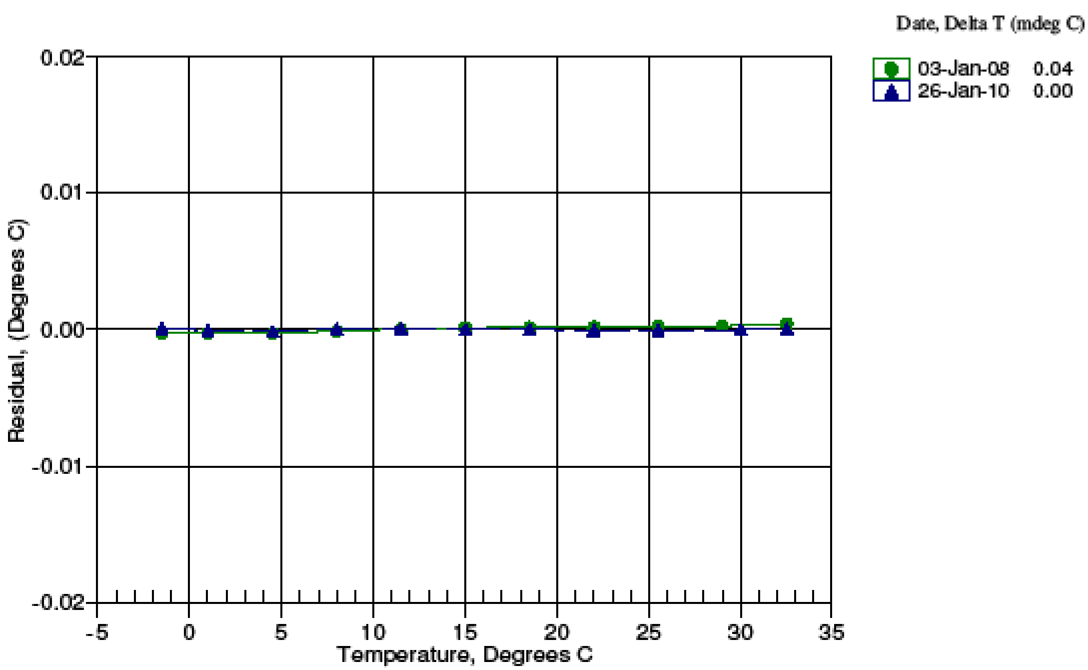
SBE 38 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
a0 = -2.126219e-005
a1 = 2.756564e-004
a2 = -2.490794e-006
a3 = 1.524467e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.50010	895419.1	-1.50002	0.00008
0.99990	798448.4	0.99984	-0.00006
4.50000	682058.1	4.49983	-0.00017
7.99990	584568.4	7.99997	0.00007
11.49990	502633.3	11.50003	0.00013
15.00000	433539.8	15.00002	0.00002
18.50000	375083.6	18.50001	0.00001
22.00000	325471.2	21.99994	-0.00006
25.50000	283232.8	25.49995	-0.00005
30.00000	237850.6	29.99998	-0.00002
32.50000	216277.2	32.50005	0.00005

Temperature ITS-90 = $1/\{a0 + a1[\ln(n)] + a2[\ln^2(n)] + a3[\ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



Thermosalinograph

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0243
CALIBRATION DATE: 21-Jul-10

SBE 45 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g = -1.008835e+000        CPcor = -9.5700e-008
h =  1.573683e-001        CTcor =  3.2500e-006
i = -3.239483e-004        WBOTC =  1.1173e-006
j =  5.119501e-005
```

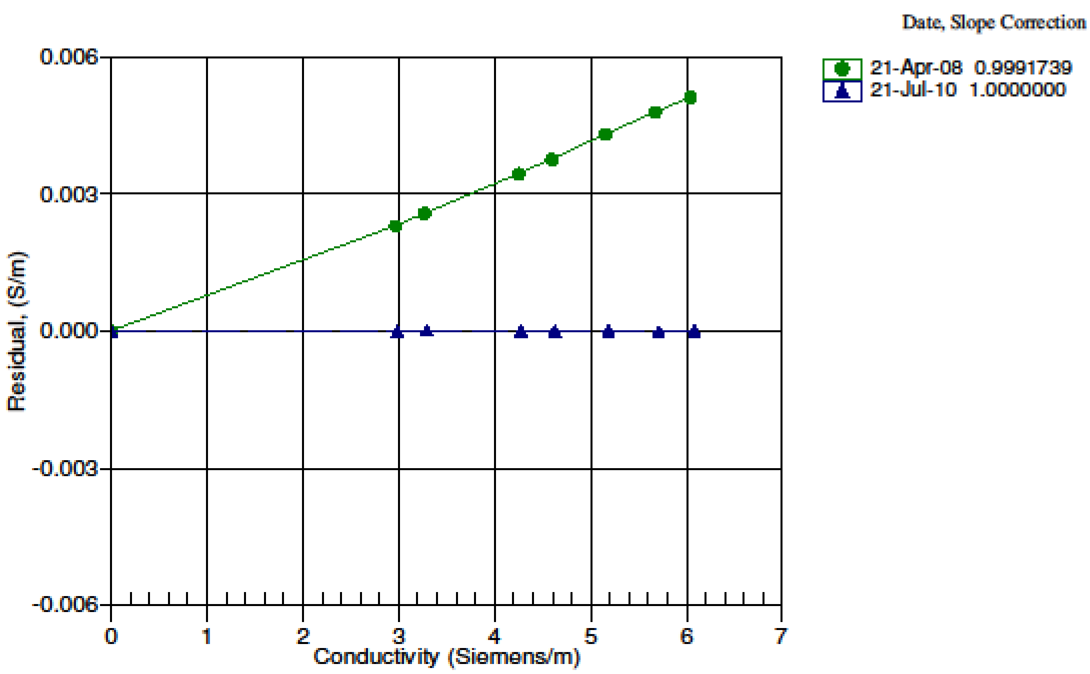
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2535.87	0.00000	0.00000
1.0000	34.9328	2.98497	5043.04	2.98496	-0.00001
4.4999	34.9132	3.29295	5233.27	3.29297	0.00001
15.0000	34.8700	4.27750	5798.83	4.27750	-0.00000
18.5000	34.8603	4.62357	5984.66	4.62357	-0.00000
23.9999	34.8493	5.18298	6273.11	5.18299	0.00001
29.0000	34.8428	5.70617	6531.01	5.70615	-0.00002
32.5000	34.8381	6.07936	6708.74	6.07937	0.00001

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

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

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

Residual = instrument conductivity - bath conductivity



Transmissometer

PO Box 518
620 Applegate St.
Philomath, OR 97370

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

WET Labs

C-Star Calibration

Date August 26, 2010 S/N# CST-553DR Pathlength 25 cm

	Analog meter
V_d	0.058 V
V_{air}	4.782 V
V_{ref}	4.687 V

Temperature of calibration water	24.9 °C
Ambient temperature during calibration	23.6 °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_d 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.

Revision L 6/9/09

Fluorometer

PO Box 518
620 Applegate St.
Philomath, OR 97370

WET Labs

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

ECO Chlorophyll Fluorometer Characterization Sheet

Date: 9/15/2009 S/N: FLRTD-399

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	0.097	0.054	0.033 V	68 counts
Scale Factor (SF)	6	12	24 µg/l/V	0.0074 µg/l/count
Maximum Output	4.96	4.96	4.96 V	16330 counts
Resolution	0.7	0.7	0.7 mV	1.0 counts

Ambient temperature during characterization 22.3 °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.

FLRTD-399_workbookj1.xls Revision J 3/17/08

PSP

EPLAB

THE EPPLEY LABORATORY, INC.

12 Sheffield Avenue, PO Box 419, Newport, Rhode Island USA 02840
Phone: 401 847.1020 Fax: 401 847.1031 Email: info@eppleylab.com

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 28933F3
Resistance: 686 Ω at 23°C
Temperature Compensation Range: -20° to + 40°C

This radiometer has been compared with Standard Precision Spectral Pyranometer, Serial Number 21231F3 in Eppley's Integrating Hemisphere under radiation intensities of approximately 700 watts meter^{-2} (roughly one half a solar constant).

As a result of a series of comparisons, it has been found to have a sensitivity of:

8.01×10^{-6} volts/watts meter^{-2}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 1400 watts meter^{-2}. This radiometer is linear to within ±0.5% up to this intensity.

The calibration of this instrument is traceable to standard self-calibrating cavity pyrheliometers in terms of the Systems Internationale des Unites (SI units), which participated in the Tenth International Pyrheliometric Comparisons (IPC X) at Davos, Switzerland in September-October 2005.

Eppley recommends a minimum calibration cycle of five (5) years but encourages annual calibrations for highest measurement accuracy. Unless otherwise stated in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEFT".

Useful conversion facts: 1 cal cm^{-2} min^{-1} = 697.3 watts meter^{-2}
1 BTU/ft^{2}-hr^{-1} = 3.153 watts meter^{-2}

Shipped to: Raytheon Polar Services
National Science Foundation
Port Hueneme, CA

Date of Test: September 9, 2010

In Charge of Test:

S.O. Number: 62700
Date: September 20, 2010

Reviewed by:

Remarks:

PIR

EPLAB

THE EPPLEY LABORATORY, INC.

12 Sheffield Avenue, PO Box 419, Newport, Rhode Island USA 02840
Phone: 401.847.1020 Fax: 401.847.1031 Email: info@eppleylab.com

STANDARDIZATION OF EPPLEY PRECISION INFRARED RADIOMETER Model PIR

Serial Number: 28903F3

Resistance: 674 Ω at 23°C
Temperature Compensation Range: -20° to + 40°C

This pyrgeometer has been compared against Eppley's Blackbody Calibration System under radiation intensities of approximately 200 watts meter^{-2} and an average ambient temperature of 23°C as measured by Standard Omega Temperature Probe, RTD#1.

As a result of a series of comparisons, it has been found to have a sensitivity of:

3.60×10^{-6} volts/watts meter^{-2}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 700 watts meter^{-2}. This radiometer is linear to within ±1.0% up to this intensity.

The calibration of this instrument is traceable to the International Practical Temperature Scale (IPTS) through a precision low-temperature blackbody.

Eppley recommends a minimum calibration cycle of five (5) years but encourages annual calibrations for highest measurement accuracy. Unless otherwise stated in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEFT".

Shipped to: Raytheon Polar Services
Port Hueneme, CA

S.O. Number: 62716
Date: October 13, 2010

Date of Test: October 13, 2010

In Charge of Test: Debra L. Genty

Reviewed by: Thomas D. Kirk

Remarks: Instrument has new dome and element repainted. No "AS FOUND" data available.

PAR

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

Calibration Date	8/31/2010
Model Number	QSR240
Serial Number	6393
Operator	TPC
Standard Lamp	GS-1024(8/26/08)
Probe Excitation Voltage Range:	6 to 10 VDC(+)
Output Polarity:	Positive

Probe Conditions at Calibration(in air):

Calibration Voltage:	6	VDC(+)
Probe Current:	1.3	mA

Probe Output Voltage:

Probe Illuminated	95.9	mV
Probe Dark	0.3	mV
Probe Net Response	95.6	mV
RG780	0.4	mV

Corrected Lamp Output:

Output In Air (same condition as calibration):

9.271E+15 quanta/cm²sec
0.01540 uE/cm²sec

Calibration Scale Factor:
(To calculate irradiance, divide the net voltage reading in Volts by this value.)

Dry: 1.0310E-17 V/(quanta/cm²sec)
6.2087E+00 V/(uE/cm²sec)

Notes:
1. Annual calibration is recommended.
2. Calibration is performed using a Standard of Spectral Irradiance traceable to the National Institute of Standards and Technology (NIST).
3. The collector should be cleaned frequently with alcohol.
4. Calibration was performed with customer cable, when available.

QSR240R 05/24/95

Temperature/Relative Humidity

Meteorological Instruments

YOUNG

COPY

Temperature Sensor Calibration Report

Customer: *Raytheon Technical Services Co*

Test Number: 44159 Customer PO: RM10889-50
Test Date: 15 April 2004 Sales Order: 7108

Test Sensor:
Model: 41372LC Serial Number: *6720*
Description: Temperature/Relative Humidity Sensor

Report of calibration comparison of test temperature sensor with National Institute of Standards and Technology traceable standard thermometers at three temperatures in the R.M. Young Company controlled temperature calibration bath facilities. Calibration accuracy ± 0.1° Celsius.

Bath Temperature (degrees C)	Current Output (milliamps)	Indicated (1) Temperature (degrees C)
-49.98	4.011	-49.93
0.03	12.006	0.04
49.97	19.994	49.96

(1) Calculated from current output

All reference equipment used in this calibration procedure have been tested by comparison to traceable standards certified by the National Institute of Standards and Technology.

Reference Instrument	Serial #	NIST Test Reference
Brooklyn Thermometer Model 43-FC	8006-118	204365
Brooklyn Thermometer Model 22332-D5-FC	25071	249763
Brooklyn Thermometer Model 2X400-D7-FC	77532	228060
Keithley Multimeter Model 191	15232	234027

Tested By: E. Chenney

R.M. YOUNG COMPANY 2801 Aero Park Drive, Traverse City, Michigan 49686 USA
Tel: 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com

Barometer

R.M. Young Company
2801 Aero Park Drive
Traverse City, Michigan 49686 USA

YOUNG

COPY

CALIBRATION REPORT

Barometric Pressure Sensor

Customer: *Raytheon Technical Services Company LLC*

Test Number: 07261 Customer ID: RR52837-01
Test Date: 28 July 2010 Sales Ord: 1325

Test Sensor:	
Model: 61201	Serial Numb: *BP50873*
Description: Barometric Pressure Sensor	

Report of calibration comparison of test barometric pressure sensor with National Institute of Standards and Technology traceable standard pressure calibrator at five pressures in the R.M. Young Company controlled pressure facility. Calibration accuracy ± 1.0 hPa.

Reference Pressure (hPa)	Voltage Output (millivolts)	Indicated (1) Pressure (hPa)
800.0	0	800.0
875.0	1251	075.1
950.0	2501	950.1
1025.0	3750	1025.0
1100.0	4997	1099.8

(1) Calculated from voltage output

All reference equipment used in this calibration procedure have been tested by comparison to traceable standards certified by the National Institute of Standards and Technology.

Reference Instrument	Serial	NIST Test Reference
Druck Pressure Controller Model DPI515	5150049	UKAS Lab 0221
Fluke Multimeter Model 8060A	486540	234027

Tested By: ____________

M E T E O R O L O G I C A L I N S T R U M E N T S
Tel 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com Web: youngusa.com

GUV

Biospherical Instruments Inc.

GUV-2511 Calibration Certificate

System Serial Number	25110805127	Date of Calibration	5/17/2010
Calibration database	25110805127v4.mdb	Date of Certificate	5/17/2010
DASSN	0111	Standard of Spectral Irradiance	GS1019(8/28/08)
Microprocessor Tag Number	2	Operator	TC

Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per µW/(cm²·nm)]	ScaleSmall [Volts per µW/(cm²·nm)]	ScaleMedium [Volts per µW/(cm²·nm)]	ScaleLarge [Volts per µW/(cm²·nm)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
Ed0306	2	305	3.9700E-11	4.0785E-06	1.1989E-03	3.6886E-01	-3.8200E-04	-5.8300E-04	-5.7100E-04	µW/(cm²nm)
Ed0313	6	313	1.7000E-10	1.7335E-05	5.0785E-03	1.7835E+00	2.2800E-04	2.4600E-04	1.5670E-03	µW/(cm²nm)
Ed0320	8	320	2.5444E-10	2.5908E-05	7.6076E-03	2.4927E+00	-1.1000E-04	-1.0900E-04	1.4100E-04	µW/(cm²nm)
Ed0340	10	340	1.9347E-10	1.9747E-05	5.7699E-03	2.0677E+00	1.9000E-04	2.0800E-04	1.6130E-03	µW/(cm²nm)
Ed0380	12	380	7.2296E-11	7.3794E-06	2.1611E-03	7.4261E-01	-1.6900E-04	-1.6500E-04	4.1000E-05	µW/(cm²nm)
Ed0395	13	395	3.0250E-10	3.0999E-05	9.0561E-03	3.0836E+00	-1.5600E-04	-1.5500E-04	-3.5100E-04	µW/(cm²nm)

Broadband Channels	Address	Wavelength [nm]	Responsivity [Amps per µE/(cm²·s)]	ScaleSmall [Volts per µE/(cm²·s)]	ScaleMedium [Volts per µE/(cm²·s)]	ScaleLarge [Volts per µE/(cm²·s)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
Ed0PAR	18	400-700	1.6747E-05	1.7075E+00	5.0004E+02	1.8492E+06	-8.3000E-05	-8.1000E-05	1.7470E-03	µE/(cm²sec)

Auxiliary Channels	Address	Wavelength	Responsivity	ScaleS	ScaleM	ScaleL	OffsetS	OffsetM	OffsetL	Measurement Units
Ed0Temp	22	C	1.0000E+00	1.0000E-02	1.0000E-02	1.0000E-02	0.0000E+00	0.0000E+00	0.0000E+00	°C
Ed0Vin	27	C	1.0000E+00	-2.5000E-01	-2.5000E-01	-2.5000E-01	0.0000E+00	0.0000E+00	0.0000E+00	V

[©] Biospherical Instruments Inc., 5340 Riley Street, San Diego, California 92110 USA. Contact support@biospherical.com for more information.

Calibration Data – Do Not Destroy page 2 of 2

CTD Sensors

CTD Fish

SEA-BIRD ELECTRONICS, IIC.

13431 NE 20th Street, Bellevue, Washington, 9805-2010 USA

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

SENSOR SERIAL NUMBER: 0377
CALIBRATION DATE: 22-Feb-11

SB19plus PRESSURE CALIBRATION DATA
10000 psia S/N 58949

DIGIQUARTZ COEFFICIENTS:

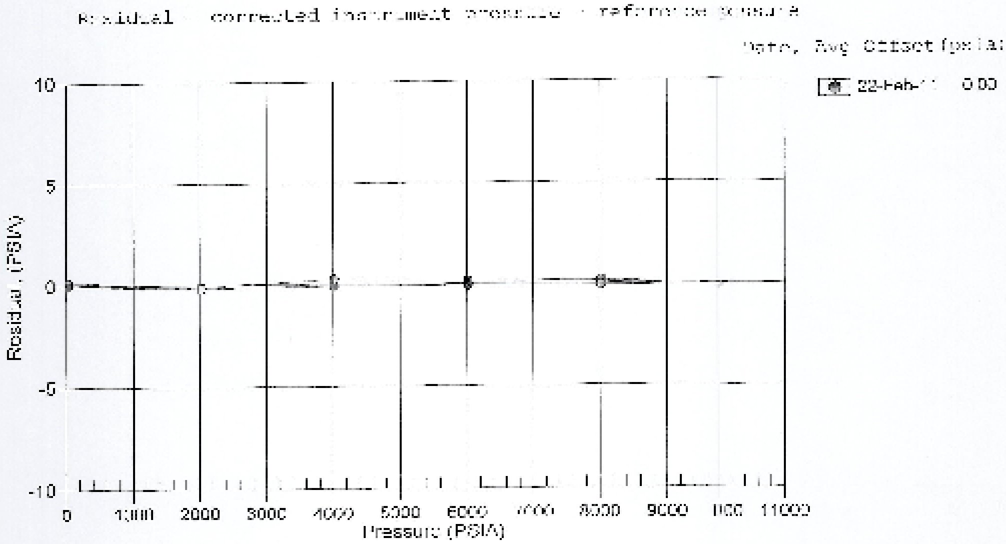
C1 = -4.840395e+004
C2 = -2.017057e-003
C3 = 1.464810e-002
D1 = 3.990600e-002
D2 = 0.000000e+000
T1 = 2.938385e+001
T2 = -2.260542e-004
T3 = 3.859120e-006
T4 = 2.152840e-009
T5 = 0.000000e+000

AD590M, AD590B, SLOPE AND OFFSET:

AD590M = 1.1000e-002
AD590B = -8.4834e+000
Slope = 0.9997
Offset = 0.403 (dbars)

PRESSURE (PSIA)	INST OUTPUT(Hz)	INST TEMP(C)	INST OUTPUT (PSIA)	CORRECTED INST OUTPUT (PSIA)	RESIDUAL (PSIA)
14.553	33360.24	21.7	14.035	14.691	0.139
2014.815	34041.30	21.8	2014.182	2014.687	0.127
4014.664	34706.31	21.8	4014.869	4014.922	0.258
6014.392	35357.88	21.8	6014.311	6014.513	0.121
8014.375	35994.79	21.8	8014.405	8014.509	0.134
10014.454	36618.76	21.9	10014.180	10014.379	-0.075
8014.210	35994.66	21.9	8014.077	8014.178	-0.033
6014.342	35357.61	21.9	6014.059	6014.257	0.082
4014.706	34706.52	21.9	4014.272	4014.625	0.021
2014.734	34041.27	21.8	2014.056	2014.562	-0.172
14.558	33360.20	21.9	13.866	14.527	-0.031

Residual = corrected instrument pressure - reference pressure



Primary Temperature

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2444
CALIBRATION DATE: 16-Apr-10

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.38205870e-003
h = 6.50408607e-004
i = 2.46631966e-005
j = 2.38544247e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.68121301e-003
b = 6.04287676e-004
c = 1.66762087e-005
d = 2.38705985e-006
f0 = 3064.748

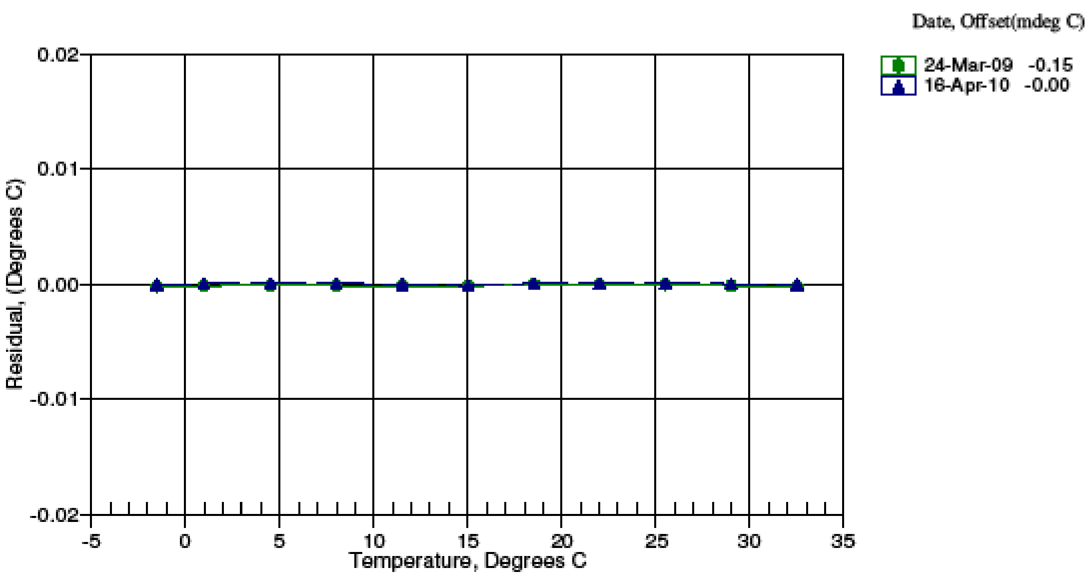
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	3064.748	-1.5001	-0.00005
1.0000	3240.142	1.0000	0.00003
4.4999	3497.728	4.5000	0.00007
7.9999	3769.727	7.9999	0.00005
11.4999	4056.514	11.4999	-0.00004
15.0000	4358.470	14.9998	-0.00018
18.5000	4675.974	18.5000	0.00004
22.0000	5009.334	22.0001	0.00006
25.5000	5358.899	25.5001	0.00006
29.0000	5724.984	29.0000	-0.00000
32.5000	6107.905	32.5000	-0.00004

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



Secondary Temperature

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 5034
CALIBRATION DATE: 17-Nov-10

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.33938443e-003
h = 6.35710344e-004
i = 2.11027299e-005
j = 1.88128700e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.68121073e-003
b = 5.97165876e-004
c = 1.50923903e-005
d = 1.88270208e-006
f0 = 2914.522

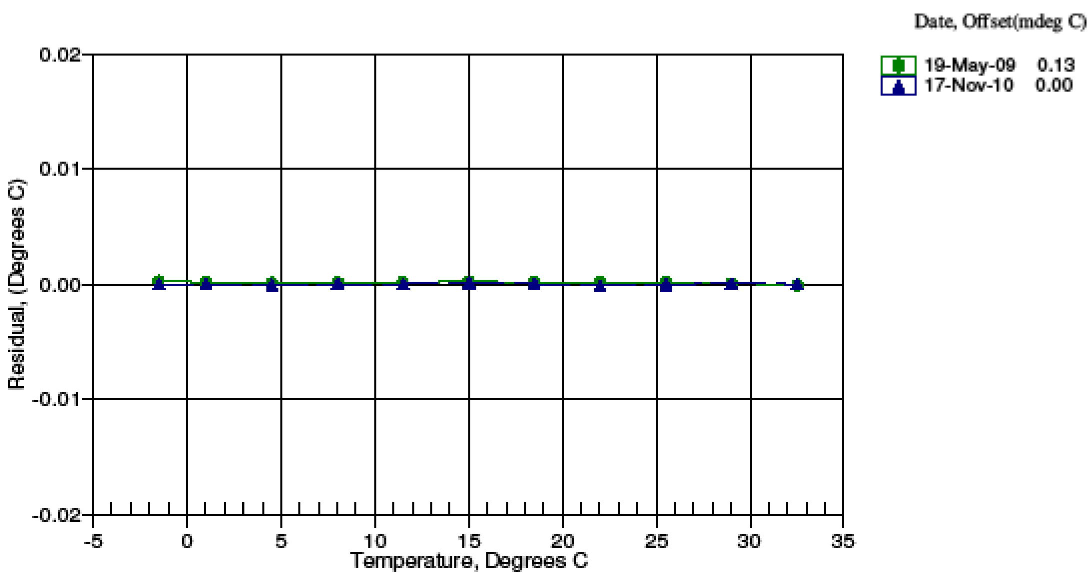
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.4999	2914.522	-1.4999	0.00002
1.0000	3083.332	1.0000	0.00001
4.5001	3331.402	4.5000	-0.00007
8.0000	3593.503	8.0000	0.00000
11.5001	3870.031	11.5001	0.00000
15.0000	4161.343	15.0001	0.00012
18.5001	4467.806	18.5001	0.00000
22.0002	4789.773	22.0001	-0.00011
25.5001	5127.586	25.5001	-0.00001
29.0001	5481.577	29.0002	0.00005
32.5001	5852.042	32.5001	-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



Primary Conductivity

SEA-BIRD ELECTRONICS, INC.
1808 - 136th Place Northeast, Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	Raytheon Polar Services Co.		
Job Number:	54609	**Date of Report:**	5/19/2009
Model Number:	SBE 04C	**Serial Number:**	043534

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 5/19/2009 **Drift since last cal:** 0.0000 **PSU/month***

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' ☐ Performed ☑ Not Performed

Date: **Drift since Last cal:** **PSU/month***

Comments:

**Measured at 3.0 S/m*

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

Secondary Conductivity

SBE SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	Raytheon Polar Services Co.		
Job Number:	62041	**Date of Report:**	11/19/2010
Model Number	SBE 04C	**Serial Number:**	043519

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ **Performed** ☐ **Not Performed**

Date: 11/19/2010 **Drift since last cal:** -0.00010 **PSU/month**

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' ☐ **Performed** ☑ **Not Performed**

Date: **Drift since Last cal:** **PSU/month**

Comments:

**Measured at 3.0 S/m*

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

Primary Dissolved Oxygen

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

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

SENSOR SERIAL NUMBER: 0196
CALIBRATION DATE: 29-Sep-10p

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS

Soc = 0.5173
Voffset = -0.5026
Tau20 = 0.95

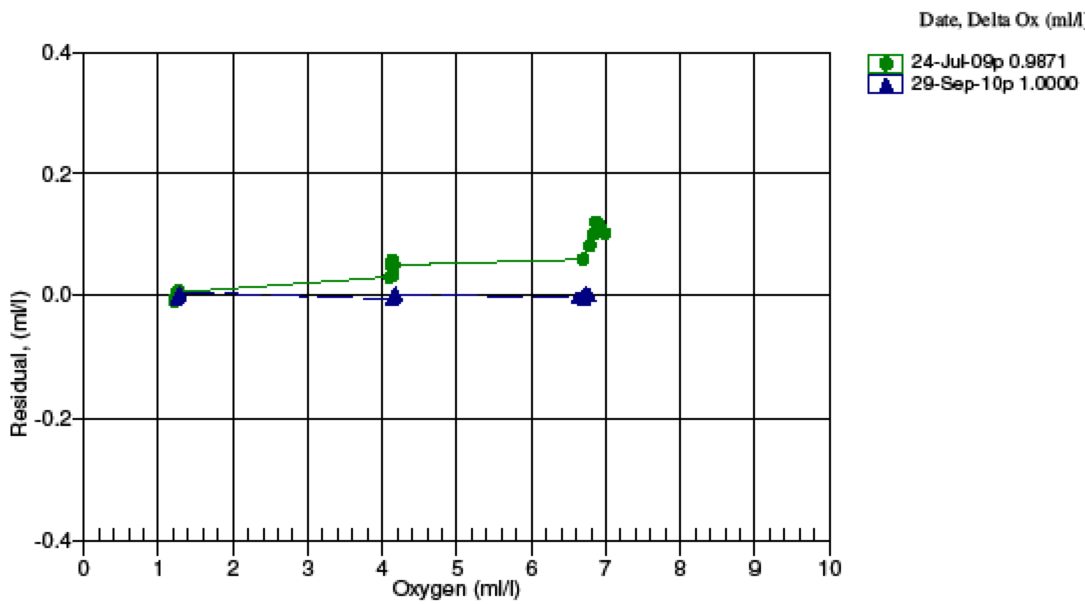
A = -6.3309e-003
B = 3.8467e-004
C = -4.7521e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS

D1 = 1.92634e-4 H1 = -3.30000e-2
D2 = -4.64803e-2 H2 = 5.00000e+3
H3 = 1.45000e+3

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.24	2.00	0.02	0.753	1.24	-0.00
1.25	6.00	0.02	0.785	1.24	-0.00
1.26	12.00	0.02	0.836	1.26	0.00
1.28	20.00	0.02	0.895	1.28	0.00
1.28	26.00	0.02	0.937	1.29	0.01
1.29	30.00	0.02	0.964	1.30	0.01
4.12	6.00	0.02	1.441	4.12	-0.00
4.14	2.00	0.02	1.339	4.14	-0.00
4.14	12.00	0.02	1.596	4.14	-0.00
4.17	20.00	0.02	1.783	4.17	-0.00
4.17	26.00	0.02	1.909	4.18	0.00
4.18	30.00	0.02	1.991	4.18	0.00
6.62	30.00	0.02	2.854	6.61	-0.00
6.68	12.00	0.02	2.266	6.68	-0.00
6.70	20.00	0.02	2.559	6.69	-0.00
6.70	26.00	0.02	2.755	6.69	-0.00
6.72	6.00	0.02	2.034	6.73	0.00
6.78	2.00	0.02	1.872	6.78	0.00

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T^2 + C * T^3) * OxSol(T,S) * exp(E * P / K)
V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU] K = temperature [deg K]
OxSol(T,S) = oxygen saturation [ml/l], P = pressure [dbar], Residual = instrument oxygen - bath oxygen



Secondary Dissolved Oxygen

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

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

SENSOR SERIAL NUMBER: 0201 SBE 43 OXYGEN CALIBRATION DATA

CALIBRATION DATE: 08-Jul-11p

COEFFICIENTS

Soc = [illegible]
Voffset = -0.4914
Tau20 = 1.22

A = -2.2675e-003
B = [illegible]
C = [illegible]
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS

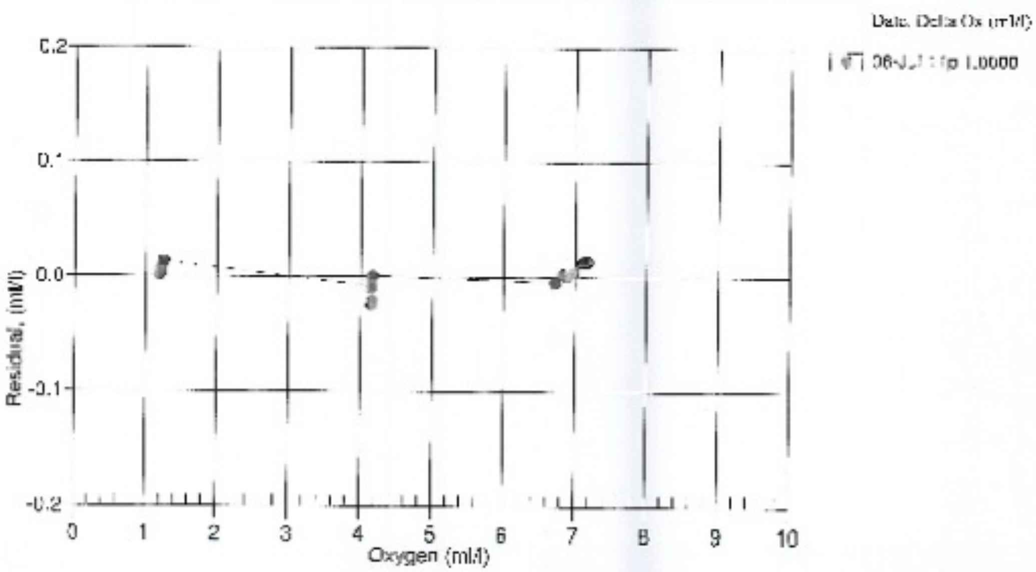
D1 = 1.92634e-4
D2 = -4.64803e-2
H1 = -3.30000e-2
H2 = 5.00000e+3
H3 = [illegible]

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
[illegible]	2.00	0.05	[illegible]	1.20	[illegible]
[illegible]	5.00	[illegible]	[illegible]	[illegible]	[illegible]
1.21	[illegible]	0.05	0.790	[illegible]	0.01
1.23	20.00	0.06	[illegible]	1.24	[illegible]
1.24	26.00	0.04	0.804	[illegible]	0.01
1.23	[illegible]	0.01	0.944	[illegible]	[illegible]
[illegible]	[illegible]	0.04	[illegible]	4.12	[illegible]
[illegible]	26.00	[illegible]	1.861	[illegible]	-0.00
4.15	[illegible]	0.05	[illegible]	4.12	[illegible]
4.15	[illegible]	0.05	[illegible]	[illegible]	[illegible]
[illegible]	6.00	0.05	1.258	[illegible]	-0.02
[illegible]	20.00	[illegible]	1.576	[illegible]	0.00
6.72	[illegible]	[illegible]	[illegible]	6.72	[illegible]
[illegible]	20.00	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	22.00	0.01	2.506	[illegible]	0.00
[illegible]	[illegible]	0.05	[illegible]	6.99	[illegible]
[illegible]	6.00	[illegible]	[illegible]	[illegible]	0.02
[illegible]	2.00	[illegible]	1.341	[illegible]	0.02

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T² + C * T³) * OxSol(T,S) * exp(E * P / K)

V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU], K = temperature [deg K]

OxSol(T,S) = oxygen saturation [ml/l], P = pressure [dbar], Residual = instrument oxygen - bath oxygen



Fluorometer

PO Box 518
620 Applegate St.
Philomath, OR 97370

WET Labs

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

ECO Chlorophyll Fluorometer Characterization Sheet

Date: 4/14/2011 S/N: FLRTD-1735

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	0.057	0.025	0.009 V	50 counts
Scale Factor (SF)	6	12	25 µg/l/V	0.0076 µg/l/count
Maximum Output	4.98	4.98	4.98 V	16380 counts
Resolution	0.8	0.8	0.8 mV	1.0 counts

Ambient temperature during characterization 22.3 °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.

FLRTD-1735.xls Revision J 3/17/08

PAR

Biospherical Instruments Inc

?

CALIBRATION CERTIFICATE

UNDERWATER PAR SENSOR WITH LOG AMPLIFIER

Calibration Date: 05/19/10 **Job No.:** R-10661
Model Number: QSP-2300
Serial Number: 4722
Operator: TPC
Standard Lamp: GS1024(8/28/08)
Operating Voltage Range: 6 to 15 VDC (+)

Note: The QSP-200 uses a log amplifier to measure the detector signal current with V = log I (Amps) / IRef
To calculate irradiance, use this formula:

Irradiance = Calibration factor * (10^Light Signal Voltage - 10^Dark Voltage)

With the appropriate (solar corrected) Irradiance Calibration Factor:

Dry Calibration Factor:	**1.95E+13**	**quanta/cm²·sec/"amps"**	**3.23E-05**	**µEinsteins/cm²·sec/"amps"**
Wet Calibration Factor:	**3.28E+13**	**quanta/cm²·sec/"amps"**	**5.45E-05**	**µEinsteins/cm²·sec/"amps"**

Sensor Test Data and Results[4)]

Sensor Supply Current (Dark):	86.9	mA			
Supply Voltage:	6	Volts			
Lamp Integrated PAR Irradiance:	9.27E+15	quanta/cm^2·sec	0.01540	µEinsteins/cm²sec	
SC3 Immersion Coefficient:	0.594	Scalar Correction:	1	PAR Solar Correction:	1.0000

Nominal Filter OD	Calibrated Trans.	Sensor Voltage	Measured Trans.		Measured Signal (Amps)	Estimated Signal (Amps)	Calc. Output (Volts)	Error (Volts)	Error (%)	Test Irrad. (quanta/ cm^2·sec)
No Filter	100.00%	2.679	100.00%		4.78E-08	4.78E-08	2.680	0.001	0.0	9.27E+15
0.3	36.10%	2.242	36.35%		1.74E-08	1.72E-08	2.240	-0.002	-0.7	3.37E+15
0.5	27.60%	2.132	28.11%		1.34E-08	1.32E-08	2.125	-0.006	-1.8	2.61E+15
1	9.27%	1.678	9.68%		4.62E-09	4.43E-09	1.661	-0.017	-4.2	8.97E+14
2	1.11%	0.862	1.20%		5.71E-10	5.30E-10	0.838	-0.024	-7.2	1.11E+14
3	0.05%	0.296	0.08%		3.92E-11	2.55E-11	0.265	-0.031	-35.0	7.62E+12

Dark Before:	0.200	Volts					
Light - No Filter Hldr.:	2.679	Volts	I_{Ref} =	1.00E-10	Amps		
Dark After - NFH:	0.201	Volts	I_{Dark} =	1.59E-10	Amps	RG780	**0.228**
Average Dark	0.200	Volts	10^{VDark} =	1.585806	Amps		

Notes:
1. Annual calibration is recommended.
2. There is increasing error associated with readings below zero.
3. The collector should be cleaned frequently with alcohol.
4) This section is for internal use and for more advanced analysis.

QSP-200L,QSP2300(2006-) .xls

Transmissometer

PO Box 518
620 Applegate St.
Philomath, OR 97370

WET Labs

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

C-Star Calibration

Date December 21, 2010 S/N# CST-406DR Pathlength 25 cm

	Analog meter
V_d	0.059 V
V_{air}	4.854 V
V_{ref}	4.751 V

Temperature of calibration water	22.8 °C
Ambient temperature during calibration	21.7 °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_d 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.

Revision L 6/9/09

MOCNESS Calibration Sheets

Pressure

DEPTH SENSOR CALIBRATION
S/N 156 XII-16-2009

The pressure sensor used in the MOCNESS is a titanium strain gauge with an internal temperature sensor. The temperature of the sensor is measured and used to correct for the thermal offsets in the measurement of pressure. The MOCNESS measures the voltage across the pressure and temperature bridges of the sensor and reports these values in its output data stream. The MOCNESS pressure sensor is calibrated at several pressure points and at two temperatures. There are no adjustments in the MOCNESS hardware and all calibration is done in software in the surface control computer. The values sent up the wire in the MOCNESS data stream (the bridge voltages) are scaled to be sent as integers in the range of 0-99999 for pressure and 0-9999 for temperature. The calibration data is fit by the following equation-

Z=(C1*Vt+C0)*Vp^2+(B1*Vt+B0)*Vp+(A1*Vt+A0)

where-
Z=pressure in decibars (1 decibar is approx 1m of water)
Vp=voltage reading in data stream from pressure sensor
Vt=voltage reading in data stream from temperature sensor

The following constants are for your MOCNESS underwater unit.

serial_number =
156
C1 =
1.906887085529089e-11
C0 =
-1.786165831421366e-08
B1 =
-3.681685468843880e-07
B0 =
0.10481555322975
A1 =
0.00198004969432
A0 =
-2.097971989891269e+02

Temperature

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: 1619
CALIBRATION DATE: 20-Mar-09

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS	IPTS-68 COEFFICIENTS
g = 4.80855703e-003	a = 3.68121496e-003
h = 6.84256994e-004	b = 6.01268271e-004
i = 3.13303977e-005	c = 1.57523242e-005
j = 2.94430043e-006	d = 2.94591648e-006
f0 = 1000.0	f0 = 5851.743

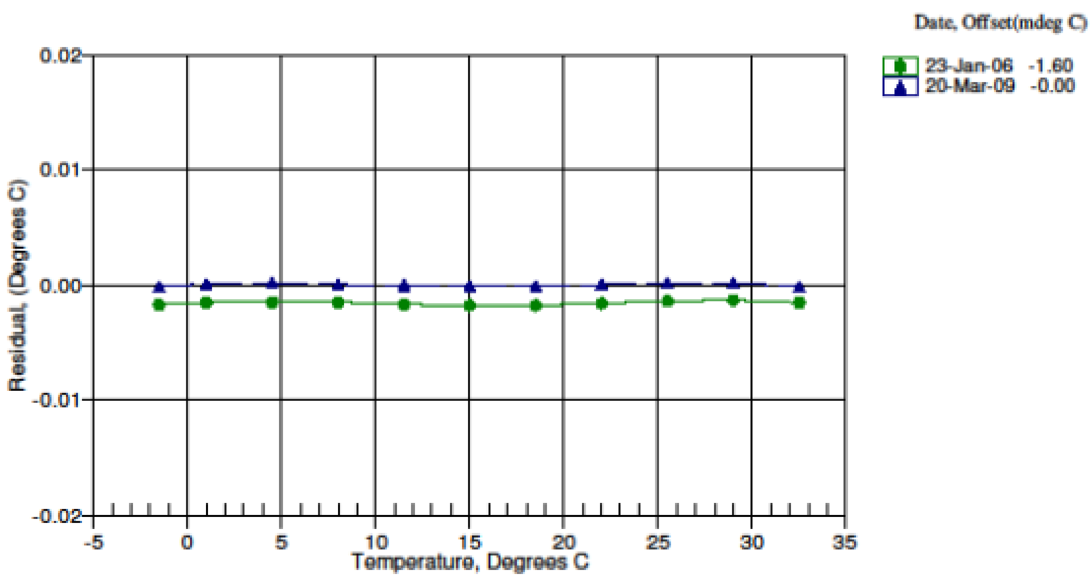
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5001	5851.743	-1.5002	-0.00010
0.9999	6188.349	1.0000	0.00006
4.4999	6682.763	4.5000	0.00014
7.9999	7204.857	7.9999	0.00003
11.4999	7755.363	11.4998	-0.00008
14.9999	8334.982	14.9998	-0.00010
18.4999	8944.359	18.4998	-0.00009
21.9999	9584.130	21.9999	-0.00001
25.4999	10254.890	25.5000	0.00014
28.9999	10957.171	29.0001	0.00017
32.4999	11691.449	32.4997	-0.00017

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



Conductivity

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2293
CALIBRATION DATE: 04-Mar-11

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

GHIJ COEFFICIENTS
g = -1.07119969e+001
h = 1.48046874e+000
i = -2.44191594e-003
j = 2.60911906e-004
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS
a = 3.16649371e-007
b = 1.47378668e+000
c = -1.06976746e+001
d = -8.47941886e-005
m = 6.5
CPcor = -9.5700e-008 (nominal)

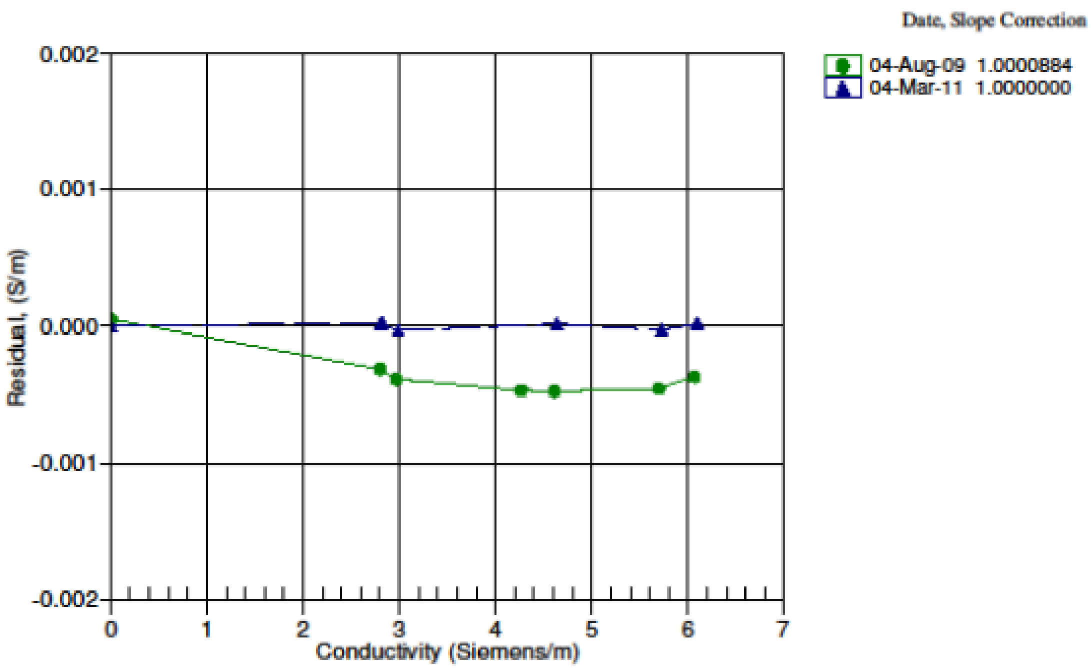
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.69416	0.00000	0.00000
-1.0000	34.9530	2.81456	5.13300	2.81458	0.00003
1.0000	34.9537	2.98659	5.24531	2.98656	-0.00003
18.5000	34.9513	4.63434	6.21883	4.63436	0.00002
29.0000	34.9445	5.72095	6.78406	5.72092	-0.00003
32.5000	34.9307	6.09368	6.96728	6.09369	0.00002

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



Transmissometer

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C-Star Calibration

Date March 22, 2011 S/N# CST-407DR Pathlength 25 cm

	Analog meter
V_d	0.059 V
V_{air}	4.785 V
V_{ref}	4.684 V

Temperature of calibration water	22.5 °C
Ambient temperature during calibration	21.4 °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_d 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.

Revision L 6/9/09

Acquisition and Processing Information

Processing Specifics

Refer to the InstCoef.txt file along with the specific instrument calibration sheets, both located in the Cal/ directory of the data distribution, for information on how the RVDAS data was collected and processed.

Errors and Events

This section lists all significant events and known problems with acquisition during this cruise including instrument failures, data acquisition system failures, and other factors affecting this data set.

The PCO2 system was turned off when it was discovered that there was no regulator onboard for the Chilean replacement Nitrogen tank. Palmer Station supplied the LMG with an appropriate tank for running the PCO2 system during the Northbound Drake passage.

Date (Julian)	Time (GMT)	Event	Location
307	03:00	Started data collection. Trimble GPS not functioning	@68W
308		Turned off bottom tracking ADCP	
311	22:09	Suspended water sampling and sonars.	Arrive Palmer Station
313	09:49	Resumed seawater and sonars	Departing Palmer Station
313	12:01	Turned on bottom tracking ADCP	
320	22:00	PCO2 system turned off	
330	10:09	Suspended water sampling and sonars.	Arrive Palmer Station
331	10:09	Resumed seawater and sonars	Departing Palmer Station
335	02:35	End data collection	@68W