
LMG10-10

Joe Warren

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All of the data has been archived with the Unix "tar" command and/or compressed using Unix "gzip" compression.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

<p>ADCP: ADCP.tar</p> <p>Cal: InstCoef.txt uw/ ctd/</p> <p>CTD: ctd.tar</p> <p>Imagery: Imag.tar</p> <p>Maps: (various)</p> <p>Process: JGOF.tar PCO2.tar PROC.tar QC.tar</p> <p>Report: Report.doc</p> <p>RVDAS: nav/ uw/</p> <p>Science: (various)</p> <p>Utility: Acrobat Winzip</p>		
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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. Processed data is usually available shortly after the cruise at <http://currents.soest.hawaii.edu>

Calibration

/Cal/

The tar files in the Cal directory contain images of calibration sheets for each of the following systems: Sound Velocity Probe (SVP_CALS.TAR), Meteorological System (MET_CALS.TAR), Underway System (UW_CALS.TAR), and CTD_CALS.pdf.

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.

CTD

CTD/

CTD/Scripts/

This directory contains the control files used for preliminary processing of the data. Processing performed by the vessel technicians is for *quality control purposes only*, as a check that the instruments are performing correctly.

CTD//raw

Contains the raw data from the instrument.

CTD/process

Contains the files generated as a result of the preliminary post processing. For more details, refer to the SBE Data Processing documentation available on the SeaBird website (<http://www.seabird.com>).

Ice Images

/ICE_IMAGE/

This directory contains .jpg files of Terrascan ice imagery sent to the ship from Palmer station to aid in navigation of the ship and science.

Isobar Charts

/Isobars/

This directory contains GIF image files. These file are an analysis of mean sea level pressure from the National Center for Environmental Prediction's Medium Range Forecast Model. They are updated every 6 hours. Naming the convention is as follows yyjjj.hh.gif where yy is the year, jjj is the day number, and hh is the hour.

Data and Science Report

/Report/

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

Sitrep

/Sitrep/

If this directory exists, it contains copies of the vessels Daily Situation Report.

XBT

/XBT/

If this directory exists, it contains data from Expendable Bathythermographic (XBT) “Deep Blue” probes were used to obtain water column temperature profiles. The dataset includes the following files:

dat.zip	The probe drop schedule and other configuration files.
efiles.zip	The edited data files.
log.zip	The log files for drop and GPS positioning.
nav.zip	The navigation files.
sfiles.zip	The raw data files.
*.pdf	Scanned images of the paper log sheets.

XCTD

/XCTD/

If this directory exists, it contains data from Expendable Conductivity, Temperature, and Depth (XCTD) digital probes were used to obtain water column temperature and Salinity profiles. Two files are created for each drop .RDF files contain the raw data, and the .EDF contain the exported ascii data.

TCO2

/TCO2/

This directory contains the log sheet for the TCO2 sample during the Drake Transect Sampling. For further information on this data, contact Tim Newberger at tnewberg@ldeo.columbia.edu

Salts

/SALT/

If this directory exists, it 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 are normally analyzed with a Guildline Autosalinometer.

Drifters

/DRIFTERS/

This directory contains the log sheet for the drifter buoys released during the Drake Transect.

Science

/Science/

If this directory is populated, it will contain various files, data, digital photos, and/or other information collected by the individual scientists.

Maps

/Maps/

If this directory is present, it contains maps generated by vessel staff or provided by the science party. Maps may be in any number of formats, some of which may be proprietary or vendor specific. Maps generated by the Marine Electronics and Instrument Specialists are typically JPEG images.

WAYPOINTS

/WAYPTS/

If this directory is present, it contains files in CSV format detailing various navigation waypoints.

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 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	$\mu\text{Einsteins/meters}^2 \text{ sec}$
10	Sea surface temperature	$^{\circ}\text{C}$
11	Conductivity	S/m
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	$^{\circ}\text{C}$
17	Relative humidity	%
18	Barometric pressure	mBars
19	Sea surface fluorometry	$\mu\text{g/l}$
20	Transmissometer	Vols (0-5 FSO)
21	PSP	W/m^2
22	PIR	W/m^2

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	R. M. young 5106
PAR, (Photosynthetically-Available Radiation)	lmwx	continuous	1 sec	BSI QSR-240
Barometer	lmwx	continuous	1 sec	R. M. young 61201
GUV & PUV	lguv	continuous	1 sec	GUV2511 & PUV2510
PIR (LW radiation)	lmwx	continuous	1 sec	Eppler PIR
PSP (SW radiation)	lmwx	continuous	1 sec	Eppler PSP
Port Ultrasonic Wind Speed/Direction	lmwx	continuous	1 sec	Gill Wind Observer II

Navigational Data

Measurement	File ID	Collect. Status	Rate	Instrument
Attitude GPS	lash	continuous	1 sec	Ashtec ADU-2
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
Net Depth Sensor	lnds	variable	~1/3 sec	Omega PX-605
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)	ldfl	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	

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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	Navigation Data	File ID
Meteorological - Cambell	lmwx	Gyro Compass	lgyr
Knudsen	lknu	P-CODE GPS	tgps
microTSG	utsg	Ashtech ADU2 GPS	lash
Digital Remote Temperature	lrtm	Garmin 17 GPS	lgar
Fluorometer - Turner	lflr	Seapath 330 GPS	Lsep
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		

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 field separations are clearly understood. An example data string is provided with each instrument section for your convenience, however it is always best to refer directly to the raw data.

Iknu – 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	

Field	Data	Units
9	LF – Depth Valid Flag	

Inds – 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 Identifier, DUSH-X where X is 4, 5, or 11	
4	Tension	lbs
5	Speed	Meters/minute
6	Payout	meters
7	Checksum	

Imwx - Campbell Meteorological DAS

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

Field	Data	Units
1	RVDAS Time Tag	
2	PUS tag – Port 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	meaningless
8	Sonic Temperature	meaningless
9	Status, 0=ok, 60=Heating Enabled & ok, Other value mean a fault	meaningless
10	Check Sum	meaningless

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 on www.seabird.com on 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

Irtm – 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

Iflr – Fluorometer, Turner

04+107:16:48:02.342 0 5450 :: 4/16/04 09:44:17 = 0.632 (RAW)

Field	Data	Units
1	RVDAS Time Tag	
2	Zero Field	numeric
3	Sample Number	numeric
4	Fluorometer Date	mm/dd/yy
5	Fluorometer Time	hh:mm:ss
6	Digital output of fluorometer	Volts
7	(RAW)	

Idfl – 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	

loxy - 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	°C
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	VCO ₂	mL
7	Equilibrator temperature	°C
8	PCO ₂	millibars
9	Gas flow	mL/min
10	Solenoid position ID	number
11	Valve Position ID	number
12	Measured gas	name

Iguv – 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

Isvp - 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

¹The 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.

²The speed output 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).

lash – Ashtech GPS

ATTD: Attitude Data

01+081:00:00:00.806 \$PASHR,ATT,345605.0,165.03,+001.86,-01.96,0.0018,0.0173,0*22

Field	Data	Units
1	RVDAS Time Tag \$PASHR	
2	ATT	
3	GPS Time sec. of the week	Seconds
4	heading (rel. to true North)	Degrees
5	pitch	Degrees
6	roll	Degrees
7	Measurement RMS error	Meters
8	Baseline RMS error	Meters
9	attitude reset flag	

01+081:00:00:00.966 \$GPGGA,235952.00,6051.7937,S,06030.2175,W,1,08,01.0,+00068,M,,M,,*79

Field	Data	Units
1	RVDAS Time Tag \$GPGGA	
2	UTC time at position	hhmmss.ss
3	Latitude	ddmm.mmm

Field	Data	Units
4	North (N) or South (S)	
5	Longitude	ddmm.mmm
6	East (E) or West (W)	
7	GPS quality (1=GPS 2=DGPS)	
8	Number of GPS satellites used	
9	HDOP	
10	Antenna Height	Meters
11	M for Meters	
12	Geoidal height	Meters
13	M for meters	
14	age of diff. GPS data	Sss
15	differential reference station ID	Aaaa

Igyr - 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	

Igar - 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)	

Field	Data	Units
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	

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

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	

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	

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
-------	------	-------

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
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

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	

¹Geoidal 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 – Latitude/Longitude

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	Longitude	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		Collected
Starboard Anemometer	Gill Ultrasonic Wind Observer II	71738		Collected
Barometer	R.M. Young 61201	BP01150	08-May-2009	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	32031F3	15-Jan-2010	Collected
PSP	Eppley PSP	31701F3	15-Jan-2010	Collected
GUV (Mast)	Biosph. Inst. GUV-2511	25110805126	19-May-2009	Collected
Transmissometer	WET Labs C-Star 25 cm deep	CST-407DR	13-Oct-2009	Collected
MicroTSG	Sea-Bird 45	200	12-Aug-2010	Collected
Digital Remote Temp	Sea-Bird 38	351	16-Sep-2008	Collected
Fluorometer	WET Labs ECO-FL	FLRTD-399	15-Sep-09	Collected

CTD Sensors

Sensor	Description	Serial #	Cal. Date	Status
CTD Fish	Seabird SBE9Plus	0328	19-Aug-2009	Collected
Primary Temperature	Seabird SBE3	2658	29-Jul-2009	Collected
Secondary Temperature	Seabird SBE3	1529	29-Jul-2009	Collected
Primary Conductivity	Seabird SBE4	350	28-Jul-2009	Collected
Secondary Conductivity	Seabird SBE4	2293	04-Aug-2009	Collected
Primary Dissolved Oxygen	Seabird SBE43	202	10-Feb-2010	Collected
Secondary Dissolved Oxygen	Seabird SBE43	179	11-Feb-2010	Collected
Primary Fluorometer (see notes in Errors and Events)	Wet Labs ECO	FLRTD-867	30-Sep-2010	Collected
Secondary Fluorometer (see notes in Errors and Events)	Wet Labs ECO	FLRTD-1735	04-Feb-2010	Collected
PAR	Biosph. Inst. QSP-2300	4403	05-Feb-2010	Collected
Transmissometer	Wet Labs C-Star	CST-830DR	14-Oct-2009	Collected

For Official Use Only

Underway Calibration Sheets

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

Remote Temperature (SBE-38)

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: 0351
CALIBRATION DATE: 16-Sep-08

SBE 38 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

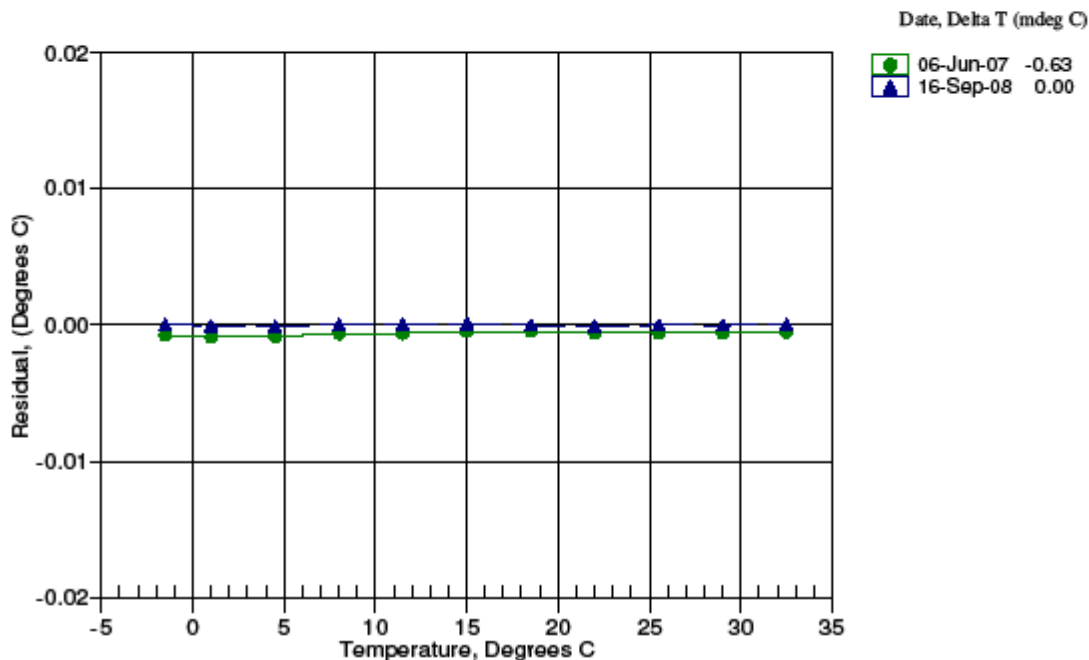
ITS-90 COEFFICIENTS

a0 = -1.726168e-005
a1 = 2.760151e-004
a2 = -2.333162e-006
a3 = 1.553861e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.50010	767504.4	-1.50005	0.00005
0.99990	685724.0	0.99985	-0.00005
4.50000	587333.1	4.49993	-0.00007
8.00000	504698.0	8.00002	0.00002
11.50000	435062.4	11.50004	0.00004
14.99990	376188.2	14.99997	0.00007
18.50000	326250.7	18.49999	-0.00001
22.00000	283763.4	21.99993	-0.00007
25.49990	247504.5	25.49990	-0.00000
28.99990	216469.9	28.99988	-0.00002
32.49990	189830.6	32.49993	0.00003

Temperature ITS-90 = $1/[a_0 + a_1[\ln(n)] + a_2[\ln^2(n)] + a_3[\ln^3(n)]] - 273.15$ (°C)

Residual = instrument temperature - bath temperature



Transmissometer (Wetlabs C-Star)

PO Box 518
620 Applegate St.
Philomath, OR 97370



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

C-Star Calibration

Date	October 13, 2009	S/N#	CST-407DR	Pathlength	25 cm
<hr/>					
		Analog meter			
V_d		0.059 V			
V_{air}		4.794 V			
V_{ref}		4.687 V			
Temperature of calibration water					22.6 °C
Ambient temperature during calibration					22.0 °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 (Wetlabs ECO-FL)

PO Box 518
620 Applegate St.
Philomath, OR 97370



(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:

$$\text{CHL } (\mu\text{g/l}) = \text{Scale Factor} * (\text{Output} - \text{Dark Counts})$$

	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: $SF = x \div (\text{output} - \text{dark counts})$, 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 (Eppley model PSP)**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: 31701F3

Resistance: 674 Ω at 23°C

Temperature Compensation Range: -20°C 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:

$$8.36 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

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 $\pm 0.5\%$ 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/ft²-hr⁻¹ = 3.153 watts meter⁻²

Shipped to: Raytheon Technical Services (NSF) Date of Test: January 15, 2010
Port Hueneme, CA

S.O. Number: 62361
Date: January 20, 2010

In Charge of Test: *Robert L. Bortz*
Reviewed by: *Thomas J. Smith*

Remarks:

PIR (Eppley model PIR)**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: 32031F3

Resistance: 709 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:

$$3.86 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

The calculation of this constant is based on the fact that the relationship between radiation intensity and cmf is rectilinear to intensities of 700 watts meter⁻². This radiometer is linear to within $\pm 1.0\%$ 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 Technical Services (NSF) Date of Test: January 15, 2010
Port Hueneme, CA

S.O. Number: 62360
Date: January 20, 2010

In Charge of Test: *Julia L. Beatty*
Reviewed by: *Thomas D. Keck*

Remarks:

PAR (QSR-240P)**Biospherical Instruments Inc.****CALIBRATION CERTIFICATE**

Calibration Date: 8/31/2010
 Model Number: QSR240
 Serial Number: 6393
 Operator: TPC
 Standard Lamp: GS-1024(8/25/08)
 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 μE/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/(μE/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 03/24/05

Temperature/Relative Humidity (RMYoung model 41372LC)

Meteorological Instruments

COPY

Temperature Sensor Calibration ReportCustomer: *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 $\pm 0.1^\circ$ 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 InstrumentSerial # 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. Chiriac*

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 (RMYoung model 61201)

R.M. Young Company
2831 Acorn Park Drive
Traverse City, Michigan 49685 USA

CALIBRATION REPORT **Barometric Pressure Sensor**

Customer: *Raytheon Polar Services*

Test Number: 95081
Test Date: 8 May 2009

Customer PO: R44967-01
Sales Order: 030

<u>Test Sensor:</u>	
Model: 61201	Serial Number: B01150
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	-2	799.9
875.0	1250	875.0
950.0	2501	950.1
1025.0	3751	1025.1
1100.0	4999	1099.9

(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
Druck Pressure Controller Model DPI515
Fluke Multimeter Model 8060A

Serial # Is Test Reference
51500497 UKAS Lab 0221
4865407 234027

Tested By: E. Channing

METEOROLOGICAL INSTRUMENTS
Tel: 231.945.5980 Fax: 231.346.7772 Email: met@rmyoungusa.com Website: www.rmyoungusa.com

GUV (Biospherical Instruments 2511)



GUV-2511 Calibration Certificate										
System Serial Number		25110805126		Date of Calibration		5/19/2009		TC		
Calibration database		25110805126v4.mdb		Date of Certificate		5/19/2009				
DASSN		0109		Standard of Spectral Irradiance		GS-1019(8/28/08)		Operator		
Microprocessor Tag Number		2								
Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per $\mu W/(cm^2 \cdot nm)$]	Scale			Offset			Measurement Units
				Small [Volts per $\mu W/(cm^2 \cdot nm)$]	Medium [Volts per $\mu W/(cm^2 \cdot nm)$]	Large [Volts per $\mu W/(cm^2 \cdot nm)$]	Small [Volts]	Medium [m [Volts]	Large [Volts]	
E40305	2	305	4.6000E-11	5.0254E-06	1.4537E-03	4.4747E-01	-9.4003E-05	-8.8000E-05	1.1000E-03	$\mu W/(cm^2 \cdot nm)$
E40313	6	313	2.4300E-10	2.5241E-05	7.3730E-03	2.5959E+00	-1.2602E-04	-1.3000E-04	1.0532E-03	$\mu W/(cm^2 \cdot nm)$
E40320	8	320	2.8300E-10	2.7268E-05	8.0230E-03	2.7771E+00	-3.2103E-04	-3.1400E-04	3.8502E-04	$\mu W/(cm^2 \cdot nm)$
E40340	10	340	2.0100E-10	2.0445E-05	5.9531E-03	2.1181E+00	-1.1400E-04	-1.1800E-04	1.1020E-03	$\mu W/(cm^2 \cdot nm)$
E40380	12	380	7.5400E-11	7.6359E-06	2.2427E-03	7.8731E-01	-4.0500E-04	-4.0400E-04	3.2900E-04	$\mu W/(cm^2 \cdot nm)$
E40385	13	385	3.2800E-10	3.3334E-05	9.7882E-03	3.4048E+00	1.2000E-05	1.2000E-05	1.2970E-03	$\mu W/(cm^2 \cdot nm)$
Broadband Channels	Address	Wavelength [nm]	Responsivity [Amps per $\mu E/(cm^2 \cdot s)$]	Scale			Offset			Measurement Units
				Small [Volts per $\mu E/(cm^2 \cdot s)$]	Medium [Volts per $\mu E/(cm^2 \cdot s)$]	Large [Volts per $\mu E/(cm^2 \cdot s)$]	Small [Volts]	Medium [m [Volts]	Large [Volts]	
E40PAR	15	400-700	1.7100E-05	1.7421E+00	5.1048E+02	1.7889E+05	-2.3000E-05	-2.3000E-05	1.3450E-03	$\mu E/(cm^2 \cdot sec)$
Auxiliary Channels	Address	Wavelength [nm]	Responsivity	Scale			Offset			Measurement Units
				Small	Medium	Large	Small	Medium	Large	
E40Temp	22	0	1	0.01	0.01	0.01	0	0	0	$^{\circ}C$
E40Vin	27	0	1	-0.25	-0.25	-0.25	0	0	0	V

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Calibration Data - Do Not Destroy

page 2 of 2

CTD Calibration Sheets

CTD Fish

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: 0328
CALIBRATION DATE: 19-Aug-09

SBE9plus PRESSURE CALIBRATION DATA
10000 psia S/N 53980

DIGIQUARTZ COEFFICIENTS:

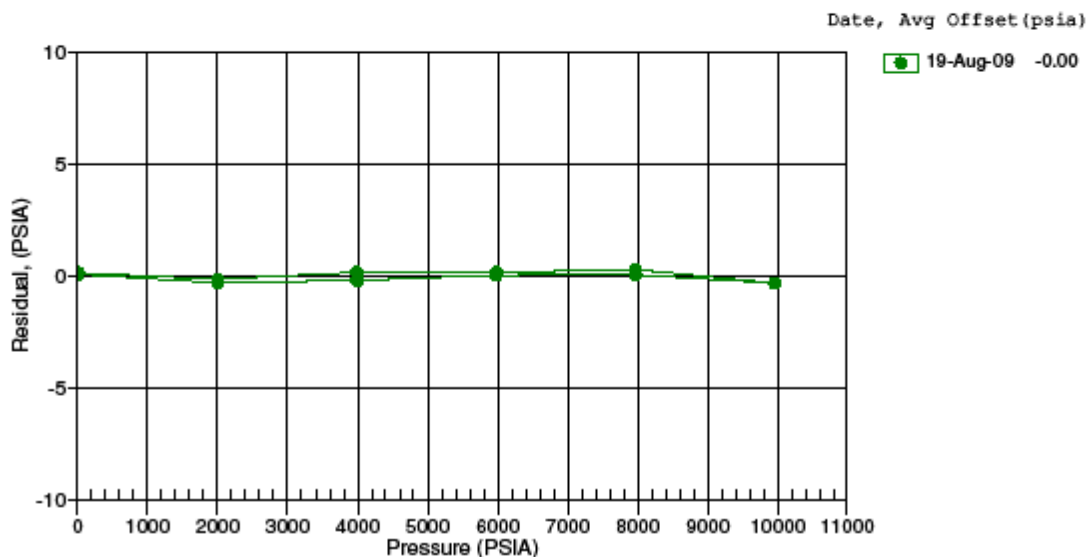
C1 = -5.847002e+004
C2 = 6.910390e-001
C3 = 1.753360e-002
D1 = 4.241600e-002
D2 = 0.000000e+000
T1 = 3.026040e+001
T2 = -1.938830e-004
T3 = 4.330190e-006
T4 = 2.020250e-009
T5 = 0.000000e+000

AD590M, AD590B, SLOPE AND OFFSET:

AD590M = 1.13300e-002
AD590B = -8.47592e+000
Slope = 0.99997
Offset = -0.8399 (dbars)

PRESSURE (PSIA)	INST OUTPUT(Hz)	INST TEMP(C)	INST OUTPUT (PSIA)	CORRECTED INST OUTPUT (PSIA)	RESIDUAL (PSIA)
14.520	33053.30	23.1	15.810	14.592	0.072
2001.763	33609.50	23.3	2002.737	2001.462	-0.301
3988.549	34155.10	23.3	3989.690	3988.358	-0.191
5975.575	34690.70	23.4	5976.997	5975.609	0.034
7962.513	35216.60	23.5	7964.018	7962.573	0.060
9949.782	35733.30	23.6	9950.981	9949.479	-0.303
7967.565	35218.00	23.8	7969.306	7967.861	0.296
5975.765	34690.80	24.0	5977.316	5975.928	0.163
3988.162	34155.10	24.1	3989.657	3988.325	0.163
2000.167	33609.10	24.2	2001.302	2000.027	-0.140
14.515	33053.30	24.4	15.882	14.663	0.148

Residual = corrected instrument pressure - reference pressure



CTD Temperature (Primary)

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER: 2658
CALIBRATION DATE: 29-Jul-09SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

$g = 4.31211016e-003$
 $h = 6.40111133e-004$
 $i = 2.26655687e-005$
 $j = 2.13388029e-006$
 $f_0 = 1000.0$

IPTS-68 COEFFICIENTS

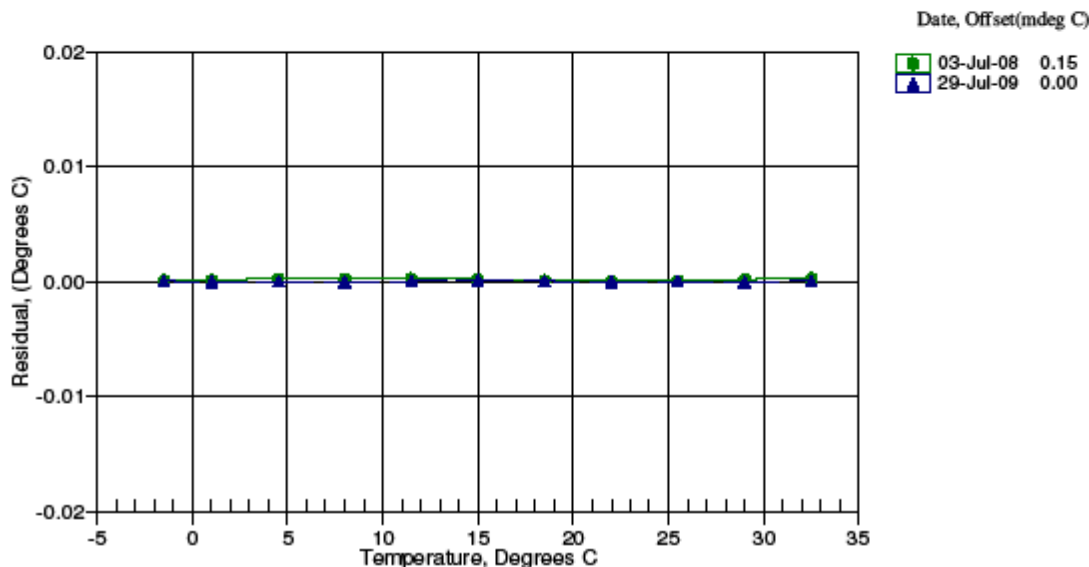
$a = 3.68121329e-003$
 $b = 6.00716702e-004$
 $c = 1.61707613e-005$
 $d = 2.13541887e-006$
 $f_0 = 2769.988$

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5001	2769.988	-1.5001	0.00003
0.9999	2929.468	0.9999	-0.00004
4.4999	3163.780	4.4999	0.00000
7.9999	3411.290	7.9999	-0.00003
11.4999	3672.365	11.4999	-0.00000
14.9999	3947.355	15.0000	0.00007
18.4999	4236.584	18.4999	0.00003
21.9999	4540.384	21.9998	-0.00008
25.4999	4859.095	25.4999	0.00001
28.9999	5192.993	28.9999	-0.00001
32.4999	5542.387	32.4999	0.00002

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

$$\text{Temperature IPTS-68} = 1/[a + b[\ln(f_0/f)] + c[\ln^2(f_0/f)] + d[\ln^3(f_0/f)]] - 273.15 \text{ (}^\circ\text{C)}$$
Following the recommendation of JPTS: T_{68} is assumed to be $1.00024 * T_{90}$ (-2 to 35 $^\circ\text{C}$)

Residual = instrument temperature - bath temperature



CTD Temperature (Secondary)

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER: 1529
CALIBRATION DATE: 29-Jul-09SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

$g = 4.82660904e-003$
 $h = 6.71428659e-004$
 $i = 2.57444850e-005$
 $j = 2.05178869e-006$
 $f0 = 1000.0$

IPTS-68 COEFFICIENTS

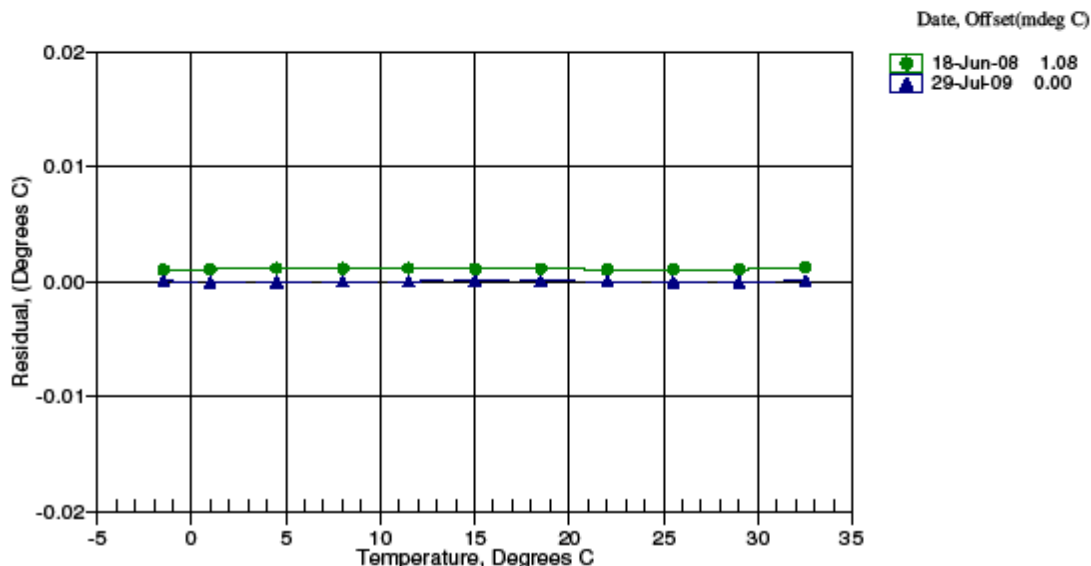
$a = 3.68121321e-003$
 $b = 5.98432700e-004$
 $c = 1.46066236e-005$
 $d = 2.05319361e-006$
 $f0 = 6133.876$

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5001	6133.876	-1.5001	0.00003
0.9999	6488.365	0.9999	-0.00004
4.4999	7009.141	4.4999	-0.00002
7.9999	7559.191	7.9999	-0.00000
11.4999	8139.286	11.4999	-0.00001
14.9999	8750.193	14.9999	0.00005
18.4999	9392.615	18.4999	0.00003
21.9999	10067.265	21.9999	-0.00001
25.4999	10774.827	25.4999	-0.00001
28.9999	11515.932	28.9998	-0.00008
32.4999	12291.256	32.5000	0.00006

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

$$\text{Temperature IPTS-68} = 1/[a + b[\ln(f_0/f)] + c[\ln^2(f_0/f)] + d[\ln^3(f_0/f)]] - 273.15 \text{ (}^\circ\text{C)}$$
Following the recommendation of JPOTS: T_{68} is assumed to be $1.00024 * T_{90}$ (-2 to 35 $^\circ\text{C}$)

Residual = instrument temperature - bath temperature



CTD Conductivity (Primary)

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

SENSOR SERIAL NUMBER: 0350
 CALIBRATION DATE: 28-Jul-09

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

GHJ COEFFICIENTS

g = -4.23251518e+000
 h = 4.99914660e-001
 i = -2.44893875e-004
 j = 3.78740725e-005
 CPcor = -9.5700e-008 (nominal)
 CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 6.40695357e-006
 b = 4.99193815e-001
 c = -4.23061882e+000
 d = -8.92405219e-005
 m = 4.5
 CPcor = -9.5700e-008 (nominal)

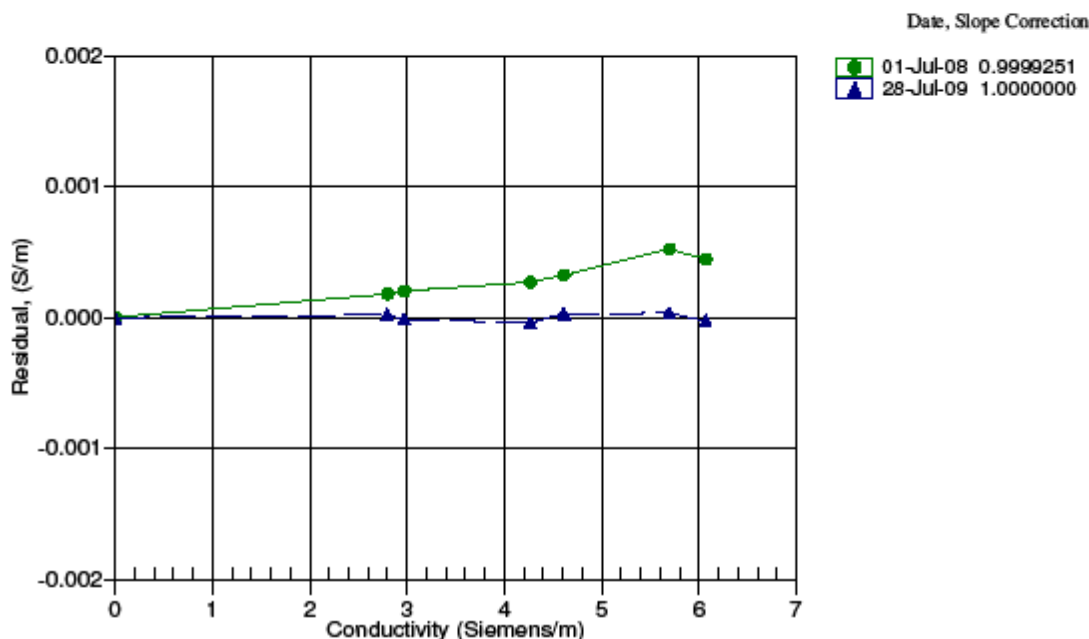
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.91086	0.00000	0.00000
-1.0000	34.7322	2.79843	8.02396	2.79845	0.00002
1.0000	34.7330	2.96952	8.23360	2.96951	-0.00001
15.0000	34.7346	4.26265	9.67046	4.26261	-0.00004
18.5000	34.7345	4.60869	10.01954	4.60871	0.00003
29.0000	34.7349	5.69049	11.03817	5.69052	0.00003
32.5000	34.7322	6.06298	11.36722	6.06296	-0.00003

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

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

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

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



CTD Conductivity (Secondary)

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

SENSOR SERIAL NUMBER: 2293
 CALIBRATION DATE: 04-Aug-09

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

GHJ COEFFICIENTS

$g = -1.07106977e+001$
 $h = 1.47937162e+000$
 $i = -2.03328336e-003$
 $j = 2.25937108e-004$
 $CP_{cor} = -9.5700e-008$ (nominal)
 $CT_{cor} = 3.2500e-006$ (nominal)

ABCDM COEFFICIENTS

$a = 6.88055225e-007$
 $b = 1.47388455e+000$
 $c = -1.06988411e+001$
 $d = -8.11854457e-005$
 $m = 6.1$
 $CP_{cor} = -9.5700e-008$ (nominal)

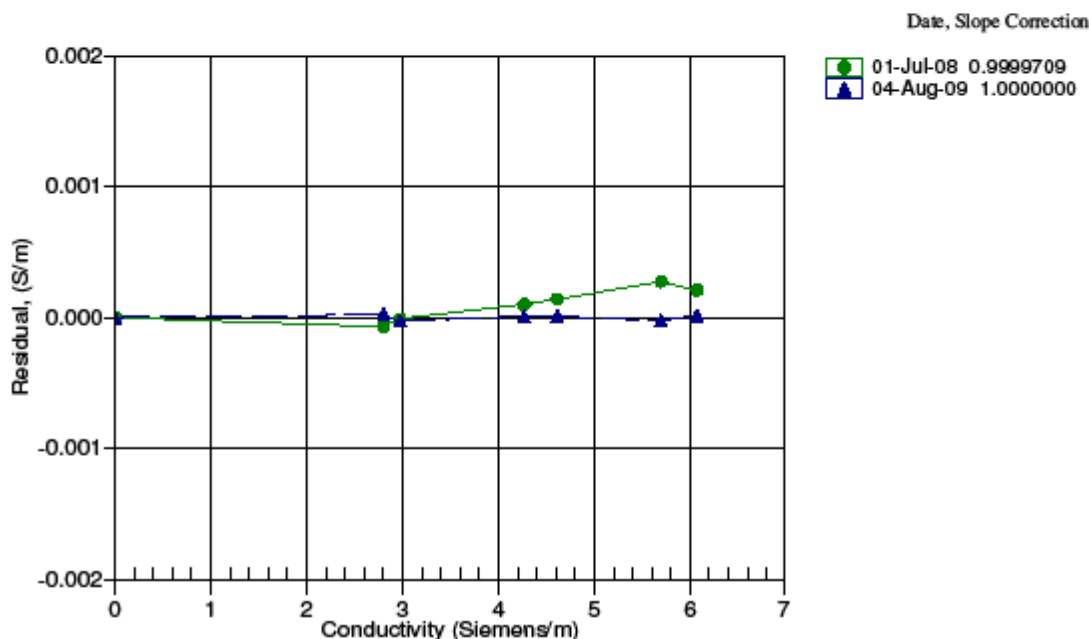
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.69423	0.00000	0.00000
-1.0000	34.7538	2.80001	5.12316	2.80003	0.00002
1.0000	34.7552	2.97124	5.23516	2.97121	-0.00003
15.0000	34.7564	4.26504	6.01421	4.26505	0.00001
18.5000	34.7564	4.61128	6.20600	4.61129	0.00001
29.0000	34.7556	5.69349	6.77016	5.69347	-0.00002
32.5000	34.7512	6.06592	6.95362	6.06594	0.00001

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

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

t = temperature[°C]; p = pressure[decibars]; δ = CT_{cor} ; ϵ = CP_{cor} ;

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



CTD Dissolved Oxygen (Primary)

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: 0202
CALIBRATION DATE: 10-Feb-10p

SBE43 OXYGEN CALIBRATION DATA

COEFFICIENTS

Soc = 0.4396

Voffset = -0.5190

Tau20 = 1.60

A = -2.5352e-003

B = 1.5776e-004

C = -2.8566e-006

E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS

D1 = 1.92634e-4 H1 = -3.30000e-2

D2 = -4.64803e-2 H2 = 5.00000e+3

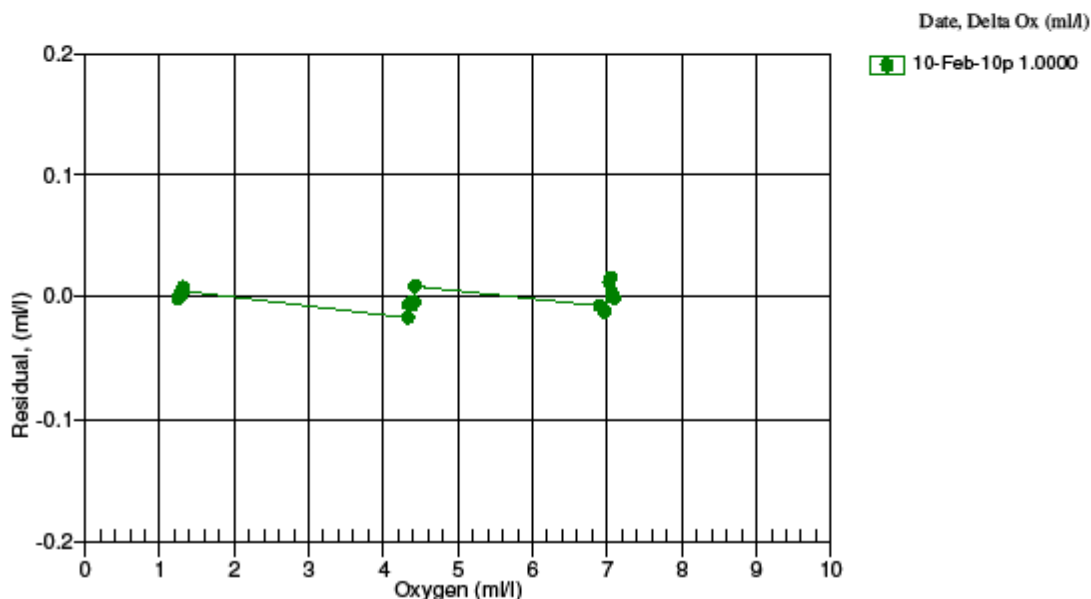
H3 = 1.45000e+3

BATH OX (m/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(m/l)	RESIDUAL (m/l)
1.24	2.00	0.00	0.812	1.24	-0.00
1.26	6.00	0.01	0.853	1.27	0.00
1.28	12.00	0.01	0.912	1.29	0.00
1.29	20.00	0.01	0.987	1.30	0.00
1.31	26.00	0.02	1.053	1.32	0.01
1.32	30.00	0.02	1.097	1.33	0.01
4.33	2.00	0.00	1.538	4.31	-0.02
4.34	6.00	0.01	1.662	4.33	-0.01
4.38	20.00	0.01	2.101	4.38	-0.00
4.39	12.00	0.01	1.857	4.38	-0.01
4.42	30.00	0.02	2.438	4.41	-0.00
4.42	26.00	0.02	2.312	4.43	0.01
6.90	30.00	0.02	3.516	6.89	-0.01
6.97	20.00	0.01	3.033	6.96	-0.01
7.02	26.00	0.02	3.365	7.04	0.01
7.04	6.00	0.01	2.382	7.06	0.02
7.06	2.00	0.00	2.188	7.07	0.00
7.09	12.00	0.01	2.686	7.09	-0.00

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

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

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



CTD Dissolved Oxygen (Secondary)

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: 0179
CALIBRATION DATE: 11-Feb-10p

SBE43 OXYGEN CALIBRATION DATA

COEFFICIENTS

Soc = 0.4665

Voffset = -0.4865

Tau20 = 1.12

A = -9.7918e-003

B = 4.0107e-004

C = -3.6104e-006

E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS

D1 = 1.92634e-4 H1 = -3.30000e-2

D2 = -4.64803e-2 H2 = 5.00000e+3

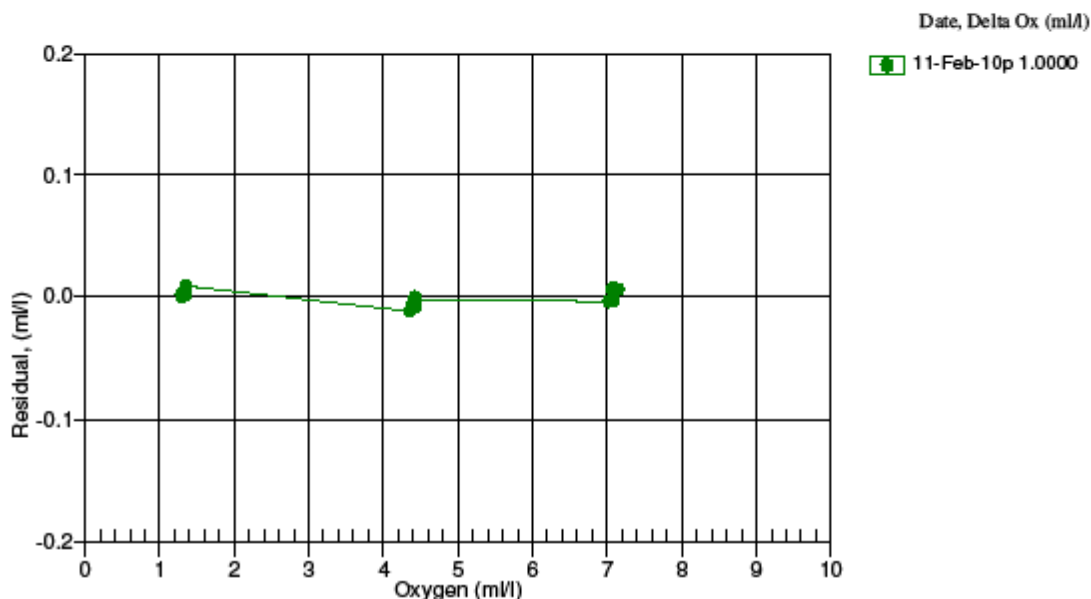
H3 = 1.45000e+3

BATH OX (m/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(m/l)	RESIDUAL (m/l)
1.29	2.00	0.01	0.778	1.29	0.00
1.30	6.00	0.01	0.822	1.30	-0.00
1.32	12.00	0.01	0.888	1.32	0.00
1.33	20.00	0.01	0.968	1.34	0.00
1.34	26.00	0.02	1.021	1.35	0.00
1.35	30.00	0.02	1.054	1.36	0.01
4.35	2.00	0.01	1.465	4.34	-0.01
4.38	6.00	0.01	1.613	4.37	-0.01
4.41	12.00	0.01	1.827	4.40	-0.00
4.42	20.00	0.01	2.075	4.41	-0.01
4.43	26.00	0.02	2.240	4.43	0.00
4.43	30.00	0.02	2.336	4.42	-0.00
7.02	30.00	0.02	3.420	7.02	-0.00
7.06	12.00	0.01	2.639	7.07	0.01
7.07	20.00	0.01	3.031	7.06	-0.00
7.09	6.00	0.01	2.314	7.09	0.00
7.10	2.00	0.01	2.090	7.11	0.01
7.15	26.00	0.02	3.322	7.16	0.01

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

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

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



CTD Primary Fluorometer (starting at cast 5)

PO Box 518
620 Applegate St.
Philomath, OR 97370



(541) 828-5650
Fax (541) 828-5277
www.wetlabs.com

ECO Chlorophyll Fluorometer Characterization Sheet

Date: 9/30/2010

S/N: FLRTD-867

Chlorophyll concentration expressed in $\mu\text{g/l}$ can be derived using the equation:

$$\text{CHL } (\mu\text{g/l}) = \text{Scale Factor} * (\text{Output} - \text{Dark Counts})$$

	Analog Range 1	Analog Range 2	Analog Range 4 (default)	Digital
Dark Counts	0.088	0.054	0.037 V	54 counts
Scale Factor (SF)	6	13	25 $\mu\text{g/l/V}$	0.0076 $\mu\text{g/l/count}$
Maximum Output	4.91	4.91	4.91 V	16326 counts
Resolution	0.7	0.7	0.7 mV	1.0 counts

Ambient temperature during characterization

21.5 °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: $\text{SF} = x \div (\text{output} - \text{dark counts})$, 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-867_workbook.xls

Revision J

3/17/08

CTD Secondary Fluorometer (was primary for cast 1 through 4)

PO Box 518
620 Applegate St.
Philomath, OR 97370



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

ECO Chlorophyll Fluorometer Characterization Sheet

Date: 2/4/2010

S/N: FLRTD-1735

Chlorophyll concentration expressed in $\mu\text{g/l}$ can be derived using the equation:

$$\text{CHL } (\mu\text{g/l}) = \text{Scale Factor} * (\text{Output} - \text{Dark Counts})$$

	Analog Range 1	Analog Range 2	Analog Range 4 (default)	Digital
Dark Counts	0.059	0.026	0.010 V	52 counts
Scale Factor (SF)	6	13	25 $\mu\text{g/l/V}$	0.0078 $\mu\text{g/l/count}$
Maximum Output	4.97	4.97	4.97 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: $\text{SF} = x \div (\text{output} - \text{dark counts})$, 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_workbookj1.xls

Revision J

3/17/08

CTD PAR

Biospherical Instruments Inc

CALIBRATION CERTIFICATE

UNDERWATER PAR SENSOR WITH LOG AMPLIFIER

Calibration Date: <u>02/05/10</u>		Job No.: <u>R-10502</u>	
Model Number: <u>QSP-200L</u>			
Serial Number: <u>4403</u>			
Operator: <u>TPC</u>			
Standard Lamp: <u>GS1024(8/28/08)</u>			
Operating Voltage Range: <u>6</u> to <u>15</u> VDC (+)			
Note: The QSP-200 uses a log amplifier to measure the detector signal current with $V = \log I \text{ (Amps)} / I_{\text{Ref}}$			
To calculate irradiance, use this formula:			
$\text{Irradiance} = \text{Calibration factor} * (10^{\text{Light Signal Voltage}} - 10^{\text{Dark Voltage}})$			
With the appropriate (solar corrected) Irradiance Calibration Factor:			
Dry Calibration Factor:	<u>2.08E+13</u>	quanta/cm ² -sec/"amps"	<u>3.45E-05</u> μEinsteins/cm ² -sec/"amps"
Wet Calibration Factor:	<u>3.50E+13</u>	quanta/cm ² -sec/"amps"	<u>5.81E-05</u> μEinsteins/cm ² -sec/"amps"
Sensor Test Data and Results⁴⁾			
Sensor Supply Current (Dark):	<u>86.4</u>	mA	
Supply Voltage:	<u>6</u>	Volts	
Lamp Integrated PAR Irradiance:	<u>9.27E+15</u>	quanta/cm ² -sec	<u>0.01540</u> μEinsteins/cm ² -sec
SC3 Immersion Coefficient:	<u>0.594</u>	Scalar Correction:	<u>1</u> PAR Solar Correction: <u>1.0000</u>
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%	<u>2.651</u>	100.00%
0.3	36.10%	<u>2.218</u>	36.70%
0.5	27.60%	<u>2.105</u>	28.22%
1	9.27%	<u>1.661</u>	9.95%
2	1.11%	<u>0.854</u>	1.29%
3	0.05%	<u>0.260</u>	0.09%
Dark Before: <u>0.145</u> Volts Light - No Filter Hldr.: <u>2.650</u> Volts Dark After - NFH: <u>0.146</u> Volts Average Dark <u>0.145</u> Volts			
$I_{\text{Ref}} = \frac{1.00E-10}{10^{V_{\text{Dark}}}} \text{ Amps}$ $I_{\text{Dark}} = \frac{1.40E-10}{10^{V_{\text{Dark}}}} \text{ Amps}$ $10^{V_{\text{Dark}}} = \frac{1.397655}{I_{\text{Dark}}} \text{ Amps}$			
RG780 0.205			
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

CTD Transmissometer

PO Box 518
620 Applegate St.
Philomath, OR 97370



(541) 829-5650
Fax (541) 829-5277
www.wetlabs.com

C-Star Calibration

Date	October 14, 2009	S/N#	CST-B30DR	Pathlength	25 cm
Analog meter					
V_d	0.059 V				
V_{air}	4.793 V				
V_{ref}	4.651 V				
Temperature of calibration water	23.1 °C				
Ambient temperature during calibration	23.0 °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.

Date (Julian)	Time (GMT)	Event	Location
330	05:21	Started data logging at 68° West	
333	16:15	Stopped data logging	Palmer Station
334	15:38	Started data logging	Palmer Station
337		Fluorometer s/n 1735 on the CTD was suspiciously low. On cast number 5, we put another fluorometer, s/n 867, on as the primary and kept 1735 on as the secondary. The raw voltage from 1735 was reading much lower than 867. It was definitely broken. Data should be taken from 867.	
349	22:04	Stopped data logging	Palmer Station
350	14:10	Started data logging	Palmer Station
354	07:23	Stopped data logging	68° West data limit