Data Report NBP0508

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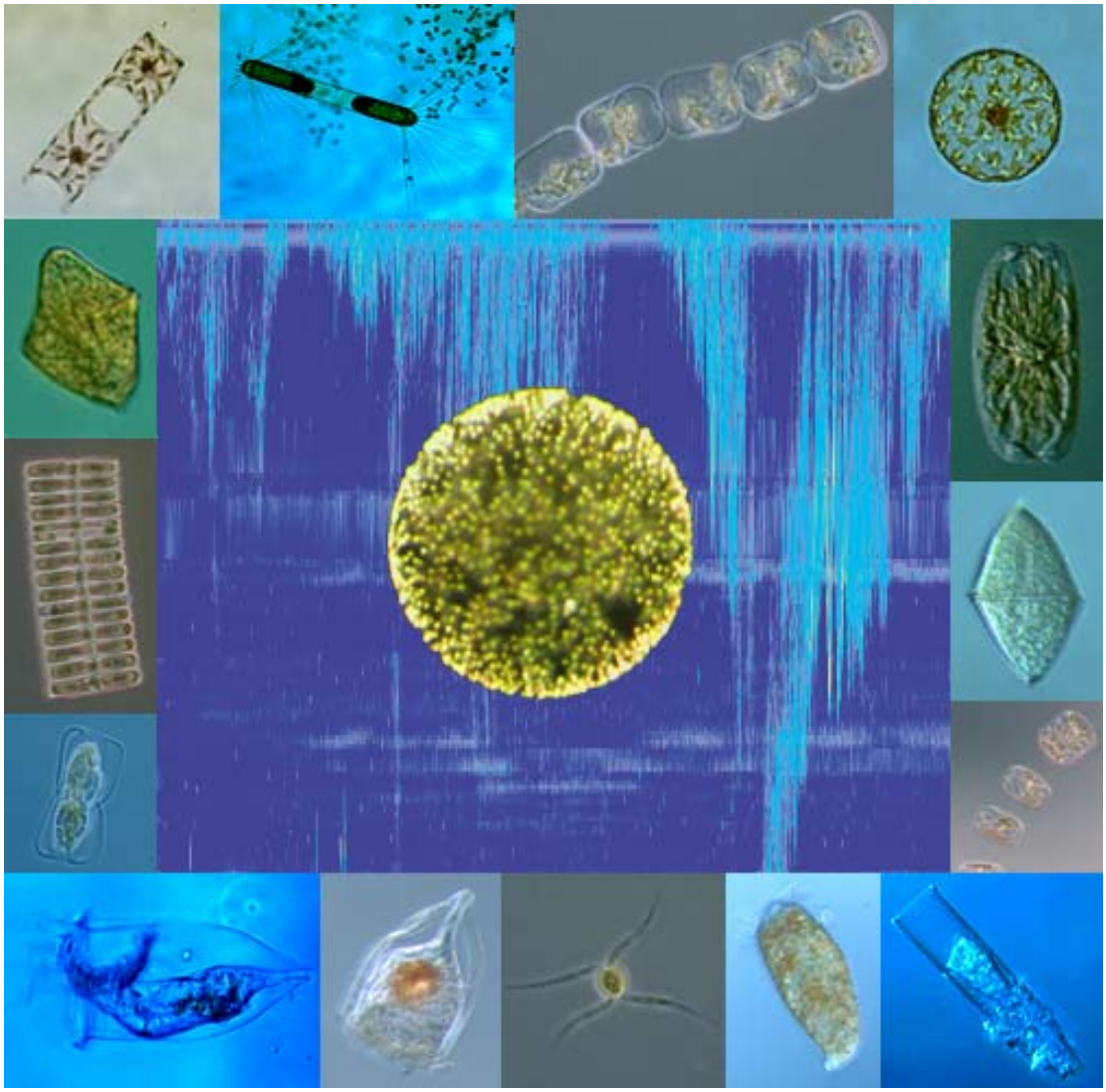

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United States Antarctic Program

RVIB Nathaniel B. Palmer

Raytheon Polar Services

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Table of Contents

Introduction

The NBP data acquisition systems continuously log data from the instruments used during the cruise. This document describes:

- The structure and organization of the data on the distribution media
- The format and contents of the data strings
- Formulas for calculating values
- Information about the specific instruments in use during the cruise
- A log of acquisition problems and events during the cruise that may affect the data
- Scanned calibration sheets for the instruments in use during the cruise.

The data is distributed on a DVD-R written in ISO9660 format. It is readable by virtually every computing platform.

All data has been packaged in Unix tar archive files. Most tar archives have been compressed using gzip to reduce size. Compressed tar files are identifed by the extension “tgz”. Tools are available on all platforms for uncompressing and de-archiving these formats:

On Macintosh, use Stuffit Expander with DropStuff.

tar, gzip, and gunzip are standard tools on all Unix-based systems.

MultiBeam and BathyW data are distributed separately.

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

Archive Commands

All archives were created using the command:

```
tar [z]cvf archive_name files_to_archive
```

With [z] being used to create “.tgz” archives.

To create a list of the files in the archive, use the Unix command:

```
tar [z]tvf  archive_name  > contents.list
```

where `contents.list` is the name of the file to create

To extract the files from the archive:

```
tar [z]xvf  archive_name file(s)_to_extract
```

Distribution Contents at a Glance

Volume (DVD) 1

```
NBP0508.gmt
NBP0508.mgd
0508_mgd.be
NBP0508.ps
NBP0508.pdf
NBP0508.trk
0508data.doc
instcoef.txt


imagery/     isobars.tar
             ozone.tar
             RadarSat.tar
             Weather.tar
             Ice.tar
             Modis.tar


ocean/ctd/ 0508ctd.tar

process/    0508JGOF.tar
            0508MGD.tar
            0508PROC.tar
            0508PCO2.tar
            0508QC.tar
```

Volume (DVD) 1

```
rvdas/nav/  0508adcp.tar
            0508gp02.tar
            0508gyr1.tar
            0508PCOD.tar
            0508seap.tar
            0508trax.tar

rvdas/uw/   0508bat1.tar
            0508bwnc.tar
            0508eng1.tar
            0508flr1.tar
            0508gen2.tar
            0508grv1.tar
            0508knud.tar
            0508lwnc.tar
            0508met1.tar
            0508pco2.tar
            0508pguv.tar
            0508sim1.tar
            0508svp1.tar
            0508tsg1.tar
            0508uwnc.tar

other/      GUV_PUV.zip
            0508rep.zip
            castlog.zip
            IceLogs.zip
            Chloroph.zip
            Sit_reps.zip
            Water_s.zip
            PUV.zip
            Maps.zip
```

Distribution Contents

CRUISE INFORMATION

NBP0508 was an Antarctic science cruise that took place on the R/V Nathaniel B Palmer. It departed Lyttelton, New Zealand on October 26, 2005 and returned to Lyttelton, New Zealand on December 11, 2005.

The purpose of NBP0508 was to conduct several types of studies in the Ross Sea Polynya region. The Neale (B203), Jeffrey (B200) and Gargett (B208) groups investigated UV effects on phytoplankton and bacteria in the context of vertical mixing (collectively, the Mixing and Ultraviolet Radiation in the Ross Sea or MIXURS project). The Goes (B206) project presented similar goals, and it studied UV effects on fatty acid, carbohydrate and amino acid metabolism in phytoplankton. The Kieber/ Kiene group (B002/266) investigated both photochemical and biological processes affecting the fluxes of dimethylsulfide (DMS) and related sulfur compounds with an emphasis on UV effects. The Gast/Caron group (B207) sampled a variety of Ross Sea pelagic environments to study genetic diversity of protozoan groups. The cruise also hosted an OPP postdoctoral fellow, Brook Nunn, who studied iron acquisition by phytoplankton.

Data collection started on JD299 upon leaving Lyttelton. Data collection ended on JD345 before arriving in Lyttelton. Data was collected within New Zealand's EEZ on both legs of the journey.

The SR-18 was installed on the ship for this cruise. The SR18 is a moderate resolution spectroradiometer that measures spectral UV between 290 and 330 nm which is designed and constructed by the Solar Radiation Lab at the Smithsonian Environmental Research Center. It continuously records incident UV as one minute averages in mW m-2 nm-1 at a wavelength interval of 2 nm from 290 to 324 nm and at 330 nm. Operation features are a cosine-corrected diffuser for light sampling, a filter wheel with 18 2nm-nominal band pass interference filters and one 10 nm band pass filter (at 330 nm) mounted in the periphery, a collimator, and a solar blind R-1657 photomultiplier tube (PMT). The PMT housing is temperature regulated with a thermostated thermoelectric system (25 degrees C). The filter wheel turns at 15 RPM, and spectra from the rotations are averaged over one minute. The PMT current output (which is proportional to the radiation intensity through each filter) is converted to a voltage and measured by a precision 18 bit A/D converter. An on-board microprocessor acquires the voltages and produces a text output which is transmitted by an RS-422 interface. SR-18 data was collected through the ship's data acquisition system. SR-18 data files are labeled with the prefix 'gen2.'

Cruise Tracks

In the root directory of the distribution DVD there are two printable/viewable files of the cruise track: NBP0508.ps and NBP0508.jpg. There is also a data file, NBP0508.trk that contains the latitude and longitude at one minute intervals extracted from the NBP0508.gmt file.

Satellite Images

Satellite images processed during this cruise can be found in the directory /images in the following tar files: `isobars.tar, ozone.tar, RadarSat.tar, Weather.tar and Ice.tar`. Ice and weather files are named using the convention, IdDDDYYA.jpg where:

Id = image type (ice = ice, wx = weather)
DDD = year-day
YY = year
A = allows for multiple images of one type for one day

Science Reports

Weekly cruise science reports will be found in the directory /other.

NBP DATA PRODUCTS

Two primary datasets are generated on each NBP cruise: JGOFS and MGD77. The MGD77 and JGOFS datasets are processed data. They have had all calibrations applied, and they have been cleaned of obviously bad data.

Postscript-format plots of processed data for each day of collection are located in: /process/0508QC.tar

The raw data is distributed in the /rvdas directory.

The data processing scripts create a number of intermediate files. These files are included on the data distribution media in the file /process/0508PROC.tar. They are included to make re-processing easier in the event of an error, but no detail of the formats is included in this document. If you have any questions, please contact itvessel@usap.gov.

JGOFS

The JGOFS data set can be found on the distribution media in the file /process/0508JGOF.tar. The archive contains one file produced for each day named jgDDD.dat, where DDD is the year-day the data was acquired. Each daily file consists of 22 columnar fields in text format as described in the table below. The JGOFS data set is created from calibrated data decimated at one-minute intervals. Several fields are derived measurements from more than a single raw input. For example, Course Made Good (CMG) and Speed Over Ground (SOG) are calculated from gyro and GPS inputs. Daily plots during the cruise are produced from the JGOFS data set. Note: Null, unused, or unknown fields are indicated as “NAN” or 9999 in the JGOFS data.

Field	Data	Units
01	GMT date	dd/mm/yy
02	GMT time	hh:mm:ss
03	NGL latitude (negative is South)	tt.tttt
04	NGL longitude (negative is West)	ggg.gggg
05	Speed over ground	Knots
06	GPS HDOP	-
07	Gyro Heading	Degrees (azimuth)
08	Course made good	Degrees (azimuth)
09	Mast PAR	μEinsteins/meter^2 sec
10	Sea surface temperature	°C
11	Sea surface conductivity	siemens/meter
12	Sea surface salinity	PSU
13	Sea depth (uncorrected, calc. sw sound vel. 1500 m/s)	meters
14	True wind speed (max speed windbird)	meters/sec
15	True wind direction (max speed 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

MGD77

The MGD77 data set is contained in a single file for the entire cruise. It can be found in the top level of the distribution data structure as NBP0508.mgd. The file NBP0508.gmt is created from the MGD77 dataset using the "mgd77togmt" utility. NBP0508.gmt can be used with the GMT plotting package.

There are two GMT files on the data set. They are the same file--one is in little endian format (for linux) and the other is in big endian format (for Sun). Big endian format is labeled 0508mgd.tar.be

The data used to produce the NBP0508.mgd file can be found on the distribution media in the file /process/0508PROC.tar. The data files in the archive contain a day's data and follow the naming convention Dddd.fnl.gz, where ddd is the year-day. These files follow a space-delimited columnar format that may be more accessible for some purposes. They contain data at one-second intervals rather than one minute and are individually "gzipped" to save space. Below is a detailed description of the MGD77 data set format. The other files in the archive contain interim processing files and are included to simplify possible reprocessing of the data using the RVDAS NBP processing scripts.

All decimal points are implied. Leading zeros and blanks are equivalent. Unknown or unused fields are filled with 9's. All "corrections", such as time zone, diurnal magnetics, and EOTVOS, are included.

Col	Len	Type	Contents	Description, Possible Values, Notes
1	1	Int	Data record type	Set to "5" for data record
2-9	8	Char	Survey identifier	
10-12	3	int	Time zone correction	Corrects time (in characters 13-27) to GMT when added; 0 = GMT
13-16	4	int	Year	4 digit year
17-18	2	int	Month	2 digit month
19-20	2	int	Day	2 digit day
21-22	2	Int	Hour	2 digit hour
23-27	5	real	Minutes x 1000	
28-35	8	real	Latitude x 100000	+ = North - = South. (–9000000 to 9000000)
36-44	9	real	Longitude x 100000	+ = East - = West. (–18000000 to 18000000)
45	1	int	Position type code	1=Observed fix 3=Interpolated 9=Unspecified
46-51	6	real	Bathymetry, 2- way travel time	In 10,000th of seconds. Corrected for transducer depth and other such corrections
52-57	6	real	Bathymetry, corrected depth	In tenths of meters.
58-59	2	int	Bathymetric correction code	This code details the procedure used for determining the sound velocity correction to depth
60	1	int	Bathymetric type code	1 = Observed 3 = Interpolated (Header Seq. 12) 9 = Unspecified
61-66	6	real	Magnetics total field, 1^{ST} sensor	In tenths of nanoteslas (gammas)
67-72	6	real	Magnetics total field, 2^{ND} sensor	In tenths of nanoteslas (gammas), for trailing sensor
73-78	6	real	Magnetics residual field	In tenths of nanoteslas (gammas). The reference field used is in Header Seq. 13
79	1	int	Sensor for residual	1 = 1^{st} or leading sensor

Col	Len	Type	Contents	Description, Possible Values, Notes
			field	2 = 2nd or trailing sensor 9 = Unspecified
80-84	5	real	Magnetics diurnal correction	In tenths of nanoteslas (gammas). (In nanoteslas) if 9-filled (i.e., set to "+9999"), total and residual fields are assumed to be uncorrected; if used, total and residuals are assumed to have been already corrected.
85-90	6	F6.0	Depth or altitude of magnetics sensor	(In meters) + = Below sea level 3 = Above sea level
91-97	7	real	Observed gravity	In 10th of mgals. Corrected for Eotvos, drift, tares
98-103	6	real	EOTVOS correction	In 10th of mgals. E = 7.5 V cos phi sin alpha + 0.0042 V*V
104-108	5	real	Free-air anomaly	In 10th of mgals G = observed G = theoretical
109-113	5	char	Seismic line number	Cross-reference for seismic data
114-119	6	char	Seismic shot number	
120	1	int	Quality code for navigation	5=Suspected, by the originating institution 6=Suspected, by the data center 9=No identifiable problem found

SCIENCE OF OPPORTUNITY

ADCP

The shipboard ADCP system measures currents in a depth range from about 30 to 300 m -- in good weather. In bad weather or in ice, the range is reduced, and sometimes no valid measurements are made. ADCP data collection is the OPP-funded project of Eric Firing (University of Hawaii) and Teri Chereskin (Scripps Institution of Oceanography). Data is collected on both the LMG and the NBP for the benefit of scientists on each cruise, and for the long-term goal of building a profile of current structure in the Southern Ocean.

A data feed is sent from the ADCP system to RVDAS whenever a reference layer is acquired. This feed contains east and north vectors for ship's speed, relative to the reference layer, and ship's heading. Collected files (one per day) are archived in `0508adcp.tar` in the directory `/rvdas/nav`.

pCO_2

The NBP carries a pCO_2 measurement system from Lamont-Doherty Earth Observatory (LDEO). pCO_2 data is recorded by RVDAS and transmitted to LDEO at the end of each cruise. You will find pCO_2 data in a file named `0508PCO2.tar` in the `/process` directory, which contains the pCO_2 instrument's data merged with GPS, meteorological and other oceanographic measurements. For more information contact: Colm Sweeney (csweeney@ldeo.columbia.edu).

CRUISE SCIENCE

CTD

CTDs were performed on the cruise for several purposes, including observing the near-surface (< 200 m) profile of biological and physical parameters, observing fine-scale density structure for the purpose of estimating turnover scales, taking water samples with the CTD rosette bottles, and observing biological and physical parameters in deep waters (> 200 m). The most common type of cast combined fine-structure observations over a series of 2-4 repeated up and down profiles ("yo-yo's") with rosette water samples. Details on type of cast and bottle depths sampled are in the file castlog_0508.xls.

Ctd data has been placed in /`ocean/ctd/0508ctd.tar`.

RVDAS

The Research Vessel Data Acquisition System (RVDAS) was developed at Lamont-Doherty Earth Observatory of Columbia University and has been in use on its research ship for many years. It has been extensively adapted for use on the USAP research vessels.

Daily data processing of the RVDAS (Research Vessel Data Acquisition System) data is performed to calibrate and convert values into useable units and as a check of the proper operation of the DAS. Both raw and processed data sets from RVDAS are included in the data distribution. The tables below provide detailed information on the sensors and data. Be sure to read the "Significant Acquisition Events" section for important information about data acquisition during this cruise.

Sensors and Instruments

RVDAS data is divided into two general categories, *underway and navigation*. They can be found on the distribution media as subdirectories under the top level rvdas directory: `/rvdas/uw`, and `/rvdas/nav`. Processed oceanographic data is in the top level directory, `/process`. Each instrument or sensor produces a data file named with its channel ID. Not all data types are collected every day or on every cruise.

The naming convention for data files produced by the sensors and instruments is

NBP[CruiseID][ChannelID].dDDD

Example: `NBP0107met1.d317`

- The CruiseID is the numeric name of the cruise, in this case, NBP0507.
- The ChannelID is a 4-character code representing the system being logged. An example is "met1," the designation for meteorology.
- DDD is the day of year the data was collected

Underway Sensors

Meteorology and Radiometry

Measurement	Channel ID	Collect. Status	Rate	Instrument
Air Temperature	met1	continuous	1 sec	R. M. Young 41372LC
Relative Humidity	met1	continuous	1 sec	
Wind Speed/Direction	met1	continuous	1 sec	R.M. Young 05106
Barometer	met1	continuous	1 sec	R.M. Young 61201
PIR (LW radiation)	met1	continuous	1 sec	Eppley PIR

Measurement	Channel ID	Collect. Status	Rate	Instrument
PSP (SW radiation)	met1	continuous	1 sec	Eppley PSP
PAR	met1	continuous	1 sec	BSI QSR-240
GUV	pguv	continuous	2 sec	BSI GUV-2511
PUV	pguv	continuous	2 sec	BSI PUV-2500

Geophysics

Measurement	Channel ID	Collect. Status	Rate	Instrument
Gravimeter	grv1	continuous	10 sec*	LaCoste & Romberg
Magnetometer	mag1	not collected	15 sec	EG&G G-866
Bathymetry	bat1	continuous*	Varies	ODEC Bathy 2000
Bathymetry	knu1	continuous*	Varies	Knudsen 320B/R
Bathymetry	sim1	during ctd's	Varies	Simrad EK500 Sonar

*Data is output every second but it only changes every 10 seconds.

*The Bathy 2000 and Knudsen both collected data during NBP0508. These instruments did not collect data simultaneously.

Oceanography

Measurement	Channel ID	Collect. Status	Rate	Instrument
Conductivity	tsg1	continuous	6 sec	SeaBird SBE-21
Salinity	tsgfl	continuous	6 sec	Calc. from pri. temp
Sea Surface Temp	tsg1	continuous	6 sec	SeaBird 3-01/S
Fluorometry	flr1	continuous	1 sec	Turner 10-AU-005
Fluorometry	flr1 & tsg1	continuous	6 sec	
Transmissometry	tsg1	continuous	6 sec	WET Lab C-Star
pCO_2	pco2	continuous	70 sec	(LDEO)
ADCP	adcp	continuous	varies	RD Instruments

Navigational Instruments

Measurement	Channel ID	Collect. Status	Rate	Instrument
Trimble GPS	PCOD	continuous	1 sec	Trimble 20636-00SM
Gyro	gyr1	continuous	0.2 sec	Yokogawa Gyro
SeaPath	seap	continuous	1 sec	SeaPath 200

DATA

Data is received by the RVDAS system via RS-232 serial connections. A time tag is added at the beginning of each line of data in the form,

```
yy+dd:hh:mm:ss.sss [data stream from instrument]
```

where

yy = two-digit year
ddd = day of year
hh = 2 digit hour of the day
mm = 2 digit minute
ss.sss = seconds

All times are reported in UTC.

The delimiters that separate fields in the raw data files are often spaces and commas but can be other characters such as : = @. Occasionally no delimiter is present. Care should be taken when reprocessing the data that the field's separations are clearly understood.

In the sections below a sample data string is shown, followed by a table that lists the data contained in the string.

Underway Data

Sound Velocity Probe (svp1)

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

Field	Data	Units
1	RVDAS Time tag	
2	Sound velocity in ADCP sonar well	m/s

Meteorology (met1)

```
01+322:00:03:27.306 04.5 292 010 05.7 294 010 0959.6 000.2 093.0 -
000.1537 0001.0886 0012.8248
```

Field	Data	Units
1	RVDAS time tag	
2	Port anemometer speed (relative)	m/s
3	Port anemometer direction (relative)	deg
4	Port anemometer standard deviation	deg
5	Starboard anemometer speed (relative)	m/s
6	Starboard anemometer direction (relative)	deg
7	Starboard anemometer standard deviation	deg
8	Barometer	mBar
9	Air temperature	°C
10	Relative humidity	%
11	PSP (short wave radiation)*	mV
12	PIR (long wave radiation)*	mV
13	PAR (photosynthetically available radiation)*	mV

*See page 19 for calculations.

Gravimeter (grv1)

There are now two sets of fields output by the gravity meter. The data record is output once per second, and identified by "$DAT" in the id field. A summary of sensor environmental data is output every ten seconds, identified by "%ENV" in the id field.

Data record ($DAT):

05+194:00:00:27.995 $DAT,2005/ 7/13, 0: 7: 7.36,194, 9050.37, 9050.06, 5410.86, -0.00, -0.01, -0.02, 0.00, 0.00, 0.70, 0.19, -0.12, -0.25, 0.00, -69.45711315, -54.32181487, 0.000, 285.200

Field	Data	Conversion	Units
1	RVDAS time tag		
2	Text string (id field)	$DAT for data record	
3	Date	YYYY/MM/DD	
4	Time	HH:MM:SS.SS	
5	Day of Year	DDD	
6	Gravity count	mgal = count x 1.0046 + offset	count
7	Spring Tension		CU
8	Beam Position	Volts x 750,000	
9	VCC		
10	AL		
11	AX		
12	VE		
13	AX2		
14	XACC2		
15	LACC2		
16	CROSS ACCEL		GAL
17	LONG ACCEL		GAL
18	EOTVOS CORR		MGAL
19	LONGITUDE		Degrees
20	LATITUDE		Degrees
21	HEADING		Degrees
22	VELOCITY		Knots

Environmental record ($ENV)

```
05+183:19:13:10.945 %ENV,2005/ 7/ 2,19:19:52.16,183,S-036/V1.5,    3.34,
47.19,   20.34,1.111840E-1,-0.57700,-0.10591, 0.40180, 2.55260, 0.43000,
1, 300
```

Field	Data	Conversion	Units
1	RVDAS time tag		
2	Text string (id field)	$ENV for environmental record	
3	Date	YYYY/MM/DD	
4	Time	HH:MM:SS.SS	
5	Day of Year	DDD	
6	Meter ID		
7	Meter Pressure		inch-Hg
8	Meter temp		°C
9	Ambient temp		°C
10	K-Factor		
11	VCC Coeff		

Field	Data	Conversion	Units
12	AL Coeff		
13	AX Coeff		
14	VE Coeff		
15	AX2 Coeff		
16	Serial Filter Length		Seconds
17	QC Filter Length		Seconds

Bathy 2000 (bat1)

```
00+019:23:59:53.901 ;I04485.3ME -23.0, I00000.0,-99.9,0000@01/11/00,
23:59:52.08 PW2 PF1 SF1 PL3 MO4 SB3 PO0 TX1 TR: GM5 1500 06.7 -72.1
```

Field	Data	Format / Possible Values	Units
1	RVDAS time tag		
2	Flagged low frequency chn. depth w/ units	;FDDDDD.Dun where F = flag (V for valid, I for invalid), D=depth, un = units	meters
3	Low Frequency echo strength	EEE.EE	dB
4	Flagged high freq. chn. depth	not used	
5	High frequency echo strength	not used	
6	Signed heave data	SHHHH	cm
7	Date	mm/dd/yy	
8	Time	hh:mm:ss	
9	Transmit pulse window type	PW1=Rectangular PW2=Hamming PW3=Cosine PW4=Blackman	
10	Primary transmit frequency	PF1=3.5 kHz PF2=12.0 kHz	kHz
11	Parametric mode secondary frequency	SF1=3.5 kHz SF2=12.0 kHz	kHz
12	Pulse length	PL1=200usec PL2=500usec PL3=1msec PL4=2msec PL5=5msec PL6=10msec PL7=25msec If transmit mode is FM: PL1=25msec PL2=50msec PL3=100msec	
13	Operating mode	MO1=CW parametric MO2=CW MO3=FM parametric MO4=FM	
14	Frequency sweep bandwidth	SB1=1 kHz SB2=2 kHz SB3=5 kHz	kHz
15	Power level	PO1 = 0dB PO2 = -6dB PO3 = -12dB PO4 = -18dB PO5 = -24dB PO6 = -30dB PO6 = -30 dB	

Field	Data	Format / Possible Values	Units
		PO7 = -36dB PO8 = -42dB	
16	Transmit mode	TX1=single ping active TX2=pinger listen TX3=multipinging TR TX4=multipinging TR TX5=multipinging TTRR TX6=multipinging TTTTRRRR TX7=multipinging TTTTTRRRRR	
17	Transmit Rate	TR3 = 4Hz TR4 = 2Hz TR5 = 1Hz TR6 = .5Hz TR7 = .33Hz TR8 = .25Hz TR9 = .20Hz TR: = .10Hz TR; = .05Hz	Hz
18	System gain mode	GM0=hydrographic AGC GM1 to GM9=hydrographic +3db to + 27db manual. GMA to GMD=hydrographic + 30db through + 60db manual GME to GMK=sub-bottom 1 through sub-bottom 7	
19	Speed of sound		m/sec
20	Depth of sonar window below sea-level		meters
21	Background noise level in fixed point reference		dB/V

Knudsen (knud)

```
99+099:00:18:19.775 HF,305.2,LF,304.3
```

Field	Data	Units
1	RVDAS time tag	
2	HF = High frequency flag (12 kHz)	
3	High frequency depth	meters
4	LF = Low frequency flag (3.5 kHz)	
5	Low frequency depth	meters

Simrad EM120 (mbdp)

Field	Data	Units
1	LDTDS	
2	$EMDPT	
3	Depth (corrected)	Meters

Simrad EK500 (sim1)

```
00+005:00:00:52.388 D1,23583509,1479.6, 17,  1,  0
```

Field	Data	Units
1	RVDAS time tag	
2	Header	
3	Time tag	hhmmss.sss
4	Depth	m
5	Bottom surface backscattering strength	dBar
6	Transducer number (1 = 38 kHz)	
7		

Thermosalinograph (tsg1)

```
00+019:23:59:46.976 15A16CFC163F8C2C100
```

Field	Data	Units
1	RVDAS time tag	
2	Seabird hex string (see page 19 for conversion to real units)	

Fluorometer (flr1)

```
00+019:23:59:58.061 0  0818 ::  1/19/00 17:23:17 = 0.983  (RAW)   1.2 (C)
```

Field	Data	Units
1	RVDAS time tag	
2	Marker 0 to 8	
3	4-digit index	
4	Date	mm/dd/yy
5	Time	hh:mm:ss
6	Signal	
7	Signal units of measurement	
8	Cell temperature (if temperature compensation package is installed)	
9	Temperature units (if temperature compensation package is installed)	

pCO_2

```
00+021:23:59:43.190 2000021.99920 2382.4 984.2 30.73 50.8 345.9 334.1 -1.70
-68.046 -144.446 Equil
```

Field	Data	Units
1	RVDAS time tag	
2	pCO_2 time tag (decimal is fractional time of day)	yyyyddd.ttt
3	Raw voltage (IR)	mV
4	Cell temperature	°C
5	Barometer	MBar
6	Concentration	ppm
7	Equilibrated temperature	°C
8	pCO_2 pressure	microAtm
9	Flow rate	ml / min
10	Source ID #	1 or 2 digits
11	Valve position	1 or 2 digits
12	Flow source (Equil = pCO_2 measurement)	text

Navigational Data

Seapath GPS (seap)

The Seapath GPS outputs seven data strings, four in NMEA format and two in proprietary PSXN format:

- GPZDA
- GPGGA
- GPVTG
- GPHDT
- PSXN, 20
- PSXN, 22
- PSXN, 23

GPZDA

```
02+253:00:00:00.772 $GPZDA,235947.70,09,09,2002,,*7F
```

Field	Data	Units
1	RVDAS time tag	
2	$GPZDA	
3	time	hhmmss.ss
4	Day	dd
5	Month	mm
6	Year	yyyy
7	(empty field)	
8	Checksum	

GPGGA

```
02+253:00:00:00.938
GPGGA,235947.70,6629.239059,S,06827.668899,W,1,07,1.0,11.81,M,,M,,*6F
```

Field	Data	Units
1	RVDAS time tag	
2	$GPGGA	
3	time	hhmmss.ss
4	Latitude	ddmm.mmmmmm
5	N or S for north or south latitude	
6	Longitude	ddmm.mmmmmm
7	E or W for east or west longitude	
8	GPS quality indicator, 0=invalid, 1=GPS SPS, 2=DGPS, 3=PPS, 4=RTK, 5=float RTK, 6=dead reckoning	
9	number of satellites in use (00-99)	
10	HDOP	x.x
9	height above ellipsoid in meters	m.mm
11	M	
12	(empty field)	
13	M	
14	age of DGPS corrections in seconds	s.s
15	DGPS reference station ID (0000-1023)	
16	Checksum	

GPVTG

```
02+253:00:00:00.940 $INVTG,19.96,T,,M,4.9,N,,K,A*39
```

Field	Data	Units
1	RVDAS time tag	
2	$GPVTG	
3	course over ground, degrees true	d.dd
4	T	
5	,	
6	M	
7	speed over ground in knots	k.k
8	N	
9	,	
10	K	
11	Mode	
12	Checksum	

GPHDT

```
02+253:00:00:00.941 $GPHDT,20.62,T*23
```

Field	Data	Units
1	RVDAS time tag	
2	$GPHDT	
3	Heading, degrees true	d.dd
4	T	
5	Checksum	

PSXN,20

```
02+253:00:00:00.942 $PSXN,20,0.43,0.43*39
```

Field	Data	Units
1	RVDAS time tag	
2	$PSXN	
3	20	
4	Horizontal position & velocity quality: 0=normal, 1=reduced performance, 2=invalid data	
5	Height & vertical velocity quality: 0=normal, 1=reduced performance, 2=invalid data	
6	Heading quality: 0=normal, 1=reduced performance, 2=invalid data	
7	Roll & pitch quality: 0=normal, 1=reduced performance, 2=invalid data	
8	Checksum	

PSXN,22

```
02+253:00:00:00.942 $PSXN,22,0.43,0.43*39
```

Field	Data	Units
1	RVDAS time tag	
2	$PSXN	
3	22	
4	gyro calibration value since system start-up in degrees	d.dd
5	short term gyro offset in degrees	d.dd
6	Checksum	

PSXN,23

```
02+253:00:00:02.933 $PSXN,23,0.47,0.57,20.62,0.03*0C
```

Field	Data	Units
1	RVDAS time tag	
2	$PSXN	
3	23	
4	roll in degrees, positive with port side up	d.dd
5	pitch in degrees, positive with bow up	d.dd
6	Heading, degrees true	d.dd
7	heave in meters, positive down	m.mm
8	Checksum	

Trimble (P-Code) GPS (PCOD)

The Trimble GPS, which formerly output Precise Position (*P-Code*) strings, but now only outputs Standard Position (*Civilian*) strings, outputs three NMEA standard data strings:

- Position fix (GGA)
- Latitude / longitude (GLL),
- Track and ground speed (VTG)

GGA: GPS Position Fix – Geoid/Ellipsoid

```
01+319:00:04:11.193 $GPGGA,000410.312,6227.8068,S,06043.6738,W,1,06,1.0,
031.9,M,-017.4,M,,*49
```

Field	Data	Units
1	RVDAS Time tag	
2	$GPGGA	
3	UTC time at position	hhmmss.sss
4	Latitude	ddmm.mmm
5	North (N) or South (S)	
6	Longitude	ddmm.mmm
7	East (E) or West (W)	
8	GPS quality: 0 = Fix not available or invalid 1 = GPS, SPS mode, fix valid 2 = DGPS (differential GPS), SPS mode, fix valid 3 = P-CODE PPS mode, fix valid	
9	Number of GPS satellites used	
10	HDOP (horizontal dilution of precision)	
11	Antenna height	meters
12	M for meters	
13	Geoidal height	meters
14	M for meters	
15	Age of differential GPS data (no data in the sample string)	
16	Differential reference station ID (no data in the sample string)	
17	Checksum (no delimiter before this field)	

GLL: GPS Latitude/Longitude

```
01+319:00:04:11.272 $GPGLL,6227.8068,S,06043.6738,W,000410.312,A*32
```

Field	Data	Units
1	RVDAS Time tag	

Field	Data	Units
2	$GPGLL	
3	Latitude	degrees
4	North or South	
5	Longitude	degrees
6	East or West	
7	UTC of position	hhmmss.sss
8	Status of data (A = valid)	
9	Checksum	

VTG: GPS Track and Ground Speed

```
01+319:00:04:11.273 $GPVTG,138.8,T,126.0,M,000.0,N,000.0,K*49
```

Field	Data	Units
1	RVDAS time tag	
2	$GPVTG	
3	Heading	degrees
4	Degrees true (T)	
5	Heading	degrees
6	Degrees magnetic (M)	
7	Ship speed	knots
8	N = knots	
9	Speed	km/hr
10	K = km per hour	
11	Checksum	

Gyro Compass (gyr1)

```
00+019:23:59:59.952 $HEHDT 25034,-020*73
```

Field	Data	Units
1	RVDAS time tag	
2	$HEHDT	
3	Heading, Degrees True	degrees
4	Rate of change SYYY S = +/-, YYY = r.rr	
5	Checksum	

ADCP Course (adcp)

```
05+209:15:04:14.575 $PUHAW,UVH,9.95,-0.98,99.7
```

Field	Data	Units
1	RVDAS time tag	
2	$PUHAW	
3	UVH (E-W, N-S, Heading)	
4	Ship Speed relative to reference layer, east vector	knots
5	Ship Speed relative to reference layer, north vector	knots
6	Ship heading	degrees

Processed Data

pCO2-merged

```
00+346:23:58:20.672 2000346.9991 2398.4 1008.4 0.01 45.4 350.3 342.6
15.77 Equil -43.6826 173.1997 15.51 33.90 0.33 5.28 9.05 1007.57 40.0
14.87 182.44
```

Field	Data	Units
1	RVDAS time tag	
2	PCO_2 time tag (decimal is time of day)	yyyddd.ttt
3	Raw voltage	mV
4	Barometer	mB
5	Cell temperature	°C
6	Flow rate	cm^3/min
7	Concentration	ppm
8	PCO_2 pressure	microAtm
9	Equilibrated temperature	°C
10	Flow Source (Equil = pCO_2 measurement)	
11	RVDAS latitude	degrees
12	RVDAS longitude	degrees
13	TSG external temperature	°C
14	TSG salinity	PSU
15	TSG fluorometry	V
16	RVDAS true wind speed	m/s
17	RVDAS true wind direction	degrees
18	Barometric Pressure	mBars
19	Uncontaminated seawater pump flow rate	l/min
20	Speed over ground	knots
21	Course made good	degrees

tsgfl

```
00+075:00:00:04.467 -01.488 -01.720 02.6783 33.63748 1.002442 0.002442
```

Field	Data	Units
1	RVDAS time tag	
2	Internal water temperature	°C
3	Sea Surface Temperature	°C
4	Conductivity	μSiemens
5	Salinity	PSU
6	Fluorometry	V
7	Transmissivity	V

Calculations

The file `instcoef.txt` located in the `/` directory contains the calibration factors for shipboard instruments. This was the file used by the RVDAS processing software.

TSG

Raw TSG data is stored as a 20 byte (character) long hex string

Bytes	Data
1-4	Sensor Temperature
5-8	Conductivity
9-14	Remote Temperature
15-17	Fluorometer voltage
18-20	Transmissometer voltage

The coefficients for temperature and conductivity sensors can be found the rvdascal.txt file and on the calibrations sheets in the appendix.

Calculating Temperature – ITS-90

T = decimal equivalent of bytes 1-4
Temperature Frequency: f = T/19 +2100
Temperature = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Calculating Conductivity – ITS-90

C = decimal equivalent of bytes 5-8
Conductivity Frequency f = sqrt(C*2100+6250000)
Conductivity = $(g + hf^2 + if^3 + jf^4)/[10(1 + \delta t + \varepsilon p)]$ (siemens/meter)
t = temperature (°C); p = pressure (decibars); δ = Ctcor; ε = CPcor

Calculating Fluorometry Voltage

f = decimal equivalent of bytes 15-17
Fluorometry Voltage = f/819

Calculating Transmittance

V_{dark} = 0.058 V
V_{ref} = 4.765 V
t = decimal equivalent of bytes 18 – 20
Transmissometer Voltage (V_{signal}) = t/819
% Transmittance = $(V_{signal} - V_{dark}) / (V_{ref} - V_{dark})$

PAR

raw data = mV
calibration scale = 6.27 V/(μEinstiens/cm ^{2}sec)
offset (V_{dark}) = 0.3 mV
(*raw* mV - V_{dark})/scale x 10^4 cm^2/m^2 x 10^{-3} V/mV= μEinstiens/m^2sec
or
(*data* mV – 0.3 mV) x 1.65 (μEinstiens/m^2sec)/mV = μEinstiens/m^2sec

PIR

raw data = mV

calibration scale = 3.86 x 10^{-6} V/(W/m^2)
data mV / (scale x 10^3 mV/V) = W/m^2
or
data mV x 242.1(W/m^2)/mV = W/m^2

PSP

raw data = mV
calibration scale = 8.19 x 10^{-6} V/(W/m^2)
data mV / (scale x 10^3 mV/V) = W/m^2
or
data mV x 120.7 (W/m^2)/V = W/m^2

Acquisition Problems, Events, and Notes

This section lists problems with acquisition noted during this cruise including instrument failures, data acquisition system failures and any other factor affecting this data set. The format is ddd:hh:mm (ddd is year-day, hh is hour, and mm is minute). Times are reported in GMT.

Issues were encountered with sensors on NBP0508 as follows:

- The Knudsen generated bathymetry data on NBP0508. The Knudsen stopped functioning on JD303. The Bathy 2000 collected bathymetry data while the Knudsen was repaired. The (repaired) Knudsen replaced the Bathy on JD318. The Knudsen collected bathymetry data for the remainder of the cruise.
- Simrad (Sim1) logging took place during CTD's.
- The ADCP interfered with the HTI, and therefore it was turned off at various times during the cruise.
- GUV logging was disabled when PUV casts took place.
- During deep CTD casts, the Knudsen was put in "pinger" mode. Knudsen logging was affected during these times.

Start	End	Description
299:10:00		Started instrument logging, departed Lyttelton, New Zealand.
302:13:30		Left New Zealand EEZ.
303:00:35		End of good data collection from Knudsen. Knudsen replaced with Bathy 2000.
303:01:28		Bathy 2000 logging enabled.
308:19:44	308:20:15	Stop GUV logger for PUV cast (Restart GUV logger.). Reset GUV update rate to 65 at request of Science Party. Restart GUV logging at 20:15.
311:23:37		Turned on ADCP BT.
313:07:56	313:23:13	ADCP not collecting data. ADCP back online at 23:13.
314:00:45		Restarted GUV after PUV cast.
315:00:20		ADCP restarted.
315:22:50		ADCP restarted.
316:06:50		ADCP restarted.
316:09:21		ADCP enabled.
317:02:20	317:02:29	Primary data logging server locked up. Server back online/data logging resumed within 10 min.
317:09:00		Approx time when Bathy was turned off at request of Science Party.
317:13:23		Bathy pinging and logging restarted.
318:05:36		Stopped Bathy 2000 logging. Switched to Knudsen for remainder of cruise.
318:05:50		Started Knudsen logging.
318:10:26	320:21:07	ADCP enabled.

320:23:43	321:17:30	ADCP enabled.
321:06:23	321:07:15	At the request of PI stopped logging & processed 6 hours of data
323:23:20		Sim transducer set to passive; Sim output off
324:00:08		Start Sim 38kHz, Sim output on.
324:00:15	324:10:45	PCO2 logging stopped. Restarted program.
326:14:10	326:14:17	Primary data logging server locked up. Server back online/data logging resumed within 10 min.
326:21:00		Entered new sound velocity in Knudsen based on CTD = 1440m/s.
326:23:16	327:13:05	ADCP enabled.
327:01:45	327:04:27	Knudsen data collection offline.
327:14:52	327:16:51	ADCP enabled.
328:11:55	328:14:49	ADCP enabled.
329:22:43	330:00:49	Knudsen data collection offline.
330:07:03	330:18:26	Knudsen logging junk data. Knudsen back online at 18:26.
333:06:17		Started GUV.
333:11:59		Started Knudsen – low frequency.
334:04:50		ADCP enabled.
336:13:08	336:13:32	Knudsen disabled due to serial connector issue.
339:05:20		GUV restarted.
342:11:23		Entered New Zealand EEZ.
343:19:31	343:20:43	ADCP's disabled for CTD cast.
344:00:00		Ended data logging for NBP0508.

Appendix: Sensors and Calibrations

NBP0508 Sensors

Sensor	Description	Serial #	Last Calibration Date	Comments
Meteorology & Radiometers				
Port Anemometer	RM Young 5106	WM46262	12/12/04	Port side installed 8/7/05
Stbd Anemometer	RM Young 5106	WM51143	10/07/05	Stbd side installed 10/22/05
Barometer	RM Young 61201	01706	04/23/05	Installed 04/23/05
Humidity/Wet Temp	RM Young 41372LC	06733	06/24/05	Installed 4/23/05
PIR (Pyrgeometer)	Eppley PIR	33023F3	01/20/05	Installed 4/25/05
PSP (Pyranometer)	Eppley PSP	33090F3	11/8/04	Installed 4/25/05
PAR (Mast)	BSI-QSR-240	6356	05/16/05	Installed 7/16/05
GUV (Mast)	BSI GUV-2511	25110203114	09/07/05	Installed 10/3/04
PUV (Underwater)	BSI PUV-2500	25000203114	09/07/05	Installed 11/1/05
PRR (Mast)	BSI PRR-610	9696	01/09/04	Installed 11/1/05
PRR (Underwater)	BSI PRR-600	9695	01/09/04	Installed 11/1/05
Underway				
TSG	SeaBird SBE21	2131020-3198	02/01/05	Installed 2/27/05
TSG Remote Temp	SeaBird 3-01/S	031267	01/27/05	Installed 4/23/05
Fluorometer	Turner 10-AU-005	5333-FRXX	N/A	Installed 4/14/04
Transmissometer	WET Labs C-Star	CST-557DR	04/07/05	Installed 9/16/05
Magnetometer	EG&G G-866		n/a	
Gravimeter	LaCoste & Romberg Gravity Meter		n/a	Gravity Tie 10/24/05
Bathymetry	Simrad EK500	3001	n/a	
Bathymetry	Knudsen 320B/R		n/a	
Bathymetry	Bathy 2000		n/a	

Other				
P-Code GPS	Trimble 20636-00 (SM)	0220035116	n/a	

NBP0508 CTD Sensors

Sensor	Description	Serial #	Last Calibration Date	Comments
CTD Fish	SeaBird model SBE 9+	09P7536-0328	04/18/05	Installed on 10/28/05 on 30L Rosette
CTD Fish Pressure	Paroscientific model 410K-105 pressure sensor	53980	04/18/05	Installed on 10/28/05 on 30L Rosette
CTD Deck Unit	SeaBird model SBE 11+	11P19858-0490	n/a	
Primary Temperature Sensor	SeaBird model 3-02/F	031541	01/20/05	
Secondary Temperature Sensor	SeaBird model 3-02/F	031649	01/20/05	
Primary Conductivity Sensor	SeaBird model 4-02/0	041431	01/20/05	
Secondary Conductivity Sensor	SeaBird model 4C	042069	01/20/05	
Dissolved Oxygen Sensor	SeaBird model SBE43	430082	02/11/05	
PAR Sensor	Biospherical Instruments QSP-2300	4717	08/16/05	
CTD Fluorometer	WET Labs Chlorophyll Fluorometer	AFLT-009	03/21/05	
CTD Transmissometer	WET Labs C-Star	CST-889DR	08/08/05	
CTD Pump (Primary)	SeaBird 5T, PN 90160	051642 3.0K	12/01/04	
CTD Pump (Secondary)	SeaBird 5T, PN 90160	051645 3.0K	01/10/04	
Bottom Contact Switch	SeaBird	#1	n/a	
Pinger	OIS 6000 (6000m)	5117	n/a	New battery installed 10/30/05
Slip Ring Assembly		1.406	n/a	Installed 3/27/04
Carousel Water Sampler	SeaBird SBE-32	3214153-0140	n/a	Installed 10/25/05 on 30L Rosette

CALIBRATIONS

The following pages are replicas of calibration sheets for the sensors used during this cruise.

Gravity Tie

Gravity Tie Spreadsheet

The fields outlined in BOLD MUST BE FILLED IN for this spreadsheet to operate properly. The automatically calculated values show up in the shaded fields.

Date:	10/24/2005
Location:	**Lyttelton/Christchurch, New Zealand**
Station:	Ranger's Hut, Botanical Gardens
Latitude:	43 31.77 S
Longitude:	172 37.18 E
Elevation:	6.7 meters
Gravity:	980494.29

Reference Code Numbers:

ADIC	0217-0
IGC	48732A
DSIR	P11
GW	79
NHO	16

	Value	Time (GMT)	ST (cu)		Gravity (cu)
Ship's meter before gravity tie (Digital Gravity)	8177.3	00:31		8177.1	8177.3
Ship's meter after gravity tie (Digital Gravity)	8177.3	04:31		8177.7	8177.3
Average	8177.5				
Ship Gravimeter's Calibration Constant	1.0046				
Corrected ship's meter (Digital Gravity)	8215.1				

	Value	Time (GMT)
Ship's meter before gravity tie (serial, RVDAS)	8177.6	00:35
Ship's meter after gravity tie (serial, RVDAS)	8177.6	04:34
Average (for comparison check only)	8177.5	

Portable Gravimeter Correction Divisor 1.007937

Station	Value	Time (GMT)	Temp	Date	OBS mgal, averaged
Pier measurement 1	4122.82	01:12	53.5	October 24, 2005	
Pier measurement 2	4122.83	01:14	53.5	October 24, 2005	4090.34
Pier measurement 3	4122.75	01:15	53.5	October 24, 2005	
Average	4122.80				
Station measurement 1	4091.18	02:26	53.5	October 24, 2005	
Station measurement 2	4091.17	02:28	53.5	October 24, 2005	4058.95
Station measurement 3	4091.16	02:29	53.5	October 24, 2005	
Average	4091.17				
Pier measurement 4	4122.86	04:21	53.5	October 24, 2005	
Pier measurement 5	4122.88	04:22	53.5	October 24, 2005	4090.40
Pier measurement 6	4122.85	04:24	53.5	October 24, 2005	
Average	4122.86				

Gravity offset from last tie	972304.02
Drift since last tie	6.32

OBS Differences	
Station to Pier (1, 2, & 3 averaged)	31.38
Station to Pier (4, 5, & 6 averaged)	31.44
Averaged Differences	31.41
Gravity at pier	980525.70
Elevation of pier above gravimeter, meters	-1.0
Earth differential gravity, mgal/meter	0.3
Gravity at ship's gravimeter	980525.40
Gravity Offset	972310.34

Comments

*** Please clear up discrepancy of which "digital gravity" value to use amongs (ST(cu), Gravity(cu), and QC Gravity) from values above.

*** Also, spreadsheet doesn't seem to be calculating correctly (e.g. look at cell C17 which has the average of 8177.3 & 8177.3 as 8177.5 ---- not in my math

Shore tie completed by J. Lenorovitz at fueling pier in Lyttleton Harbor (from port side of ship). Note: Elevation of pier

METEROLOGY SYSTEM

Anemometer (Port)

RM Young Anemometer Calibration, Model 05106

S/N: 46262 Date: 12-Dec-04 Cal'd By: W. Gallagher

Clockwise Cal Motor RPM	Calculated Windspeed m/s	Measured Windspeed m/s	Delta m/s	Knots
0	0.00	0.0	0.0	0.0
200	0.98	0.9	0.1	1.9
500	2.45	2.3	0.2	4.8
1000	4.90	4.9	0.0	9.5
1500	7.35	7.4	-0.1	14.3
2000	9.80	9.8	0.0	19.0
3000	14.70	14.8	-0.1	28.6
4000	19.60	19.8	-0.2	38.1
5000	24.50	24.8	-0.3	47.6
6000	29.40	29.8	-0.4	57.1
7000	34.30	34.7	-0.4	66.6
8000	39.20	39.8	-0.6	76.2
9000	44.10	44.7	-0.6	85.7
10000	49.00	49.7	-0.7	95.2
12000	58.80	59.5	-0.7	114.2

Direction	Measured Direction	Delta Direction
0	1	0
30	30	0
60	60	0
90	89	1
120	119	1
150	149	1
180	179	1
210	210	0
240	241	-1
270	272	-2
300	302	-2
330	332	-2
0	1	-1

Note: Delta direction should not exceed + or - 3 degrees.

Counter Clockwise Cal Motor RPM	Calculated Windspeed m/s	Measured Windspeed m/s	Delta m/s
0	0.00	0.0	0.0
200	0.98	0.9	0.1
500	2.45	2.3	0.2
1000	4.90	4.9	0.0
1500	7.35	7.3	0.0
2000	9.80	9.8	0.0
3000	14.70	14.8	-0.1
4000	19.60	19.8	-0.2
5000	24.50	24.8	-0.3
6000	29.40	29.8	-0.4
7000	34.30	34.8	-0.5
8000	39.20	39.8	-0.6
9000	44.10	44.7	-0.6
10000	49.00	49.8	-0.8
12000	58.80	59.7	-0.9

Caution: Do Not exceed 12000 rpm during Wind Speed test.

Wind Speed Threshold < 2.9 gm?	yes
Wind Direction Threshold < 30 gm?	yes

Additional Comments
INSTALLED NEW BEARINGS AND PROPELLER SHAFT. TESTED OKAY

Note: Delta Windspeed should not exceed + or - 0.3 m/s for 0 - 5000 rpm

Anemometer (Starboard)

RM Young Anemometer Calibration, Model 05106

S/N: 51143 Date: 07-Oct-05 Cal'd By: J. Lenorovitz

Clockwise Cal Motor RPM	Calculated Windspeed m/s	Measured Windspeed m/s	Delta m/s	Knots
0	0.00	0.00	0.00	0.0
200	0.98	0.90	0.08	1.9
500	2.45	2.35	0.10	4.8
1000	4.90	4.85	0.05	9.5
1500	7.35	7.35	0.00	14.3
2000	9.80	9.80	0.00	19.0
3000	14.70	14.75	-0.05	28.6
4000	19.60	19.75	-0.15	38.1
5000	24.50	24.70	-0.20	47.6
6000	29.40	29.65	-0.25	57.1
7000	34.30	34.65	-0.35	66.6
8000	39.20	39.60	-0.40	76.2
9000	44.10	44.55	-0.45	85.7
10000	49.00	49.50	-0.50	95.2
12000	58.80	59.35	-0.55	114.2

Direction	Measured Direction	Delta Direction
0	0	0
30	30	0
60	60	0
90	90	0
120	120	0
150	150	0
180	180	0
210	208	2
240	239	1
270	269	1
300	300	0
330	330	0
0	0	0

Note: Delta direction should not exceed + or - 3 degrees.

Counter Clockwise Cal Motor RPM	Calculated Windspeed m/s	Measured Windspeed m/s	Delta m/s
0	0.00	0.00	0.00
200	0.98	0.85	0.13
500	2.45	2.35	0.10
1000	4.90	4.85	0.05
1500	7.35	7.35	0.00
2000	9.80	9.75	0.05
3000	14.70	14.75	-0.05
4000	19.60	19.75	-0.15
5000	24.50	24.70	-0.20
6000	29.40	29.65	-0.25
7000	34.30	34.65	-0.35
8000	39.20	39.55	-0.35
9000	44.10	44.55	-0.45
10000	49.00	49.50	-0.50
12000	58.80	59.35	-0.55

Caution: Do Not exceed 12000 rpm during Wind Speed test.

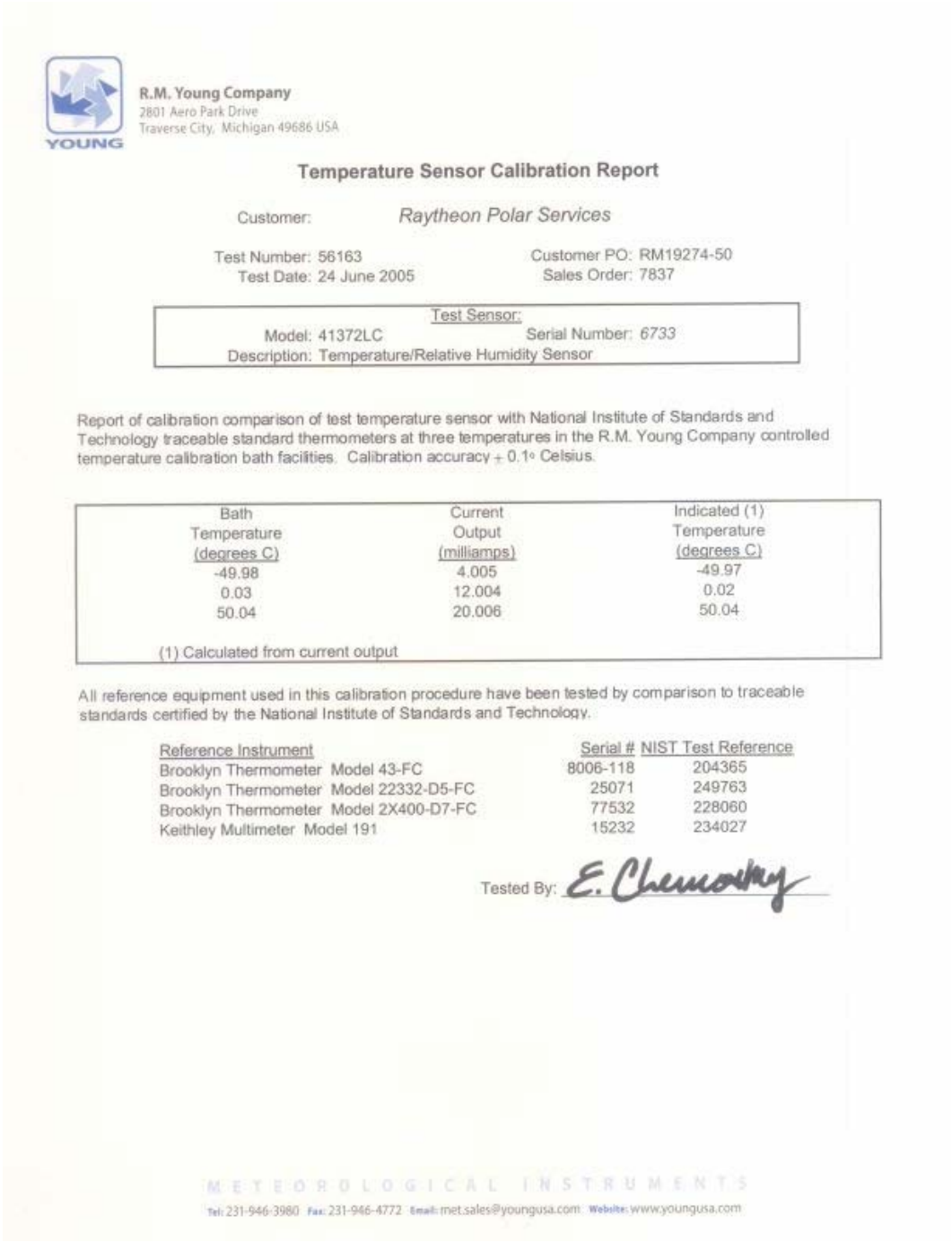
Wind Speed Threshold < 2.9 gm? yes
Wind Direction Threshold < 30 gm? yes

Additional Comments

No repairs or adjustments needed. Unit was spot on from the drawer.

Note: Delta Windspeed should not exceed + or - 0.3 m/s for 0 - 5000 rpm

Humidity / Wet Temp



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

Temperature Sensor Calibration Report

Customer: *Raytheon Polar Services*

Test Number: 56163 Customer PO: RM19274-50
Test Date: 24 June 2005 Sales Order: 7837

Test Sensor:
Model: 41372LC Serial Number: *6733*
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	4.005	-49.97
0.03	12.004	0.02
50.04	20.006	50.04

(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. Chemovsky

METEOROLOGICAL INSTRUMENTS
Tel: 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com Website: www.youngusa.com

PIR

THE EPPLEY LABORATORY, INC.
12 Sheffield Ave., P.O. Box 419, Newport, RI 02840 USA
Telephone: 401-847-1020 Fax: 401-847-1031
Email: eplab@mail.bbsnet.com Internet: www.eppleylab.com

EPLAB
Scientific Instruments for Precision Measurements Since 1917

STANDARDIZATION OF EPPLEY PRECISION INFRARED RADIOMETER Model PIR

Serial Number: 33023F3

Resistance: 764 Ω at 23 °C
Temperature Compensation Range: -20 to 40 °C

This pyrgeometer has been compared with Precision Infrared Radiometer, Serial Number 29326F3 in Eppley's Blackbody Calibration System under radiation intensities of approximately 200 watts meter^{-2} and an average ambient temperature of 25 °C.

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

3.86 x 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.

Shipped to:
National Science Foundation
Port Hueneme, CA

S.O. Number: 60151
Date: January 24, 2005

Date of Test: January 20, 2005

In Charge of Test: R. T. Eppley

Reviewed by: Thomas J. Kirk

Remarks:

PSP

THE EPPLEY LABORATORY, INC.
12 Sheffield Ave., P.O. Box 419, Newport, RI 02840 USA
Telephone: 401-847-1020 Fax: 401-847-1031
Email: eplab@mail.bbsnet.com Internet: www.eppleylab.com

EPLAB
Scientific Instruments for Precision Measurements Since 1917

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 33090F3

Resistance: 699 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). The adopted calibration temperature is 25 °C.

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

8.19 x 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 Ninth International Pyrheliometric Comparisons (IPC IX) at Davos, Switzerland in September-October 2000.

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:
National Science Foundation
Port Hueneme, CA

Date of Test: November 8, 2004

In Charge of Test: R.T. Eppley

S.O. Number: 60076
Date: November 11, 2004

Reviewed by: Thomas D. Kirk

Remarks:

PAR

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

Calibration Date	5/16/2005
Model Number	QSR-240
Serial Number	6356
Operator	TPC
Standard Lamp	99189(4/12/05)
Probe Excitation Voltage Range:	6 to 18 VDC(+)
Output Polarity:	POSITIVE

Probe Conditions at Calibration(in air):

Calibration Voltage:	6 VDC(+)
Probe Current:	1.2 mA

Probe Output Voltage:

Probe Illuminated	86.9 mV
Probe Dark	0.1 mV
Probe Net Response	86.8 mV

Corrected Lamp Output:

Output In Air (same condition as calibration):

8.34E+15 quanta/cm²sec
0.01384 uE/cm²sec

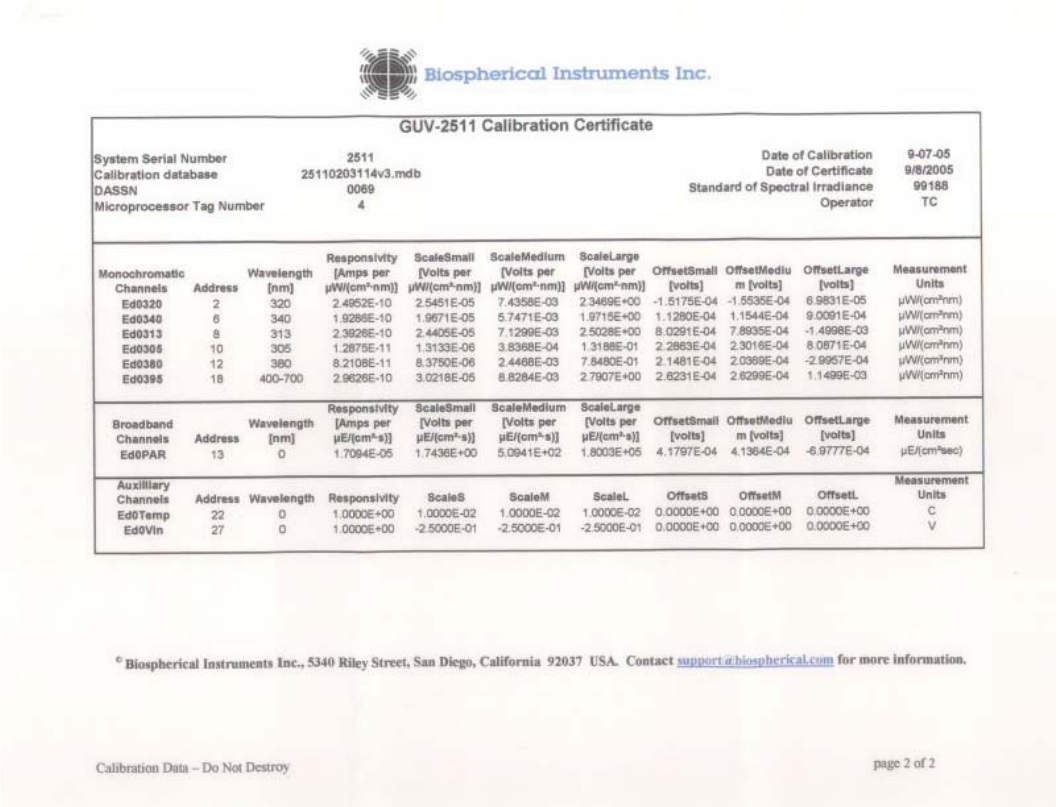
Calibration Factor:
(To calculate irradiance, divide the net voltage reading in Volts by this value.)

Dry:	1.04E-17 V/(quanta/cm²sec)
	6.27E+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

GUV



Biospherical Instruments Inc.

GUV-2511 Calibration Certificate

System Serial Number	2511	Date of Calibration	9-07-05
Calibration database	25110203114v3.mdb	Date of Certificate	9/8/2005
DASSN	0069	Standard of Spectral Irradiance	99188
Microprocessor Tag Number	4	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
Ed0320	2	320	2.4952E-10	2.5451E-05	7.4358E-03	2.3469E+00	-1.5175E-04	-1.5535E-04	6.9831E-05	µW/(cm²nm)
Ed0340	6	340	1.9286E-10	1.9671E-05	5.7471E-03	1.9715E+00	1.1280E-04	1.1544E-04	9.0091E-04	µW/(cm²nm)
Ed0313	8	313	2.3926E-10	2.4405E-05	7.1299E-03	2.5028E+00	8.0291E-04	7.8935E-04	-1.4998E-03	µW/(cm²nm)
Ed0305	10	305	1.2875E-11	1.3133E-06	3.8368E-04	1.3188E-01	2.2863E-04	2.3016E-04	8.0871E-04	µW/(cm²nm)
Ed0380	12	380	8.2108E-11	8.3750E-06	2.4468E-03	7.8480E-01	2.1481E-04	2.0369E-04	-2.9957E-04	µW/(cm²nm)
Ed0395	18	400-700	2.9626E-10	3.0218E-05	8.8284E-03	2.7907E+00	2.6231E-04	2.6299E-04	1.1499E-03	µW/(cm²nm)

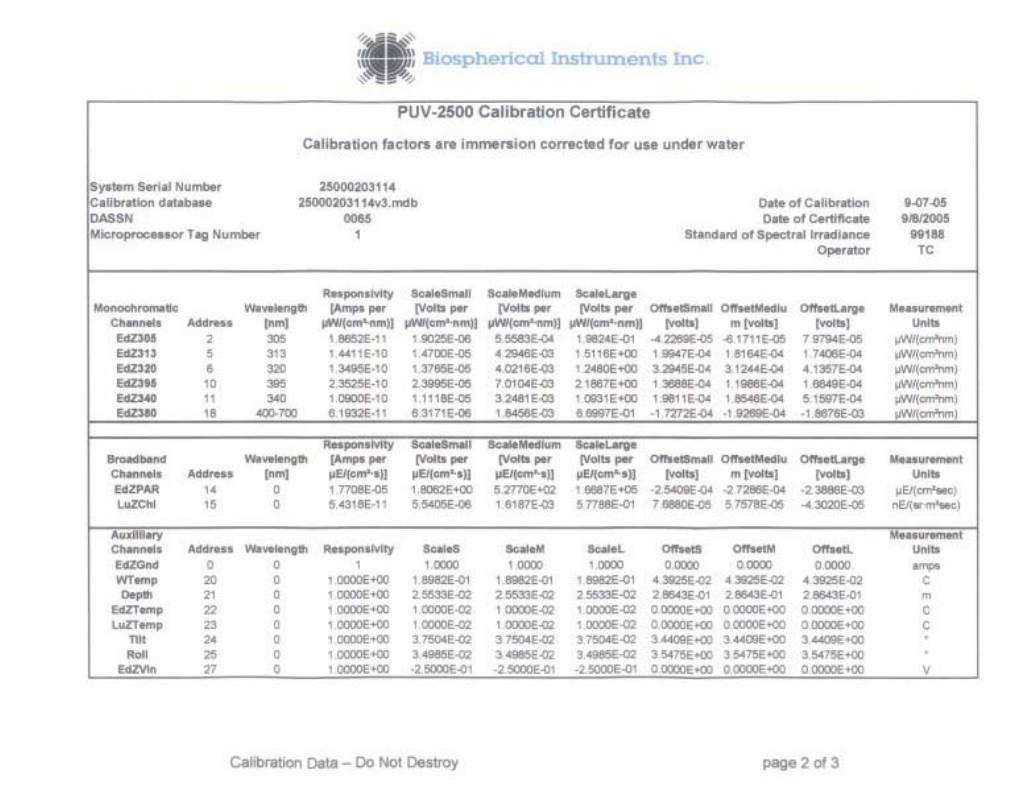
Broadband Channels	Address	Wavelength [nm]	Responsivity [Amps per µE/(cm²-s)]	ScaleSmall [Volts per µE/(cm²-s)]	ScaleMedium [Volts per µE/(cm²-s)]	ScaleLarge [Volts per µE/(cm²-s)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
Ed0PAR	13	0	1.7094E-05	1.7436E+00	5.0941E+02	1.8003E+05	4.1797E-04	4.1364E-04	-6.9777E-04	µE/(cm²sec)

Auxilliary Channels	Address	Wavelength	Responsivity	ScaleS	ScaleM	ScaleL	OffsetS	OffsetM	OffsetL	Measurement Units
Ed0Temp	22	0	1.0000E+00	1.0000E-02	1.0000E-02	1.0000E-02	0.0000E+00	0.0000E+00	0.0000E+00	C
Ed0Vin	27	0	1.0000E+00	-2.5000E-01	-2.5000E-01	-2.5000E-01	0.0000E+00	0.0000E+00	0.0000E+00	V

Calibration Data – Do Not Destroy

page 2 of 2

PUV



Biospherical Instruments Inc.

PUV-2500 Calibration Certificate

Calibration factors are immersion corrected for use under water

System Serial Number	25000203114		
Calibration database	25000203114v3.mdb	Date of Calibration	9-07-05
DASSN	0065	Date of Certificate	9/8/2005
Microprocessor Tag Number	1	Standard of Spectral Irradiance	99188
		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
EdZ305	2	305	1.8652E-11	1.9025E-06	5.5583E-04	1.9824E-01	-4.2269E-05	-6.1711E-05	7.9794E-05	μW/(cm²nm)
EdZ313	5	313	1.4411E-10	1.4700E-05	4.2946E-03	1.5116E+00	1.9947E-04	1.8164E-04	1.7406E-04	μW/(cm²nm)
EdZ320	6	320	1.3495E-10	1.3765E-05	4.0216E-03	1.2480E+00	3.2945E-04	3.1244E-04	4.1357E-04	μW/(cm²nm)
EdZ395	10	395	2.3525E-10	2.3995E-05	7.0104E-03	2.1867E+00	1.3688E-04	1.1986E-04	1.6649E-04	μW/(cm²nm)
EdZ340	11	340	1.0900E-10	1.1118E-05	3.2481E-03	1.0931E+00	1.9811E-04	1.8548E-04	5.1597E-04	μW/(cm²nm)
EdZ380	18	400-700	6.1932E-11	6.3171E-06	1.8456E-03	6.6997E-01	-1.7272E-04	-1.9269E-04	-1.8676E-03	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
EdZPAR	14	0	1.7708E-05	1.8062E+00	5.2770E+02	1.6687E+05	-2.5409E-04	-2.7286E-04	-2.3886E-03	μE/(cm²sec)
LuZChl	15	0	5.4318E-11	5.5405E-06	1.6187E-03	5.7788E-01	7.6880E-05	5.7578E-05	-4.3020E-05	nE/(sr·m²sec)

Auxilliary Channels	Address	Wavelength	Responsivity	ScaleS	ScaleM	ScaleL	OffsetS	OffsetM	OffsetL	Measurement Units
EdZGnd	0	0	1	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	amps
WTemp	20	0	1.0000E+00	1.8982E-01	1.8982E-01	1.8982E-01	4.3925E-02	4.3925E-02	4.3925E-02	C
Depth	21	0	1.0000E+00	2.5533E-02	2.5533E-02	2.5533E-02	2.8643E-01	2.8643E-01	2.8643E-01	m
EdZTemp	22	0	1.0000E+00	1.0000E-02	1.0000E-02	1.0000E-02	0.0000E+00	0.0000E+00	0.0000E+00	C
LuZTemp	23	0	1.0000E+00	1.0000E-02	1.0000E-02	1.0000E-02	0.0000E+00	0.0000E+00	0.0000E+00	C
Tilt	24	0	1.0000E+00	3.7504E-02	3.7504E-02	3.7504E-02	3.4409E+00	3.4409E+00	3.4409E+00	°
Roll	25	0	1.0000E+00	3.4985E-02	3.4985E-02	3.4985E-02	3.5475E+00	3.5475E+00	3.5475E+00	°
EdZVin	27	0	1.0000E+00	-2.5000E-01	-2.5000E-01	-2.5000E-01	0.0000E+00	0.0000E+00	0.0000E+00	V

Calibration Data – Do Not Destroy page 2 of 3

PRR (Mast)

Biospherical Instruments Inc.

Calibration Certificate for PRR Spectroradiometer

Calibration Date: 1/9/2004 **Job:** R8581
Model Number: PRR-610
Serial Number: 9696
Operator: TPC
Standard Lamp: 98700(5/19/01)

Ch	Tag	λ (nm)	Lamp Output	Calibration Voltage - Dark[3]	Calibration Voltage - Light	Calibration Factor - Dry (V/µW)	Max E (Dry)
		SURFACE IRRADIANCE CHANNELS				Irradiance Units: µW/cm^2·nm, E = Irradiance	
1	2	412	2.487	0.000179	-0.086517	-0.034864	286.8
2	2	443	3.835	0.000537	-0.129277	-0.033850	295.4
3	2	490	6.380	0.000326	-0.224434	-0.035229	283.9
4	2	510	7.591	0.000742	-0.279080	-0.036861	271.3
5	2	555	10.441	0.000210	-0.355556	-0.034074	293.5
6	2	665	16.920	0.000442	-0.586821	-0.034708	288.1
7	2	PAR[4]	0.0152	0.000502	-0.238069	-15.719604	0.636 [4]
8	2	Gnd.[5]	0.000429	Volts			

Calibration Factors: DRY = (Light - Dark)/Lamp Output

NOMINAL TO ACTUAL VOLTAGE CONVERSION FACTORS (For use with external sensors, only, see manual)

	Irr. Array
Scale	1.067455
Offset	0.000402
Full Scale Voltage	9.3681

FIRMWARE VERSION

	Tag 2
Surface ROM	3759B

Notes:
1. Annual calibration is recommended.
2. Calibrations were made at approximately 20 to 30 °C.
3) Dark values represent a blocking of the calibration source. These values should not be used as the 'offset' when entering values into the calibration file. Use the totally dark sensor values obtained at the temperature where the instrument will be used.
4) PAR irradiance units are µEinsteins/cm^2·sec.
5) Nominal/Typical value(s).

PRR-610 01/08/98

PRR (Underwater)

Biospherical Instruments Inc.

Calibration Certificate for PRR Spectroradiometer

Calibration Date: 1/9/2004 Job: R8580
Model Number: PRR-600
Serial Number: 9695
Operator: TPC
Standard Lamp: 98700(5/19/01)

Ch	Tag	λ (nm)	Lamp Irradiance @ 50 cm	Immersion Coefficient (Type P6-2)	Calibration Voltage - Dark[3]	Calibration Voltage - Light	Calibration Factor - Dry (V/µW)	Calibration Factor - Wet (V/µW)	Max E (Dry)	
DOWNWELLING IRRADIANCE CHANNELS						Irradiance Units: µW/cm²·nm, E = Irradiance				
1	0	412	2.487	0.677	0.000038	-0.077209	-0.031064	-0.021022	321.9	
2	0	443	3.835	0.682	0.000057	-0.119412	-0.031152	-0.021248	321.0	
3	0	490	6.380	0.690	-0.000034	-0.203165	-0.031839	-0.021973	314.1	
4	0	510	7.591	0.694	0.000006	-0.233650	-0.030779	-0.021348	324.9	
5	0	555	10.441	0.701	0.000055	-0.336024	-0.032188	-0.022574	310.7	
6	0	665	16.920	0.720	-0.000038	-0.578613	-0.034194	-0.024628	292.4	
7	0	PAR[4]	0.01518	0.700	0.000222	-0.210089	-13.857534	-6.700274	0.722	µEinsteins/cm2 sec.
8	0	Gnd.[5]	0.000048	Volts						

Calibration Factor: WET = ((Light - Dark) x Immers. Coeff.)/Lamp Output
DRY = (Light - Dark)/Lamp Output

Ch	Tag	λ (nm)	Lamp Irradiance @ 50 cm	Immersion Coefficient (BK7 window)	Plaque Reflectivity 23695-1-2	Radiance[6]	Calibration Voltage - Dark	Calibration Voltage - Blocked[3]	Calibration Voltage - Light	Calibration Factor - Wet (V/µW)	Max L (Wet)
UPWELLING RADIANCE CHANNELS						Radiance Units: µW/cm²·nm·sr, L = Radiance					
2	1	412	2.487	1.747	0.990	0.022	-0.000216	-0.000279	-0.036332	-0.917976	10.9
3	1	443	3.835	1.742	0.991	0.035	-0.000002	0.000005	-0.052521	-0.868721	11.5
4	1	490	6.380	1.735	0.992	0.058	0.000124	0.000095	-0.109067	-1.088467	9.2
5	1	510	7.591	1.733	0.991	0.069	-0.000270	-0.000278	-0.134537	-1.127518	8.9
6	1	555	10.441	1.729	0.991	0.094	0.000147	0.000115	-0.240297	-1.472111	6.8
7	1	665	16.920	1.721	0.992	0.153	-0.000110	-0.000154	-0.313643	-1.188520	8.4
8	1	Gnd.[5]	-0.000027	Volts							

Dry Radiance = (Lamp Output x Plaque Reflectivity x Lamp Distance Factor)/π
Lamp Distance Factor = $(50\ cm)^2/(295.2\ cm)^2$
Calibration Factor: WET = (Light - Dark)/(Dry Radiance x Immersion Coefficient)

9	0	TEMPERATURE[7,8]	Temperature (°C) = (Voltage - Offset)/Scale	
		Scale	0.1010	
		Offset	-0.0103	
10	0	PRESSURE/DEPTH[8,9]	Pressure/Depth (dbars or meters) = (a x Voltage³) + (b x Voltage) + c	
		Scale Factor "a"	0.6122	Profiler
		Scale Factor "b"	64.6815	Scale 0.015076
		Offset "c"	24.4862	Offset -0.365680

NOMINAL TO ACTUAL VOLTAGE CONVERSION FACTORS (For use with external sensors, only, see manual)

	Irr. Array	Rad. Array
Scale Factor	1.066754	1.087465
Offset	0.000047	0.000139
Full Scale Voltage	9.3742	9.1957

FIRMWARE VERSION(S)

	Tag 0	Tag 1
Underwater ROM	2765B	2043B

Notes:
1. Annual calibration is recommended.
2. Calibrations were performed at approximately 20 to 30 °C.
3) "Dark" irradiance and "Blocked" radiance values represent a blocking of the calibration source. These values should not be used as the "Offset" when entering values into the calibration file. Use the totally dark sensor values obtained at the temperature where the instrument will be used.
4) PAR irradiance units are µEinsteins/cm²·sec.
5) Nominal/Typical value(s).
6) For conversion of area to solid angle, a factor (divisor) of Pi is incorporated.
7) Water temperature sensor.
8) A change in depth of 1 meter in seawater corresponds to approximately a 1 dbar change in pressure.
9)This channel/sensor was not calibrated during this service period.

PRR-600 01/08/98

TSG CALIBRATION FILES

Underway Conductivity

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: 3198
CALIBRATION DATE: 01-Feb-05

SBE21 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -4.26982501e+000
h =  5.04451229e-001
i = -5.14140226e-004
j =  5.01516148e-005
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  1.64605226e-006
b =  5.02580692e-001
c = -4.26144824e+000
d = -8.98538292e-005
m =  5.0
CPcor = -9.5700e-008 (nominal)
```

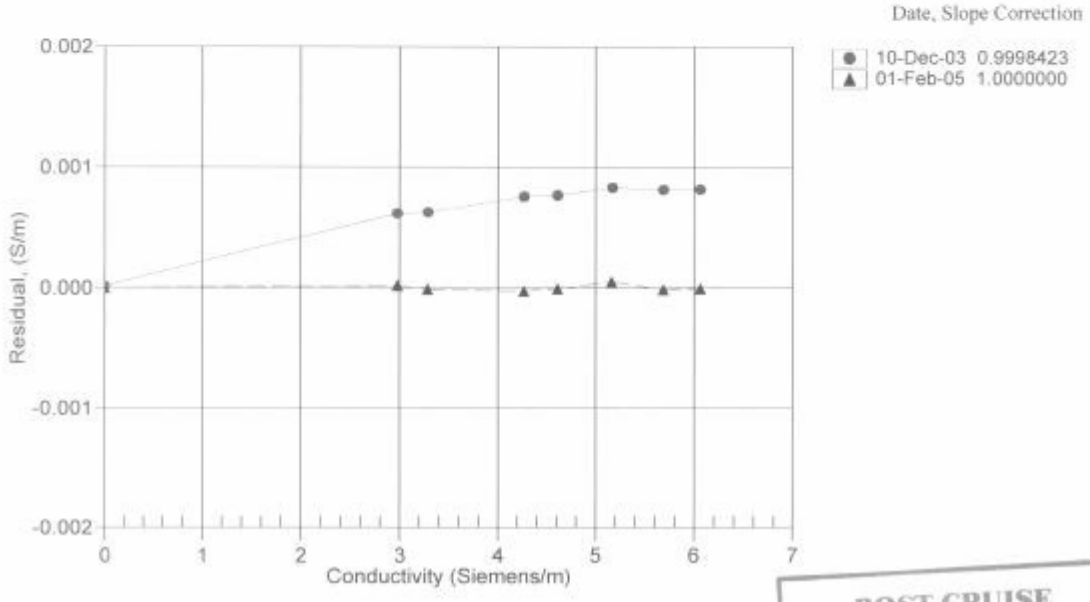
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.91244	0.00000	0.00000
0.9999	34.7963	2.97441	8.21830	2.97443	0.00002
4.4999	34.7760	3.28129	8.58001	3.28127	-0.00001
15.0000	34.7322	4.26239	9.64456	4.26236	-0.00003
18.5000	34.7227	4.60729	9.99140	4.60728	-0.00001
24.0000	34.7124	5.16487	10.52745	5.16492	0.00005
29.0000	34.7074	5.68649	11.00459	5.68647	-0.00001
32.5001	34.7057	6.05889	11.33265	6.05888	-0.00001

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



POST CRUISE CALIBRATION

Underway Temperature Sensor

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: 3198
CALIBRATION DATE: 01-Feb-05

SBE21 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-90 COEFFICIENTS

g = 4.22378538e-003
h = 6.27547484e-004
i = 1.87696196e-005
j = 1.08059211e-006
f0 = 1000.0

ITS-68 COEFFICIENTS

a = 3.64763575e-003
b = 5.95164358e-004
c = 1.57386940e-005
d = 1.08194901e-006
f0 = 2568.337

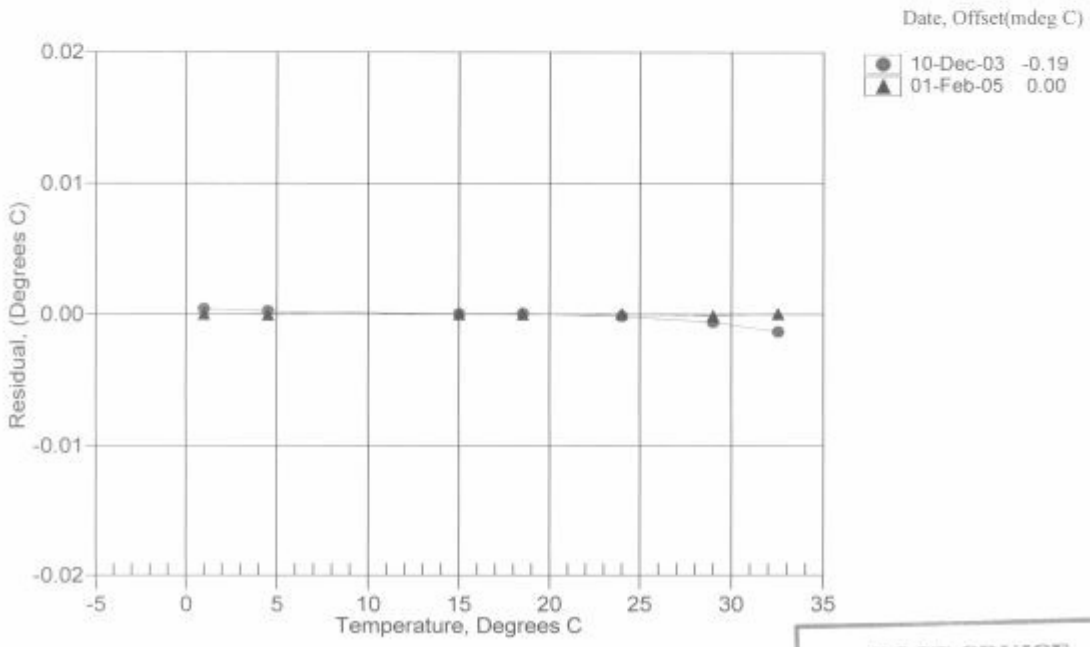
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	2568.337	0.9999	0.00002
4.4999	2775.111	4.4998	-0.00004
15.0000	3467.500	15.0000	0.00002
18.5000	3723.427	18.5000	0.00000
24.0000	4152.232	24.0000	0.00004
29.0000	4571.184	28.9999	-0.00009
32.5001	4881.480	32.5001	0.00005

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 ITS-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



POST CRUISE CALIBRATION

Underway Remote Temperature Sensor

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: 1267
CALIBRATION DATE: 27-Jan-05

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-90 COEFFICIENTS

g = 4.76634262e-003
h = 6.64670506e-004
i = 2.85058534e-005
j = 2.64012684e-006
f0 = 1000.0

ITS-68 COEFFICIENTS

a = 3.68121281e-003
b = 5.89542737e-004
c = 1.47371122e-005
d = 2.64160048e-006
f0 = 5707.057

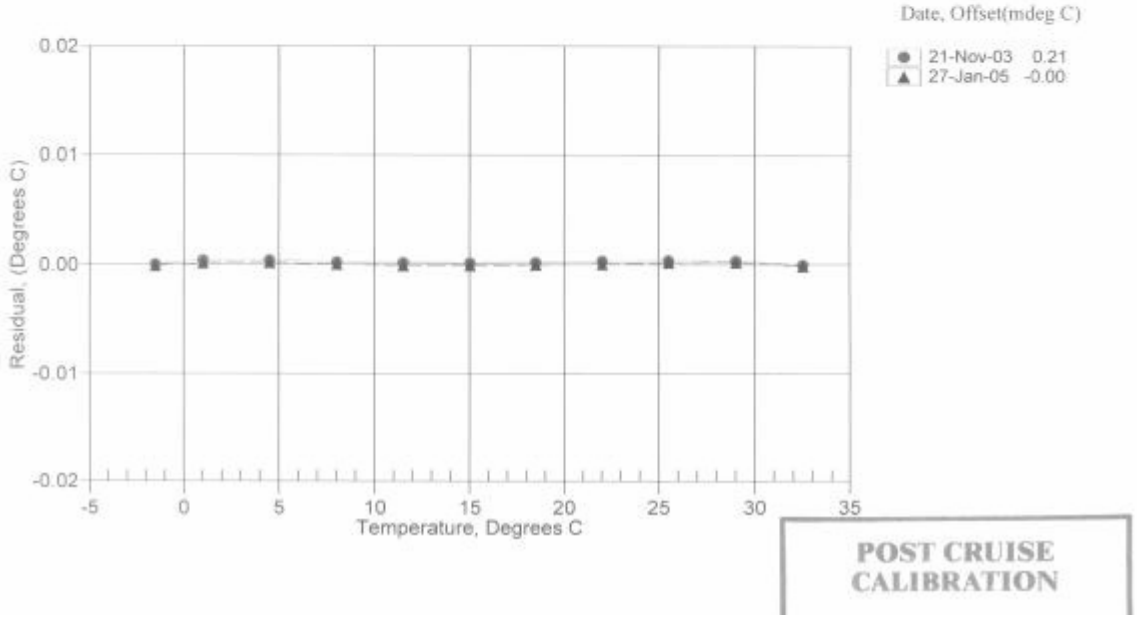
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.4999	5707.057	-1.5000	-0.00014
1.0002	6042.071	1.0003	0.00011
4.5002	6534.710	4.5004	0.00017
8.0002	7055.658	8.0002	0.00002
11.5002	7605.713	11.5001	-0.00013
15.0002	8185.648	15.0001	-0.00012
18.5002	8796.166	18.5001	-0.00006
22.0002	9437.953	22.0002	0.00001
25.5002	10111.682	25.5003	0.00014
29.0002	10817.954	29.0004	0.00017
32.5002	11557.311	32.5000	-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 ITS-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



Underway 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	April 7, 2005	Customer	Raytheon Polar Service Co.	Work order	005
Job #	0201020	S/N#	CST-557DR	Pathlength	25 cm

	Analog meter
V_d	0.060 V
V_{air}	4.851 V
V_{ref}	4.732 V

Temperature of calibration water	20.0 °C
Ambient temperature during calibration	23.4 °C

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

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.

cstarwkbkf1.xls Revision F 1/17/05

CTD SENSORS

CTD Fish Sensor

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: 18-Apr-05

SBE9plus PRESSURE CALIBRATION DATA
10000 psia S/N 53980

DIGIQUARTZ COEFFICIENTS:

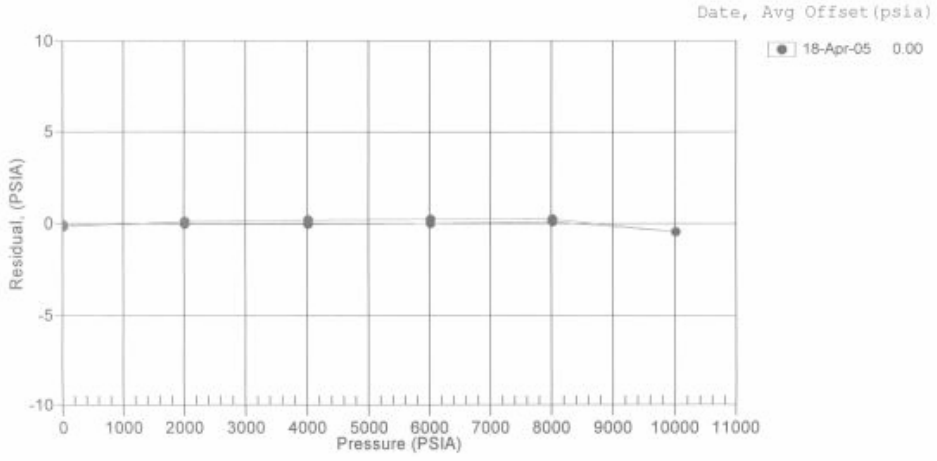
C1 =	-5.847002e+004
C2 =	6.910390e-001
C3 =	1.753360e-002
D1 =	4.241600e-002
D2 =	0.000000e+000
T1 =	3.026040e+001
T2 =	-1.938830e-004
T3 =	4.330190e-006
T4 =	2.020250e-009
T5 =	0.000000e+000

AD590M, AD590B, SLOPE AND OFFSET:

AD590M =	1.13300e-002
AD590B =	-8.47592e+000
Slope =	1.00004
Offset =	-0.7426 (dbars)

PRESSURE (PSIA)	INST OUTPUT(Hz)	INST TEMP(C)	INST OUTPUT (PSIA)	CORRECTED INST OUTPUT (PSIA)	RESIDUAL (PSIA)
14.762	33053.29	22.0	15.752	14.675	-0.087
2014.939	33613.14	23.1	2015.888	2014.886	-0.053
4014.919	34162.20	23.1	4015.804	4014.878	-0.041
6014.986	34701.06	23.2	6015.837	6014.986	-0.000
8014.992	35230.18	23.2	8015.861	8015.085	0.093
10015.554	35749.99	23.2	10015.800	10015.099	-0.455
8014.880	35230.20	23.3	8015.894	8015.117	0.237
6014.818	34701.08	23.3	6015.881	6015.030	0.212
4014.816	34162.23	23.3	4015.923	4014.996	0.180
2014.828	33613.16	23.3	2015.925	2014.923	0.095
14.761	33053.25	23.4	15.657	14.580	-0.181

Residual = corrected instrument pressure - reference pressure



CTD Fish Pressure

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: 18-Apr-05

SBE9plus PRESSURE CALIBRATION DATA
10000 psia S/N 53980

DIGIQUARTZ COEFFICIENTS:

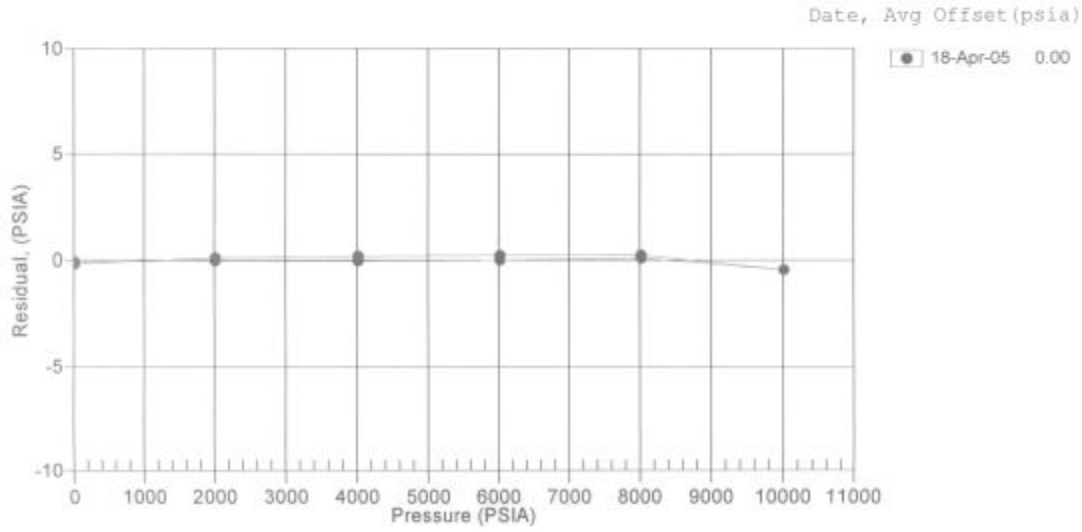
C1 =	-5.847002e+004
C2 =	6.910390e-001
C3 =	1.753360e-002
D1 =	4.241600e-002
D2 =	0.000000e+000
T1 =	3.026040e+001
T2 =	-1.938830e-004
T3 =	4.330190e-006
T4 =	2.020250e-009
T5 =	0.000000e+000

AD590M, AD590B, SLOPE AND OFFSET:

AD590M =	1.13300e-002
AD590B =	-8.47592e+000
Slope =	1.00004
Offset =	-0.7426 (dbars)

PRESSURE (PSIA)	INST OUTPUT(Hz)	INST TEMP(C)	INST OUTPUT (PSIA)	CORRECTED INST OUTPUT (PSIA)	RESIDUAL (PSIA)
14.762	33053.29	22.0	15.752	14.675	-0.087
2014.939	33613.14	23.1	2015.888	2014.886	-0.053
4014.919	34162.20	23.1	4015.804	4014.878	-0.041
6014.986	34701.06	23.2	6015.837	6014.986	-0.000
8014.992	35230.18	23.2	8015.861	8015.085	0.093
10015.554	35749.99	23.2	10015.800	10015.099	-0.455
8014.880	35230.20	23.3	8015.894	8015.117	0.237
6014.818	34701.08	23.3	6015.881	6015.030	0.212
4014.816	34162.23	23.3	4015.923	4014.996	0.180
2014.828	33613.16	23.3	2015.925	2014.923	0.095
14.761	33053.25	23.4	15.657	14.580	-0.181

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: 1541
CALIBRATION DATE: 20-Jan-05

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-90 COEFFICIENTS

g = 4.82560126e-003
h = 6.65828792e-004
i = 2.41056759e-005
j = 1.83349029e-006
f0 = 1000.0

ITS-68 COEFFICIENTS

a = 3.68120908e-003
b = 5.96383203e-004
c = 1.41086972e-005
d = 1.83482410e-006
f0 = 6186.190

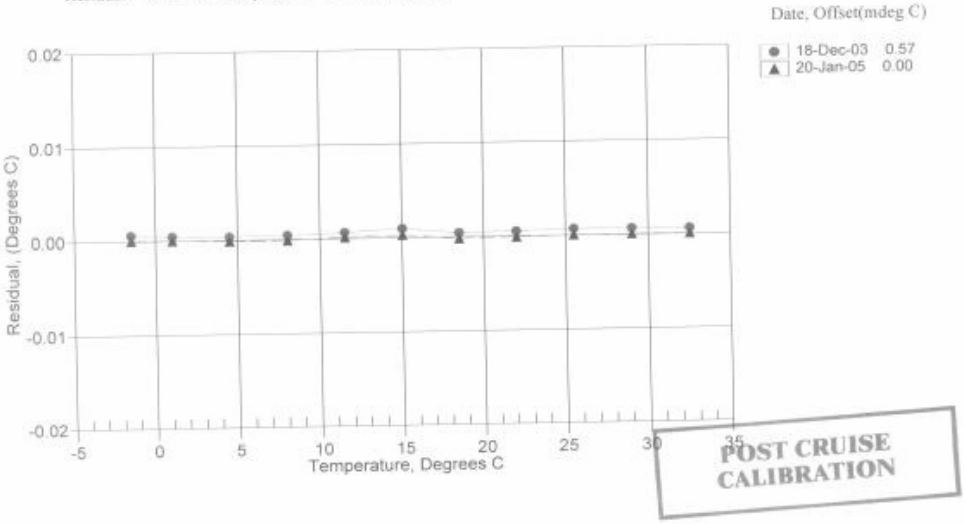
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.4998	6186.190	-1.4998	0.00004
1.0002	6544.957	1.0002	0.00001
4.5002	7072.066	4.5001	-0.00010
8.0002	7628.914	8.0001	-0.00010
11.5001	8216.302	11.5002	0.00012
15.0002	8835.008	15.0005	0.00028
18.5002	9485.619	18.5000	-0.00021
22.0002	10169.107	22.0001	-0.00009
25.5002	10886.062	25.5002	0.00002
29.0002	11637.136	29.0002	0.00004
32.5002	12422.981	32.5002	0.00000

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 ITS-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



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: 1649
CALIBRATION DATE: 20-Jan-05

ITS-90 COEFFICIENTS
g = 4.80540802e-003
h = 6.62765436e-004
i = 2.07460285e-005
j = 1.30493770e-006
f0 = 1000.0

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-68 COEFFICIENTS
a = 3.68120408e-003
b = 6.01328219e-004
c = 1.37860247e-005
d = 1.30618871e-006
f0 = 5958.116

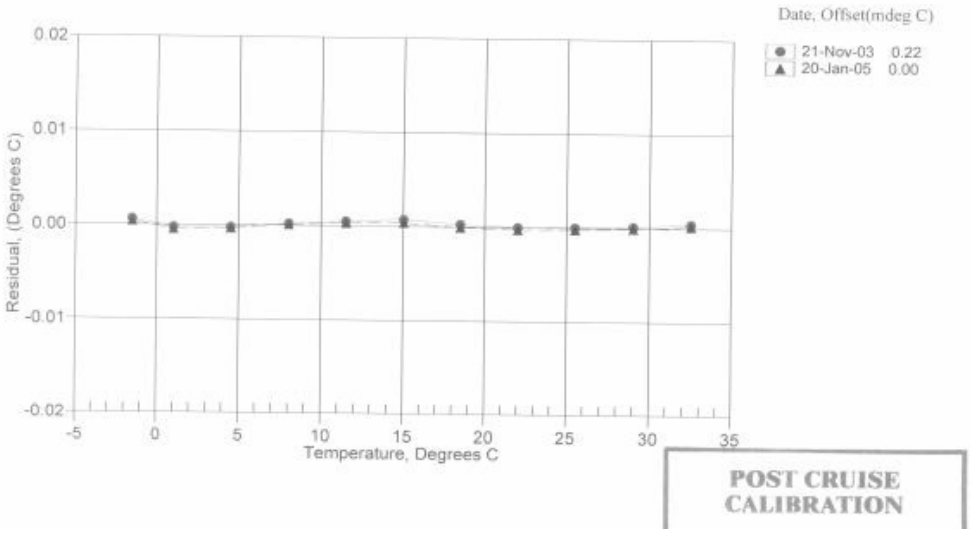
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.4998	5958.116	-1.4994	0.00041
1.0002	6300.599	0.9997	-0.00046
4.5002	6803.649	4.4999	-0.00035
8.0002	7334.731	8.0003	0.00010
11.5001	7894.482	11.5004	0.00031
15.0002	8483.685	15.0006	0.00038
18.5002	9102.922	18.5001	-0.00006
22.0002	9753.021	21.9999	-0.00026
25.5002	10434.649	25.5000	-0.00020
29.0002	11148.412	29.0001	-0.00007
32.5002	11894.941	32.5004	0.00020

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 ITS-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



POST CRUISE CALIBRATION

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: 1431
CALIBRATION DATE: 20-Jan-05

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

GHIJ COEFFICIENTS

g = -4.24942523e+000
h = 5.51507008e-001
i = -1.47228373e-004
j = 3.71318019e-005
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 1.67593103e-005
b = 5.51057980e-001
c = -4.24802429e+000
d = -8.13470803e-005
m = 4.2
CPcor = -9.5700e-008 (nominal)

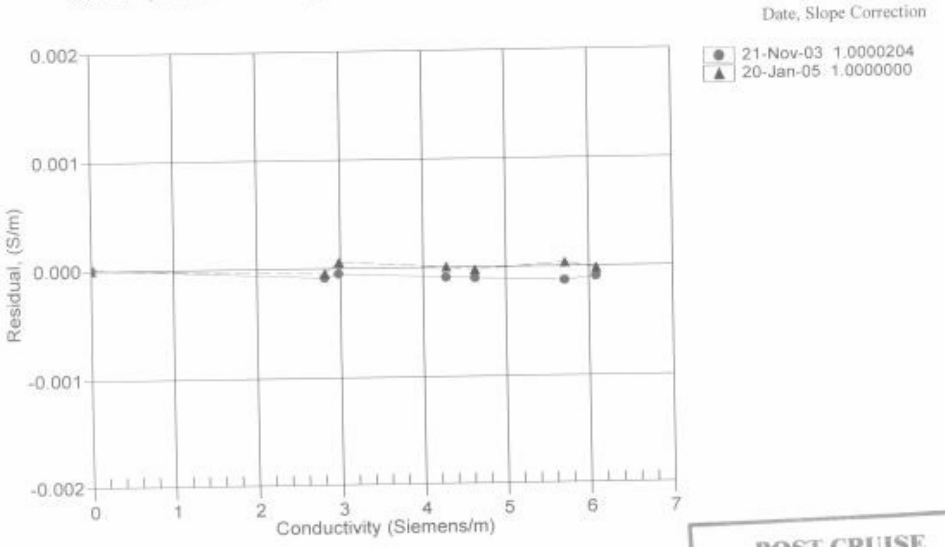
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.77612	0.00000	0.00000
-1.0005	34.8856	2.80959	7.65094	2.80955	-0.00005
0.9995	34.8853	2.98126	7.85088	2.98131	0.00006
14.9995	34.8869	4.27931	9.22087	4.27931	0.00000
18.4995	34.8872	4.62671	9.55372	4.62668	-0.00003
28.9995	34.8854	5.71231	10.52506	5.71234	0.00003
32.4995	34.8798	6.08575	10.83858	6.08574	-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



POST CRUISE CALIBRATION

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: 2069
CALIBRATION DATE: 20-Jan-05

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

GHIJ COEFFICIENTS

g = -1.02737290e+001
h = 1.43384927e+000
i = -3.82306739e-003
j = 3.55928131e-004
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 1.63893740e-008
b = 1.42226692e+000
c = -1.02447982e+001
d = -6.47559628e-005
m = 7.9
CPcor = -9.5700e-008 (nominal)

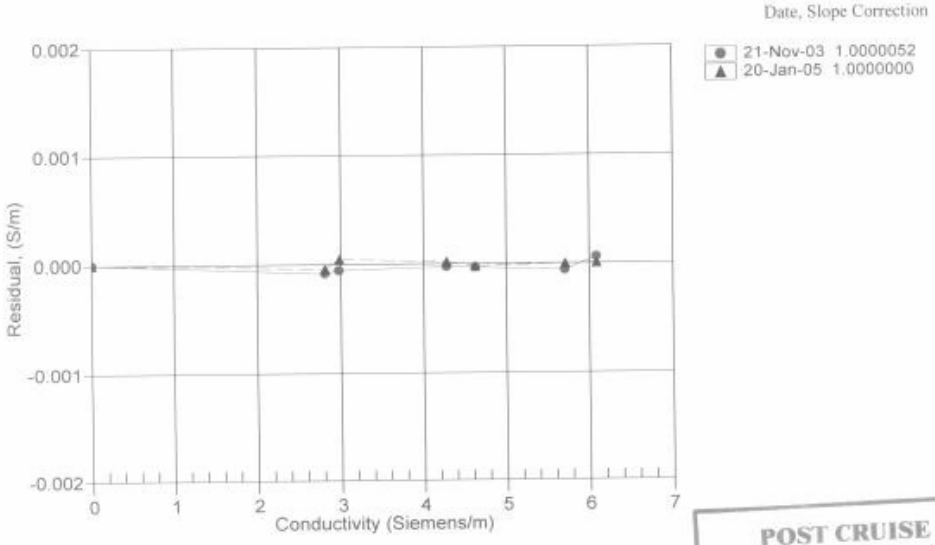
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.68399	0.00000	0.00000
-1.0005	34.8856	2.80959	5.19156	2.80955	-0.00004
0.9995	34.8853	2.98126	5.30651	2.98130	0.00004
14.9995	34.8869	4.27931	6.10520	4.27932	0.00002
18.4995	34.8872	4.62671	6.30162	4.62668	-0.00002
28.9995	34.8854	5.71231	6.87895	5.71230	-0.00000
32.4995	34.8798	6.08575	7.06647	6.08576	0.00000

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



POST CRUISE CALIBRATION

CTD Dissolved Oxygen

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: 0082
CALIBRATION DATE: 11-Feb-05p

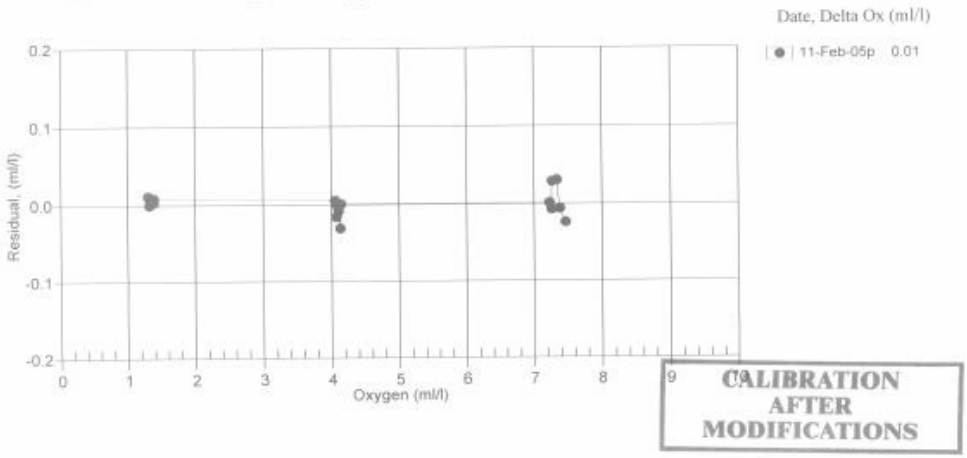
SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS
Soc = 0.3299
Boc = 0.0000
Voffset = -0.6097

TCor = -0.0006
PCor = 1.350e-04

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.30	12.00	0.01	1.142	1.31	0.01
1.31	6.00	0.00	1.072	1.32	0.01
1.32	20.00	0.01	1.246	1.32	-0.00
1.34	2.00	0.00	1.032	1.34	0.00
1.39	26.00	0.01	1.366	1.39	0.00
1.39	30.00	0.01	1.427	1.40	0.01
4.06	12.00	0.01	2.257	4.06	0.01
4.07	20.00	0.01	2.568	4.05	-0.02
4.08	6.00	0.00	2.036	4.08	-0.00
4.10	26.00	0.01	2.834	4.09	-0.01
4.13	2.00	0.00	1.897	4.10	-0.03
4.14	30.00	0.01	3.031	4.14	0.00
7.23	30.00	0.01	4.839	7.23	0.00
7.26	20.00	0.01	4.111	7.25	-0.01
7.26	12.00	0.01	3.565	7.29	0.03
7.34	6.00	0.00	3.185	7.37	0.03
7.38	26.00	0.01	4.617	7.37	-0.01
7.47	2.00	0.00	2.947	7.44	-0.02

oxygen (ml/l) = (Soc * (V + Voffset)) * exp(Tcor * T) * Oxsat(T,S) * exp(Pcor * P)
V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU]
Oxsat(T,S) = oxygen saturation [ml/l], P = pressure [dbar]
Residual = instrument oxygen - bath oxygen



CALIBRATION AFTER MODIFICATIONS

CTD Fluorometer

PO Box 518
620 Applegate St.
Philomath OR 97370

WET Labs

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

Chlorophyll Fluorometer Incoming Characterization

Date:	**03/21/05**
Serial #:	AFLT-009
Job#:	0009099
Tech:	K.C

CWO (Vblank)	**0.171 volts**
CEV	**2.98 volts**
SF	**8.8999**
FSV	**5.45 volts**
Linearity:	**0.999 R^2 (0–1.5 volts)** **0.995 R^2 (0– 5.45 volts)**

Notes:

CWO (Vblank) is the clean water offset value and is obtain using pure filtered de-ionized water.

CEV is the chlorophyll equivalent voltage. This value is the signal output of the fluorometer when using a fluorescent proxy that has been determined to be approximately equivalent to **25 µg/l** of a *Thalassiosira weissflogii* phytoplankton culture.

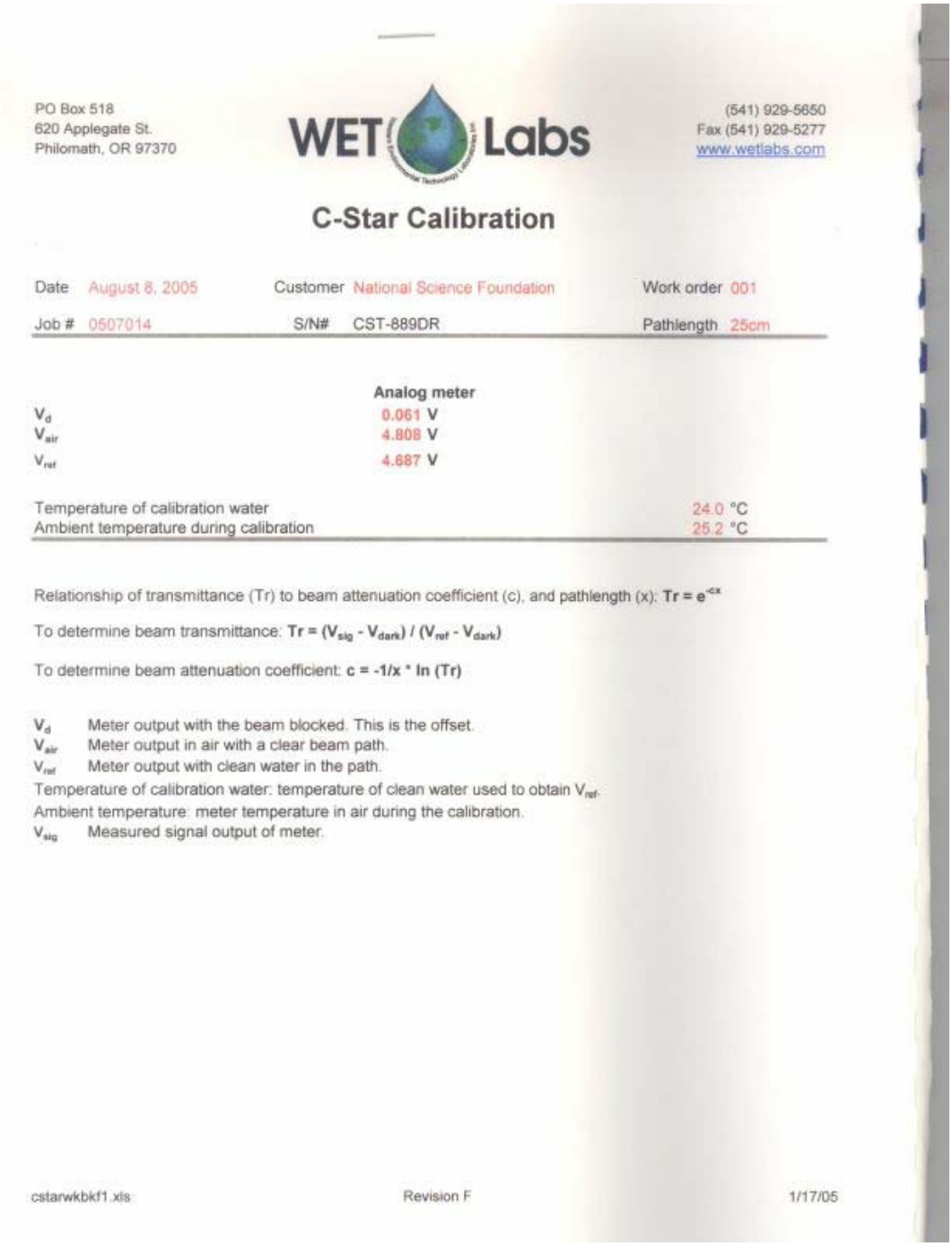
SF is the scale factor used to derive chlorophyll concentration from the signal voltage output of the fluorometer. The scale factor is determine by using the following equation: SF = (25) / (CEV – CWO) e.g.(25 / (2.865 – 0.238) = 9.516)

FSV is the maximum signal voltage output that the fluorometer is capable of.

Chlorophyll concentration expressed in µg/l (mg/m^3) can be derived by using the following equation: (µg/l) = (Vmeasured – CWO) * SF

The relationship between fluorescence and chlorophyll-*a* concentrations in-situ is high variable. The scale factor listed on this document was determined by 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 determination of chlorophyll concentration see [Standard Methods For The Examination Of Water And Wastewater] part 10200 H published jointly by: American Public Health Association, American Water Works Association and Water Environment Federation.

CTD Transmissometer



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WET Labs

C-Star Calibration

Date August 8, 2005 Customer National Science Foundation Work order 001

Job # 0507014 S/N# CST-889DR Pathlength 25cm

Analog meter

V_d	0.061 V
V_{air}	4.808 V
V_{ref}	4.687 V

Temperature of calibration water	24.0 °C
Ambient temperature during calibration	25.2 °C

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

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

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

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.

cstarwkbkf1.xls Revision F 1/17/05

CTD PAR

Biospherical Instruments Inc

CALIBRATION CERTIFICATE

UNDERWATER PAR SENSOR WITH LOG AMPLIFIER

Calibration Date: 08/16/05 **Job No.:** L9099
Model Number: QSP2300
Serial Number: 4717
Operator: AMB
Standard Lamp: 99188(4/12/05)
Operating Voltage Range: 6 to 15 VDC (+)

Note: The QSP-200L 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:	**2.13E+13**	**quanta/cm²-sec/"amps"**	**3.53E-05**	**µEinsteins/cm²-sec/"amps"**
Wet Calibration Factor:	**3.58E+13**	**quanta/cm²-sec/"amps"**	**5.95E-05**	**µEinsteins/cm²-sec/"amps"**

Sensor Test Data and Results[4)]

Sensor Supply Current (Dark):	82.9	mA			
Supply Voltage:	6	Volts			
Lamp Integrated PAR Irradiance:	7.80E+15	quanta/cm²·sec	0.01295	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/ cm² sec)
No Filter	100.00%	2.566	100.00%		3.68E-08	3.68E-08	2.568	0.002	0.0	7.80E+15
0.3	36.10%	2.125	35.96%		1.32E-08	1.33E-08	2.128	0.003	0.4	2.80E+15
0.5	27.60%	2.014	27.76%		1.02E-08	1.02E-08	2.013	-0.001	-0.6	2.16E+15
1	9.27%	1.564	9.58%		3.53E-09	3.41E-09	1.552	-0.012	-3.3	7.47E+14
2	1.11%	0.770	1.19%		4.39E-10	4.09E-10	0.748	-0.022	-6.9	9.30E+13
3	0.05%	0.259	0.08%		3.01E-11	1.97E-11	0.233	-0.026	-34.8	6.39E+12

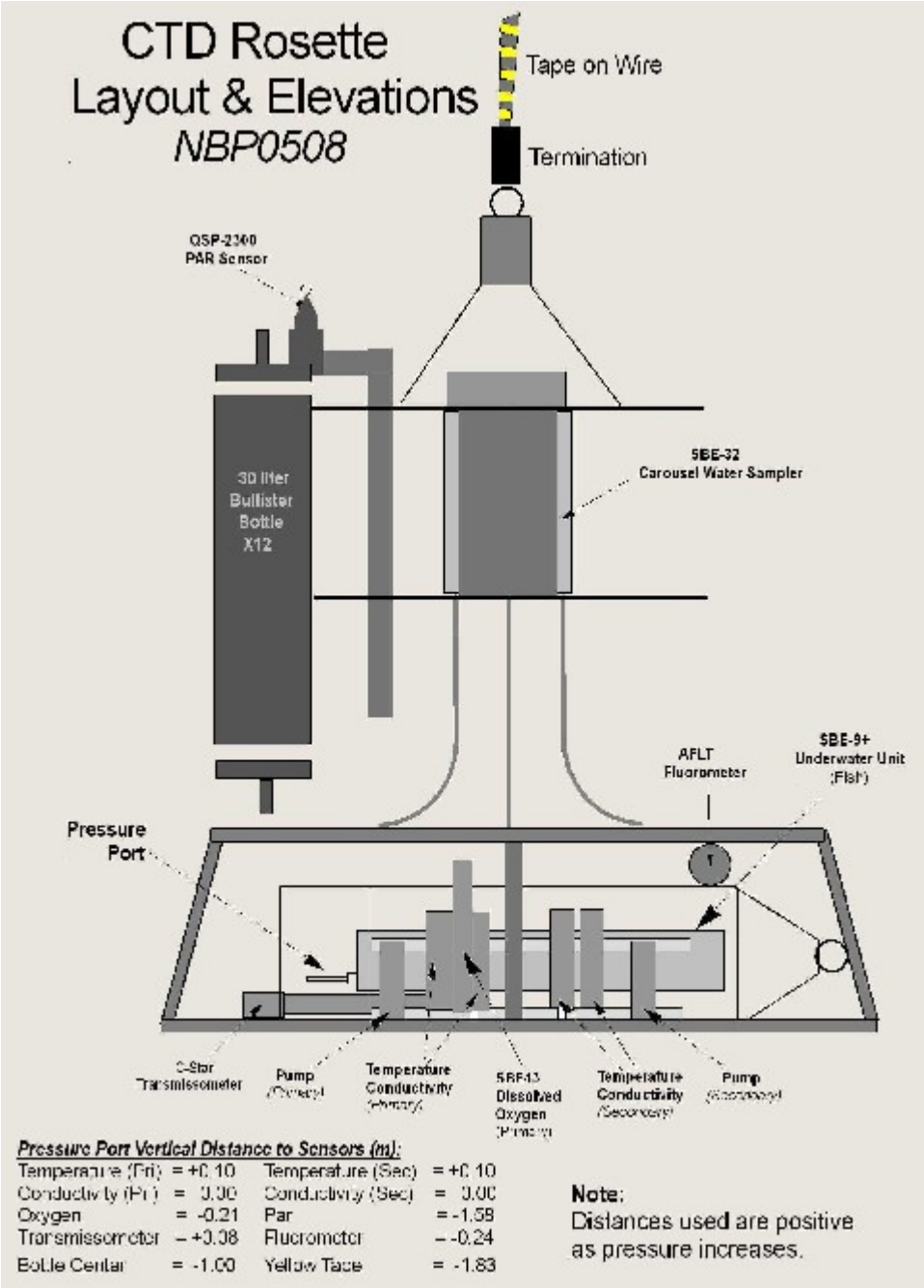
Dark Before: 0.180 Volts
Light - No Filter Hldr.: 2.566 Volts
Dark After - NFH: 0.181 Volts
Average Dark 0.1805 Volts

I_{Ref} = 1.00E-10 Amps
I_{Dark} = 1.52E-10 Amps
10^{VDark} = 1.515305 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 .xls

CTD Diagram


CTD Rosette
Layout & Elevations
NBP0508
Tape on Wire
Termination
OSP-2300
PAR Sensor
30 liter
Bullister
Bottle
X12
SBE-32
Carousel Water Sampler
AFLT
Fluorometer
SBE-9+
Underwater Unit
(Fish)
Pressure
Port
C-Star
Transmissometer
Pump
Temperature
Conductivity
SBE43
Dissolved
Oxygen
Temperature
Conductivity
Pump
Pressure Port Vertical Distance to Sensors (m):
Temperature (Pri) = +0.10
Conductivity (Pri) = 0.00
Oxygen = -0.21
Transmissometer = +0.38
Bottle Center = -1.00
Temperature (Sec) = +0.10
Conductivity (Sec) = 0.00
Par = -1.59
Fluorometer = -0.24
Yellow Tape = -1.83
Note:
Distances used are positive
as pressure increases.