NBP0608

End of Cruise Data Report

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Introduction

The NBP data acquisition system continuously logs 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 level-1 format. It is readable by virtually every computing platform.

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

On Macintosh, use Stuffit Expander with DropStuff or the command line utilities.

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

MultiBeam data is 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

VOL 1 (dvd)

NBP0608.gmt
NBP0608.be
NBP0608.mgd
NBP0608.trk
0608map.jpg
0608data.pdf
0608data.doc
instcoef.txt

imagery/	0608imag.tar
ocean/	0608ctd.tar
process/	0608JGOF.tar 0608MGD.tar 0608PROC.tar 0608PCO2.tar 0608QC.tar
rvdas/nav/	0608adcp.tar 0608sp2a.tar 0608gyr1.tar 0608PCOD.tar 0608seap.tar 0608sp1b.tar
rvdas/uw/	0608eng1.tar 0608flr1.tar 0608grv1.tar 0608knud.tar 0608met1.tar 0608pco2.tar 0608pguv.tar 0608svp1.tar 0608tsg1.tar 0608gen6.tar (see Other Data section for more info)

Distribution Contents

Cruise Information

Cruise NBP0608, CORSACS, embarked for the Ross Sea, Antarctica from Lyttelton New Zealand on November 01, 2006 and returned to Lyttleton on December 15, 2006. Basic JGOFS data was collected for the entire cruise starting on Thursday, November 2rd at 04:50 GMT until Thursday, December 14 at approx 16:00 GMT. CORSACS cruise data was only collected after we entered international waters starting on Friday, November 3rd at 16:45 and ending on Monday, December 11 at 11:46 GMT. Two science of opportunity projects had permits to collect data in New Zealand waters. There were three data sets produced at the end of the cruise. The CORSACS data set includes only data collected in international waters. The data sets compiled for each of the two science of opportunity projects include all basic underway data collected from dock to dock. See below for more information on science of opportunity projects.

Cruise Track

The distribution DVD includes a GMT cruise track file NBP0608.trk. It contains the longitude and latitude at one-minute intervals extracted from the NBP0608.gmt file.

A plot of the cruise track is available jpeg formats in the file: NBP0608.jpg.

Satellite Images

Satellite, weather, and isobar images processed during this cruise can be found in the directory /images in the file 0608img.tar

NBP Data Products

Two primary datasets are created on each cruise: JGOFS and MGD77.

The data processing scripts used to produce JGOFS and MGD77 data sets create a number of intermediate files. These files are included on the data distribution media in a file called 0608proc.tar. They are included to make re-processing easier in the event of an error, but no extensive detail of the formats is included in this document. For information, please contact itvessel@usap.gov.

JGOFS

The JGOFS data set may be found on the distribution media in the file /process/607CJGOF.tar. The archive contains one file produced for each day named jgDDD.dat.gz, where DDD is the year-day the data was acquired. The ".gz" extension indicates that the individual files are compressed before archiving. 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

Field	Data	Units
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 NBP0608.mgd. The file NBP0608.gmt is created from the MGD77 dataset using the "mgd77togmt" utility. NBP0608.gmt can be used with the GMT plotting package.

The data used to produce the NBP0608.mgd file can be found at the root of the distribution media and in the file /process/0608PROC.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.

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 understood to be added.

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)

Col	Len	Type	Contents	Description, Possible Values, Notes
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 field	1 = 1^{st} or leading sensor 2 = 2^{nd} 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 10^{th} of mgals. Corrected for Eotvos, drift, tares
98-103	6	real	EOTVOS correction	In 10^{th} of mgals. E = 7.5 V cos phi sin alpha + 0.0042 V*V
104-108	5	real	Free-air anomaly	In 10^{th} of mgals G = observed G = theoretical
109-113	5	char	Seismic line number	Cross-reference for seismic data
114-119	6	char	Seismic shot-point 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 ADCP system measures currents in a depth range up to 1200 m (OS38 in deep profiling mode). In bad weather, ice, or unfavorable sea state 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. This data is saved in files located in `607Cadcp.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. pCO_2 data is archived in the file `607Cpco2.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

Other Data

The file 0608gen6.tar contains data collected from a PH meter temporarily installed for this cruise. For more information contact Rob Dunbar at (dunbar@stanford.edu).

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 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 this data distribution. Quality-control plots for most instruments are created daily, and may be found in postscript format in the file /process/607CQC.tar. 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*. Raw data will be found on the distribution media as subdirectories under the top level rvdas directory: `/rvdas/uw`, and `/rvdas/nav`. Each instrument or sensor produces a data file named with its channel ID. Each data file is compressed using 'g-zip' to save space on the distribution media. 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: `NBP0608met1.d317`

- The CruiseID is the numeric name of the cruise, in this case, NBP0608.

- The ChannelID is a 4-character code representing the system being logged. For example the meteorology designation is “met1”.
- DDD is the day of year the data was collected. In this case JD317.

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 5106
Barometer	met1	Continuous	1 sec	R.M. Young 61201
PIR (LW radiation)	eng1	Continuous	1 sec	Eppley PIR
PSP (SW radiation)	met1	Continuous	1 sec	Eppley PSP
PAR	met1	Continuous	1 sec	BSI QSR-240
GUV	guv	Continuous	2 sec	BSI PUV-2511
PUV	puv	Not Collected		BSI PUG-2500

Geophysics

Measurement	Channel ID	Collect. Status	Rate	Instrument
Gravimeter	grv1	Continuous	10 sec*	LaCoste & Romberg
Magnetometer	mag1	Not collected	1 sec	Sea Spy
Bathymetry	bat1	Not collected	Varies	ODEC Bathy 2000
Bathymetry	knu1	Continuous	Varies	Knudsen 320B/R
Bathymetry	sim1	Not collected	Varies	Simrad EK500 Sonar

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

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
SeaPath	sp2a	Continuous	1 sec	SeaPath 200

Raw Data

Data is received from the instrument system via RS-232 serial connections. A time tag is added by RVDAS 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

Syntron Data (syn1)

```
00+120:10:46:30.665 *GCS 900228     005
811.00001E00/04/29:10:45:5311060600000000403000-0.050.023    00000000-
00101AP1N 000156498-0100002AP1N 00016350100100003AP1N 000162497-
0200004AP1N 00015850000000005AP1N 00015550100100006AP1N 000157500000000
```

Field	Data	Units

Field	Data	Units
1	RVDAS time tag	
2	String tag	
3	Number of bytes	
4	Line number	
5	Shotpoint number	

Oyo

```
04+009:08:21:53.799   3388     31     49
```

Field	Data	Units
1	RVDAS Time Tag	
2	OYO Shot	
3	Reel	
4	Channel	

Meteorology (met1)

```
01+322:00:03:27.306 04.5 292 010 05.7 294 010 0959.6 000.2 093.1

-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 (photo synthetically available radiation)*	mV

*See page 20 for calculations.

Gravimeter (grv1)

There are 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		

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

Magnetometer (mag1)

```
06+286:00:00:03.075 *06.286/00:00:03.0 F:055248.303 S:193 D:+037.8m  L0
0965ms Q:99
```

Field	Data	Units
1	RVDAS time tag	
2	Time	*YY.JJJ/HH:MM:SS.S
3	Magnetic Field	nT
4	Signal Strength (over 80 is acceptable)	3 digits
5	Towfish Depth	m
6	Leak Sensor (0 is no leak, 9 is leak present	1 digit
7	Measurement time	ms
8	Signal quality (00-99)	2 digit

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	kHz

Field	Data	Format / Possible Values	Units
		SB3=5 kHz	
15	Power level	PO1 = 0dB PO2 = -6dB PO3 = -12dB PO4 = -18dB PO5 = -24dB PO6 = -30dB PO6 = -30 dB 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 20 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)	

pCO2

```
00+021:23:59:43.190 2006114.02630 1960.80 20.64 1003.5 346.81 -1.63 341.7
52.49 0 13 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 temp (C)	°C

Field	Data	Units
5	Barometric pressure (mbar)	MBar
6	CO2 conc. (ppm)	ppm
7	Equilibrator Temp (C)	°C
8	pCO_2 pressure (uatm)	microAtm
9	Flow rate (cc/min)	ml / min
10	Valve Position (integer, note position 9 does not write, defaults to 1)	1 or 2 digits
11	Sample Code number (integer)	1 or 2 digits
12	Flow source (Equil = pCO_2 measurement)	text

Engineering Das (eng1)

```
06+284:01:17:03.259 111,2006,284,116,12.11,23.91,6.096,.14,127.4,-
.432,.914,10.64,-6999,-6999,-6999
```

Field	Data	Units
1	RVDAS time tag	
2	Campbell code (111)	3 digits
3	Year	yyyy
4	Julian day	jjj
5	Time GMT	hhmm
6	Power Supply Voltage	V
7	Internal Case Temperature	C
8	Pump #1 flow rate	L/min
9	Pump #2 flow rate	L/min
10	Pump #3 flow rate	L/min
11	Seismic Air Pressure	Lbs/sq. in.
12	PIR case thermistor resistance	K ohms
13	PIR thermophile (pin A to C)	mv
14	Freezer #1 Temp	°C
15	Freezer #1 Temp	°C
16	Freezer #1 Temp	°C

Navigational Data

Seapath GPS (seap & sp2a)

The Seapath GPS outputs the following 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	

Field	Data	Units
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	
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)

```
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, east vector	knots
5	Ship Speed relative to reference layer, north vector	knots
6	Ship heading	degrees

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

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 fractional time of day)	yyyyddd.ttt
3	Raw voltage (IR)	mV
4	Cell temp (C)	°C
5	Barometric pressure (mbar)	MBar
6	CO2 conc. (ppm)	ppm
7	Equilibrator Temp (C)	°C
8	pCO_2 pressure (uatm)	microAtm
9	Flow rate (cc/min)	ml / min
10	Valve Position (integer, note position 9 does not write, defaults to 1)	1 or 2 digits
11	Sample Code number (integer)	1 or 2 digits
12	Flow source (Equil = pCO_2 measurement)	text
13	RVDAS latitude	degrees
14	RVDAS longitude	degrees
15	TSG external temperature	°C
16	TSG salinity (PSU)	PSU
17	TSG fluorometry (mV -0-5)	V
18	RVDAS true wind speed	m/s
19	RVDAS true wind direction	degrees
20	Barometric Pressure	mBars
21	Uncontaminated seawater pump flow rate	l/min
22	Speed over ground (knots)	knots
23	Course made good (deg)	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}) = 0.1 mV
(*raw* mV - V_{dark})/scale x 10^4 cm^2/m^2 x 10^{-3} V/mV= µEinstiens/m^2sec
or
(*data* mV - 0.1 mV) x 1.65 (µEinstiens/m^2sec)/mV = µEinstiens/m^2sec

PIR

raw data = mV

calibration scale = 4.09×10^{-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 = 7.94×10^{-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 and Events

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.

Our biggest problem on this cruise was the seawater pump. The gravity meter also broke during this cruise and was not able to be fixed. We shipped it out through McMurdo via helicopter on Dec 1st hoping to get it back for the next cruise where it will be needed.

Time	Description
304:04:12	Prepared RVDAS by running New_Cruise for NBP0608
305:03:15	RVDAS data collection started.
305:06:49	Start GUV on RVDAS
307:16:45	Exit New Zealand EEZ.
309:	Seawater pump down from 20:00 – 24:00
310:	Seawater pump down from 00:00 – 02:00 & 01:00 – 12:00
316:21:18	Turned “on” bottom tracking on ADCP
317:	Seawater pump up and down most of the day
318:01:40	Gravity meter dies
318:21:36	Turned “off” bottom tracking on ADCP
321:	Seawater pump down from 22:00 – 24:00
322:23:59	P-Code died
327:	Seawater pump up and down briefly this day
334:	Seawater pump down from 213:00 – 14:00
336:	Seawater pump up and down briefly this day
337:	Seawater pump intermittent all day
338:06:00	Seawater pump down from 06:00 on
339:03:00	Seawater pump back on
340:	Seawater pump intermittent all day.
341:	Seawater pump intermittent all day
342:	Seawater pump intermittent all day
345:11:46	Re-enter New Zealand EEZ

Appendix: Sensors and Calibrations

NBP0608 Sensors:

Shipboard Sensors

Sensor	Description	Serial #	Last Calibration Date	Comments
Meteorology & Radiometers				
Port Anemometer	RM Young 5106	WM46263	05/20/06	
Stbd Anemometer	RM Young 5106	WM 45834	05/20/06	
Barometer	RM Young 61201	01705	07/15/04	
Humidity/Wet Temp	RM Young 41372LC	06733	06/24/05	
PIR (Pyrgeometer)	Eppley PIR	33023F3	01/18/06	
PSP (Pyranometer)	Eppley PSP	33090F3	01/18/06	
PAR (Mast)	BSI-QSR-240	6356	05/16/05	
GUV (Mast)	BSI GUV-2511	25110805126	09/07/05	
PUV (Underwater)	BSI PUV-2500	25000203114	09/07/05	
PRR (Mast)	BSI PRR-610	9696	01/09/04	
PRR (Underwater)	BSI PRR-600	9695	01/09/04	
Underway				
TSG	SeaBird SBE21	218091-1390	03/12/05	
TSG Remote Temp	SeaBird 3-01/S	031497	11/10/05	
Fluorometer	Turner 10-AU-005	5333-FRXX	N/A	
Transmissometer	WET Labs C-Star	CST-439DR	12/09/05	
Gravimeter	LaCoste & Romberg Gravity Meter		n/a	
Bathymetry	Knudsen 320B/R		n/a	
Bathymetry	Bathy 2000		n/a	
Other				
P-Code GPS	Trimble 20636-00 (SM)	0220035116		

Calibrations

The following pages are replicas of current 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: 10/25/2006
Location: Lyttelton/Christchurch, New Zealand
Station: Mag-Obs Workshop, 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)
Ship's meter before gravity tie (Gravity (cu))	8168.7	0:15
Ship's meter after gravity tie (Gravity (cu))	8168.3	4:23
Average	8168.5	
Ship Gravimeter's Calibration Constant	1.0046	
Corrected ship's meter (QC Grav (mgal))	8206.1	

	Value	Time (GMT)
Ship's meter before gravity tie (serial, RVDAS)	8168.6	0:16
Ship's meter after gravity tie (serial, RVDAS)	8168.3	4:24
Average (for comparison check only)	8168.5	

Portable Gravimeter Interval Factor: 1.00953 From Table 1 of Model G #807 Meter

Station	Value	Time (GMT)	Temp	Date	OBS mgal, averaged
Pier measurement 1	4123.65	1:15	54	October 25, 2006	
Pier measurement 2	4123.59	1:18	54	October 25, 2006	4162.93
Pier measurement 3	4123.66	1:22	54	October 25, 2006	
Average	4123.63				
Station measurement 1	4092.54	2:09	54	October 25, 2006	
Station measurement 2	4092.54	2:15	54	October 25, 2006	4131.55
Station measurement 3	4092.56	2:24	54	October 25, 2006	
Average	4092.55				
Pier measurement 4	4123.95	4:00	54	October 25, 2006	
Pier measurement 5	4123.98	4:12	54	October 25, 2006	4163.27
Pier measurement 6	4123.99	4:15	54	October 25, 2006	
Average	4123.97				

Gravity offset from last tie: 972320.26
Drift since last tie: -0.19

OBS Differences	
Station to Pier (1, 2, & 3 averaged)	31.38
Station to Pier (4, 5, & 6 averaged)	31.73
Averaged Differences	31.55
Gravity at pier	980525.84
Elevation of pier above gravimeter, meters	1.0
Earth differential gravity, mgal/meter	0.3
Gravity at ship's gravimeter	980526.14
Gravity Offset (for RVDAS)	972320.07

Comments

Gravity tie completed by Walter Gallagher and Valerie Park at the Workshop Hut, Botanical Gardens, Christchurch, New Zealand.

Meteorology System

Anemometer (Port)

RM Young Anemometer Calibration, Model 05106

S/N: 46263 **Date:** 20-May-06 **Cal'd By:** S. Blackman

Clockwise Cal Motor RPM	Calculated Windspeed m/s	Measured Windspeed m/s	Delta m/s	Knots
0	0.00	0.0	0.00	0.0
200	0.98	0.9	0.08	1.9
500	2.45	2.3	0.15	4.8
1000	4.90	4.8	0.10	9.5
1500	7.35	7.2	0.15	14.3
2000	9.80	9.8	0.00	19.0
3000	14.70	14.7	0.00	28.6
4000	19.60	19.7	-0.10	38.1
5000	24.50	24.7	-0.20	47.6
6000	29.40	29.6	-0.20	57.1
7000	34.30	34.6	-0.30	66.6
8000	39.20	39.6	-0.40	76.2
9000	44.10	44.6	-0.50	85.7
10000	49.00	49.5	-0.50	95.2
12000	58.80	59.4	-0.60	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	210	0
240	240	0
270	270	0
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	0.0	0.00
200	0.98	0.8	0.18
500	2.45	2.3	0.15
1000	4.90	4.8	0.10
1500	7.35	7.3	0.05
2000	9.80	9.8	0.00
3000	14.70	14.8	-0.10
4000	19.60	19.7	-0.10
5000	24.50	24.7	-0.20
6000	29.40	29.6	-0.20
7000	34.30	34.6	-0.30
8000	39.20	39.6	-0.40
9000	44.10	44.6	-0.50
10000	49.00	49.5	-0.50
12000	58.80	59.4	-0.60

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
Removed from drawer for installation. Calibration checked.

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: 45834 **Date:** 20-May-06 **Cal'd By:** S. Blackman

Clockwise Cal Motor RPM	Calculated Windspeed m/s	Measured Windspeed m/s	Delta m/s	Knots
0	0.00	0.0	0.00	0.0
200	0.98	0.8	0.18	1.9
500	2.45	2.3	0.15	4.8
1000	4.90	4.8	0.10	9.5
1500	7.35	7.3	0.05	14.3
2000	9.80	9.8	0.00	19.0
3000	14.70	14.8	-0.10	28.6
4000	19.60	19.7	-0.10	38.1
5000	24.50	24.7	-0.20	47.6
6000	29.40	29.6	-0.20	57.1
7000	34.30	34.6	-0.30	66.6
8000	39.20	39.6	-0.40	76.2
9000	44.10	44.6	-0.50	85.7
10000	49.00	49.5	-0.50	95.2
12000	58.80	59.3	-0.50	114.2

Direction	Measured Direction	Delta Direction
0	0	0
30	29	1
60	59	1
90	89	1
120	119	1
150	149	1
180	180	0
210	210	0
240	240	0
270	271	-1
300	300	0
330	331	-1
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	0.0	0.00
200	0.98	0.9	0.08
500	2.45	2.3	0.15
1000	4.90	4.8	0.10
1500	7.35	7.3	0.05
2000	9.80	9.8	0.00
3000	14.70	14.7	0.00
4000	19.60	19.8	-0.20
5000	24.50	24.7	-0.20
6000	29.40	29.6	-0.20
7000	34.30	34.6	-0.30
8000	39.20	39.6	-0.40
9000	44.10	44.6	-0.50
10000	49.00	49.5	-0.50
12000	58.80	59.3	-0.50

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
Removed from drawer for installation and calibration checked.

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

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: info@eppleylab.com Internet: www.eppleylab.com

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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 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 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 Date of Test: January 17, 2006
Port Hueneme, CA

In Charge of Test: R.T. Essenwanger

S.O. Number: 50573
Date: January 18, 2006 Reviewed by: George L. Kuhn

Remarks:

PSP

THE EPPLEY LABORATORY, INC.
12 Sheffield Ave., P.O. Box 419, Newport, RI 02840 USA
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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:

8.11 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 Date of Test: Jan.11,2006
Port Hueneme, CA

In Charge of Test: R. T. Essenwanger

S.O. Number: 60573
Date: January 18, 2006 Reviewed by: George L. Kub

Remarks:

GUV

Biospherical Instruments Inc.

GUV-2511 Calibration Certificate

System Serial Number	25110805126	Date of Calibration	10-06-05
Calibration database	2511020805126v1.mdb	Date of Certificate	10/6/2005
DASSN	0109	Standard of Spectral Irradiance	99188(4/12/05)
Microprocessor Tag Number	2	Operator	TC

Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per µW/(cm²·nm)]	ScaleSmall [Volts per µW/(cm²·nm)]	ScaleMedium [Volts per µW/(cm²·nm)]	ScaleLarge [Volts per µW/(cm²·nm)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
Ed0305	2	305	4.9261E-11	5.0677E-06	1.4809E-03	4.5088E-01	2.0487E-04	2.0331E-04	1.0603E-03	µW/(cm²nm)
Ed0313	6	313	2.5572E-10	2.6076E-05	7.6233E-03	2.6829E+00	1.9751E-04	1.9723E-04	1.0837E-03	µW/(cm²nm)
Ed0320	8	320	2.6686E-10	2.7159E-05	7.9822E-03	2.7630E+00	-4.2714E-05	-4.3319E-05	3.9397E-04	µW/(cm²nm)
Ed0340	10	340	1.9062E-10	1.9410E-05	5.6899E-03	2.0110E+00	2.7562E-04	2.7424E-04	1.3301E-03	µW/(cm²nm)
Ed0380	12	380	7.7757E-11	7.9234E-06	2.3121E-03	8.1165E-01	-2.1246E-05	-2.4711E-05	5.1751E-04	µW/(cm²nm)
Ed0395	13	395	3.6823E-10	3.7655E-05	1.1057E-02	3.8462E+00	2.9189E-04	2.8674E-04	1.1440E-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	18	400-700	1.7044E-05	1.7362E+00	5.0875E+02	1.7808E+05	2.6695E-04	2.6347E-04	1.2584E-03	µE/(cm²sec)

Auxiliary Channels	Address	Wavelength	Responsivity	ScaleS	ScaleM	ScaleL	OffsetS	OffsetM	OffsetL	Measurement Units
Ed0Gnd	0	0	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	V
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

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

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: 1390
CALIBRATION DATE: 12-Mar-05

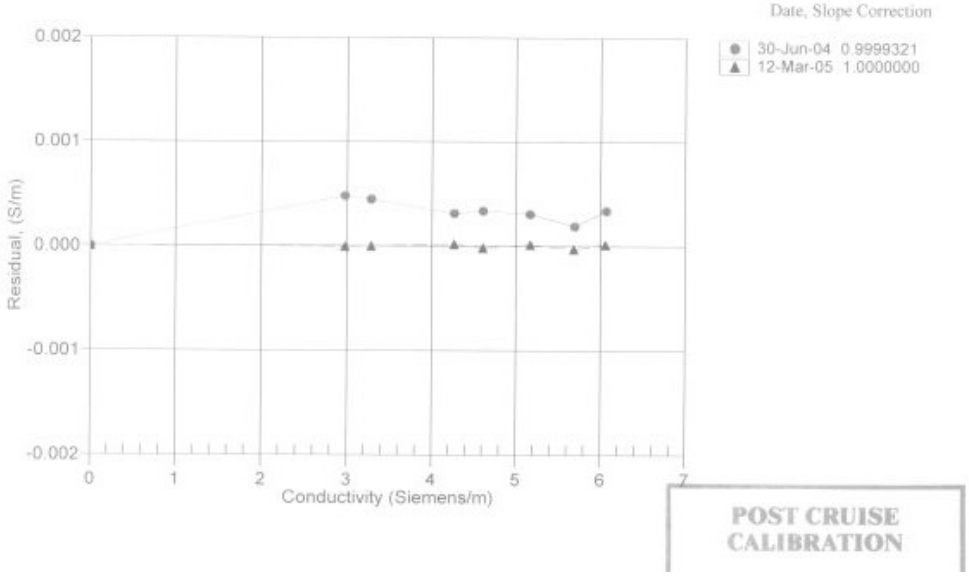
SBE21 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS
g = -3.93226726e+000
h = 4.70569719e-001
i = 6.34631789e-004
j = -9.87772523e-006
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS
a = 4.43616567e-003
b = 4.64684698e-001
c = -3.92316496e+000
d = -8.75063759e-005
m = 2.4
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	2.88539	0.00000	0.00000
0.9999	34.7900	2.97392	8.41759	2.97392	-0.00000
4.5000	34.7690	3.28070	8.79114	3.28070	-0.00000
14.9999	34.7244	4.26152	9.89031	4.26154	0.00002
18.5000	34.7146	4.60633	10.24842	4.60632	-0.00002
24.0000	34.7039	5.16375	10.80209	5.16377	0.00001
29.0000	34.6989	5.68525	11.29521	5.68522	-0.00003
32.5000	34.6969	6.05752	11.63436	6.05754	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



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: 1390
CALIBRATION DATE: 12-Mar-05

SBE21 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-90 COEFFICIENTS

g = 4.21050756e-003
h = 5.95355230e-004
i = 4.97876949e-006
j = -1.73798388e-006
f0 = 1000.0

ITS-68 COEFFICIENTS

a = 3.64763867e-003
b = 5.81216773e-004
c = 9.98586302e-006
d = -1.73747972e-006
f0 = 2600.263

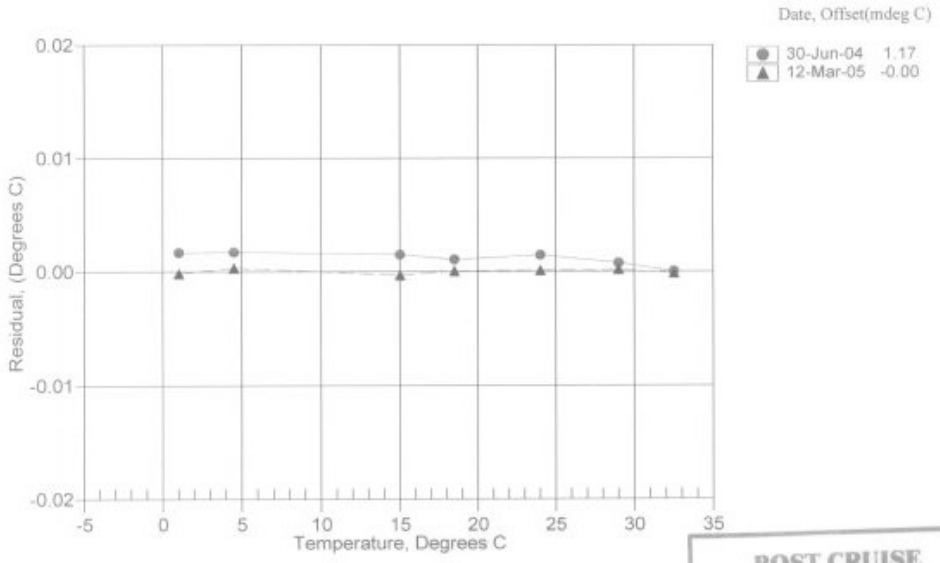
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	2600.263	0.9997	-0.00018
4.5000	2814.731	4.5003	0.00033
14.9999	3533.537	14.9996	-0.00033
18.5000	3799.663	18.5000	0.00004
24.0000	4245.995	24.0001	0.00012
29.0000	4682.732	29.0002	0.00018
32.5000	5006.584	32.4998	-0.00016

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: 1497
CALIBRATION DATE: 10-Nov-05

ITS-90 COEFFICIENTS
g = 4.73766449e-003
h = 6.68793556e-004
i = 2.84645709e-005
j = 2.61326034e-006
f0 = 1000.0

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-68 COEFFICIENTS
a = 3.68121909e-003
b = 5.95381666e-004
c = 1.53096888e-005
d = 2.61478510e-006
f0 = 5372.992

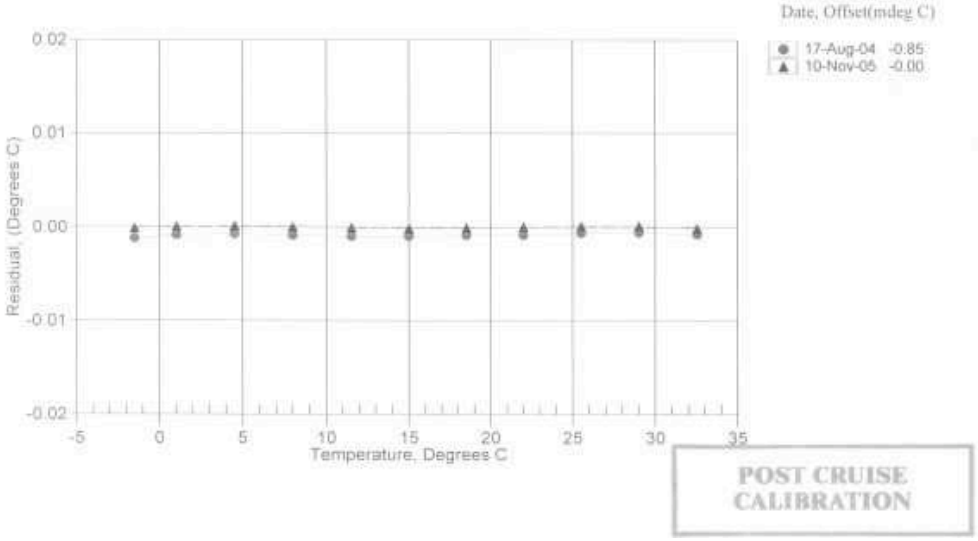
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5004	5372.992	-1.5005	-0.00010
0.9996	5685.203	0.9997	0.00008
4.4996	6144.063	4.4997	0.00010
7.9996	6628.986	7.9996	0.00004
11.4996	7140.671	11.4995	-0.00006
14.9996	7679.800	14.9995	-0.00015
18.4996	8247.050	18.4995	-0.00005
21.9996	8843.015	21.9996	0.00002
25.4996	9468.305	25.4997	0.00013
28.9996	10123.458	28.9997	0.00012
32.4996	10808.995	32.4995	-0.00013

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 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 December 9, 2005 Customer National Science Foundation Work order 007

Job # 0102007 S/N# CST-439DR Pathlength 25 cm

	Analog meter
V_d	0.060 V
V_{air}	4.804 V
V_{ref}	4.707 V

Temperature of calibration water	16.9 °C
Ambient temperature during calibration	22.6 °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.

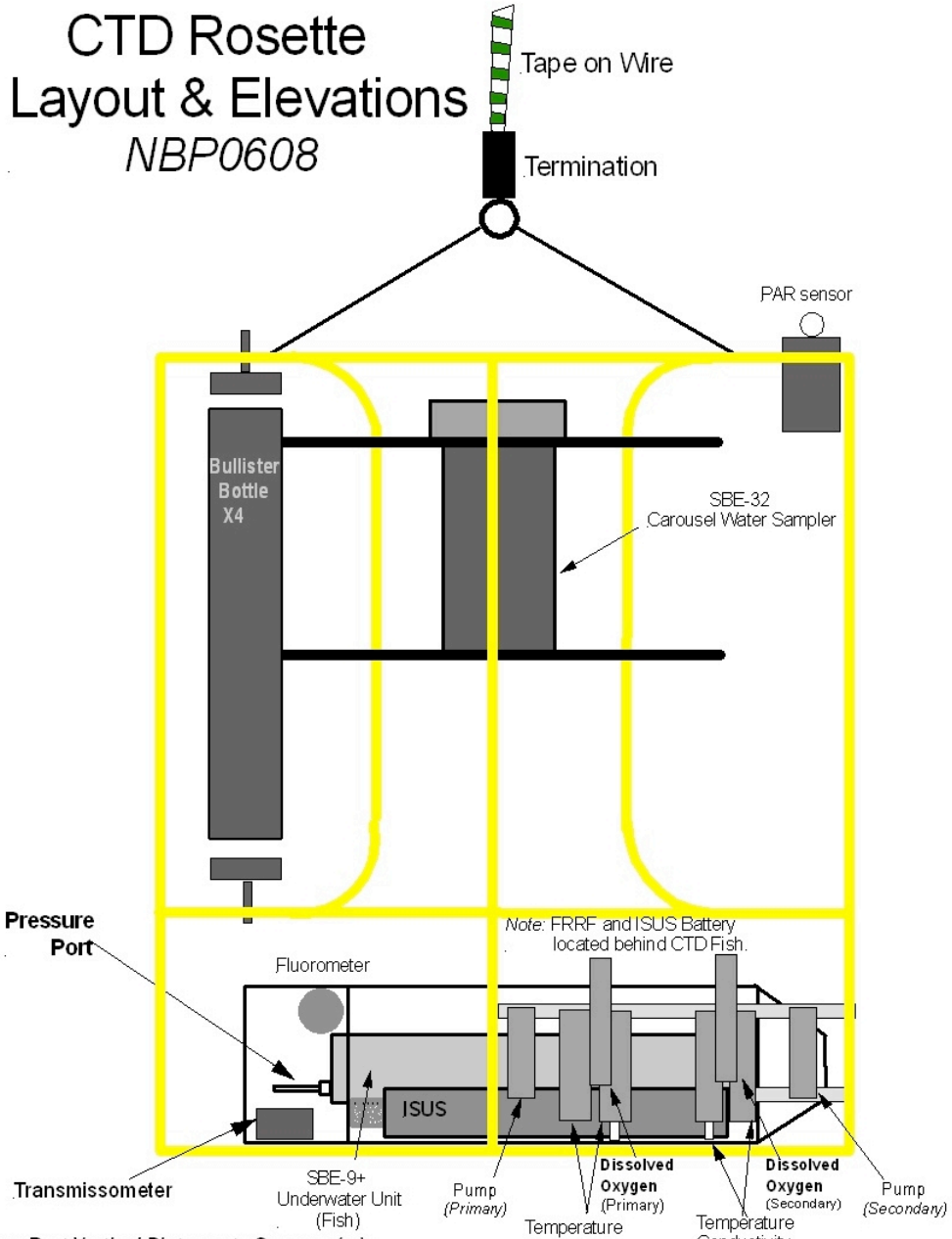
cstarwkbkf1.xls Revision F 1/17/05

CTD

CTD Sensor List

CTD Sensors (NBP0608)			
Sensor	**Serial Number**	**Last Calibration**	**Comments**
CTD Fish	09P7536-0328	4/18/2005	Installed 12/12/05 on 24 Rosette
CTD Fish Pressure	53980	4/18/2005	Installed 12/12/05 on 24 Rosette
CTD Deck Unit	11P19858-0490	N/A	SBE 11-Plus
Slip-Ring Assembly	1.406	N/A	Installed: 3/27/04
Carousel Water Sampler	3211265-0066	N/A	Rebuilt 10/10/2006
Pump	051645	4/10/2006	Installed 11/1/2006
Pump (secondary)	051646	4/10/2006	Installed 11/1/2006
Conductivity	0924	3/10/2006	Installed 11/1/2006
Conductivity (secondary)	1314	3/10/2006	Installed 11/1/2006
Temperature	1238	2/27/2006	Installed 11/1/2006
Temperature (secondary)	2186	2/27/2006	Installed 11/1/2006
Dissolved oxygen	0082	2/17/2006	Installed 11/1/2006
Dissolved oxygen (secondary)	0139	2/18/2006	Installed 11/1/2006
Transmissometer	CST-892DR	10/12/2005	Installed 11/1/2006
PAR	4361	1/13/2006	Installed 11/1/2006
Fluorometer **(6000 m rated)**	AFLT-009	7/12/2006	Installed 11/1/2006
Pinger	5118	N/A	Installed 11/1/2006
ISUS (Owned by Walker)	037	N/A	Installed 11/1/2006
FRRF (Owned by MBARI)		N/A	Installed 11/1/2006

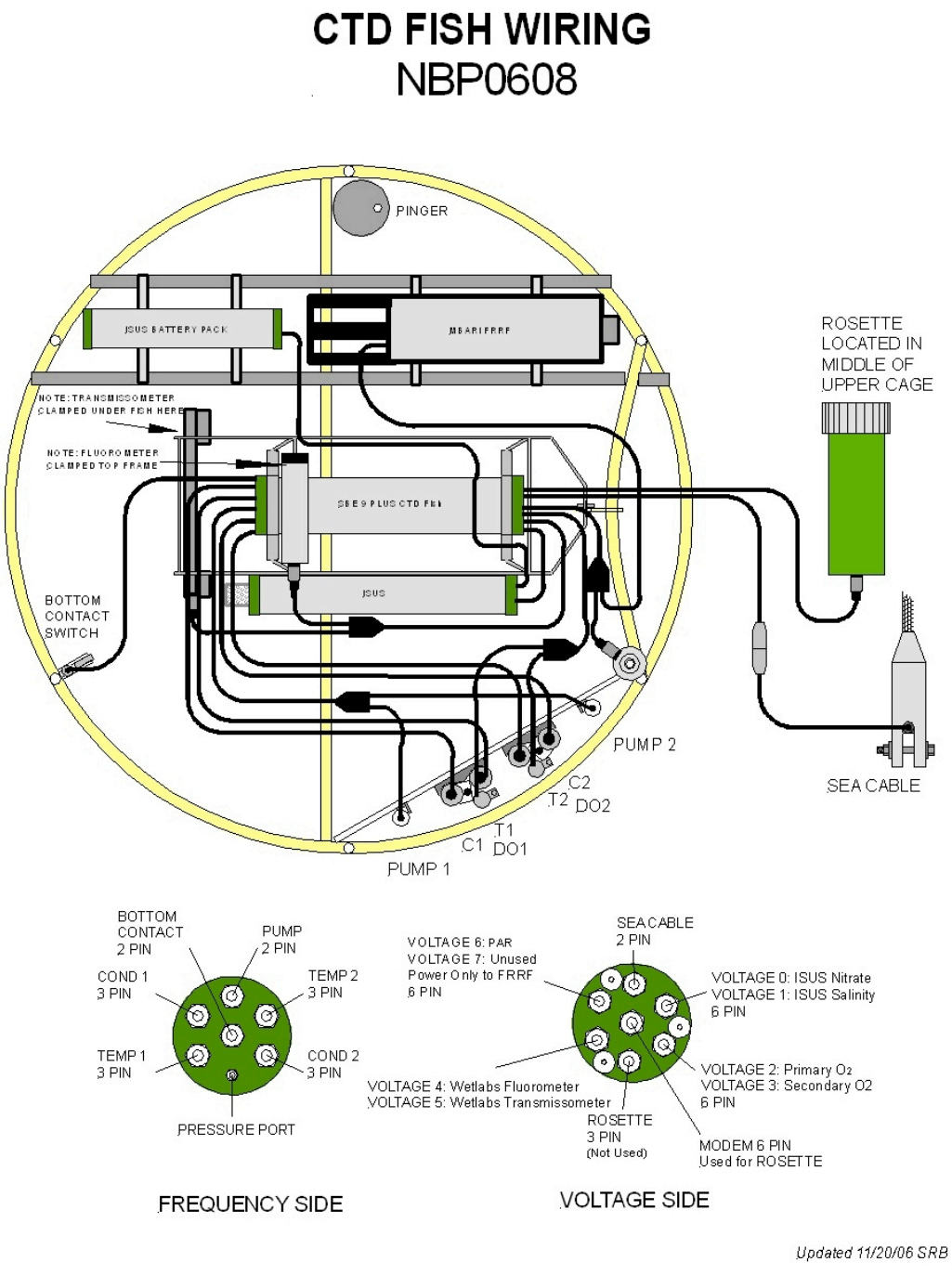
CTD Diagrams



Pressure Port Vertical Distance to Sensors (m):

Temperature (Pri)	= +0.07	Temperature (Sec)	= +0.07
Conductivity (Pri)	= -0.05	Conductivity (Sec)	= -0.05
Oxygen (Pri)	= -0.19	Oxygen (Sec)	= -0.19
Fluorometer	= -0.15	Transmissometer	= +0.08
PAR	= -1.50		
FRRF	= 0.0	ISUS	= +0.08
Bottle Center	= -1.00	Middle of Tape	= -2.25

Note:
Distances used are positive as pressure increases.



Diagrams by Sheldon Blackman

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: 18-Apr-05

SBE9plus PRESSURE CALIBRATION DATA
10000 psia S/N 53980

DIGIQUARTZ COEFFICIENTS:

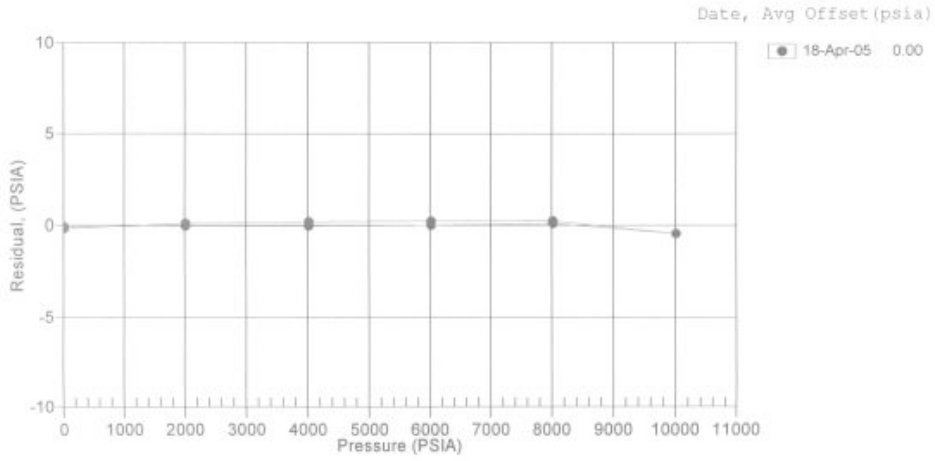
C1 =	-5.847002e+004
C2 =	6.910390e-001
C3 =	1.753360e-002
D1 =	4.241600e-002
D2 =	0.000000e+000
T1 =	3.026040e+001
T2 =	-1.938830e-004
T3 =	4.330190e-006
T4 =	2.020250e-009
T5 =	0.000000e+000

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 Primary 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: 0924
CALIBRATION DATE: 10-Mar-06

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

GHIJ COEFFICIENTS

```
g = -4.25603312e+000
h =  5.69614909e-001
i = -6.23387933e-004
j =  6.50573839e-005
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  1.74518060e-006
b =  5.67607507e-001
c = -4.25042259e+000
d = -8.91876311e-005
m =  5.1
CPcor = -9.5700e-008 (nominal)
```

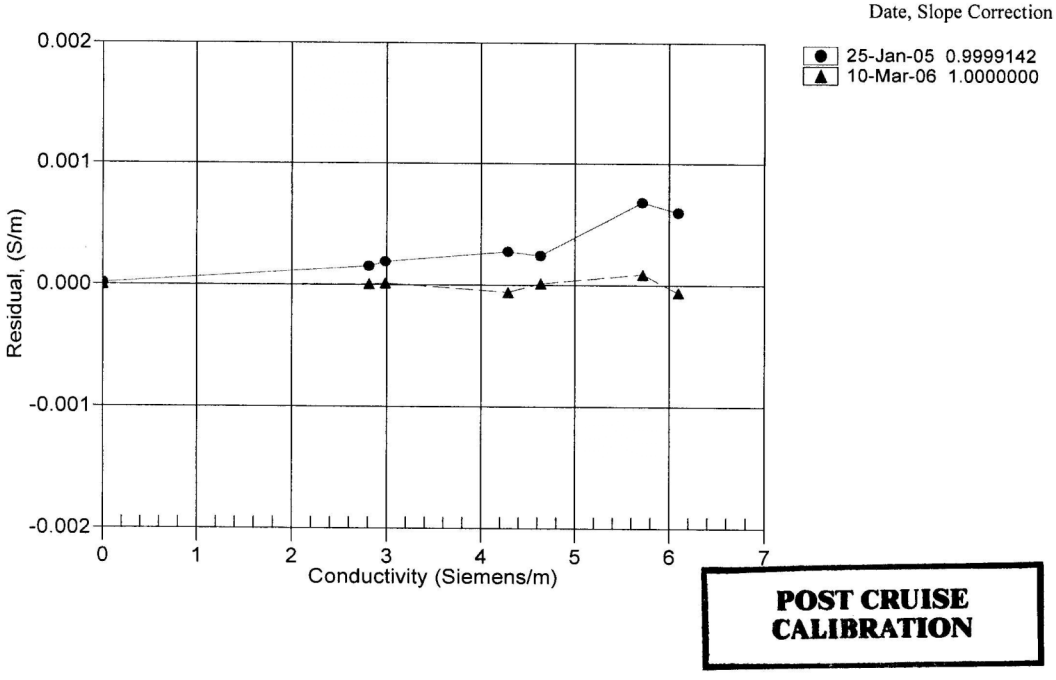
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREO (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.73638	0.00000	0.00000
-1.0000	34.9310	2.81295	7.54686	2.81296	0.00001
1.0000	34.9310	2.98483	7.74407	2.98485	0.00001
15.0000	34.9313	4.28422	9.09554	4.28417	-0.00006
18.5000	34.9306	4.63189	9.42381	4.63190	0.00001
29.0000	34.9277	5.71850	10.38139	5.71859	0.00009
32.5000	34.9190	6.09187	10.68993	6.09181	-0.00006

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 Secondary 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: 1314
CALIBRATION DATE: 10-Mar-06

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

GHIJ COEFFICIENTS

```
g = -4.07536260e+000
h =  4.70981561e-001
i = -5.52972693e-005
j =  2.88272015e-005
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  1.94216614e-005
b =  4.70855061e-001
c = -4.07525213e+000
d = -8.80860933e-005
m =  4.1
CPcor = -9.5700e-008 (nominal)
```

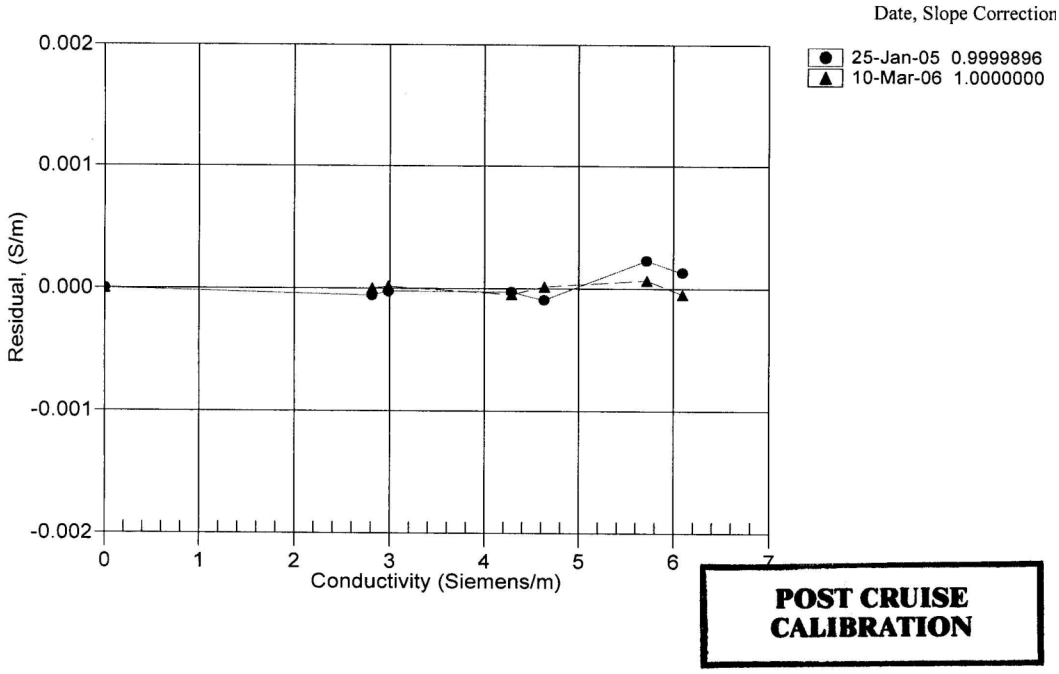
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.94131	0.00000	0.00000
-1.0000	34.9310	2.81295	8.25589	2.81295	-0.00000
1.0000	34.9310	2.98483	8.47255	2.98485	0.00002
15.0000	34.9313	4.28422	9.95663	4.28417	-0.00005
18.5000	34.9306	4.63189	10.31698	4.63190	0.00001
29.0000	34.9277	5.71850	11.36806	5.71857	0.00007
32.5000	34.9190	6.09187	11.70677	6.09182	-0.00005

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



CTD Primary Temperature

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

SENSOR SERIAL NUMBER: 1238
CALIBRATION DATE: 27-Feb-06

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-90 COEFFICIENTS

g = 4.82484656e-003
h = 6.70977642e-004
i = 2.57750761e-005
j = 2.06165518e-006
f0 = 1000.0

ITS-68 COEFFICIENTS

a = 3.68121251e-003
b = 5.98011924e-004
c = 1.45928183e-005
d = 2.06305751e-006
f0 = 6124.629

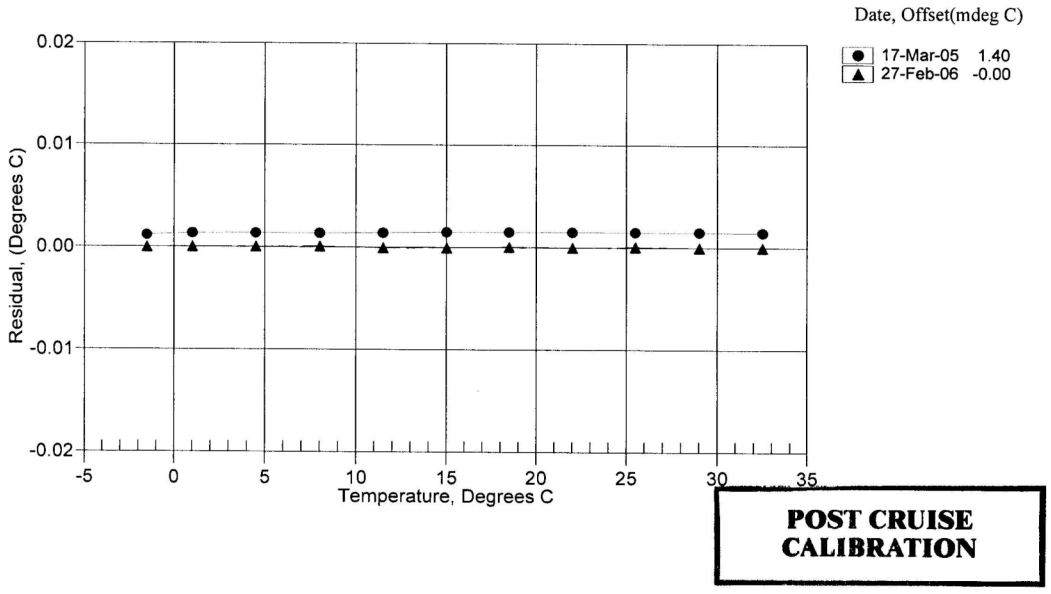
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	6124.629	-1.5000	-0.00001
1.0000	6478.852	1.0000	0.00000
4.4999	6999.231	4.4999	0.00003
7.9999	7548.907	8.0000	0.00005
11.5000	8128.634	11.4999	-0.00007
15.0000	8739.179	14.9999	-0.00005
18.4999	9381.261	18.4999	0.00004
22.0000	10055.598	22.0000	-0.00002
25.4999	10762.843	25.5000	0.00005
29.0000	11503.672	29.0000	-0.00002
32.4999	12278.668	32.4999	-0.00001

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

Temperature 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 Secondary Temperature

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

SENSOR SERIAL NUMBER: 2186
CALIBRATION DATE: 27-Feb-06

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-90 COEFFICIENTS

g = 4.34028979e-003
h = 6.44873189e-004
i = 2.33799073e-005
j = 2.21759026e-006
f0 = 1000.0

ITS-68 COEFFICIENTS

a = 3.68121213e-003
b = 6.02975408e-004
c = 1.63650825e-005
d = 2.21915961e-006
f0 = 2882.282

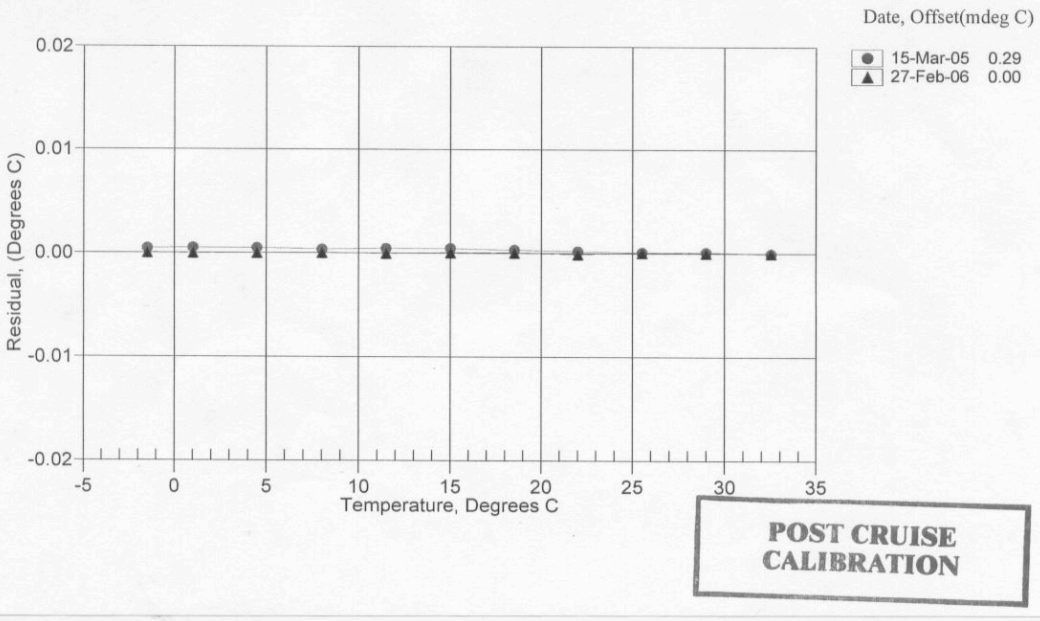
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2882.282	-1.5000	0.00001
1.0000	3047.591	1.0000	-0.00002
4.4999	3290.399	4.4999	-0.00000
7.9999	3546.826	7.9999	0.00002
11.5000	3817.233	11.5000	-0.00003
15.0000	4101.975	15.0000	0.00004
18.4999	4401.377	18.4999	0.00003
22.0000	4715.793	21.9999	-0.00011
25.4999	5045.547	25.5000	0.00006
29.0000	5390.937	29.0000	0.00001
32.4999	5752.242	32.4999	-0.00001

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

Temperature 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 Dissolved Oxygen (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: 0082
CALIBRATION DATE: 17-Feb-06p

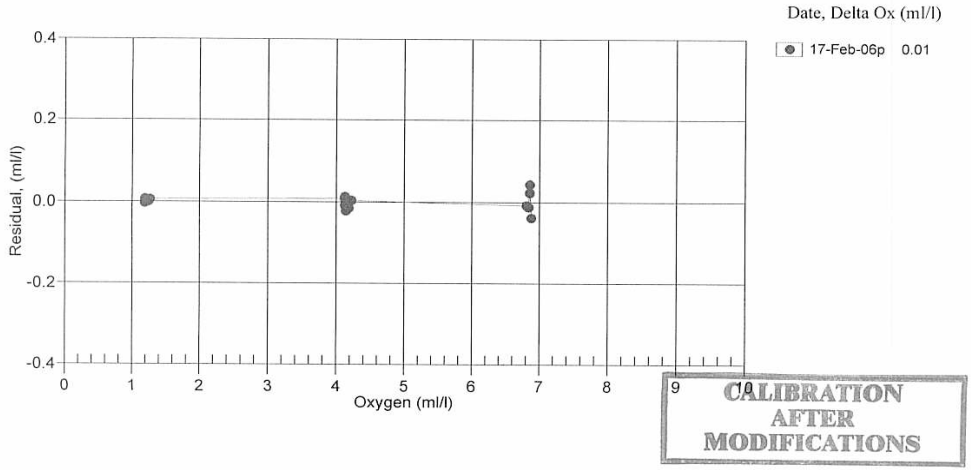
SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS
Soc = 0.2791
Boc = 0.0000
Voffset = -0.6243

TCor = 0.0013
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)
1.19	12.00	0.01	1.186	1.20	0.01
1.20	2.14	0.00	1.067	1.19	-0.00
1.20	6.02	0.00	1.116	1.20	0.01
1.21	20.00	0.01	1.291	1.21	0.00
1.24	26.00	0.01	1.386	1.24	0.00
1.26	30.00	0.01	1.454	1.27	0.01
4.13	12.02	0.01	2.562	4.13	0.01
4.13	6.05	0.00	2.318	4.14	0.01
4.13	20.00	0.01	2.891	4.12	-0.01
4.14	2.13	0.00	2.151	4.11	-0.02
4.18	26.00	0.01	3.174	4.16	-0.01
4.22	30.00	0.01	3.384	4.22	0.00
6.81	20.00	0.01	4.367	6.80	-0.01
6.84	26.00	0.01	4.803	6.82	-0.01
6.85	6.06	0.00	3.438	6.88	0.02
6.85	12.03	0.01	3.858	6.90	0.04
6.88	2.12	0.00	3.162	6.84	-0.04

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



CTD Dissolved Oxygen (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: 0139
CALIBRATION DATE: 18-Feb-06p

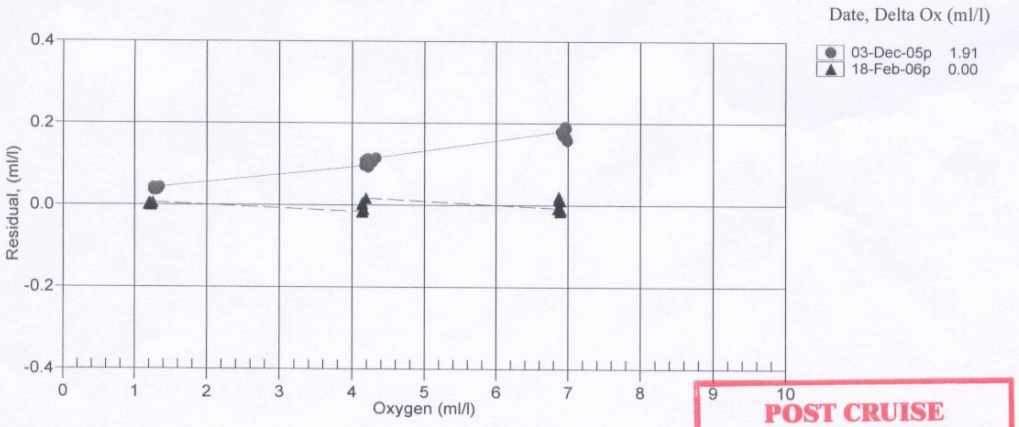
SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS
Soc = 0.3144
Boc = 0.0000
Voffset = -0.5955

TCor = 0.0016
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)
1.19	2.14	0.00	0.988	1.19	0.00
1.20	6.02	0.00	1.031	1.20	0.00
1.21	12.02	0.01	1.098	1.21	0.00
1.22	20.00	0.01	1.188	1.22	-0.00
1.24	26.00	0.01	1.262	1.24	0.00
1.26	30.00	0.01	1.320	1.26	0.01
4.13	2.13	0.00	1.948	4.11	-0.02
4.13	12.05	0.01	2.307	4.13	0.00
4.14	6.05	0.00	2.096	4.14	0.01
4.14	20.00	0.01	2.595	4.12	-0.02
4.15	26.00	0.01	2.828	4.14	-0.01
4.19	30.02	0.01	3.011	4.20	0.02
6.86	20.00	0.01	3.917	6.85	-0.01
6.87	6.06	0.00	3.093	6.89	0.02
6.87	12.06	0.01	3.451	6.89	0.01
6.88	26.00	0.01	4.294	6.87	-0.02
6.90	30.04	0.01	4.566	6.91	0.01
6.90	2.11	0.00	2.860	6.89	-0.01

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



POST CRUISE CALIBRATION

CTD 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 October 12, 2005 Customer National Science Foundation Work order 001

Job # 0508008 S/N# CST-892DR Pathlength 25 cm

	Analog meter
V_d	0.061 V
V_{air}	4.789 V
V_{ref}	4.678 V

Temperature of calibration water	21.5 °C
Ambient temperature during calibration	23.1 °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: 01/13/06 **Job No.:** R9244
Model Number: QSP200L
Serial Number: 4361
Operator: TPC
Standard Lamp: 91537(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:	**5.87E+12**	**quanta/cm²·sec/"amps"**	**9.74E-06**	**µEinsteins/cm²·sec/"amps"**
Wet Calibration Factor:	**9.88E+12**	**quanta/cm²·sec/"amps"**	**1.64E-05**	**µEinsteins/cm²·sec/"amps"**

Sensor Test Data and Results[4)]

Sensor Supply Current (Dark):	76.4	mA			
Supply Voltage:	6	Volts			
Lamp Integrated PAR Irradiance:	8.81E+15	quanta/cm²·sec	0.01463	µEinsteins/cm²sec	
SC3 Immersion Coefficient:	0.594	Scalar Correction:	1	PAR Solar Correction:	1.0000

Nominal OD	Calibrated Trans.	Sensor Voltage	Measured Trans.	Measured Signal (Amps)	Estimated Signal (Amps)	Calc. Output (Volts)	Error (Volts)	Error (%)	Test Irrad. (quanta/ cm²·sec)
ilter	100.00%	3.177	100.00%	1.50E-07	1.50E-07	3.177	0.000	0.0	8.81E+15
0.3	36.10%	2.732	35.83%	5.39E-08	5.43E-08	2.736	0.004	0.8	3.16E+15
0.5	27.60%	2.619	27.58%	4.14E-08	4.15E-08	2.620	0.001	0.1	2.43E+15
1	9.27%	2.153	9.37%	1.41E-08	1.39E-08	2.149	-0.004	-1.1	8.25E+14
2	1.11%	1.272	1.14%	1.71E-09	1.67E-09	1.261	-0.010	-2.7	1.00E+14
3	0.05%	0.433	0.08%	1.15E-10	8.03E-11	0.373	-0.059	-30.2	6.74E+12

Dark Before:	0.193	Volts			
Light - No Filter Hldr.:	3.177	Volts	I_{Ref} =	1.00E-10	Amps
Dark After - NFH:	0.193	Volts	I_{Dark} =	1.56E-10	Amps
Average Dark	0.1928	Volts	10^{vDark} =	1.558834	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 Fluorometer (6000m rated)

PO Box 518
620 Applegate St.
Philomath OR 97370

WET Labs

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

Chlorophyll Fluorometer Characterization

Date:	**07/12/06**
Serial #:	AFLT-009
Job#:	0009009
Tech:	K.C

Dark Counts	**0.174 volts**
CEV	**2.596 volts**
SF	**10.3220**
FSV	**5.45 volts**
Linearity:	**0.999 R^2 (0–1.5 volts)**
	0.995 R^2 (0– 5.45 volts)

Notes:

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

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 – dark) 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 -dark) * 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.