

# Table of Contents

<b>INTRODUCTION.....</b>	<b>1</b>
<b>DISTRIBUTION CONTENTS AT A GLANCE.....</b>	<b>2</b>
EXTRACTING DATA.....	2
<b>DISTRIBUTION CONTENTS .....</b>	<b>4</b>
CRUISE INFORMATION.....	4
<i>Cruise Track</i> .....	4
<i>Satellite Images</i> .....	4
<i>Science Report</i> .....	4
NBP DATA PRODUCTS .....	4
<i>JGOFS</i> .....	4
<i>MGD77</i> .....	5
SCIENCE OF OPPORTUNITY .....	7
<i>ADCP</i> .....	7
<i>pCO<sub>2</sub></i> .....	7
CRUISE SCIENCE .....	7
<i>CTD</i> .....	7
XBT.....	7
RVDAS .....	7
<i>Sensors and Instruments</i> .....	8
Underway Sensors .....	9
Meteorology and Radiometry.....	9
Geophysics .....	9
Oceanography.....	9
Navigational Instruments .....	9
<i>Data</i> .....	9
Underway Data .....	11
Sound Velocity Probe (svp1).....	11
Meteorology (met1).....	11
Bathy 2000 (bat1).....	12
Knudsen (knud).....	13
Simrad EM120 (mbdp).....	13
Simrad EK500 (sim1).....	13
Thermosalinograph (tsg1) .....	14
Fluorometer (flr1).....	15
pCO <sub>2</sub> .....	15
Navigational Data .....	16
Seapath GPS (seap) .....	16
Trimble (P-Code) GPS (PCOD) .....	18
Gyro Compass (gyr1) .....	19
ADCP Course (adcp).....	19
Sound Velocity Probe (svp1).....	19
<i>Process</i> .....	20
pCO <sub>2</sub> -merged .....	20
tsgfl.....	20
<b>CALCULATIONS.....</b>	<b>21</b>
TSG .....	21
PAR.....	22
PSP .....	22

<b>ACQUISITION PROBLEMS AND EVENTS.....</b>	<b>23</b>
<b>APPENDIX: SENSORS AND CALIBRATIONS.....</b>	<b>24</b>
NBP0408 SENSORS:.....	24
<i>Shipboard Sensors</i> .....	24
<i>NBP0408 CTD Sensors:</i> .....	25
CALIBRATIONS.....	26
CTD.....	26
<i>Pressure Sensor</i> .....	26
<i>Primary Temperature Sensor</i> .....	27
<i>Secondary Temperature Sensor</i> .....	28
<i>Dissolved Oxygen Sensor (1)</i> .....	29
<i>Dissolved Oxygen Sensor (2)</i> .....	30
<i>PAR</i> .....	31
<i>Transmissometer</i> .....	31
.....	31
<i>Transmissometer (continued)</i> .....	32
<i>Primary Conductivity Sensor</i> .....	33
<i>Secondary Conductivity Sensor</i> .....	34
METEOROLOGY SYSTEM.....	35
<i>Anemometer (Port)</i> .....	35
<i>Anemometer (Starboard)</i> .....	36
<i>PIR</i> .....	37
<i>PSP</i> .....	38
<i>GUV</i> .....	39
<i>PAR (ship's mast)</i> .....	40
TSG CALIBRATION FILES.....	41
<i>Underway Conductivity</i> .....	41
<i>Underway Temperature Sensor</i> .....	42
<i>Underway Remote Temperature Sensor</i> .....	43
<i>Underway Transmissometer</i> .....	44
<i>Underway Transmissometer (2)</i> .....	45
ADDITIONAL NB0408 INFORMATION.....	46
<i>CTD Layout</i> .....	46
<i>CTD Wiring</i> .....	47
<i>Daily Log: Met Example</i> .....	48
<i>Daily Log: Geophysical Example</i> .....	49
<i>Daily Log: Ocean Example</i> .....	50
<i>Daily Log: Navigation Example</i> .....	51

## 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 or CD-ROM written in ISO9660 level-1 format. It is readable by virtually every computing platform.

All the data has been compressed using Unix “gzip,” identified by the “.gz” extension. It has been copied to the distribution media in the Unix tar archive format, “.tar” extension. Tools are available on all platforms for uncompressing and de-archiving these formats: On Macintosh, use Stuffit Expander with DropStuff. On Windows operating systems use WinZip.

MultiBeam and BathyW data, if collected, are distributed separately.

*IMPORTANT: Read the last section (page 22), “Acquisition Problems and Events,” for important information that may affect the processing of this data.*

## Distribution Contents at a Glance

### DVD 1

```

    instcoef.txt
    0408.trk
    0408.mgd
    0408.gmt
    DVD_info

adcp/  adcp.tar

imagery/ README
        SatImage.doc
        AMSR.tar
        Ice.tar
        Isobar.tar
        RadarSat2.tar
        wx.tar

ocean/  0408ctd.tar
        0408xbt.tar

process/ 0408BAT.tar
        0408FBAT.tar
        0408FNAV.tar
        0408JGOF.tar
        0408MB.tar
        0408MET.tar
        0408MGD.tar
        0408PC02.tar
        0408PCD.tar
        0408QC.tar
        0408SEA.tar
        0408TSG.tar
        0408tsgf.tar

rvdas/  / nav/
        uw/

sitrep/  sitrep.rtf
        sitrep.txt

```

### DVD 2

```

report/ 04datdoc.zip
        scirepo.zip
        rvdascal.zip

Other/   cfc
        IceRepor
        ladcp
        nutrient
        O2
        Salinity
        timexxbt
        underway
        VMP
        Readme

Whale/   pictures.zip
        RosSea04.zip
        Sealce

```

## Extracting Data

The Unix tar command has many options. It is often useful to know exactly how an archive was produced when expanding its contents. All archives were created using the command,

```
tar cvf archive_filename files_to_archive
```

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

```
tar tvf archive_filename > contents.list
```

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

To extract the files from the archive:

```
tar xvf archive_filename file(s)_to_extract
```

G-zipped files will have a “.gz” extension on the filename. These files can be decompressed after de-archiving, using the Unix command,

```
gunzip filename.gz
```

In the event there are any problems found with this distribution data set, please contact [admin@nbp.usap.gov](mailto:admin@nbp.usap.gov) or [itvessel@usap.gov](mailto:itvessel@usap.gov)

# Distribution Contents

## Cruise Information

### ***Cruise Track***

The distribution DVD includes a GMT cruise track file (NBP0408.trk). It contains the longitude and latitude at one-minute intervals extracted from the NBP0408.gmt file.

(remove if not present) Two PostScript cruise track files have been produced and placed in the /plots directory. Trk.large.ps is poster-sized (~36" x 40") and trk\_small.ps is standard US Letter sized (8.5" x 11").

### ***Satellite Images***

Satellite Images processed for this cruise can be found in the directory, /Imagery in two subdirectories, ice and wx (weather). Files are named using the convention, IdDDYYA.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 Report***

The weekly science reports are stored in the directory /report/Science Report **UPDATE**

## NBP Data Products

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

### ***JGOFS***

The JGOFS data set can be found on the distribution media in the file /process/<cruiseino>.tar. The archive contains a single file produced 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. The daily file consists of 22 columnar fields in text format described in the table below. The JGOFS data set is obtained primarily by applying calibrations to raw data and decimating to whole 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. During the cruise, the JGOFS data set produces the daily data plots. Note: Null, unused, or unknown fields are indicated as "NAN" as 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	$\mu$ Einsteins/meter <sup>2</sup> sec
10	Sea surface temperature	°C

Field	Data	Units
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 (port windbird)	meters/sec
15	True wind direction (port windbird)	degrees (azimuth)
16	Ambient air temperature	°C
17	Relative humidity	%
18	Barometric pressure	mBars
19	Sea surface fluorometry	volts (0-5 FSO)
20	Not used	-
21	PSP	W/m <sup>2</sup>
22	PIR	W/m <sup>2</sup>

## 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 NBP0408.mgd. Also at the root level, NBP0408.gmt is the output of the mgd77togmt utility using NBP0408.mgd as input. The NBP0408.gmt file can be used by GMT plotting software.

The data used to produce the NBP0408.mgd file can be found on the distribution media in the file /process/<NBP0408>proc.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 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)
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

Col	Len	Type	Contents	Description, Possible Values, Notes
60	1	int	Bathymetric type code	1 = Observed 3 = Interpolated (Header Seq. 12) 9 = Unspecified
61-66	6	real	Magnetics total field, 1 <sup>ST</sup> sensor	In tenths of nanoteslas (gammas)
67-72	6	real	Magnetics total field, 2 <sup>ND</sup> 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 <sup>st</sup> or leading sensor 2 = 2 <sup>nd</sup> 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 <sup>th</sup> of mgals. Corrected for Eotvos, drift, tares
98-103	6	real	EOTVOS correction	In 10 <sup>th</sup> of mgals. $E = 7.5 V \cos \phi \sin \alpha + 0.0042 V^*V$
104-108	5	real	Free-air anomaly	In 10 <sup>th</sup> 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 shipboard ADCP system measures currents in the depth range from about 30 to 300 m -- in good weather. In bad weather or in ice, the range is less, and sometimes no valid measurements are made. It is the USAP-funded project of Eric Firing (University of Hawaii) and Teri Chereskin (Scripps Institution of Oceanography). ADCP data collection occurs on the both LMG and the NBP for the benefit of the scientists on individual cruises, and for the long-term goal of building a climatology of current structure in the Southern Ocean.

The ADCP data set collected during this cruise has been placed on the distribution media in the archive `/adcp/<NBP0408>adcp.tar`. The archive consists of a single file for each day of data collection. The files are named `PINGDATA.xxx` where `xxx` is a day number that is NOT a year-day. For the date, use the file's creation date.

Some ADCP data is also transmitted to RVDAS. East and north vectors for ship's speed relative to the reference layer and ship's heading are archived as `<NBP0408>adcp.tar` in the directory `/rvdas/nav`.

### pCO<sub>2</sub>

The NBP carries Lamont-Doherty Earth Observatory's (LDEO) pCO<sub>2</sub> system and RPSC staff maintains it. Data is sent to LDEO at the end of each cruise. The pCO<sub>2</sub> data is transmitted and archived on RVDAS. You will find it in a file named `<NBP0408>pco2.tar` in the `/process` directory, which contains the pCO<sub>2</sub> instrument's data merged with GPS, meteorological and other oceanographic measurements. For more information contact Colm Sweeney ([csweeney@ldeo.columbia.edu](mailto:csweeney@ldeo.columbia.edu)).

## Cruise Science

### CTD

The ctd data have been placed in the tar file `/ocean/<NBP0408>ctd.tar`. The archive contains tar files `<NBP0408>proc.tar`.

### XBT

During the cruise Expendable Bathythermographs were used to obtain water column temperature profiles. The data files from these launches are included as `<NBP0408>xbt.tar` in the `/ocean` directory.

### 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 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 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. Each data file is g-zipped 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:     NBP0107.met1.d317

- The CruiseID is the numeric name of the cruise, in this case, NBP0408.
- 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
PSP (SW radiation)	met1	continuous	1 sec	Eppley PSP
PAR	met1	continuous	1 sec	BSI QSR-240
GUV	guv	continuous	2 sec	BSI PUV-511
PUV	puv	not collected		BSI PUG-500

### Geophysics

Measurement	Channel ID	Collect. Status	Rate	Instrument
Gravimeter	grv1	not collected	10 sec*	LaCoste & Romberg
Magnetometer	mag1	not collected	15 sec	EG&G G-866
Bathymetry	bat1	Continuous	Varies	ODEC Bathy 2000
Bathymetry	knu1	intermittent	Varies	Knudsen 320B/R
Bathymetry	sim1	depth < 2500 m	Varies	Simrad EK500 Sonar

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

### Oceanography

Measurement	Channel ID	Collect. Status	Rate	Instrument
Conductivity	tsg1	Continuous	6 sec	SeaBird 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 <sub>2</sub>	pco2	Continuous	70 sec	(LDEO)
ADCP	adcp	Continuous	varies	RD Instruments

### Navigational Instruments

Measurement	Channel ID	Collect. Status	Rate	Instrument
Attitude GPS	Adu1	continuous	1 sec	Ashtech ADU2
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 from 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 -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 21 for calculations.

## 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 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	

Field	Data	Format / Possible Values	Units
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 )	

Field	Data	Units
7		

### Thermosalinograph (tsg1)

00+019:23:59:46.976 15A16CFC163F8C2C100

Field	Data	Units
1	RVDAS time tag	
2	Seabird hex string (see page 21 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	
9	Temperature units	

## pCO<sub>2</sub>

00+021:23:59:43.190 2000021.9992 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 <sub>2</sub> time tag (decimal is fractional time of day)	yyyyddd.ttt
3	Raw voltage	mV
4	Barometer	mBar
5	Cell temperature	°C
6	Flow rate	ml/min
7	Concentration	ppm
8	pCO <sub>2</sub> pressure	microAtm
9	Equilibrated temperature	°C
10	Latitude (not collected)	
11	Longitude (not collected)	
12	Flow source (Equil = pCO <sub>2</sub> measurement)	

## Navigational Data

### Seapath GPS (seap)

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

- GPZDA
- GPGGA
- GPVTG
- GPHDT
- 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,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 \$HEHRC 25034,-020\*73

Field	Data	Units
1	RVDAS time tag	
2	\$HEHRC	
3	Heading XXXXX = ddd.dd	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

## Process

### 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 <sub>2</sub> time tag (decimal is time of day)	yyyddd.ttt
3	Raw voltage	mV
4	Barometer	mB
5	Cell temperature	°C
6	Flow rate	cm <sup>3</sup> /min
7	Concentration	ppm
8	PCO <sub>2</sub> pressure	microAtm
9	Equilibrated temperature	°C
10	Flow Source (Equil = pCO <sub>2</sub> 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 *rvdascal.txt* located in the `/reports` 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(f0/f)] + i[ln2(f0/f)] + j[ln3(f0/f)]} -
273.15 (°C)
```

#### Calculating Conductivity – ITS-90

```
C = decimal equivalent of bytes 5-8
Conductivity Frequency f = sqrt(C*2100+6250000)
Conductivity = (g + hf2 + if3 + jf4)/[10(1 + δt + εp)]
(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

```
Vdark = 0.058 V
Vref = 4.765 V
t = decimal equivalent of bytes 18 - 20
Transmissometer Voltage (Vsignal) = t/819
% Transmittance = (Vsignal - Vdark) / (Vref - Vdark)
```

## PAR

```
raw data = mV
calibration scale = 6.10 V/(μEinstiens/cm2sec)
offset (Vdark) = 0.21 mV
(raw mV - Vdark)/scale x 104 cm2/m2 x 10-3 V/mV = μEinstiens/m2sec
or
(data mV - 0.3 mV) x 1.65 (μEinstiens/m2sec)/mV =
μEinstiens/m2secPIR
raw data = mV

calibration scale = 3.91 x 10-6 V/(W/m2)
data mV / (scale x 103 mV/V) = W/m2
or
data mV x 255.8(W/m2)/mV = W/m2
```

## PSP

```
raw data = mV
calibration scale = 8.05 x 10-6 V/(W/m2)
data mV / (scale x 103 mV/V) = W/m2
or
data mV x 124.2(W/m2)/V = W/m2
```



## 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.

Start	End	Description
JD 291 0300	JD 307 2000	Depart / Return NZ EEEZ
JD 293 1738	JD 316 2230	Terascan system down; Azimuth tracking failure. See document in "Other" on DVD for full details.
JD 296	JD 296 1800	CTD Transmissometer CST-557DR failed; CST-533DR installed
JD 297	JD 297 1000	CTD Transmissometer CST-533DR failed; CST-423PR installed
JD 300	JD 300 1920	Transmissometer CST-423PR failed, lens fogging; CST-422PR installed
JD 315 2000	JD 340 1430	Depart / Return NZ EEEZ
JD 322	JD 322 1000	Secondary Dissolved Oxygen sensor added to CTD prior to cast #88
JD 338 1539	JD 339 0000	Met Data acquisition lost
JD 340 0054	JD 340 0100	RVDAS Server down
	JD 342 0000	RVDAS Server Data Collection Ends for NBP0408

## Appendix: Sensors and Calibrations

### NBP0408 Sensors:

#### Shipboard Sensors

Sensor	Description	Serial #	Last Calibration Date	Status
<b>Meteorology &amp; Radiometers</b>				
Port Anemometer	RM Young 5106	WM51143	09/27/04	Collect
Stbd Anemometer	RM Young 5106	WM51144	09/27/04	Collect
Barometer	RM Young 61201	00872	05/13/04	Collect
Air Temp/Rel. Hum.	RM Young 41372LC	06733	08/07/04	
Mast PRR	BSI PRR-610			Not used
UW PRR	BSI PRR-600			Not used
PIR (Pyrgeometer)	Eppley PIR	33023F3	12/18/03	Collect
PSP (Pyranometer)	Eppley PSP	32850F3	06/22/04	Collect
Mast PAR	BSI QSR-240	6357	6/24/03	Collect
GUV				Not used
PUV				Not used
<b>Underway</b>				
TSG	SeaBird SBE21	2131020-3198	12/10/03	Collect
TSG Remote Temp (primary)	SeaBird 3-01/S	031267	11/21/03	Collect
TSG Remote Temp (secondary)	SeaBird 3-01/S	032691	10/21/03	Collect
Fluorometer	Turner 10-AU-005 Lamp: daylight 10-045; ref. filter: 10-052, em. filter: 10-051, ex. filter: 10-050	5333-FRXX	N/A	Collect
Transmissometer*	WET Labs C-Star	CST-557DR	01/12/04	Collect
Transmissometer*	WET Labs C-Star	CST-533DR	12/31/03	Collect
Transmissometer*	WET Labs C-Star	CST-423PR	05/25/04	Collect
Transmissometer*	WET Labs C-Star	CST-422PR	06/15/04	Collect
Magnetometer	EG&G G-866			Not used
Gravimeter	LaCoste & Romberg Gravity Meter			Collect
Bathymetry	Simrad EK500	3001	11/1/95	Collect
Bathymetry	Knudsen 320B/R			Collect
Bathymetry	Bathy 2000			Collect
<b>Other</b>				
Trimble GPS (formerly P-Code)	Trimble 20636-00 (SM)	0220035116	Key no longer used	Collect
Attitude GPS	Ashtech 12	700273F2114 FW 7B13-D1-C21	N/A	Collect

\* See previous page *Acquisition Problems and Events*

**NBP0408 CTD Sensors:**

Sensor	Description	Serial #	Last Calibration Date	Status
CTD Fish	SeaBird model SBE 9+	09P7536-0328	02/08/03	Collect
CTD Fish Pressure	Paroscientific model 410K-105 pressure sensor	53980	02/08/03	Collect
CTD Deck Unit	SeaBird model SBE 11+	11P19858-0490		Collect
Primary Temperature Sensor	SeaBird model 3-02/F	031457	12/18/03	Collect
Secondary Temperature Sensor	SeaBird model 3-02/F	031541	12/18/03	Collect
Primary Conductivity Sensor	SeaBird model 4-02/0	040924	12/18/03	Collect
Secondary Conductivity Sensor	SeaBird model 4C	041314	12/19/03	Collect
Dissolved Oxygen Sensor (primary)	SeaBird model 13-02-B	0150	12/17/03	Collect
Dissolved Oxygen Sensor (secondary)*	SeaBird model 13-02-B	0082	11/19/03	Collect
Transmissometer*	WET Labs C-Star	CST-533DR	12/31/03	Collect
Transmissometer*	WET Labs C-Star	CST-557DR	12/31/03	Collect

\* See page 22 *Acquisition Problems and Events*

## Calibrations

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

## CTD

### Pressure Sensor

#### Pressure Calibration Check

pressure sensor model: Digiquartz 410K-105  
sensor serial number: 53990  
installed in: CTD 09P7536-0328

REC'D  
2/24/03  
EAP  
18 February 2003

This pressure calibration is a check of the 'test' sensor against a stable reference pressure sensor. The reference pressure sensor is itself checked several times per year against a NIST-traceable pressure standard maintained at Paroscientific, Inc.. The circumstances of this pressure check introduce no more than 1.5 psia total error in 10,000 psi (0.015 %) in addition to the error resident in the Paroscientific site standard. The check offers a very high level certification of the health and proper operation of the 'test' sensor.

Input Pressure* [psia]	Sensor Output [Hz]	Sensor Temperature [deg C]	Pressure Factory Coef [psia]	Pressure Corrected [psia]	Error [psia]
14.739	33053.13	18.4	15.416	14.770	0.031
2014.807	33613.00	18.5	2015.792	2015.143	0.336
4015.169	34162.06	18.6	4015.928	4015.277	0.108
6015.370	34700.87	18.7	6015.956	6015.303	-0.067
8015.212	35229.94	18.7	8015.987	8015.332	0.120
10015.411	35749.65	18.8	10015.754	10015.097	-0.314
8015.408	35229.95	18.8	8016.019	8015.364	-0.044
6015.276	34700.91	18.8	6016.072	6015.419	0.143
4015.174	34162.11	18.9	4016.056	4015.405	0.231
2015.132	33613.02	18.9	2015.799	2015.151	0.019
14.729	33052.98	19.0	14.811	14.165	-0.564

Input pressure is generated with a Ruska model 5201 dead-weight tester, serial number 23130/380, and is determined by measurement with reference pressure sensor model Digiquartz 410K-105, serial number 73292.

Sensor Temperature: pressure sensor internal temperature.

Pressure Corrected: pressure computed with original factory coefficients and then corrected with a slope and offset to give the best linear agreement with the 'reference' input pressure.

Error: Corrected pressure - Input pressure

A linear fit of this calibration data, between sensor pressure computed with factory coefficients and the input pressure, yields correction coefficients:

Corrected pressure = psi slope \* Factory pressure + psi offset [psia]  
psi slope = 1.00000 and psi offset = -0.65 [psia]

These are converted to Slope and Offset for use in the SEASOFT programs by:

Slope = psi slope = 1.00000

Offset = 0.689476 \* (psi offset - 14.7 \* (1 - psi slope)) = -0.4455 [dbars]

Slope and Offset coefficients are entered into the pressure sensor calibration coefficient section of the <>.CON file using the program SEACON.

#### Digiquartz Coefficients:

C1 = -5.847002e-04  
C2 = 6.910390e-01  
C3 = 1.753360e-02  
D1 = 4.241600e-02  
D2 = 0.000000e+00  
T1 = 3.026040e+01  
T2 = -1.938830e-04  
T3 = 4.330190e-06  
T4 = 2.020250e-09

#### AD590 Pressure Temperature Coefficients:

AD590M = 0.01133  
AD590B = -8.47592

#### Calibration Correction:

Slope = 1.00000  
Offset = -0.4455

# Primary 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: 1457  
CALIBRATION DATE: 18-Dec-03

SBE3 TEMPERATURE CALIBRATION DATA  
ITS-90 TEMPERATURE SCALE

### ITS-90 COEFFICIENTS

g = 4.82820788e-003  
h = 6.70238053e-004  
i = 2.51364311e-005  
j = 1.96602122e-006  
f0 = 1000.0

### ITS-68 COEFFICIENTS

a = 3.68121252e-003  
b = 5.98491923e-004  
c = 1.44428608e-005  
d = 1.96740041e-006  
f0 = 6157.193

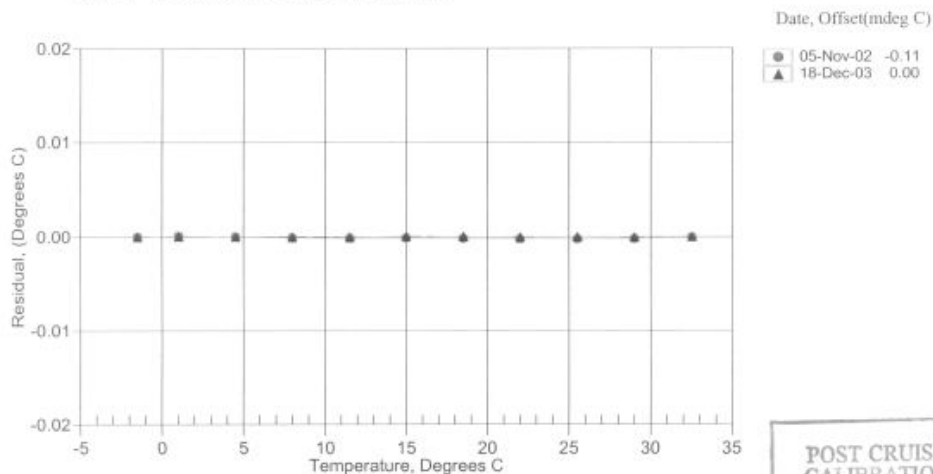
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	6157.193	-1.5000	-0.00002
1.0001	6513.019	1.0001	0.00003
4.5001	7035.686	4.5001	0.00001
8.0000	7587.689	8.0000	-0.00003
11.5001	8169.859	11.5001	-0.00004
15.0000	8782.900	15.0001	0.00006
18.5000	9427.552	18.5000	0.00003
22.0001	10104.537	22.0001	-0.00003
25.5000	10814.504	25.5000	0.00002
29.0001	11558.142	29.0001	-0.00004
32.5001	12336.061	32.5001	0.00002

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

## Secondary 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: 1541  
CALIBRATION DATE: 18-Dec-03

SBE3 TEMPERATURE CALIBRATION DATA  
ITS-90 TEMPERATURE SCALE

#### ITS-90 COEFFICIENTS

g = 4.82612605e-003  
h = 6.66564900e-004  
i = 2.44517845e-005  
j = 1.88733003e-006  
f0 = 1000.0

#### ITS-68 COEFFICIENTS

a = 3.68121127e-003  
b = 5.96394030e-004  
c = 1.41604330e-005  
d = 1.88867589e-006  
f0 = 6186.239

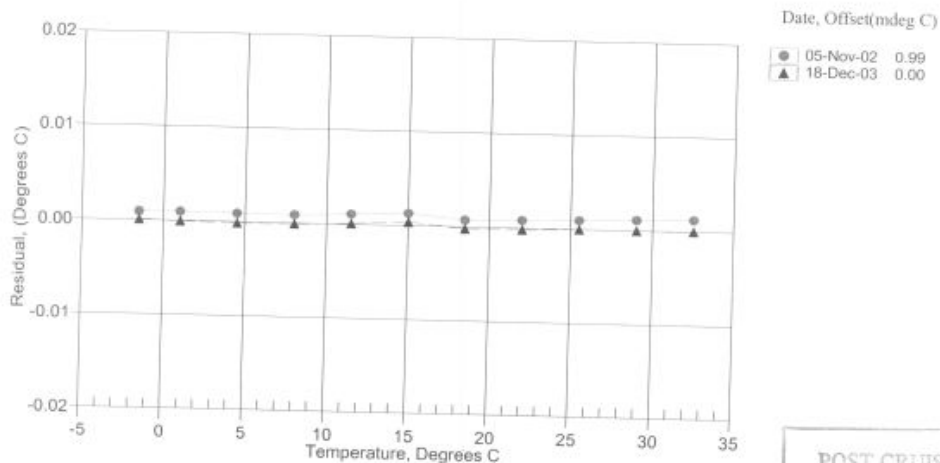
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	6186.239	-1.4999	0.00008
1.0001	6545.007	1.0001	-0.00004
4.5001	7072.121	4.5000	-0.00013
8.0000	7628.966	7.9999	-0.00009
11.5001	8216.390	11.5002	0.00009
15.0000	8835.098	15.0004	0.00038
18.5000	9485.702	18.4998	-0.00021
22.0001	10169.208	21.9999	-0.00015
25.5000	10886.159	25.5000	0.00001
29.0001	11637.250	29.0001	0.00001
32.5001	12423.096	32.5001	0.00003

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

## Dissolved Oxygen Sensor (1)

### 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: 0150  
CALIBRATION DATE: 17-Dec-03w

#### SBE 43 OXYGEN CALIBRATION DATA

##### COEFFICIENTS

Soc = 0.4426

Boc = 0.0000

Voffset = -0.4932

TCor = 0.0017

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)
1.68	25.00	0.01	1.126	1.69	0.00
1.73	5.00	0.00	0.925	1.72	-0.00
2.51	25.00	0.01	1.439	2.52	0.01
2.60	5.00	0.00	1.142	2.59	-0.02
3.38	25.00	0.01	1.770	3.40	0.02
3.49	5.00	0.00	1.369	3.49	-0.00
5.12	25.00	0.01	2.411	5.11	-0.01
5.29	5.00	0.00	1.825	5.31	0.02
6.75	5.02	0.00	2.188	6.75	-0.01
6.89	25.00	0.01	3.076	6.88	-0.01

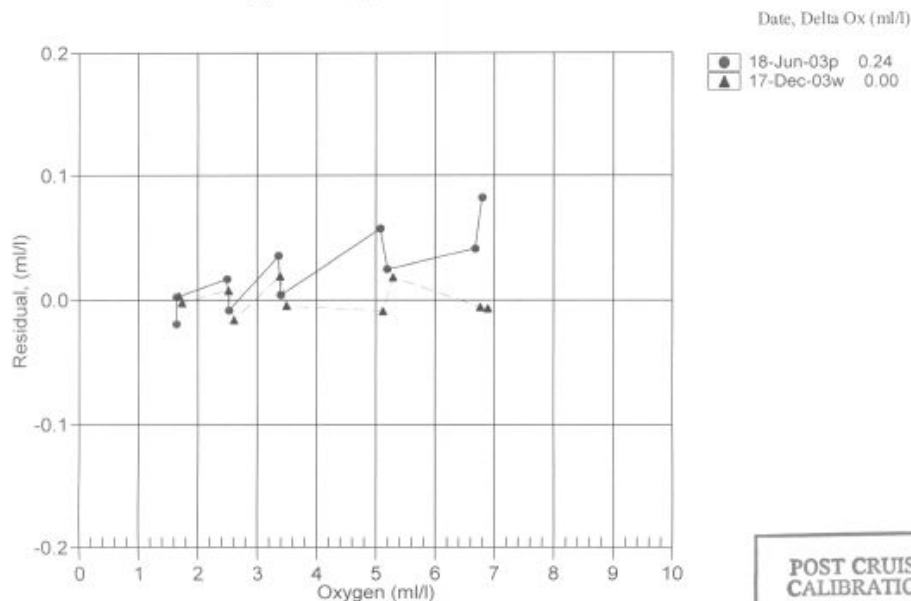
oxygen (ml/l) = (Soc \* (V + Voffset)) \* exp(Tcor \* T) \* Oxsat(T,S) \* exp(PCor \* P)

V = voltage output from SBE43, T = ocean temperature [deg C]

S = ocean salinity [PSU] from CTD, P = ocean pressure [dbar] from CTD

Oxsat(T,S) = oxygen saturation [ml/l]

Residual = instrument oxygen - bath oxygen



## Dissolved Oxygen Sensor (2)

### 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: 19-Nov-03p

#### SBE 43 OXYGEN CALIBRATION DATA

##### COEFFICIENTS

Soc = 0.3857

Boc = 0.0000

Voffset = -0.6371

TCor = 0.0015

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)
1.51	25.00	0.01	1.287	1.50	-0.01
1.62	5.00	0.00	1.107	1.63	0.01
2.39	25.00	0.01	1.673	2.39	0.00
2.48	5.00	0.00	1.352	2.48	0.01
3.30	25.00	0.01	2.063	3.30	-0.00
3.36	5.00	0.00	1.604	3.36	-0.00
5.13	25.00	0.01	2.855	5.12	-0.00
5.17	5.00	0.00	2.127	5.17	-0.00
6.77	5.00	0.00	2.588	6.77	0.00
6.99	25.00	0.01	3.666	7.00	0.00

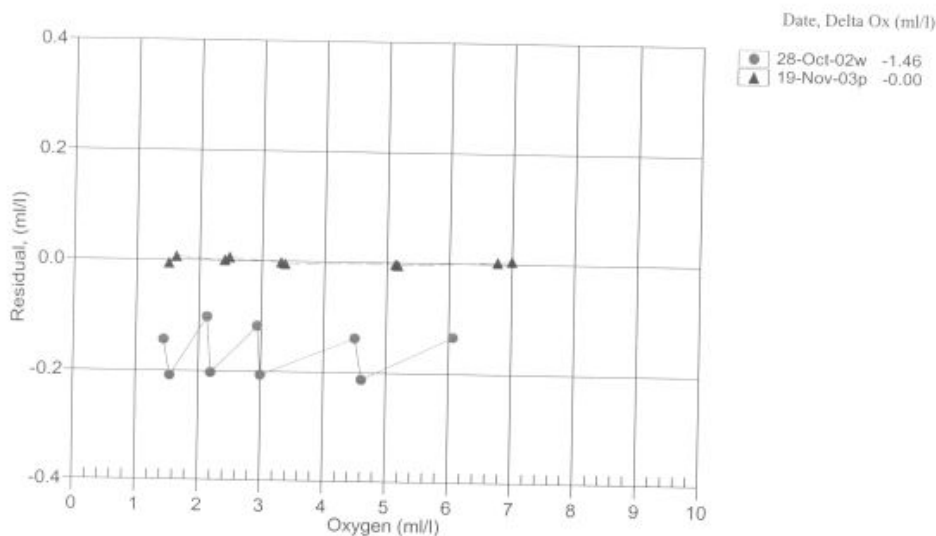
oxygen (ml/l) = (Soc \* (V + Voffset)) \* exp(Tcor \* T) \* Oxsat(T,S) \* exp(PCor \* P)

V = voltage output from SBE43, T = ocean temperature [deg C]

S = ocean salinity [PSU] from CTD, P = ocean pressure [dbar] from CTD

Oxsat(T,S) = oxygen saturation [ml/l]

Residual = instrument oxygen - bath oxygen





**PAR**

**Transmissometer**

PO Box 518  
620 Applegate St.  
Philomath, OR 97370



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

**C-Star Calibration**

Date	12/31/03	Customer	National Science Foundation	Work order	003
Job #	0111019	S/N#	CST-533DR	Pathlength	25 cm

	Analog meter
$V_d$	0.059 V
$V_{air}$	4.798 V
$V_{ref}$	4.704 V

Temperature of calibration water	20.9 °C
Ambient temperature during calibration	20.2 °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.

cstarcalsheet

Revision A

6/23/03

## Transmissometer (continued)

PO Box 518  
620 Applegate St.  
Philomath, OR 97370



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

### C-Star Calibration

Date	1/12/04	Customer	National Science Foundation	Work order	002
Job #	0201020	S/N#	CST-557DR	Pathlength	25 cm

	Analog meter
$V_d$	0.059 V
$V_{air}$	4.813 V
$V_{ref}$	4.708 V

Temperature of calibration water	23.3 °C
Ambient temperature during calibration	23.7 °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.

cstarcalsheet

Revision A

6/23/03

## Primary Conductivity 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: 0924  
CALIBRATION DATE: 18-Dec-03

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

#### GHJ COEFFICIENTS

g = -4.25424894e+000  
h = 5.69191878e-001  
i = -5.46965470e-004  
j = 6.06948352e-005  
CPcor = -9.5700e-008 (nominal)  
CTcor = 3.2500e-006 (nominal)

#### ABCDM COEFFICIENTS

a = 2.88737702e-006  
b = 5.67420323e-001  
c = -4.24898185e+000  
d = -8.21291534e-005  
m = 4.9  
CPcor = -9.5700e-008 (nominal)

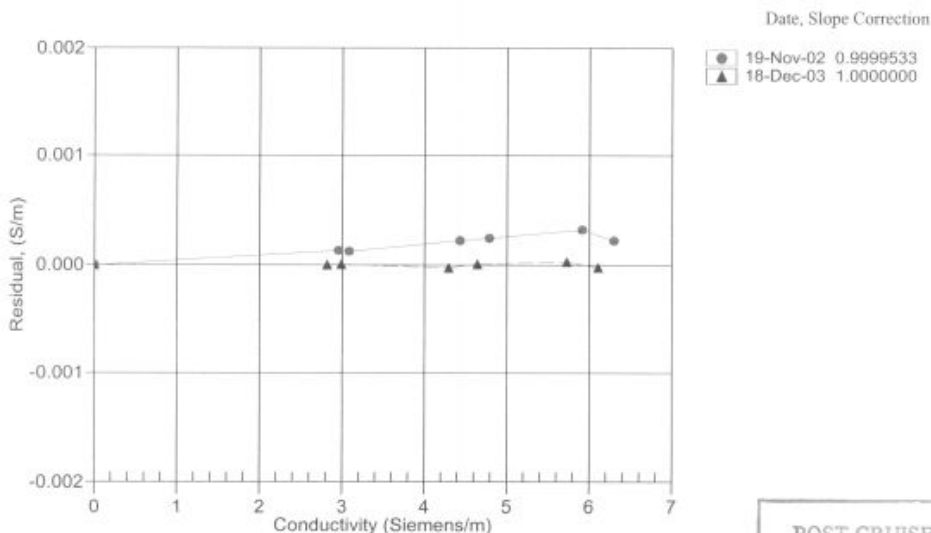
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.73640	-0.00000	-0.00000
-1.0006	34.9878	2.81705	7.55203	2.81705	0.00000
0.9995	34.9880	2.98919	7.74942	2.98920	0.00001
14.9995	34.9891	4.29051	9.10215	4.29049	-0.00002
18.4995	34.9890	4.63875	9.43074	4.63876	0.00001
28.9995	34.9874	5.72712	10.38932	5.72715	0.00003
32.4995	34.9821	6.10157	10.69868	6.10154	-0.00002

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];  $\delta$  = CTcor;  $\epsilon$  = CPcor;

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



POST CRUISE  
CALIBRATION

## Secondary Conductivity 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: 1314  
CALIBRATION DATE: 19-Dec-03

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

#### GHJ COEFFICIENTS

g = -4.07391861e+000  
h = 4.70797123e-001  
i = -2.38964773e-005  
j = 2.72896909e-005  
CPcor = -9.5700e-008 (nominal)  
CTcor = 3.2500e-006 (nominal)

#### ABCDM COEFFICIENTS

a = 2.57239717e-005  
b = 4.70702040e-001  
c = -4.07355268e+000  
d = -8.25262228e-005  
m = 4.0  
CPcor = -9.5700e-008 (nominal)

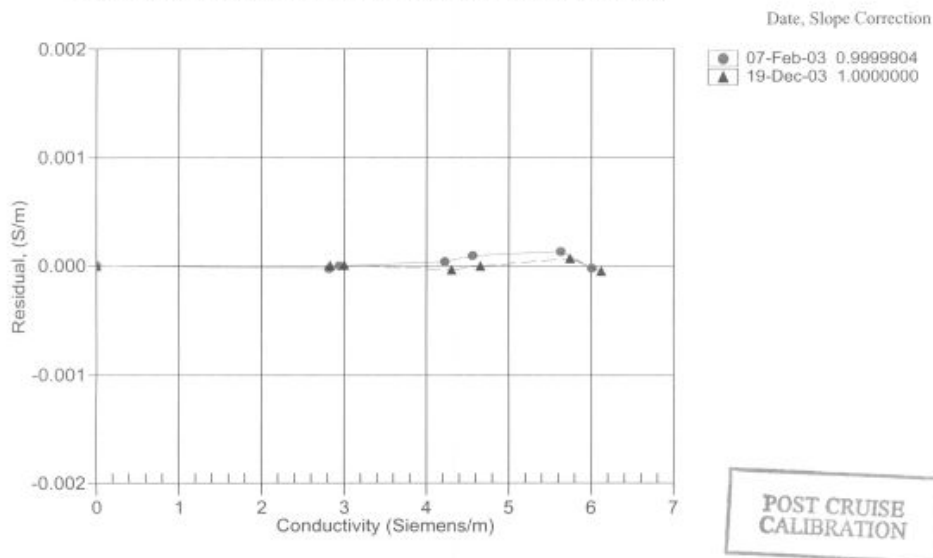
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.94112	-0.00000	-0.00000
-1.0005	35.0880	2.82437	8.27054	2.82437	0.00000
0.9995	35.0881	2.99693	8.48766	2.99694	0.00001
14.9995	35.0895	4.30151	9.97497	4.30148	-0.00004
18.4995	35.0897	4.65065	10.33616	4.65065	0.00000
28.9995	35.0881	5.74174	11.38963	5.74181	0.00007
32.4995	35.0838	6.11728	11.72967	6.11723	-0.00005

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];  $\delta$  = CTcor;  $\epsilon$  = CPcor;

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



## Meteorology System

### Anemometer (Port)

#### RM Young Anemometer Calibration, Model 05106

S/N: 51143

Date: 19-Sep-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	4.8	0.1	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	29.7	-0.3	57.1
7000	34.30	34.8	-0.5	66.6
8000	39.20	39.8	-0.6	76.2
9000	44.10	44.8	-0.7	85.7
10000	49.00	49.8	-0.8	95.2
12000	58.80	59.5	-0.7	114.2

Direction	Measured Direction	Delta Direction
0	0	0
30	28	2
60	58	2
90	88	2
120	118	2
150	148	2
180	179	1
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	0.0
200	0.98	0.9	0.1
500	2.45	2.4	0.0
1000	4.90	4.8	0.1
1500	7.35	7.4	-0.1
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	44.8	-0.7
10000	49.00	49.7	-0.7
12000	58.80	59.5	-0.7

**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 housing assy and wind direction potentiometer coupling. Good calibration.

**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: 51144

Date: 20-Sep-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	1.0	0.0	1.9
500	2.45	2.3	0.2	4.8
1000	4.90	4.8	0.1	9.5
1500	7.35	7.3	0.0	14.3
2000	9.80	9.8	0.0	19.0
3000	14.70	14.7	0.0	28.6
4000	19.60	19.6	0.0	38.1
5000	24.50	24.6	-0.1	47.6
6000	29.40	29.4	0.0	57.1
7000	34.30	34.3	0.0	66.6
8000	39.20	39.2	0.0	76.2
9000	44.10	43.9	0.2	85.7
10000	49.00	48.7	0.3	95.2
12000	58.80	58.1	0.7	114.2

Direction	Measured Direction	Delta Direction
0	0	0
30	30	0
60	60	0
90	90	0
120	120	0
150	151	-1
180	182	-2
210	212	-2
240	242	-2
270	272	-2
300	302	-2
330	332	-2
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	0.0
200	0.98	0.9	0.1
500	2.45	2.3	0.2
1000	4.90	4.8	0.1
1500	7.35	7.3	0.0
2000	9.80	9.8	0.0
3000	14.70	14.6	0.1
4000	19.60	19.6	0.0
5000	24.50	24.5	0.0
6000	29.40	29.4	0.0
7000	34.30	34.3	0.0
8000	39.20	39.1	0.1
9000	44.10	43.8	0.3
10000	49.00	48.2	0.8
12000	58.80	57.7	1.1

**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 housing assy. and wind direction coupling. Adjusted horizontal nose cone shaft. Good calibration.

**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: eplab@mail.bbsnet.com

Internet: www.eppleylab.com



Scientific Instruments  
for Precision Measurements  
Since 1917

**STANDARDIZATION OF  
EPPLEY PRECISION INFRARED RADIOMETER  
Model PIR**

Serial Number: 33023F3

Resistance: 764  $\Omega$  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<sup>-2</sup> and an average ambient temperature of 23 °C.

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

3.91  $\times 10^{-6}$  volts/watts meter<sup>-2</sup>

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<sup>-2</sup>. This radiometer is linear to within  $\pm 1.0\%$  up to this intensity.

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

Shipped to:  
National Science Foundation  
Port Hueneme, CA

S.O. Number: 59674  
Date: December 19, 2003

Date of Test: December 18, 2003

In Charge of Test: *R.T. Geman*

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



Scientific Instruments  
for Precision Measurements  
Since 1917

**STANDARDIZATION  
OF  
EPPLEY PRECISION SPECTRAL PYRANOMETER  
Model PSP**

Serial Number: 32850F3

Resistance: 706  $\Omega$  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<sup>-2</sup> (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:

8.05  $\times 10^{-6}$  volts/watts meter<sup>-2</sup>

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<sup>-2</sup>. This radiometer is linear to within  $\pm 0.5\%$  up to this intensity.

The calibration of this instrument is traceable to standard self-calibrating cavity pyrhemometers in terms of the Systems Internationale des Unites (SI units), which participated in the Ninth International Pyrhemometric Comparisons (IPC IX) at Davos, Switzerland in September-October 2000.

Useful conversion facts: 1 cal cm<sup>-2</sup> min<sup>-1</sup> = 697.3 watts meter<sup>-2</sup>  
1 BTU/ft<sup>2</sup>-hr<sup>-1</sup> = 3.153 watts meter<sup>-2</sup>

Shipped to:  
Raytheon Polar Services Co.  
Port Hueneme, CA

Date of Test: June 22, 2004

S.O. Number: 59901  
Date: June 25, 2004

In Charge of Test:

Reviewed by:

Remarks:

*D. Binkley*  
*Thomas J. Kuck*



## GUV

DASSN	DASdescription	DASType	DASnavisionJob	Firmware	Tag	SystemSN
0069	Ed0	GUV-2511	R8785	005024HB v.0001 03-06- 11		4 25110203114

ChannelDelay	Offset1	Offset16	Offset256	Gain1	Gain16	Gain256	Gain1to16
500	-0.00274658	9.5367E-05	0.00023365	-78	1259	-376	0.3125

Gain16to256	Gain16to1	Gain256to16	ResistorStoM	ResistorMtoL	ResistorMtoS	ResistorLtoM
0.01953125	0.546875	0.03417969	0.01953125	0.01953125	8.75	8.75

## PAR (ship's mast)

installed 11/2/03 03:00 GMT

### Biospherical Instruments Inc.

#### CALIBRATION CERTIFICATE

Calibration Date 6/24/03  
Model Number QSR-240  
Serial Number 6357  
Operator TPC  
Standard Lamp 98700(5/19/01)  
Probe Excitation Voltage Range: 5 to 18 VDC(+)  
Output Polarity: Positive

#### Probe Conditions at Calibration(in air):

Calibration Voltage: 6 VDC(+)  
Probe Current: 7.1 mA

#### Probe Output Voltage:

Probe Illuminated 94.7 mV  
Probe Dark 2.1 mV  
Probe Net Response 92.6 mV

#### Corrected Lamp Output:

Output In Air (same condition as calibration):

9.14E+15 quanta/cm<sup>2</sup>sec  
0.015 uE/cm<sup>2</sup>sec

#### Calibration Factor:

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

Dry: 1.01E-17 V/(quanta/cm<sup>2</sup>sec)  
6.10E+00 V/(uE/cm<sup>2</sup>sec)

#### 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: 3198  
CALIBRATION DATE: 10-Dec-03

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

##### GHJ COEFFICIENTS

g = -4.26914485e+000  
h = 5.04385767e-001  
i = -5.28033538e-004  
j = 5.13505352e-005  
CPcor = -9.5700e-008 (nominal)  
CTcor = 3.2500e-006 (nominal)

##### ABCDM COEFFICIENTS

a = 1.68075864e-006  
b = 5.02459202e-001  
c = -4.26050708e+000  
d = -9.04472870e-005  
m = 5.0  
CPcor = -9.5700e-008 (nominal)

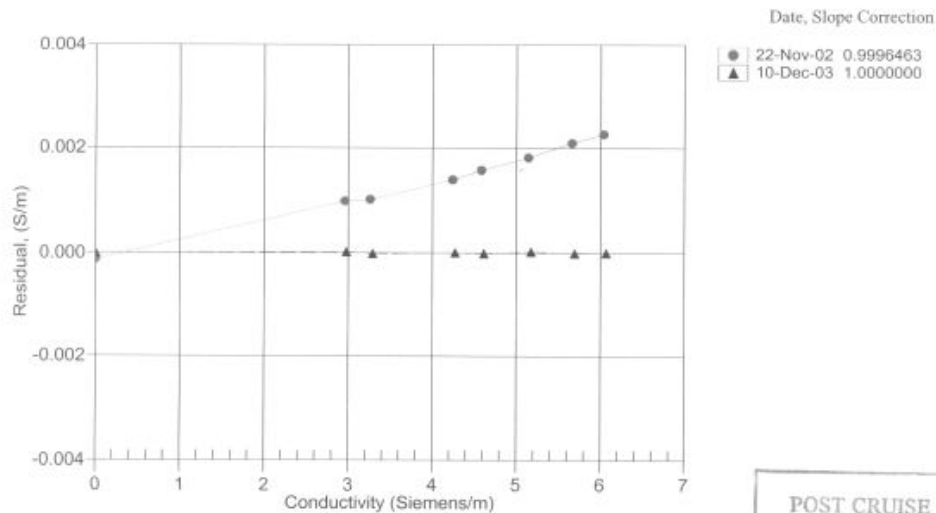
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.91249	-0.00000	-0.00000
0.9999	34.8336	2.97729	8.22249	2.97731	0.00002
4.4999	34.8127	3.28441	8.58435	3.28439	-0.00002
15.0000	34.7689	4.26641	9.64948	4.26642	0.00000
18.5000	34.7599	4.61169	9.99651	4.61168	-0.00001
23.9999	34.7503	5.16988	10.53287	5.16990	0.00002
28.9999	34.7454	5.69200	11.01026	5.69199	-0.00001
32.5000	34.7436	6.06475	11.33844	6.06474	-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];  $\delta$  = CTcor;  $\epsilon$  = 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: 3198  
CALIBRATION DATE: 10-Dec-03

SBE21 TEMPERATURE CALIBRATION DATA  
ITS-90 TEMPERATURE SCALE

#### ITS-90 COEFFICIENTS

g = 4.22427999e-003  
h = 6.28774124e-004  
i = 1.97842562e-005  
j = 1.36006195e-006  
f0 = 1000.0

#### ITS-68 COEFFICIENTS

a = 3.64763667e-003  
b = 5.95222584e-004  
c = 1.59625049e-005  
d = 1.36147300e-006  
f0 = 2568.358

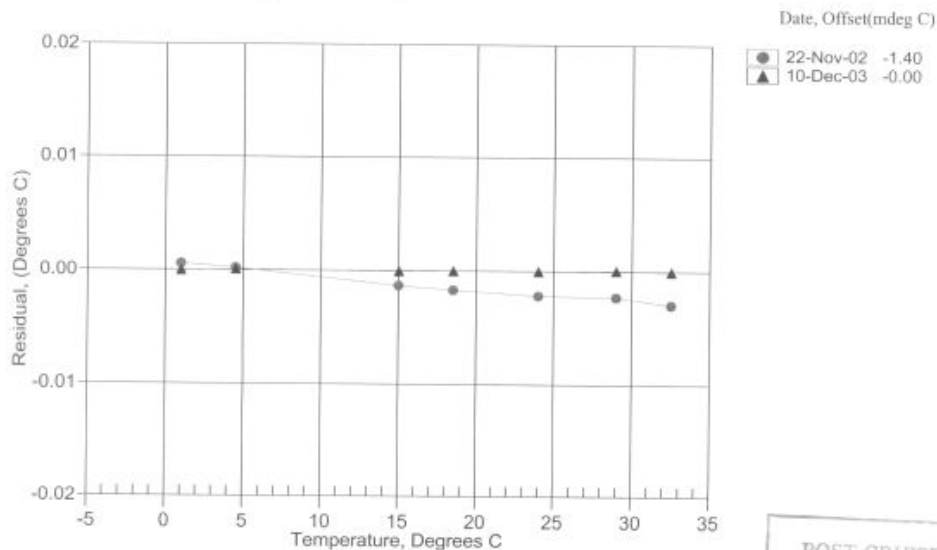
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	2568.358	0.9999	-0.00003
4.4999	2775.129	4.5000	0.00005
15.0000	3467.500	15.0000	-0.00004
18.5000	3723.433	18.5000	-0.00000
23.9999	4152.211	23.9999	-0.00001
28.9999	4571.132	29.0000	0.00006
32.5000	4881.353	32.5000	-0.00004

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

Temperature 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

For JEP

## 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: 21-Nov-03

SBE3 TEMPERATURE CALIBRATION DATA  
ITS-90 TEMPERATURE SCALE

### ITS-90 COEFFICIENTS

g = 4.76644674e-003  
h = 6.64834752e-004  
i = 2.85938689e-005  
j = 2.65570196e-006  
f0 = 1000.0

### ITS-68 COEFFICIENTS

a = 3.68121454e-003  
b = 5.89542081e-004  
c = 1.47437327e-005  
d = 2.65717814e-006  
f0 = 5707.067

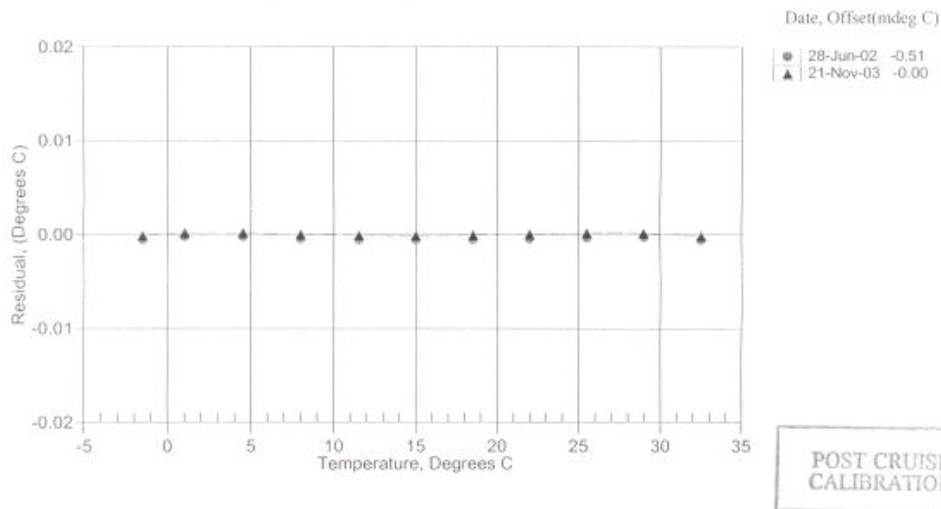
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	5707.067	-1.5002	-0.00016
1.0000	6042.079	1.0002	0.00016
4.5000	6534.713	4.5002	0.00016
8.0000	7055.660	8.0000	-0.00001
11.5000	7605.725	11.4999	-0.00011
15.0000	8185.654	14.9999	-0.00014
18.5000	8796.173	18.4999	-0.00007
22.0000	9437.967	22.0000	0.00005
25.5000	10111.686	25.5002	0.00015
29.0000	10817.942	29.0001	0.00015
32.5000	11557.289	32.4998	-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](http://www.wetlabs.com)

### C-Star Calibration

Date	6/15/2004	Customer	National Science Foundation	Work order	007
Job #	0012016	S/N#	CST-422PR	Pathlength	25 cm

	Analog meter
$V_d$	0.061 V
$V_{air}$	4.786 V
$V_{ref}$	4.687 V

Temperature of calibration water	21.3 °C
Ambient temperature during calibration	22.5 °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.

cstarcalsheet

Revision A

6/23/03

## Underway Transmissometer (2)



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Philomath, OR 97370



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

### C-Star Calibration

Date	5/25/2004	Customer	National Science Foundation	Work order	008
Job #	0012016	S/N#	CST-423PR	Pathlength	25 cm

	Analog meter
$V_d$	0.059 V
$V_{air}$	4.807 V
$V_{ref}$	4.791 V

Temperature of calibration water	22.1 °C
Ambient temperature during calibration	22.4 °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.

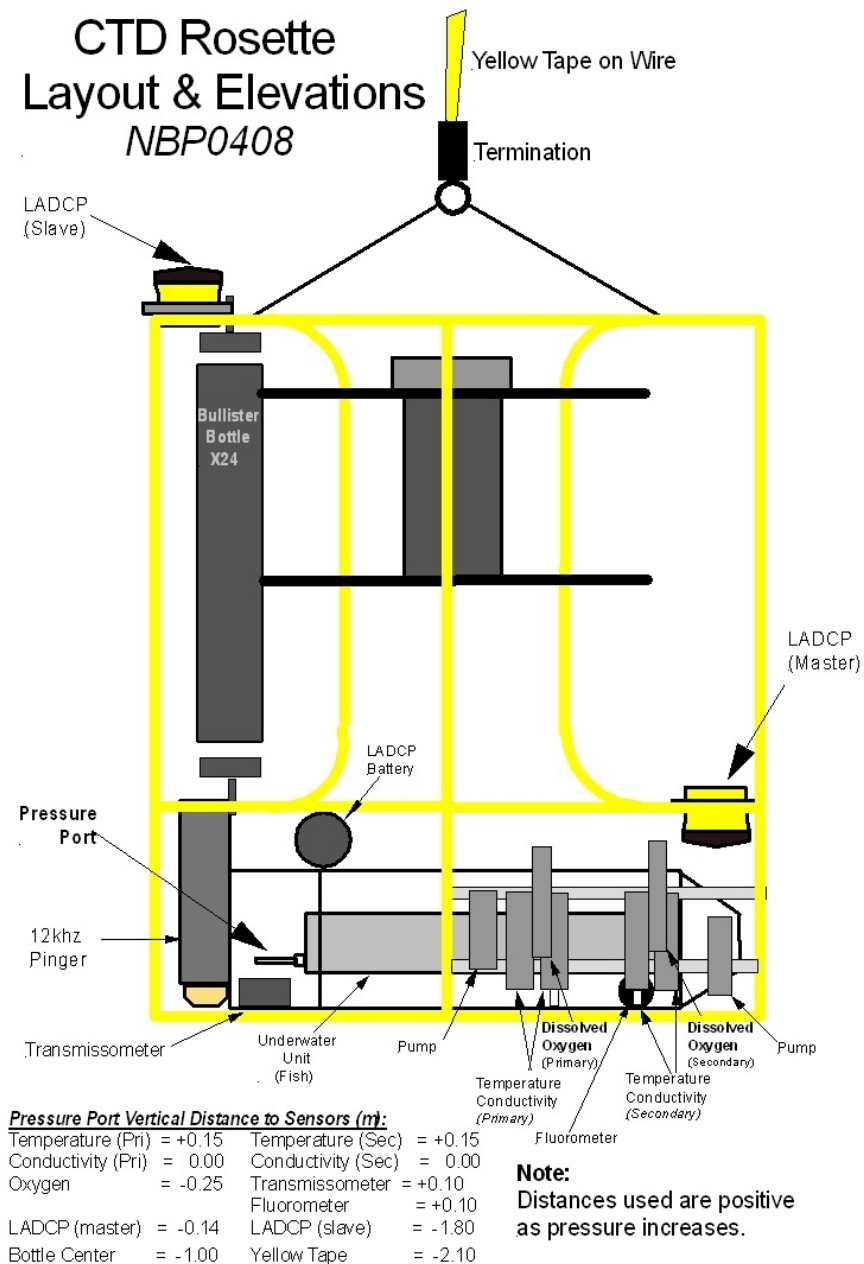
cstarcalsheet

Revision A

6/23/03

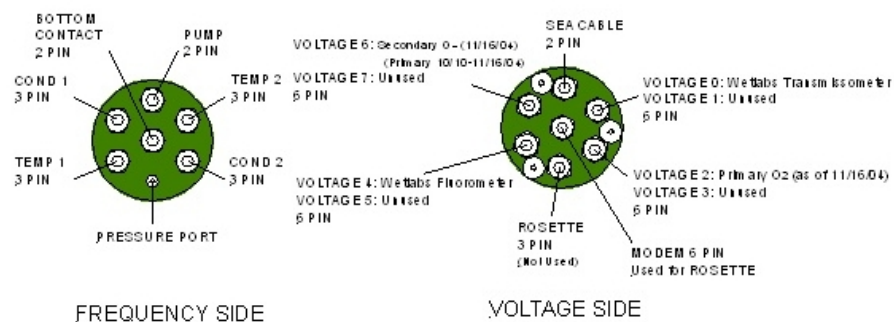
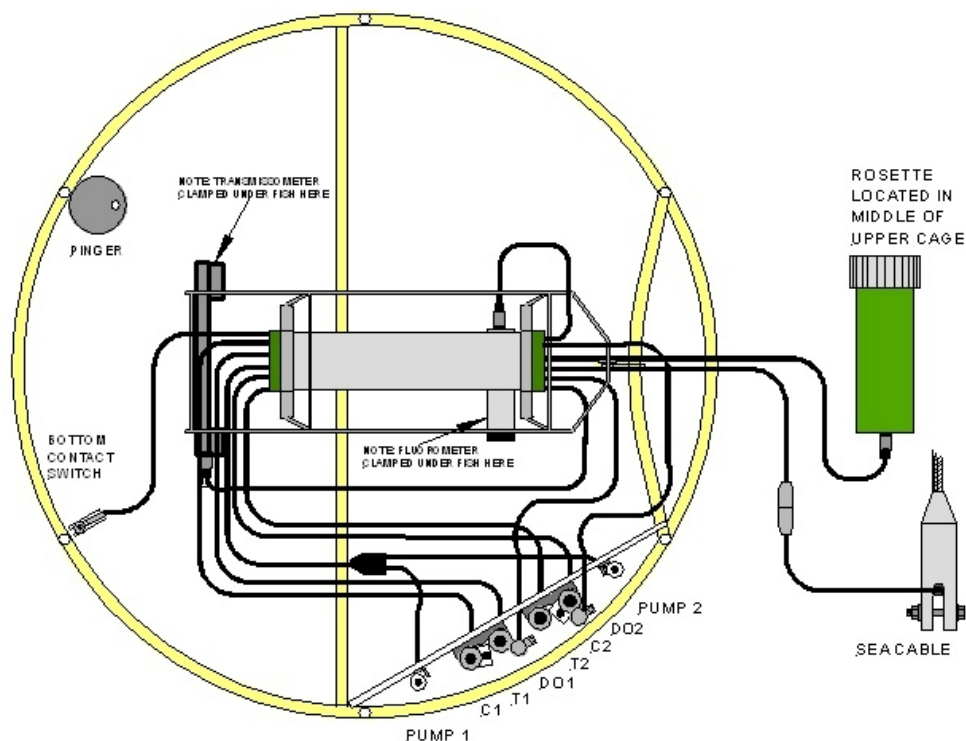
## Additional NB0408 Information

### CTD Layout





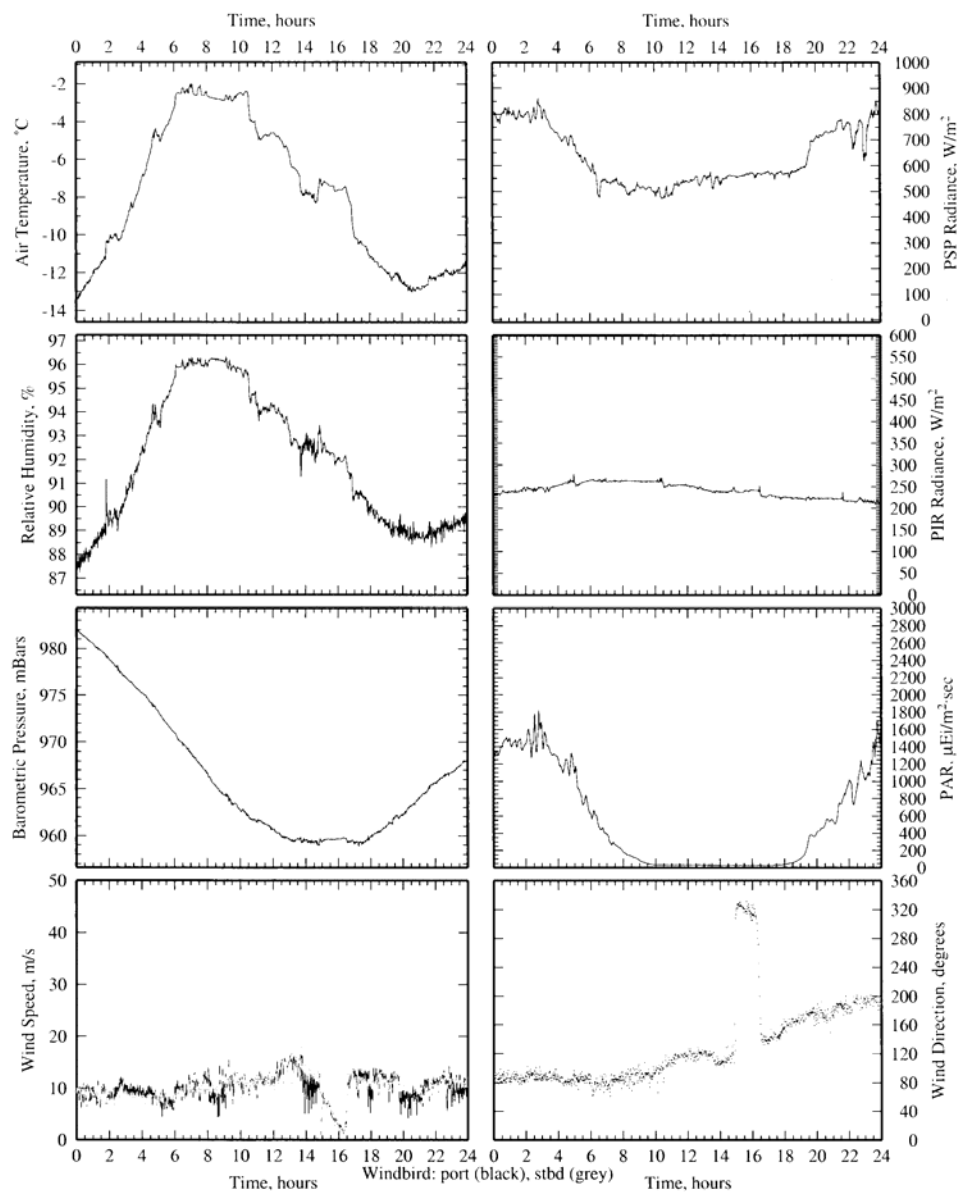
# CTD FISH WIRING NBP0408



AFN 12/1/02  
Updated 10/17/04 S RB

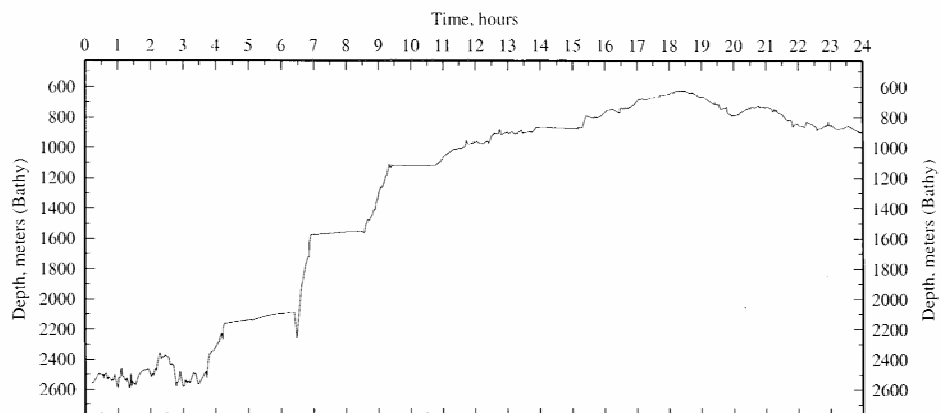
## Daily Log: Met Example

### NBP0408 yearday 295 Met



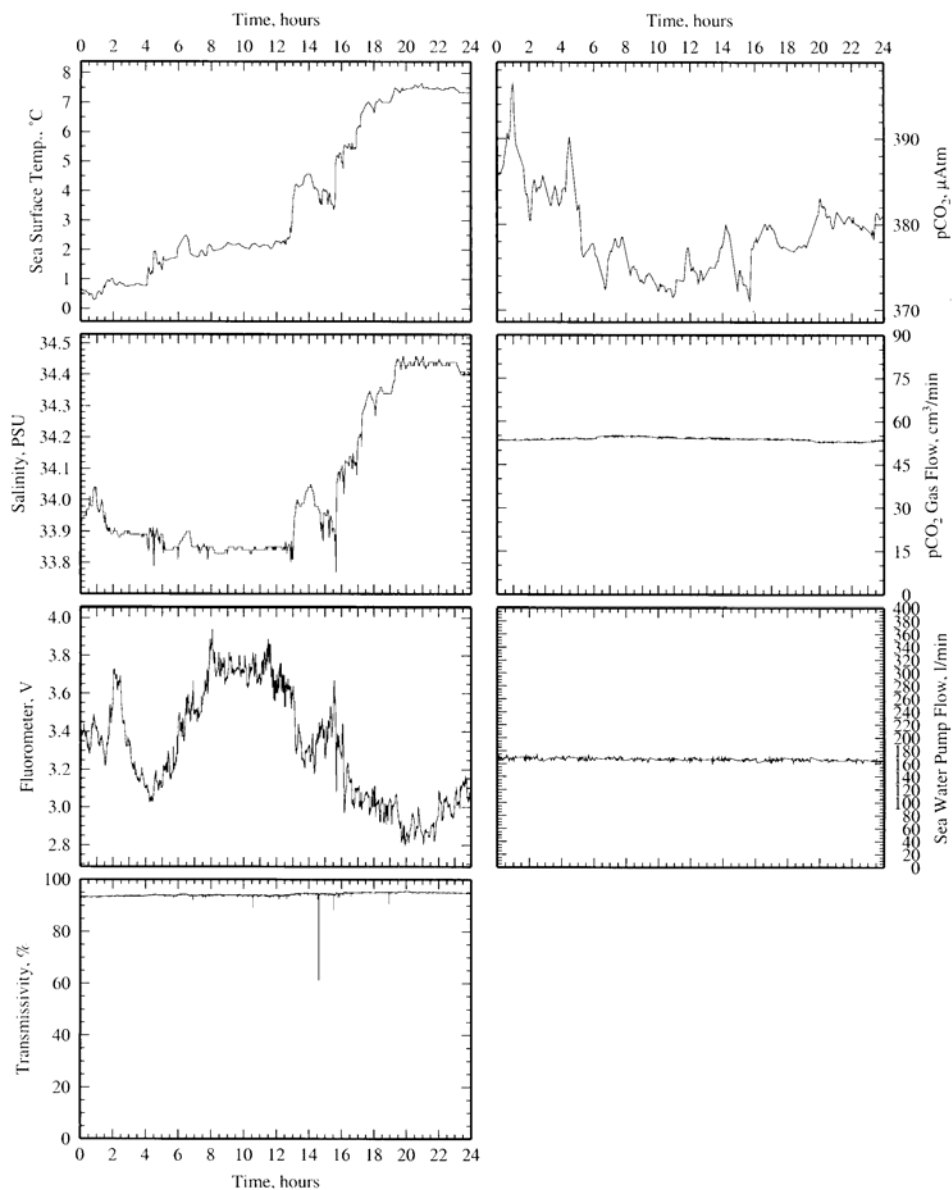
## Daily Log: Geophysical Example

### NBP0408 yearday 333 Geophysical



## Daily Log: Ocean Example

### NBP0408 yearday 308 Ocean



## Daily Log: Navigation Example

### NBP0408 yearday 302 Navigation

