RVDAS Data Report NBP0602A

SHALDRIL II

1 March – 5 April 2006

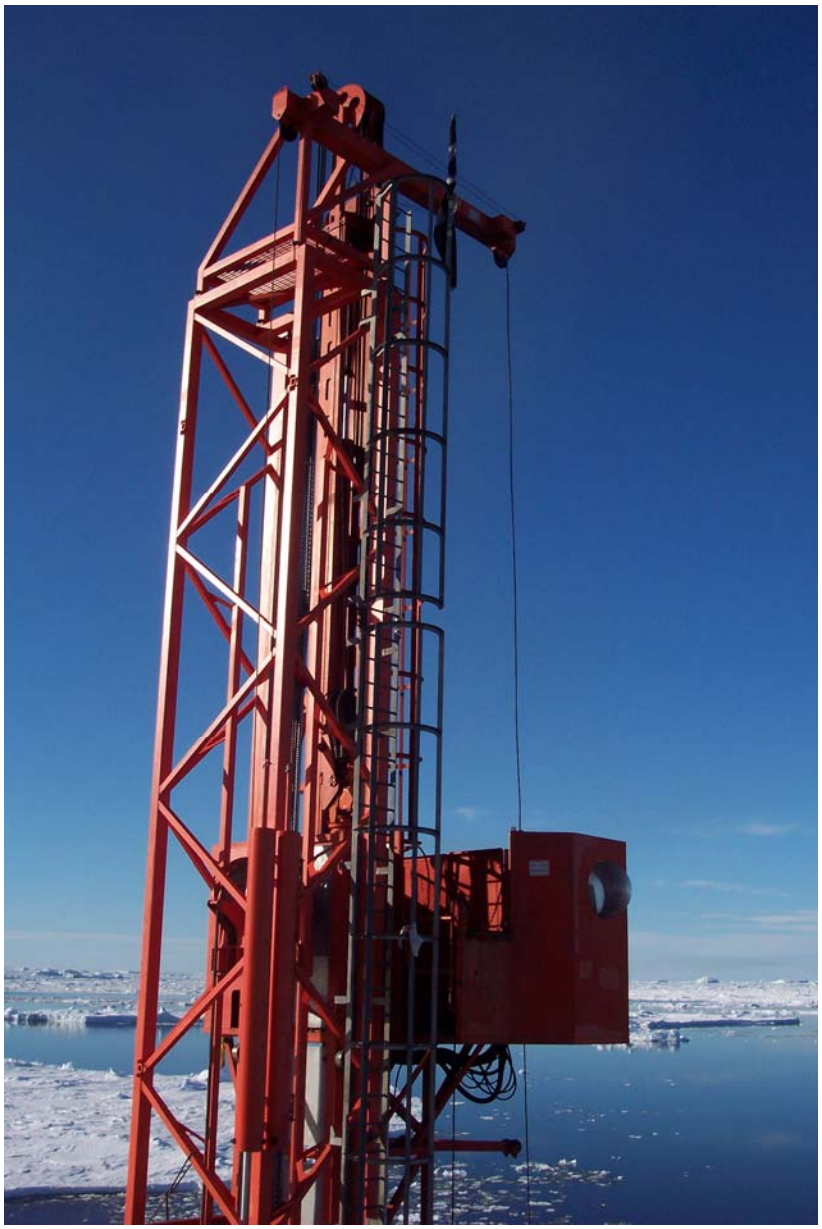

Photo credit: Nicole Evans

United States Antarctic Program

RVIB Nathaniel B. Palmer

Raytheon Polar Services

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Introduction

The NBP data acquisition systems 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.

On Windows, use WinZip or the freeware program 7zip (installer is located in `/other/7zip.exe`).

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

MultiBeam and BathyW data are distributed separately.

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

Archive Commands

All archives were created using the command:

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

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

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

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

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

To extract the files from the archive:

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

Distribution Contents at a Glance

Volume 1

NBP0602A.gmt
NBP0602A.mgd
0602Abe.mgd
0602Atrk.jpg
0602Atrk.ps
0602Atrk.pdf
NBP0602A.trk
602Adata.doc
602Adata.pdf
INSTCOEF.TXT

adcp/
- 0602Amat.tar

images/
- cruisetrk.gif
- isobars.tar
- ice.tar
- wx.tar

ocean/
- 602Axbt.tar

process/
- 602AJGOF.tar
- 602AMGD.tar
- 602APCO2.tar
- 602APROC.tar
- 602AQC.tar

rvdas/nav/
- 602Aadcp.tar
- 602Agp02.tar
- 602Agyr1.tar
- 602APCOD.tar
- 602Aseap.tar
- 602Asp1b.tar
- 602Asp2a.tar
- 602Atrax.tar

rvdas/uw/
- 602Abat1.tar
- 602Aeng1.tar
- 602Aflr1.tar
- 602Agrv1.tar
- 602Aknud.tar
- 602Ambdp.tar
- 602Amet1.tar
- 602Aoyo1.tar
- 602Apco2.tar
- 602Apguv.tar
- 602Asvp1.tar
- 602Asyn1.tar
- 602Atsg1.tar

scirep/
- *Weekly cruise reports in rich-text and PDF format.*

other/
- 7zip.exe

Distribution Contents

Cruise Information

NBP0602A, "SHALDRIL II." Punta Arenas, Chile 1 March 2006 to Punta Arenas, Chile 5 April 2006.

Cruise Track

The distribution DVD includes a GMT cruise track file (NBP0602A.trk). It contains the longitude and latitude at one-minute intervals extracted from the NBP0602A.gmt file.

A plot of the cruise track is available in postscript, pdf, and jpeg formats, in the files: 0602Atrk.jpg, 0602Atrk.pdf, and 0602Atrk.ps.

Satellite Images

Satellite, weather, and isobar images processed during this cruise can be found in the directory /images in three tar files: ice.tar, isobar.tar, and wx.tar (weather).

Science Reports

Cruise weekly science reports are located in the directory /scirep.

NBP Data Products

Two 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 602Aproc. 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/602AJGOF.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" 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)

Field	Data	Units
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 NBP0602A.mgd. The file NBP0602A.gmt is created from the MGD77 dataset using the "mgd77togmt" utility. NBP0602A.gmt can be used with the GMT plotting package.

The data used to produce the NBP0602A.mgd file can be found at the root of the distribution media and in the file /process/602Aproc.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)
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.

Col	Len	Type	Contents	Description, Possible Values, Notes
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, 1ST sensor	In tenths of nanoteslas (gammas)
67-72	6	real	Magnetics total field, 2ND 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 = 1st or leading sensor 2 = 2nd or trailing sensor 9 = Unspecified
80-84	5	real	Magnetics diurnal correction	In tenths of nanoteslas (gammas). (In nanoteslas) if 9-filled (i.e., set to "+9999"), total and residual fields are assumed to be uncorrected; if used, total and residuals are assumed to have been already corrected.
85-90	6	F6.0	Depth or altitude of magnetics sensor	(In meters) + = Below sea level 3 = Above sea level
91-97	7	real	Observed gravity	In 10th of mgals. Corrected for Eotvos, drift, tares
98-103	6	real	EOTVOS correction	In 10th of mgals. E = 7.5 V cos phi sin alpha + 0.0042 V*V
104-108	5	real	Free-air anomaly	In 10th of mgals G = observed G = theoretical
109-113	5	char	Seismic line number	Cross-reference for seismic data
114-119	6	char	Seismic shot-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.

Matlab ".mat" files containing current contour and vector data have been placed in the file `/adcp/0602AMAT.tar`. Please note that these files must be considered preliminary only. Data are not a "final product" until post-processing has been performed by the principal investigators. For more information on data format, post-processing, and for data download, please visit: http://currents.soest.hawaii.edu

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 `602Aadcp.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 `602Apco2.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

XBT

During the cruise, eXpendable BathyThermographs were used to obtain water column temperature profiles. XBT profiles allow corrections to the sound velocity profile for the multi-beam system. The data files from these launches are included as `602Axbt.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 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/602AQC.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 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: `NBP0107met1.d317`

- The CruiseID is the numeric name of the cruise, in this case, NBP602A.
- 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

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)	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-2511
PUV	puv	Continuous		BSI PUG-2500

Geophysics

Measurement	Channel ID	Collect. Status	Rate	Instrument
Gravimeter	grv1	Continuous	10 sec*	LaCoste & Romberg
Magnetometer	mag1	Not collected	15 sec	EG&G G-866
Bathymetry	bat1	Per direction	Varies	ODEC Bathy 2000
Bathymetry	knu1	Per direction	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

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

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

Environmental record ($ENV)

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

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

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

Bathy 2000 (bat1)

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

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

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

Knudsen (knud)

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

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

Simrad EM120 (mbdp)

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

Simrad EK500 (sim1)

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

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

Thermosalinograph (tsg1)

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

Field	Data	Units
1	RVDAS time tag	
2	Seabird hex string (see page 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)	

pCO_2

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

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

Navigational Data

Seapath GPS (seap)

The Seapath GPS outputs 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)	

Field	Data	Units
16	Checksum	

GPVTG

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

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

GPHDT

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

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

PSXN,20

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

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

PSXN,22

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

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

PSXN,23

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

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

Trimble (P-Code) GPS (PCOD)

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

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

GGA: GPS Position Fix – Geoid/Ellipsoid

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

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

GLL: GPS Latitude/Longitude

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

Field	Data	Units
1	RVDAS Time tag	
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

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 temperature	°C
5	Barometer	MBar
6	Concentration	ppm
7	Equilibrated temperature	°C
8	pCO_2 pressure	microAtm
9	Flow rate	ml / min
10	Source ID #	1 or 2 digits
11	Valve position	1 or 2 digits
12	Flow source (Equil = pCO_2 measurement)	text
13	RVDAS latitude	degrees
14	RVDAS longitude	degrees
15	TSG external temperature	°C
16	TSG salinity	PSU
17	TSG fluorometry	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
23	Course made good	degrees

tsgfl

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

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

Calculations

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

TSG

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

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

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

Calculating Temperature – ITS-90

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

Calculating Conductivity – ITS-90

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

Calculating Fluorometry Voltage

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

Calculating Transmittance

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

PAR

raw data = mV
calibration scale = 6.27 V/(μEinstiens/cm ^{2}sec)
offset (V_{dark}) = 0.1 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 x 10^{-6} V/(W/m^2)
data mV / (scale x 10^3 mV/V) = W/m^2
or
data mV x 242.1(W/m^2)/mV = W/m^2

PSP

raw data = mV
calibration scale = 7.94 x 10^{-6} V/(W/m^2)
data mV / (scale x 10^3 mV/V) = W/m^2
or
data mV x 120.7 (W/m^2)/V = W/m^2

Acquisition Problems 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.

Time	Description
058	Run New_Cruise
061:08:14:00	Turning on TSG, FLR
061:10:40	Started ADCP logging
061:10:45	All logging on
061:10:50	ADCP bottom tracking on
062:02:11	ADCP bottom tracking off
075	Eltanin locked up on winch logger disable. Rebooted. ~8 minutes data loss.
076:09:09:11	Eltanin crashed again on winch logger disabled. Rebooted. ~5 minutes data loss.
088 10:50 – 11:20	Transmissometer flow blocked
093:06:07	Entered Argentine EEZ (data collection under existing permit)
095 00:25	All loggers stopped, entering Chilean EEZ

Appendix: Sensors and Calibrations

NBP0602A Sensors:

Shipboard Sensors

Sensor	Description	Serial #	Last Calibration Date	Comments
Meteorology & Radiometers				
Port Anemometer	RM Young 5106	WM46262	12/12/04	Port side installed 8/7/05
Stbd Anemometer	RM Young 5106	WM51143	10/07/05	Stbd side installed 10/22/05
Barometer	RM Young 61201	01706	04/23/05	Installed 04/23/05
Humidity/Wet Temp	RM Young 41372LC	06135	06/24/05	Installed 4/23/05
PIR (Pyrgeometer)	Eppley PIR	32845F3	5/31/05	Installed 7/16/05
PSP (Pyranometer)	Eppley PSP	32850F3	5/31/05	Installed 7/16/05
PAR (Mast)	BSI-QSR-240	6356	05/16/05	Installed 7/16/05
GUV (Mast)	BSI GUV-2511	25110203114	09/07/05	Installed 10/23/05
PUV (Underwater)	BSI PUV-2500	25000203114	09/07/05	Installed 10/30/05
PRR (Mast)	BSI PRR-610	9696	01/09/04	Installed 11/1/05
PRR (Underwater)	BSI PRR-600	9695	01/09/04	Installed 11/1/05
Underway				
TSG	SeaBird SBE21	218091-1390	02/01/05	Installed 2/14/06
TSG Remote Temp	SeaBird 3-01/S	031497	01/27/05	Installed 02/02/06
Fluorometer	Turner 10-AU-005	5333-FRXX	N/A	Installed 4/14/04
Transmissometer	WET Labs C-Star	CST-557DR	04/07/05	Installed 9/16/05
Gravimeter	LaCoste & Romberg Gravity Meter		n/a	Gravity Tie 2/22/06
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: 2/22/2006
Location: Punta Arenas, Chile
Station: Harbour Admin. Bldg.
Latitude: 53 09 S
Longitude: 070 55 W
Elevation:
Gravity: 981320.82

Reference Code Numbers:
Station no. 9337-50
ISGN no. 51230N

	Value	Time (GMT)
Ship's meter before gravity tie (Gravity (cu))	8987.2	20:50
Ship's meter after gravity tie (Gravity (cu))	8987.2	22:00
Average	8987.2	
Ship Gravimeter's Calibration Constant	1.0046	
Corrected ship's meter (OC Grav (mgal))	9008.4	

	Value	Time (GMT)
Ship's meter before gravity tie (serial, RVDAS)	8987.2	20:50
Ship's meter after gravity tie (serial, RVDAS)	8987.2	22:01
Average (for comparison check only)	8987.2	

Portable Gravimeter Correction Divisor 1.007937

Station	Value	Time (GMT)	Temp	Date	OBS mgal, averaged
Pier measurement 1	4909.33	20:55	54	February 22, 2006	
Pier measurement 2	4909.40	21:00	54	February 22, 2006	4870.71
Pier measurement 3	4909.37	21:03	54	February 22, 2006	
Average	4909.37				
Station measurement 1	4909.86	21:20	54	February 22, 2006	OBS mgal, averaged
Station measurement 2	4909.82	21:21	54	February 22, 2006	4871.20
Station measurement 3	4909.92	21:23	54	February 22, 2006	
Average	4909.87				
Pier measurement 4	4909.27	21:51	54	February 22, 2006	OBS mgal, averaged
Pier measurement 5	4909.22	21:53	54	February 22, 2006	4870.59
Pier measurement 6	4909.24	21:56	54	February 22, 2006	
Average	4909.24				

Gravity offset from last tie 972309.88
Diff since last tie 2.08

OBS Differences	
Station to Pier (1, 2, & 3 averaged)	-0.50
Station to Pier (4, 5, & 6 averaged)	-0.82
Averaged Differences	-0.56
Gravity at pier	981320.26
Elevation of pier above gravimeter, meters	0.5
Earth differential gravity, mgal/meter	0.3
Gravity at ship's gravimeter	981320.41
Gravity Offset (for RVDAS)	972311.96

Comments

Gravity tie completed by Sheldon Blackman and Dan Elsberg at the Punta Arenas, Chile Harbour Administration Bldg. The tie went very smoothly, with very stable readings.

Meteorology System

Anemometer (Port)

RM Young Anemometer Calibration, Model 05106

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

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

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

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

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

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

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

Additional Comments
INSTALLED NEW BEARINGS AND PROPELLER SHAFT. TESTED OKAY

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

Anemometer (Starboard)

RM Young Anemometer Calibration, Model 05106

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

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

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

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

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

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

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

Additional Comments

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

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

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

EPLAB
Scientific Instruments for Precision Measurements Since 1917

STANDARDIZATION OF EPPLEY PRECISION INFRARED RADIOMETER Model PIR

Serial Number: 32845F3

Resistance: 739 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 25 °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:

4.09 x 10^{-6} volts/watts meter^{-2}

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

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

Shipped to:
National Science Foundation
Port Hueneme, CA

S.O. Number: 60312
Date: June 13, 2005

Date of Test: May 31, 2005

In Charge of Test: R. T. Eppley

Reviewed by: Thomas D. Ruh

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

EPLAB
Scientific Instruments for Precision Measurements Since 1917

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 32850F3

Resistance: 706 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:

7.94 x 10^{-6} volts/watts meter^{-2}

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

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

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

Shipped to:
National Science Foundation
Port Hueneme, CA

Date of Test: June 1, 2005

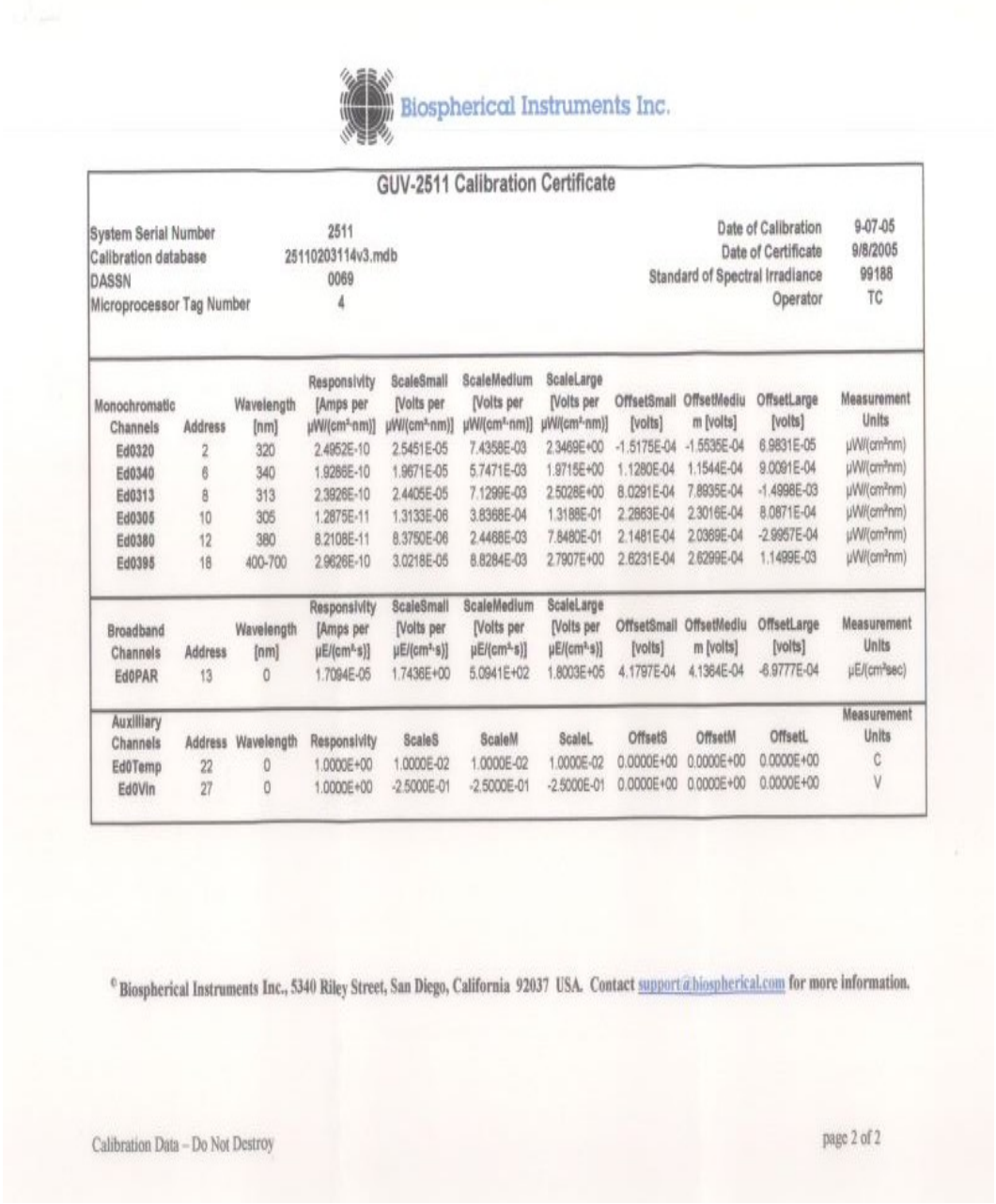
In Charge of Test: R. T. Eppley

S.O. Number: 60311
Date: June 13, 2005

Reviewed by: Thomas D. Kuhl

Remarks:

GUV



Biospherical Instruments Inc.

GUV-2511 Calibration Certificate

System Serial Number	2511	Date of Calibration	9-07-05
Calibration database	25110203114v3.mdb	Date of Certificate	9/8/2005
DASSN	0069	Standard of Spectral Irradiance	99188
Microprocessor Tag Number	4	Operator	TC

Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per µW/(cm²-nm)]	ScaleSmall [Volts per µW/(cm²-nm)]	ScaleMedium [Volts per µW/(cm²-nm)]	ScaleLarge [Volts per µW/(cm²-nm)]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
Ed0320	2	320	2.4952E-10	2.5451E-05	7.4358E-03	2.3469E+00	-1.5175E-04	-1.5535E-04	6.9831E-05	µW/(cm²nm)
Ed0340	6	340	1.9286E-10	1.9671E-05	5.7471E-03	1.9715E+00	1.1280E-04	1.1544E-04	9.0091E-04	µW/(cm²nm)
Ed0313	8	313	2.3926E-10	2.4405E-05	7.1299E-03	2.5028E+00	8.0291E-04	7.8935E-04	-1.4998E-03	µW/(cm²nm)
Ed0305	10	305	1.2875E-11	1.3133E-06	3.8368E-04	1.3188E-01	2.2863E-04	2.3016E-04	8.0871E-04	µW/(cm²nm)
Ed0380	12	380	8.2108E-11	8.3750E-06	2.4468E-03	7.8480E-01	2.1481E-04	2.0369E-04	-2.9957E-04	µW/(cm²nm)
Ed0395	18	400-700	2.9626E-10	3.0218E-05	8.8284E-03	2.7907E+00	2.6231E-04	2.6299E-04	1.1499E-03	µW/(cm²nm)

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

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

Calibration Data – Do Not Destroy

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PUV

PUV-2500 Calibration Certificate

Calibration factors are immersion corrected for use under water

System Serial Number	25000203114		
Calibration database	25000203114v3.mdb	Date of Calibration	9-07-05
DASSN	0065	Date of Certificate	9/8/2005
Microprocessor Tag Number	1	Standard of Spectral Irradiance	99188
		Operator	TC

Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per µW/(cm²·nm)]	ScaleSmall [Volts per µW/(cm²·nm)]	ScaleMedium [Volts per µW/(cm²·nm)]	ScaleLarge [Volts per µW/(cm²·nm)]	OffsetSmall [volts]	OffsetMediu m [volts]	OffsetLarge [volts]	Measurement Units
EdZ305	2	305	1.8652E-11	1.9025E-06	5.5583E-04	1.9824E-01	-4.2269E-05	-6.1711E-05	7.9794E-05	µW/(cm²nm)
EdZ313	5	313	1.4411E-10	1.4700E-05	4.2946E-03	1.5116E+00	1.9947E-04	1.8164E-04	1.7406E-04	µW/(cm²nm)
EdZ320	6	320	1.3495E-10	1.3765E-05	4.0216E-03	1.2480E+00	3.2945E-04	3.1244E-04	4.1357E-04	µW/(cm²nm)
EdZ395	10	395	2.3525E-10	2.3995E-05	7.0104E-03	2.1867E+00	1.3688E-04	1.1986E-04	1.6649E-04	µW/(cm²nm)
EdZ340	11	340	1.0900E-10	1.1118E-05	3.2481E-03	1.0931E+00	1.9811E-04	1.8548E-04	5.1597E-04	µW/(cm²nm)
EdZ380	18	400-700	6.1932E-11	6.3171E-06	1.8456E-03	6.6997E-01	-1.7272E-04	-1.9269E-04	-1.8676E-03	µW/(cm²nm)

Broadband Channels	Address	Wavelength [nm]	Responsivity [Amps per µE/(cm²·s)]	ScaleSmall [Volts per µE/(cm²·s)]	ScaleMedium [Volts per µE/(cm²·s)]	ScaleLarge [Volts per µE/(cm²·s)]	OffsetSmall [volts]	OffsetMediu m [volts]	OffsetLarge [volts]	Measurement Units
EdZPAR	14	0	1.7708E-05	1.8062E+00	5.2770E+02	1.6687E+05	-2.5409E-04	-2.7286E-04	-2.3886E-03	µE/(cm²sec)
LuZChl	15	0	5.4318E-11	5.5405E-06	1.6187E-03	5.7788E-01	7.6880E-05	5.7578E-05	-4.3020E-05	nE/(sr·m²sec)

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

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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

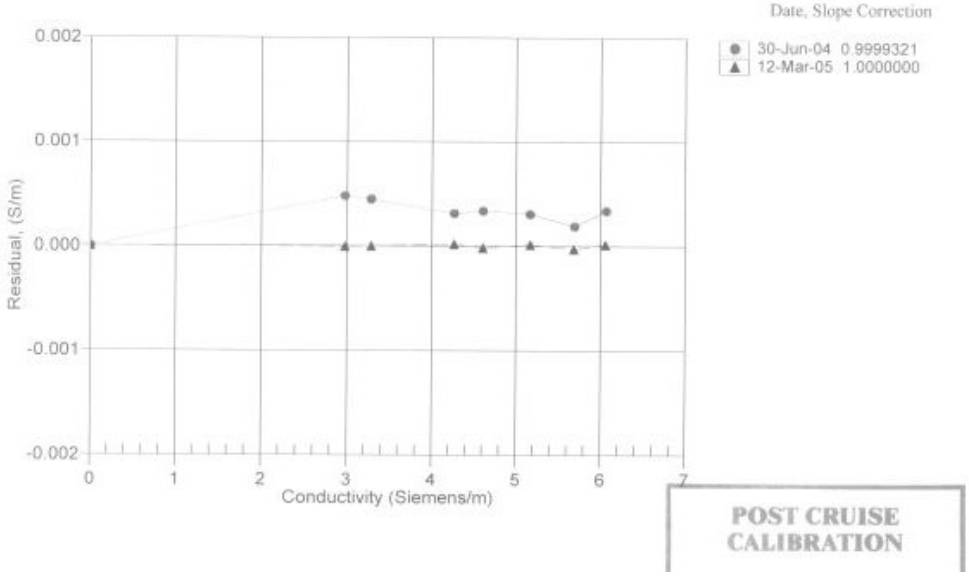
SBE21 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

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

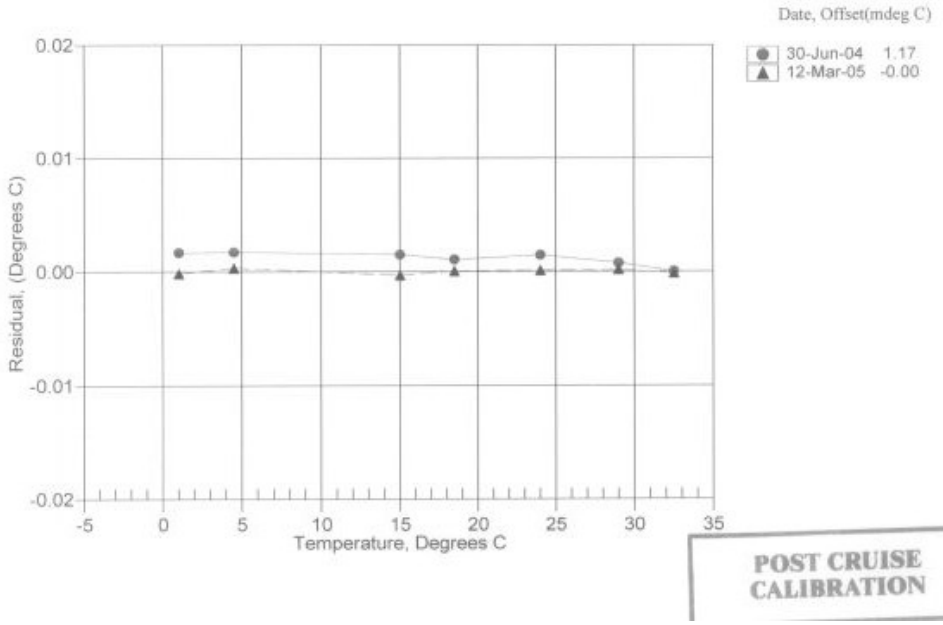
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	2600.263	0.9997	-0.00018
4.5000	2814.731	4.5003	0.00033
14.9999	3533.537	14.9996	-0.00033
18.5000	3799.663	18.5000	0.00004
24.0000	4245.995	24.0001	0.00012
29.0000	4682.732	29.0002	0.00018
32.5000	5006.584	32.4998	-0.00016

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

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

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

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

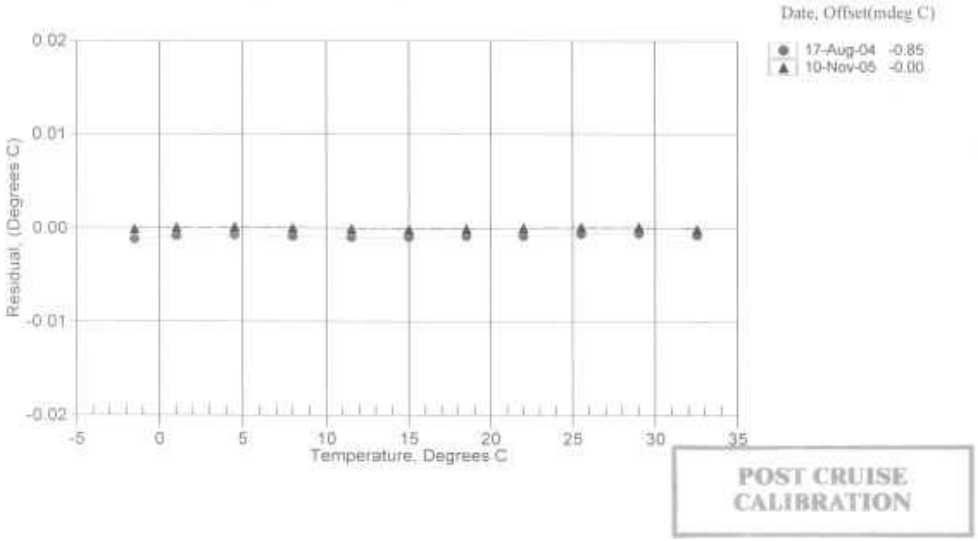
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5004	5372.992	-1.5005	-0.00010
0.9996	5685.203	0.9997	0.00006
4.4996	6144.063	4.4997	0.00010
7.9996	6628.986	7.9996	0.00004
11.4996	7140.671	11.4995	-0.00006
14.9996	7679.800	14.9995	-0.00015
18.4996	8247.050	18.4995	-0.00005
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 April 7, 2005 Customer Raytheon Polar Service Co. Work order 005

Job # 0201020 S/N# CST-557DR Pathlength 25 cm

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

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

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

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

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

V_d Meter output with the beam blocked. This is the offset.
V_{air} Meter output in air with a clear beam path.
V_{ref} Meter output with clean water in the path.
Temperature of calibration water: temperature of clean water used to obtain V_{ref}.
Ambient temperature: meter temperature in air during the calibration.
V_{sig} Measured signal output of meter.

cstarwkbkf1.xls Revision F 1/17/05