Data Report
NBP0302

Anslope I

February 25 – April 9, 2003

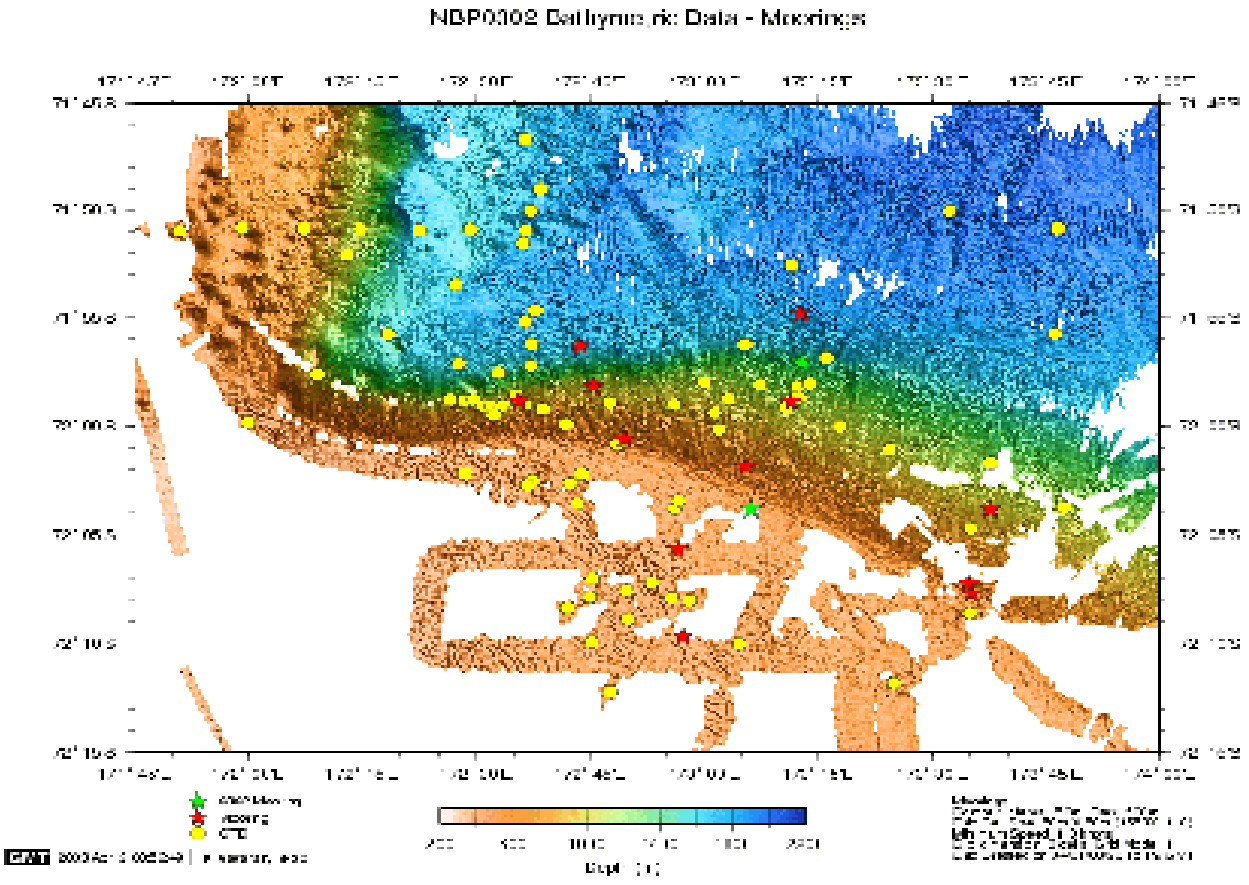

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Table of Contents

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 DDS4 tape and DVD-ROM written in ISO9660 level-1 format. It is readable by virtually every computing platform.

All the data has been compressed using Unix "gzip," identifiable 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.

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

Distribution Contents at a Glance

Volume 1

Standard NBP Data Products

0302data.doc (this report)

NBP0302.trk
NBP0302.mgd
NBP0302.gmt

inst.cof
the instrument coefficients applied to the processed data.

adcp/ rawadcp.zip (raw files)
0302adcp.zip (processed files)

images/ satellite and weather imagry

ocean/ 0302ctd.tar
0302xbt.tar
tsgfl.tar
pco2m.tar

process/ 0302jgof.tar
0302mgd.tar
0302proc.tar
0302qcps.tar

rvdas/nav 0302adcp.tar
0302adu1.tar
0302gyr1.tar
0302pcod.tar
0302seap.tar

rvdas/uw 0302bat.tar
0302flr.tar
0302grv.tar
0302mbdp.tar
0302met.tar
0302pco2.tar
0302sim.tar
0302svp.tar
0302tsg.tar

MB_maps/ MB_maps

SitReps/ SitReps.zip

Data Products Specific to NBP0203
Moorings/ moorings.zip
Mooring documentation for NBP0203

other/ autosal.tar
cfc.tar
cmpsplot.tar
(ploted CMiPS data)
iceobs.tar
Ice observations data and instructions for NBP0302.
ladcp.tar

ocean/ ctdinfo.zip
Diagrams and processing scripts for the ctd
ctd_pro.tar
Processed ctd data

Volume 2

cmipscal.tar
Cmps1raw.zip
Cmps2raw.zip

Volume 3

cmipscal.tar
Cmps3raw.zip
docs.zip
software.tar

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
```

Most newer versions of WinZip on the PC platform can be used to view all of the above files including, G-zipped and tar files.

Distribution Contents

Cruise Information

Cruise Track

The distribution CD includes a GMT cruise track file (NBP0302.trk). It contains the longitude and latitude at one-minute intervals extracted from the NBP0302.gmt file.

PostScript cruise tracks can be produced from this file

Satellite Images

Satellite Images processed for this cruise can be found in the directory, /Imagery in three subdirectories, ice, isobar (barometric) and wx (weather). Files are named using the convention, IDDDDYYA.jpg where:

ID = image type (is = ice ssmi, iv = ice visible, cw = seawifs, wx = weather)
DDD = year-day
YY = year
A = allows for multiple images of one type for one day

Science Report

The cruise weekly SitReps are on the DVD in the /SitReps directory. They are in Microsoft word format.

NBP Data Products

Two processed datasets are created on each cruise: JGOFS and MGD77. These are found in the / process directory. Additionally there are two other tar files. The 0302qcps.tar file contains all of the QC plots of the daily data in post script format. Due to ice noise on the hull of the ship, bathymetry data is processed by hand (as opposed to computer algorithm). The 0302proc file contains pings removed from the daily bathymetry and can be useful in re-processing data.

JGOFS

The JGOFS data set consists of 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 by the NGL software package. During the cruise, the JGOFS data set produces the daily data plots. Note: Null, unused, or unknown fields are indicated as "NAN" 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/meters^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 (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^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 NBP 0302.mgd. Also at the root level, NBP 0302.gmt is the output of the mgd77togmt utility using NBP 0302.mgd as input. The NBP 0302.gmt file can be used by GMT plotting software.

The data used to produce the NBP 0302.mgd file can be found on the distribution media in the file / process/NBP 0302proc.tar. The data files in the PROC directory of 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 directories 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 "3" for data record
2-9	8	Char	Survey identifier	
10-14	5	int	Time zone correction	In hundredths of hours. Corrects time (in characters 13-27) to GMT when added; 0 = GMT
15-16	2	int	Year	2 digit year
17-18	2	int	Month	2 digit month
19-20	2	int	Day	
21-22	2	int	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 tenths of mgals. E = 7.5 V cos phi sin alpha + 0.0042 V*V
104-108	5	real	Free-air anomaly	In tenths of milligals 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 in the file coadcp.zip. Each file represents 24 hours 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 `0302adcp.tar` in the file / rvdas/nav/0302adcp.tar

PCO_2

The NBP carries Lamont-Doherty Earth Observatory's (LDEO) pCO_2 system and RPSC staff maintains it. Data is sent to LDEO at the end of each cruise. The pCO_2 data is transmitted and archived on RVDAS. You will find it in a file named `0302pco2.tar` in the /rvdas/uw 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) for additional information.

Cruise Science

CTD

The /CTDCal directory on the disk contains the file ctdinfo.zip. This zip file contains diagrams and information about the CTD as it was used on NBP0302 (the cal sheets are also included in this document).

The CTD Data itself is found in /ocean/ctd.tar

Individual CTD casts are represented by a set of four files containing a bottle-firing file (.bl), a configuration file (.con), a data file (.dat) and a header file (.hdr). Casts are numbered according to the cruise id number (x302) followed by the number of the cast. For example; the raw files associated with the third cast on this cruise are: x302003.bl, x302003.con, x302003.dat, x302003.hdr. The raw and processed data files are in binary format. The 1 db bin averaged up and down traces have been converted to ascii (.asc files).

SeaBird's SeaSoft software (SeaSave-Win32-V5-25a) used to acquire the data is included in the CTD data distribution in the /ocean/seasoft.tar file. SeaSoft software can be used for playback and data analysis. The configuration files and processing scripts are also included in the/ocean/ctd-info.zip file.

File extension definitions:

EXT	Description
ASC	The data portion of a .CNV converted data file written in ASCII by ASCIIOUT, or files written by TERM37.
BL	Created by SEASAVE when a bottle fire confirmation is received. Contains bottle sequence number, position, date, time, beginning and ending scan numbers.
BTL	Created by ROSSUM. This is a summary of the data in a .ROS file.
BSR	Bottle scan range file, used by DATCNV to create a .ROS file.
CFG	Used by SEASOFT modules to store the input filename, input data path, output data path, and other miscellaneous module specific parameters.
CTR	Density contour file generated by CONTOUR.
CNV	'Converted' engineering unit data file. An ASCII header precedes the data.
CON	Contains instrument configuration and calibration coefficients, used by SEACON, SEASAVE, and DATCNV
DAT	Raw binary data, optionally with header information (SBE 9/11, 11X, 9/11*plus*, and data files created with previous versions of SEASOFT).
DSP	Used by SEASAVE to store data acquisition and display parameters.
HDR	R. Header portion of a .CNV converted data file written by ASCIIOUT. 2) Header recorded when acquiring real time data or uploading archived data.
HEX	Raw HEX data with header information (SBE 16, 17, 19, 21, and 25)
MRK	Marker file created by SEASAVE during real time data acquisition.
PLT	Used by SEAPLOT to store display parameters
ROS	Scans marked with the bottle fire confirmation bit, or defined by a .BSR file, written by DATCNV.

*Note: This is a complete list of all file extensions. This data set may not contain ALL of the above extension files.

SEASOFT modules search the current directory for DSP, PLT, and CFG files. SEASOFT modules search the 'input data path' for CON, HEX, DAT, and CNV files. One exception is SEACON which searches the current directory for CON files.

For more information and updated software visit the web site at www.seabird.com; or contact (206) 643-9866, seabird@seabird.com, Sea-Bird Electronics 1808 – 136th Place NE Bellevue, WA 98005

XBT, XCTD

During the cruise Expendable Bathythermographs and Expendable CTDs were used to obtain water column temperature profiles. The data files from these launches are included in the file / ocean/0302xbt.tar

RVDAS

The Research Vessel Data Acquisition System (RVDAS) was developed at Lamont-Doherty Earth Observatory of Columbia University and has been in use on its research ship for several years. It has been 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 /rvdas/uw and /rvdas/nav. Processed oceanographic data is in / 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, NBP 02-07.
- The Channel ID 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	

Measurement	Channel ID	Collect. Status	Rate	Instrument
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	Not collected		BSI PUV-511
PUV	puv	Not collected		BSI PUG-500

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	Collected	Varies	ODEC Bathy 2000
Bathymetry	knu1	Not collected	Varies	Knudsen 320B/R
Bathymetry	sim1	Collected	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_2	pco2	Continuous	70 sec	(LDEO)
ADCP	adcp	Continuous	varies	RD Instruments

Navigational Instruments

Measurement	Channel ID	Collect. Status	Rate	Instrument
Attitude GPS	3df1	Continuous	1 sec	Ashtech ADU2
P-Code GPS	PCOD	Continuous	1 sec	Trimble 20636-00SM
Gyro	gyr1	Continuous	0.2 sec	Yokogawa Gyro
SeaPath	Seap	Continuous	1 sec	Seatex 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

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 23 for calculations. **********

Gravimeter (grv1)

```
99+099:00:18:19.775 your_line#1999 99 01818 9735.4
```

Field	Data	Conversion	Units
1	RVDAS time tag		
2	Text string		
3	Gravity device date	Yyyydddhhmmss	
4	Gravity count	mgal = count x 1.0047 + offset	count

Bathy 2000 (bat)

```
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 POO 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	

Field	Data	Format / Possible Values	Units
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	
17	Transmit Rate	TR3 = 4Hz TR4 = 2Hz TR5 = 1Hz TR6 = .5Hz TR7 = .33Hz TR8 = .25Hz TR9 = .20Hz TR: = .10Hz TR; = .05Hz	Hz

Field	Data	Format / Possible Values	Units
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

Simrad (sim1) – Special String for AnSlope I

The Simrad EK500 was specially configured on NBP0302 to collect back scatter data. The EK500 collected Q1, Q2 and Q3 echograms.

Q1, Q2 and Q3 contain echogram data: header, time tag, TVG type, depth [meter], range start [meter], range end [meter], number of echogram values, bottom range start [meter], bottom range end [meter], no. of bottom of echogram values, echogram data [dB].

The NEMA depth output telegram conforms to the standard NMEA-0183 DBS (Depth Below Surface) telegram format.

See the file ek500-pa.rms in the root directory of this disk for the simrad setup parameters.

```
02+119:00:00:00.974 Q2,23584296,0, 0.00,     0.0,  100.0,250,   10.0,   -5.0, 75,
  -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2,
  -235.2, -235.2, -235.2, -235.2, -235.2, -235.2,   -4.7,   -3.9,   -8.0,  -42.3,
   -49.1,  -57.9,  -55.8,  -54.1,  -61.6,  -67.1,  -67.3,  -66.2,  -68.7,  -59.3,
   -59.0,  -63.7,  -71.1,  -73.7,  -70.8,  -68.4,  -73.2,  -83.1,  -81.5,  -86.9,
   -98.8,  -97.9,  -98.4,  -97.6,  -92.4,  -93.3, -104.2, -105.6,  -97.8,  -98.3,
  -105.6, -105.1, -109.9, -106.2, -103.9, -112.2, -109.7, -111.1, -108.1, -112.0,
  -115.5, -107.8, -103.1, -106.3, -101.1, -102.0, -114.4, -112.0, -107.1, -108.5,
  -111.0, -111.9, -121.6, -235.2, -117.3, -123.3, -235.2, -235.2, -112.9, -106.2,
  -107.6, -108.9, -122.7, -108.5, -107.3, -110.8, -111.2, -116.1, -121.8, -117.7,
  -112.2, -108.3, -102.3, -100.0, -103.7, -106.9, -105.8, -115.2, -120.5, -120.3,
  -112.5, -107.5, -107.6, -108.5, -115.0, -114.1, -112.8, -235.2, -235.2, -235.2,
  -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -110.7, -235.2, -110.7, -235.2,
  -235.2, -114.1, -110.1, -114.4, -235.2, -235.2, -235.2, -235.2, -235.2, -106.3,
  -105.1, -113.5, -108.0, -108.6, -116.2, -235.2, -235.2, -235.2, -115.8, -235.2,
  -110.5, -115.4, -110.3, -235.2, -235.2, -235.2, -107.1, -107.7, -108.1, -235.2,
  -235.2, -107.0, -105.2, -235.2, -235.2, -106.2, -100.3, -109.6, -235.2, -235.2,
  -235.2, -101.8,  -98.3, -103.4, -103.1, -235.2, -104.2, -109.5, -235.2, -108.5,
   -99.3, -104.3, -109.1, -102.7, -235.2, -103.1, -100.8, -235.2, -235.2, -235.2,
  -235.2, -235.2, -235.2, -102.8,  -99.2, -111.5, -235.2, -235.2, -235.2, -235.2,
  -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -110.6, -235.2, -235.2, -235.2,
  -235.2, -105.1, -235.2, -235.2, -235.2, -101.8, -100.7, -235.2, -235.2, -235.2,
  -235.2, -235.2, -235.2, -235.2, -100.4,  -96.5, -235.2, -106.0, -100.2,  -99.9,
  -235.2, -235.2, -108.7, -235.2, -235.2,  -82.2,  -59.7,  -60.7,  -62.6,  -62.3,
   -62.1,  -62.6,  -62.9,  -62.7,  -62.7,  -62.7,  -62.8,  -62.7,  -62.7,  -62.5,
   -62.5,  -62.4,  -62.3,  -62.3,  -62.2,  -62.2,  -62.2,  -62.1,  -58.7, -235.2,
  -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2,
  -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2,
  -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2,
  -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2,
  -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2,
  -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2,
  -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2, -235.2,
  -235.2, -235.2, -235.2, -235.2, -235.2,
```

Field	Data	Units
1	RVDAS time tag	
2	Header	
3	Time tag	hhmmss.sss
4	Depth	m
	Back scatter data	

Thermosalinograph (tsg1)

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

Field	Data	Units
1	RVDAS time tag	
2	Seabird hex string (see page 25 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_2

```
03+055:23:22:24.010 2003055.976 2482.8 32.82 991.1 386.5 -1.11 376 47.97
0 Equil
```

Field	Data	Units
1	RVDAS time tag	
2	PCO_2 time tag (decimal is time of day)	yyyyddd.tttt
3	IR Raw voltage	mV
4	Cell temperature	°C
5	Barometric pressure	mB
6	CO_2 Concentration	ppm
7	Equilibrated temperature	°C
8	PCO_2 pressure	microAtm
9	Flow rate	cm^3/min
10	Position	Integer
11	Flow Source (Equil = pCO_2 measurement) cm^3/min	

Navigational Data

Seapath GPS (seap)

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

- INZDA
- INGGA

- INVTG
- INHDT
- PSXN, 22
- PSXN, 23

INZDA

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

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

INGGA

```
02+253:00:00:00.938
INGGA,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	$INGGA	
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	

INVTG

```
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	$INVTG	
3	course over ground, degrees true	d.dd
4	T	
5	,	

Field	Data	Units
6	M	
7	speed over ground in knots	k.k
8	N	
9	,	
10	K	
11	Mode	
12	Checksum	

INHDT

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

Field	Data	Units
1	RVDAS time tag	
2	$INHDT	
3	Heading	
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	
7	heave in meters, positive down	m.mm
8	Checksum	

Ashtech GPS (3df1)

The Ashtech GPS outputs three NMEA standard data strings:

- Measurement data (PBN)
- Attitude data (ATT)
- GPS position fix (GGA)

Measurement data (PBN)

```
01+324:00:00:00.064 $PASHR,PBN,172812.00,2129908.6,-1869076.7,-5694992.4,
-063:41.9477,-041:16.0918,00066.2,000.16,002.85,-000.90,08,????,02,01,01,
01*3A
```

Field	Data	Units
1	RVDAS time tag	
2	$PASHR	
3	PBN	
4	GPS Time sec. of the week	seconds
5	Station Position: ECEF X	meters
6	Station Position: ECEF Y	meters
7	Station Position: ECEF Z	meters
8	Latitude (- = South)	deg:min
9	Longitude (- = West)	deg:min
10	Altitude	meters
11	Velocity8 in ECEF X	m/sec
12	Velocity in ECEF Y	m/sec
13	Velocity in ECEF Z	m/sec
14	Number of satellites used	
15	Site name	
16	PDOP	
17	HDOP	
18	VDOP	
19	TDOP	

GPS Position Fix – Geoid/Ellipsoid (GGA)

```
01+324:00:00:00.323 $GPGGA,235959.00,6341.9477,S,04116.0918,W,1,08,00.9,
+00066,M,,M,,*77
```

Field	Data	Units
1	RVDAS time tag	
2	$GPGGA	
3	UTC time at position	hhmmss.ss
4	Latitude	ddmm.mmm
5	North (N) or South (S)	
6	Longitude	ddmm.mmm
7	East (E) or West (W)	
8	GPS quality: (1 = GPS, 2 = DGPS)	
9	Number of GPS satellites used	
10	HDOP	
11	Antenna height	meters
12	M for Meters	
13	Geoidal height (no data in the sample string)	meters
14	M for meters	
15	Age of diff. 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)	

Attitude Data (ATT)

```
01+324:00:00:00.845 $PASHR,ATT,172813.0,137.88,+000.52,-001.41,0.0029, 0.0254,0*2F
```

Field	Data	Units
1	RVDAS Time tag	
2	$PASHR	

Field	Data	Units
3	ATT	
4	GPS Time sec. Of the week	seconds
5	Heading (rel. to true North)	degrees
6	Pitch	degrees
7	Roll	degrees
8	Measurement RMS error	meters
9	Baseline RMS error	meters
10	Attitude reset flag	

Trimble P-Code GPS (PCOD)

The PCode GPS outputs three NMEA standard data strings:

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

GGA: GPS Position Fix – Geoid/Ellipsoid

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

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

GLL: GPS Latitude/Longitude

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

Field	Data	Units
1	RVDAS Time tag	

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

VTG: GPS Track and Ground Speed

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

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

Gyro Compass (gyr1)

```
00+019:23:59:59.952 $HEHRC25034,-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	kn
5	Ship Speed relative to reference layer, north vector	kn
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

Ocean

pCO2-merged (pco2m.tar)

```
03+055:23:22:24.010 2003055.976 2482.8 32.82 991.1 386.5 -1.11 376 47.97 0 Equil
-77.6784 166.0242 -1.84 34.01 0.28 9.34 120.44 987.81 206.9 11.12 330.92
```

Field	Data	Units
1	RVDAS time tag	
2	PCO_2 time tag (decimal is time of day)	yyyyddd.tttt
3	IR Raw voltage	mV
4	Cell temperature	°C
5	Barometric pressure	mB
6	CO_2 Concentration	ppm
7	Equilibrated temperature	°C
8	PCO_2 pressure	microAtm
9	Flow rate	cm^3/min
10	Position	Integer
11	Flow Source (Equil = pCO_2 measurement) cm^3/min	
12	RVDAS latitude	degrees
13	RVDAS longitude	degrees
14	TSG external temperature	°C
15	TSG Sea surface salinity	PSU
16	TSG fluorometry	MV –0-5
17	RVDAS true wind speed	m/s
18	RVDAS true wind direction	degrees
19	Barometric pressure	mBars
20	Uncontaminated seawater pump flow rate	l/min
21	Speed over ground	knots
22	Course made good	degrees

tsgfl (tsgfl.tar)

```
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	Unused	

Data Products Specific to NBP0203

Autosal

Water samples were analyzed for salinity using the vessel's Guildline 8400B Laboratory Salinometer (autosal, sn 59-213). Salinometer control and data acquisition was performed via an interface box and software constructed by Scripps Institute of Oceanography. The autosal directory contains raw and processed data files from the autosal runs, plus a log file summarizing all of the run parameters. Raw data files are named nnncc where nnn=station number for the first batch in a run cc=cast number. The nnncc.lst files are processed versions of the data, with drift corrections applied. All files are ASCII.

Format of the raw files is:

One header line, followed by data in the form:

```
0197 01 00 24 1.99986 worm 6132 21:34:21 21:34:21 01
```

or

```
0197 01 01 24 1.98481  d01 6132 21:38:59 21:39:28 02 1.98482 1.98481
```

Field	Data	Units
1	4 digit station number	
2	2 digit cast number	
3	Rosette number	
4	Bath temperature setting	Degrees C
5	Average conductivity ratio x 2	
6	Sample ID (worm = standard water)	
7	Standby number	
8	Sample start time	
9	Sample end time	
10	Number of readings for calculation of average in field 5, n	
11-11+n	Raw (conductivity ratio x 2) readings (except in case of standard, in which case the record ends with field 10)	

Processed data listing:

6 header lines, followed by

```
0197 0100 1.99986 <1> 1.99986 <2> 1.99986 <1> 34.9972   D worm 21:34:21 6132
```

or

```
0197 0101 1.98482 <1> 1.98481 <2> 1.98481 <2> 34.7013   D  d01 21:39:28 6132
```

Field	Data	Units
1	4 digit station number	
2	Cast number/rosette number nnrr	
3	First valid conductivity ratio reading	
4	<n> where n is the number of the first valid conductivity reading	
5	Last valid conductivity reading	
6	<n> where n is the number of the last valid conductivity reading	
7	Average, drift-corrected conductivity ratio x 2	
8	<n > where n is the number of readings used to compute the average value in field 7	
9	Salinity computed for field 7 conductivity ratio	PSU
10	Salinity sample bottle case ID	
11	Salinity sample bottle ID	
12	Sample run time	
13	Autosal standby number	

In both raw and processed files the standards are typically the first and last data records.

LADCP

The Lamont-Doherty Earth Observatory Lowered Acoustic Doppler Current Profiler (LADCP) provides ocean velocity profiles with each CTD cast. This directory contains raw and processed data, and some of the Matlab m-files used for display of the processed data.

Raw – 2 subdirectories exist for each station, each containing raw data from either the upward-looking or down-looking ADCP head. The directories and files are named according to the convention annn[u|d] where nnn = 3 digit station number, u=uplooking ; d=downlooking. The raw data files are in RDI's binary format. Ancillary log files are included which describe the commands used for each deployment.

Processed - the raw LADCP data were processed using LDEO LADCP software v7.b. There is a single subdirectory for each station, which contains processed data as a Matlab mat file, processed velocities as an ASCII file, two diagnostic plots as postscript files, and assorted additional diagnostic files. The processed directory also contains ctd data files used in processing the LADCP data.

The subdirectory DOS contains RDI DOS batch files and programs for downloading and examining raw ADCP data, plus a sample command file for the cruise. Note that the command files used for each station's deployment are located in the raw subdirectories.

The LADCP processing software is available from http://www.ldeo.columbia.edu/~visbeck.

CFC

Water samples were analyzed for chloro-fluorocarbons (CFC) utilizing the Lamont-Doherty Earth Observatory CFC analysis system (W. Smethie, Principal Investigator).

Data — contains raw data files produced by the CFC extraction system.

Qpro — contains ASCII tables of processed CFC data, in the format described below. Note that these data have also been merged with the CTD bottle files (bot4.nnn) found in the ctd_pro directory.

2 header lines:

206 66.42 158 00 E (station, `rough latitude, rough longitude`)

Run Depth Sample Syringe F11 F12 F113 F11/F12 F113/F11 (column descriptors)

Data records:

```
2487   2      23     98     5.408  2.799  0.478         1.932  0.088
```

Field	Data	Units
1	Run number	
2	Depth at which sample was collected, from station bottle log	m
3	Rosette bottle number	
4	Syringe ID	
5	F11	pMole/Kg
6	F12	pMole/Kg
7	F113	pMole/Kg
8	Ratio of F11 to F12	
9	Ratio of F113 to F11	

Calculations

The file *inst.cof* 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 = 6.08 V/(µEinstiens/cm ^{2}sec)
offset (V_{dark}) = 0.3 mV
(*raw* mV – V_{dark})/scale x 10^4 cm^2/m^2 x 10^{-3} V/mV= µEinstiens/m^2sec
or
(*data* mV – 0.3 mV) x 1.65 (µEinstiens/m^2sec)/mV = µEinstiens/m^2sec

PIR

raw data = mV

calibration scale = 4.13 x 10^{-6} V/(W/m^2)
data mV / (scale x 10^3 mV/V) = W/m^2
or

data mV x 242.1(W/m^2)/mV = W/m^2

PSP

raw data = mV
calibration scale = 8.28 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 yy+ddd:hh:mm (yy is 2-digit year, ddd is year-day, hh is hour, and mm is minute). Times are reported in GMT.

Start	End	Description
03+056:00:00		Start Data Logging.
03+086:09:15:50	03+086:15:37:01	Seawater flow sensor stops working until replaced. Seawater is still flowing well, but rates are not recorded.
03+092:23:59		End of NBP0302 Shutdown

Appendix: Sensors and Calibrations used on NBP0302

Shipboard Sensors

Sensor	Description	Serial #	Last Calibration Date	Status
Meteorology & Radiometers				
Port Anemometer	RM Young 5106	WM51144	03/15/02	Collect
Stbd Anemometer	RM Young 5106	WM46263	03/15/02	Collect
Barometer	RM Young 61201	01705	06/01/01	Collect
Air Temp/Rel. Hum.	RM Young 41372LC	06134	06/01/01	
Mast PRR	BSI PRR-610			Not used
UW PRR	BSI PRR-600			Not used
PIR (Pyrgeometer)	Eppley PIR	32845F3	06/11/02	Collect
PSP (Pyranometer)	Eppley PSP	33090F3	12/06/01	Collect
Mast PAR	BSI QSR-240	6357	06/11/02	Collect
GUV				Not used
PUV				Not used
Underway				
TSG	SeaBird SBE21	3198	02/26/02	Collect
TSG Remote Temp	SeaBird 3-01/S	034071	04/16/02	Collect
Fluorometer	Turner 10-AU-005 Lamp: daylight 10-045; ref. filter: 10-052, em. filter: 10-051, ex. filter: 10-050	5651 FRTD	N/A	Collect
Transmissometer	WET Labs C-Star	CST-423PR	07/02/02	2/25-3/1
Transmissometer	WET Labs C-Star	CST-439PR	12/20/01	3/1-4/11
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			Not Used
Bathymetry	Bathy 2000			Collect
Other				
P-Code GPS	Trimble 20636-00 (SM)	0220035116	Key expired 03/30/03	Collect
Attitude GPS	Ashtech 12	700273F2114 FW 7B13-D1-C21	N/A	Collect

NBP 0302 CTD Sensors:

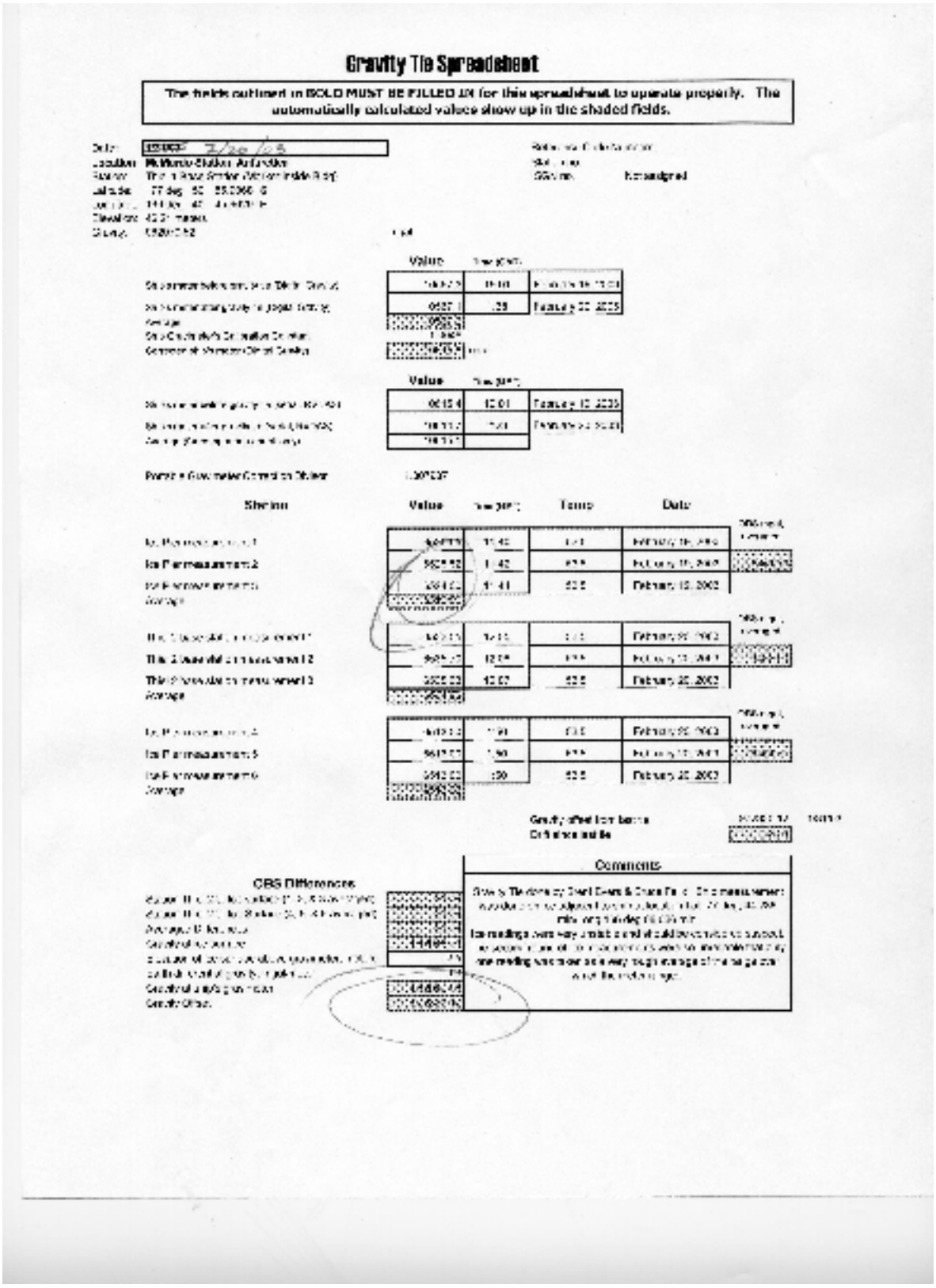
Also see /ocean/ctd-info.zip

Sensor	Description	Serial #	Last Calibration Date	Status
CTD Fish	SeaBird model SBE 9+	09P10716-0377	7/13/01	Collect
CTD Fish Pressure	Paroscientific model 410K-105 pressure sensor	58949	7/13/01	Collect
CTD Deck Unit	SeaBird model SBE 11+	N/A		Collect
Primary Temperature Sensor	SeaBird model 3-02/F	03P2367	06/28/02	Collect
Secondary Temperature Sensor	SeaBird model 3-02/F	03P2186	06/28/02	Collect
Primary Conductivity Sensor	SeaBird model 4-02/0	42513	06/27/02	Collect
Secondary Conductivity Sensor	SeaBird model 4C	42067	06/27/02	Collect
Dissolved Oxygen Sensor	SeaBird model 13-02-B	0080	06/27/02	Collect
Ctd Pump (primary)	SeaBird Model 5T	051646 3.0k	N/A	
Ctd Pump (secondary)	SeaBird Model 5T	051645 3.0k	N/A	
Transmissometer	WET Labs CST-423PR, C-Star	N/A		Not used
PAR Sensor	Biospherical Instruments QSR-240	N/A		Not used
SeaCat	SeaBird SBE 37SM	2504		Mooring 3
SeaCat	SeaBird SBE 37SM	2505		Mooring 3
SeaCat	SeaBird SBE 37SM	1264		Mooring 3

Calibrations

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

GravityTie



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.

Comments

CBS Differences

Meteorology System

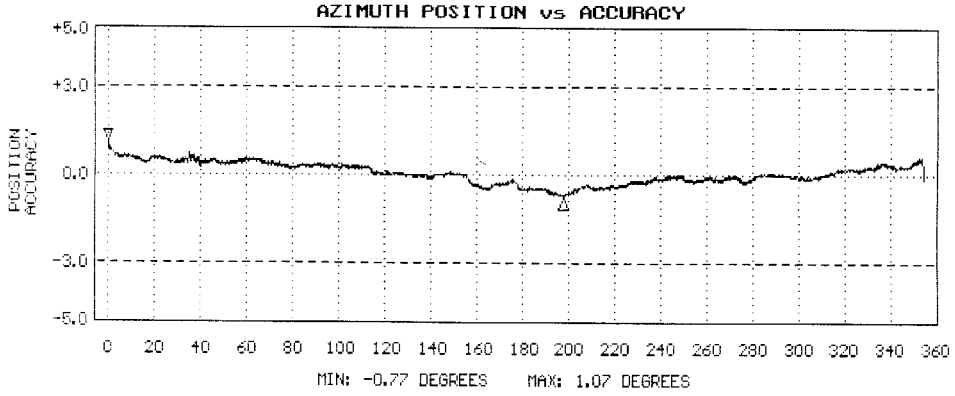
Anemometer (Port)

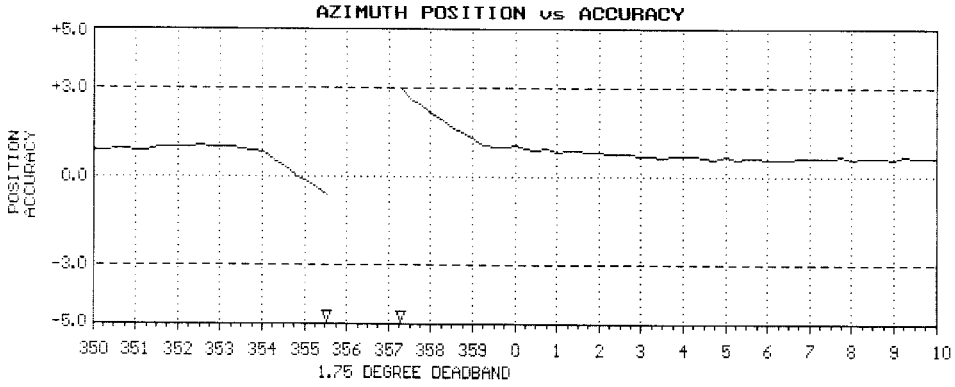
None available

Anemometer (Starboard)

R. M. YOUNG COMPANY WIND SENSOR CALIBRATION CERTIFICATE

SENSOR:	05106 WIND MONITOR-MA
SENSOR SERIAL NUMBER:	WM46263
BEARINGS:	SEALED/WATERPROOF GREASE
DATE:	APR 11 2001
WIND SPEED THRESHOLD TEST:	PASS
LOW WIND SPEED AMPLITUDE/FREQUENCY TEST:	PASS
HIGH WIND SPEED AMPLITUDE/FREQUENCY TEST:	PASS
VANE TORQUE TEST:	PASS
SPECIAL NOTES:	
SPECIAL NOTES:	





NOTE: Azimuth Position vs Accuracy graphs are accurate to within 0.5 degrees. The accuracy shown in the potentiometer deadband region between 355 and 0 degrees is the result of no resistance change while position changes. The gap represents the actual deadband (open circuit).

PIR (Mast)

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@ma1.bbsnet.com Internet: www.eppleylab.com

EPLAB

Scientific Instruments for Precision Measurements Since 1917

STANDARDIZATION OF EPPLEY PRECISION INFRARED RADIOMETER Model PIR

Serial Number: 32847F3

Resistance: 739 Ω at 23 °C
Temperature Compensation Range: -20 to 40 °C

This pyrgeometer has been compared with Precision Infrared Radiometer, Serial Number 29326F3 in Eppley's Blackbody Calibration System under radiation intensities of approximately 200 watts meter^{-2} and an average ambient temperature of 23 °C.

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

$$4.13 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

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

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

Shipped to:
National Science Foundation
Port Hueneme, CA

P.O. Number: 59011
Date: June 19, 2002

Date of Test: June 11, 2002

In Charge of Test:

Reviewed by:

Remarks:

PSP (Mast)

THE EPPLEY LABORATORY, INC.
12 Sheffield Ave P.O. Box 419 Newport RI 02842 USA
Telephone: 401-847-1020 Fax: 401-847-1031
Email: eplab@mail.bbsnet.com Internet: www.eppleylab.com

EPLAB

Scientific Instruments for Precision Measurement since 1931

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 32850F3

Resistance: 705 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 23 °C.

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

8.71 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 2400 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

P.O. Number: 5901
Date: June 19, 2002

Date of Test: June 11, 2002

In Charge of Test:

Reviewed by:

Remarks:

GUV (Mast)

None used on this cruise.

PAR (mast)

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

Calibration Date	6/7/01
Model Number	QSR-240
Serial Number	6357
Operator	TPC
Standard Lamp	94532(03/13/99)
Probe Excitation Voltage Range	5 to 18 VDC(+)
Output Polarity	POSITIVE

Probe Conditions at Calibration (in air):

Calibration Voltage	6	VDC(+)
Probe Current	7.2	mA

Probe Output Voltage

Probe Illuminated	91.8	mV
Probe Dark	2.1	mV
Probe Net Response	89.5	mV

Corrected Lamp Output

Output In Air (same conditions as calibration):

[illegible]E+15	quanta/cm²sec
0.014	µE/cm²sec

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

Dry:	1.06E-17	V/(quanta/cm²sec)
	[illegible]E+00	V/(µE/cm²sec)

Notes:
1. Annual calibration is recommended.
2. Calibration is performed using a Standard of Spectral Irradiance traceable to the National Institute of Standards and Technology (NIST).
3. The collector should be cleaned frequently with alcohol.
4. Calibration was performed with customer cable, when available.

QSR240R.CE.04.06

TSG Calibration Files

Underway Conductivity (TSG)

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER = 3198
CALIBRATION DATE: 22-Nov-02

SBE 21 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

G,H,I COEFFICIENTS

g = -9.88456745e-00
h = 1.08825293e-01
i = -4.[illegible]e-04
j = 6.74961058e-05
CTcor = 3.57e-06 (nominal)
CPcor = -9.57e-08 (nominal)

A,B,C,D,M COEFFICIENTS

a = 2.82777974e-05
b = 5.92152048e-01
c = 4.25671660e-03
d = 8.90278752e-05
m = 4.5
CPcor = 9.57e-08 (nominal)

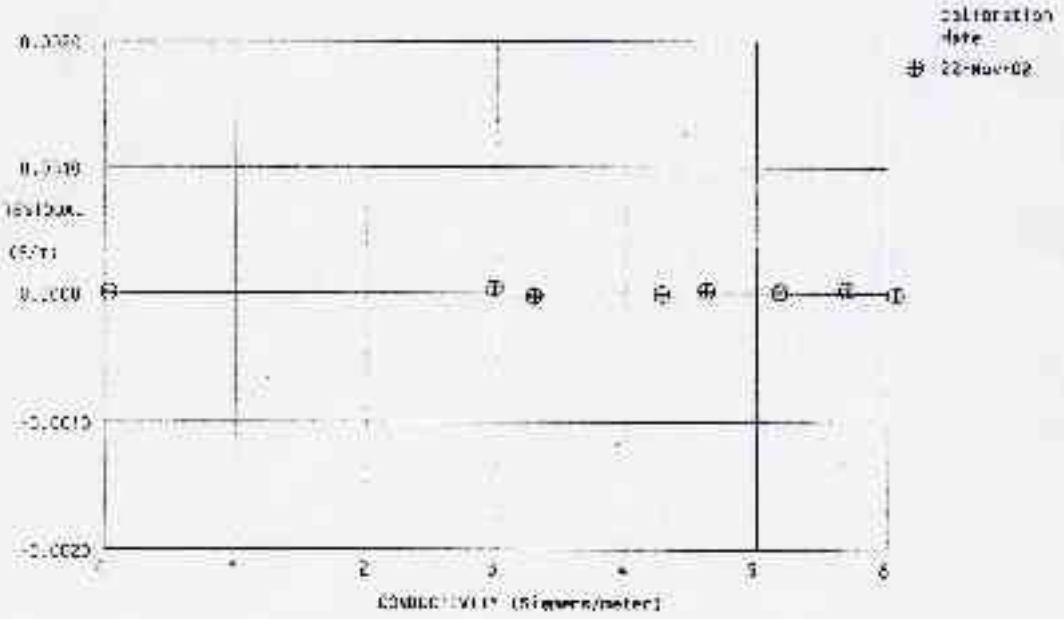
BATH TEMP (ITS-90) °C	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
25.0000	3.0000	0.00000	2.91424	-0.00000	0.00000
1.0000	34.0582	2.95600	8.19797	2.95603	0.00003
6.0000	34.0525	3.26281	8.50067	3.26278	-0.00003
15.0000	34.0575	4.24321	9.62714	4.24319	-0.00002
18.0000	34.0572	4.58709	9.97436	4.58710	0.00001
24.0000	34.0565	5.14423	10.52052	5.14423	0.00000
28.9999	34.0561	5.66432	10.98738	5.66434	0.00002
32.0002	34.0531	6.03528	11.31483	6.03526	-0.00002

Conductivity = $(g + hf^2 + if^3 + jf^4) / [10(1 + dt + cp)]$ Siemens/meter

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

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

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



Underway Temperature Sensor (TSG)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 2193
CALIBRATION DATE: 22-Nov-02

SBE 21 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.22430239e-03
h = 6.25100753e-04
i = 1.99300644e-05
j = 1.33971759e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.64755597e-03
b = 5.95226037e-04
c = 1.60360574e-05
d = 1.49103836e-06
f_0 = 2558.397

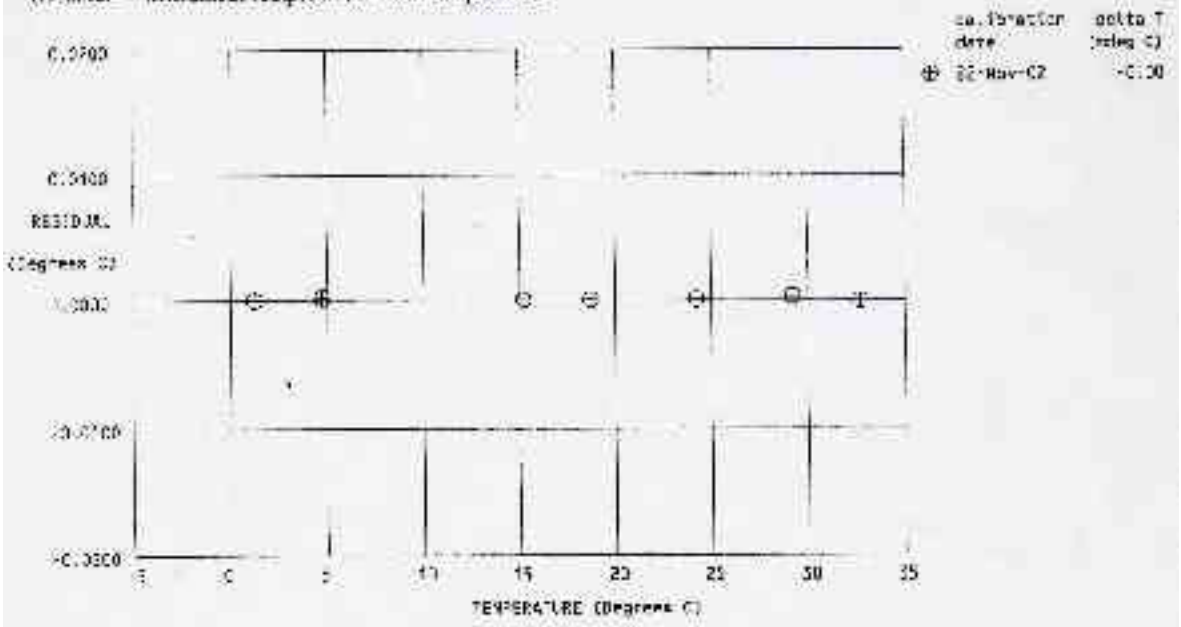
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
1.0000	2558.297	0.9959	-0.00038
4.5000	2775.144	4.5001	0.00013
14.9980	3407.400	14.9995	-0.00006
18.5000	3723.505	18.4989	-0.00005
24.0000	4152.042	24.0000	-0.00004
29.0000	4573.926	29.0003	0.00025
32.5002	4861.105	32.5001	-0.00015

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 IPTS-68 = $1/\{a + b[\ln(f_0/f)] + c[\ln^2(f_0/f)] + d[\ln^3(f_0/f)]\} - 272.15$ (°C)

Following the recommendation of IPTS: T_{68} is assumed to be 1.00024 * T_{90} - 2.4e-05 °C).

Residual = instrument temperature - bath temperature



Underway Temperature Sensor (Primary)

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

SENSOR SERIAL NUMBER = [illegible]
CALIBRATION DATE: 04-Mar-03

SBE 3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.31952560e-03
h = [illegible]
i = 2.22037007e-05
j = 1.92751301e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS
a = 3.68281027e-03
b = 5.84960356e-04
c = 1.37238376e-05
d = [illegible]
f_0 = 3105.219

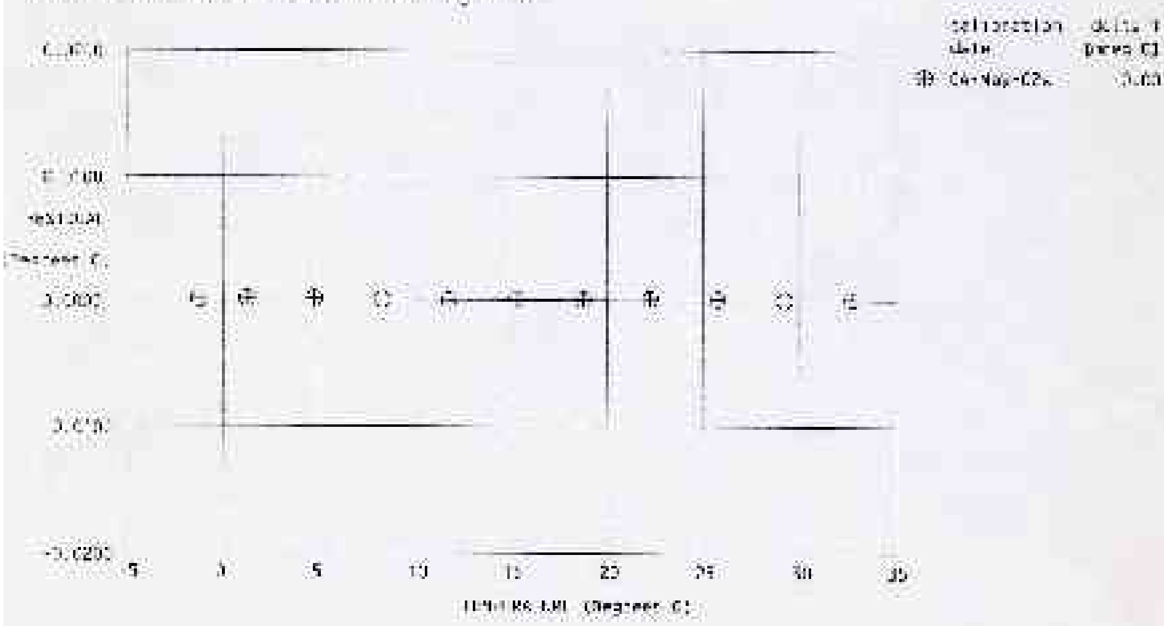
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
-1.4998	3105.219	-1.4998	-0.00005
1.0002	3266.[illegible]	1.0003	0.00005
4.5002	3579.[illegible]	4.5003	0.00005
8.0002	[illegible]	8.0002	0.00004
11.5002	[illegible]	11.5002	-0.00009
15.0002	[illegible]	15.0002	0.00001
18.5002	[illegible]	18.5002	0.00004
22.0002	[illegible]	22.0002	0.00003
25.5002	5531.[illegible]	25.5002	-0.00002
29.0002	5923.208	29.0002	-0.00003
32.5002	[illegible]	32.5002	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 IPTS-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 Remote Temperature Sensor (Engine room)

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

NBP 0204 Remote Temp

SENSOR SERIAL NUMBER = 4071
CALIBRATION DATE: 16-Apr-02s

SBE 3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE
TSG in Wet Lab

ITS-90 COEFFICIENTS

g = 4.35876516e-03
h = 6.39863070e-04
i = 2.13393613e-05
j = 1.57577668e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.68121033e-03
b = 5.98920278e-04
c = 1.61869089e-05
d = 1.57723580e-06
f_0 = 2991.316

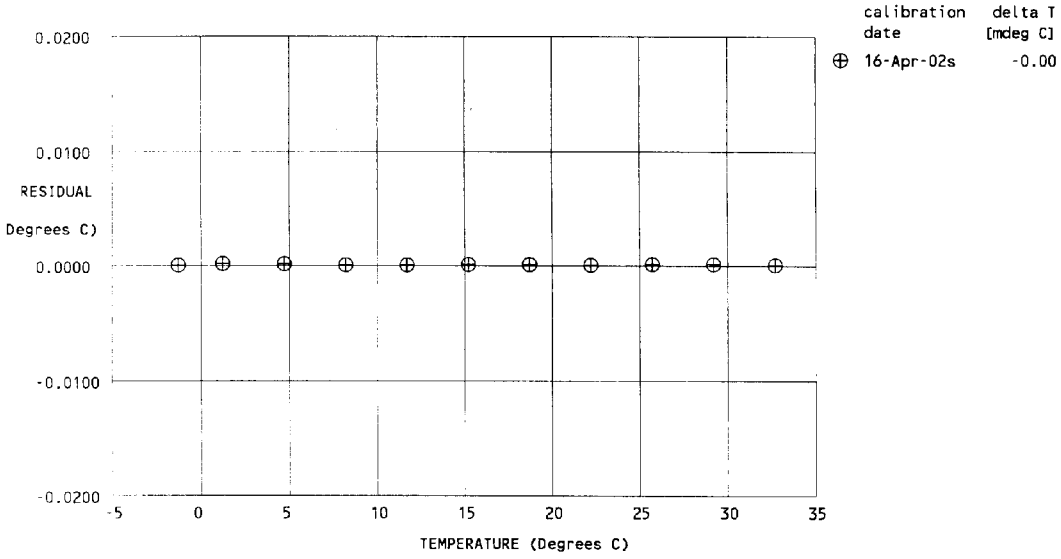
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
-1.4998	2991.316	-1.4999	-0.00005
1.0002	3164.085	1.0003	0.00007
4.5002	3417.963	4.5002	0.00005
8.0002	3686.226	8.0002	-0.00005
11.5002	3969.295	11.5002	-0.00004
15.0002	4267.566	15.0002	0.00001
18.5002	4581.420	18.5002	0.00001
22.0003	4911.248	22.0003	-0.00002
25.5002	5257.401	25.5002	0.00003
29.0002	5620.254	29.0002	0.00003
32.5002	6000.144	32.5002	-0.00003

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

Temperature IPTS-68 $= 1/\{a + b[\ell n(f_0/f)] + c[\ell n^2(f_0/f)] + d[\ell n^3(f_0/f)]\} - 273.15$ (°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 (Wet Lab) Changed out on 03/01/03

PO Box 518
620 Applegate St.
Philomath OR 97370

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

WET Labs

as of 02/25/03
Original
This was changed on 3/1/03

C-Star Calibration Sheet

Date:	**07/02/02**
Customer:	**National Science Foundation**
Serial Number:	**CST-423PR**
Job Number:	**0012016**
Work Order:	**004**

V_d = V dark	**0.058**
V_{air} = V out in air	**4.856**
V_{ref} = V out in water	**4.840**
Calibration Temperature of water	20.5
Ambient Temperature	**25.3**

% Transmission = $(V_{sig}-V_d)/(V_{ref}-V_d)$
$Tr = e^{-cx}$
To solve for the attenuation coefficient c in units of m^{-1} use the following equation.
$c = -1/x\ (\ln(V_{sig}-V_d)/(V_{ref}-V_d))$
For further information on these calculations please see C-Star User's Guide, Section 2.

Temperature Error: 0.02% F.S./°C

NOTES

- (V_d) – analog output of the instrument with the beam blocked. This is an instrumental offset.
- (V_{air})—analog output voltage of the instrument with a cleared beam path.
- (V_{ref})—analog output voltage of the instrument with clean H_2O in the path.
- **(Calibration Temperature of water)**—temperature of the clean water used to obtain V_{ref}.
- **(Ambient Temperature)** – temperature of the instrument during the calibration procedures.
- (V_{sig}) – measured signal voltage of the C-Star.

Underway Transmissometer (Wet Lab) Installed 03/01/03

PO Box 518
620 Applegate St.
Philomath OR 97370

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

WET Labs

Installed on 3/1/03

C-Star Calibration Sheet

Date:	**12/21/01**
Customer:	**National Science Foundation**
Serial Number:	**CST-439DR**
Job Number:	**0102007**
Work Order:	**002**

V_d = V dark	**0.056**
V_{air} = V out in air	**4.829**
V_{ref} = V out in water	**4.738**
Calibration Temperature of water	**22.6**
Ambient Temperature	**22.2**

% Transmission = $(V_{sig}-V_d)/(V_{ref}-V_d)$
$Tr = e^{-cx}$
To solve for the attenuation coefficient c in units of m^{-1} use the following equation:
$c = -1/x\ (\ln(V_{sig}-V_d)/(V_{ref}-V_d))$
For further information on these calculations please see C-Star User's Guide, Section 2.

Temperature Error: 0.02% F.S./°C

NOTES

- **(V_d)**—analog output of the instrument with the beam blocked. This is an instrumental offset.
- **(V_{air})**—analog output voltage of the instrument with a cleared beam path.
- **(V_{ref})**—analog output voltage of the instrument with clean H_2O in the path
- **(Calibration Temperature of water)**—temperature of the clean water used to obtain V_{ref}.
- **(Ambient Temperature)**—temperature of the instrument during the calibration procedures.
- **(V_{sig})**—measured signal voltage of the C-Star

Pressure Sensor (CTD)

Pressure Calibration Check

13 July 2001

pressure sensor model: Digiquartz 410K-105
sensor serial number: 58949
installed in: CTD 09P10716-0377

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]
14.700	33360.59	23.2	14.668	14.986	0.286
2014.689	34041.54	23.2	2014.473	2014.776	0.087
4014.348	34706.93	23.3	4014.163	4014.452	0.104
6013.814	35357.64	23.3	6013.643	6013.918	0.104
8013.175	35994.51	23.3	8013.027	8013.288	0.113
10012.889	36618.31	23.3	10012.365	10012.612	-0.277
8013.257	35994.54	23.3	8013.101	8013.362	0.105
6013.753	35357.61	23.3	6013.535	6013.811	0.058
4014.262	34706.87	23.4	4013.938	4014.227	-0.035
2014.600	34041.43	23.4	2014.097	2014.400	-0.200
14.670	33360.38	23.4	14.007	14.325	-0.345

Input pressure is generated with a Ruska model 5201 dead-weight tester, serial number 23330/380, and is determined by measurement with reference pressure sensor model Digiquartz 410K-000, 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 = 0.99999 and psi_offset = +0.32 [psia]

These are converted to Slope and Offset in decibars for use in the SEASOFT programs by: Slope = psi_slope = 0.99999
Offset = C * (psi_offset - 14.7 * (1 - psi_slope)) = +0.2188 [dbars]
C = 0.689476 [dbar/psi]

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

Digiquartz Coefficients:

C1 = -4.840395e+04
C2 = -2.017057e-03
C3 = 1.464810e-02
D1 = 3.990600e-02
D2 = 0.000000e+00
T1 = 2.998386e+01
T2 = -2.560542e-04
T3 = 3.869120e-06
T4 = 2.452640e-09

AD590 Pressure Temperature Coefficients:

AD590M = 0.01146
AD590B = -8.45734

Calibration Correction:

Slope = 0.99999
Offset = +0.2188

Primary Temperature Sensor (CTD)

SEA-BIRD ELECTRONICS, INC.
1606 136th Place N.E., Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 Internet: seabird@seabird.com

SENSOR SERIAL NUMBER = 2367
CALIBRATION DATE: 28-Jun-02

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS 90 COEFFICIENTS

g = 4.33455095e-03
h = 6.42033580e-04
i = 2.35528241e-05
j = 2.23723422e-06
f_0 = 1000.000

IPTS 68 COEFFICIENTS

a = 3.68120886e-03
b = 6.00889806e-04
c = 1.64506201e-05
d = 2.26287047e-06
f_0 = 2865.671

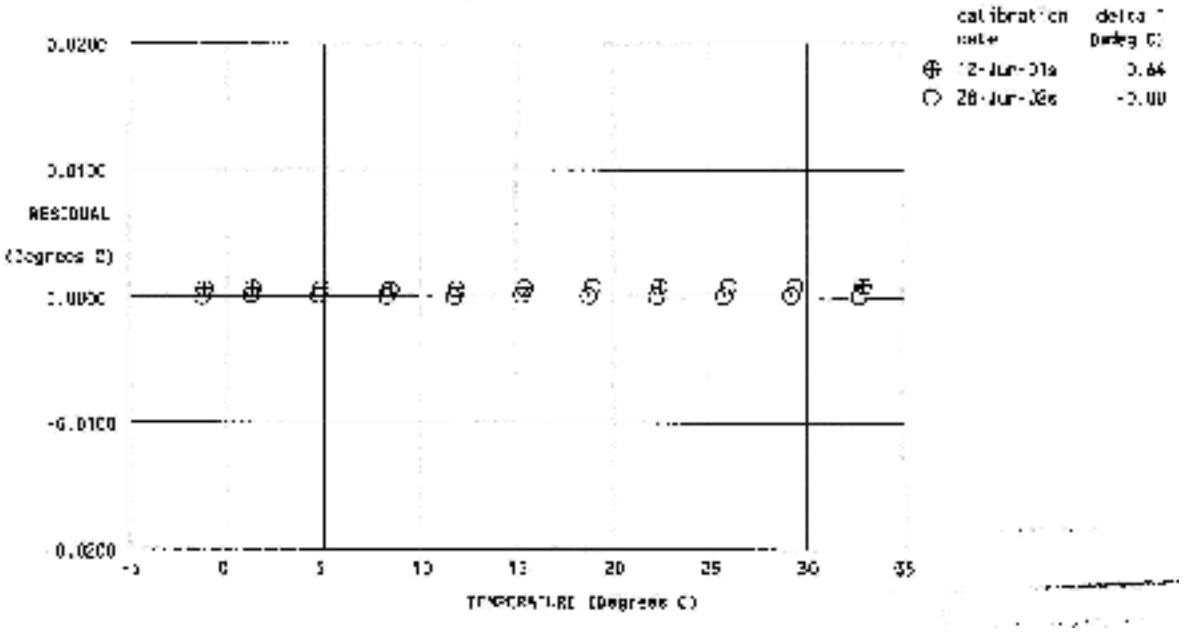
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
-1.4997	2865.871	-1.4997	-0.00005
1.0003	3030.838	1.0004	0.00007
4.5003	3273.200	4.5003	0.00004
8.0005	3529.224	8.0003	-0.00006
11.5005	3795.293	11.5002	-0.00005
15.0005	4083.774	15.0004	0.00005
18.5003	4282.992	18.5002	0.00002
22.0005	4697.301	22.0003	0.00000
25.5005	5027.025	25.5003	-0.00002
29.0005	5272.484	29.0003	0.00001
32.5005	5733.970	33.5003	-0.00005

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

Temperature [IPTS-68] = 1/{a + b[ln(f_y/f)] + c[ln^2(f_y/f)] + d[ln^3(f_y/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



Secondary Temperature Sensor (CTD)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 2186
CALIBRATION DATE: 28-Jun-02

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS 90 COEFFICIENTS

g = 4.34030599e-03
h = 5.49017766e-04
i = 2.34157873e-05
j = 2.25758868e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.68120066e-03
b = 6.02977589e-04
c = 1.63692014e-05
d = 2.22915934e-06
f_0 = 2882.286

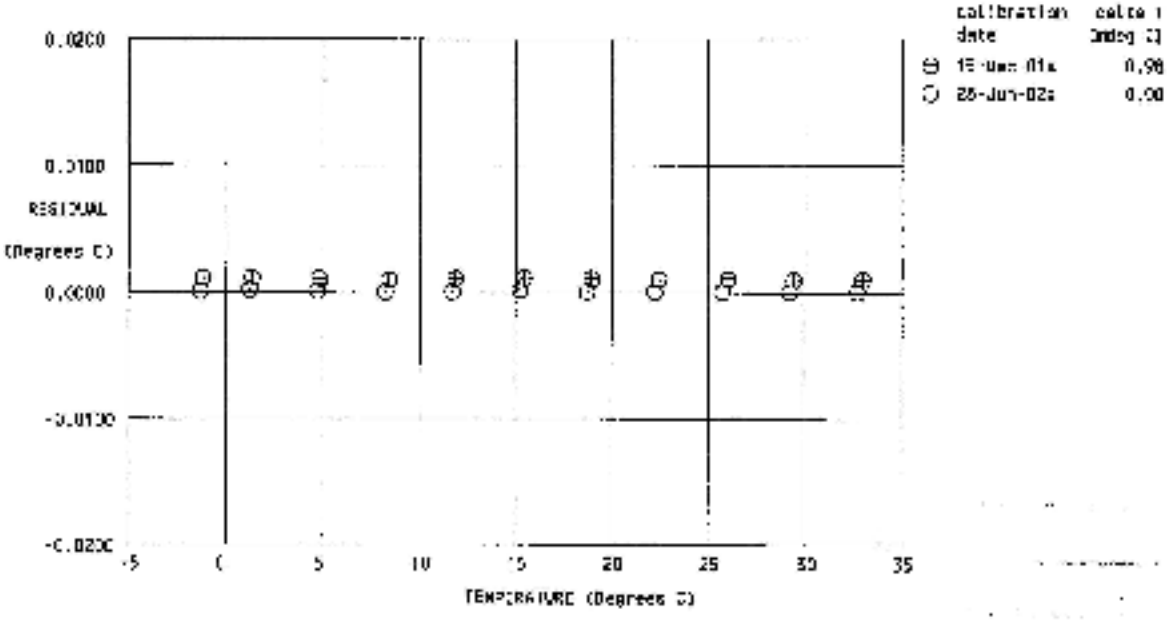
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
-1.4997	2882.286	-1.4997	-0.00003
1.5003	3047.603	1.5004	0.00006
4.5003	3290.412	4.5003	0.00000
8.0003	3546.837	8.0002	0.00008
11.5003	3817.236	11.5003	0.00004
15.0003	4101.984	15.0004	0.00013
18.5003	4401.382	18.5003	-0.00000
22.0003	4715.794	22.0002	-0.00005
25.5003	5045.542	25.5003	-0.00001
29.0002	5390.923	29.0003	0.00001
33.5003	5752.231	32.5003	0.00000

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

Temperature IPTS-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 IPTS-68, T_{68} is assumed to be $1.00024 * T_{90}$ (-2 to 35 °C)

Residual = instrument temperature - bath temperature



Dissolved Oxygen Sensor (1) (CTD)

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington 98005 USA
Phone: (425) 643 9866 Fax: (425) 643 9954 Internet: seabird@seabird.com

SENSOR SERIAL NUMBER = 0080
CALIBRATION DATE: 27-Jun-02

SBE 43
OXYGEN CALIBRATION DATA

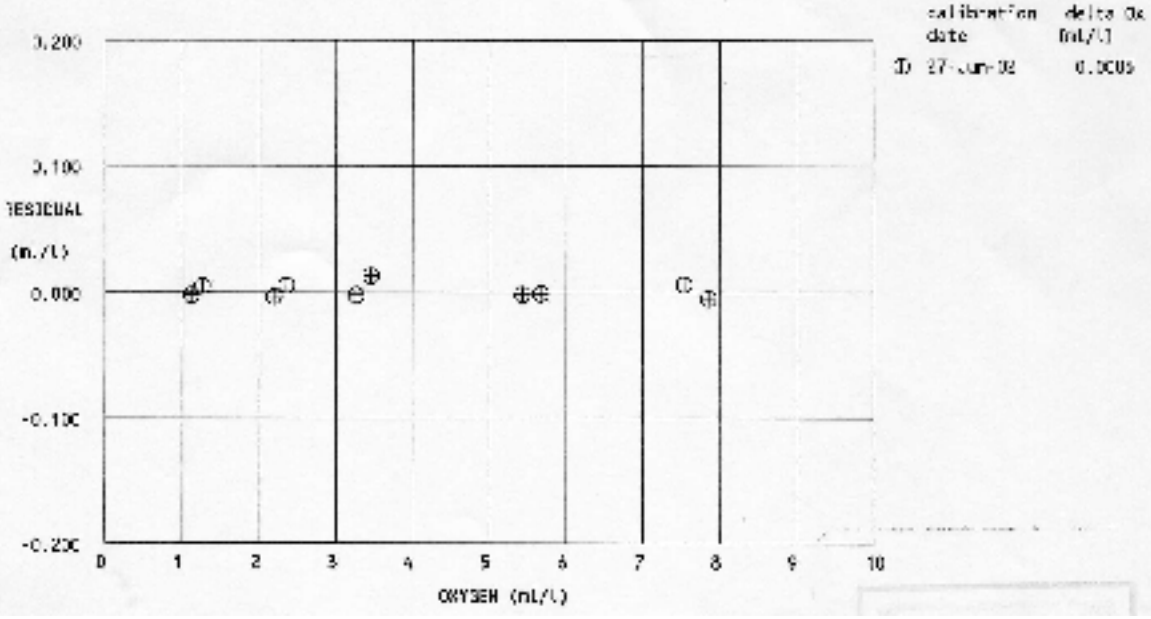
COEFFICIENTS:

Soc = 0.3943
Boc = 0.0000
Voffset = -0.5445

TCor = 0.0002
PCor = 1.350e-04

BATH OX ml/l	BATH TEMP (ITS-90 °C)	BATH SAL PSU	INSTRUMENT VOLTS	INST OX ml/l	RESIDUAL ml/l
1.37	5.30	34.94	0.869	1.96	-0.00
1.32	25.30	34.93	1.378	1.88	-0.00
2.11	5.30	34.94	1.122	2.54	-0.00
3.30	25.30	34.93	1.883	3.30	-0.00
3.21	5.30	34.94	1.446	4.22	-0.00
5.40	25.30	34.93	2.039	5.41	-0.01
5.38	5.30	34.94	2.221	5.38	-0.00
5.62	25.30	34.93	2.309	5.63	-0.00
7.49	5.30	34.94	2.622	7.50	-0.01
7.91	25.30	34.93	2.930	7.91	-0.01

V = voltage output from SBE-43
T = ocean temperature [°C] from CTD
S = ocean salinity [PSU] from CTD
P = ocean pressure [dbar] from CTD
Oxsat(T, S) = oxygen saturation [ml/l]
oxygen (ml/l) = (Soc * (V + Voffset)) * exp(Tcor * T) * Oxsat(T, S) * exp(Pcor * P)
Residual = instrument oxygen - bath oxygen



Primary Conductivity Sensor (CTD)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 2512
CALIBRATION DATE: 27-Jun-02

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

GHH COEFFICIENTS

g = -1.05829607e+01
h = 1.63273083e+00
i = -1.64558607e-03
j = 2.35181212e-04
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

ABCDM COEFFICIENTS

a = 5.77452853e-06
b = 1.62695189e+00
c = -1.23767003e+01
d = -8.74742113e-05
m = 5.3
CPcor = -9.57e-08 (nominal)

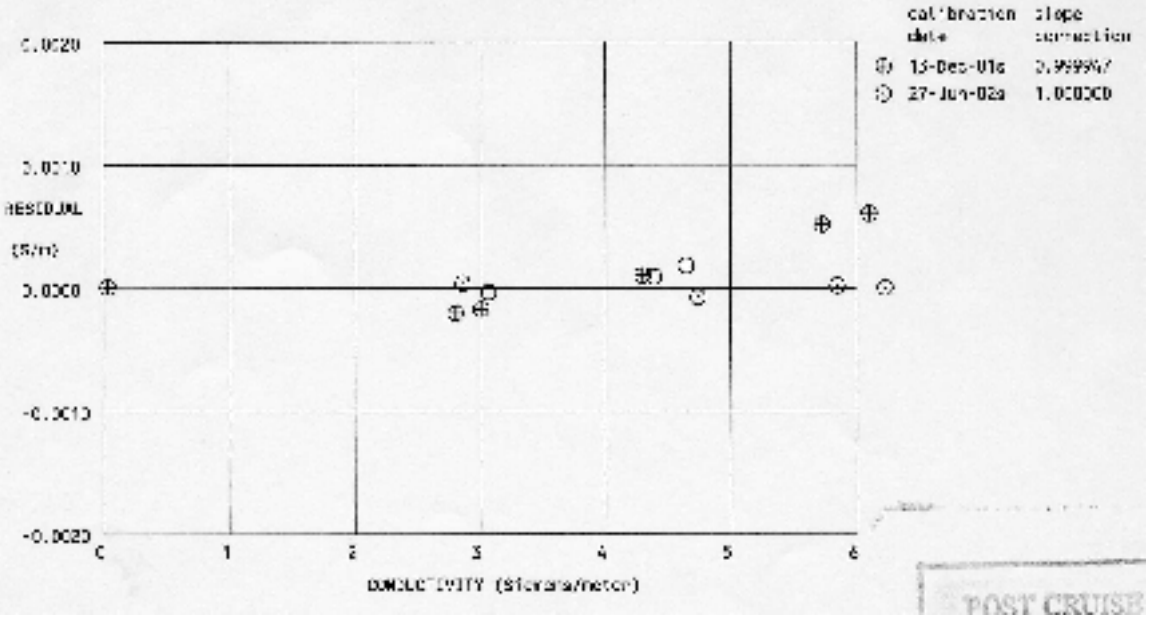
BATH TEMP (ITS-90 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.54801	0.00000	0.00000
-1.4012	33.5974	2.82696	4.88177	2.82699	0.00003
0.9988	33.5990	3.03629	5.07139	3.03625	-0.00004
14.9988	33.5985	4.35714	5.76229	4.35723	0.00009
18.4988	33.5995	4.71076	5.94702	4.71068	-0.00008
28.9989	33.5962	5.81533	6.49019	5.81534	0.00001
32.4987	33.5911	6.19545	6.66674	6.19545	0.00000

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 [deg C]; p = pressure [decibars]; δ = CTcor; ε = CPcor;

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



POST CRUISE

Secondary Conductivity Sensor (CTD)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 2067
CALIBRATION DATE: 27-Jun-02

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

GHIJ COEFFICIENTS

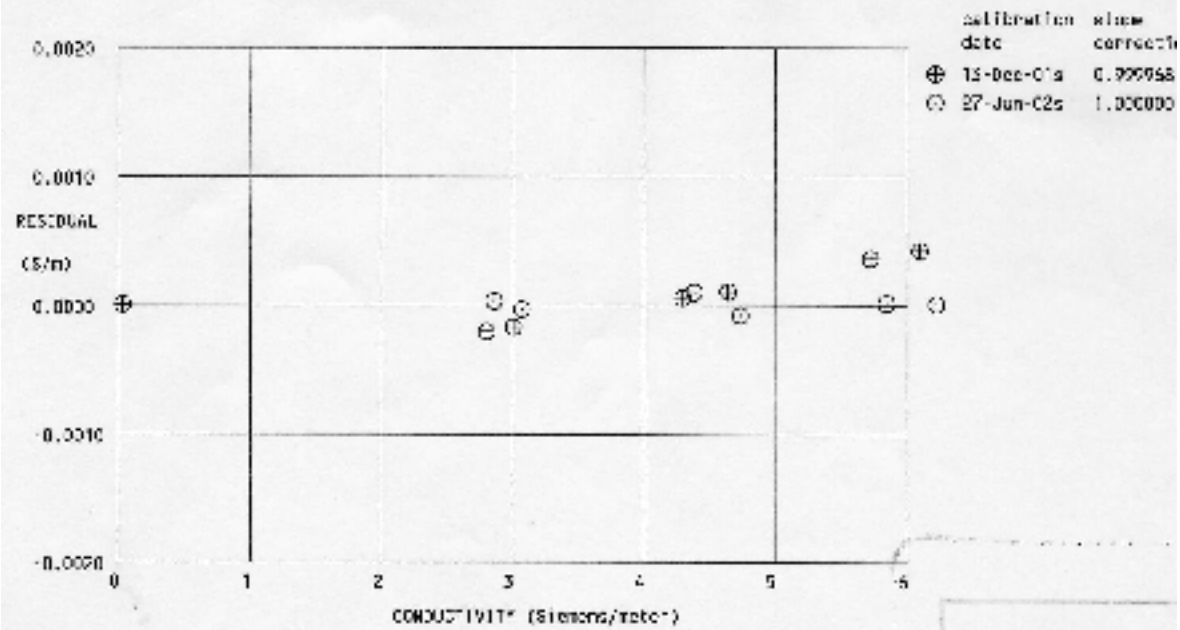
g = 1.0390725e-01
h = 1.4648712e+00
i = -4.6410352e-03
j = 4.2461424e-04
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

ABCDM COEFFICIENTS

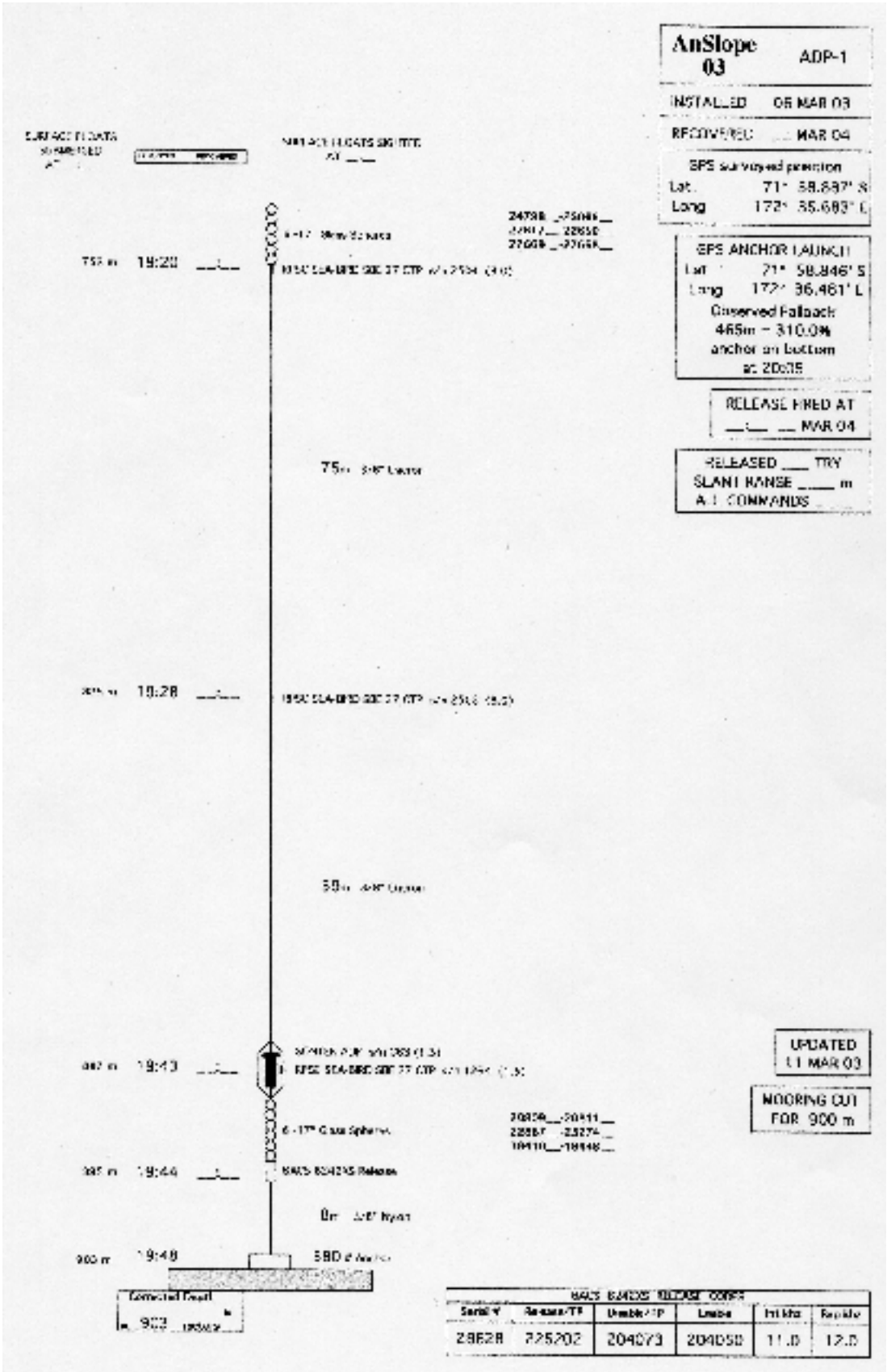
a = 2.6875314e-09
b = 1.4503516e+00
c = -1.0352638e+01
d = -4.5750044e-05
m = 8.6
CPcor = -9.57e-08 (nominal)

BATH TEMP (ITS-90 C)	BATH SAL. (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.67194	0.00000	0.00000
-1.4372	35.5974	2.82696	5.16007	2.82698	0.00002
0.9988	35.5990	3.03629	5.29798	3.03625	-0.00004
14.9988	35.5985	4.35716	6.09542	4.35723	0.00009
18.4988	35.5995	4.71076	6.29273	4.71068	-0.00008
28.9988	35.5962	5.81533	6.86967	5.81534	0.00001
32.4987	35.5911	5.19545	7.05710	6.19545	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 [deg C]; p = pressure [decibars]; δ = CTcor; ϵ = CPcor;
Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



Drawing of Mooring ADP-1



SeaCat SBE 37 (Mooring ADP –1)

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

SENSOR SERIAL NUMBER = 126
CALIBRATION DATE: 23-Nov-02

PRESSURE CALIBRATION DATA
1500 psia S/N [illegible]

SBE 37 PRESSURE COEFFICIENTS

PA0 = 1.[illegible]e+00
PA1 = 6.[illegible]e-02
PA2 = 2.401691e-08

PTCA0 = 1.[illegible]e+03
PTCA1 = 1.[illegible]e+00
PTCA2 = 1.[illegible]e-03
PTCB0 = [illegible]e+01
PTCB1 = [illegible]e-04
PTCB2 = [illegible]e+00

PRESSURE SPAN CALIBRATION:

PRESSURE PSIA	PRESSURE OUTPUT	THERM (DEG C)	COMPUTED PRESSURE	ERROR % FSR
14.7[illegible]	314.5	23.7	14.[illegible]	-0.03
[illegible]	5322.8	23.7	[illegible].54	-0.06
[illegible]	10200.7	23.7	[illegible].54	-0.06
[illegible]	15235.4	23.7	[illegible]	-0.04
[illegible]	20164.5	23.7	[illegible]	-0.03
[illegible]	25276.5	23.7	[illegible]	-0.00
[illegible]	20176.7	23.7	[illegible]	0.03
[illegible]	15221.5	23.7	[illegible]	0.05
[illegible]	10513.9	23.7	[illegible].18	0.05
[illegible]	5529.8	23.7	[illegible].11	0.05
[illegible]	368.9	23.7	[illegible]	0.03

THERMAL OFFSET:

TEMPERATURE (ITS-90 °C)	PRESSURE OUTPUT
32.[illegible]	393.79
[illegible]	384.70
[illegible]	373.56
[illegible]	363.64
[illegible]	355.56
[illegible]	343.39
[illegible]	335.51

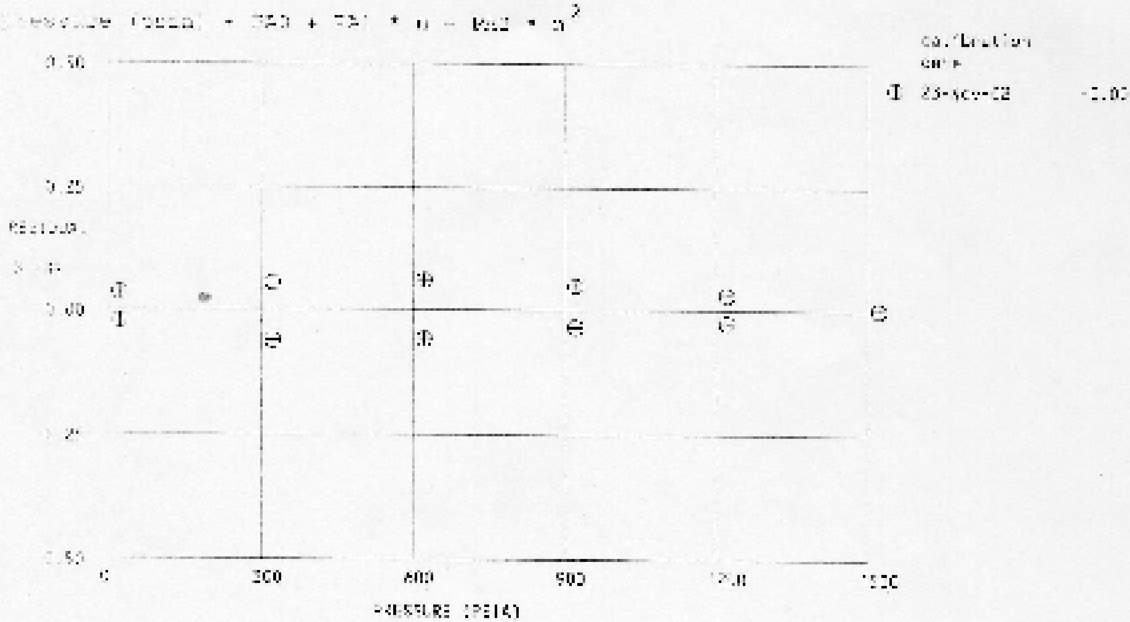
SPAN THERMAL SENSITIVITY:

TEMPERATURE (ITS-90 °C)	SPAN FV
[illegible]	30.1[illegible]
[illegible]	30.[illegible]

x = pressure output − PTCA0 − PTCA1 * t − PTCA2 * t^2

n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)

pressure (psia) = PA0 + PA1 * n + PA2 * n^2



SeaCat SBE 37 (Mooring ADP –1)

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

Conductivity Calibration Report

Customer:	Raytheon Polar Services Co.		
Job Number:	30668R	Date of Report:	18-Nov-02
Model Number:	SBE 37SM	Serial Number:	37SM21877-1264

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustment, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or if otherwise required.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manuals). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED' CALIBRATION ☑ *Performed* ☐ *Not Performed*

Date: 07-Nov-02 *Drift since last cal:* 0.0370 *PSU/month**

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' ☑ *performed* ☐ *Not Performed*

Date: 15 Nov 02 *Drift since last cal:* 0 *PSU/month**

Comments:

**Measured at 5.0 S/m*

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in pre-cleaning calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

SeaCat SBE 37 (Mooring ADP –1)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 1264
CALIBRATION DATE: 07-Nov-02

SBE 37
CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.29.4 Siemens/meter

COEFFICIENTS:

g =	-1.035106e+00	CPcor =	-9.5700e-08
h =	1.529 [illegible]e-01	CTcor =	3.2500e-06
i =	-3.302000e-04	WBOTC =	1.6442e-05
j =	5.8600586e-05		

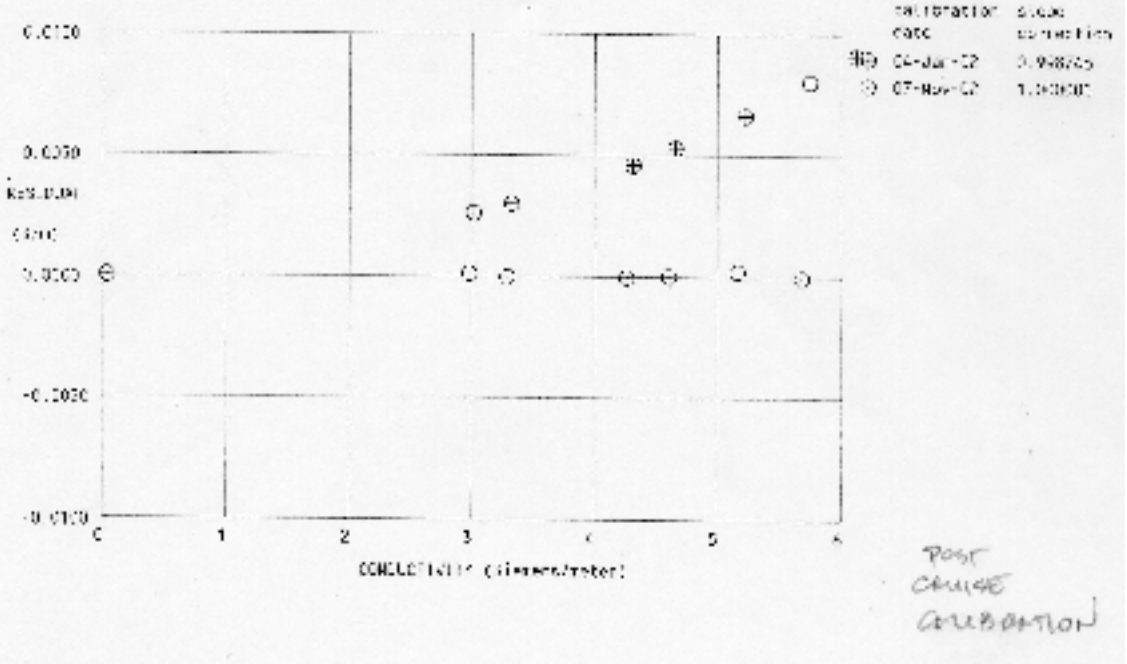
BATH TEMP (ITS-90 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	3036.70	0.00000	-0.00000
1.0000	34.1719	2.94956	5135.91	2.94963	0.00007
8.0000	34.4760	3.25575	5700.96	3.25570	-0.00006
15.0000	34.1767	4.03403	6873.12	4.03415	0.00012
18.0000	34.4798	4.57799	7389.71	4.57790	-0.00009
22.0000	34.1716	5.19206	8130.72	5.19214	0.00008
29.0000	34.4832	5.65095	8610.18	5.65086	-0.00009

f = INST FREQ / sqrt(1.0 + WBOTC * (t + 1000.0))

t = temperature (deg C); p = pressure (decibars); t = CTcor; c = CPcor.

Conductivity = (g + hf^2 + if^3 + jf^4) / (1 + at + bp) Siemens/meter

Residual = (instrument conductivity - bath conductivity)



POST CRUISE CALIBRATION

SeaCat SBE 37 (Mooring ADP –1)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 1264
CALIBRATION DATE: 15-Nov-02

SBE 37
CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.02148e+01
h = 1.617e+00
i = -1.0278e-01
j = 2.4842e-04

CPcor = -9.5700e-08
CTcor = 3.2500e-06
WBOTC = -2.8602e-06

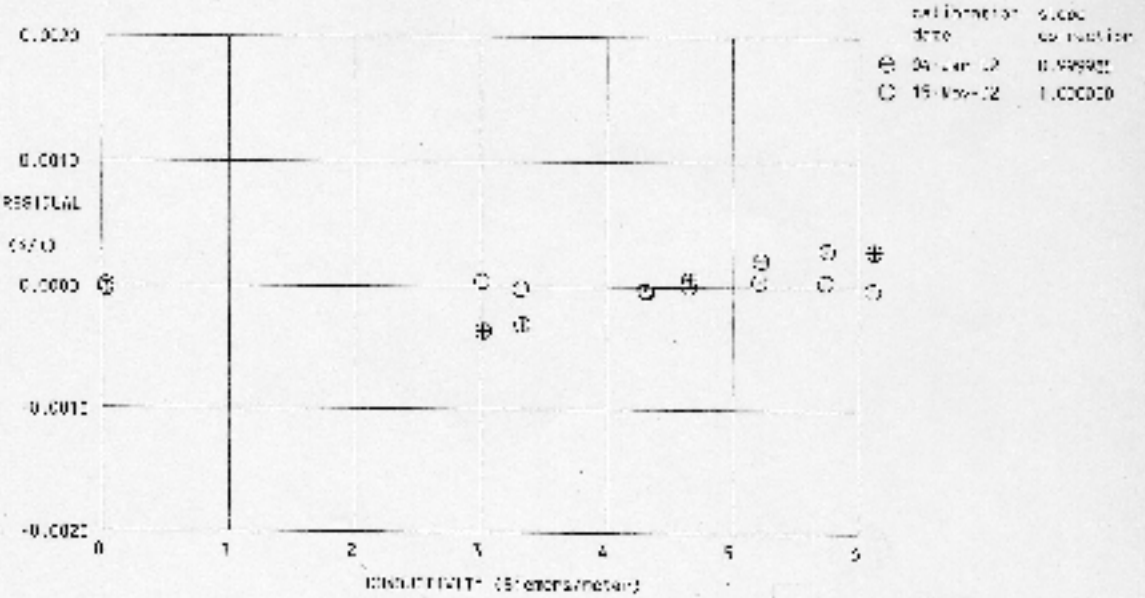
BATH TEMP (ITS-90 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2604.59	0.00000	-0.00000
0.9999	34.8282	2.97096	5138.24	2.97099	-0.00003
4.5000	34.8315	3.25502	5481.96	3.25599	-0.00002
14.9999	34.8569	4.27361	6696.43	4.27369	-0.00004
18.5000	34.8588	4.62064	7085.30	4.62064	0.00000
24.0000	34.8588	5.18130	7678.47	5.18134	-0.00004
28.9999	34.8538	5.70185	8240.22	5.70186	-0.00001
32.4999	34.8507	6.07821	8626.72	6.07817	0.00003

INST FREQ * sqrt(1.0 + WBOTC * t) / 100.0

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

Conductivity = (g + hf² + if⁴ + jf⁵) / (1 + δt + εp) Siemens/meter

Residual = (instrument conductivity - bath conductivity)



SeaCat SBE 37 (Mooring ADP –1)

SEA-BIRD ELECTRONICS, INC.

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

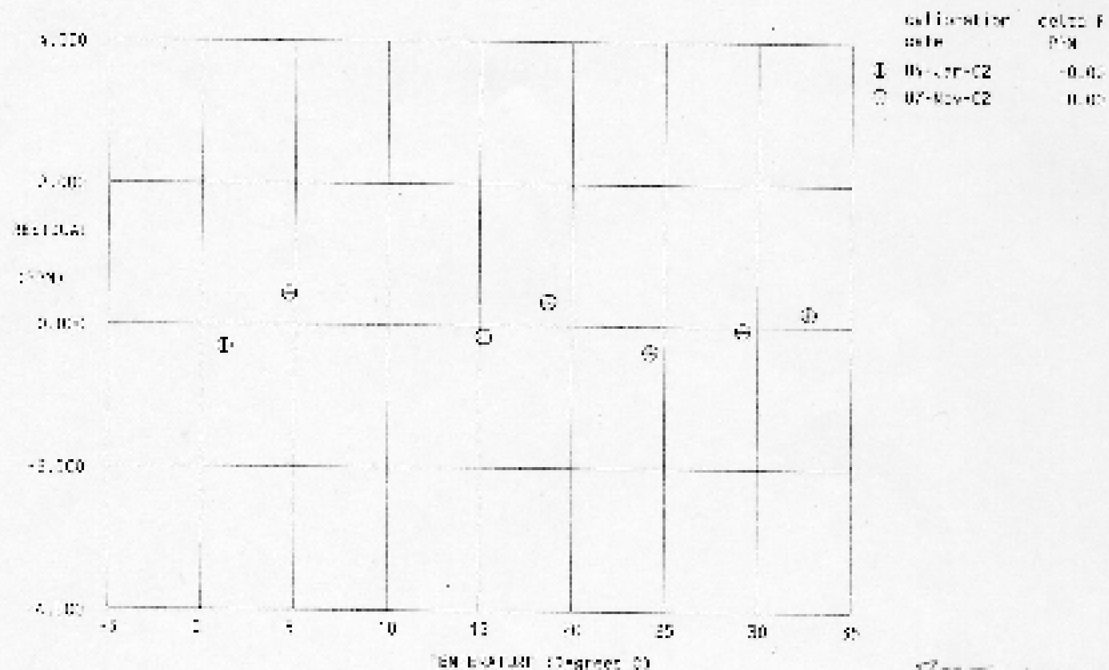
SENSOR SERIAL NUMBER = 1364
CALIBRATION DATE: 07-Nov-02

RTC CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

SBE 37 COEFFICIENTS
rtca0 = [illegible]
rtca1 = 1.620313e-06
rtca2 = -3.3[illegible]e-08

BATH TEMP (ITS-90 °C)	RTC FREQ	COMPUTED FREQ	RESIDUAL PPM
1.0000	0.9999820	0.9999817	-0.3
6.0000	0.9999870	0.9999874	0.4
12.0000	1.0000000	0.9999998	[illegible]
18.0000	1.0000020	1.0000023	0.3
23.9999	1.0000050	1.0000046	-0.4
28.9998	1.0000040	1.0000043	-0.[illegible]
32.9001	1.0000040	1.0000042	0.2

RTC frequency = a0 + a1 * t + a2 * t²
Residual = (Computed RTC frequency - Measured RTC frequency) * 1e6



POST CRUISE CALIBRATION

Sea

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER = 1261
CALIBRATION DATE: 15-Nov-02

RTC CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

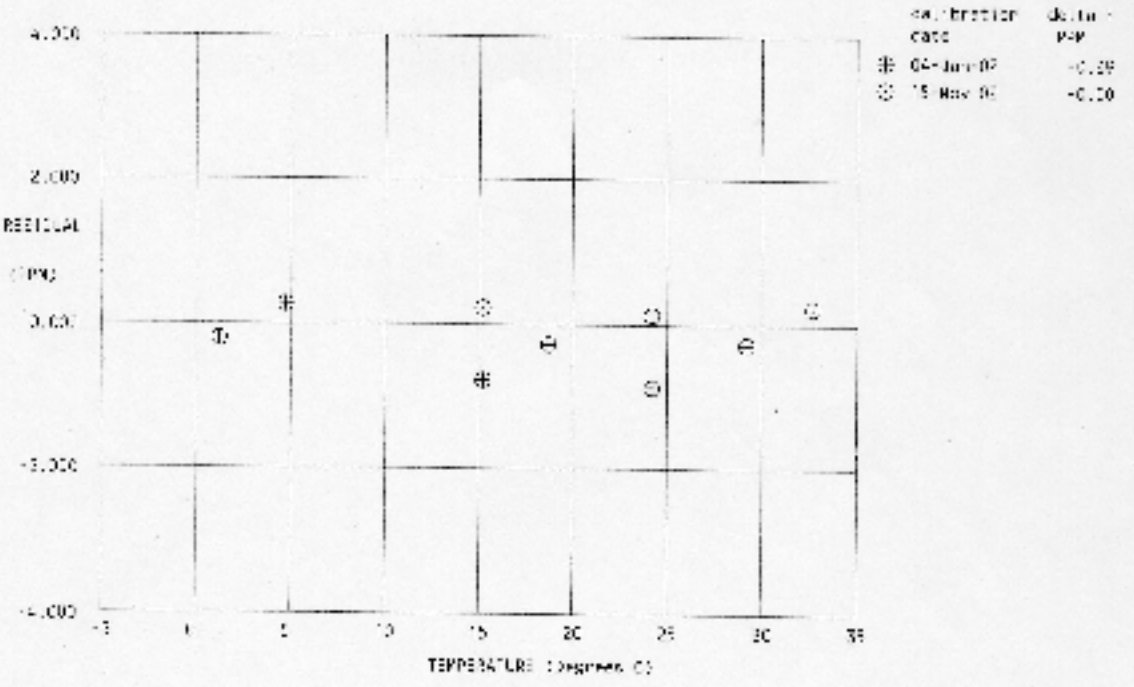
SBE 37 COEFFICIENTS

a0	= 9.999807e+01
a1	= 1.737470e-05
a2	= -3.053719e-08

RATE TEMP (ITS-90 °C)	RTC FREQ	COMPUTED FREQ	RESIDUAL PPM
1.9999	0.99999620	0.99999613	0.2
4.3000	0.99999670	0.99999673	0.3
14.9999	0.99999882	0.99999882	0.2
18.7000	1.00000021	1.00000027	0.3
24.0000	1.00000042	1.00000041	0.1
28.9999	1.00000052	1.00000047	-0.3
32.4999	1.00000067	1.00000062	0.2

RTC frequency = a0 + a1 * n + a2 * n²

Residual = (Computed RTC frequency - Measured RTC frequency) * 1e6



Cat SBE 37 (Mooring ADP –1)

SeaCat SBE 37 (Mooring ADP –1)

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

Temperature Calibration Report

Customer:	Raytheon Polar Services Co.		
Job Number:	30665	Date of Report:	18-Nov-02
Model Number:	SBE 37SM	Serial Number:	37SM21877-1264

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'offset' allows a shift correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED' CALIBRATION ☑ Performed ☐ Not Performed

Date: 07-Nov-02 Drift since last cal: +.00230 Degrees Celsius/year

Comments:

'FINAL CALIBRATION' ☑ performed ☐ Not Performed

Date: 15-Nov-02 Drift since 04 Jan 02 +.00021 Degrees Celsius/year

Comments:

SeaCat SBE 37 (Mooring ADP –1)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 1764
CALIBRATION DATE: 15-Nov-02

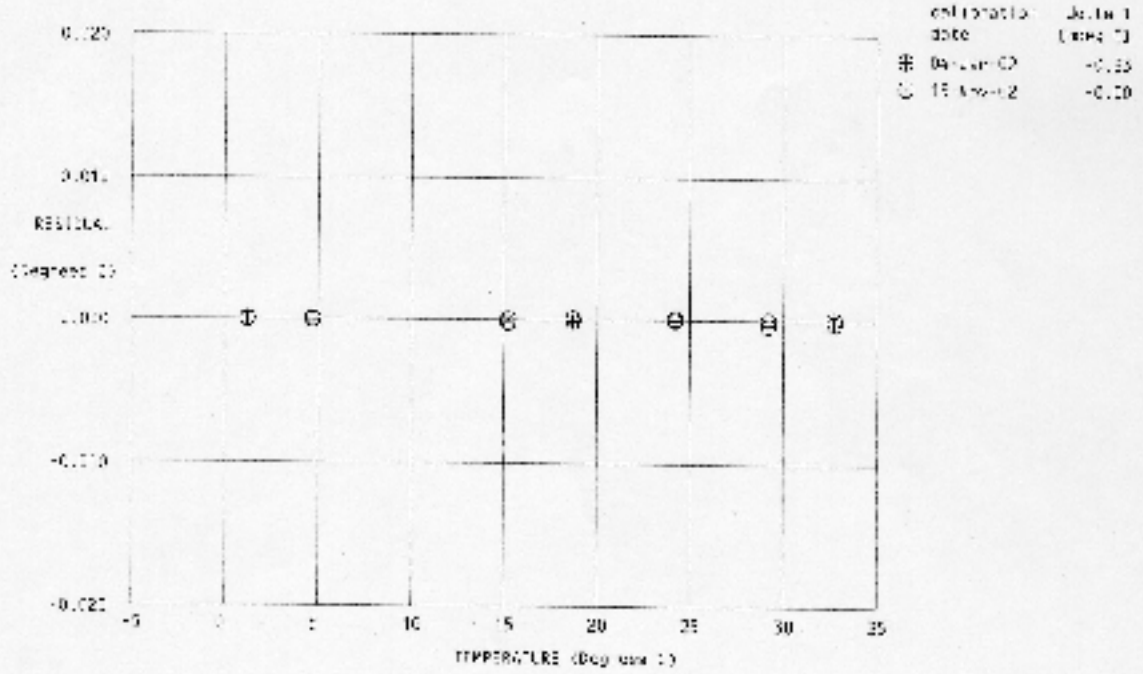
SBE 37
TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS

a0 = -4.561684e-05
a1 = 3.9[illegible]e-04
a2 = -3.175084e-06
a3 = 1.579203e-07

BATH TEMP (ITS-90 °C)	INSTRUMENT OUTPUT	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
0.3554	631344.8	0.3999	0.0000
4.5001	541722.0	4.5000	0.0000
14.9999	367477.4	14.9999	-0.0000
18.5002	331363.7	18.5000	0.0000
24.0000	282773.1	24.0000	0.0000
28.9996	2[illegible]6.3	28.9999	0.0000
32.4999	2[illegible]6.5	32.4999	0.0000

Temperature ITS-90 = 1/{a0 + a1[ln(n)] + a2[ln(n)]^2 + a3[ln(n)]^3} - 273.15 (°C)
Residual = instrument temperature - bath temperature



SeaCat SBE 37 (Mooring ADP –1)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 1254
CALIBRATION DATE: 07-Nov-02

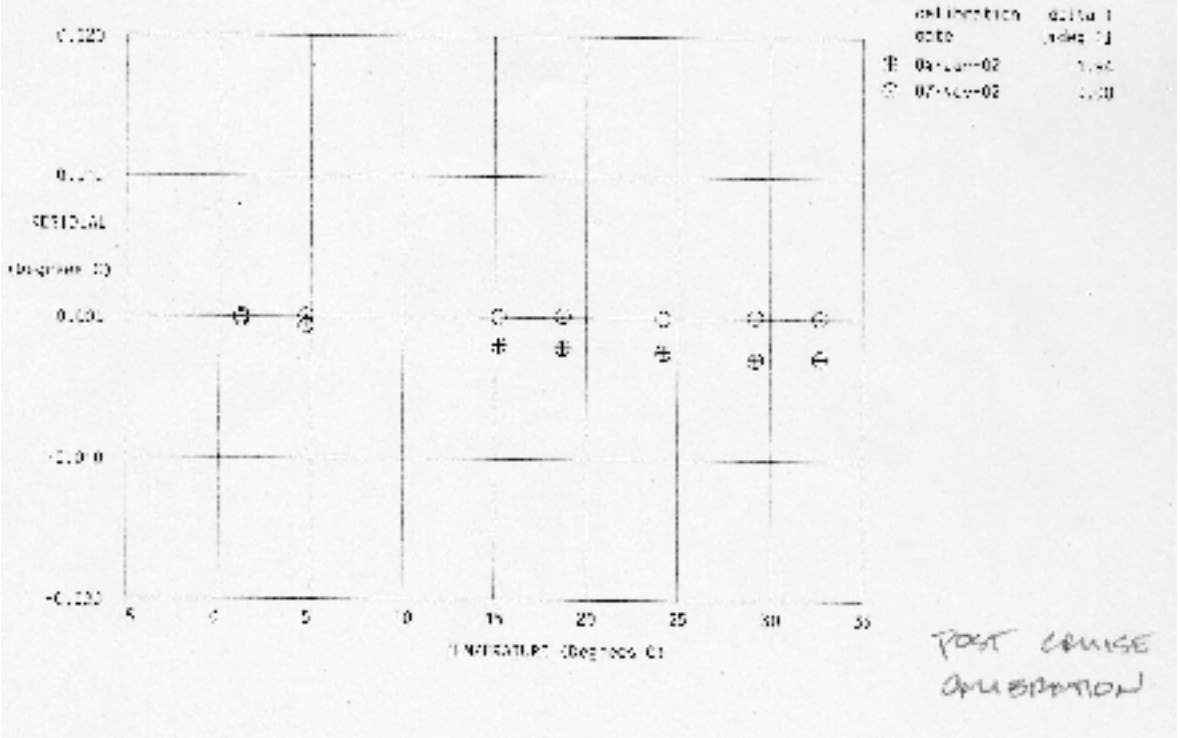
SBE 37
TEMPERATURE CALIBRATION DATA
ITS 90 TEMPERATURE SCALE

COEFFICIENTS

a0 = 4.38638e-03
a1 = 2.5069[illegible]e-04
a2 = 3.[illegible]e-06
a3 = [illegible]e-07

BATH TEMP (ITS-90 °C)	INSTRUMENT OUTPUT	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
1.0000	65[illegible].5	1.0000	0.0000
4.5000	54[illegible].5	4.5000	-0.0000
15.0000	34[illegible].8	15.0000	-0.0000
18.5000	30[illegible].7	18.5001	0.0001
23.0000	26[illegible].6	23.0005	-0.0005
28.9999	20[illegible].0	28.9999	0.0000
32.5001	75[illegible].1	32.5001	-0.0000

Temperature ITS-90 = 1/{a0 + a1[ln(f)] + a2[ln(f)]^2 + a3[ln(f)]^3} - 273.15 (°C)
Residual = instrument temperature - bath temperature



SeaCat SBE 37 (Mooring ADP –1)

Sea-Bird Electronics, Inc.
1808 136th Place NE, Bellevue, Washington 98005 USA
Website: http://www.seabird.com

SBE Pressure Test Certificate

Test Date: 7/26/02 Description SBE-37 Microcat

Job Number: 30884 Customer Name RAYTHEON

SBE Sensor Information:

Model Number: 37
Serial Number: 2504

Pressure Sensor Information:

Sensor Type: Druck
Sensor Serial Number: 2111
Sensor Rating: 2900

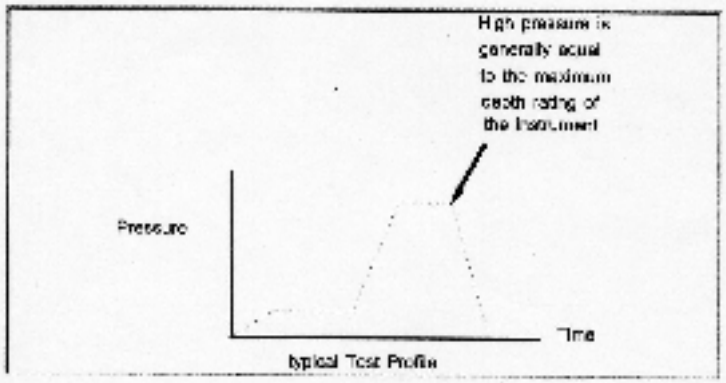
Pressure Test Protocol:

Low Pressure Test: 50 PSI Held For 15 Minutes

High Pressure Test: 2900 PSI Held For 15 Minutes

Passed Test: ☑

Tested By: PCC



typical Test Profile

SeaCat SBE 37 (Mooring ADP –1)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 2504
CALIBRATION DATE: 07 Aug 02

PRESSURE CALIBRATION DATA
3000 psia S/N 2111

SEE 37 PRESSURE COEFFICIENTS

AO =	1.484717e+00	PTCA0 =	-1.291158e+02
A1 =	1.267493e-01	PTCA1 =	1.291044e-01
A2 =	-9.851115e-09	PTCA2 =	4.711354e-03
		PTCB0 =	2.5[illegible]00e+01
		PTCB1 =	2.475000e-03
		PTCB2 =	0.000000e+00

PRESSURE SPAN CALIBRATION:

PRESSURE PSIA	PRESSURE OUTPUT	TEMP (ITS-90 °C)	COMPUTED PRESSURE	ERROR % FSR
14.70	21.5	23.8	14.75	0.00
614.68	9000.0	23.8	614.78	-0.00
1214.94	17797.0	23.8	1214.89	-0.00
1814.96	26563.0	23.8	1815.00	0.00
2414.86	35370.6	23.8	2414.98	0.00
3014.92	44206.6	23.8	3014.87	-0.00
2414.82	35375.7	23.8	2414.99	0.00
1814.64	26539.0	23.8	1814.96	0.00
1214.54	17756.9	23.8	1214.87	0.00
614.79	8961.9	23.8	614.72	-0.00
14.66	-21.8	23.8	14.71	0.00

THERMAL OFFSET:

TEMPERATURE (ITS-90 °C)	PRESSURE OUTPUT
32.50	-8.90
29.00	-11.68
24.00	-16.54
18.50	-17.90
15.00	-19.31
4.00	-23.55
1.00	-24.91

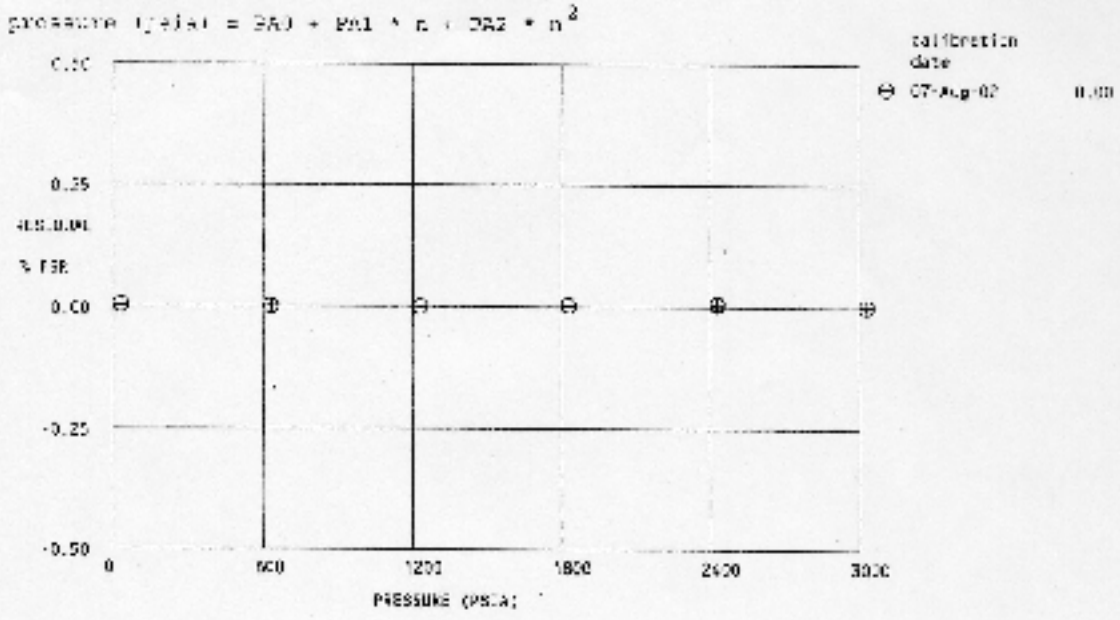
SPAN THERMAL SENSITIVITY:

TEMPERATURE (ITS-90 °C)	SPAN MV
-5.00	28.16
35.00	29.05

N = pressure output - PTCA0 - PTCA1 * t - PTCA2 * t^2

n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)

pressure (psia) = A0 + A1 * n + A2 * n^2



SeaCat SBE 37 (Mooring ADP –1)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 2504
CALIBRATION DATE: 19-Nov-02

SBE 37
CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.002841e+00
h = 1.441625e-01
i = -1.273456e-04
j = 3.208282e-05

CPcor = -9.5700e-08
CTcor = 3.2500e-06
WBOTC = -4.1052e-06

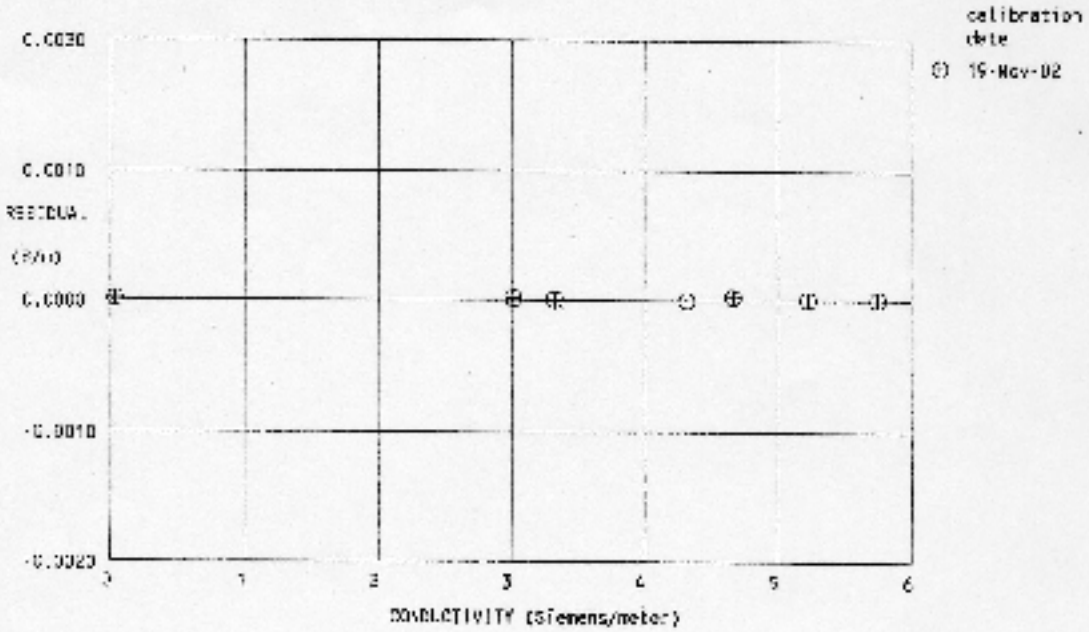
BATH TEMP (ITS-90 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2638.57	-0.00000	-0.00000
1.0000	34.9397	2.98550	5255.38	2.98551	0.00000
4.5000	34.9410	3.29533	5454.89	3.29532	-0.00000
15.0000	34.9420	4.28540	6047.69	4.28539	-0.00001
18.5000	34.9414	4.63317	6242.20	4.63315	0.00001
24.0000	34.9391	5.19487	6544.07	5.19485	-0.00000
29.0000	34.9325	5.71917	6813.39	5.71917	0.00000

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

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

Conductivity = (g + hf^2 + if^3 + jf^4) / (1 + δt + εp) Siemens/meter

Residual = (instrument conductivity - bath conductivity)



SeaCat SBE 37 (Mooring ADP –1)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 2504
CALIBRATION DATE: 19-Nov-02

RTC CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

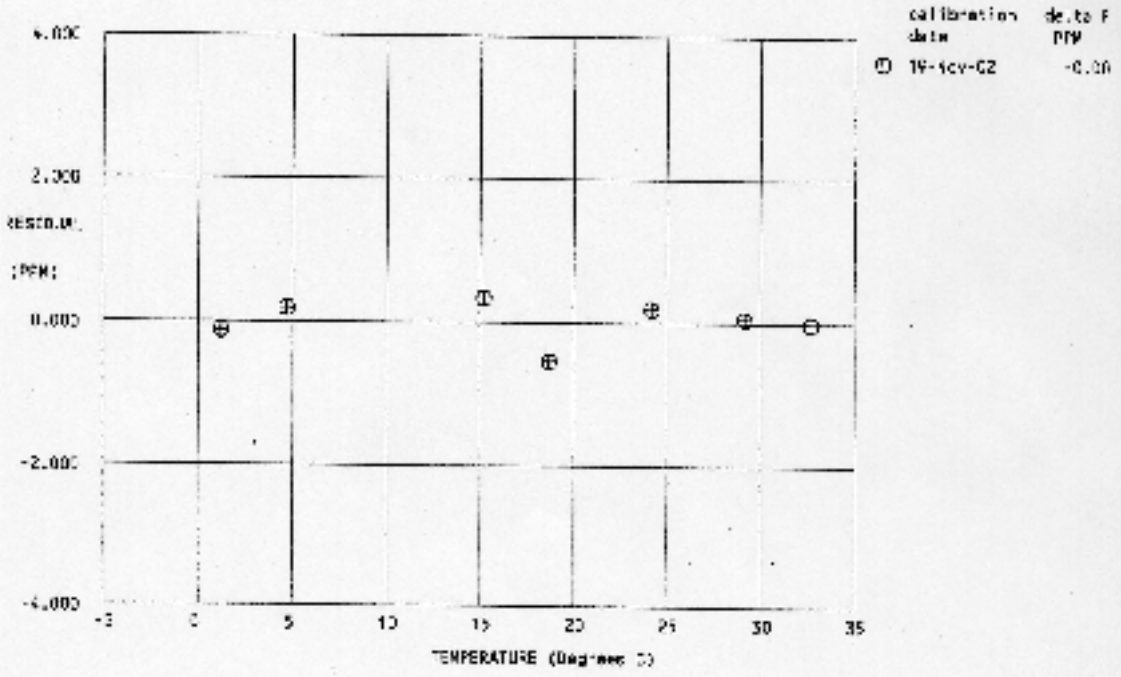
SBE 37 COEFFICIENTS

rtca0 = 9.999842e-01
rtca1 = 1.696467e-06
rtca2 = -3.252424e-08

BATH TEMP (ITS-90 °C)	RTC FREQ	COMPUTED FREQ	RESIDUAL PPM
1.0000	0.9999660	0.9999659	-0.1
4.5000	0.9999910	0.9999912	0.2
15.0000	1.0000020	1.0000023	0.3
18.5000	1.0000050	1.0000044	-0.6
24.0000	1.0000060	1.0000062	0.2
29.0000	1.0000080	1.0000085	0.5
32.4999	1.0000050	1.0000050	-0.0

RTC frequency = a0 + a1 * t + a2 * t^2

Residual = (Computed RTC frequency - Measured RTC frequency) * 1e6



SeaCat SBE 37 (Mooring ADP –1)

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

SENSOR SERIAL NUMBER = 2504
CALIBRATION DATE: 19-Nov-02

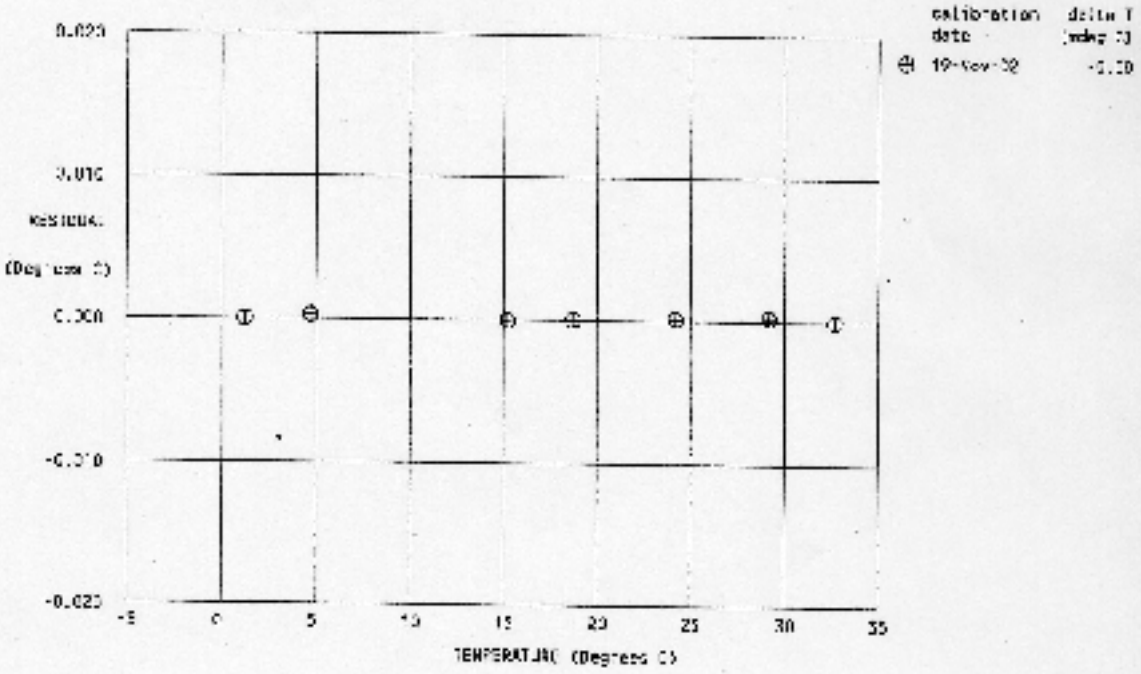
SBE 37
TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

a0 = 1.994457e-04
a1 = 3.114123e-04
a2 = -4.933962e-06
a3 = 2.219492e-07

BATH TEMP (ITS-90 °C)	INSTRUMENT OUTPUT	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
1.0000	720135.4	0.9999	-0.0001
4.5000	617421.6	4.5002	0.0002
15.0000	356604.7	14.9999	-0.0001
18.5000	344275.3	18.5000	0.0000
24.0000	277241.9	24.0001	0.0001
29.0000	229054.7	29.0001	0.0001
32.4999	201052.9	32.4996	-0.0001

Temperature ITS-90 = $1 / \{ a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)] \} - 273.15$ (°C)
Residual = instrument temperature - bath temperature



SeaCat SBE 37 (Mooring ADP –1)

Sea-Bird Electronics, Inc.
Website: http://www.sea-bird.com

SBE Pressure Test Certificate

Test Date: 7/26/02 Description: SBE-37 Microcat

Job Number: 30913 Customer Name: RAYTHEON

SBE Sensor Information:

Model Number: 37
Serial Number: 2505

Pressure Sensor Information:

Sensor Type: Druck
Sensor Serial Number: 2112
Sensor Rating: 2900

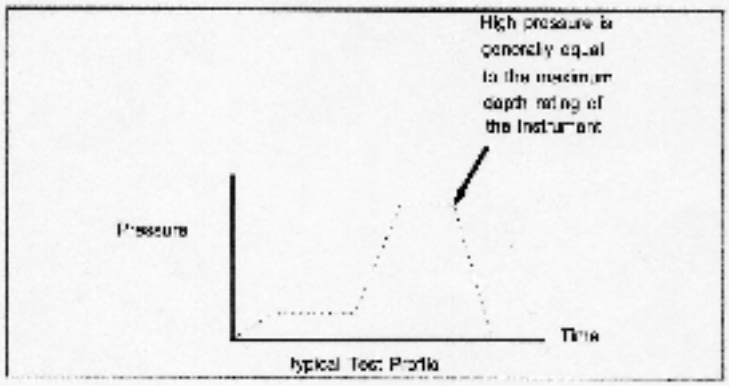
Pressure Test Protocol:

Low Pressure Test: 50 PSI Held For 15 Minutes

High Pressure Test: 2900 PSI Held For 15 Minutes

Passed Test: ✓

Tested By: PCC



SeaCat SBE 37 (Mooring ADP –1)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 2608
CALIBRATION DATE: 07-Aug-03

PRESSURE CALIBRATION DATA
3000 psia S/N 2112

SBE 37 PRESSURE COEFFICIENTS

PA0 = 1.934383e-00
PA1 = 1.268158e-01
PA2 = -4.003317e-08

PTCA0 = 8.675256e-01
PTCA1 = 5.979300e-02
PTCA2 = 1.000941e-01
PTCB0 = 2.503438e-01
PTCB1 = 9.250000e-04
PTCB2 = 0.000000e+00

PRESSURE SPAN CALIBRATION:

PRESSURE PSIA	PERIOD OUTPUT	TEMP (ITS-90 °C)	COMPUTED PRESSURE	ERROR % FSR
14.70	21.5	23.8	14.69	-0.00
614.75	8409.5	23.8	614.75	0.00
1214.81	16605.8	23.8	1214.81	-0.00
1814.88	24815.8	23.8	1814.90	-0.00
2414.96	33038.5	23.8	2415.00	0.01
3014.93	41269.5	23.8	3014.94	-0.00
2414.92	33038.8	23.8	2415.07	0.00
1814.94	24817.2	23.8	1814.96	0.00
1214.84	16607.2	23.8	1214.86	-0.00
614.79	8409.0	23.8	614.81	0.00
14.68	21.6	23.8	14.74	0.00

THERMAL OFFSET:

TEMPERATURE (ITS-90 °C)	PRESSURE OUTPUT
32.50	24.43
28.00	25.51
24.00	29.43
18.50	26.21
15.00	24.20
6.50	18.03
1.00	18.75

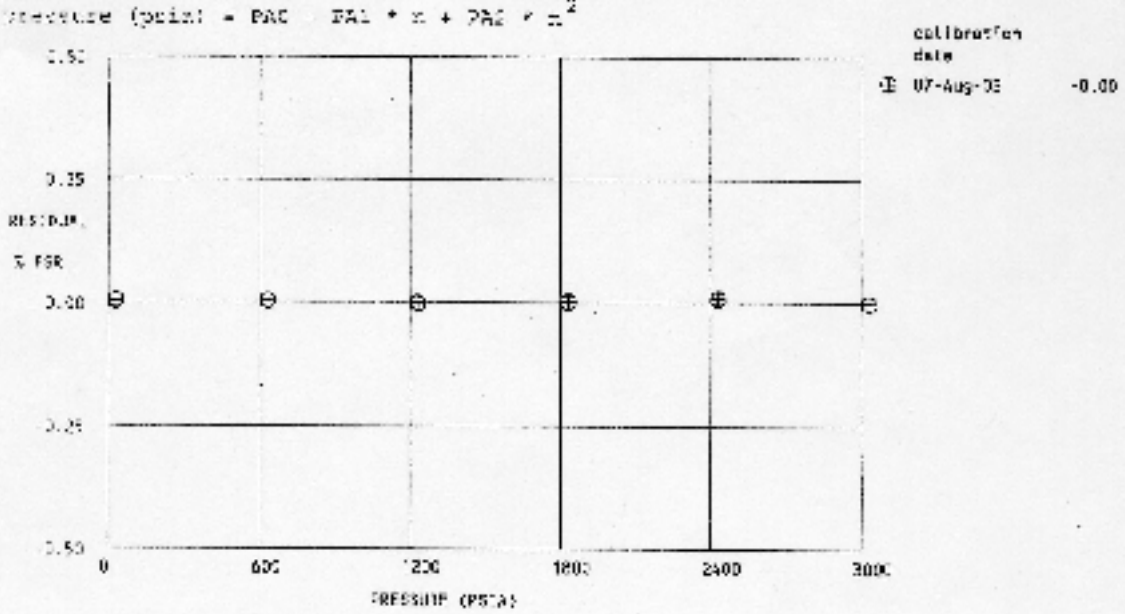
SPAN THERMAL SENSITIVITY:

TEMPERATURE (ITS-90 °C)	SPAN MV
-5.00	25.20
32.00	25.16

x = pressure output = PTCA0 + PTCA1 * t + PTCA2 * t^2

b = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)

Pressure (psia) = PA0 + PA1 * x + PA2 * x^2



SeaCat SBE 37 (Mooring ADP –1)

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER = 2505
CALIBRATION DATE: 20-Nov-02

SBE 37
CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.022073e+00
h = 1.399892e-01
i = -6.800723e-05
j = 2.778102e-05

CPcor = -9.5700e-08
CTcor = 3.2500e-06
WBOTC = -6.1362e-06

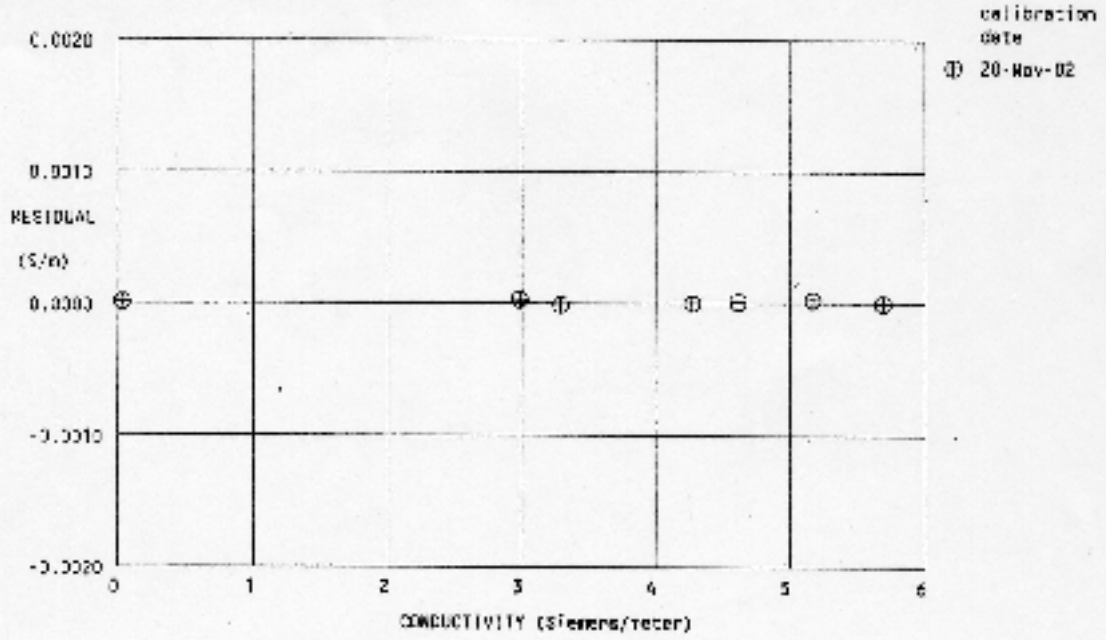
BATH TEMP (ITS 90 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2702.07	-0.00000	-0.00000
0.9995	34.5145	2.95261	5320.55	2.95262	0.00002
4.5001	34.5153	3.25920	5521.09	3.25918	-0.00002
15.0000	34.5192	4.23900	6117.35	4.23899	-0.00001
18.4999	34.5199	4.56326	6313.19	4.56327	0.00000
23.9999	34.5203	5.12943	6617.08	5.12945	0.00003
28.9999	34.5194	5.65913	6898.60	5.65912	-0.00001

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

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

Conductivity = (g + hf^2 + if^3 + jf^4) / (1 + δ + εp) Siemens/meter

Residual = (instrument conductivity - bath conductivity)



SeaCat SBE 37 (Mooring ADP –1)

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

SENSOR SERIAL NUMBER = 2505
CALIBRATION DATE: 20-Nov-02

RTC CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

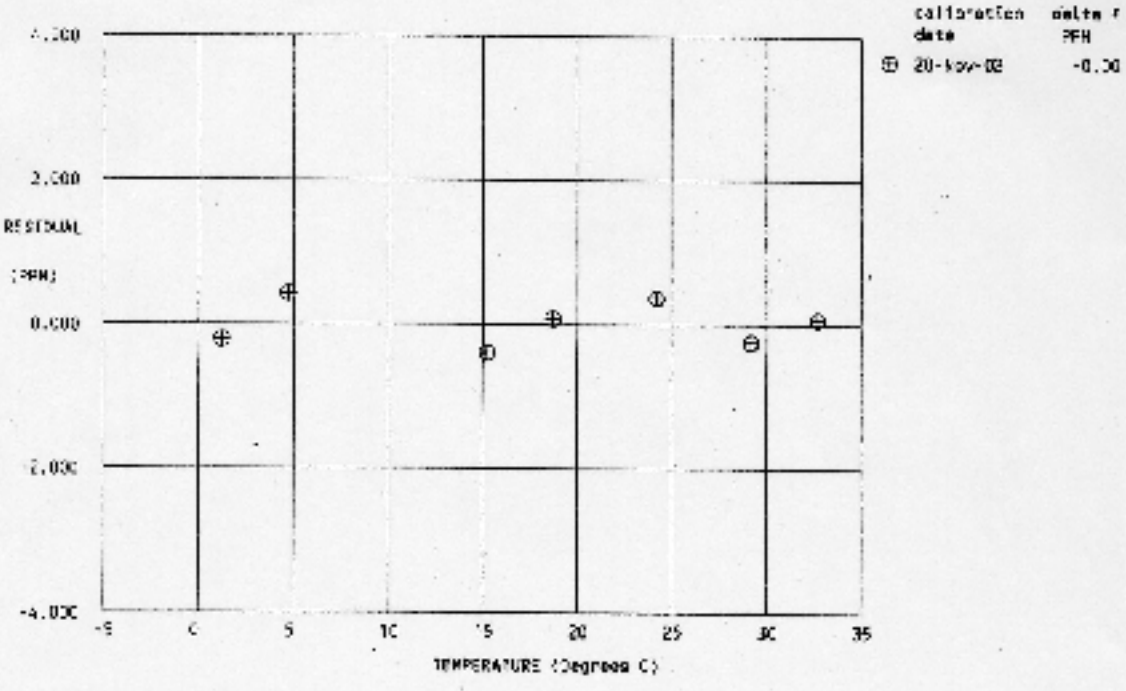
SBE 37 COEFFICIENTS

```
rtca0 =  9.999850e-01
rtca1 =  1.789218e-06
rtca2 = -3.225192e-08
```

BATH TEMP (ITS-90 °C)	RTC FREQ	COMPUTED FREQ	RESIDUAL PPM
0.9999	0.9999870	0.9999868	-0.2
4.9991	0.9999920	0.9999924	0.4
15.0000	1.0000050	1.0000046	-0.4
18.4999	1.0000070	1.0000071	0.1
23.9999	1.0000090	1.0000094	0.4
26.9999	1.0000100	1.0000097	-0.3
32.5000	1.0000090	1.0000091	0.1

RTC frequency = a0 + a1 * t + a2 * t^2

Residual = (Computed RTC frequency - Measured RTC frequency) * 1e6



SeaCat SBE 37 (Mooring ADP –1)

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington 98005 USA
Phone: (425) 643 - 9866 Fax: (425) 643 - 9954 Internet: seacird@seabird.com

SENSOR SERIAL NUMBER = 2505
CALIBRATION DATE: 20-Nov-02

SBE 37
TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

a0 = -4.334549e-03
a1 = 2.864129e-04
a2 = -2.942328e-06
a3 = 1.623143e-07

BATH TEMP (ITS-90 °C)	INSTRUMENT OUTPUT: n	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
0.9999	558699.7	0.9999	0.0000
4.5001	564838.1	4.5000	-0.0001
15.0000	362971.0	15.0000	0.0000
18.4999	315120.0	18.5000	0.0001
23.9999	253812.4	23.9998	-0.0001
28.9999	209725.6	25.9998	-0.0001
32.5000	184096.1	32.5001	0.0001

Temperature ITS-90 = 1 / { a0 + a1[ln(n)] + a2[ln²(n)] + a3[ln³(n)] } - 273.15 (°C)
Residual = instrument temperature - bath temperature