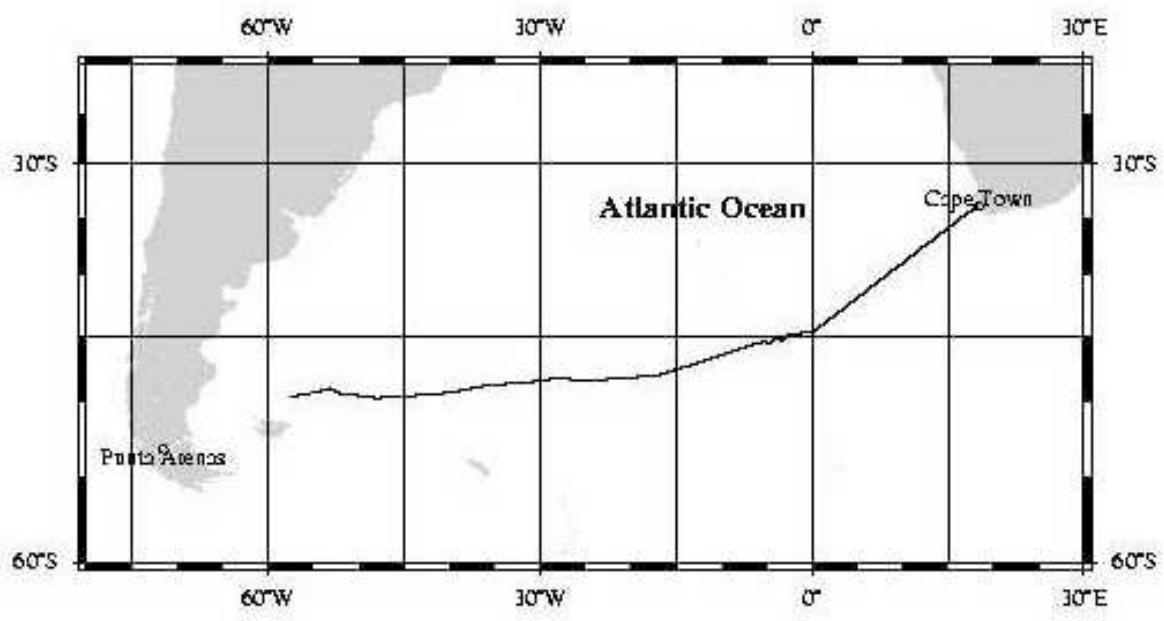
Data Report

NBP0102

Stock

April 1 - April 17, 2001



Raytheon Polar Services Company

April 17, 2001

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Introduction

The NBP data acquisition systems continuously log data from instruments throughout the cruise. This document describes the format of that data and its location on the distribution DAT tapes. It also contains important information which may affect how this data is processed such as instrument failures or other known problems with acquisition.

The data collected during this cruise is distributed on a CD-ROM written in ISO9660 level-1 format. This data format has very strict requirements on filenames and organization. However, it is readable by virtually every computing platform.

The data is contained in a Unix tar archive called NBP0102.tar. All of the data has been compressed using Unix “gzip” compression. Gzipped files have a “.gz” extension. Tools are available on all platforms for uncompressing and de-archiving these formats. On Macintosh, Stuffit Expander with DropStuff will open a tar archive and uncompress gzipped and Unix compressed files. For Windows9X, WinZip, a shareware utility included on this CD (remember, it is shareware) will open these files.

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

Archive Data Extraction

It is often useful to know exactly how an archive was produced when expanding its contents. NBP0102.tar was created on an SGI using the following commands:

```
tar cvf archive-file files-to-be-archived
```

To create a list of the files in the archive:

```
tar tvf  archive-file  > contents.list
```

To extract the files from the archive:

```
tar xvf  archive-file file(s)-to-extract
```

G-zipped files will have a ".gz" extension on the filename. These files can be decompressed after de-archiving, using:

```
gunzip filename.gz
```

The directories in the archive are structured in the following manner:

adcp/
    0102ping.tar
amended/ *corrected data from prior cruises*
    nbp0007b/
    nbp0008/
cals/
    0102tie.xls
    instrcal.txt
    scans of calibration sheets
geopdata/
    0102jgof.tar
    0102proc.tar
    0102bat.tar
    0102grv.tar
    0102mag.tar
    0102nav.tar
    0102qcps.tar *Daily QC plots*
ocean/
    0102pcom.tar
    0102tsgf.tar
    0102xbt.tar
NBP0102.ps
NBP0102.trk
NBP0102.mgd
NBP0102.gmt

NBP0102/
    0102segy.tar *Bathy 2000 SEG-Y Data*
report/
    0102data.doc
    0102data.htm
    0102data.txt
rvdas/
  nav/
    0102adu.tar
    0102adcp.tar
    0102gyr.tar
    0102ngl.tar
    0102pcod.tar
  uw/
    0102bar.tar
    0102bat.tar
    0102eng.tar
    0102grv.tar
    0102mag.tar
    0102met.tar
    0102pco2.tar
    0102svp.tar
    0102syn.tar
    0102tsg.tar

Distribution Contents

ADCP

The ADCP data set is broken up into files representing 24 hours of data collection. The files are named pingdata.xxx (xxx representing a day number). Note that these extensions do NOT represent Julian day numbers. Please refer to 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 in the navigational data section of RVDAS.

Cruise Track

A PostScript cruise track file has been produced for this cruise: NBP0102.ps (US Letter sized 8.5" x 11"). A GMT cruise track file (0102.trk) is also included, which contains the longitude and latitude at one-minute intervals extracted from the NBP0102.gmt file.

NBP Data Products: MGD77 & JGOFS

NBP0102.mgd
NBP0102.gmt
/geopdata/0102jgof.tar
/geopdata/0102proc.tar

Two data products are created on each cruise of the NBP: JGOFS and MGD77.

JGOFS

The JGOFS data set consists of a single file produced each day named jgDDD.dat.gz where DDD is the Julian day the data was acquired. The ".gz" extension indicates that the individual files are compressed before archiving. The daily file consists of 20 separate columnar fields in text format, which are described below. The JGOFS data set is obtained primarily by applying calibrations to raw data and decimating to whole minute intervals. However, 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. Similarly, the wind direction field is the vector sum of the separate X and Y inputs received from the wind instrument. The JGOFS data set was used to produce the daily data plots during the cruise. *Note: Null, unused, or unknown fields are filled with 9's in the JGOFS data. TSG data is processed by RVDAS.*

Field	Data	Units
01	GMT date	dd/mm/yy
02	GMT time	hh:mm:ss
03	NGL latitude (negative is South)	dd.dddd
04	NGL longitude (negative is West)	ddd.dddd
05	speed over ground	Knots
06	GPS HDOP	-
07	Gyro Heading	Degrees (azimuth)
08	course made good	Degrees (azimuth)
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)

Field	Data	Units
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 named NBP0102.mgd, There is also a file named NBP0102.gmt. This file is the output of the mgd77togmt utility using NBP0102.mgd as input. The "gmt" file can be useful for plotting data using the GMT plotting package. The archive /geopdata/0102proc contains a file from each day of data acquisition named: Dddd.fnl.gz, where ddd is the Julian day. These files contain all the data used to produce the "mgd" file, but in a space-delimited columnar format that may be more accessible for some purposes. In addition, these files contain data at one-second intervals rather than one minute and are individually "gzipped" to save space. Below is a detailed description of the MGD77 data set format.

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

Col	Len	Type	Description
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: equals zero when time is GMT.
15-16	2	int	YEAR 2 digit year
17-18	2	int	MONTH (e.g. May is represented as 05)
19-20	2	int	DAY Day of month
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 TRAVELTIME: In 10,000th of seconds. Corrected for transducer depth and other such corrections
52-57	6	real	BATHYMETRY, CORRECTED DEPTH: In tenths of meters.
58-59	2	int	BATHYMETRIC CORRECTION CODE: This code details the procedure used for determining the sound velocity correction to depth
60	1	int	BATHYMETRIC TYPE CODE: 1 = Observed; 3 = Interpolated (Header Seq. 12); 9 = Unspecified
61-66	6	real	MAGNETICS TOTAL FIELD, 1^{ST} SENSOR: In tenths of nanoteslas (gammas).
67-72	6	real	MAGNETICS TOTAL FIELD, 2^{ND} SENSOR: In tenths of nanoteslas (gammas). For trailing sensor.
73-78	6	real	MAGNETICS RESIDUAL FIELD: In tenths of nanoteslas (gammas). The reference field used is in Header Seq. 13.
79	1	int	SENSOR FOR RESIDUAL FIELD 1 = 1^{st} or leading sensor; 2 = 2^{nd} or trailing sensor; 9 = Unspecified
80-84	5	real	MAGNETICS DIURNAL CORRECTION: In tenths of nanoteslas (gammas). (In nanoteslas) if 9-filled (i.e., set to "+9999"), total and residual fields are assumed to be uncorrected; if used, total and residuals are assumed to have been already corrected.
85-90	6	F6.0	DEPTH OR ALTITUDE OF MAGNETICS SENSOR: In meters. + = Below sea level 3 = Above sea level
91-9	7	real	OBSERVED GRAVITY: In 10^{th} of mgals. Corrected for Eotvos, drift, tares.
98-10	6	real	EOTVOS CORRECTION: In tenths of mgals.

Col	Len	Type	Description
			E = 7.5 V cos phi sin alpha + 0.0042 V*V
104-108	5	real	FREE-AIR ANOMALY In tenths of milligals Free-air Anomaly = G(observed) – G(theoretical)
109-113	5	char	SEISMIC LINE NUMBER: Used for cross-referencing with 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

RVDAS

rvdas/uw
rvdas/nav

RVDAS (Research Vessel Data Acquisition System) was developed at Lamont-Doherty Earth Observatory of Columbia University and has been used on the R/V Maurice Ewing for several years. It was adapted for use on the Nathaniel B. Palmer and her sister ship, the R/V Laurence M. Gould.

Daily data processing of the RVDAS data is performed to convert values into usable units and as a check of the proper operation of the DAS. Both the raw and processed data sets from RVDAS are included in the data distribution. Below you will find detailed information on the data included. Be sure to read the "Significant Acquisition Events" section below for important information about data acquisition during this cruise.

Meteorological and Light Data

Measurement	File ID	Collect. Status	Rate	Instrument
Air Temperature	met1	continuous	0.5 sec	R. M. young 41342C
Relative Humidity	met1	continuous	0.5 sec	Rotonics MP-101A-C4
Wind Speed/Direction	met1	continuous	0.5 sec	Belfort Model 5-122AHD
PIR (LW radiation)	met1	continuous	0.5 sec	Eppley PIR
PSP (SW radiation)	met1	continuous	0.5 sec	Eppley PSP
PAR	met1	not functioning	0.5 sec	BSI QSR-240
Barometer	bar1	continuous	9 sec	AIR-DB-3A

Navigational Data

Measurement	File ID	Collect. Status	Rate	Instrument
Attitude GPS	3df1	continuous	1 sec	Ashtec 12
P-Code GPS	PCOD	continuous	1 sec	Trimble 20636-00SM
Gyro	gyr1	continuous	0.2 sec	Yokogawa Gyro
NGL	ngl1	continuous	1 sec	NGL Processed Nav Data

Geophysical Data

Measurement	File ID	Collect. Status	Rate	Instrument
Gravimeter	grv1	continuous	10 sec	Lacoste & Romberg Gravity
Magnetometer	mag1	continuous	15 sec	EG&G G-866
Bathymetry	bat1	continuous	Varies	ODEC Bathy 2000
Bathymetry	sim1	depth < 2500 m	Varies	Simrad EK200 Sonar

Oceanographic Data

Measurement	File ID	Collect. Status	Rate	Instrument
Conductivty	tsg1	continuous	15 sec	SeaBird 21
Salinity	tsgfl	continuous	15 sec	calculated from conductivity
Sea S Temperature	tsg1	continuous	15 sec	SeaBird 3-01/S
Fluorometry	flr1 & tsg1	continuous	15 sec	Turner 10-AU-005
pCO_2	pco2	continuous	70 sec	
ADCP	adcp	continuous	1 sec	RD Instruments

Data File Names and Structures

RVDAS data is divided into two broad categories, ***Underway*** and ***Navigation***. The groups are abbreviated "uw" and "nav". Thus, these two subdirectories exist under the top-level rvdas directory. The instruments are broken down as shown. Each data file is g-zipped to save space on the distribution. Not all data types are collected everyday or on every cruise.

RVDAS data files are named following the convention: NBP[CruiseID][ChannelID].dDDD.

- The CruiseID is the numeric name of the cruise, for example: NBP0102.
- The FileID (aka Channel ID) is a 4-character code representing the system being logged, for example: met1 (for meteorology)
- DDD is the Julian day of the data collection

Underway Data	Channel ID
Barometer	bar1
Bathy 2000	bat1
Fluorometer	flr1
Gravimeter	grv1
Magnetometer	mag1
Meteorological	met1
Simrad	sim1
Thermosalinograph	tsg1
pCO_2	pco2

Navigation Data	Channel ID
Ashtech GPS	3df1
Trimble GPS (P-Code)	PCOD
Gyro Compass	gyr1
Furuno GPS	gp02
NGL	ngl1
ADCP course	adcp

Data is received by the RVDAS system via RS-232 serial connections. The data files that comprise the rvdas data set are described below. A time tag is added to each line of data received and the data is written to disk.

```
YY+DDD:HH:MM:SS.SSS [data stream from instrument]
```

Where, YY: two-digit year, DDD: Julian Day, HH: 2 digit hours, MM: 2 digit minutes SS.SSS: seconds. All times are UTC.

The delimiters used to separate fields in the raw data files are usually spaces and commas, but other delimiters are used (::, =, @) and occasionally there is no delimiter. Care should be taken when reprocessing the data that the fields separations are clearly understood. An example data

bar1

```
00+019:23:59:57.441  963.25
```

Field	Data	Units
1	Time Tag	
2	Pressure	mBar

bat1

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

Field	Data	Units
1	RVDAS Time Tag	
2	Flagged Low Freq. Chn. Depth w/ units ;FDDDDD.DUN F= V valid, I invalid	meters
3	Low Freq. Echo Strength EEE.EE	dB
4	Flagged High Freq. Chn. Depth – unused	
5	High Freq. Echo Strength – unused	
6	Signed Heave Data SHHHH	cm
7	Date	mm/dd/yy
8	Time	hh:mm:ss
9	transmit pulse window type: PW1 Rectangular, PW2 Hamming, PW3 Cosine, PW4 Blackman	

Field	Data	Units
10	Primary transmit frequency PF1 3.5 kHz, PF2 12.0 kHz	
11	Parametric mode secondary freq. SF1 3.5 kHz, SF2 12.0 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	
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 mulitpinging TTTTRRRR, TX7 mulitpinging TTTTTRRRRR	
17	Transmit Rate: TR3 4Hz, TR4 2Hz, TR5 1Hz, TR6 .5Hz, TR7 .33Hz, TR8 .25Hz, TR9 .20Hz, TR: = .10Hz, TR; = .05Hz	
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

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	

grv1

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

Field	Data	Units	Conversion
1	RVDAS Time Tag		
2	text string		
3	gravity device date	yyyyjjjhhmmss	
3	gravity count	count	mgal = count x 1.0047 + offset

knud

```
99+099:00:18:19.775 hf,305.2,lf,304.3
```

Field	Data	Units
1	RVDAS Time Tag	
2	hf – high frequency flag (12 kHz)	
3	high fequency depth	meters
4	lf – low frequency flag (3.5 kHz)	
5	low frequency depth	meters

mag1

```
99+099:00:00:23.203 %  0  98 235928    0?372453
```

Field	Data	Units
1	RVDAS Time Tag	

Field	Data	Units
2	% 0 denotes G-866 magnetometer	
3	Julian Day	
4	Time	
5	0? denotes high noise condition	
6	Magnetic Data (last digit is 10^{th}'s place)	nT

met1

```
00+019:23:59:59.761 $MET:  0.84, 1.12, 0.76, 1.06, 4.98, 0.26, 1.49, 3.93, 8.94, 0.80, 0.01,
0.01, 0.01, 0.22, 0.02, 0.1,40.11,4.96
```

Field	Data	Units	Conversion
1	RVDAS Time Tag		
2	$MET		
3	starboard windbird north rel. speed vector voltage	V	m/s = 7.553 x voltage
4	starboard windbird east rel. speed vector voltage	V	m/s = 7.553 x voltage
5	Port windbird north rel. speed vector voltage	V	m/s = 7.553 x voltage
6	Port windbird east rel. speed vector voltage	V	m/s = 7.553 x voltage
7	Air temperature	V	°C = 10 x voltage - 50
8	PIR Eppley Pyrgeometer	V	W/m^2 = 923.87 x voltage
9	PSP Eppley Pyranometer	V	W/m^2 = 194.53 x voltage
10	Temperature at the Relative Humidity Sensor	V	°C = 10 x voltage – 40
11	Relative Humidity	V	%RH = 10 x voltage
12	PAR Irradiance	V	$\mu Ei/m^2s$ = 1662.24 x voltage
13-17	spare channels		
18	AC line voltage	V	VAC = 150 x voltage
19	uMac Temperature	C	
20	uMac DC Supply	V	

pCO_2

```
00+021:23:59:43.190 2000021.9992 2382.4 984.2 30.73 50.8 345.9 334.1 -1.70 -68.046 -144.446 Equil
```

Field	Data	Units
1	RVDAS Time Tag	
2	pCO_2 Time Tag (decimal is time of day)	yyyjdd.fod
3	raw voltage	mV
4	barometer	mBar
5	cell temperature	°C
6	flow rate	cm^3/min
7	concentration	ppm
8	pCO_2 pressure	microAtm
9	Equilibrated temperature	°C
10	Latitude	degrees
11	Longitude	degrees
12	Flow Source (Equil = pCO_2 measurement)	

sim1

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

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

stc1

```
00+019:23:59:46.976 ##ryyyydddhhmmssuuuuuuSSCC

00+347:00:00:05.013 ##BFFFF3470000049568311529
```

Field	Data	Units
1	RVDAS Time Tag	
2	r is the input time code "B" for IRIG-B	
3	yyyy is the year (FFFF if IRIG input)	
4	ddd is the 3 digit day of the year	
5	hh is 2 digit hour of day	
6	mm is 2 digit minute of hour	
7	ss is 2 digit second of minute	
8	uuuuuu is 6 digits for microseconds digits	
9	SS is 2 hex character DP-Extd_Sts dual port RAM value	
10	CC is checksum	

svp1

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

Field	Data	Units
1	RVDAS Time Tag	
2	Sound velocity	m/s

syn1

```
00+120:10:46:30.665 *GCS900228     005   811.00001E00/04/29:10:45:5311060600000000403000-
0.050.023    00000000-00101AP1N 000156498-0100002AP1N 000163501001000003AP1N 000162497-0200004AP1N
0001585000000000 5AP1N 000155501001000006AP1N 000157500000000
```

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

tsg1

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

Field	Data	Units
1	RVDAS Time Tag	
2	Seabird Hex string (see notes on converting to real units)	

adu

PBEN: Measurement Data

```
00+019:23:59:57.054 $PASHR,PBN,345609.00,-1695527.0,-1569301.4,-5925126.0,-068:49.6968,-
137:12.8448,00047.7,-000.69,000.67,-000.51,08,????,02,01,02,01*32
```

Field	Data	Units
1	RVDAS Time Tag $PASHR	
2	PBN	
3	GPS Time sec. of the week	seconds
4	Station Postion: ECEF X	meters
5	Station Postion: ECEF Y	meters
6	Station Postion: ECEF Z	meters
7	Latitude (- = South)	deg:min
8	Longitude (- = West)	deg:min
9	altitude	meters
10	velocity in ECEF X	m/sec
11	velocity in ECEF Y	m/sec

Field	Data	Units
12	velofity in ECEF Z	m/sec
13	number of satellites used	
14	site name	
15	PDOP	
16	HDOP	
17	VDOP	
18	TDOP	

ATTD: Attitude Data

```
00+019:23:59:57.854 $PASHR,ATT,345610.0,252.82,+000.52,+001.95,0.0011,0.0068,0
```

Field	Data	Units
1	RVDAS Time Tag $PASHR	
2	ATT	
3	GPS Time sec. of the week	seconds
4	heading (rel. to true North)	degrees
5	pitch	degrees
6	roll	degrees
7	Measuremnet RMS error	meters
8	Baseline RMS error	meters
9	attitude reset flag	

GGA: GPS Position Fix – Geoid/Ellipsoid

```
00+019:23:59:57.134 $GPGGA,235956.00,6849.6968,S,13712.8448,W,1,08,01.0,+00048,M,,M,,
```

Field	Data	Units
1	RVDAS Time Tag $GPGGA	
2	UTC time at position	hhmmss.ss
3	Latitude	ddmm.mmm
4	North (N) or South (S)	
5	Longitude	ddmm.mmm
6	East (E) or West (W)	
7	GPS quality (1=GPS 2=DGPS)	
8	Number of GPS satellites used	
9	HDOP	
10	Antenna Height	meters
11	M for Meters	
12	Geoidal height	meters
13	M for meters	
14	age of diff. GPS data	
15	differential reference station ID	

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	

ngl1

```
00+019:23:59:59.857 -68.82822,-137.21416,1.10,279.27,251.10,0.00,0.00,0,18.2587,1,1146973
```

Field	Data	Units
1	RVDAS Time Tag	

Field	Data	Units
2	Latitude (south is negative)	degrees
3	Longitude (west is negative)	degrees
4	Ship Speed	knots
5	Course made good	degrees
6	Gyro Heading	degrees
7	PDOP	
8	HDOP	
9	quality	
10	GPS up	
11	Fix Number	

PCOD

GGA: GPS Position Fix – Geoid/Ellipsoid

```
00+019:23:59:59.301 $GPGGA,235958.409,6849.6944,S,13712.8472,W,1,06,1.2,092.4,M,047.3,M,,*67
```

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 (1=GPS 2=DGPS 3=P-CODE)	
9	Number of GPS satellites used	
10	HDOP	
11	Antenna Height	meters
12	M for Meters	
13	Geoidal height	meters
14	M for meters	
15	age of diff. GPS data	
16	differential reference station ID	
17	checksum	

GLL: GPS Latitude/Longitude

```
00+019:23:59:59.381 $GPGLL,6849.6944,S,13712.8472,W,235958.409,A*35
```

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

VTG: GPS Track and Ground Speed

```
00+019:23:59:59.382 $GPVTG,238.7,T,182.3,M,001.8,N,003.3,K*41
```

Field	Data	Units
1	RVDAS Time Tag	
2	$GPVTG	
3	Heading	degrees
4	degrees True (T)	

Field	Data	Units
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	

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	degrres

Ocean Data Files

ocean/

pCO2-merged

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

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

tsgfl

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

Field	Data	Units
1	RVDAS Time Tag	
2	Internal water temperature	°C
3	Sea Surface Temperature	°C

Field	Data	Units
4	Conductivity	μSiemens
5	Salinity	PSU
6	Fluorometry	V
7	unused	

xbt

During the cruise Expendable Bathythermographs were used to obtain water column temperature profiles. These were used to adjust the sound velocity profile for the SeaBeam system. The data files from these launches are included.

PROCESSING NOTES

TSG

Raw TSG data is stored as a hex string 20 bytes long.

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

In all of the formulas listed below, the variables can be found in the TSGcal file.

Calculating Temperature

```
T = decimal equivalent of bytes 1-4
Temperature Frequency:  f = T/19 +2100
q = ln(fo/f)
Temperature = 1/{a + b * q + c * q2 + d * q3} -273.15 (degrees C)
```

Calculating Conductivity

```
C = decimal equivalent of bytes 5-8
Conductivity Frequency f = sqrt(C*2100+6250000)
Conductivity = (afm +bf2 +c +dt)/[10(1+ep)] (siemens/meter)
note e = epsilon in the TSGcal file
```

Calculating Fluorometry Voltage

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

PSP

raw data = V
calibration scale = 8.31×10^{-6} V/(W/m^2)
signal conditioner1 = 309.3
signal conditioner2 = 2
V / (scale x conditioner1 x conditioner2) = W/m^2
or
V x 194.53 (W/m^2)/V = W/m^2

PIR

raw data = V
calibration scale = 3.52×10^{-6} V/(W/m^2)
signal conditioner1 = 307.5
signal conditioner2 = 1
V / (scale x conditioner1 x conditioner2) = W/m^2
or
V x 923.87 (W/m^2)/V = W/m^2

NBP0102 Sensors

Shipboard Sensors

Sensor	Description	Serial #	Cal. Date	Status
Port Anemometer	Belfort 5-122AHD	7956	4/1/00	collect
Stbd Anemometer	Belfort 5-122AHD	7957	4/2/00	collect
Barometer	Atmospheric Instr. AIR-DB-3A	7G3095	7/21/00	collect
Mast PRR	BSI PRR-610	9696	3/18/99	not collect
UW PRR	BSI PRR-600	9695	3/18/99	not collect
Rel. Hum./Air Temp	Rotronics MP-101A-C4	R45618	6/20/00	collect
Mast PAR	BSI QSR-240	6357	1/4/01	failed
P-Code GPS	Trimble 20636-00 (SM)			PCD/CIV
Attitude GPS	Ashtech 12	700273F2114 FW 7B13-D1-C21		collect
Pyranometer	Eppley PSP	33090F3	11/7/00	collect
Pyrgeometer	Eppley PIR	33023F3	6/23/00	collect
Dry Air Temp	R. M. Young 41342C	1645	2/09/00	collect
TSG	SeaBird SBE21	218091-1390	11/20/99	collect
TSG Remote Temp	SeaBird 3-01/S	32593	81/03/01	collect
Fluorometer	Turner 10-AU-005 Lamp: daylight 10-045, reference filter: 10-052, emission filter: 10-051, excitation filter: 10-050.	5651 FRTD		collect
Magnetometer	EG&G G-866			collect
Gravimeter	Lacoste & Romberg Gravity Meter			collect
Bathymetry	Simrad EK200	3001	11/1/95	collect
Bathymetry	Bathy 2000			collect

Acquisition Problems and Events

This section lists all known problems with acquisition during this cruise including instrument failures, data acquisition system failures and any other factor affecting this data set. The format is jjj:hh:mm (jjj is julian day, hh is hour, and mm is minute). All times are in GMT.

Start	End	Event
01+092:14:20		started logging at 200 mi limit
01+092:17:30	01+093:00:03	NGL crashed
01+093:23:55	01+094:00:01	stopped gravity logger to change calibration constant
01+098:10:08	01+094:10:37	ECO shut off power in hydrolab to fix AC outlets, shut off TSG and pCO2
	01+094:12:20	pCO2 system did not come back up cleanly, had to power cycle the IR box
01+102	01+102	problems with deck box caused several outages during the day, swapping of deck box fixes problem
01+105:14:10		end logging at 200 mi limit

Calibrations

Installed 12/14/99 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 = 1390
CALIBRATION DATE: 20-Nov-99

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

GHIJ COEFFICIENTS

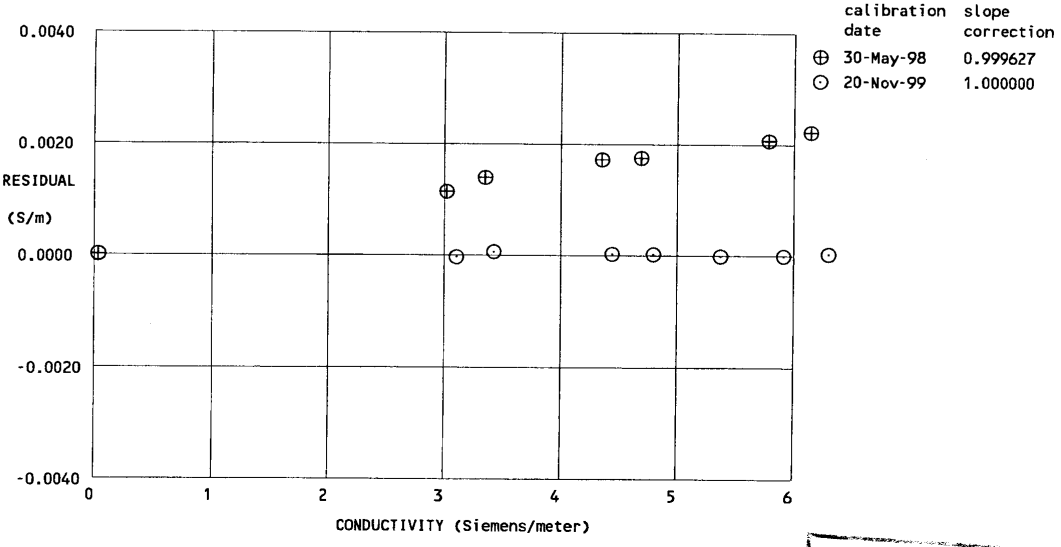
g = -3.93202500e+00
h = 4.70256307e-01
i = 7.32400918e-04
j = -1.40591115e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

ABCDM COEFFICIENTS

a = 1.47556503e-02
b = 4.52645265e-01
c = -3.91849365e+00
d = -9.05554567e-05
m = 2.2
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)
22.0000	0.0000	0.00000	2.88550	0.00000	0.00000
1.0000	36.0948	3.07458	8.53995	3.07454	-0.00004
4.5000	36.0923	3.39296	8.92178	3.39301	0.00005
15.0000	36.0872	4.41063	10.04412	4.41064	0.00001
18.4999	36.0860	4.76818	10.40948	4.76819	0.00001
23.9999	36.0835	5.34578	10.97375	5.34576	-0.00002
29.0000	36.0788	5.88528	11.47555	5.88526	-0.00002
32.5000	36.0722	6.26964	11.81996	6.26966	0.00002

Conductivity = $(g + hf^2 + if^3 + jf^4) / [10(1 + \delta t + \epsilon p)]$ Siemens/meter
Conductivity = $(af^m + bf^2 + c + dt) / [10(1 + \epsilon p)]$ Siemens/meter
t = temperaure [deg C]; p = pressure [decibars]; δ = CTcor; ϵ = CPcor;
Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



POST CRUISE CALIBRATION

Installed 12/14/99

TSG Internal

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 = 1390
CALIBRATION DATE: 20-Nov-99

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.19943404e-03
h = 6.02868891e-04
i = 5.34296192e-06
j = -1.77943713e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.64763555e-03
b = 5.88552771e-04
c = 1.03072229e-05
d = -1.77889932e-06
f_0 = 2522.389

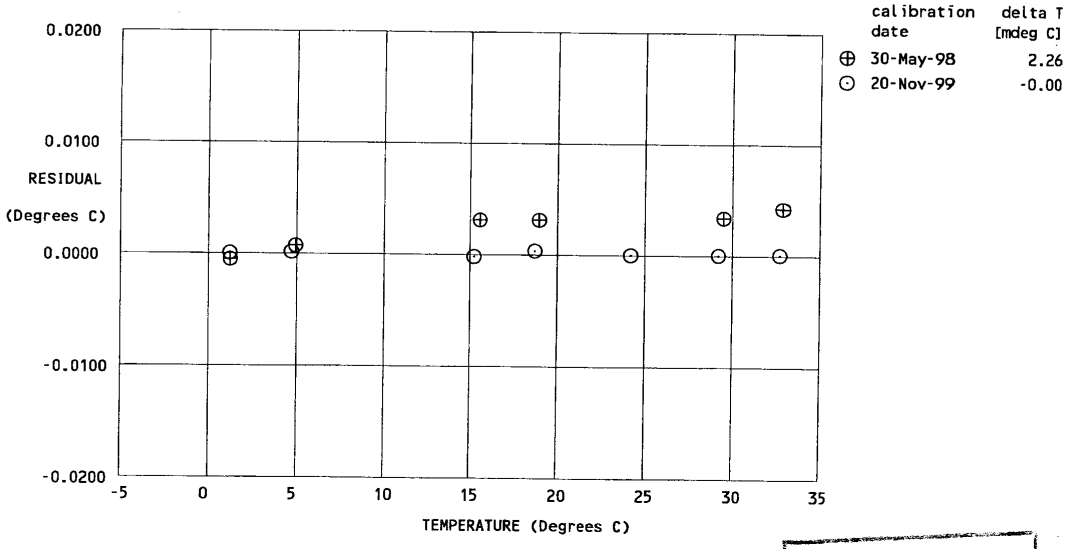
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
1.0000	2522.389	1.0000	-0.00004
4.5000	2727.711	4.5001	0.00009
15.0000	3414.661	14.9997	-0.00026
18.4999	3668.526	18.5002	0.00027
23.9999	4093.784	23.9998	-0.00005
29.0000	4509.404	29.0000	-0.00002
32.5000	4817.316	32.5000	0.00001

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



POST CRUISE CALIBRATION

TSG extend

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 = 2593
CALIBRATION DATE: 03-Jan-01s

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.27987204e-03
h = 6.19581534e-04
i = 2.06356990e-05
j = 1.60635055e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.67988692e-03
b = 5.83301097e-04
c = 1.58473443e-05
d = 1.60775530e-06
f_0 = 2715.661

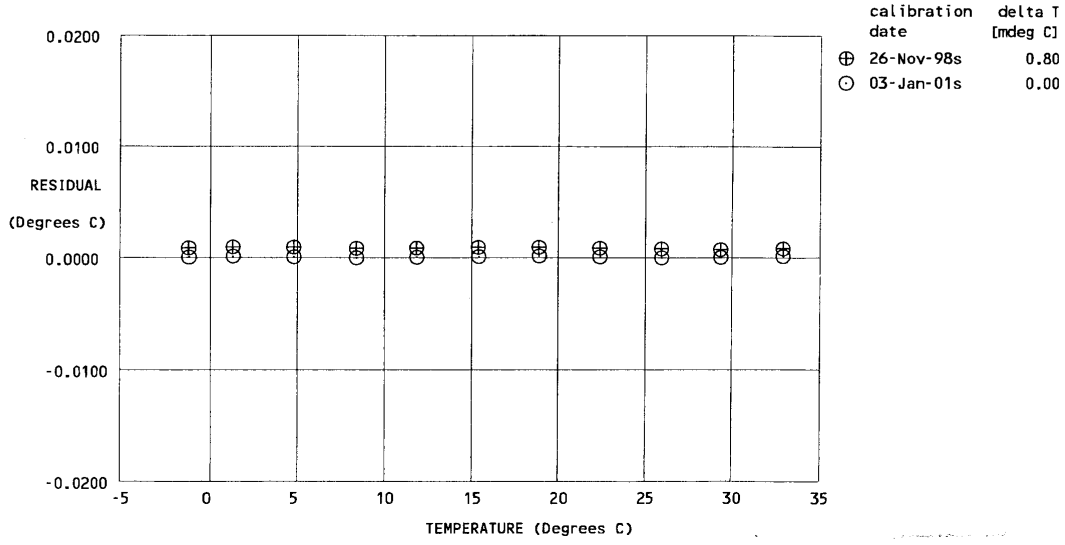
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
-1.4022	2715.661	-1.4022	-0.00002
1.1071	2877.328	1.1072	0.00005
4.5999	3113.969	4.5999	0.00001
8.1982	3372.323	8.1981	-0.00007
11.6315	3633.030	11.6314	-0.00003
15.1880	3918.156	15.1881	0.00003
18.6926	4214.514	18.6926	0.00008
22.1918	4526.070	22.1918	0.00002
25.7512	4859.455	25.7512	-0.00007
29.1661	5195.287	29.1660	-0.00004
32.6976	5559.429	32.6976	0.00005

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



rotronic
instrument corp

160 E. Main Street, Huntington, NY 11743 • 516-427-3898 • FAX 516-427-3902 • 1-800-628-7101 • http://www.rotronic-usa.com

CERTIFICATE OF TEMPERATURE CALIBRATION

Model : MP101A
Serial # : 45618

In reference to the values published in standard DIN 43760, the manufacturer of the Pt100 RTD used in this instrument has specified a maximum tolerance of +/- 0.2 Deg. C, both at 0 and 100 Deg. C.

The measuring circuit of this instrument has been electronically tested with a Pt100 simulator with an accuracy of 0.1% in reference to the values of standard DIN 43760. This instrument was also placed in a ventilated tunnel having a minimum air velocity of 180 Ft/min. and calibrated against a certified thermometer traceable to the National Institute of Standards and Technology..

Based on the above procedure, the accuracy of this unit has been found to be as follows:

	Reference	Reading	Correction
Simulator :	-25.0	-25.0	0.0
	0.0	0.0	0.0
	25.0	25.0	0.0
	50.0	50.0	0.0
Thermometer :	29.5	29.1	0.4

Note: Temperatures Values in Deg.C

By: _____ Date:6/20/2000

ROTRONIC Instrument Corp.

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instrument corp

160 E. Main Street, Huntington, NY 11743 • 516-427-3898 • FAX 516-427-3902 • 1-800-628-7101 • http://www.rotronic-usa.com

CERTIFICATE OF HUMIDITY CALIBRATION

Model : MP101A
Serial # : 45618

This instrument was placed in a ventilated tunnel having a minimum air velocity of 180 Ft/min. and calibrated against two reference instruments.

Calibration of the reference instruments was both with saturated salt solutions and with a certified chilled mirror instrument, traceable to the National Institute of Standards and Technology (NIST). A certified, traceable thermometer was used to monitor temperature. The %RH values of the saturated salt solutions were taken from the tables published by the National Bureau of Standards (now NIST), L. Greenspan, Journal of Research, Vol. 81A, January - February 1977. Details regarding calibration with saturated salt solutions may be found in ASTM standard E104-85.

Based on the above procedures, the accuracy of this instrument has been found to be as follows:

Reference	Reading	Correction
35.0	35.0	0.0
80.0	80.0	0.0
0.3	0.3	0.0

Note: Humidity Values in %RH.

By: _____ Date:6/20/2000

ROTRONIC Instrument Corp.

Belfort Wind Vector Transmitter Calibration

Serial # 7956
Calibration Date: 04/01/00
Calibration By: Craig Huhta

Comments: Original voltage measurements were 0.788, 1.805 and 3.55 volts prior to adjusting calibration screw.

Generator Outputs

Calibration Date: 04/01/00

Shaft Speed RPM	Theoretical Volts	Actual Volts	Error Volts	Tolerance Volts
140.5	0.81	0.815	0.00	+/-0.05
321.7	1.86	1.854	0.00	+/-0.05
634.9	3.66	3.65	0.01	+/-0.05
0	0.00	0	0.00	+/-0.05
0	0.00	0	0.00	+/-0.05

Used to convert RPM to Voltage		
	RPM	Voltage
High	1800	10.37
Low	180	1.04

Sine-Cosine Potentiometer Outputs

Reference Voltage Input: 5.18
Calibration Date: 04/01/00

Cosine Output Voltages

Azimuth Degrees	Theoretical Volts	Actual Volts	Error +/-0.13
0	2.59	2.58	0.01
15	2.5	2.57	-0.07
30	2.24	2.23	0.01
45	1.83	1.76	0.07
60	1.3	1.24	0.06
75	0.67	0.63	0.04
90	0	-0.05	0.05
105	-0.67	-0.73	0.06
120	-1.3	-1.34	0.04
135	-1.83	-1.9	0.07
150	-2.24	-2.26	0.02
165	-2.5	-2.49	-0.01
180	-2.59	-2.52	-0.07
195	-2.5	-2.5	0
210	-2.24	-2.22	-0.02
225	-1.83	-1.82	-0.01
240	-1.3	-1.29	-0.01
255	-0.67	-0.69	0.02
270	0	-0.07	0.07
285	0.67	0.64	0.03
300	1.3	1.28	0.02
315	1.83	1.83	0
330	2.24	2.25	-0.01
345	2.5	2.51	-0.01

Cosine RMS Error* 0.04113

***not to exceed 0.05v**

Sine Output Voltages

Azimuth Degrees	Theoretical Volts	Actual Volts	Error +/-0.13
0	0	-0.05	0.05
15	0.67	0.57	0.1
30	1.3	1.23	0.07
45	1.83	1.84	-0.01
60	2.24	2.27	-0.03
75	2.5	2.53	-0.03
90	2.59	2.58	0.01
105	2.5	2.52	-0.02
120	2.24	2.18	0.06
135	1.83	1.75	0.08
150	1.3	1.2	0.1
165	0.67	0.6	0.07
180	0	-0.06	0.06
195	-0.67	-0.75	0.08
210	-1.3	-1.34	0.04
225	-1.83	-1.82	-0.01
240	-2.24	-2.22	-0.02
255	-2.5	-2.47	-0.03
270	-2.59	-2.52	-0.07
285	-2.5	-2.52	0.02
300	-2.24	-2.27	0.03
315	-1.83	-1.89	0.06
330	-1.3	-1.35	0.05
345	-0.67	-0.69	0.02

Sine RMS Error*

Replaced Sin-Cos pot and calibrated on ship 4/4/99

K. Bliss

BELFORT INSTRUMENT COMPANY
727 S. WOLFE ST.
BALTIMORE, MD 21231

14560D
PAGE 1 OF 2

INSPECTION REPORT
INDIVIDUAL

INSTRUMENT: WIND VECTOR TRANSMITTER — NSN 6660-01-130-8590
CAT. NO. 5-122 SERIES TYPE "N", PN [illegible]3 — PAT. SPEC. FAAD-F-1330
BELFORT ENG. SPEC. #14559 — CONTRACT NO. _____

VISUAL AND MECHANICAL INSPECTION I.A.W. (PAR. 2)
PER MIL-STD-454, REQUIREMENT 9
SATISFACTORILY COMPLETED YES ____ NO

GENERATOR OUTPUTS (PAR. 3.2) AZIMUTH RING SET AT ZERO

SHAFT SPEED RPM	OUTPUT VOLTS REQUIRED		ERROR VOLTS	TOLERANCE VOLTS
~~180~~ 372	~~1.04~~	2.13	-0.01	+0.05
~~540~~ 678	~~3.12~~	3.90	0.00	
~~900~~ 1038	~~5.18~~	6.00	+0.03	
~~1800~~	~~10.36~~			

OK

SINE-COSINE POTENTIOMETER OUTPUTS (PAR. 4) REF. VOLTAGE INPUT 5.18V

COSINE OUTPUT VOLTS				SINE OUTPUT VOLTS			
AZIMUTH RING SETTING	THEORETICAL (T)	MEASUREMENT (M)	ERROR (T-M) VOLTS 0.13 MAX	AZIMUTH RING SETTING	THEORETICAL (T)	MEASUREMENT (M)	ERROR (T-M) VOLTS 0.13 MAX
0	2.59	2.60	-0.01	0	0.00	0.00	0
15	2.50	2.60	-0.10	15	0.67	0.65	0.02
30	2.24	2.29	-0.05	30	1.30	1.27	0.03
45	1.83	1.87	-0.04	45	1.83	1.82	0.01
60	1.30	1.32	-0.02	60	2.24	2.25	-0.01
75	0.67	0.75	-0.08	75	2.50	2.52	-0.02
90	0.00	0.06	-0.06	90	2.59	2.60	-0.01
105	-0.67	-0.62	-0.05	105	2.50	2.60	-0.10
120	-1.30	-1.24	-0.06	120	2.24	2.31	-0.07
135	-1.83	-1.78	-0.05	135	1.83	1.89	-0.06
150	-2.24	-2.20	-0.04	150	1.30	1.34	-0.04
165	-2.50	-2.45	-0.05	165	0.67	0.71	-0.04
180	-2.59	-2.50	-0.09	180	0.00	-0.01	+0.01
195	-2.50	-2.48	-0.02	195	-0.67	-0.66	-0.01
210	-2.24	-2.24	0	210	-1.30	-1.27	-0.03
225	-1.83	-1.84	+0.01	225	-1.83	-1.80	-0.03
240	-1.30	-1.28	-0.02	240	-2.24	-2.21	-0.03

OK

14560D

S/N 7957
4/4/99

14560D
PAGE 2 OF 2

			(T-M)				(T-M)
255	-0.67	-0.65	-0.02	255	-2.50	-2.45	-0.05
270	0.00	0.02	-0.02	270	-2.59	-2.51	-0.08
285	0.67	0.69	-0.02	285	-2.50	-2.48	-0.02
300	1.30	1.36	-0.06	300	-2.24	-2.23	-0.01
315	1.83	1.89	-0.06	315	-1.83	-1.83	0
330	2.24	2.25	-0.01	330	-1.30	-1.29	-0.0
345	2.50	2.55	-0.05	345	-0.67	-0.66	-0.0

0.0573 ✓ 0.03?? ✓

Root mean square error not to exceed 0.05 volts (50MV).

COSINE RMSE = $\left[\frac{1}{N}\sum_{N=1}^{24}(T-M)^2\right]^{1/2}$ = 0.049 VOLTS ✓ OK

SINE RMSE = $\left[\frac{1}{N}\sum_{N=1}^{24}(T-M)^2\right]^{1/2}$ = 0.039 VOLTS

STARTING TORQUE (PAR. 5)

WEIGHT REQUIRED TO ROTATE
NOT TO EXCEED 42-GRAMS GRAMS

VANE STATIC BALANCE (PAR. 6)

WEIGHT REQUIRED AT TAIL
EQUAL TO OR LESS THAN 5-GRAMS GRAMS
WEIGHT AT NOSECAP
EQUAL TO OR LESS THAN 15-GRAMS GRAMS

VANE BEARING FRICTION (PAR. 7)

WEIGHT REQUIRED TO ROTATE TRANSMITTER
EQUAL TO OR LESS THAN 95-GRAMS FOR
HEATED TRANSMITTER GRAMS

SERIAL NO. 7957

INSPECTED - K. Bliss

DATE 4/9/99

14560D

Meteorological Instruments

R.M. YOUNG COMPANY
2801 Aero Park Drive, Traverse City, Michigan 49686 USA
Tel: 231-946-3980 Fax: 231-946-4772 Email: metsales@youngusa.com

Temperature Sensor Calibration Report

Customer: *Antarctic Support Associates*

Test Number: 02091
Test Date: 9 Feb 00

Customer PO: M59150-01
Sales Order: 4701

Test Sensor:
Model: 41342LC Serial Number: *1645*
Description: Temperature Sensor

Report of calibration comparison of test temperature sensor with National Institute of Standards and Technology traceable standard thermometers at three temperatures in the R.M. Young Company controlled temperature calibration bath facilities. Calibration accuracy ± 0.1° Celsius.

Bath Temperature (degrees C)	Current Output (milliamps)	Indicated (1) Temperature (degrees C)
-49.70	4.059	-49.63
0.03	12.005	0.03
50.12	20.017	50.11

(1) Calculated from current output

All reference equipment used in this calibration procedure have been tested by comparison to traceable standards certified by the National Institute of Standards and Technology.

Reference Instrument	Serial #	NIST Test Reference
Brooklyn Thermometer Model 43-FC	8006-118	204365
Brooklyn Thermometer Model 22332-D5-FC	25071	249763
Brooklyn Thermometer Model 2X400-D7-FC	77532	228060
Keithley Multimeter Model 191	15232	234027

Tested By: E. Chernosky

VAISALA

CERTIFICATE OF CALIBRATION

Certificate Number: 0007171003

Customer:	RAYTHEON TECHNICAL SERVICE CO. RAYTHEON POLAR SERVICES CO. 61 INVERNESS DRIE EAST, STE 300 ENGLEWOOD, CO 80112

Model Number	Serial Number
AIR-DB-3A	7G3095

Calibration Expiration	JULY 21, 2001

Vaisala Inc. does hereby certify that the product listed above meets or exceeds all published specifications and has been calibrated using standards whose accuracy's are traceable to the National Institute of Standards and Technology, or have been derived from accepted values of natural physical constants. NIST test numbers on standards used are available upon request.

Certified by 7-21-00 Date

Vaisala Inc.
Boulder Operations
8401 Baseline Road
Boulder, CO 80303

Phone (303) 499-1701
Fax (303) 499-1767
Web http://www.vaisala.com

THE EPPLEY LABORATORY, INC.
12 Sheffield Ave., P.O. Box 419, Newport, RI 02840 USA
Telephone: 401-847-1020 Fax: 401-847-1031

EPLAB
Scientific Instruments for Precision Measurements Since 1917

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 33090F3

Resistance: 699 Ω at 23 °C
Temperature Compensation Range: -20 to 40 °C

This radiometer has been compared with Standard Precision Spectral Pyranometer, Serial Number 21231F3 in Eppley's Integrating Hemisphere under radiation intensities of approximately 700 watts meter^{-2} (roughly one-half a solar constant). The adopted calibration temperature is 25 °C.

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

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

5.77 millivolts/cal cm^{-2} min^{-1}

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

The calibration of this instrument is traceable to standard self-calibrating cavity pyrheliometers in terms of the Systems Internationale des Unites (SI units), which participated in the Eighth International Pyrheliometric Comparisons (IPC VIII) at Davos, Switzerland in October 1995.

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 Heuneme, CA

Date of Test: November 7, 2000

In Charge of Test: R. T. Eppman

S.O. Number: 58282
Date: December 14, 2000

Reviewed by: Thomas D Kirk

Remarks:

THE EPPLEY LABORATORY, INC.
12 Sheffield Ave., P.O. Box 419, Newport, RI 02840 USA
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STANDARDIZATION OF EPPLEY PRECISION INFRARED RADIOMETER Model PIR

Serial Number: 33023F3

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

This pyrgeometer has been compared 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 28 °C.

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

$$3.95 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

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

S.O. Number: 58282
Date: December 14, 2000

Date of Test: June 23, 2000

In Charge of Test: R.T. Epperman

Reviewed by: Thomas D Kirk

Remarks:

Gravity Tie Calculations

Cape Town

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

Date	3/31/2001			Reference Code Numbers:		
Location	Cape Town, South Africa			Station no.		
Reference	PAARL Monument			ISGN no.		
Latitude	33 46.0 E					
Longitude	18 56.6 S					
Elevation	362.5 m					
Gravity	979526.1					

	Station	Value	Time (GMT)	Temp	Date	
						OBS mgal, averaged
	Ship measurement 1	3235.70	7:34	53.5	March 31, 2001	
	Ship measurement 2	3235.70	7:39	53.5	March 31, 2001	3210.220
	Ship measurement 3	3235.70	7:42	53.5	March 31, 2001	
	Average	3235.700				
						OBS mgal, averaged
	PAARL Monument	3124.51	8:54	53.5	March 31, 2001	
	PAARL Monument	3124.51	8:58	53.5	March 31, 2001	3099.906
	PAARL Monument	3124.51	9:02	53.5	March 31, 2001	
	Average	3124.510				
						OBS mgal, averaged
	Ship measurment 4	3235.70	10:22	53.5	March 31, 2001	
	Ship measurment 5	3235.70	10:24	53.5	March 31, 2001	3210.217
	Ship measurment 6	3235.69	10:26	53.5	March 31, 2001	
	Average	3235.697				
				Gravity offset from last tie		972439.27
	Known Gravity at PAARL Monument.	979526.100				
				Drift since last tie		-13.146
	Ship's meter averaged over period of the tie	7186.60	From gravity PC serial data to RVDAS, including calibration constant.			
	Corrected ship's meter average	7210.28	(To remove wrong calibration constant of 1.0013, stored in gravity P			
			and use correct calibration constant of 1.0046, supplied by L&R.)			
	Portable Gravimeter Correction Divisor	1.007937				
	Ship's Gravimeter Calibration Constant	1.0046				

	OBS Differences		Comments
	PARRL Monument to Ship (1, 2, &3 average	110.314	Gravity Tie done by Fred Stuart
	PARRL Monument to Ship (4, 5, & 6 averag	110.311	
	Averaged Differences	110.313	
	Gravity at pier	979636.413	
	Elevation of pier above gravimeter, meters	0.000	
	Earth differential gravity, mgal/meter	0.3	
	Gravity at ship's gravimeter	979636.413	
	Ship's relative gravity	7210.28	
	Gravity Offset	972426.128	

Spreadsheet repairs, 4/10/01:

1. **Ship's meter average recalculated to use correct calibration constant.**
2. **Gravimeter Calibration Constant changed from 1.0047 to 1.0046 as per correspondence with LaCoste & Romberg.**
3. **Ship's relative gravity = Ship's meter average of serial data output.**