Webb Research Corporation

82 Technology Park Drive, E. Falmouth, MA 02536-4441 (508) 548-2077 FAX (508) 540-1686

TEMPERATURE PROFILER - MANUAL 20, 21

REV DATE: 4/28/97
Prepared for NOAA- AOML, Contract no. 50WCNR706030
WRC Job no. 428

I. ALKALINE BATTERY WARNING

The profiler contains alkaline "D" cells.
There is a small but finite possibility that batteries of alkaline cells will release a combustible gas mixture. This gas release generally is not evident when batteries are exposed to the atmosphere, as the gases are dispersed and diluted to a safe level. When the batteries are confined in a sealed instrument mechanism, the gases can accumulate and an explosion is possible.
Webb Research Corp. has added a catalyst inside of these instruments to recombine Hydrogen and Oxygen into H2O, and the instrument has been designed to relieve excessive internal pressure buildup by having the upper endcap release.
Webb Research Corp. knows of no way to completely eliminate this hazard. The user is warned, and must accept and deal with this risk in order to use this instrument safely as so provided. Personnel with knowledge and training to deal with this risk should seal or operate the instrument. Webb Research Corp. disclaims liability for any consequences of combustion or explosion.

II. Reset and Self Test

Profilers are shipped to the deployment site in Hibernate mode. Shortly before deployment, the profiler is reset by passing a magnet over a marked location on the pressure case. The profiler then runs a self-test, transmits for 6 hours, then begins its pre-programmed mission.

It is preferable to deploy during the 6 hour transmission period, because the external bladder is full, preventing trapped air in the lower endcap. If deployment is delayed, the profiler can be reset again to keep the bladder full. The six ARGOS transmissions during self test do not contain meaningful data, nor do the transmissions during the initial 6 hour period.

Procedure:
- Hold the provided magnet at RESET position marked on the hull for several seconds.
- Note: The internal magnetic reed switch must be activated (held) for at least one second to reset the instrument. (This is to provide a safety against accidental reset during transport.) **Thus, if the ALACE does not respond as below, the instrument was probably not reset.**
- The pump will operate for 1 second, this is best heard with your ear against the pressure case.
- PTT will transmit 6 times at 6 second intervals. Place the ARGOS receiver/beeper close to the antenna to detect transmissions.
- Pump will operate for 16 seconds.
- After a pause, the pump will start again.
- The bladder will expand, this should take 35 - 60 minutes.
- 6 hours after reset, the bladder will deflate, the profiler begins its programmed mission.

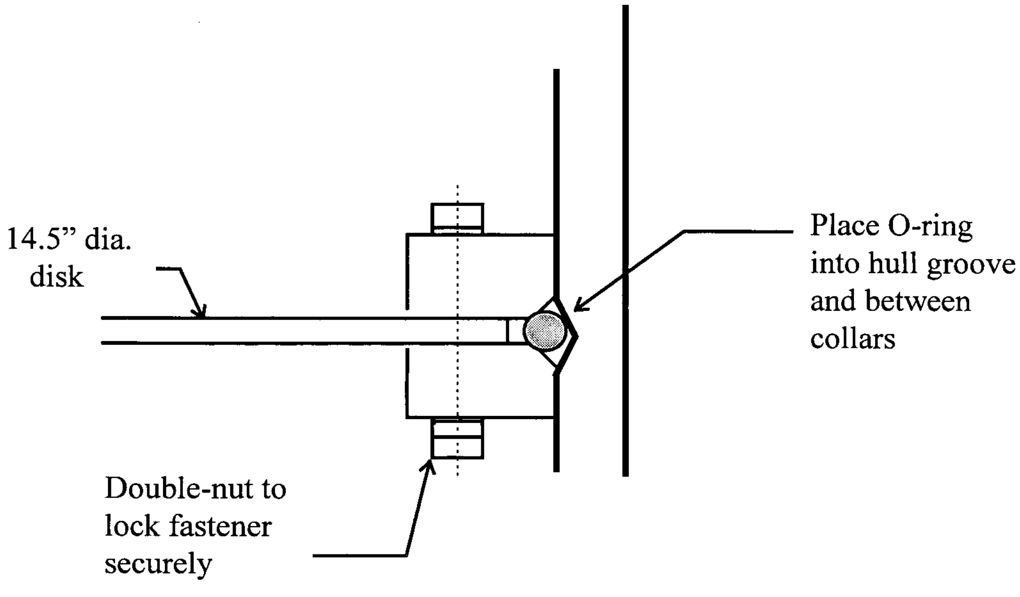
During self test, the controller checks the internal vacuum sensor. If the internal pressure has increased above a preset limit (i.e. hull leakage caused loss of vacuum), the instrument will not pump.

If you do not detect the 6 test transmissions, and if the bladder does not inflate, then the self test has failed and the instrument should not be deployed.

III. Mounting Damper Disk

To aid surface following, a 14.5" diameter disk is mounted to the outside of the pressure case. The damper parts should be ballasted with each instrument, and numbered accordingly. Below are instructions which should be provided to the deployment crew:

- Remove the ALACE from the crate and secure horizontally on foam cradles.
- Unpack the appropriate numbered stability disk.
- Remove the titanium hardware and one gray collar.
- Sandwich the clear disk between 2 gray collars.
- NOTE: the chamfered edge of the collar must be toward the O-ring as shown below.
- Install 6 bolts firmly - use 2 flatwashers for each bolt, one on each side of collar.
- Using two wrenches, tighten the second nut against the first to lock fasteners in place.
- Note: Be sure to use the hardware particular to each instrument as each ALACE is ballasted to .1 grams.



IV. Deployment

- RESET instrument.
- SELF TEST starts automatically (see above).
- When pump stops, external bladder is full, PTT will transmit for 6 hours at 90 second intervals.
- Six hours after reset, the bladder will deflate.
- It is preferable to deploy ALACE with its external bladder full, this prevents trapped air in the lower endcap cavity. So, deploy within 6 hours after RESET.

- Pass a rope through the hole in the stability disk.
- Holding both ends of the rope, carefully lower the ALACE into the water.
- Take care not to damage the antenna.
- Do **not** leave the rope with the instrument, release one end and retrieve the rope.
- The ALACE will remain on the surface until the 6 hour interval has expired.

V. ARGOS DATA

A. SERVICE ARGOS PARAMETERS

The user must specify various options to Service ARGOS. These choices depend on how the user wishes to receive and process data. Typical parameters are listed below:

- Standard location.
- Processing: Type A2 (pure binary input; hexadecimal output)
- Results Format: DS (all results from each satellite pass), Uncompressed.
- Distribution Strategy: Scheduled, all results, every 24 hours.
- Number of bits transmitted: 32

B. DATA FORMAT

Data is sent via ARGOS in 32 byte messages. The first byte in every message is a CRC byte that can be used to verify the other 31 bytes. The second byte in every message is a sequential message number. The remaining 30 bytes are used for data transmission.

Message number one has the following format:

Byte	
01	CRC
02	Message number
03	Serial number
04	Profile number
05	Profile length
06	Profile termination flag byte
07 & 08	Bottom temperature
09	Bottom ocean pressure
10	Battery voltage
11	Surface pressure
12 to 32	2 byte temperature measurement.

The profile length is the number of bytes from the profile length byte through the last temperature measurement.

The profile termination flag byte can have the following values:

00	Pressure reached surface pressure.
01	Programmed ascent time ran out before surface.
02	Pressure reached zero.
04	Pressure unchanged for 17 minutes.

Longer profiles will have sequential messages with a CRC byte, a message number and up to 15 double bytes of temperature data in each ARGOS message.

C. CRC

Because ARGOS data may contain transmission errors, the first byte of each message contains an error checking value. This value is a Cyclic Redundancy Check (CRC), and is calculated as a function of the message content (bytes 2 to 32).

- For each message, calculate a CRC value
- Compare the calculated CRC to the transmitted CRC (byte no. 1)
- If the calculated and transmitted CRC values are not equal, the message has been corrupted and should be deleted before further data processing.

Below is a sample program (in BASIC) to calculate the CRC value for a message. This program can be provided upon request in Basic, Fortran or C.

```
DECLARE FUNCTION CRC% (IN() AS INTEGER, N AS INTEGER)
'CRC routine to check data validity in ARGOS message.
'Bathy Systems, Inc. RAFOS Float data transmission.
'3 December, 1990.
'The 1st of 32 bytes in an ARGOS message is the CRC.
'The function CRC will compute CRC for byte 2 through 32.
'Hasard is used for Random because Random is reserved by BASIC.
'Stored as file CRC in C:\RAFOS\RAF11.
DECLARE SUB Hasard (ByteN AS INTEGER)
DEFINT A-Z
DIM in(32) AS INTEGER
'RAF11F message number 08 HEX ID 11502 01-02-93   CRC is O.K.
A$ = "8F00081C8E47239148A4D2E9743A1D0E070381C06030984C2693492492C964B2"

        N = 32
        FOR I = 1 to N
                in(I) = VAL("&H" + MID$(A$, 2 + I - 1, 2))
        NEXT I
        PRINT in(1); CRC(in(), N);

FUNCTION CRC% (IN() AS INTEGER, N AS INTEGER) STATIC
DIM ByteN as INTEGER
         I = 2
 ByteN = in(2)
                DO
                        CALL Hasard(ByteN)
                        I = I + 1
                        ByteN = ByteN XOR in(I)
                LOOP UNTIL  I = N
        CALL Hasard (ByteN)
        CRC = ByteN
END FUNCTION

DEFINT A-Z
SUB Hasard (ByteN AS INTEGER) STATIC
x% = 0
        IF ByteN = 0 THEN ByteN = 127: EXIT SUB
        IF (ByteN AND 1) = 1 THEN x% = x% + 1
        IF (ByteN AND 4) = 4 THEN x% = x% + 1
        IF (ByteN AND 8) = 8 THEN x% = x% + 1
        IF (ByteN and 16) = 16 THEN x% = x% + 1
        IF (X% AND 1) = 1 THEN
                ByteN = INT(ByteN / 2) + 128
        ELSE
                ByteN = INT(ByteN / 2)
        END IF
END SUB
```

D. CONSTANTS

Temperature is averaged every 4 seconds and stored at every other pressure count (**PC**) above the bottom PC, up to a PC of 29. It is then stored at each PC up to the surface PC that was stored at the initial descent. This sampling scheme is not user programmable.

Nominal pressure resolution is 5.2 db per count. Thus, 29 counts minus a surface set count of 10 is approximately 100 db. Sampling every other count from 1000 to 100 dbar will result in 87 temperature measurements, plus another 19 measurements from 100 to 0 dbar. Each profile will have 106 measurements with 2 bytes for each measurement, or 212 bytes plus 11 bytes of engineering data for each profile. Plus 6 bytes for CRC. A profile with 229 bytes will be transmitted in 8 messages.

INSTRUMENT 20
Resistance (k-ohms) = A + Bx + Cx^2 +Dx^3
x is in decimal number/1000,
A = -1.01768, B = 11.78354, C = .01116, D = .00045

A1 = 9.281023e-4
B2 = 2.220996e-4
C3 = 1.24094e-7
T = Temperature, Kelvin (degC + 273.15)
LnR = natural lof of resistance in ohms (not kohms)

1/T = A1 + B2(LnR) + C3(LnR)^3
Temperature in degrees C = [1/(A1 + B2(LnR) + C3(LnR)^3)] - 273.15

Pressure (PSI) = counts * 8.122907 - 77.2751
counts is in decimal number

Voltage (V) = counts * .098531 + .894
counts is in decimal number
nominal 15V, decreasing

INSTRUMENT 21
Resistance (k-ohms) = A + Bx + Cx^2 +Dx^3
x is in decimal number/1000,
A = .73908, B = 10.77384, C = .26201, D = -.01588

A1 = 9.964399e-4
B2 = 2.126178e-4
C3 = 1.514521e-7

T = Temperature, Kelvin (degC + 273.15)
LnR = natural lof of resistance in ohms (not kohms)

1/T = A1 + B2(LnR) + C3(LnR)^3
Temperature in degrees C = [1/(A1 + B2(LnR) + C3(LnR)^3)] - 273.15

Pressure (PSI) = counts * 7.706585 - 73.5103
counts is in decimal number

Voltage (V) = counts * .098531 + .894
counts is in decimal number
nominal 15V, decreasing

VI. MISSIONS

INSTRUMENT 20
H APF version 01 27 97

91D50 ARGOS ID number.
090 seconds repetition rate.
004 hour Trip interval.
060 intervals DOWN.
006 intervals UP.
016 minutes deep pump time.
010 minutes 1st surface pump time.
100 minutes 2nd surface pump time.
250 minutes ascend time.

INSTRUMENT 21
H APF version 01 27 97

91DAF ARGOS ID number.
090 seconds repetition rate.
004 hour Trip interval.
060 intervals DOWN.
006 intervals UP.
016 minutes deep pump time.
010 minutes 1st surface pump time.
100 minutes 2nd surface pump time.
250 minutes ascend time.

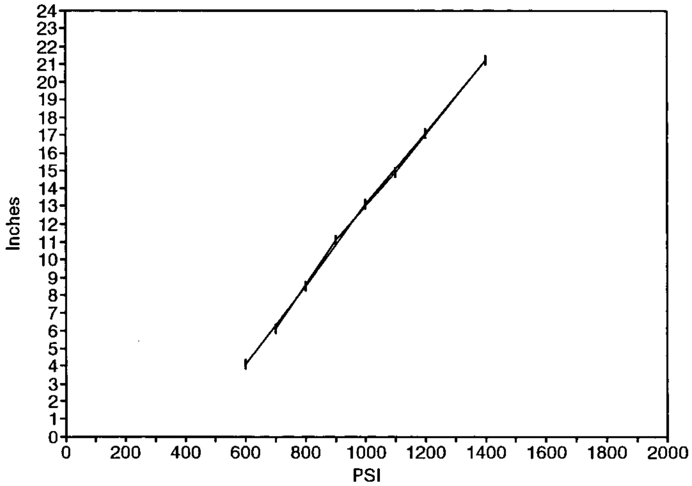
VII. RECORDS & CALIBRATIONS

APF BALLASTING

FLOAT:	20		Regression Output:		
DATE:	3/12/97		Constant		-8.66316
TEMP:	15.7	C	Std Err of Y Est		0.259651
TARGET DEPTH:	1000	db	R Squared		0.998245
IN SITU PTANK:	1.0036	g/cm3	No. of Observations		8
INITIAL CHAIN:	0.9	inches	Degrees of Freedom		6
AIR WT. INST:	23827.3	grams			
EXTERNAL WT:	149.2	grams	X Coefficient(s)	0.021481	
BALLAST WT:	878.0	grams	Std Err of Coef.	0.000368	

Where y = mx + b
y = (X Coefficient)x + Constant

PSI	Inches	# Obs.
600	4.1	1
800	8.5	2
1000	13.1	3
1200	17.1	4
1400	21.2	5
1100	14.9	6
900	11.1	7
700	6.1	8
		9
		10
		11
		12
		13
		14
		15
		16
		17
		18



2 CHAINS stainless steel
@ (.91g/in WET) EACH
Scale etc. wt. 46.5 grams

MISSION PARAMETERS:

LOCATION:	?		CYCLE:	10	days
DEPTH:	1000	db	TRANSMISSION:	18	hrs
TEMPERATURE:	4	C	PTT ID:	9333, 91D50	
SALINITY:	34.6	pss			
IN SITU DENSITY:	1.032078	g/cm3			

R Sqared = measurement of validity of the model, 0..1 1 being the optimal for a linear curve
Degrees of Freedom = (number of observations) - (number of independent x variables) + 1

X Coefficient = coefficients of the independent x variables in the model (m)
Std Err of Coef. = error estimate of the coefficients

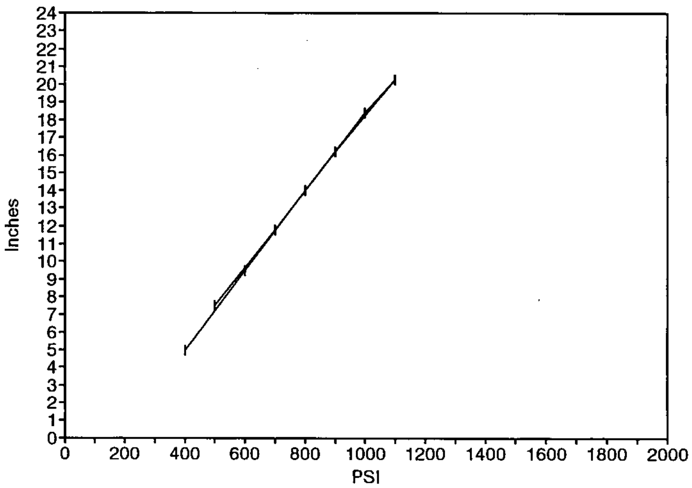
Where y = mx + b
y = (X Coefficient)x + Constant

					(grams)	
Wt. of instrument (grams)					23827.3	From log book
	PSI	pss	temp C			
Nb wt @	0	0	15.7			
scale, tape, tiewraps, hoseclamp					46.5	Wet wt.
washers external					130.6	Dry wt. * .875
chain initialize					-17.4	(Const-init)*2chains*.91g/in
Nb wt @	1450	0	15.7		56.7	Slope*targPSI*2chains*.91g/in
Subtotal				24043.6		
Temp. adj.			4		-20.6	Subtot wt*alum coef*
coef. aluminum		7.08E-05				(targtemp-tanktemp)*targdens
Density adj.		34.6			682.3	Subtot wt*
						(targdens/tankdens-1)
Final	1450	34.6	4		878.0	
Total Instrument wt.					24705.3	
FLOAT:	20					

APF BALLASTING

FLOAT:	21		Regression Output:		
DATE:	4/14/97		Constant		-3.60536
TEMP:	16.2	C	Std Err of Y Est		0.158318
TARGET DEPTH:	1000	db	R Squared		0.999254
IN SITU PTANK:	1.003509	g/cm3	No. of Observations		8
INITIAL CHAIN:	0.9	inches	Degrees of Freedom		6
AIR WT. INST:	23832	grams			
EXTERNAL WT:	133	grams	X Coefficient(s)	0.021899	
BALLAST WT:	875.6	grams	Std Err of Coef.	0.000244	

PSI	Inches	# Obs.
400	4.95	1
600	9.5	2
800	14	3
1000	18.4	4
1100	20.25	5
900	16.2	6
700	11.75	7
500	7.5	8
		9
		10
		11
		12
		13
		14
		15
		16
		17
		18



2 CHAINS stainless steel
@ (.91g/in WET) EACH
Scale etc. wt. 46.5 grams

MISSION PARAMETERS:

LOCATION:	?		CYCLE:	10	days
DEPTH:	1000	db	TRANSMISSION:	18	hrs
TEMPERATURE:	4	C	PTT ID:	9334, 91DAF	
SALINITY:	34.6	pss			
IN SITU DENSITY:	1.032078	g/cm3			

R Sqared = measurement of validity of the model, 0..1 1 being the optimal for a linear curve
Degrees of Freedom = (number of observations) - (number of independent x variables) + 1

X Coefficient = coefficients of the independent x variables in the model (m)
Std Err of Coef. = error estimate of the coefficients

Where y = mx + b
y = (X Coefficient)x + Constant

	PSI	pss	temp C		(grams)	
Wt. of instrument (grams)					23832.0	From log book
Nb wt @	0	0	16.2			
scale, tape, tiewraps, hoseclamp					46.5	Wet wt.
washers external					116.4	Dry wt. * .875
chain initialize					-8.2	(Const-init)*2chains*.91g/in
Nb wt @	1450	0	16.2		57.8	Slope*targPSI*2chains*.91g/in
Subtotal				24044.5		
Temp. adj.			4		-21.4	Subtot wt*alum coef*
coef. aluminum		7.08E-05				(targtemp-tanktemp)*targdens
Density adj.		34.6			684.5	Subtot wt* (targdens/tankdens-1)
Final	1450	34.6	4		875.6	
Total Instrument wt.					24707.6	
FLOAT:	21					

APF Board check out sheet:

Serial number: 25

Date: 3/11/97

Operator: CPJ

Instrument: R-20

Job: 428

Power Consumption: @ 15 Volts

Awake w/o SAIL	135.	uA
Awake w/ SAIL	2.2	MA
Motor on	117.	MA
Valve open	.	MA
Valve close	.	MA
PTT warm	13.4	MA
PTT x-mit	.4	A
Hibernate w/o SAIL	86.	uA

Voltage Calibration:

Volts	Counts
15.0	143
12.0	113
8.0	72

Pressure Calibration: S/N 23089

PSI	Counts
0	10
310	46
701	96
1105	144

Vacuum Calibration:

in HG	Counts
ATM	75
5"	~~25~~ 60
12	43

Temperature Calibration: S/N 45

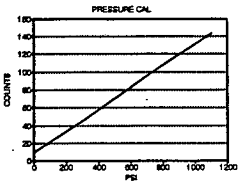
Resistance	Counts	Temp. C
94.98	8065	0
86.09	7326	2
78.11	6662	4
70.96	6065	6
64.53	5527	8
58.75	5043	10
53.54	4606	12
48.84	4212	14
44.60	3855	16
40.77	3532	18
37.30	3241	20

Calibration File: APF25.WCA

Notes:

APF25 CALIBRATION

PSI	COUNTS
0	10
310	46
701	96
1105	144

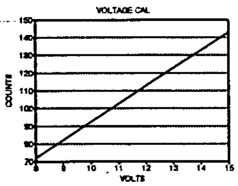


Regression Output:

Constant	-77.2751
Std Err of Y Est	10.10059
R Squared	0.999704
No. of Observations	4
Degrees of Freedom	2

X Coefficient(s)	8.192907
Std Err of Coef.	0.099698

VOLTS	COUNTS
15	143
12	113
8	72



Regression Output:

Constant	0.893991
Std Err of Y Est	0.034363
R Squared	0.999952
No. of Observations	3
Degrees of Freedom	1

X Coefficient(s)	0.098531
Std Err of Coef.	0.000682

Program TCAL13.BAS 16 January, 1997
Temperature Calibration 23 April, 1997 A1912.dat

Controller board number 1912 serial 20

For degree of 1 Coefficients are :
A = -1.48733
B = 11.95222
Beta is 0.001666

X	Y	Cmp. Val.	Diff
8.065	94.98	94.9074	0.0726
7.326	86.09	86.0747	0.0153
6.662	78.11	78.1384	-0.0284
6.065	70.96	71.0029	-0.0429
5.527	64.53	64.5726	-0.0426
5.043	58.75	58.7877	-0.0377
4.606	53.54	53.5646	-0.0246
4.212	48.84	48.8554	-0.0154
3.855	44.60	44.5885	0.0115
3.532	40.77	40.7279	0.0421
3.241	37.30	37.2498	0.0502

For degree of 2 Coefficients are :
A = -0.94738
B = 11.74229
C = 0.01883
Beta is 0.000022

X	Y	Cmp. Val.	Diff
8.065	94.98	94.9791	0.0009
7.326	86.09	86.0874	0.0026
6.662	78.11	78.1156	-0.0056
6.065	70.96	70.9624	-0.0024
5.527	64.53	64.5276	0.0024
5.043	58.75	58.7479	0.0021
4.606	53.54	53.5372	0.0028
4.212	48.84	48.8453	-0.0053
3.855	44.60	44.5990	0.0010
3.532	40.77	40.7613	0.0087
3.241	37.30	37.3072	-0.0072

Controller board number 1912 serial 20

For degree of 3 Coefficients are :

A = -1.01768
B = 11.78354
C = 0.01116
D = 0.00045
Beta is 0.000020

X	Y	Cmp. Val.	Diff
8.065	94.98	94.9809	-0.0009
7.326	86.09	86.0862	0.0038
6.662	78.11	78.1139	-0.0039
6.065	70.96	70.9614	-0.0014
5.527	64.53	64.5276	0.0024
5.043	58.75	58.7488	0.0012
4.606	53.54	53.5385	0.0015
4.212	48.84	48.8465	-0.0065
3.855	44.60	44.5997	0.0003
3.532	40.77	40.7610	0.0090
3.241	37.30	37.3055	-0.0055

For degree of 4 Coefficients are :

A = -0.68303
B = 11.52070
C = 0.08589
D = -0.00868
E = 0.00041
Beta is 0.000024

X	Y	Cmp. Val.	Diff
8.065	94.98	94.9821	-0.0021
7.326	86.09	86.0839	0.0061
6.662	78.11	78.1133	-0.0033
6.065	70.96	70.9625	-0.0025
5.527	64.53	64.5292	0.0008
5.043	58.75	58.7498	0.0002
4.606	53.54	53.5382	0.0018
4.212	48.84	48.8453	-0.0053
3.855	44.60	44.5982	0.0018
3.532	40.77	40.7604	0.0096
3.241	37.30	37.3072	-0.0072

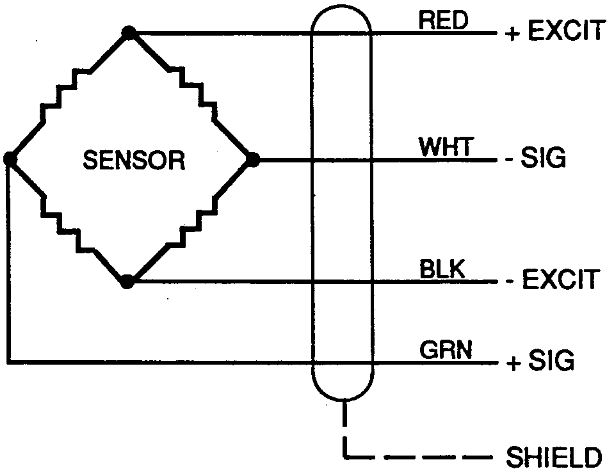
Micron Instruments Mon, Feb 10, 1997

Transducer Data Sheet

Model Number: 140522-A-2000-G

Serial Number: 23089

Excitation: 5.00 VDC



PRESSURE READINGS

PSI	Incr.	Decr.
0	0.13	0.13
1000	49.93	49.99
2000	99.91	
SENS	99.78	

Temp.	75°F	30°F	130°F	±1°
0 Press	0.13	-0.22	0.72	mv
FS Press	99.95	99.57	100.57	mv
SENS	99.82	99.79	99.85	mv

Date run: Oct 8, 1996

RESISTANCE READINGS

Input Resistance 1.446KΩ

Output Resistance 775Ω

PERFORMANCE

Balance (Zero) 0.13 mv

Full Scale Sensitivity 20 mv/V

Static Error Band 0.0500 %FS BFSL

Thermal Balance Deviation - °F		%FS/°F
X	30 - 75	0.0077
Y	75 - 130	0.0107
Average Deviation (X+Y)÷2		0.0093

Thermal Sensitivity Deviation - °F		%FS/°F
X	30 - 75	0.0006
Y	75 - 130	0.0005
Average Deviation (X+Y)÷2		0.0006

Trace# ____________

Other ____________

4509 Runway Street • Simi Valley • CA • 93063
805-522-4676 FAX 805-522-4982

APF Board check out sheet:

Serial number: 30

Date: 4/8/97

Operator: CPJ

Instrument: R-21

Job: 428

Power Consumption: @ 15 Volts

Awake w/o SAIL	132.	uA
Awake w/ SAIL	2.2	MA
Motor on	120.	MA
PTT warm	12.1	MA
PTT x-mit	.4	A
Hibernate w/o SAIL	93.	uA

Voltage Calibration:

Volts	Counts
15.0	143
12.0	113
8.0	72

Pressure Calibration: S/N 23078 Micron

PSI	Counts
0	10
308	49
707	101
1080	150

Vacuum Calibration:

in HG	Counts
ATM	76
	60
12	43

Temperature Calibration: S/N 52

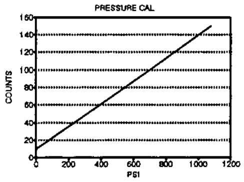
°C (Nominal)	Res. Kohm	Counts
0	94.98	7952
2	86.09	7211
4	78.11	6543
6	70.96	5970
8	64.53	5441
10	58.75	4971
12	53.54	4536
14	48.84	4151
16	44.60	3793
18	40.77	3481
20	37.30	3199

Calibration File: APF21.WCA

Notes:

APF30 CALIBRATION

PSI	COUNTS
0	10
308	49
707	101
1080	150

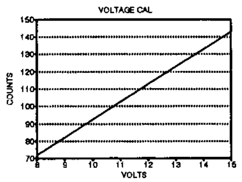


Regression Output:

Constant	-73.5103
Std Err of Y Est	4.387217
R Squared	0.999942
No. of Observations	4
Degrees of Freedom	2

X Coefficient(s)	7.706585
Std Err of Coef.	0.041498

VOLTS	COUNTS
15	143
12	113
8	72



Regression Output:

Constant	0.893991
Std Err of Y Est	0.034363
R Squared	0.999952
No. of Observations	3
Degrees of Freedom	1

X Coefficient(s)	0.098531
Std Err of Coef.	0.000682

Program TCAL13.BAS 16 January, 1997
Temperature Calibration 23 April, 1997 A1912.dat

Controller board number 1912 serial 21

For degree of 3 Coefficients are :

A = 0.73908
B = 10.77384
C = 0.26201
D = -0.01588

Beta is 0.003520

X	Y	Cmp. Val.	Diff
7.952	94.98	94.9953	-0.0153
7.211	86.09	86.0988	-0.0088
6.543	78.11	78.0009	0.1091
5.970	70.96	71.0182	-0.0582
5.441	64.53	64.5582	-0.0282
4.971	58.75	58.8196	-0.0696
4.536	53.54	53.5180	0.0220
4.151	48.84	48.8401	-0.0001
3.793	44.60	44.5072	0.0928
3.481	40.77	40.7478	0.0222
3.199	37.30	37.3660	-0.0660

For degree of 4 Coefficients are :

A = -9.21505
B = 18.69805
C = -2.02208
D = 0.26705
E = -0.01274

Beta is 0.002141

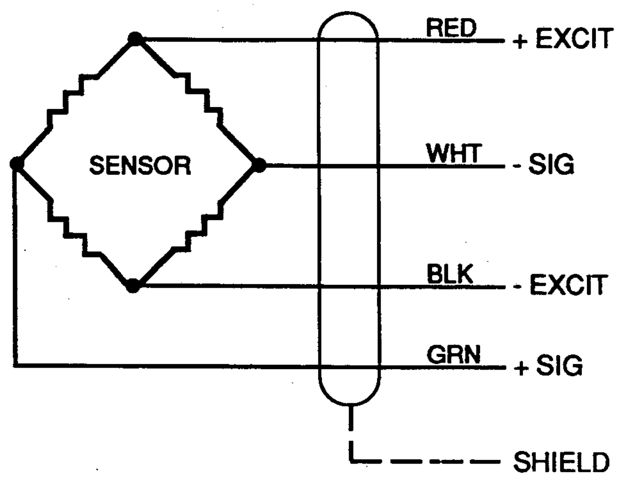
X	Y	Cmp. Val.	Diff
7.952	94.98	94.9607	0.0193
7.211	86.09	86.1661	-0.0761
6.543	78.11	78.0191	0.0909
5.970	70.96	70.9859	-0.0259
5.441	64.53	64.5112	0.0188
4.971	58.75	58.7918	-0.0418
4.536	53.54	53.5259	0.0141
4.151	48.84	48.8776	-0.0376
3.793	44.60	44.5517	0.0483
3.481	40.77	40.7647	0.0053
3.199	37.30	37.3154	-0.0154

Transducer Data Sheet

Model Number: 140522-A-2000-G

Serial Number: 23078

Excitation: 5.00 VDC



PRESSURE READINGS

PSI	Incr.	Decr.
0	0.03	0.06
1000	51.10	51.01
2000	102.19	
SENS	102.16	

Temp.	75°F	30°F	130°F	±1°
0 Press	0.06	0.50	-0.54	mv
FS Press	102.21	102.49	102.14	mv
SENS	102.15	101.99	102.68	mv

Date run: Oct 8, 1996

RESISTANCE READINGS

Input Resistance 1.517KΩ

Output Resistance 732Ω

PERFORMANCE

Balance (Zero) 0.03 mv

Full Scale Sensitivity 20.4 mv/V

Static Error Band 0.0400 %FS BFSL

Thermal Balance Deviation - °F		%FS/°F
X	30 - 75	-0.0095
Y	75 - 130	-0.0106
Average Deviation (X+Y)÷2		-0.0099

Thermal Sensitivity Deviation - °F		%FS/°F
X	30 - 75	0.0034
Y	75 - 130	0.0094
Average Deviation (X+Y)÷2		0.0063

Trace# ____________

Other ____________

4509 Runway Street • Simi Valley • CA • 93063
805-522-4676 FAX 805-522-4982

Webb Research Corporation

82 Technology Park Drive, E. Falmouth, MA 02536-4441 (508) 548-2077 FAX (508) 540-1686

TEMPERATURE PROFILER - TECHNICAL MANUAL

REV DATE: 4/22/97
Prepared for NOAA - AOML, Contract no. 50WCNR706030
WRC Job no. 428

I. ALKALINE BATTERY WARNING

The profiler contains alkaline "D" cells.
There is a small but finite possibility that batteries of alkaline cells will release a combustible gas mixture. This gas release generally is not evident when batteries are exposed to the atmosphere, as the gases are dispersed and diluted to a safe level. When the batteries are confined in a sealed instrument mechanism, the gases can accumulate and an explosion is possible.
Webb Research Corp. has added a catalyst inside of these instruments to recombine Hydrogen and Oxygen into H2O, and the instrument has been designed to relieve excessive internal pressure buildup by having the upper endcap release.
Webb Research Corp. knows of no way to completely eliminate this hazard. The user is warned, and must accept and deal with this risk in order to use this instrument safely as so provided. Personnel with knowledge and training to deal with this risk should seal or operate the instrument. Webb Research Corp. disclaims liability for any consequences of combustion or explosion.

II. GENERAL FEATURES

A. CONTROLLER and PTT

The controller is based on a MC68HC705A processor, and is programmed in assembly language. Controller hardware and software are provided by Bathy Systems Inc. The Seimac PTT mounts directly to the controller board.

B. HYDRAULIC SYSTEM

To become positively buoyant, the profiler increases its displacement by pumping oil from an internal bladder to an external one. Nominally 625 cc are pumped. This requires about 40 minutes at zero pressure with a fresh battery.

Note that if the pump is left on, or if the valve is left open (i.e. Down Valve I5) while the instrument is standing vertically, expansion of the external bladder will cause the instrument to fall over.

Gas bubbles and dissolved gas are carefully removed from the hydraulic circuit before the profiler is shipped. A small bubble may appear in the internal bladder, especially after storage for several weeks. Store under vacuum per below.

C. INTERNAL VACUUM

Instruments are stored and deployed with partial vacuum (12" Hg) inside the pressure case, for several reasons:

- Draws oil back from external bladder when valve is opened to descend.
- Reduces migration of gas into internal oil bladder.
- Pre-loads o-rings in correct direction
- Checks for seal leakage (see vacuum sensor below)

D. VALVE

To make the profiler sink to neutral depth, a latching solenoid valve opens to allow oil to return to the internal bladder. The valve remains open until ascent time.
Command terminology:
I5 Actuate DOWN valve = OPEN the valve
I6 Actuate UP valve = CLOSE the valve

Be sure to OPEN the valve (I5) before ballasting, so that the external bladder will be completely empty.

The valve should not be opened at high external pressures, as this may cause the internal hose to blow off of its fitting.

E. VACUUM SENSOR

A sensor measures air pressure inside the instrument, in order to:
- Ensure consistent air pressure, hence air mass, during ballasting.
- Check for loss of internal vacuum (i.e. hull leakage) during storage and transport.

The sensor will read 78 counts at ambient pressure and room temperature. It will then read 43 counts at ~12" Hg at room temperature. Self-test will fail if vacuum counts are 60 (~6" Hg) or less, indicating hull leakage. The 60 count setpoint is not user programmable.

F. INTERNAL OIL SENSOR

The controller monitors the amount of oil in the internal bladder, in order to turn off the pump motor before the bladder is empty. The oil volume measurement is based on a capacitative sensor attached to the internal bladder.

A rectangle of copper foil adhered to the internal bladder moves toward the aluminum chassis as the bladder empties. Capacitance between the foil and chassis is a function of bladder oil volume, and is sampled every 2 seconds during the P3 pump interval. The pump is turned off when 3 consecutive samples are 10 counts (~60 pF) or higher, approximately 75 to 100 cc of oil remaining in the bladder. Expected values are 5 counts (20 pF) for full bladder, and 14-17 counts (~90-120 pF) when empty. The 10 count setpoint is not user programmable.

Command **I7** displays capacitance value in counts.

Note that the wire from copper foil to connector H4 should not be re-routed or altered, as this may introduce a small offset in the capacitance measurement.

G. BATTERIES

Input voltage is nominal 15VDC, provided by alkaline D-cells. Five-cell (i.e. 7.5V) pucks are paired in series. Three pairs are standard, and 4 may be used when necessary. One puck in each pair has a diode to prevent reverse charging. The puck with red/black leads has a diode, puck with orange/ brown leads does not.

Battery voltage is telemetered with the ARGOS data.

III. TEMPERATURE SAMPLING

Temperature is averaged every 4 seconds and stored at every other pressure count (**PC**) above the bottom PC, up to a PC of 29. It is then stored at each PC up to the surface PC that was stored at the initial descent. This sampling scheme is not user programmable.

Potentiometer VR2 should be adjusted so that pressure reads 10 counts at 1 atmosphere. Nominal pressure resolution is 5.3 db per count. So 29 counts is approximately 100 db.

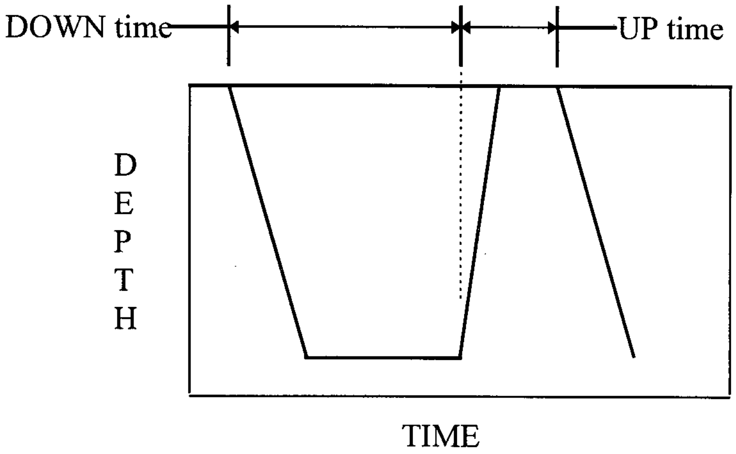
Other sampling sequences can be coded, depending on operating depth and science objectives. The T sampling sequence is stored in PROM and is not user programmable.

IV. MISSION TIMING

A. UP and DOWN TIMES

Integer multiples of time interval **T** are used to define Up time (**U** x **T**) and Down time (**D** x **T**).
Up time begins when the pump first starts, and ends when the valve opens to descend.
Down time begins when the valve opens, and ends when the pump starts.

Total Up time (U x T) is typically 12 to 20 hours, increasing proportional to depth and amount of data to be transmitted per profile. Another factor is deployment location: due to the polar orbit of ARGOS, the number of passes per day increases at high latitudes.



B. PUMP TIMING

In order to minimize energy usage, pump time is broken into intervals as follows. Example values are given for 1000 meter deployment. Average ascent rate is approximately 10 cm/sec.

P1 Deep pump time:
Brief pump interval to start ascent. Example value: 16 min.
Y ASCEND time: pause between P1 and P2. Example value: 250 min.
P2 1st surface pump time:
Controller does not monitor internal oil sensor during this interval. Example value: 10 min.
P3 2nd surface pump time:
Final near-surface pumping continues until either the internal oil sensor toggles (preferred), or the P3 time interval expires (timeout). Example value: 100 min.

V. CONNECTING A TERMINAL

The user can program and test the instrument, communicating via a 20 mA current loop. The comm. port is located on lower endcap, and consists of a non-pressure rated connector protected by a seal plug. Or connection may be made to H2 on the internal board. The current loop has no polarity.

Connect the provided comm. cable to RS232 port on computer. Run a communications program such as Procomm. **Settings: 1200 N81 full duplex**

If a terminal is connected, after a reset the profiler lists status (same as **L** command) then waits for keyboard input. If no terminal is connected, self-test then the programmed mission begin after reset.

Note that it is possible to reset the profiler without a terminal connected, then connect a terminal. The data collection sequence is listed on screen, but no keyboard entries can be made.

VI. COMMANDS

A. LISTING

? Print this help file. **Note all entries must be UPPER CASE.**
A Enter ARGOS ID number in HEX.
C Calibrate: displays T, P & volts.
D Enter number of DOWN intervals.
E Execute profiler program.
H Hibernate until reset.
I Immediate mode for testing.
L List profile parameters.
P1 Enter deep pump time.
P2 Enter 1st surface pump time.
P3 Enter 2nd surface pump time.
R Enter ARGOS Repetition Rate.
S Serial number.
T Enter Trip interval.
U Enter number of UP intervals.
V Version number.
Y Enter ASCEND time.

Immediate mode test functions.
I? Print this help file.
I1 Run pump for 1 sec.
I2 ARGOS transmitter test. *Sends message # followed by all threes*
I3 Turn pump on.
I4 Turn pump off.
I5 Actuate DOWN valve. *OPENS the latching valve*
I6 Actuate UP valve. *CLOSES valve*
I7 Display oil level count.
ID Display all EEPROM data.
IE Examine 1st 16 EEPROM bytes.
IZ 400 Hz at TCMP pin.
+

B. CALIBRATION

Use command C to display counts for temperature, pressure, internal vacuum and battery voltage.
Results will list on screen in this format:

t p vac v
C 0000 000 000 000

Calibration values for each instrument must be recorded for later use in ARGOS data processing.

VII. EXAMPLE MISSION PROGRAMMING

The example below illustrates programming a profiler for a typical 1000 m. deployment.
Total DOWN time is entered as 240 hours (60 intervals of 4 hours each)
Total UP time is 18 hours (6 intervals).
User entries are shown **boldface**, comments in *italics*.
Entries must be UPPER CASE.

After reset, the terminal lists status.

L APF version 1 27 97 — *software revision date*

DD123 ARGOS ID number. — *current ID in hex format*
098 seconds repetition rate.
001 hour Trip interval. — *these intervals are from an accelerated testing sequence*
001 intervals DOWN.
001 intervals UP.
005 minutes deep pump time.
005 minutes 1st surface pump time.
010 minutes 2nd surface pump time.
010 minutes ascend time.
+
A 859FB <ENTER> *enter new ARGOS ID in hex format*
A 859FB+
R 90 <ENTER> *enter ARGOS transmission rep. rate of 90 seconds*
090 +
T 4 <ENTER> *enter trip interval of 4 hours*
004 +
D 60 <ENTER> *enter 60 down intervals*
60 +
U 6 <ENTER> *enter 6 up intervals*
006 +
P 1 16 <ENTER> *enter P1 pump of 16 minutes*
016 +

P 2 10 <ENTER> *enter P2 pump of 10 minutes*
010 +
P 3 100 <ENTER> *enter P3 pump of 100 minutes*
070 +
Y 250 <ENTER> *enter ASCEND time (the pause between P1 and P2) of 250 minutes.*
250 +

L APF version 1 27 97 *now list status to confirm*

859FB ARGOS ID number.
090 seconds repetition rate.
004 hour Trip interval.
060 intervals DOWN.
006 intervals UP.
016 minutes deep pump time.
010 minutes 1st surface pump time.
100 minutes 2nd surface pump time.
250 minutes ascend time.
+

VIII. Reset and Self Test

Profilers are generally shipped to the deployment site in Hibernate mode. Shortly before deployment, the profiler is reset by passing a magnet over a marked location on the pressure case. The profiler then runs a self-test, transmits for 6 hours, then begins its preprogrammed mission.

It is preferable to deploy during the 6 hour transmission period, because the external bladder is full, preventing trapped air in the lower endcap. If deployment is delayed, the profiler can be reset again to keep the bladder full.

The six ARGOS transmissions during self test do not contain meaningful data, nor do the transmissions during the initial 6 hour period.

Procedure:
- Hold the provided magnet at RESET position marked on the hull for several seconds.
- Note: The internal magnetic reed switch must be activated (held) for at least one second to reset the instrument. (This is to provide a safety against accidental reset during transport.)

Thus, if the ALACE does not respond as below, the instrument was probably not reset.
- The pump will operate for 1 second, this is best heard with your ear against the pressure case.
- PTT will transmit 6 times at 6 second intervals. Place the ARGOS receiver/beeper close to the antenna to detect transmissions.
- Pump will operate for 16 seconds.
- After a pause, the pump will start again.

- The bladder will expand, this should take 30 - 60 minutes.
- 6 hours after reset, the bladder will deflate, the profiler begins its programmed mission.

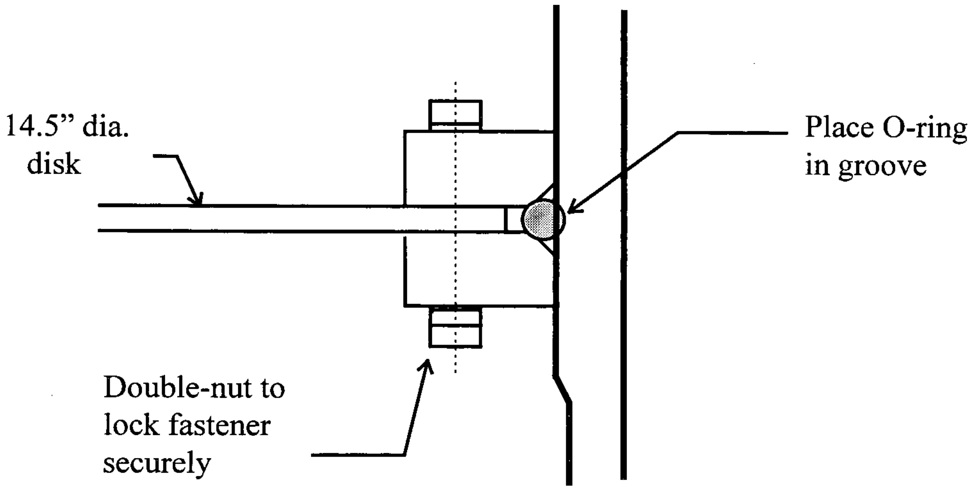
During self test, the controller checks the internal vacuum sensor. If the internal pressure has increased above a preset limit (i.e. hull leakage caused loss of vacuum), the instrument will not transmit or pump. This preset limit is 60 counts. See vacuum sensor section.

If you do not detect the 6 test transmissions, or if the bladder does not inflate, then the self test has failed and the instrument should not be deployed.

IX. Mounting Damper Disk

To aid surface following, a 14.5" diameter disk is mounted to the outside of the pressure case. The damper parts should be ballasted with each instrument, and numbered accordingly. Below are instructions which should be provided to the deployment crew:

- Remove the ALACE from the crate and secure horizontally on foam cradles.
- Unpack the appropriate numbered stability disk and hardware kit.
- Place the O-ring in the groove (located near the top of the pressure case) as shown.
- Sandwich the clear disk between 2 gray collars.
  NOTE: the chamfered edge of the collar must be toward the O-ring as shown below.
- Install 6 bolts firmly - use 2 flatwashers for each bolt, one on each side of collar.
- Using two wrenches, tighten the second nut against the first to lock fasteners in place.
- Note: Be sure to use the hardware particular to each instrument as each ALACE is ballasted to .1 grams.



X. Deployment

- RESET instrument.
- SELF TEST starts automatically (see above).
- When pump stops, external bladder is full, PTT will transmit for 6 hours at 90 second intervals.
- Six hours after reset, the bladder will deflate.
- It is preferable to deploy ALACE with its external bladder full, this prevents trapped air in the lower endcap cavity. So, deploy within 6 hours after RESET.

- Pass a rope through the hole in the stability disk.
- Holding both ends of the rope, carefully lower the ALACE into the water.
- Take care not to damage the antenna.
- Do **not** leave the rope with the instrument, release one end and retrieve the rope.
- The ALACE will remain on the surface until the 6 hour interval has expired.

XI. ARGOS DATA

A. SERVICE ARGOS PARAMETERS

The user must specify various options to Service ARGOS. These choices depend on how the user wishes to receive and process data. Typical parameters are listed below:

Standard location.
Processing: Type A2 (pure binary input; hexadecimal output)
Results Format: DS (all results from each satellite pass), Uncompressed.
Distribution Strategy: Scheduled, all results, every 24 hours.
Number of bits transmitted: 32

B. DATA FORMAT and CONVERSION

Data is sent via ARGOS in 32 byte messages. The first byte in every message is a CRC byte that can be used to verify the other 31 bytes. The second byte in every message is a sequential message number. The remaining 30 bytes are used for data transmission.

Message number one has the following format:

This applies to software version 11-21-96, board s/n 1-5

Byte	
01	CRC
02	Message number
03	Serial number
04	Profile number
05	Profile length
06	Profile termination flag byte
07 & 08	Bottom temperature
09	Bottom ocean pressure
10	Battery voltage
11	Surface pressure
12 to 32	2 byte temperature measurement.

The profile length is the number of bytes from the profile length byte through the last temperature measurement.

The profile termination flag byte can have the following values:

00	Pressure reached surface pressure.
01	Programmed ascent time ran out before surface.
02	Pressure reached zero.
04	Pressure unchanged for 17 minutes.

Longer profiles will have sequential messages with a CRC byte, a message number and up to 15 double bytes of temperature data in each ARGOS message.

C. The CRC

Because ARGOS data may contain transmission errors, the first byte of each message contains an error checking value. This value is a Cyclic Redundancy Check (CRC), and is calculated as a function of the message content (bytes 2 to 32).

- For each message, calculate a CRC value
- Compare the calculated CRC to the transmitted CRC (byte no. 1)
- If the calculated and transmitted CRC values are not equal, the message has been corrupted and should be deleted before further data processing.

Below is a sample program (in BASIC) to calculate the CRC value for a message.

```
DECLARE FUNCTION CRC% (IN() AS INTEGER, N AS INTEGER)
'CRC routine to check data validity in ARGOS message.
'Bathy Systems, Inc. RAFOS Float data transmission.
'3 December, 1990.
'The 1st of 32 bytes in an ARGOS message is the CRC.
'The function CRC will compute CRC for byte 2 through 32.
'Hasard is used for Random because Random is reserved by BASIC.
'Stored as file CRC in C:\RAFOS\RAF11.
DECLARE SUB Hasard (ByteN AS INTEGER)
DEFINT A-Z
DIM in(32) AS INTEGER
'RAF11F message number 08 HEX ID 11502 01-02-93   CRC is O.K.
A$ = "8F00081C8E47239148A4D2E9743A1D0E070381C06030984C2693492492C964B2"

        N = 32
        FOR I = 1 to N
                in(I) = VAL("&H" + MID$(A$, 2 + I - 1, 2))
        NEXT I
        PRINT in(1); CRC(in(), N);

FUNCTION CRC% (IN() AS INTEGER, N AS INTEGER) STATIC
DIM ByteN as INTEGER
         I = 2
 ByteN = in(2)
                DO
                        CALL Hasard(ByteN)
                        I = I + 1
                        ByteN = ByteN XOR in(I)
                LOOP UNTIL  I = N
        CALL Hasard (ByteN)
        CRC = ByteN
END FUNCTION

DEFINT A-Z
SUB Hasard (ByteN AS INTEGER) STATIC
x% = 0
        IF ByteN = 0 THEN ByteN = 127: EXIT SUB
        IF (ByteN AND 1) = 1 THEN x% = x% + 1
        IF (ByteN AND 4) = 4 THEN x% = x% + 1
        IF (ByteN AND 8) = 8 THEN x% = x% + 1
        IF (ByteN and 16) = 16 THEN x% = x% + 1
        IF (X% AND 1) = 1 THEN
                ByteN = INT(ByteN / 2) + 128
        ELSE
                ByteN = INT(ByteN / 2)
        END IF
END SUB
```

XII. Schematic and Flow Charts