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USER MANUAL – APEX RAFOS-SBE PROFILER

APEX-SBE INSTRUMENTS
Serial #'s 1644~1648 with RAFOS Receiver

WRC Job no. IFM 1001
Manual Rev Date: 7-25-04
Software Rev 07-08-04
Profile depth: 2000 dbar

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. System Description – Subsurface Acoustic Tracking

For this application, a RAFOS acoustic receiver was integrated to the APEX CTD profiler, to enable subsurface acoustic tracking. The acoustic receiver is made by SeaScan, and was integrated to the APEX controller by Bathy Systems. A Benthos AQ-16 hydrophone, mounted to the upper end cap, is connected to the receiver.

The standard APEX profiler carries a SeaBird model 41 CTD sensor, which samples salinity, temperature, and pressure during up cast. Samples are taken at predetermined pressure values (ie the depth table, see section VII part B).

Two acoustic reception windows, each 80 minutes long, are opened each day. The acoustic receiver is active only during these windows, which must be synchronized with the acoustic source transmissions. For each acoustic reception window, three correlation heights (one byte) and three travel times (2 bytes) are recorded.

Note the acoustic window times are programmed in firmware and cannot be changed via an external terminal.

Correlation height range is 0 – 255 decimal. .

Travel time: elapsed time between start of 80 minute window and end of 80s acoustic signal. For example, if start of 80s acoustic signal coincides with start of 80 minute window, value returned is 80s. Each count = 0.3075 seconds

III. Ice detection feature

1) The median of 7 near-surface temperature points (50, 45, 40, 35, 30, 25, 20 db) is calculated. If the median is less than -1.79 C, there is a high probability of ice, so ascent is aborted, and the profile data are discarded. The next profile will occur on the same schedule, and the profile number (byte 06 of message one) will increment for each ascent, regardless of whether or not the abort occurs. If a profile has been aborted due to ice detection byte 18 of message one will increment by one for each occurrence.

2) If ASCEND TIME (P9) expires before pressure has reached the surface pressure, and current T < -1.79 C (one sample) then abort. If T ≥ -1.79 C, the float will go to maximum buoyancy condition and attempt to surface.

Ascend time is typically set to 150-200% of expected time required for ascent at 0.08 m/s. A standard float goes to maximum buoyancy when ascend time expires. This feature is intended to ensure that the float reaches the surface in locations with unusual near-surface stratification.

IV. Testing

See separate Final Test Manual. Shown Below are tests unique to the optional Rafos feature.

A. TIMING and CLOCK SETTING/CHECKING

All time values are entered in GMT.
Note the APEX clock is momentarily interrupted (stopped) when the RESET magnet is used to activate the float.
Apex Rafos clock time is transmitted in message 1 in bytes 18 & 19. Clock error can be determined by comparing to Argos time stamp.
To Check Apex Clock time, while connected to a terminal enter upper case T
To Set Apex Clock time enter lower case t followed by hh mm ss (spaces necessary), time is set on carriage return.

<u>Screen shot of Time check and set:</u>

```
T 16:17:22
+
t Set clock as hh mm ss.  Esc to exit.
16 17 45
16 17 45
+
```

B. Acoustic Receiver Test

When deployed the acoustic receiver has two 80 minute listen periods per day storing the 3 largest correlations per period begun at 01:00 and 13:00 with 13:00 followed by a CTD sample. With a terminal connected to the float the listen period can be tested.

The Rafos Acoustic Receiver can be tested by Issuing command Ir (case sensitive). An 82 minute process is begun with an 80 minute "listen" period opened immediately. 82 (or more) minutes after Ir command is issued the command Ic should be issued and the results will be displayed on the screen. The Apex will then list in hex the six best correlation heights and corresponding times. Each count equals .3075 seconds.

<u>Screen shot</u>

I c D5 13A8 36 26FA 34 1B42 30 297A 2E 392F 2D 2879

In example above the first correlation height of D5 is a decimal value of 213 and 13A8 (hex) is a time of 1547.3 seconds.

V. Reset and Self Test

Attention: Floats should not be reset between (10:00 and 12:00) and (22:00 and 24:00) GMT as this will result in a Rafos acoustic window being lost. This assumes float timing reflected in this manual has not been changed. If timing is changed please consult Webb Research or understand that the last Rafos window before surfacing could be jeopardized.

Profilers are shipped to the deployment site in Hibernate mode. Shortly before deployment, reset the profiler by passing a magnet over the marked location on the pressure case. The profiler will run a self-test, transmit for *5 to 6 hours with the bladder extended, and then begin its pre-programmed mission.

*Note Rafos Apex Floats will descend at the beginning of the 6th hour after reset. Ie if float is reset at 00 30 00 float will descend at 05 00 00

The six ARGOS transmissions during self-test and the transmissions during the initial 6 hour period contain data about the instrument and are outlined in (V) ARGOS DATA, part (C) TEST MESSAGE FORMAT.

Procedure:

1. Secure float in horizontal position, using foam cradles from crate.

IMPORTANT: Remove plastic bag and three plugs from CTD sensor, if they have not already been removed.

2. Minimum temperature –2 deg C. If necessary, let float warm indoors before proceding.

3. Carefully pry black rubber plug out of bottom center of yellow plastic cowling to verify bladder inflation (per below). **Be sure to replace plug before deployment.**

Note: it can be very difficult to replace plug when air bladder is fully inflated. Replace plug during beginning of air bladder inflation. Purpose of plug is to prevent silt entry if float contacts sea floor.

4. Hold provided magnet at RESET position marked on for several seconds, then remove magnet.

Note: Magnetic 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 float does not respond as below, the instrument was probably not reset.**

5. The air pump will operate for 1 second.
6. The PTT will transmit 6 times at 6 second intervals. Place ARGOS receiver/beeper close to antenna to detect transmissions.
7. The piston pump will begin to operate. The piston will move to the retracted Storage Position, if not already there, pause 2 seconds and then move to full extension.
8. The oil bladder will expand, this should take 15 - 25 minutes.
9. After the piston pump stops, PTT will transmit at specified ARGOS rate.
10. At every PTT transmission, the air pump will turn on for 6 seconds until the air portion of the bladder has been inflated. The pump should turn on 8 – 10 times.
11. 6 hours after reset, transmissions will cease, the bladder will deflate, and the piston pump will retract, the profiler begins its programmed mission.
12. Reminder - replace black rubber plug in cowling hole before deployment.

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!**

VI. Deployment

- RESET instrument.
- SELF-TEST starts automatically (see above).
- When piston pump stops, air pump inflates, external bladder is full, PTT will transmit for 6 hours at ARGOS Repetition rate intervals. Normally 90 seconds.
- Six hours after reset, the piston pump will retract and bladder will deflate. Deploy before this time is up or reset the instrument again to re-initialize the 6 hour period. The purpose is to have the instrument on the surface and receive test transmissions.
- Pass a rope through the hole in the damper plate.
- Holding both ends of the rope, carefully lower the float 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 float will remain on the surface until the 6 hour interval has expired

VII. 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 bytes transmitted: 31 per message*

Note: Webb Research strongly recommends all users to use ARGOS "Multi Satellite Service", which provides receptions from 3 satellites instead of 2 for a small incremental cost.

* Using Argos 28-bit ID Format, 31 data bytes are transmitted in each message. With 20-bit ID Format, each message had 32 data bytes. (see Appendix D for more information).

B. DATA FORMAT #23 -- 28 bit ID, with two Rafos windows

Data is sent via ARGOS in 31 byte hex messages. The number of 31 byte messages sent depends on the programmed quantity of temperature measurements per profile.

Format for message number 1 only:
Byte #

- 01 **CRC**, described in section C
- 02 **Message number**, Assigned sequentially to each 32 byte message (Total number of messages per profile is shown below). Messages are transmitted in sequential order starting with 1 and incrementing by one for the data set.
- 03 **Message block number**, begins as 1 and increments by one for every ARGOS message data set. This, combined with the ARGOS repetition rate (section VI), allows the user to track surface drift. Byte 03 will roll-over at 256 and will reset to 1 on each new profile.
- 04 & 05 **Serial number**, identifies the controller board number. (This may not be the same as instrument number.)
- 06 **Profile number**, begins with 1 and increases by one for every float ascent.
- 07 **Profile length**, is the number of six byte STD measurements in the profile. Total number of bytes of STD data from each profile depends on the sampling strategy chosen.
- 08 **Profile termination flag byte 2** –see appendix A
- 09 **Piston position**, recorded as the instrument reaches the surface.
- 10 **Format Number** (identifier for message one type)
- 11 **Depth Table Number** (identifier for profile sampling depths)
- 12 & 13 **Pump motor time,** in two second intervals. (multiply by 2 for seconds)
- 14 **Battery voltage,** at initial pump extension completion
- 15 **Battery current,** at initial pump extension completion one count = 13 mA
- 16 **profile piston position** *(park and profile floats only)*
- 17 **Air bladder pressure** measured in counts - approximately 148 counts
- 18 & 19 **Time** one count = +2 seconds from 00:00:00
- 20 **Abort Profile count (ice detect feature)**

Rafos Data format begins: (An example of Decoded data is included in appendix D)

APF-8R RAFOS listen schedule and data storage format

Listening schedule: 80 minute listen period (window) at following times:

Window	**byte**	
01:00	**21**	**largest correlation height**
	22 & 23	**largest correlation time**
	24	**2nd largest correlation height**
	25 & 26	**2nd largest correlation time**
	27	**3rd largest correlation height**
	28 & 29	**3rd largest correlation time**

Window byte
13:00 30 largest correlation height
31 & 03 (of message2) largest correlation time (split between messages)
04 2nd largest correlation height
0 5 & 06 2nd largest correlation time
07 3rd largest correlation height
08 & 09 3rd largest correlation time

Each travel time count is one .3075 second tick.
The Ctd is sampled after the 13:00 listen period
10 & 11 Temperature
12 & 13 Salinity
14 & 15 Pressure.

The above Rafos data format is repeated for each day at depth.

The RAFOS data block end is marked with DDDD.

RAFOS data end:
two bytes "**DD**" Marker for end of Rafos data
- two bytes **Park temperature**, sampled just before instrument descends to profile depth.
- two bytes **Park salinity**, sampled just before instrument descends to profile depth.
- two bytes **Park pressure**, sampled just before instrument descends to profile depth.
- one byte **Park battery voltage**, no load
- one byte **Surface battery voltage,** no load
- two bytes **Surface Pressure** as recorded just before last descent with an offset of +5 dbar
- one byte **Internal vacuum** measure in counts- approximately 101 counts
- one byte **park piston position**
- one byte **SBE pump current**
-

Depth Table Sampling begins

- two bytes **Bottom temperature**
- two bytes **Bottom salinity**
- two bytes **Bottom pressure**

T,S & P Sampling Continues Per Depth Table

FFFF: Invalid data points to fill last 31-byte ARGOS message (end of Depth Table Sampling)

Format for message number 2 and higher:

Byte #
- 01 **CRC**, described in section C.
- 02 **Message number**

– 03-32 in sequence described.
– Note: Should the first byte of a two-byte value fall in byte 31, the remaining byte will be byte # 3 in the next message.

Profile length, and number of ARGOS messages, may change if bottom pressure varies. APEX records a profile during ascent (ie up cast). Bottom pressure may change due to several causes, such variation of insitu density, internal waves, float grounding in shallows, change of float mass, etc. APEX automatic depth adjustment will compensate in most, but not all, cases.

Indicators of float grounding:

- Bottom pressure is reduced
- Profile length (byte 07 of message 01) is reduced. This may result in fewer ARGOS messages.
- Bottom piston position decreases to 12 (typical value is 20-30)

The number of sample points taken is proportional to depth, as per sample depth table below. The first (i.e. deepest) sample is taken at the first point in the depth table above bottom pressure.

Depth Table No 38

sample point	pressure dbar	sample point	pressure dbar	sample point	pressure dbar	sample point	pressure dbar
1	2000	19	480	37	240	55	80
2	1900	20	460	38	230	56	75
3	1800	21	440	39	220	57	70
4	1700	22	420	40	210	58	65
5	1600	23	400	41	200	59	60
6	1500	24	380	42	190	60	55
7	1400	25	360	43	180	61	50
8	1300	26	350	44	170	62	45
9	1200	27	340	45	160	63	40
10	1100	28	330	46	150	64	35
11	1000	29	320	47	140	65	30
12	900	30	310	48	130	66	25
13	800	31	300	49	120	67	20
14	700	32	290	50	110	68	15
15	650	33	280	51	100	69	10
16	600	34	270	52	95	70	7
17	550	35	260	53	90	71	4 or surf
18	500	36	250	54	85		

* The SeaBird CTD is not sampled at zero pressure, to avoid pumping the cell dry and/or ingesting surface oil slicks. The shallowest profile point is taken at either 4 dbar or at the last recorded surface pressure plus 5 dbar, whichever value is larger.

C. TEST MESSAGE FORMAT

The test message is sent whenever an **I2** command is given, the six transmissions during the startup cycle, and during the six hour surface mode period prior to the first dive. Each test message has 31 bytes, in hex unless otherwise noted, with the following format:

Byte #

- 01 **CRC**, described in section C.
- 02 **Message block number**, begins as 1 and increments by one for every ARGOS message.
- 03 & 04 **Serial number**, identifies the controller board number. (This may not be the same as instrument number.)
- 05 & 06 **Time** one count = +2 seconds from 00:00:00
- 07 **Flag (2) byte**
- 08 & 09 **Current pressure**
- 10 **Battery voltage**
- 11 **Current Bladder pressure,** in counts
- 12 **Flag (1) Byte**
- 13 **Up time**, in intervals
- 14 & 15 **Down time**, in intervals
- 16 & 17 **Park pressure,** in dbar
- 18 **Park piston position**, in counts
- 19 **Depth correction factor,** in counts
- 20 **Ballast / storage piston position**, in counts
- 21 **Fully extended piston position**, in counts
- 22 & 23 **Profile pressure**
- 24 **profile piston position**
- 25 **OK vacuum count at launch**, in counts
- 26 **Ascend time**, in intervals
- 27 **Target bladder pressure**, in counts
- 28 **initial piston extension count**
- 39 **Month**, software version number (in decimal).
- 30 **Day**, software version number (in decimal).
- 31 **Year**, software version number (in decimal).

Flag (2) byte:
1 rafos corr done
2 Pressure reached zero
3 25 minute Next Pressure timeout
4 piston fully extended before surface
5 Ascend time out
6 Test message at turn on
7 Six hour surface message
8 Seabird string length error

Flag (1) byte:
1 Trip interval time
2 Profile in progress
3 Timer done
4 UP/ DOWN
5 Arithmetic round up
6 Measure battery
7 Piston motor running
8 Negative SBE number

D. Telemetry error-checking (CRC)

Because ARGOS data contains 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.

Appendix (B) lists 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

E. Conversion from hexadecimal to useful units

The pressure is measured every 6 seconds. Temperature, salinity and pressure are measured and stored at each point in the depth table. Two hex bytes are stored for each sensor. The decimal numbers from the STD sensors are converted to hex for compression in the ARGOS transmission as follows:

Temperature: 5 digits, 1 milli-degree resolution.
Salinity: 5 digits, .001 resolution
Pressure: 5 digits, 10 cm resolution.

To convert the hex ARGOS message back to decimal numbers:

	hex →	dec	=	converted	units
Temperature:	3EA6 →	16038	=	16.038	C
Temperature*:	F58B →	02677	=	-2.677	C
Salinity**:	8FDD →	36829	=	36.829	
Pressure:	1D4C →	7500	=	750.0	decibars
Current:	0A→	10	=	130	mA
Volts:	99 →	153	=	15.7	volts
Correlation time:	03DE →	990	=	304.425	Seconds

Voltage (V) = counts/10 + .4 (counts is in decimal number) nominally 15 V and decreasing.
Current (mA) = counts *13 (counts is in decimal number)
Vacuum (inHg) = counts *-0.209 + 26.23 (counts is in decimal number) nominally 5 inHg.

*Note regarding <u>negative</u> temperatures (T °C < 0)
Positive temperature range is 0 to 62.535C (0 to F447 hex)
Negative temperature range is -0.001 to -3.000C (FFFF to F448 hex).
If (hex value) ≥ F448, then compute FFFF - (hex value) = Y
Convert Y to decimal = dec_Y
(dec_Y + 1) / 1000*-1 = degrees C

**The 5 most significant salinity digits are telemetered. The 6 digit salinity number is rounded up and converted to hex. 36.8286 rounds to 36.829 and converts to 8FDD.

VIII. MISSIONS

This section lists the parameters for each float covered by this manual.
The parameter listing appears when the float is RESET while connected to a terminal.

INSTRUMENT # 1644

APEX version 07 08 04 sn 1927 023 038
78D0413 ARGOS ID number.
044 seconds repetition rate.
219 hours DOWN.
021 hours UP.
0200 d-bar park pressure. P1
130 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
243 piston full extension. P5
2000 d-bar profile pressure. P6
025 profile piston position. P7
115 OK vacuum count. P8
009 hours ascend time. P9
145 air bladder pressure. PB
025 Initial piston extension.
19:10:24

INSTRUMENT #1645

APEX version 07 08 04 sn 1971 023 038
78D0426 ARGOS ID number.
046 seconds repetition rate.
219 hours DOWN.
021 hours UP.
0200 d-bar park pressure. P1
130 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
250 piston full extension. P5
2000 d-bar profile pressure. P6
025 profile piston position. P7
115 OK vacuum count. P8
009 hours ascend time. P9
145 air bladder pressure. PB
025 Initial piston extension.
18:56:04

INSTRUMENT # 1646

APEX version 07 08 04 sn 1972 023 038
78D0435 ARGOS ID number.
044 seconds repetition rate.
219 hours DOWN.
021 hours UP.
0200 d-bar park pressure.   P1
130 park piston position.   P2
012 ascent rate correction. P3
100 storage piston position. P4
253 piston full extension.   P5
2000 d-bar profile pressure. P6
025 profile piston position. P7
115 OK vacuum count.   P8
009 hours ascend time.   P9
145 air bladder pressure.   PB
025 Initial piston extension.
19:13:40

INSTRUMENT #1647

APEX version 07 08 04 sn 1973 023 038
78D044C ARGOS ID number.
046 seconds repetition rate.
219 hours DOWN.
021 hours UP.
0200 d-bar park pressure.   P1
130 park piston position.   P2
012 ascent rate correction. P3
100 storage piston position. P4
247 piston full extension.   P5
2000 d-bar profile pressure. P6
025 profile piston position. P7
115 OK vacuum count.   P8
009 hours ascend time.   P9
145 air bladder pressure.   PB
025 Initial piston extension.
19:04:06

INSTRUMENT #1648

APEX version 07 08 04 sn 1974 023 038
78D045F ARGOS ID number.
044 seconds repetition rate.
219 hours DOWN.
021 hours UP.
0200 d-bar park pressure.   P1
130 park piston position.   P2
012 ascent rate correction. P3
022 storage piston position. P4
247 piston full extension.   P5
2000 d-bar profile pressure. P6
025 profile piston position. P7
115 OK vacuum count.   P8
009 hours ascend time.   P9
145 air bladder pressure.   PB
025 Initial piston extension.
15:26:24

Appendix A: Flag Byte Description

Two memory bytes are used, one bit at a time, to store 16 different bits of program flow information. Both of these bytes are telemetered in the test messages sent at startup and for the initial 6 hour surface period. Only flag byte 2 is sent in the data messages, as part of message number 1. Bit one is set for each deep profile .

Below is a list of what each bit in each byte signifies.

	bit	
Flag (2) byte:	1	Deep profile
	2	Pressure reached zero
	3	25 minute NextP timeout
	4	Piston fully extended
	5	Ascend timed out
	6	Test message at turn on
	7	Six hour surface message
	8	Seabird string length error

	bit	
Flag (1) byte:	1	Trip interval time
	2	Profile in progress
	3	Timer done (2 min bladder deflate time.)
	4	UP/DOWN
	5	Arithmetic round up
	6	Measure battery while pumping
	7	Piston motor running
	8	Negative SBE number

The flag bytes are transmitted as two hex characters with four bits of information encoded in each character. Each hex character can have one of 16 different values as shown in the following table.

1	0	0000	10	9	1001
2	1	0001	11	A	1010
3	2	0010	12	B	1011
4	3	0011	13	C	1100
5	4	0100	14	D	1101
6	5	0101	15	E	1110
7	6	0110	16	F	1111
8	7	0111			
9	8	1000			

Bit 8 is the most significant bit and bit 1 is the least significant bit in the byte.

As an example: if a deep profile ended with the piston fully extended and ascend had timed out, then bits 1, 4 and 5 would be set in the termination byte. This binary pattern, 0001 1001, would be transmitted as the two hex characters, 19.

As another example: if a regular profile ended with the piston fully extended and the 25 minute next pressure had timed out, then bits 3 and 4 would be set in the termination byte. This binary pattern, 0000 1100, would be transmitted as the two hex characters, 0C.

Appendix B: CRC Algorithm in BASIC

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
```

Appendix C: Surface arrival time, and total surface time

Some users may wish to determine surface arrival time, and total surface time, in order to calculate drift vectors.

Although each 32-byte message is time-stamped by ARGOS, there may not be a satellite in view when the float surfaces.

When the float surfaces (ie detects surface pressure recorded before last descent) it will begin ARGOS telemetry. Messages are transmitted in numerical order, starting with message no. 1.
When all messages have been transmitted, the cycle starts again at message no. 1.

<u>Elapsed time since surfacing (Te)</u>

Te = (m-1)*n*r
Where: m =   message block number (byte 03 of message 01)
n =   total number of messages to transmit profile
r =   repetition rate

Total number of messages (n) is described in section IV (b), or may be determined from the ARGOS data. Note (n) may be less than specified in user manual if the float is operating in shallow water, causing reduced profile length.

Repetition rate (r) is the time interval between ARGOS transmissions. This value can be determined from section V, or from the ARGOS data.

<u>Approximate time of surfacing</u>

Approximate time of surfacing can be determined by subtracting Te from the ARGOS time stamp

<u>Example</u>

Below is message 01 in DS format

2001-11-02 22:47:54 1 CF 01 05 02
AF 02 2F 00
85 01 01 01
16 92 17 19
FF 9E 94 01
AD 85 09 1F
48 97 9B 00
46 62 24 0E

m =   message block number (byte 03) = 5
n =   total number of messages to transmit profile = 11
r =   repetition rate = 62 seconds

Te = elapsed time since surfacing = (m-1)*n*r = (5-1)*11*62 s = 2728 s = 00h 45m 28s

Approximate time of arrival at surface:
ARGOS time stamp - Te = 22:47:54 - 00:45:28 = 22:02:26

Total time spent at surface transmitting (Tsurf):

This is determined by subtracting ascent time from UP time.
Tsurf = (UP time, hr) - (bottom pressure)/(ascent rate 0.08 dbar/s)/3600

Bottom pressure is telemetered as bytes 24 & 25 of message 01.

Example:

For bottom pressure of 2000 dbar, and UP time of 18 hours
Tsurf = (18 hr) - (2000/0.08/3600) = 11 hr

APPENDIX E: CTD Calibration and Ballasting records