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USER MANUAL – APEX-SBE PROFILER

APEX-SBE INSTRUMENTS
Serial # 1846~1850

WRC Job no. 1043 AWI
Manual Rev Date: 11-11-04
Software Rev 06-27-02

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, reset the profiler by passing a magnet over the marked location on the pressure case. The profiler will run a self-test, transmit for 6 hours with the bladder extended, and then begin its pre-programmed mission.

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.

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.**

Purpose of plug is to prevent silt entry if float contacts sea floor.

4. 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 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 the ARGOS receiver/beeper close to the antenna to detect transmissions.
7. The piston pump will begin to operate. The piston will move to the retracted Ballast 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, the PTT will transmit at the 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!**

III. 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.

IV. 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: 32 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.

B. 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 $T \geq -1.79$ 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.

C. DATA FORMAT #6

Data is sent via ARGOS in 32 byte hex messages. The number of 32 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 flag byte description

  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
- 16 **Air pump current**
- 17 **Profile piston position**
- 18 **Ice detect count,** increments by one every time float aborts profile due to ice detection
- 19 **Air bladder pressure,** in counts
-
- <u>The following data format assumes a 10 day cycle with park samples recorded every 24 hours. The data format will change if either of these parameters are changed.</u>
-
- 20 & 21 **1st sample at depth - temperature**, sampled at 24 hrs.
- 22 & 23 **1st sample at depth - salinity**, sampled at 24 hrs.
- 24 & 25 **1st sample at depth - pressure**, sampled at 24 hrs.
- 26 & 27 **2nd sample at depth - temperature**, sampled at 48 hrs.
- 28 & 29 **2nd sample at depth - salinity**, sampled at 48 hrs.
- 30 & 31 **2nd sample at depth - pressure**, sampled at 48 hrs.
- 32 **First of two bytes *of 3rd sample at depth temperature.***

Format for message number 2:

Byte #

- 01 **CRC**, described in section C.
- 02 **Message number**
- 03 **second of two bytes *of 3rd sample at depth* – temperature** sampled at 72 hrs.
- 04 & 05 **3rd sample at depth - salinity**, sampled at 72 hrs
- 06 & 07 **3rd sample at depth - pressure**, sampled at 72 hrs.
- 08 & 09 **4th sample at depth – temperature** sampled at 96 hrs
- 10 & 11 **4th sample at depth - salinity**, sampled at 96 hrs
- 12 & 13 **4th sample at depth - pressure**, sampled at 96 hrs.
- 14 & 15 **5th sample at depth – temperature** sampled at 120 hrs
- 16 & 17 **5th sample at depth - salinity**, sampled at 120 hrs
- 18 & 19 **5th sample at depth - pressure**, sampled at 120 hrs.
- 20 & 21 **6th sample at depth – temperature** sampled at 144 hrs
- 22 & 23 **6th sample at depth - salinity**, sampled at 144 hrs
- 24 & 25 **6th sample at depth - pressure**, sampled at 144 hrs.
- 26 & 27 **7th sample at depth – temperature** sampled at 168 hrs
- 28 & 29 **7th sample at depth - salinity**, sampled at 168 hrs
- 30 & 31 **7th sample at depth - pressure**, sampled at 168 hrs.
- 32 **First of two bytes *of 8th sample at depth temperature***

Format for message number 3

Byte #

- 01 **CRC**, described in section C.
- 02 **Message number**
- 03 **second of two bytes *of 8th sample at depth* – temperature** sampled at 192 hrs.
- 04 & 05 **8th sample at depth - salinity**, sampled at 192 hrs
- 06 & 07 **8th sample at depth - pressure**, sampled at 192 hrs.
- 08 & 09 **9th sample at depth – temperature** sampled at 216 hrs
- 10 & 11 **9th sample at depth - salinity**, sampled at 216 hrs
- 12 & 13 **9th sample at depth - pressure**, sampled at 216 hrs.

  14 & 15 **Park temperature**, sampled just before instrument ascends
- 16 & 17 **Park salinity**, sampled just before instrument ascends.
- 18 & 19 **Park pressure**, sampled just before instrument ascends.
- 20 **Bottom battery voltage**, no load

  21 **Surface battery voltage,** no load
- 22 & 23 **Surface Pressure,** recorded just before last descent with offset of +5 dbar
- 24 **Internal vacuum**
- 25 **park piston position**
- 26 **SBE pump current**
- 27 & 28 **temperature – Begin depth table sampling**
- 29 & 30 **salinity – Begin depth table sampling**
- 31 & 32 **pressure – Begin depth table sampling**

Format for message number 4 and higher:

Byte #

- 01 **CRC**, described in section C.
- 02 **Message number**
- 03 to 32 6 bytes in sequence:
  - 2 bytes **temperature**
  - 2 bytes **salinity**
  - 2 bytes **pressure**

The above data format assumes a 10 day cycle with park samples recorded every 24 hours. The data format will change if either of these parameters are changed

Message Format and Sampling Depths

BTYE #	MSG 3
14 & 15	Tp*
16 & 17	Sp*
18 & 19	Pp*

BTYE #	MSG 3	MSG 4	MSG 5	MSG 6	MSG 7	MSG 8	MSG 9
3 &4	X	T2	T7	T12	T17	T22	T27
5 & 6	X	S2	S7	S12	S17	S22	S27
7 & 8	X	P2	P7	P12	P17	P22	P27
9 & 10	X	T3	T8	T13	T18	T23	T28
11 & 12	X	S3	S8	S13	S18	S23	S28
13 & 14	X	P3	P8	P13	P18	P23	P28
15 & 16	X	T4	T9	T14	T19	T24	T29
17 & 18	X	S4	S9	S14	S19	S24	S29
19 & 20	X	P4	P9	P14	P19	P24	P29
21 & 22	X	T5	T10	T15	T20	T25	T30
23 & 24	X	S5	S10	S15	S20	S25	S30
25 & 26	X	P5	P10	P15	P20	P25	P30
27 & 28	T1	T6	T11	T16	T21	T26	T31
29 & 30	S1	S6	S11	S16	S21	S26	S31
31 & 32	P1	P6	P11	P16	P21	P26	P31

BTYE #	MSG 10	MSG 11	MSG 12	MSG 13	MSG 14	MSG 15	MSG 16	MSG 17
3 & 4	T32	T37	T42	T47	T52	T57	T62	T67
5 & 6	S32	S37	S42	S47	S52	S57	S62	S67
7 & 8	P32	P37	P42	P47	P52	P57	P62	P67
9 & 10	T33	T38	T43	T48	T53	T58	T63	T68
11 & 12	S33	S38	S43	S48	S53	S58	S63	S68
13 & 14	P33	P38	P43	P48	P53	P58	P63	P68
15 & 16	T34	T39	T44	T49	T54	T59	T64	T69
17 & 18	S34	S39	S44	S49	S54	S59	S64	S69
19 & 20	P34	P39	P44	P49	P54	P59	P64	P69
21 & 22	T35	T40	T45	T50	T55	T60	T65	T70
23 & 24	S35	S40	S45	S50	S55	S60	S65	S70
25 & 26	P35	P40	P45	P50	P55	P60	P65	P70
27 & 28	T36	T41	T46	T51	T56	T61	T66	T71
29 & 30	S36	S41	S46	S51	S56	S61	S66	S71
31 & 32	P36	P41	P46	P51	P56	P61	P66	P71

X see above data format

* Tp, Sp, and Pp are bottom Temperature, Salinity, and Pressure values

** T, S, and P are Temperature, Salinity, and Pressure values

*** **FFFF**: Invalid data points

Data format chart above assumes that bottom pressure (maximum hydrostatic pressure at start of profile) was reached. Data format will change if bottom pressure varies.

APEX records a profile during ascent (ie upcast). 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.

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
	Bottom				
1	2000	27	340	53	90
2	1900	28	330	54	85
3	1800	29	320	55	80
4	1700	30	310	56	75
5	1600	31	300	57	70
6	1500	32	290	58	65
7	1400	33	280	59	60
8	1300	34	270	60	55
9	1200	35	260	61	50
10	1100	36	250	62	45
11	1000	37	240	63	40
12	900	38	230	64	35
13	800	39	220	65	30
14	700	40	210	66	25
15	650	41	200	67	20
16	600	42	190	68	15
17	500	43	180	69	10
18	500	44	170	70	7
19	480	45	160	71	*4 or surf
20	460	46	150		
21	440	47	140		
22	420	48	130		
23	400	49	120		
24	380	50	110		
25	360	51	100		
26	350	52	950		

* 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.

D. 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 32 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 from start up,** in seconds
- 07 **Flag (2) byte**
- 08 & 09 **Current pressure,** in dbar
- 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 **Interval time,** in hours
- 17 & 18 **Park pressure,** in dbar*
- 19 **Park piston position**, in counts*
- 20 **Depth correction factor,** in counts
- 21 **Ballast / storage piston position**, in counts
- 22 **Fully extended piston position**, in counts
- 23 **OK vacuum count at launch**, in counts
- 24 **Ascend time**, in intervals
- 25 **Target bladder pressure**, in counts
- 26 & 27 **Profile Pressure**
- 28 **Profile piston position**
- 29 **Sample at Depth interval** (first sample taken at 24 hours after descent)
- 30 **Month**, software version number (in decimal).
- 31 **Day**, software version number (in decimal).
- 32 **Year**, software version number (in decimal).

Flag (2) byte:		Flag (1) byte:	
1	Deep profile	1	Trip interval time
2	Pressure reached zero	2	Profile in progress
3	25 minute Next Pressure timeout	3	Timer done
4	piston fully extended before surface	4	UP/ DOWN
5	Ascend time out	5	Data entry error
6	Test message at turn on	6	Measure battery
7	Six hour surface message	7	Piston motor running
8	Arithmetic round up	8	Negative SBE number

*these points will be bottom values for non park and profile floats sampled just before ascent.

E. 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 and bit 8 is set each time the last SBE sensor value used an arithmetic round up.

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.

F. 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
```

G. 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

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 negative 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.

V. MISSIONS

INSTRUMENT #1846

APEX version 06 27 02 sn 2207 006 038
7B0D3 ARGOS ID number.
044 seconds repetition rate.
001 hour Trip interval.
228 intervals DOWN.
012 intervals UP.
0800 d-bar park pressure. P1
096 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 ascend time intervals. P9
145 air bladder pressure. PB
024 hours bottom sample interval PD
025 Initial piston extension.

INSTRUMENT #1847

APEX version 06 27 02 sn 2208 006 038
7B139 ARGOS ID number.
044 seconds repetition rate.
001 hour Trip interval.
228 intervals DOWN.
012 intervals UP.
0800 d-bar park pressure. P1
096 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
252 piston full extension. P5
2000 d-bar profile pressure. P6
025 profile piston position. P7
115 OK vacuum count. P8
009 ascend time intervals. P9
145 air bladder pressure. PB
024 hours bottom sample interval PD
025 Initial piston extension.

INSTRUMENT #1848

APEX version 06 27 02 sn 2209 006 038
7B2BE ARGOS ID number.
044 seconds repetition rate.
001 hour Trip interval.
228 intervals DOWN.
012 intervals UP.
0800 d-bar park pressure. P1
096 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 ascend time intervals. P9
145 air bladder pressure. PB
024 hours bottom sample interval PD
025 Initial piston extension.

INSTRUMENT #1849

APEX version 06 27 02 sn 2210 006 038
7B78E ARGOS ID number.
046 seconds repetition rate.
001 hour Trip interval.
228 intervals DOWN.
012 intervals UP.
0800 d-bar park pressure. P1
096 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
251 piston full extension. P5
2000 d-bar profile pressure. P6
025 profile piston position. P7
115 OK vacuum count. P8
009 ascend time intervals. P9
145 air bladder pressure. PB
024 hours bottom sample interval PD
025 Initial piston extension.

INSTRUMENT #1850

APEX version 06 27 02 sn 2211 006 038
7BA46 ARGOS ID number.
044 seconds repetition rate.
001 hour Trip interval.
228 intervals DOWN.
012 intervals UP.
0800 d-bar park pressure. P1
096 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
251 piston full extension. P5
2000 d-bar profile pressure. P6
025 profile piston position. P7
115 OK vacuum count. P8
009 ascend time intervals. P9
145 air bladder pressure. PB
024 hours bottom sample interval PD
025 Initial piston extension.

VI. RECORDS & CALIBRATIONS

(included in hard copy only)