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APEX PROFILER USER MANUAL

Applies to Serial Numbers:	Revision Date:	07/14/08

4269 - 4278

Customer Name:BSH   BSH
WRC Job Number: 1451.9
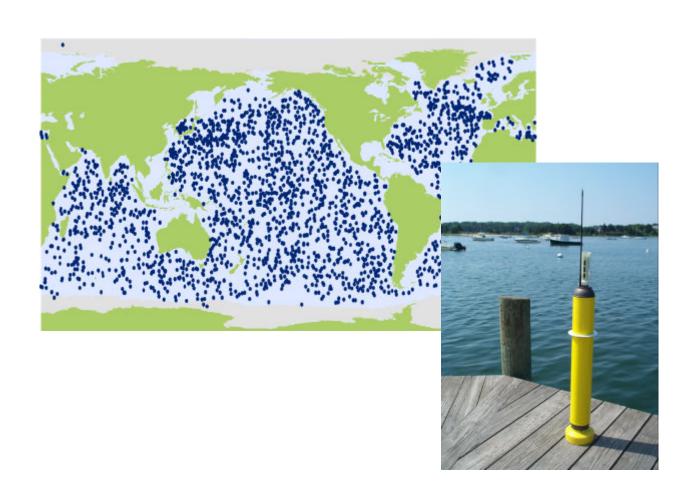Firmware Revision   APF9A F/W **062608**
Features:

APF9A Controller
Flash Depth Table 34   Park and Profile with 20- or 28-bit ARGOS ID
Profile Observation   Deep Profile First (DPF)
Pressure Activation (optional)

I.   Alkaline Battery Warning

The profiler contains batteries comprised of alkaline manganese dioxide "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 H_2O, and the instrument has been designed to relieve excessive internal pressure buildup by having the upper end cap 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.   APF9 Operations Warning for APF8 Operators

This APEX manual describes floats using a new controller design. The new design is designated APF9. The prior design, which is still in production and widely used, is designated APF8.

The operator interface and behavior of the APF9 are similar to, **but not identical to**, the operator interface and behavior of the APF8. If you are an experienced APF8 user, please observe appropriate cautions and **do not assume an expected behavior**. Several important differences are listed below. These points should also be helpful to those without an APF8 background.

- To reset an APF9 for a deployment you should hold the Reset Tool stationary against the RESET label until you hear the air pump run. Typically, the air pump will run 2 to 3 seconds after you position the Reset Tool over the RESET label. (For the APF8 it was necessary to hold the Reset Tool in place and then remove it to trigger the float.)
- The serial baud rate for communications is 9600, with 8 data bits, no parity, and 1 stop bit. (The APF8 baud rate is 1200.)
- If not already in Command Mode, an APF9 can only enter Command Mode from Sleep. Either the Reset Tool or a keystroke at the terminal will trigger the transition from Sleep to Command Mode.
- If the APF9 is performing some task (e.g., self tests), it is not listening and cannot be placed in Command Mode with either the Reset Tool or a keystroke at the terminal.
    - o There is one exception. If the piston is moving, the Reset Tool (but not a keystroke) can be used to terminate the move. The APF9 will transition to its next state or task. Typically this will be either Command Mode or Sleep, so try a keystroke or a second application of the Reset Tool after the piston stops to confirm or trigger the transition to Command Mode.
- If the APF9 is not responding, it is probably busy with some task. Be patient and occasionally try to get the attention of the float with either the Reset Tool or a keystroke.

III. Maximum Operating Pressure

APEX profilers have a maximum operating pressure of 2000 dbar (2900 psi).   However, for shallower applications, thinner walled pressure cylinders can be used.   These cylinders have a reduced pressure rating, but less mass, which allows them to carry a larger battery payload. Three cylinder pressure ratings are available:

- 2000 dbar   maximum pressure rating
- 1500 dbar   battery payload typically 14% greater than with 2000 dbar cylinder
- 1200 dbar   battery payload typically 28% greater than with 2000 dbar cylinder

For example, if an APEX profiler is specified by the customer for 1400 dbar maximum (profile) depth, then the 1500 dbar cylinder would normally be used.

CAUTION:

If you will be:

- Exposing floats to significant hydrostatic pressure during ballasting or testing
- Re-ballasting and re-programming floats for a depth greater than the original specification

Please contact Webb Research to confirm the pressure rating of specific floats.
Do not exceed the rated pressure, or the hull may collapse.

IV.   Evaluating the Float and Starting the Mission

Profilers are shipped to the customer in Hibernate mode. **The Pressure Activation feature is NOT ACTIVE.** With the Pressure Activation feature included in this version of the APF9A firmware, there are two possible deployment procedures. The procedures are described below.

IMPORTANT: Pressure Activation is NOT automatic for this firmware version of the APF9A. The Pressure Activation feature MUST be MANUALLY ACTIVATED by the OPERATOR using a PC to communicate with the float.

The following sections, "Manual Deployment with the Reset Tool" and "Pressure Activation Deployment", provide operational summaries for these two possible deployment scenarios. Both sections refer to self tests conducted by the float and float function checks performed by the operator.

A detailed description of proper float behavior, self tests, and the associated operator actions and observations needed to evaluate the float for deployment is provided in "Mission Activation and Operator Float Function Check".

IMPORTANT: The float should not be deployed if it does not behave as described in "Mission Activation and Operator Float Function Check".

**Webb Research Corporation
strongly recommends testing all APEX Profilers
on receipt by the customer and before deployment
to ensure no damage has occurred during shipping.**

A.   Manual Deployment with the Reset Tool

Shortly before deployment, reset the profiler by holding the Reset Tool over the marked location on the pressure case. Hold the Reset Tool in position for approximately 3 seconds. Remove the Reset Tool only after you hear the air pump activate.

The float will run a brief self test. This is the Mission Activation phase. During this time the operator should verify proper function of the float (see "Mission Activation and Operator Float Function Check"). The float will then transmit test messages for 6 hours at the programmed repetition rate during the Mission Prelude phase. Six hours is typical; the duration of the Mission Prelude can be set by the operator. The piston will be fully extended at the beginning of the Mission Prelude (before the test transmissions begin) and the air bladder will be fully inflated during the first dozen or so test transmissions. At the conclusion of the Mission Prelude the float will begin its pre-programmed mission.

Manual Deployment Summary:

- Hold the Reset Tool over the RESET label
- Mission Activation
    - Air pump runs once
    - Self test conducted (see below for verification procedure)
        - Internal tests run (can be monitored if communication cable is connected, see "Connecting a Terminal")
        - 6 ARGOS transmissions
    - Piston EXTENDED fully
- Mission Prelude
    - Test transmissions at the programmed repetition rate
    - Mission Prelude duration is typically 6 hours
    - Air pump run during transmissions until air bladder is fully inflated

The float can be deployed after the Mission Activation phase and confirmation of proper float function have been successfully completed. We advise waiting until the air bladder is fully inflated during the first dozen or so test transmissions of the Mission Prelude before deploying the float.

B.   Pressure Activation Deployment

To use the Pressure Activation feature you must first connect the provided communication cable between your PC and the float (see "Connecting a Terminal" at the end of this manual for additional information). The normal port settings for an APF9A are 9600, 8, N 1. Press [ENTER] to wake the float from Hibernate mode. The float will respond that it has detected an "asynchronous wake-up" and will enter Command mode. Press [ENTER] in Command mode to display the main menu. Menu selections are not case sensitive.

Press 'a' or 'A' to activate the Pressure Activation feature and start the deployment. The float will run a brief self test (Mission Activation). During this time the operator should verify proper function of the float (see below - Mission Activation and Operator Float Function Check). The float will then fully retract the piston and deflate the air bladder so that it can sink when deployed. Once the piston is fully retracted, the float enters the Pressure Activation phase. During this phase the float makes a pressure measurement every two hours, hibernating between measurements. If the pressure is less than 25 dbar the float returns to hibernation. If the pressure exceeds 25 dbar the float fully extends the piston and begins the Mission Prelude with test transmissions and air bladder inflation.

During the Pressure Activation phase the operator can communicate with the float. This does NOT NORMALLY deactivate Pressure Activation. However, a 'k' or 'K' (kill) command during this phase will deactivate Pressure Activation and stop the mission.

DO NOT DEPLOY THE FLOAT AFTER A KILL (K) COMMAND UNLESS YOU HAVE STARTED A MANUAL DEPLOYMENT OR RESTARTED A PRESSURE ACTIVATION DEPLOYMENT. IF YOU FAIL TO OBSERVE THIS CAUTION AND LAUNCH THE FLOAT IT WILL SINK TO A NEUTRAL DEPTH AND STAY THERE. IT WILL NOT SURFACE AGAIN.

In the absence of a kill command the float will automatically resume the Pressure Activation phase after several minutes without operator input. Placing the Reset Tool over the RESET mark during the Pressure Activation phase will start a deployment.

Pressure Activation Deployment Scenario

Using the Pressure Activation feature minimizes operator/float interaction while at sea. A skilled operator can fully test the float while still in the laboratory environment or while the vessel is still at the dock. At the conclusion of testing the Pressure Activation feature can be activated and the float can be left to await deployment. When the vessel is on-station it only remains to launch the float (see "Deploying the Float"). No further communications with the float is required and the float can be reliably deployed by relatively inexperienced personnel.

<u>One caution is in order</u>. The air bladder is not automatically inflated until the beginning of the Mission Prelude phase of a deployment. This means it cannot be checked by the operator for leaks during the normal course of a Pressure Activation deployment. Therefore, we strongly recommend that you either:

- Manually inflate and check the air bladder before starting a Pressure Activation deployment. Be sure to manually close the air valve before trying to inflate the air bladder. Starting a Pressure Activation deployment will automatically deflate the bladder.

Or:

- Start a Manual Deployment with the Reset Tool or an operator command and reassert operator control after the Mission Activation and initial portion of the Mission Prelude phases, with attendant operator float function check, has successfully completed.

<u>Pressure Activation Deployment Summary:</u>

- Establish communication with the float (see "<u>Connecting a Terminal</u>")
- Press 'a' or 'A'
- Mission Activation
  - Air pump runs once
  - Self test conducted (see below for verification procedure)
    - Internal tests run (can be monitored if communication cable is connected, see "<u>Connecting a Terminal</u>")
    - 6 ARGOS transmissions
  - Air bladder deflated
  - Piston RETRACTED fully
- Deploy the float
- Pressure Activation
  - Pressure measured every 2 hours
  - Pressure in excess of 25 dbar extends piston, inflates air bladder, triggers transition to Mission Prelude
- Mission Prelude
  - Test transmissions (6 hours typical)
  - Air pump run during transmissions until air bladder is fully inflated

The float can be deployed after the Mission Activation phase and proper functioning of the float have been successfully completed.
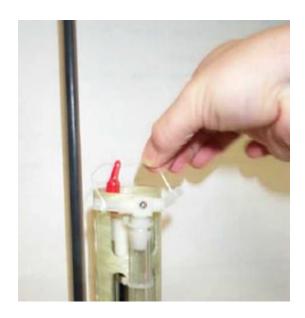
C. Mission Activation and Mission Prelude ARGOS Transmissions

The six ARGOS transmissions during Mission Activation and the transmissions during the Mission Prelude contain data about the instrument. The information needed to decode these messages is provided in the "<u>ARGOS Data</u>" section of this manual.

D.   Mission Activation and Operator Float Function Check

1) Secure the float in a horizontal position using the foam cradles from the shipping crate.

2) The minimum internal temperature of the float is -2.0°C. If necessary, allow the float to warm up indoors before proceeding.

3) Remove the plastic bag and three (3) plugs from the CTD sensor as shown in the two images below.

4) Carefully remove the black rubber plug from the bottom center of the yellow cowling as shown in the image below. This will allow you to verify air bladder inflation in the steps below. **Use only your fingers to remove the plug. Tools may puncture or otherwise harm the bladder. Be sure to replace the plug before deployment!**

Note: It can be difficult to replace the plug when the air bladder is fully inflated. We suggest that you reinsert the plug before the bladder is fully inflated. The plug prevents the entry of silt into the cowling in the event the float contacts the sea floor.
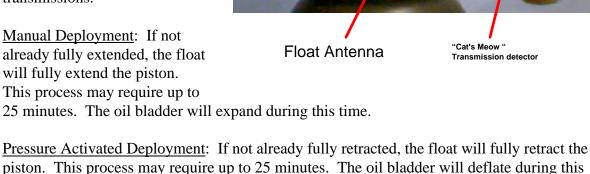
5) Start a Manual or Pressure Activated Deployment as described above in the "Manual Deployment with the Reset Tool" and "Pressure Activation Deployment" sections. This will trigger the Mission Activation self tests. Where applicable, the description below indicates where the two versions of the self tests differ.

Verify by ear that the air pump is activated for approximately 1 second.

DO NOT DEPLOY THE FLOAT IF IT DOES NOT BEHAVE AS DESCRIBED BELOW. FLOATS THAT DO NOT PASS THE SELF TESTS SHOULD NOT BE DEPLOYED. CONTACT WEBB RESEARCH FOR ASSISTANCE.

6) The float will conduct self tests for approximately 15 seconds. Progress and diagnostic messages will be displayed if a terminal is connected to the float (see "Connecting a Terminal" for additional information).

7) If the float passes the self tests, it will make 6 ARGOS transmissions with a 6 second interval. You can detect these transmissions using the "cat's meow" sensor as shown in the image at right. Hold the sensor parallel to and within 15 cm (6 inches) of the float's antenna. The cat's meow will beep during each ARGOS transmission. Do not deploy the float if you do not detect the six (6) ARGOS transmissions.

= 15 cm

Float Antenna

"Cat's Meow "
Transmission detector

8) Manual Deployment: If not already fully extended, the float will fully extend the piston. This process may require up to 25 minutes. The oil bladder will expand during this time.

Pressure Activated Deployment: If not already fully retracted, the float will fully retract the piston. This process may require up to 25 minutes. The oil bladder will deflate during this time.

The volume of oil in the bladder is difficult to detect by hand. You may be able to hear the pump by placing your ear against the hull.

9) Manual Deployment: Once the piston is fully extended the float enters the Mission Prelude phase. During this phase it will transmit test messages at the operator specified ARGOS repetition period. These transmissions can be detected with the Cat's Meow. The float will run the air pump for 6 seconds during each test transmission until the air bladder is fully inflated. Inflating the air bladder typically requires 8 to 10 repetitions. Check for air bladder inflation by sticking your finger (**not a tool!**) through the hole in the bottom of the yellow cowling as described in Step (4) above. **Don't forget to replace the plug before deploying the float.**

The duration of the Mission Prelude is set by the operator. 6 hours is typical. At the end of the Mission Prelude the ARGOS test transmissions will cease, the float will deflate the air bladder and retract the piston, and the first descent of the programmed mission will begin.

Pressure Activated Deployment: Once the piston is fully retracted the float will enter the Pressure Activation phase. During this phase it will check the pressure every two hours, hibernating in between. The float will not enter the Mission Prelude phase until it detects a pressure in excess of 25 dbar. There will be no test transmissions nor inflation of the air bladder until the Mission Prelude phase begins.

When the trigger pressure is detected the float will extend the piston and begin the Mission Prelude, making ARGOS test transmissions at the specified repetition rate and also running the air pump to inflate the air bladder (see above). The duration of the Mission Prelude is set by the operator. 6 hours is typical. At the end of the Mission Prelude the ARGOS test transmissions will cease, the float will deflate the air bladder and retract the piston, and the first descent of the programmed mission will begin

10) The float is ready to deploy.

E.   Notes and Caveats

Self Tests: During the self tests the float checks:

- The internal vacuum
- Communication with the CTD
- The internal alarm timer settings

If any of the self tests fail the float will abort the mission. The clearest indication to the operator that this has occurred is the failure of the float to make the initial 6 ARGOS transmissions at 6 second intervals.

**If you do not detect these Mission Activation transmissions with the Cat's Meow,
DO NOT DEPLOY THE FLOAT!**

Manual Deployment: In the case of a Manual deployment, if the float is not deployed before the completion of the Mission Prelude phase,

**RESET the float again and wait for it to complete the Mission Activation phase and begin
the Mission Prelude before you deploy it.**

Pressure Activated Deployment: In the case of a Pressure Activated Deployment, the operator is necessarily absent when the float begins the Mission Prelude. This means the operator does not have the opportunity to check the air bladder for leaks that a Manual Deployment offers.

**For this reason we strongly recommend that you manually inflate and check the bladder
before starting a Pressure Activated Deployment.**

V.   Deploying the Float

1) Pass a rope through the hole in the plastic damper plate, which is shown in the image at right. The rope should fit easily through the hole and be capable of supporting 50 kg (100 lb).

2) Holding **both** ends of the rope bight, carefully lower the float into water. The damper plate is amply strong enough to support the weight of the float. However, do not let rope slide rapidly through the hole as this may cut the plastic disk and release the float prematurely.

3) Take care not to damage the CTD or the ARGOS antenna against the side of the ship while lowering the float.

4) **Do not leave the rope with the instrument.** Once the float is in the water, let go of the lower end of the rope and pull on the top end slowly and carefully until the rope clears the hole and the float is released.

   It may take several minutes for the cowling to fully flood with water and the float may drift at an angle or even rest on its side during this period. This is normal behavior and not a cause for concern.

5) Manual Deployment: The float will remain on surface for the duration of the Mission Prelude.

   Pressure Activated Deployment: The float will sink immediately. It will return to the surface within 3 hours and begin the Mission Prelude after detecting a pressure in excess of 25 dbar.

VI.   Park and Profile

The APF9A float can be set to profile from a maximum depth (Profile Depth) after a programmable number (N) of profiles from a shallower depth (Park Depth). Special cases are conducting all profiles from either the Profile Depth or the Park Depth. The latter is an important special case that can be selected by setting N = 254. This will cause all profiles start at the Park Depth; the programmed Profile Depth is ignored. Between profiles the float drifts at the Park Depth.

Terminology:
?	Park Depth	Intermediate depth at which the float drifts between profiles and from which the float profiles in cycles not evenly divisible by N.
?	Profile Depth	Maximum depth to which the float descends from the Park Depth every Nth cycle and from which each Nth profile is conducted.
?	Down Time	Programmed time-limit for descending from the surface and drifting at the Park Depth. Down Time is commonly set to 10 days or to 10 days less the Up Time.
?	Up Time	Programmed time-limit for ascending from the Park or the Profile Depth and drifting at the surface while transmitting the data acquired during the profile. Up Time is typically set between 12 hours and 20 hours, increasing with the amount of data to be transmitted per profile. The latitude of the deployment also matters; ARGOS satellites are in polar orbits, so the number of satellite passes per day increases with latitude.
?	Ascent Rate	The ascent rate of the float is maintained at or above 8 cm/s. The float extends the piston by a user specified amount to add buoyancy when the ascent rate falls below this threshold.

A.   Profile Ascent Timing

Profiles from the Park Depth begin when the operator programmed Down Time expires. The float extends the piston by an operator programmed initial amount and begins the ascent.   A PTS sample is collected at the end of the Park phase.

When a profile is to begin from the Profile Depth, the float will retract the piston and descend from the Park Depth an operator programmed interval before the expiration of the Down Time. This interval, Parameter Mtj, Deep-profile descent time in hours, provides the additional time needed to descend to and profile from the Profile Depth without losing significant surface time, the period when data from the profile are transmitted. . A PTS sample is collected at the beginning of the Profile phase at the achieved profile depth. Subsequent PTS samples are collected during profile ascent per the programmed depth table.
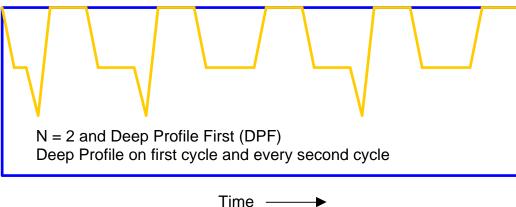
B.   Profile and Profile Cycle Schematics

Down Time ⟷ Up Time

Surface

Park Depth

Profile Depth

Time ⟶

N = 1
Deep Profile every cycle

N = 3
Deep Profile every third cycle

Time ⟶

VII. Deep Profile First (DPF)

Independent of the Park and Profile cycle length, the first profile is always a Deep Profile that begins at the Profile Depth. This means the float returns a CTD profile relatively soon, typically less than a day, after the float is deployed. This feature supports comparison of the initial float profile with a conventional CTD cast from the ship.

The first descent begins at the end of the Mission Prelude. A schematic representation of DPF with a Park and Profile parameter N = 2 is shown below.

N = 2 and Deep Profile First (DPF)
Deep Profile on first cycle and every second cycle

Time ⟶

Note: For maximum battery life in ARGO applications, WRC recommends use of PD > one, with park depth ≤ 1500 db.

VIII. ARGOS Data

A. SERVICE ARGOS Parameters

Each float operator must specify various options to Service ARGOS. These choices depend on how the user plans to receive and process data. Typical Service ARGOS Parameters are:

- Standard location
- Processing: Type A2   Binary input, hexadecimal output
- Result (output) format: DS   All results from each satellite pass
- Compression: None   Uncompressed
- Distribution strategy: Scheduled   All results every 24 hours
- Number of bytes transmitted: 31 per message[1]

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[1] When using a 28-bit ARGOS ID, 31 data bytes are transmitted in each message. 32 data bytes are transmitted in each message when using a 20-bit ARGOS ID.

B.   Test Messages - 28-bit ARGOS ID - Mission Prelude

The test message block is comprised of two messages. Each of the 6 messages sent during the Mission Activation phase is a Test Message 1. During the Mission Prelude the two test messages alternate, with one sent during each ARGOS transmission. The formats of the two test messages are show in the tables below:

Test Message 1 - 28-bit ARGOS ID

Byte(s)	Mnemonic	Description
1	CRC	Message CRC
2	MSG	Message ID - 1 for Test Message 1
3	BLK	Message block ID - increments with each transmitted message block and wraps at 0xFF
4	MON	F/W Revision - Month
5	DAY	F/W Revision - Day
6	YR	F/W Revision - Year (2-digit)
7 - 8	FLT	Float ID (hull number)
9 - 10	SEC	Time since the start of the Mission Prelude [seconds]
11 - 12	STATUS	Float status word - 16 bits, see below
13 - 14	P	Pressure measured once for each test message block [centibars]
15	VAC	Vacuum measured during self tests [counts]
16	ABP	Air bladder pressure measured once for each test message block [counts]
17	BAT	Quiescent battery voltage measured once for each test message block [counts]
18	UP	Up time [hours]
19 - 20	DOWN	Down time [hours]
21 - 22	PRKP	Park pressure [decibars]
23	PPP	Park piston position [counts]
24	NUDGE	Buoyancy nudge during ascent [counts]
25	OK	Internal vacuum threshold [counts]
26	ASCEND	Ascent time-out [hours]
27	TBP	Maximum air bladder pressure [counts]
28 - 29	TP	Profile pressure [decibars]
30	TPP	Profile piston position [counts]
31	N	Park and profile cycle length
32		Not used - only exists for a float with a 20-bit ARGOS ID

Test Message 2 - 28-bit ARGOS ID

Byte(s)	Mnemonic	Description
1	CRC	Message CRC
2	MSG	Message ID - 2 for Test Message 2
3	BLK	Message block ID - increments with each transmitted message block and wraps at 0xFF
4	MON	F/W Revision - Month
5	DAY	F/W Revision - Day
6	YR	F/W Revision - Year (2-digit)
7	FEXT	Piston full extension [counts]
8	FRET	Piston full retraction [counts]
9	IBN	Initial buoyancy nudge (starts profile) [counts]
10	CHR	Compensator hyper-retraction [counts]
11	DPDP	Deep profile descent period [hours]
12	PDP	Park descent period [hours]
13	PRE	Mission prelude period [hours]
14	REP	ARGOS transmission repetition period [seconds]
15 – 16	SBESN	Seabird SBE41 serial number (encoded as a hex integer, e.g., S/N 8413 is encoded as 0x20DD)
17 - 18	SBEFW	Seabird SBE41 F/W Revision (encoded as a hex integer after multiplication by 100, e.g., F/W 2.6 ? 260 ? 0x0104)
19 - 22	EPOCH	Current UNIT epoch (GMT) of Apf9a RTC (little endian order)
23 - 24	TOD	Minutes past midnight when down-time will expire. If ToD feature disabled, bytes = 0xfffe.
25 - 26	DEBUG	Debugging Verbosity for generating engineering log entries.
27 – 32		Not used [0xFF]

Test Message 1 - Status Word - 16 bits

Bit	Mnemonic	Description
0x0001	DeepProfile	Current profile is a Deep Profile
0x0002	ShallowWaterTrap	Shallow water trap detected
0x0004	Obs25Min	Sample time-out (25 minutes) expired
0x0008	PistonFullExt	Piston fully extended before surface detected
0x0010	AscentTimeOut	Ascent time-out expired
0x0020	TestMsg	Current message is a test message
0x0040	PreludeMsg	Current messaged transmitted during Mission Prelude
0x0080	PActMsg	Current message is a Pressure Activation test message
0x0100	BadSeqPnt	Invalid sequence point detected
0x0200	Sbe41PFail	SBE41 pressure measurement exception
0x0400	Sbe41PtFail	SBE41 pressure-temperature measurement exception
0x0800	Sbe41PtsFail	SBE41 pressure-temperature-salinity measurement exception
0x1000	Sbe41Unreliable	SBE41 pressure measurement unreliable
0x2000	AirSysBypass	Air inflation system bypassed; excessive energy consumption.
0x4000	WatchDogAlarm	Wake-up by watchdog alarm
0x8000	PrfIdOverFlow	8-bit profile counter overflowed [255 ? 0]

C.   Data Messages - 28-bit ARGOS ID

The number of data messages depends on the number of measurements made during the profile. The formats of the data messages are shown in the tables below. Data Message 1 contains float, profile, and engineering data.

Data Message 1 - 28-bit ARGOS ID

Byte(s)	Mnemonic	Description
1	CRC	Message CRC
2	MSG	Message ID - each data message block is comprised of multiple messages, this will be a 1 for Data Message 1
3	BLK	Message block ID - increments with each transmitted message block and wraps at 0xFF
4 - 5	FLT	Float ID (apf9a controller serial number)
6	PRF	Profile number (wraps to 0 from 255)
7	LEN	Number of TSP samples in this message block
8 - 9	STATUS	Same as the Test Message 1 Status word (see above)
10 - 11	SP	Surface pressure at end of Up Time [centibars]
12	VAC	Internal vacuum at end of Park phase [counts]
13	ABP	Air bladder pressure at end of each ARGOS transmission [counts]
14	SPP	Piston position when surface detected [counts]
15	PPP2	Piston position at end of Park phase [counts]
16	PPP	Piston position at end of last Deep descent phase [counts]
17 - 18	SBE41	SBE41 status word - 16 bits, see below
19 - 20	PMT	Cumulative piston on time during ascent [seconds]
21	VQ	Battery voltage at end of Park phase [counts]
22	IQ	Battery current at end of Park phase [counts]
23	VSBE	Battery voltage while SBE41 sampling at end of Park phase [counts]
24	ISBE	Battery current while SBE41 sampling at end of Park phase [counts]
25	VHPP	Battery voltage measured just before the end of the initial piston extension beginning Profile phase [counts]
26	IHPP	Battery current measured just before the end of the initial piston extension beginning Profile phase [counts]
27	VAP	Battery voltage while air pump running [counts]
28	IAP	Battery current while air pump running [counts]
29	PAP	Number of 6-second pulses of the air pump require to inflate the air bladder.
30 - 31	VSAP	Integrated Measure of (Volt-Sec) of volume of air pumped during telemetry cycle.
32		Not used - only exists for a float with a 20-bit ARGOS ID

The SBE41 status word is shown in the table below.

SBE41 Status Word - 16 bits

Bit	Mnemonic	Description
0x0001	Sbe41PedanticExceptn	An exception was detected while parsing the P-only pedantic regular expression
0x0002	Sbe41PedanticFail	The SBE41 response to P-only measurement failed the pedantic regular expression
0x0004	Sbe41RegexFail	The SBE41 response to P-only measurement failed the non-pedantic regular expression
0x0008	Sbe41NullArg	NULL argument detected during P-only measurement
0x0010	Sbe41RegExceptn	An exception was detected while parsing the P-only non-pedantic regular expression
0x0020	Sbe41NoResponse	No response detected from SBE41 for P-only request
0x0040		Not (yet) used
0x0080		Not (yet) used
0x0100	Sbe41PedanticExceptn	An exception was detected while parsing the PTS pedantic regular expression
0x0200	Sbe41PedanticFail	
0x0400	Sbe41RegexFail	The SBE41 response to PTS measurement failed the pedantic regular expression
0x0800	Sbe41NullArg	NULL argument detected during PTS measurement
0x1000	Sbe41RegExceptn	An exception was detected while parsing the PTS non-pedantic regular expression
0x2000	Sbe41NoResponse	No response detected from SBE41 for PTS request
0x4000	Sbe41ConfigFail	SBE41 error occurred during configuration
0x8000		Not (yet) used

Data Message 2 continues with miscellaneous engineering data and statistics for the PTS measurements taken periodically during the Park phase.

Data Message 2 - 28-bit ARGOS ID

Byte(s)	Mnemonic	Description
1	CRC	Message CRC
2	MSG	Message ID - each data message block is comprised of multiple messages, this will be a 2 for Data Message 2
3 - 6	EPOCH	Unix epoch when down time expired (Apf9a RTC)
7 - 8	TINIT	Time (minutes) when telemetry phase was initiated relative to EPOCH. (2's compliment signed integer)
9	NADJ	Number of active ballast adjustments made during Park phase/
10 – 11	ParkN	Number of samples collected during Park phase
12 – 13	TMean	Mean temperature during Park phase
14 – 15	PMean	Mean pressure during Park phase
16 – 17	StDevT	Standard deviation of temperature during Park phase
18 – 19	StDevP	Standard deviation of pressure during Park phase
20 – 21	TMin	Minimum temperature during Park phase
22 – 23	TMinP	Pressure associated with minimum temperature during Park phase
24 – 25	TMax	Maximum temperature during Park phase
26 – 27	TMaxP	Pressure associated with maximum temperature during Park phase
28 - 29	PMin	Minimum pressure during Park phase
30 – 31	PMax	Maximum pressure during Park phase
32	NA	Not used - only exists for a float with a 20-bit ARGOS ID

The hydrographic data are transmitted in messages 3 – N in the order that they were collected. The sample taken at the end of the Park phase is transmitted first followed by the samples collected during the profile phase.

Data Message 3 - 28-bit ARGOS ID

Byte(s)	Mnemonic	Description
1	CRC	Message CRC
2	MSG	Message ID - each data message block is comprised of multiple messages, this will be a 2 for Data Message 2
3 - 4	Tpark	Temperature at end of Park phase
5 - 6	Spark	Salinity at end of Park phase
7 - 8	Ppark	Pressure at end of Park phase
9 – 10	Tprofile	Temperature at start of Profile phase
11 – 12	Sprofile	Salinity at start of Profile phase
13 – 14	Pprofile	Pressure at start of Profile phase
15 – 16	T1	Temperature (first point in depth table)
17 – 18	S1	Salinity
19 – 20	P1	Pressure
21 – 22	T2	Temperature (second point in depth table)
23 – 24	S2	Salinity
25 – 26	P2	Pressure
27 – 28	T3	Temperature (etc. to end of table)
29 – 30	S3	Salinity
31	P3 (half)	Pressure (first byte, second byte in next message)
32	NA	Not used - only exists for a float with a 20-bit ARGOS ID

The pattern of sequential PTS measurements continues in subsequent messages with measurement triples breaking across message boundaries as necessary. The measurements each occupy 2 bytes and are encoded as 4 hex characters. The procedures for converting these encoded data from the hexadecimal format to physical units are described in the next section, "Conversion from Hexadecimal to Physical Units".

<u>Auxiliary Engineering Data</u>
If there is space at the end of the last message in the block, it is filled with Auxiliary Engineering data. These data are not used to generate an additional message and if they are not sufficient to fill the available space the remaining bytes are set to 0xFF. These data are comprised of the time of profile initiation plus a series of pressure measurements taken at just after the piston is retracted and at hourly intervals during the descent to the Park Depth. Descent rates are calculated from these data. The information begins in the byte immediately following the end of the hydrographic data. The table below shows an example.

The byte immediately following the hydrographic data is the time of profile initiation (the time difference in minutes between the start of the profile and the end of down time). The descent pressure marks are next. The first byte is the count of the number of descent pressure mark. The following bytes are the descent pressure measurements in bars.

Below is an example of a final message. The actual byte location of the last sample and start of the auxiliary data will depend on actual number of samples collected. This is an example to demonstrate auxiliary data format only.

Final Data Message - 28-bit ARGOS ID

Byte(s)	Mnemonic	Description
1	CRC	Message CRC
2	MSG	Message ID - each data message block is comprised of multiple messages, this will be a 2 for Data Message 2
3 - 4	TN-2	Temperature
5 - 6	SN-2	Salinity
7 - 8	PN-2	Pressure
9 - 10	TN-1	Temperature (second to last point in depth table)
11 - 12	SN-1	Salinity
13 14	PN-1	Pressure
15 - 16	TN	Temperature (last point in depth table)
17 - 18	SN	Salinity
19 - 20	PN	Pressure
21-22	Ptime	Profile initiation time (minutes) 2's compliment signed integer (positive values – profile initiated after down time expired) (negative values – profile initiated before down time expired)
23	NDM	Number of descent pressure measurements
24	DM1	Pressure taken at end of piston retraction
25	DM2	Pressure taken 1 hour after beginning of descent (bars)
26	DM3	Pressure taken 2 hours after beginning of descent (bars)
27	DM4	Pressure taken 3 hours after beginning of descent (bars)
28	DM5	Pressure taken 4 hours after beginning of descent (bars)
29	DM6	Pressure taken 5 hours after beginning of descent (bars)
30		Filler 0xFF
31		Filler 0xFF
32	NA	Not used - only exists for a float with a 20-bit ARGOS ID

D.   Conversion from Hexadecimal to Physical Units

The temperature, salinity, pressure, voltage, and current values measured by the float are encoded in the Data Messages as hex integers. This compression reduces the number of bytes in the ARGOS transmissions. The resolution of the encoded hydrographic values is shown in the table below:

Measurement	Resolution	Range	Data Format	Conversion
Temperature	0.001 °C	-4.095 °C to 61.439 °C	16-bit unsigned with 2's complement	$T = T_{raw} / 1000$
Salinity	0.001 psu	-4.095 psu to 61.439 psu	16-bit unsigned with 2's complement	$S = S_{raw} / 1000$
Pressure	0.1 dbar	-3276.7 dbar to 3276.7 dbar	16-bit unsigned with 2's complement	$P = P_{raw} / 10$
Volts	V		8 bits unsigned	$V = (V_{raw} * 0.077 + 0.486$
Current	MA		8 bits unsigned	$I = (I_{raw} * 4.052) - 3.606$
Vacuum	InHg		8 bits unsigned	$V = (V_{raw} * 0.293) -29.767$

To convert the hex values in an ARGOS message back to physical units, proceed as described in the table below. The initial conversion from Hexadecimal to Decimal should assume the hex value is an unsigned integer with a range of 0 to 65535 for temperature, salinity, and pressure measurements, a range of 0 to 255 for voltage and current measurements and a range of 0 to 4095 for optode measurements. If temperature, salinity or pressure raw values are above the maximum unisigned value listed, a 2's complement conversion should be applied to obtain a signed (negative) value. This allows for representation of a full range of values.

Measurement	Hexadecimal	Decimal and Conversion Steps	Physical Result
Temperature = 0	0x3EA6 (<0xEFFF) ?	$T_{raw} = 16038$ $T = T_{raw} / 1000$?	16.038 °C
Temperature < 0	0xF58B (= 0xF001) ?	$T_{raw} = 62859$ $T_{2sComplement} = T_{raw} - 65536 = -2677$ $T = T_{2sComplement} / 1000$?	-2.677 °C
Salinity	0x8FDD (<0xEFFF) ?	$S_{raw} = 36829$ $S = S_{raw} / 1000$?	36.829 psu
Salinity	0xF003 (= 0xF001) ?	$S_{raw} = 61443$ $S_{2sComplement} = S_{raw} - 65536 = -4093$ $S = S_{2sCompement} / 1000$?	-4.093 psu

Pressure = 0	0x1D4C (< 0x8000) ?	$P_{raw} = 7500$ $P = P_{raw} / 10$?	750.0 dbar
Pressure < 0	0xFFFA (= 0x8000) ?	$P_{raw} = 65530$ $P_{2sCompliment} = P_{raw} - 65536 = -6$ $P = P_{2sCompliment} / 10$?	-0.6 dbar
Volts	0xBB ?	$V_{raw} = 187$ $V = (V_{raw} *0.077) + 0.486$?	14.9 V
Current	0x0A ?	$I_{raw} = 10$ $I = (I_{raw} * 4.052) -3.606$?	36.9 mA
Vacuum	0x56 ?	$V_{raw} = 86$ $V = (V_{raw}* 0.293) -29.767$?	-4.5 inHg

Conversion Notes:

The temperature range is -4.095 °C to 61.439 °C. Hex values 0xF000 (nonfinite), 0xF001 (= -4.095), 0xEFFF (= 61.439), and 0xFFFF (missing data) are used to flag out-of-range measurements or are otherwise reserved. Temperatures in the range -0.0015 °C to -0.0005 °C are mapped to 0xFFFE.

The salinity range is -4.095 psu to 61.439 psu. Hex values 0xF000 (nonfinite), 0xF001 (= -4.095), 0xEFFF (= 61.439), and 0xFFFF (missing data) are used to flag out-of-range measurements or are otherwise reserved. Salinities in the range -0.0015 psu to -0.0005 psu are mapped to 0xFFFE.

The pressure range is -3276.7 dbar to 3276.7 dbar. Hex values 0x8000 (nonfinite), 0x8001 (= -3276.7), 0x7FFF (= 32767.7), and 0xFFFF (missing data) are used to flag out-of-range measurements or are otherwise reserved. Pressures in the range -0.15 dbar to -0.05 dbar are mapped to 0xFFFE.

E.   Depth Table 34 for PTS Samples
Depth Table 34 below, with values expressed in decibars (dbar), defines where PTS measurements are acquired during a profile.

2000. 0	1950. 0	1900. 0	1850. 0	1800. 0	1750. 0	1700. 0	1650. 0
1600. 0	1550. 0	1500. 0	1450. 0	1400. 0	1350. 0	1300. 0	1250. 0
1200. 0	1150. 0	1100. 0	1050. 0	1000. 0	950. 0	900. 0	850. 0
800. 0	750. 0	700. 0	675. 0	650. 0	625. 0	600. 0	575. 0
550. 0	525. 0	500. 0	475. 0	450. 0	425. 0	400. 0	375. 0
350. 0	325. 0	300. 0	275. 0	250. 0	225. 0	200. 0	180. 0
160. 0	140. 0	120. 0	100. 0	80. 0	70. 0	60. 0	50. 0
40. 0	30. 0	20. 0	10. 0	4. 0	0. 0		

To prevent fouling of the CTD by surface and near-surface contaminants, the shallowest PTS sample is taken when the pressure is between 6 dbar and 4 dbar.

F.   Telemetry Error Checking (CRC)

ARGOS messages can contain transmission errors. For this reason the first element of each message is a CRC (Cyclic Redundancy Check) byte. The value is calculated by the float, not by ARGOS, from the remaining bytes of that message. A bad CRC generally means a corrupted message. It is worth noting that a good CRC is a good indicator that the message is OK, but it is possible to have a good CRC even when the message is corrupt. This is particularly true for a short CRC - this one is only 8 bits long. Comparing multiple realizations of each ARGOS message (e.g., all received versions of Data Message 3 for some particular profile) to identify uncorrupted versions of the message is strongly recommended.

A sample code fragment in C that can be used to calculate CRC values is shown below. This code was written by Dana Swift of the University of Washington. The original algorithm was developed in the 1970s by Al Bradley and Don Dorson of the Woods Hole Oceanographic Institution. The algorithm attempts to distribute the space of possible CRC values evenly across the range of single byte values, 0 to 255. Sample programs in C, Matlab, FORTRAN, and BASIC can be provided by WRC on request. The Matlab version provides the user with a GUI interface into which individual ARGOS messages can be entered by cutting and pasting with a mouse.

```c
static unsigned char CrcDorson(const unsigned char *msg,
                                     unsigned int n) {

    unsigned char i,crc=CrcScrambler(msg[1]);

    for (i=2; i<n; i++)     {
       crc ^= msg[i];
       crc  = CrcScrambler(crc);
    }

    return crc;
}

static unsigned char CrcScrambler(unsigned char byte) {

    unsigned char sum=0,tst;

    if (!byte) byte = 0xff;

    tst = byte; if (tst % 2) sum++;
    tst >>= 2; if (tst % 2) sum++;
    tst >>= 1; if (tst % 2) sum++;
    tst >>= 1; if (tst % 2) sum++;

    sum %= 2;

    return (byte>>1) + (sum<<7);
}
```

IX.   Missions

This section lists the parameters for each float covered by this manual.

To display the parameter list, connect a communications cable to the float, press <ENTER> to wake the float from hibernate and start command mode, and press 'l' or 'L' to list the parameters. See "Connecting a Terminal" and "APF9A Command Summary" for more information.

Instrument # 4269

APEX version 062608 sn 6190
66A9F8B 28-bit hex Argos id.   Ma
  042 Argos repetition period (Seconds)   Mr
 0720 ToD for down-time expiration. (Minutes) Mtc
  336 Down time. (Hours)   Mtd
  012 Up time. (Hours)   Mtu
  009 Ascent time-out. (Hours)   Mta
  003 Deep-profile descent time. (Hours) Mtj
  006 Park descent time. (Hours)   Mtk
  006 Mission prelude. (Hours)   Mtp
 1500 Park pressure. (Decibars)   Mk
 2000 Deep-profile pressure. (Decibars)   Mj
  041 Park piston position. (Counts)   Mbp
  000 Compensator hyper-retraction. (Counts) Mbh
  016 Deep-profile piston position. (Counts) Mbj
  010 Ascent buoyancy nudge. (Counts)   Mbn
  022 Initial buoyancy nudge. (Counts)   Mbi
  001 Park-n-profile cycle length.   Mn
  120 Maximum air bladder pressure. (Counts) Mfb
  096 OK vacuum threshold. (Counts)   Mfv
  226 Piston full extension. (Counts)   Mff
  100 Piston storage position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D
 0002 DebugBits.   D
 b3f5 Mission signature (hex).

Instrument # 4270

APEX version 062608 sn 6191
66A9F98 28-bit hex Argos id.   Ma
  044 Argos repetition period (Seconds)   Mr
 0720 ToD for down-time expiration. (Minutes) Mtc
  336 Down time. (Hours)   Mtd
  012 Up time. (Hours)   Mtu
  009 Ascent time-out. (Hours)   Mta
  003 Deep-profile descent time. (Hours) Mtj
  006 Park descent time. (Hours)   Mtk
  006 Mission prelude. (Hours)   Mtp
 1500 Park pressure. (Decibars)   Mk
 2000 Deep-profile pressure. (Decibars)   Mj
  041 Park piston position. (Counts)   Mbp
  000 Compensator hyper-retraction. (Counts) Mbh
  016 Deep-profile piston position. (Counts) Mbj
  010 Ascent buoyancy nudge. (Counts)   Mbn
  022 Initial buoyancy nudge. (Counts)   Mbi
  001 Park-n-profile cycle length.   Mn
  120 Maximum air bladder pressure. (Counts) Mfb
  096 OK vacuum threshold. (Counts)   Mfv
  226 Piston full extension. (Counts)   Mff
  100 Piston storage position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D
 0002 DebugBits.   D
 460f Mission signature (hex).

Instrument # 4271

APEX version 062608 sn 6192
66A9FAD 28-bit hex Argos id.   Ma
  046 Argos repetition period (Seconds)   Mr
 0780 ToD for down-time expiration. (Minutes) Mtc
  336 Down time. (Hours)   Mtd
  011 Up time. (Hours)   Mtu
  009 Ascent time-out. (Hours)   Mta
  003 Deep-profile descent time. (Hours)   Mtj
  006 Park descent time. (Hours)   Mtk
  006 Mission prelude. (Hours)   Mtp
 1500 Park pressure. (Decibars)   Mk
 2000 Deep-profile pressure. (Decibars)   Mj
  041 Park piston position. (Counts)   Mbp
  000 Compensator hyper-retraction. (Counts)   Mbh
  016 Deep-profile piston position. (Counts)   Mbj
  010 Ascent buoyancy nudge. (Counts)   Mbn
  022 Initial buoyancy nudge. (Counts)   Mbi
  001 Park-n-profile cycle length.   Mn
  120 Maximum air bladder pressure. (Counts)   Mfb
  096 OK vacuum threshold. (Counts)   Mfv
  225 Piston full extension. (Counts)   Mff
  100 Piston storage position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D
 0002 DebugBits.   D
 0426 Mission signature (hex).

Instrument # 4272

APEX version 062608 sn 6193
66A9FBE 28-bit hex Argos id.   Ma
  042 Argos repetition period (Seconds)   Mr
 0780 ToD for down-time expiration. (Minutes) Mtc
  336 Down time. (Hours)   Mtd
  011 Up time. (Hours)   Mtu
  009 Ascent time-out. (Hours)   Mta
  003 Deep-profile descent time. (Hours)   Mtj
  006 Park descent time. (Hours)   Mtk
  006 Mission prelude. (Hours)   Mtp
 1500 Park pressure. (Decibars)   Mk
 2000 Deep-profile pressure. (Decibars)   Mj
  041 Park piston position. (Counts)   Mbp
  000 Compensator hyper-retraction. (Counts)   Mbh
  016 Deep-profile piston position. (Counts)   Mbj
  010 Ascent buoyancy nudge. (Counts)   Mbn
  022 Initial buoyancy nudge. (Counts)   Mbi
  001 Park-n-profile cycle length.   Mn
  120 Maximum air bladder pressure. (Counts)   Mfb
  096 OK vacuum threshold. (Counts)   Mfv
  226 Piston full extension. (Counts)   Mff
  100 Piston storage position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D
 0002 DebugBits.   D
 1107 Mission signature (hex).

Instrument # 4273

APEX version 062608 sn 6211
5AED6D4 28-bit hex Argos id.   Ma
  044 Argos repetition period (Seconds)   Mr
 0660 ToD for down-time expiration. (Minutes) Mtc
  336 Down time. (Hours)   Mtd
  013 Up time. (Hours)   Mtu
  009 Ascent time-out. (Hours)   Mta
  003 Deep-profile descent time. (Hours)   Mtj
  006 Park descent time. (Hours)   Mtk
  006 Mission prelude. (Hours)   Mtp
 1500 Park pressure. (Decibars)   Mk
 2000 Deep-profile pressure. (Decibars)   Mj
  041 Park piston position. (Counts)   Mbp
  000 Compensator hyper-retraction. (Counts)   Mbh
  016 Deep-profile piston position. (Counts)   Mbj
  010 Ascent buoyancy nudge. (Counts)   Mbn
  022 Initial buoyancy nudge. (Counts)   Mbi
  001 Park-n-profile cycle length.   Mn
  120 Maximum air bladder pressure. (Counts)   Mfb
  096 OK vacuum threshold. (Counts)   Mfv
  226 Piston full extension. (Counts)   Mff
  100 Piston storage position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D
 0002 DebugBits.   D
  a8c3 Mission signature (hex).

Instrument # 4274

APEX version 062608 sn 6263
5AED6E1 28-bit hex Argos id.   Ma
  046 Argos repetition period (Seconds)   Mr
 0660 ToD for down-time expiration. (Minutes) Mtc
  336 Down time. (Hours)   Mtd
  013 Up time. (Hours)   Mtu
  009 Ascent time-out. (Hours)   Mta
  003 Deep-profile descent time. (Hours)   Mtj
  006 Park descent time. (Hours)   Mtk
  006 Mission prelude. (Hours)   Mtp
 1500 Park pressure. (Decibars)   Mk
 2000 Deep-profile pressure. (Decibars)   Mj
  041 Park piston position. (Counts)   Mbp
  000 Compensator hyper-retraction. (Counts)   Mbh
  016 Deep-profile piston position. (Counts)   Mbj
  010 Ascent buoyancy nudge. (Counts)   Mbn
  022 Initial buoyancy nudge. (Counts)   Mbi
  001 Park-n-profile cycle length.   Mn
  120 Maximum air bladder pressure. (Counts)   Mfb
  096 OK vacuum threshold. (Counts)   Mfv
  226 Piston full extension. (Counts)   Mff
  100 Piston storage position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D
 0002 DebugBits.   D
  23d1 Mission signature (hex).

Instrument # 4275

APEX version 062608 sn 6319
5AED6F2 28-bit hex Argos id.   Ma
  042 Argos repetition period (Seconds)   Mr
 0660 ToD for down-time expiration. (Minutes) Mtc
  336 Down time. (Hours)   Mtd
  013 Up time. (Hours)   Mtu
  009 Ascent time-out. (Hours)   Mta
  003 Deep-profile descent time. (Hours)   Mtj
  006 Park descent time. (Hours)   Mtk
  006 Mission prelude. (Hours)   Mtp
 1500 Park pressure. (Decibars)   Mk
 2000 Deep-profile pressure. (Decibars)   Mj
  041 Park piston position. (Counts)   Mbp
  000 Compensator hyper-retraction. (Counts) Mbh
  016 Deep-profile piston position. (Counts) Mbj
  010 Ascent buoyancy nudge. (Counts)   Mbn
  022 Initial buoyancy nudge. (Counts)   Mbi
  001 Park-n-profile cycle length.   Mn
  120 Maximum air bladder pressure. (Counts) Mfb
  096 OK vacuum threshold. (Counts)   Mfv
  226 Piston full extension. (Counts)   Mff
  100 Piston storage position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D
 0002 DebugBits.   D
 3f6e Mission signature (hex).

Instrument # 4276

APEX version 062608 sn 6320
5B0256A 28-bit hex Argos id.   Ma
  044 Argos repetition period (Seconds)   Mr
 0780 ToD for down-time expiration. (Minutes) Mtc
  336 Down time. (Hours)   Mtd
  011 Up time. (Hours)   Mtu
  009 Ascent time-out. (Hours)   Mta
  003 Deep-profile descent time. (Hours)   Mtj
  006 Park descent time. (Hours)   Mtk
  006 Mission prelude. (Hours)   Mtp
 1500 Park pressure. (Decibars)   Mk
 2000 Deep-profile pressure. (Decibars)   Mj
  041 Park piston position. (Counts)   Mbp
  000 Compensator hyper-retraction. (Counts) Mbh
  016 Deep-profile piston position. (Counts) Mbj
  010 Ascent buoyancy nudge. (Counts)   Mbn
  022 Initial buoyancy nudge. (Counts)   Mbi
  001 Park-n-profile cycle length.   Mn
  120 Maximum air bladder pressure. (Counts) Mfb
  096 OK vacuum threshold. (Counts)   Mfv
  225 Piston full extension. (Counts)   Mff
  100 Piston storage position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D
 0002 DebugBits.   D
 7355 Mission signature (hex).

Instrument # 4277

APEX version 062608 sn 6321
5B02579 28-bit hex Argos id.   Ma
  046 Argos repetition period (Seconds)   Mr
 0780 ToD for down-time expiration. (Minutes) Mtc
  336 Down time. (Hours)   Mtd
  011 Up time. (Hours)   Mtu
  009 Ascent time-out. (Hours)   Mta
  003 Deep-profile descent time. (Hours)   Mtj
  006 Park descent time. (Hours)   Mtk
  006 Mission prelude. (Hours)   Mtp
 1500 Park pressure. (Decibars)   Mk
 2000 Deep-profile pressure. (Decibars)   Mj
  041 Park piston position. (Counts)   Mbp
  000 Compensator hyper-retraction. (Counts) Mbh
  016 Deep-profile piston position. (Counts) Mbj
  010 Ascent buoyancy nudge. (Counts)   Mbn
  022 Initial buoyancy nudge. (Counts)   Mbi
  001 Park-n-profile cycle length.   Mn
  120 Maximum air bladder pressure. (Counts) Mfb
  096 OK vacuum threshold. (Counts)   Mfv
  226 Piston full extension. (Counts)   Mff
  100 Piston storage position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D
 0002 DebugBits.   D
 1f45 Mission signature (hex).

Instrument # 4278

APEX version 062608 sn 6322
5B0258B 28-bit hex Argos id.   Ma
  042 Argos repetition period (Seconds)   Mr
 0780 ToD for down-time expiration. (Minutes) Mtc
  336 Down time. (Hours)   Mtd
  011 Up time. (Hours)   Mtu
  009 Ascent time-out. (Hours)   Mta
  003 Deep-profile descent time. (Hours)   Mtj
  006 Park descent time. (Hours)   Mtk
  006 Mission prelude. (Hours)   Mtp
 1500 Park pressure. (Decibars)   Mk
 2000 Deep-profile pressure. (Decibars)   Mj
  041 Park piston position. (Counts)   Mbp
  000 Compensator hyper-retraction. (Counts) Mbh
  016 Deep-profile piston position. (Counts) Mbj
  010 Ascent buoyancy nudge. (Counts)   Mbn
  022 Initial buoyancy nudge. (Counts)   Mbi
  001 Park-n-profile cycle length.   Mn
  120 Maximum air bladder pressure. (Counts) Mfb
  096 OK vacuum threshold. (Counts)   Mfv
  225 Piston full extension. (Counts)   Mff
  100 Piston storage position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D
 0002 DebugBits.   D
 72b4 Mission signature (hex).

Appendix A: Surface Arrival Time and Total Surface Time

Calculating surface drift vectors may require that you estimate the surface arrival time. Although each message is time stamped by ARGOS, there may not be a satellite in view at the time the float surfaces. In this case the initial messages are not received.

ARGOS telemetry begins when the float detects the surface. The messages are transmitted in numerical order starting with Message 1. When all of the messages in the block have been transmitted the cycle repeats. Transmissions continue at the programmed repetition rate until the Up Time expires.

The elapsed time since surfacing can be estimated using the message block number (m), the number of messages in the block (n), and the programmed ARGOS repetition period (p).

$$Te = (m-1) \times n \times p$$

The block number (BLK) is included in each ARGOS message set.

The total number of messages can be determined from the information in Data Message 1, which includes the number of PTS measurements made during the profile (LEN). Note that this value may not be the same as the number of entries in the depth table. For example, a float may drift into shallow water and not be able to reach the some depths. The total number of messages will include message 1 and message 2 plus the number of messages needed for the PTS data.

The repetition period is known *a priori* or can be determined form the ARGOS time stamps on sequential messages.

Subtracting the Te calculated from a particular Message 1 from the message's time stamp produces an estimate of the time at which the float surfaced. An example is shown below

Example Message 1
DS format

	Block Number	
2001-11-02 22:47:54 1	Byte 2 = 0x05	m = 5
CF 01 05 02	Number of PTS measurements	
AF 02 47 00	Byte 6 = 0x47 ? 71	
85 01 01 01	71 × 6 = 426 bytes	
16 92 17 19	Number of Msgs for data	
9E 94 01 AD	= 426 bytes / 28 bytes per msg = 16	
85 09 1F 48	Total messages = Msg1 + Msg2 + Data Msgs	
97 9B 00 46	= 1 + 1 + 16	n = 18
62 24 0E		
	Repetition Period	p = 46 seconds

Calculate the elapsed time on the surface:

$$Te = (m- 1) \times n \times p = (5 - 1) \times 18 \times 46 = 3312 = 00h \ 55m \ 12s$$

Subtracting this from the time stamp of the ARGOS message yields the approximate time of arrival at the surface:

$$22:47:54 - 00:55:12 = 20:52:42$$

The total time spent at the surface can now be calculated by subtracting Te from the known expiration of the Up Time.

Appendix B: Argos ID formats, 28-bit and 20-bit

In 2002 Service Argos notified its users there were a limited number of 20-bit Ids available and to begin preparing for a transition to 28-bit IDs. The 28 bit-IDs reduced from 32 to 31 the number of data bytes in each message. Data provided by Argos will consist of 31 hex bytes per message. Data acquired by use of an uplink receiver will consist of 32 hex bytes per message. The first byte, when using an uplink receiver, is a 28-bit ID identifier used by Argos and is not represented in the Apex Data formats included in this manual.

Appendix C: Storage conditions

For optimum battery life, floats should be stored in a controlled environment in which the temperature is restricted to the range +10 °C to +25 °C. When activated, the floats should be equilibrated at a temperature between -2 °C and +54 °C before proceeding with a deployment.

If the optional VOS or aircraft deployment containers are used, they must be kept dry, and should only be stored indoors.

Appendix D: Connecting a Terminal

The float can be programmed and tested by an operator using a 20 mA current loop and a terminal program. The current loop has no polarity. Connections should be made through the hull ground and a connector or fitting that is electrically isolated from the hull. This is shown in the image below. In this case one side of the current loop is clipped to the zinc anode and the other is clipped to the pressure port.

The communications cables and clamps are included in the float shipment. An RS-232 to current-loop converter is provided with the communications cables. This converter requires a 12 VDC supply.

The RS-232 communications cable should be connected to the COM port of a PC. Run a communications program such as ProComm or HyperTerminal on the PC. Both programs can be downloaded from various Internet sites. HyperTerminal is generally included with distributions of the Windows Operating System.

COM Port Settings: 9600, 8, N, 1
- 9600 baud
- 8 data bits
- No parity
- 1 stop bit
- no flow control / no handshaking
- full duplex

Webb Research Corporation recommends the practice of capturing and archiving a log file of all communications with each float. If in doubt about a test, email the log file to your chief scientist and/or to Webb Research.

Once you have started the communications program and completed the connections described above, press [ENTER] to wake the float from Hibernate mode. The float will respond that it has detected an "asynchronous wake-up" and will enter Command mode. Press [ENTER] in Command mode to display the main menu. Menu selections are not case sensitive. See "APF9A Command Summary" for a complete list of available commands.

Appendix E: APF9A Command Summary

Uppercase commands are used here for clarity; however, APF9A commands are not case sensitive. The menus presented below were copied verbatim from a terminal session with an APF9A controller. ">" is the APF9A prompt for operator input. The first menu is displayed in response to either a question mark ("?") or the [ENTER] when no preceding command is entered.

Main Menu

```
> ?
Menu selections are not case sensitive.
?  Print this help menu.
A  Initiate pressure-activation of mission.
C  Calibrate: battery volts, current, & vacuum.
D  Set logging verbosity. [0-5]
E  Execute (activate) mission.
I  Diagnostics agent.
I? Diagnostics menu.
K  Kill (deactivate) mission.
L  List mission parameters.
M  Mission programming agent.
M? Mission programming menu.
P  Display the pressure table.
Q  Exit command mode.
S  Seabird CTD agent.
S? Seabird CTD menu.
T  Get/Set RTC time. (format 'mm/dd/yyyy:hh:mm:ss')
```

Diagnostics Menu

```
> I ?
Menu of diagnostics.
?  Print this menu.
a  Run air pump for 6 seconds.
b  Move piston to the piston storage position.
c  Close air valve.
d  Display piston position
e  Extend the piston 4 counts.
g  Goto a specified position. [1-254] (counts)
o  Open air valve.
r  Retract the piston 4 counts.
t  Argos PTT test.
z  Calculate ToD down-time expiration.
1  Run air pump for 6 seconds (deprecated).
2  Argos PTT test (deprecated).
5  Retract the piston 4 counts (deprecated).
6  Extend the piston 4 counts (deprecated).
7  Display piston position (deprecated).
8  Open air valve (deprecated).
9  Close air valve (deprecated).
```

Deployment Parameter Menu

```
> L
APEX version 013108   sn 0000
551D479 28-bit hex Argos id.                      Ma
    060 Argos repetition period (Seconds)          Mr
INACTV ToD for down-time expiration (Minutes) Mtc
    240 Down time. (Hours)                              Mtd
    013 Up time. (Hours)                                Mtu
    009 Ascent time-out. (Hours)                        Mta
    006 Deep-profile descent time. (Hours)              Mtj
    006 Park descent time. (Hours)                      Mtk
    006 Mission prelude. (Hours)                        Mtp
   1000 Park pressure. (Decibars)                       Mk
   2000 Deep-profile pressure. (Decibars)               Mj
    066 Park piston position. (Counts)                  Mbp
    000 Compensator hyper-retractin (Counts)            Mbh
    016 Deep-profile piston position. (Counts)          Mbj
    010 Ascent buoyancy nudge. (Counts)                 Mbn
    022 Initial buoyancy nudge. (Counts)                Mbi
    004 Park-n-profile cycle length.                    Mn
    120 Maximum air bladder pressure. (Counts)          Fb
    096 OK vacuum threshold. (Counts)                   Fv
    227 Piston full extension. (Counts)                 Ff
    016 Piston storage position. (Counts)               Fs
      2 Logging verbosity. [0-5]                         D
   0002 DebugBits                                        D
   c745 Mission signature (hex).

> ?
Menu selections are not case sensitive.
?  Print this help menu.
A  Enter ARGOS ID in HEX.
B  Buoyancy control agent.
Bh Compensator hyper-retraction for park descent.[0-254] (counts)
Bi Ascent initiation buoyancy nudge. [25-254] (piston counts)
Bj Deep-profile piston position. [1-254] (counts)
Bn Ascent maintenance buoyancy nudge. [5-254] (piston counts)
Bp Park piston position [1-254] (counts)
F  Float vitals agent.
Fb Maximum air-bladder pressure. [1-254] (counts)
Ff Piston full extension. [1-254] (counts)
Fn Display float serial number.
Fs Storage Piston Position. [1-254] (counts)
Fv OK vacuum threshold. [1-254] (counts)
L  List mission parameters.
N  Park and profile cycle length. [1-254]
J  Deep-profile Pressure. (0-2000] (decibars)
K  Park Pressure.  (0-2000] (decibars)
Q  Quit the mission programming agent.
R  Repetition period for Argos transmissions [30-120] (sec).
T  Mission Timing Agent
Ta Ascent time-out period. [1-10 hours] (Hours)
```

```
Td Down time (0-336 hours] (Hours).
Tj Deep-profile descent time. [0-6 hours] (Hours).
Tk Park descent time. (0-6 hours] (Hours).
Tp Mission prelude. (0-6 hours] (Hours).
Tu Up time (0-24 hours] (Hours).
Z  Analyze the current mission programming
```

Buoyancy Parameter Menu
```
> B ?
Menu of buoyancy control parameters.
?  Print this menu.
Bh Compensator hyper-retraction for park descent.[0-254] (counts)
Bi Ascent initiation buoyancy nudge. [25-254] (piston counts)
Bj Deep-profile piston position. [1-254] (counts)
Bn Ascent maintenance buoyancy nudge. [5-254] (piston counts)
Bp Park piston position [1-254] (counts)
```

Timing Parameter Menu
```
> T ?
Menu of mission timing parameters.
?  Print this menu.
Ta Ascent time-out period. [1-10 hours] (Hours)
Td Down time (0-336 hours] (Hours).
Tj Deep-profile descent time. [0-6 hours] (Hours).
Tk Park descent time. (0-6 hours] (Hours).
Tp Mission prelude. (0-6 hours] (Hours).
Tu Up time (0-24 hours] (Hours).
```

SBE41 Menu
```
> S ?
Menu of SBE41 functions.
?  Print this menu.
Sc Display the SBE41 calibration coefficients.
Sf Display SBE41 firmware revision.
Sm Measure power consumption by SBE41.
Sn Display SBE41 serial number.
Sp Get SBE41 P.
Ss Get SBE41 P T & S.
St Get SBE41 P & T (low-power).
```

Float Vitals Menu
```
> F ?
?  Print this menu.
Fb Maximum air-bladder pressure. [1-254] (counts)
Ff Piston full extension. [1-254] (counts)
Fn Display float serial number.
Fs Storage Piston Position.  [1-254] (counts)
Fv OK vacuum threshold. [1-254] (counts)
```

Appendix F: Returning APEX floats for factory repair or refurbishment

Contact WRC before returning APEX floats for repair or refurbishment. All returns from outside USA, please specify our import broker:

Consignee: Webb Research Corporation
                82 Technology Park Drive
                East Falmouth, MA 02536

Notify: DHL-Danzas Freight Forwarding Agents
                Attn: Ellis Hall, Import Broker
                Phone (617) 886-6665, FAX (617) 242-1470
                500 Rutherford Avenue
                Charlestown, MA 02129

Note on shipping documents: US MADE GOODS

CAUTION: If the float was recovered from the ocean, it may contain water, which presents a safety hazard due to possible chemical reaction of batteries in water. The reaction may generate explosive gases (see "<u>Alkaline Battery Warning</u>" at the beginning of this manual).   In this case, be sure to remove the seal plug to ventilate the instrument before shipping. Do this is a well ventilated location and do not lean over the seal plug while loosening it. Use a 3/16 inch hex wrench (provided), or pliers, to rotate the plug counter-clockwise.

Seal Plug

Appendix G: CTD Calibration and Ballasting records

(included in hard copy only)