

When a SBD message is received it is appended to an XXXX.txt file by the 'ground station' (the computer processing the incoming SBD emails), where XXXX is the serial number of Spray. The file continues to grow as each new dive is appended onto the end. Lines are terminated by a Carriage Return/Line Feed (Hex = 0x0d0a).

At the beginning of the file are the configuration and calibration lines that are required for processing the data. Here is a short example of the beginning of the XXXX.txt file:

```
V 019 4 2 HOTS      Dec2006 Deployment from R/V Wyrтки, Honolulu
V FLUOR
# Argos 22768
C   -10 0.0400          #Pressure offset, gain
C   -5 0.0010      -1 0.0010  #Toff, Tgain, Soff, Sgain
C    0 0.0010  30      #Optical offset, gain, Set_gain
MD HOTS      Dec2006 Deployment from R/V Wyrтки, Honolulu
#----start calibration coefficients -----
VN 0019 4 2 0610
VO FLUOR
VA 22768 Argos ID
CP12  -10  0.04
CT22  -5  0.001
CS32  -1  0.001
CO44   0  0.001  30  1.00
#----end calibration coefficients -----
!dive  0          999 06Dec2006 20:08:03
G   0 0 06 Dec 2006 20:07 1 +21 16.47 -158 7.63  50 7 16 37 63 1.0 0 1  21.2745 -158.1272
```

The first six lines ('V', 'C') are the old format calibration lines (refer to i.e. 'Spray_TXT_0610a.pdf'). These lines will be shortly obsolete, once all programs are changed to handle the new lines. Starting at 'MD' are the new calibration lines, where the first two characters uniquely define the format and length of the remainder of the line:

MD <E_Name> <Description> : MD = Mission Description line
 E_Name = 8-char experiment name.
 Description = unique description for this Spray.

The MD line is used to describe the Spray when the user goes to queue a shore command.

This helps ensure that the user is sending the command to the correct serial number.

V : Vehicle Information

VN <s/n> <nsensor> <CTD_Type> <EEPROM_Ver>
 <s/n> is the Spray serial number.
 <nsensor> # of sensors returned, normally 4 (P, T, C, O).
 <CTD_Type> =1 for PME conductivity cell (obsolete 2004).
 =2 for SBE CTD
 <EEPROM_Ver>= YYMM = Year & month of the Eeprom code version,
 i.e. 0612.

VO <string>: <string> = FLUOR for fluorometer, OBS for optical backscatter.

VA <ptt_id> = Argos PTT ID.

G line**GPS information Sep2006 added decimal degrees at the end.**

```

G 1 1 22 Sep 2006 18:38 1 +33 26.08 -117 43.36 60 7 27 49 75 1.4 1 1 33.4347 -117.7227
i= 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
i=1 = dive#
2 = mission status at time of fix
0=start of mission, 1=start of dive, 2=end of dive, 3=in abort mode
( 3,4,5 ) = date
( 6:7 ) = time (UTC)
8 = valid flag: 0=bad fix, 1 = good
(9 10) Latitude
(11 12) Longitude
13 = Tfix = time (s) to acquire a fix
14 = Nsat = # of satellites in view
15 = minimum SNR of Nsat
16 = mean SNR
17 = max SNR
18 = HDOP
19 = GPS Health Status :
1=incomplete almanac, 2=bad back-up battery, 4=poor satellite coverage, 8=antenna fault.
20 = Wing Index / Roll Status, operational as of JUL06
bit assignment is:
b0 = is set to the GPS wing (1=port,0=stbd): Used by Sprays outfitted with an antenna switch.
b1 = 1 = roll function timed out (slow motor/bad pot)
b2 = 1 = failure in the last 2 s of operation (slow motor/bad pot).
b3 = 1 = bad potentiometer (pot is out-of-bounds by over 200 counts).
b4 = 1 = starboard wing is not at the correct antenna comms position.
b5 = 1 = port wing " ".
b6 = 1 = zero wing (wings flat) " ".
b7 = 1 = intermittent pot behavior (the pot initially reads in-bounds, and then bad).
Operationally, values = 2 (slow motor) happen frequently, and represent hysteresis problems near zero roll.

21, 22 = Decimal Degrees Lat and Lon. (Added Sep 2006)

```

If the fix is bad, the position reported is the last valid position. The longitude will always be positive if the fix is invalid.

E line Engineering Data Parameters 26, 27, 28 added Sep2006 : 'E' = old format

```

E 170 505 14.31 1.07 104.016 225 17 -1931 -1940 +31.084 -122.662 1 1 5 0 1 00 240 13 29 -1033 0 58 -4 25 350 100 4020
E 171 507 14.28 1.08 104.016 228 17 -2056 -1844 +31.084 -122.662 1 1 5 1 1 00 240 16 25 -1029 2 57 -4 19 360 100 4020
i 1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 17 18 19 20 21 22 23 24 25 26 27 28

```

```

i=1 = dive #
2 = max depth [dBar].
3 = Battery Volts (while pumping down deep).
4 = Pump current [amps] (while pumping down deep).
5 = altimeter reading at max depth [dBar].
6 = computed heading to steer (desired heading) [degrees].
7 = pitch angle (degrees).
8, 9 = dead-reckoning East and North component [m].
10, 11 = waypoint latitude and longitude
12 = Ntries = # of tries sending an Iridium SBD message.
13 = Nsent = # of messages sent.
14 = Navg = # of points averaged for each output point in the SBD profile.
15 = Wing used (used for Sprays with antenna switches).
16 = SBD status of last message sent.
17 = Status of Shore-based command.
18 = Surface pressure counts (gives idea of pressure sensor drift).
19 = Tpumpl = time to pump deep(seconds = Tpumpl*10) to get to neutral buoyancy.
20 = Tpumpp2 = remaining time pumped (s = Tpumpp2*10); includes ascent and surface pump times.
    Tpumpp = Tpumpl + Tpumpp2 = total time pumping.
21 = Internal vacuum ( in-Hg *100 ).
22 = Time ( seconds/10) until the max amps was observed during the deep pump.
23 = max amps (ampere = x*0.02) during the deep pump.
24 = JUL06 = Integrated error used in PI loop for heading control.
    counts/1.92 = [degrees] roll required to go straight.
25 = time (s) required to send the last message via SBD.
26 = Time (s) to leave the surface (after GPS is off, until P>2 dBar ).
27 = Time (s) From time at surface (P<2) until the GPS is turned on.
28 = Exception Status Word (printed in hexadecimal)..Let b0 = bit[0] = Lsbit, b15 = bit[15] = Msbit.
    b0 = Pump Recovery was required.                    b8 = CF1 Close File error.
    b1 = Drop Weight Activated.                        b9 = High pump amps at the 50 m safety pump.
    b2 = Pressure>20 m 'at the surface.'              b10= Press=0 counts (broken) 'at the surface.'
    b3 = Depth>1500 m detected.                        b11= No SBD message sent in the last 48 hrs.
    b4 = The Altimeter triggered turn-around.        b12= Cannot overcome the current (current-bucking mode).
    b5 = Backed off the surface.                      b13= Spurious Reset Detected (added OCT06).
    b6 = Extra pumps req'd at end of ascent.        b14= Altimeter reading is from an ADP.
    b7 = Took >700 s to leave the surface.          b15= Not Used.

b12=1 means that although current correction is applied, the current is too strong to maintain course.
b14 is used to help interpret the altimeter reading in the 'E' line.

```

As of Nov2006, new, two-letter (**EC, EF, EN, EP**) lines have been added, to break out the engineering information into sub-groups. Once this format is accepted by all programs, the old 'E ' line will be removed.

Exvv <data>, new Engineering Line, where

- E** first character 'E' signifies that engineering information follows.
- x** 2nd character is the type of engineering data:
- C** Communication (SBD) data.
- F** Flight information.
- N** Navigation information.
- P** Pump information.
- ' ' ('space' character) Old engineering format line; there is no **vv**.
- vv** Characters 3-4 = version number (Version 1 = '01').

FORMATS:

Communication line

```
EC01 135 2 1 1 00 26 1
      j1 j2 j3 j4 j5 j6 j7
```

- j1 = Dive number.
- j2 = Ntries = #tries sending an Iridium SBD message during the LAST surfacing.
- j3 = Nsent = # of SBD messages actually sent during the LAST surfacing.
- j4 = SBDI_STAT = status of the last attempt to send a message.
- j5 = SBD_SHORE_STAT = status of parsing the last shore command.
- j6 = T_SBD = time [s] that the modem actively tried to send a message.
- j7 = Wing used to send the SBD message.

Flight line.

```
EF01 135 5 241 506 17 99 0 -2.1 4000
      j1 j2 j3 j4 j5 j6 j7 j8 j9
```

- j1 = Dive number.
- j2 = Navg = # of 8s samples averaged for each datum in the SBD message.
- j3 = Psurf = Surface pressure counts.
- j4 = Zmax = Maximum depth [dBar] recorded in the bottom turn.
- j5 = Pitch = pitch angle [degrees].
- j6 = Altimeter minimum depth to the bottom [m].
- j7 = ADP altimeter bottom intensity level [dB] (set=0 for the Trittech).
- j8 = ROLL_ERR = Integrated roll error[degrees], from the PI loop.
- j9 = EXC_STATUS = Exception Status bit settings(hexadecimal).

Navigation Line

EN01 135 -2296 -1608 31.084 -122.662 290 100 0 235 T
j1 j2 j3 j4 j5 j6 j7 j8 j9 F

j1 = Dive number.

j2 = DRx [m] = dead-reckoning x distance traveled during the dive.

j3 = Dry [m] = dead-reckoning y distance traveled during the dive.

j4 = WLAT [decimal degrees] = Waypoint Latitude.

j5 = WLON [decimal degrees] = Waypoint Longitude.

j6 = Tleave[s]= Time at start-of-dive to leave the surface (P>2 m).

j7 = Tend [s] = Time at end-of-dive since p<2 m until GPS is turned on.

j8 = Tslow [s]= Time off of the surface where vertical speed |w|< 5 cm/s.

(not sent for version <=0610)

j9 = Desired Heading [degrees] = what we tried to steer.

F = T=TRUE for heading (v0608, 0610).

M=Magnetic for heading (< 0608).

Pump Line

EP01 135 506 14.29 1.05 0 0 1.18 10.32 15 25
j1 j2 j3 j4 j5 j6 j7 j8 j9 j10

j1 = Dive number.

j2 = Max Depth [dBar]: redundant with EF, but helps interpret amps and times.

j3 = Volts = Average battery Volts during the bottom turn pumping.

j4 = Amps = Average pump current during the bottom turn.

j5 = NBAD_AMP = # of times that pump current exceeded the max allowed.

j6 = T_max_amp [s/10]=time when the Max_Amps occurred during the bottom turn.

j7 = Max_Amps [amps] = Max pump current recorded in the bottom turn.

j8 = Vacuum [in-Hg] inside the Spray pressure case.

j9 = T_PUMP_1 [s/10] = time pumped in bottom turn until Spray was neutral.

j10= T_PUMP_2 [s/10] = remaining pump time; includes ascent+surface pump time.

T_PUMP_1 + T_PUMP_2 = total pump time.

ETxx : ET = Engineering Time-Series**xx** = Sensor ID

- 0 time [s] since start-of-dive (wing down and valve opened).
- 1 Pressure [counts] (process the same as the profile data).
- 2 Heading [degrees*10] from the compass.
- 3 Pitch Angle [degrees*10] from the compass tilt sensor.
- 4 Roll Angle [degrees*10] from the compass tilt sensor.
- 5 Pitch potentiometer [counts].
- 6 Roll potentiometer [counts].

The **ET** line format is:

```
ET00  2  20  12  0
  xx  j1  j2  j3  j4
xx = Sensor ID (see above).
j1 = Dive number.
j2 = Number of datum in the time series.
j3 = Number of datum per output line (# of columns per line).
j4 = Packet ID (SBD message # for Dive j1 ).
```

This is followed by $N=\text{ceiling}(j2/j3)$ lines of ET data, where each data line begins with 'e ':

```
e   10   11   12   13   14   15   16   17   18   19   20   21
e   22   23   24   25   26   27   28   29
```

The time-series is a decimated sub-sample of the 8-s raw scans, where the decimation = n_{dec} , and the selection of the desired returned sensors, are controlled by the shore command 'H' (refer to that documentation for further details). These time-series allow further diagnosis of:

- a) Descent speed.
- b) Heading control.
- c) Health of pitch and roll sensors.
- d) Health of pitch and roll mechanisms.

M Line**Mission Identifier Line**

M 1 06/05:01
 i= 1 2 3 4
 i=1 = dive number
 i=2 = year
 i=3 = month
 i=4 = mission identifier number: yr/mo:id are set in the Spray EEPROM by the user before the mission.

D Line**Start of the Sensor Profile Data**

D 1 49 npts
 i= 1 2 : i=1 = Dive number; i=2 = npts = # of scans in the profile (npts lines immediately follow)

p Line**Sensor profile data** The npts lines of profile data immediately follow the 'D' line, with format:

p 1 0 2859 14267 35043 27
 i= 1 2 3 4 5 6
 i=1 = dive number.
 i=2 = packet index (normally =0; if the profile takes 2 SBD messages, the 2nd SBD's index = 1).
 i=3 = pressure counts : dBar = (Pgain*counts) + Poff (see calibration lines for Pgain, Poff).
 i=4 = Temperature counts: deg C = (Tgain*counts) + Toff.
 i=5 = Salinity counts: PSU = (Sgain*counts) + Soff.
 i=6 = Optical counts: VOLTS = (Ogain*counts) + Ooff.

If no data is available for a sensor, its place in the profile listing is filled with a zero.

Doppler Data

B line Contains the Doppler parameters (values can be changed via shore command).

```
B 1 5 4 8 255
i= 1 2 3 4 5
i=1 =dive number.
i=2 =NCELL = number of cells (bins) for each ensemble-average.
i=3 =CELLSIZE = cell size [m], as measured along the central axis of the three-beam system.
i=4 =PULSE_LENGTH = pulse length [m], as measured along the central axis.
i=5 =MIN_SNR = Minimum Signal-to-Noise-Ratio [counts] to use to decide if the data is 'good'.
    one count = 0.43 dB. If = 255 (= -1 unsigned byte), then MIN_SNR criteria is NOT used.
```

A line Doppler profiler data follows: This line tells you type of data, and number of points.

```
A 1 23 npts 0
i= 1 2 3
i=1 = dive number;
i=2 = npts = number of profile points that follow in the 'a' lines.
i=3 = Doppler sensor type.
0 = ADP_P = pressure values for each ensemble-average sample.
1 = ADP_E = east component of velocity ( units = mm/s, >0 for East flow).
2 = ADP_N = north component of velocity ( mm/s, >0 for North flow).
3 = ADP_W = vertical component of velocity (mm/s, >0 for upwards flow).
4 = ADP_I = the 3-beam average intensity for the last cell in the ensemble (1 count = 0.43 dB).
5 = Pitch = measured pitch at each ensemble, 1 count = 0.4 degrees.
6 = Roll = measured roll at each ensemble, 1 count = 0.4 degrees.
7 = Heading = measured compass heading, 1 count = 0.1 degrees.
8 = ADP_ABS = 3-beam average back-scatter (corrected for spreading plus absorption).
```

a line Immediately follows the 'A' line, with *npts* lines of data.

```
a 1 0 381
i= 1 2 3
i=1 = dive number.
i=2 = packet index (if data is split into two SBD messages, the second message i2=1 ).
i=3 = sensor data for the Doppler Sensor Type, as defined in the 'A' line.
```

See the file 'ADP_SBD_format.doc' for further description of the Doppler data.

Sep 2006: Updates for code version 0608: same for 0610**R line** contains the basic route information

```
R 1 6 6 2 1 1 0 0 -1 0 0 0 -1 1
i= 1 2 3 4 5 6 7 8 9 10 11 12 13 14
```

i=1 = dive number;

i=2 = Number of points in the route

i=3 = Route entry that we're now heading for.

i=4 = End-of-Route Action:

0= go to the HOME waypoint (waypoint #0).

1= Repeat the route from the beginning.

2= Reverse the route (trace the route back to the beginning).

3= Stay stationed at the last waypoint.

4= ABORT (End mission) when the waypoint is reached.

i=5 = Direction that we're going through the route: 1=forward, -1=reverse

i=6 = 1= current-bucking is on, 0=off (this has no dive time-out).

i=7 = Current-Crossing Angle (degrees, <0 steer to left of current, >0=to the right, 0=off).

i=8 = Max Dive to use the current-crossing mode (is not used if Dive#> Max_dive).

i=9 = Manual Steering; -1=off, 0..360 Heading(TRUE), -2 = do circles (constant roll).

i=10= Max Dive to use the manual steering mode.

i=11= Steering Point (km).

i=12= Max Dive to use the steering point mode.

i=13= Min Correction Angle(current-bucking/ current-crossing / steering-point modes).

i=14= Max Correction Angle (degrees).

r line contains the info for each route entry

```
r 1 1 3 0
i= 1 2 3 4
```

i=1 = route entry index.

i=2 = Detect-Mode parameter:

0= Arrival is based on range only.

1= Arrival is based on either range or bisector angle (finish-line approach).

2= Based on bisector angle only.

i=3 = Watch-Circle Radius [km]. If the Spray is within this range, then we're at the waypoint.

0=auto-compute, based on the last dive-depth.

i=4 = Approach Angle: 1..360 degrees = approaching the next waypoint at this angle.

0=auto-compute.

W line contains the Waypoint list info

```
W 1 7
i= 1 2
i=1 = dive number.
i=2 = number of waypoints in the list.
```

w line contains the waypoint values: list immediately follows the 'W' line.

```
w 1 +34.325 -120.782
i= 1 2 3
i=1 = Waypoint index ( 0=HOME waypoint).
i=2 = Latitude (decimal degrees).
i=3 = Longitude(decimal degrees).
```

S line is the echo of the string of shore commands received.

```
S 1 3 1 33.6254 -118.5118;3 2 33.4799 -118.5150;
```

each command is delimited by ';'. See the sbd_cmd.doc for each command description.

X line header line to the list of parameter values

```
X 1 0608 37
i= 1 2 3

i=1 = Dive number.
i=2 = Code version ('0608' = year 2006, month 08 )
i=3 = Number of parameters that follow.
```

x line contains the parameter values.

```
x 28 600
i= 1 2
i=1 = address.
i=2 = value.
```