Carousel Auto Fire Module (AFM)

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User's Manual

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Manual Version #011, 02/01/10
Firmware Version 2.0a
SBE Data Processing Version 7.20a and later

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Table of Contents

Section 1: Introduction

This section includes a Quick Start procedure, and photos of a standard Auto Fire Module (AFM) shipment.

About this Manual

This manual is to be used with the AFM. It is organized to guide the user from installation through operation, data collection, and basic data processing. We have included detailed specifications, command descriptions, maintenance information, and helpful notes throughout the manual.

Sea-Bird welcomes suggestions for new features and enhancements of our products and/or documentation. Please contact us with any comments or suggestions (seabird@seabird.com or 425-643-9866). Our business hours are Monday through Friday, 0800 to 1700 Pacific Standard Time (1600 to 0100 Universal Time) in winter and 0800 to 1700 Pacific Daylight Time (1500 to 0000 Universal Time) the rest of the year.

Quick Start

Follow these steps to get a Quick Start using the AFM. The manual provides details for performing each task in *Section 3: Deploying and Operating System*:

1. Install AFM and CTD on SBE 32 Carousel Water Sampler.

2. Connect AFM's data I/O cable to computer.

3. Set up AFM and CTD using SeatermAF software:
   A. Select AFM with applicable CTD in Configure menu. Enter AFM and CTD communication settings, bottle closure logic, and bottle closure pressures/times. Save settings.
   B. Click Connect AFM to communicate with AFM. Set AFM date and time with **DateTime=mmddyyyyhhmmss**. Click Program to send bottle closure parameters to AFM.
   C. Click Connect CTD to communicate with CTD. Send commands to CTD to change instrument setup. Send **QS** to put CTD in quiescent (sleep) state (not applicable to SBE 50).

4. Arm AFM and deploy system:
   A. Click Connect AFM to communicate with AFM. Click ARM.
   B. Disconnect AFM's I/O cable; replace with dummy plug and locking sleeve.
   C. Turn on CTD's magnetic switch (if applicable) to start logging.
   D. Deploy system.

Note:
You must upload data from the AFM before redeploying. On redeployment, the AFM overwrites any data in its memory.

Unpacking AFM

Shown below is a typical AFM shipment.

AFM

Data I/O Cable (4 pin JB3 on AFM)

Note:
Typical shipment includes cable to Carousel and cable to SBE 19, 19*plus*, 19*plus* V2, or 25,
OR
Y-cable to Carousel and SBE 50.

CTD / Carousel Cables

Cable to SBE 32 Carousel Water Sampler (from 6-pin JB2 on AFM)

Cable to CTD - SBE 19, 19*plus*, 19*plus* V2, or 25 (from 3-pin JB1 on AFM)

Double Y-Cable to Carousel and SBE 50 (from 6-pin JB2 and 3-pin JB1 on AFM)

Jackscrew Kit

Spare o-ring and hardware kit

AFM Mount Kit for SBE 32 Carousel (optional) - photo not available

AFM User Manual

Software, and Electronic Copies of Software Manuals and User Manual

Section 2: Description of AFM

This section describes the functions and features of the AFM, including system description, specifications, dimensions, and end cap connectors.

System Description

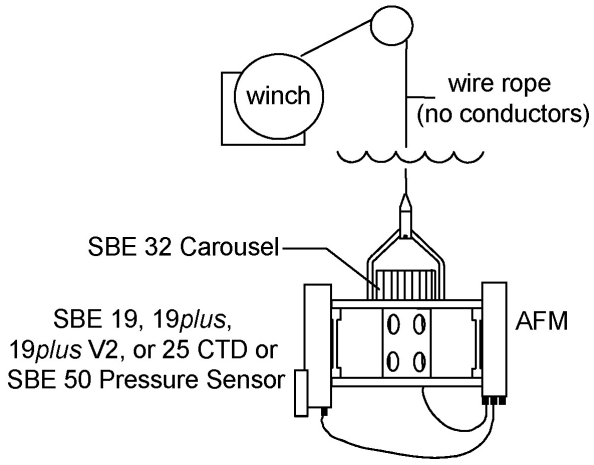
The Carousel Auto-Fire Module (AFM) allows the SBE 32 Carousel Water Sampler to operate autonomously on non-conducting cables. The AFM includes a microprocessor, solid-state memory, RS-232 interface, and battery power that supply the operating voltage, logic, and control commands to operate the Carousel.

Notes:
- The term *Carousel* or *SBE 32 Carousel* applies to all Carousel models: SBE 32 (full size), 32C (compact), and 32SC (sub-compact).
- Except where noted, the term *CTD* refers to the SBE 19, 19*plus*, 19*plus* V2, and 25 CTD *as well as* to the SBE 50 Digital Oceanographic Pressure Sensor.
- The AFM provides power for the SBE 50 Pressure Sensor, which has no internal power supply.
- The SBE 19, 19*plus*, 19*plus* V2, and 25 simultaneously record data (including pressure) in memory while transmitting pressure data in real-time to the AFM. The SBE 50 does not have an internal memory.

When the Carousel is used without a CTD, the AFM is programmed to fire bottles at predefined intervals of elapsed time after receipt of the **Arm** command. The point at which samples are taken can be determined (approximately) by monitoring the paid out cable length and elapsed time. The AFM records bottle sequence and number, date and time, and firing confirmation for each bottle fired. At the end of a cast, the bottle data (.afm) file is uploaded from the AFM.

When the Carousel is used with a CTD (SBE 19, 19*plus*, or 19*plus* V2 SEACAT Profiler, SBE 25 SEALOGGER CTD, or SBE 50 Pressure Sensor), the AFM:
- Monitors the pressure data transmitted in real-time by the SBE 19, 19*plus*, 19*plus* V2, 25, or 50,
- Fires bottles at predefined pressures (depths), on upcast, downcast, or whenever the Carousel is stationary for a specified period of time, and
- Records bottle sequence and number, time, firing confirmation, and five scans of CTD data in AFM memory for each bottle fired.

At the end of a cast, the SBE 19, 19*plus*, 19*plus* V2, or 25 CTD data is uploaded from the CTD (through the AFM), and the bottle data is uploaded from the AFM.
SBE Data Processing's Data Conversion module converts the raw data and creates a .cnv data file from the uploaded CTD data and a .ros bottle file from the uploaded AFM data.



The AFM is powered by 9 alkaline D-size cells (Duracell MN1300, LR20), which provide approximately 60 hours of operation. Optionally, the AFM can be powered by rechargeable Ni-Cad or NiMH batteries. Battery endurance is predominantly a function of the amount of time the AFM is powered and armed; the number of bottles fired has little impact. Setup, checkout, and data extraction are performed (without opening the housing) with our SeatermAF terminal program.

A standard AFM (PN 90208) is supplied with:
- Anodized aluminum housing rated to 6800 meters (22,300 feet)
- Impulse glass-reinforced epoxy bulkhead connectors for the CTD, Carousel, and Data I/O (RS-232) mounted on the housing end cap
- Cables from AFM to Carousel and CTD

As an option, the AFM (PN 90491) is supplied with wet-pluggable (MCBH) connectors and compatible cables in place of standard glass-reinforced epoxy connectors.

The AFM is typically installed on the Carousel, using the same mounting bracket used to mount a SEACAT, and hangs vertically between the upper and lower adapter plates.

Future upgrades and enhancements to the AFM firmware can be easily installed in the field through a computer serial port and the data I/O bulkhead connector on the AFM, without the need to return the AFM to Sea-Bird.

The AFM is supplied with a powerful Win 2000/XP software package, SEASOFT V2, which includes:
- **SeatermAF** - terminal program for easy communication and data retrieval.
- **SBE Data Processing** - program for calculation, display, and plotting of temperature, conductivity, pressure, auxiliary sensor data, and derived variables such as salinity and sound velocity.

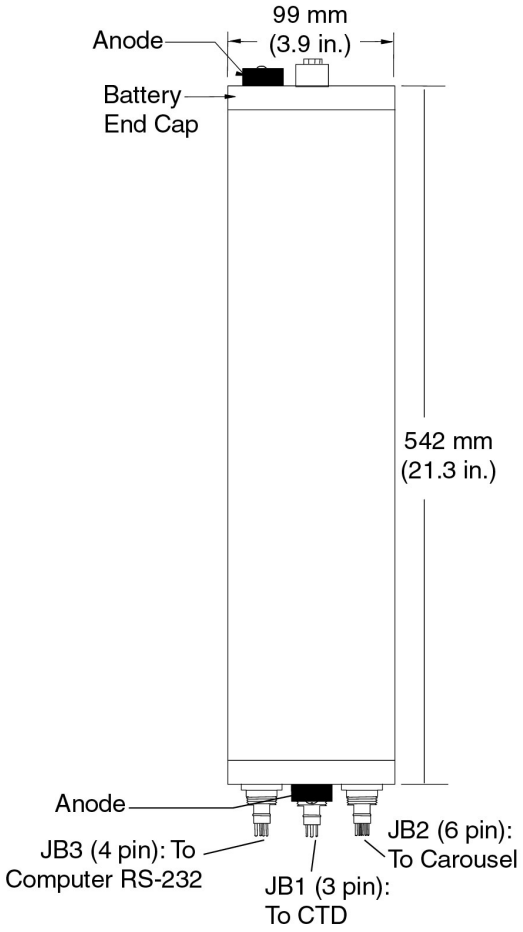
Notes:
- Help files provide detailed information on the software.
- A separate software manual on CD-ROM contains detailed information on SBE Data Processing.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our FTP site. See our website (www.seabird.com) for the latest software version number, a description of the software changes, and instructions for downloading the software from the FTP site.

Specifications

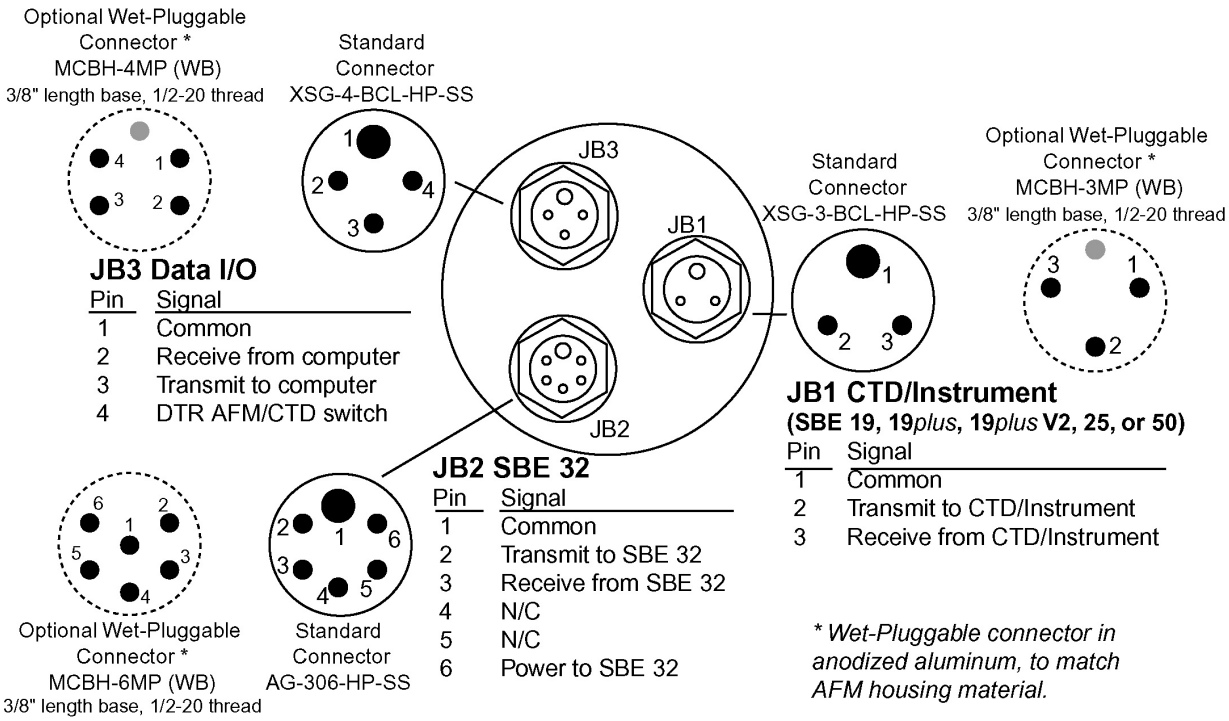
Memory and Data Storage	64K byte static RAM memory. Memory space for 1 cast (24 bottles maximum). AFM memory records for each bottle fired: • Bottle sequence and number, date and time, firing confirmation, battery voltage, scan number of first of 5 CTD scans, and 5 scans of CTD data, or • (if used without a CTD) Bottle sequence and number, date and time, firing confirmation, and battery voltage
Real-Time Clock	32,768 Hz TCXO accurate to ± 1 minute/year
Internal Batteries	*Standard*: 9 alkaline D-size batteries (Duracell MN1300, LR20) *Optional*: rechargeable 9-cell Ni-Cad or NiMH battery pack
Current	*Quiescent Current*: 30 microamps *Operating Current*: Not armed - 3 milliamps Armed, Carousel capacitor charged - 160 milliamps Armed, Carousel capacitor charging - 300 milliamps
Battery Endurance	Approximately 60 hours for alkaline batteries, 45 hours for NiMH batteries, or 25 hours for Ni-Cad batteries.
Materials	Anodized aluminum housing rated at 6800 meters (22,300 feet)
Weight	In air: 8.1 kg (18 lbs) In water: 4.1 kg (9 lbs)

Note:
In response to low battery voltage, the AFM turns off power (goes to sleep). For **Ni-Cad or NiMH** batteries, the AFM turns off power when voltage drops below 7.3 volts or is less than 10 volts and voltage drop is greater than 1 volt/minute. This reduces battery load to quiescent current once the first cell in the battery pack is exhausted. For **alkaline** batteries, the AFM turns off power when voltage drops below 7.3 volts.

Dimensions and End Cap Connectors



Notes:
- JB1 to CTD's 4-pin data I/O connector
- JB2 to SBE 32 Carousel's 6-pin modem connector
- When used with an SBE 50, a double Y-cable connects to JB1 and JB2, and to the SBE 50 and 32. This provides power to the SBE 50, which does not have an internal power supply.



JB3 Data I/O

Pin	Signal
1	Common
2	Receive from computer
3	Transmit to computer
4	DTR AFM/CTD switch

JB2 SBE 32

Pin	Signal
1	Common
2	Transmit to SBE 32
3	Receive from SBE 32
4	N/C
5	N/C
6	Power to SBE 32

JB1 CTD/Instrument
(SBE 19, 19*plus*, 19*plus* V2, 25, or 50)

Pin	Signal
1	Common
2	Transmit to CTD/Instrument
3	Receive from CTD/Instrument

** Wet-Pluggable connector in anodized aluminum, to match AFM housing material.*

Section 3: Deploying and Operating System

This section describes the procedures for installing software; installing, setting up, and deploying the system; and uploading data.

Installing Software

Notes:
- Help files provide detailed information on the software. A separate software manual on the CD-ROM contains detailed information on SBE Data Processing.
- It is possible to use the AFM without SeatermAF by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our FTP site. See our website (www.seabird.com) for the latest software version number, a description of the software changes, and instructions for downloading the software from the FTP site.

Sea-Bird recommends the following minimum system requirements for installing the software: Windows 2000 or later, 500 MHz processor, 256 MB RAM, and 90 MB free disk space for installation. Although SEASOFT V2 was designed to work with a PC running Win 2000/XP; extensive testing has not shown any compatibility problems when using the software with a PC running Windows Vista.

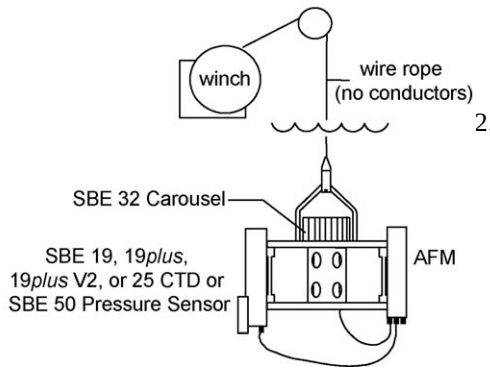
If not already installed, install SeatermAF and other Sea-Bird software programs on your computer using the supplied software CD:

1. Insert the CD in your CD drive.
2. Install software: Double click on **SeasoftV2_*date*.exe** (*date* is the date that version of the software was created). Follow the dialog box directions to install the software. The installation program allows you to install the desired components. Install all the components, or just install SeatermAF (terminal program) and SBE Data Processing (data processing).

The default location for the software is c:\Program Files\Sea-Bird. Within that folder is a sub-directory for each program (SeatermAF, etc.)

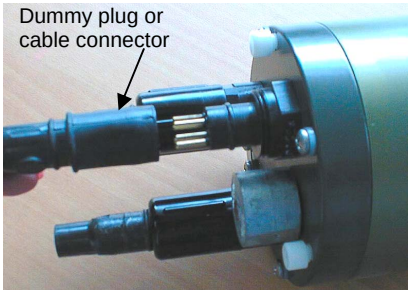
Installing System

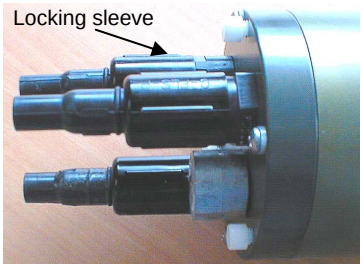
Note:
If you order the AFM, Carousel, and CTD as a package, the AFM and CTD may be factory-installed on the Carousel, depending on the Carousel model.



1. Install the AFM and CTD on the Carousel Water Sampler (see the instructions provided with the Mount Kit):
   A. Put a layer of Teflon tape on the inside of the steel clamps to provide electrical isolation between the clamps and the AFM's aluminum housing.
   B. Attach the AFM to the mounting bracket using the clamps.
   C. Install the mounting bracket on the Carousel in place of a sample bottle. (On some Carousels, extra mounting positions are provided to mount the AFM and CTD, in addition to the full number of bottles).
   D. Repeat Steps A through C for the CTD.
2. Install the cables connecting the AFM to the CTD and Carousel:
   - **No CTD** - AFM's 6-pin **JB2** to Carousel's 6-pin modem connector.
   - **SBE 19, 19*plus*, 19*plus* V2, or 25 CTD** - AFM's 6-pin **JB2** to Carousel's 6-pin modem connector and AFM's 3-pin **JB1** to CTD's 4-pin data I/O connector.
     Note: SBE 19s and 25s configured with a pump, and all SBE 19*plus* V2s, have a 6-pin data I/O - pump connector. These CTDs are supplied with a Y-cable (6-pin to CTD, 4-pin data I/O, 2-pin pump); connect the AFM's 3-pin JB1 to the 4-pin data I/O connector on the Y-cable.
   - **SBE 50** – Double Y-cable from AFM's 6-pin JB2 and 3-pin JB1 to Carousel's 6-pin modem connector and SBE 50's 4-pin data I/O connector.

CAUTION:
Do not use WD-40 or other petroleum-based lubricants, as they will damage the connector.





For each cable connector:

A. Remove dummy plug (if installed).
   (1) By hand, unscrew the locking sleeve from the connector. **If you must use a wrench or pliers, be careful not to loosen the bulkhead connector instead of the locking sleeve**.
   (2) Remove the dummy plug from the connector by pulling the plug firmly away from the connector.

B. Lightly lubricate the inside of the cable connector with silicone grease (DC-4 or equivalent).

C. **Standard Connector** - Install the cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the instrument. Remove any trapped air by *burping* or gently squeezing the connector near the top and moving your fingers toward the end cap. **OR**
MCBH Connector – Install the cable connector, aligning the pins.

D. Place the locking sleeve over the connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

Testing and Setting Up System

1. Connect the AFM's 4-pin **JB3** to your computer's serial port using the supplied cable. This cable (with blue tape on both ends) uses the Data Terminal Ready (DTR) line from the computer to control internal switches in the AFM. These switches allow the terminal program (SeatermAF) to communicate with the AFM or CTD without switching cables or COM ports (SeatermAF sets the DTR line high to select the AFM and low to select the CTD). **The CTD's data I/O cable is not able to communicate with the AFM.**

   A. If there is a dummy plug on the connector, remove as follows:
      (1) By hand, unscrew the locking sleeve from the connector. **If you must use a wrench or pliers, be careful not to loosen the bulkhead connector instead of the locking sleeve**.
      (2) Remove the dummy plug from the connector by pulling the plug firmly away from the connector.

   B. **Standard Connector** - Install the cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the AFM. **OR**
   MCBH Connector – Install the cable connector, aligning the pins.

   C. Connect the 9-pin end to your computer's serial port.

Using SeatermAF

Proceed as follows:

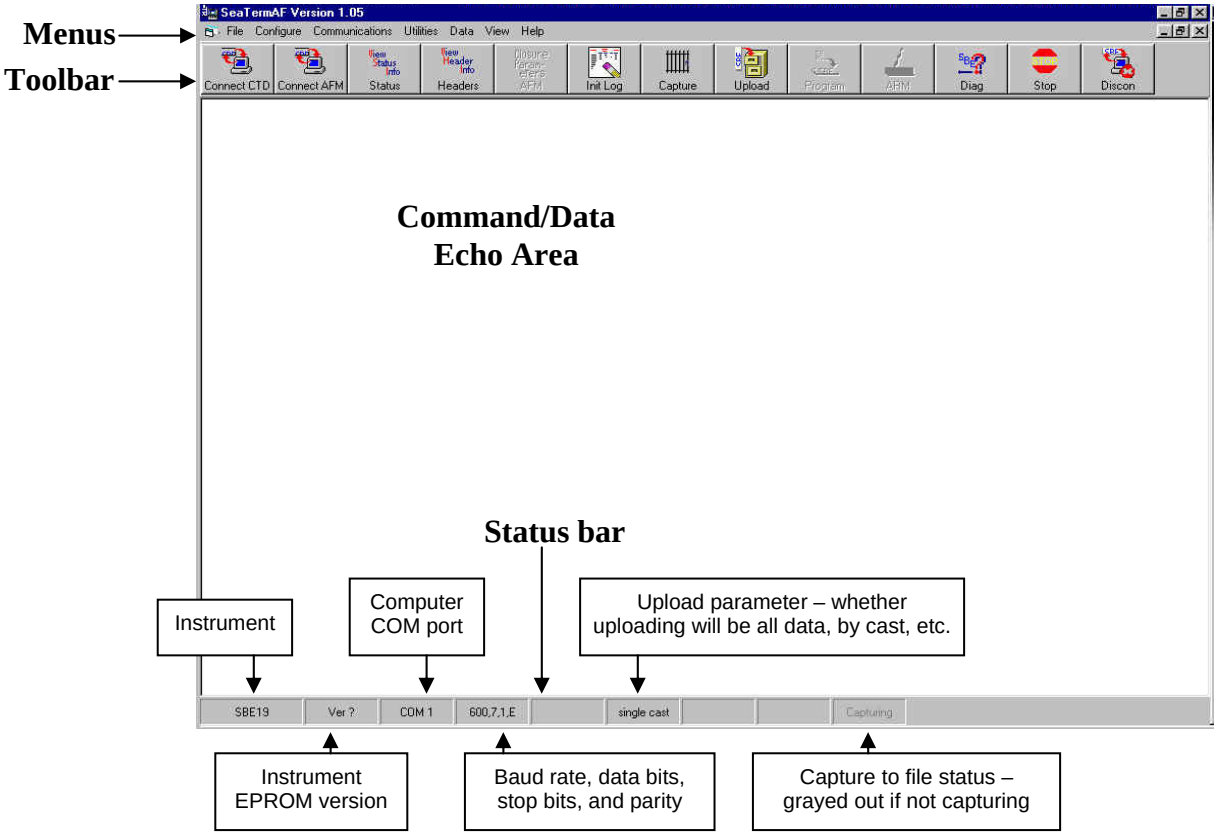
Notes:
- SeatermAF's initialization file, SeaTermAF.ini, includes information on the last instrument used when the program was closed, and the location of that instrument's settings (.ini) file. As a default, the instrument's .ini file is saved to the same directory as SeatermAF.exe.
- See SeatermAF's Help files.

Note:
If using an SBE 19*plus* V2, select *AFM with SBE 19plus* as the instrument type in SeatermAF.

1. Double click on SeatermAF.exe. If this is the first time the program is used, the setup dialog box appears:

Select the instrument type (*AFM with SBE 19*, *AFM with SBE 19plus*, *AFM with SBE 25*, *AFM with SBE 50*, or *AFM with no CTD*) and computer COM port for communication with the AFM. Click OK.

2. The main screen looks like this:



Note:
There is at least one way, and as many as three ways, to enter a command:
- Manually type a command in Command/Data Echo Area
- Use a menu to automatically generate a command
- Use a Toolbar button to automatically generate a command

Note:
Once the system is configured and the computer is communicating with the AFM or CTD, to update the Status bar:
- on the Toolbar, click Status; or
- from the Utilities menu, select Instrument Status.

SeatermAF sends the status command, which displays in the Command/Data Echo Area, and updates the Status bar.

Description of SeatermAF main screen:
- Menus – Contains tasks and frequently executed instrument commands.
- Toolbar – Contains buttons for frequently executed tasks and instrument commands. All tasks and commands accessed through the Toolbar are also available in the Menus. To display or hide the Toolbar, select View Toolbar in the View menu. Grayed out Toolbar buttons are not applicable.
- Command/Data Echo Area – Echoes a command executed using a Menu or Toolbar button, as well as the instrument's response. Additionally, a command can be manually typed in this area, from the available commands for the instrument. Note that the instrument must be *awake* for it to respond to a command (use Connect AFM or Connect CTD on the Toolbar to wake up the instrument).
- Status bar – Provides status information. To display or hide the Status bar, select View Status Bar in the View menu.

You must test and set up both the AFM and the CTD. The Status bar indicates which instrument is active.
- Menus, toolbar buttons, and manually typed commands associated with the AFM are only applicable when the AFM is *connected* (use Connect AFM on the Toolbar).
- Menus, toolbar buttons, and manually typed commands associated with the CTD are only applicable when the CTD is *connected* (use Connect CTD on the Toolbar).

Following are the Toolbar buttons applicable to the AFM and/or CTD (some apply to both, others apply to only the AFM or only the CTD):

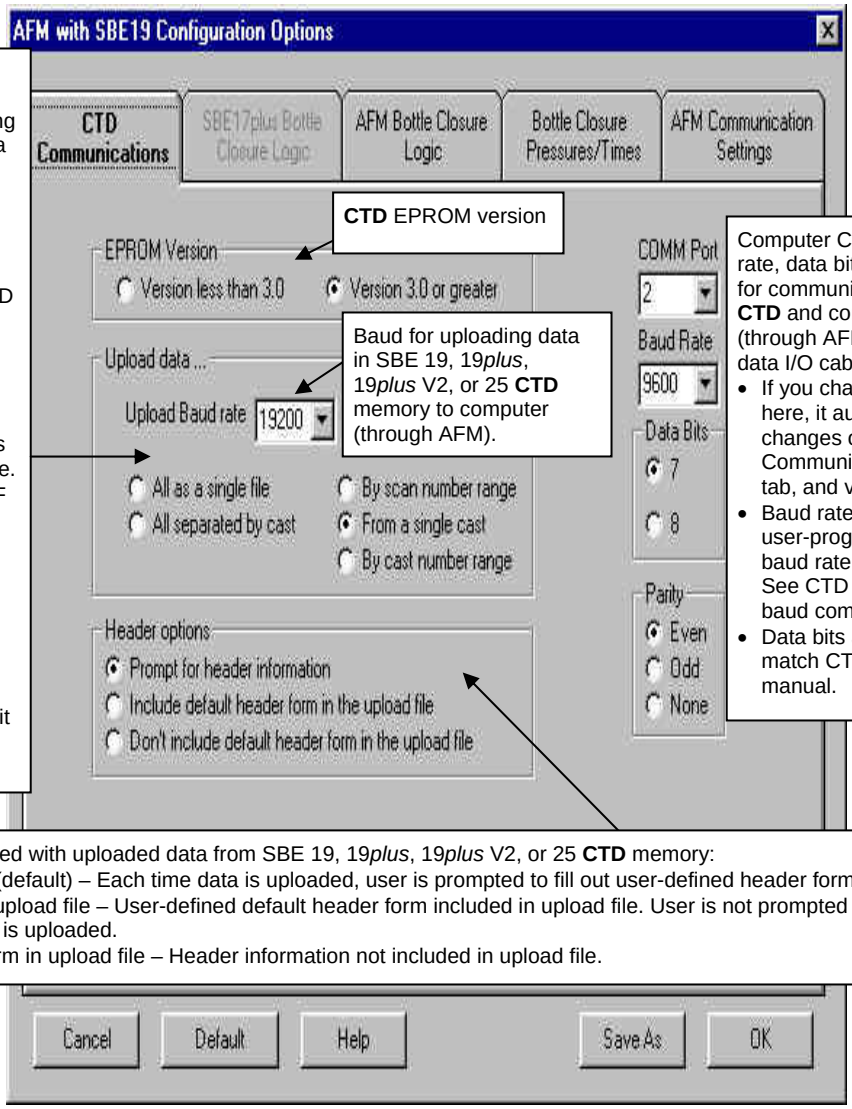
Toolbar Buttons	Description	Equivalent Command*
Connect CTD	Re-establish communications with **CTD** (SBE 19, 19*plus*, 19*plus* V2, 25, or 50). Computer responds with S> prompt. SBE 19, 19*plus*, 19*plus* V2, or 25 *goes to sleep* after 2 minutes without communication from computer have elapsed.	—
Connect AFM	Re-establish communications with **AFM**. Computer responds with A> prompt. AFM *goes to sleep* after 2 hours without communication from computer have elapsed.	—
Status	Display **AFM or CTD** instrument status — provide information on instrument setup and current status.	**DS**
Headers	View SBE 19, 19*plus*, 19*plus* V2, or 25 **CTD** data headers (cast number, date and time, number of samples in cast, etc.). A new header is generated for each CTD cast.	**DH**
Closure Parameters AFM	Display all auto fire parameters and auto fire status for **AFM**.	**CP**
Init Log	Reset data pointers and cast numbers for SBE 19, 19*plus*, 19*plus* V2, or 25 **CTD**. This should be performed after existing data has been uploaded from CTD and prior to recording new data.	SBE 19 or 25: **IL** SBE 19*plus* or 19*plus* V2: **InitLogging**
Capture	Capture instrument (**AFM or CTD**) responses on screen to file; may be useful for diagnostics. File has .cap extension. Press Capture again to turn off capture. Capture status displays in Status bar.	—
Upload	Upload data from **AFM or CTD** (SBE 19, 19*plus*, 19*plus* V2, or 25), in format post-processing software can use. Before using upload: • CTD: Stop logging. • Configure upload and header parameters in Configure menu.	AFM or SBE 19, 19*plus*, 19*plus* V2, or 25 CTD: **DD**
Program	Send auto fire information input in Configure menu to **AFM**. Must send this information before deployment for auto fire capability to function.	—
ARM	Enable **AFM's** auto fire algorithm to close bottles. Must arm AFM before deployment for auto fire capability to function. AFM will automatically disarm itself and enter the quiescent (sleep) state after 24 hours.	**Arm**
Diag	Perform one or more diagnostic tests on **CTD**. Diagnostic test(s) accessed in this manner are non-destructive – they do not write over any existing instrument settings.	SBE 19 or 25: **DS, J, VR, FR** SBE 19*plus* or 19*plus* V2: **DS, DCal, TS, TSR** SBE 50: (not applicable)
Stop	Halt current command for **AFM or CTD**.	(press Esc key or Ctrl C)
Disconnect	Free computer COM port used to communicate with **AFM or CTD**. COM port can then be used by another program.	—

*See *AFM Command Descriptions* and the applicable CTD manual for detailed command descriptions.

Note:
If using an SBE 19*plus* V2, select *AFM with SBE 19plus* in the Configure menu.

Testing and Setting Up AFM and CTD

3. In SeatermAF's Configure menu, select the AFM with the applicable CTD. The dialog box looks like this for the AFM with SBE 19 (others are similar):



Data upload type from SBE 19, 19*plus*, 19*plus* V2, or 25 **CTD** memory (through AFM) when using Upload on Toolbar or Upload Data in Data menu:
- All as single file – All data uploaded into 1 file.
- All separated by cast - All data uploaded. Separate file written for each cast, with 3-digit cast ID (001, etc.) appended to user-selected file name.
- By scan number range – SeatermAF prompts for beginning and ending scan (sample) numbers, and uploads all data within range into one file.
- From a single cast - SeatermAF prompts for cast number, and uploads all data from cast into 1 file.
- By cast number range - SeatermAF prompts for beginning and ending cast numbers, and uploads data within that range. Separate file written for each cast, with 3-digit cast ID (001, etc.) appended to user-selected file name.

CTD EPROM version

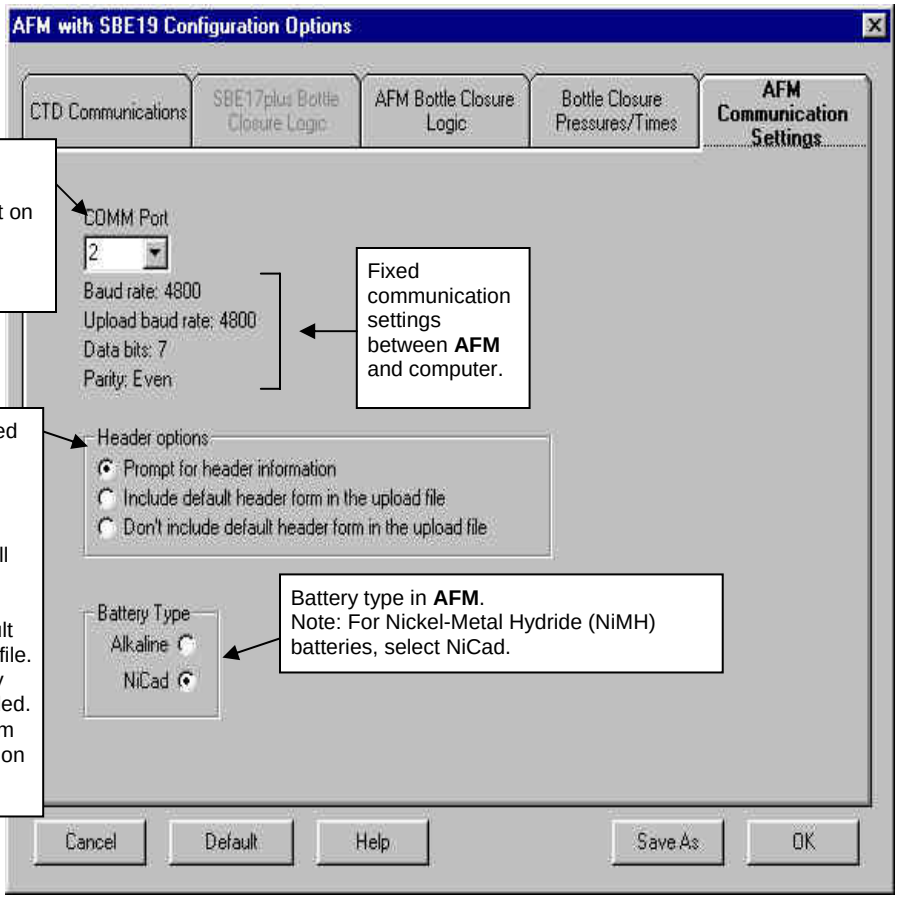
Baud for uploading data in SBE 19, 19*plus*, 19*plus* V2, or 25 **CTD** memory to computer (through AFM).

Computer COM port, baud rate, data bits, and parity for communication between **CTD** and computer (through AFM and AFM data I/O cable).
- If you change COM port here, it automatically changes on AFM Communication Settings tab, and vice versa.
- Baud rate must match user-programmable baud rate set in CTD. See CTD manual for baud command.
- Data bits and parity must match CTD. See CTD manual.

Defines header information included with uploaded data from SBE 19, 19*plus*, 19*plus* V2, or 25 **CTD** memory:
- Prompt for header information (default) – Each time data is uploaded, user is prompted to fill out user-defined header form.
- Include default header form in upload file – User-defined default header form included in upload file. User is not prompted to add any information when data is uploaded.
- Don't include default header form in upload file – Header information not included in upload file.

Make the selections on the CTD Communications tab (see CTD manual for communication parameters for your instrument).
Note that selections for uploading data and header options can be made now or when you are ready to upload data from memory after deployment - they have no effect on system operation.

4. Click on the AFM Communication Settings tab. The dialog box looks like this:



Computer COM port for communication between **AFM** and computer. If you change COM port on this tab, it automatically changes on CTD Communications tab, and vice versa.

Fixed communication settings between **AFM** and computer.

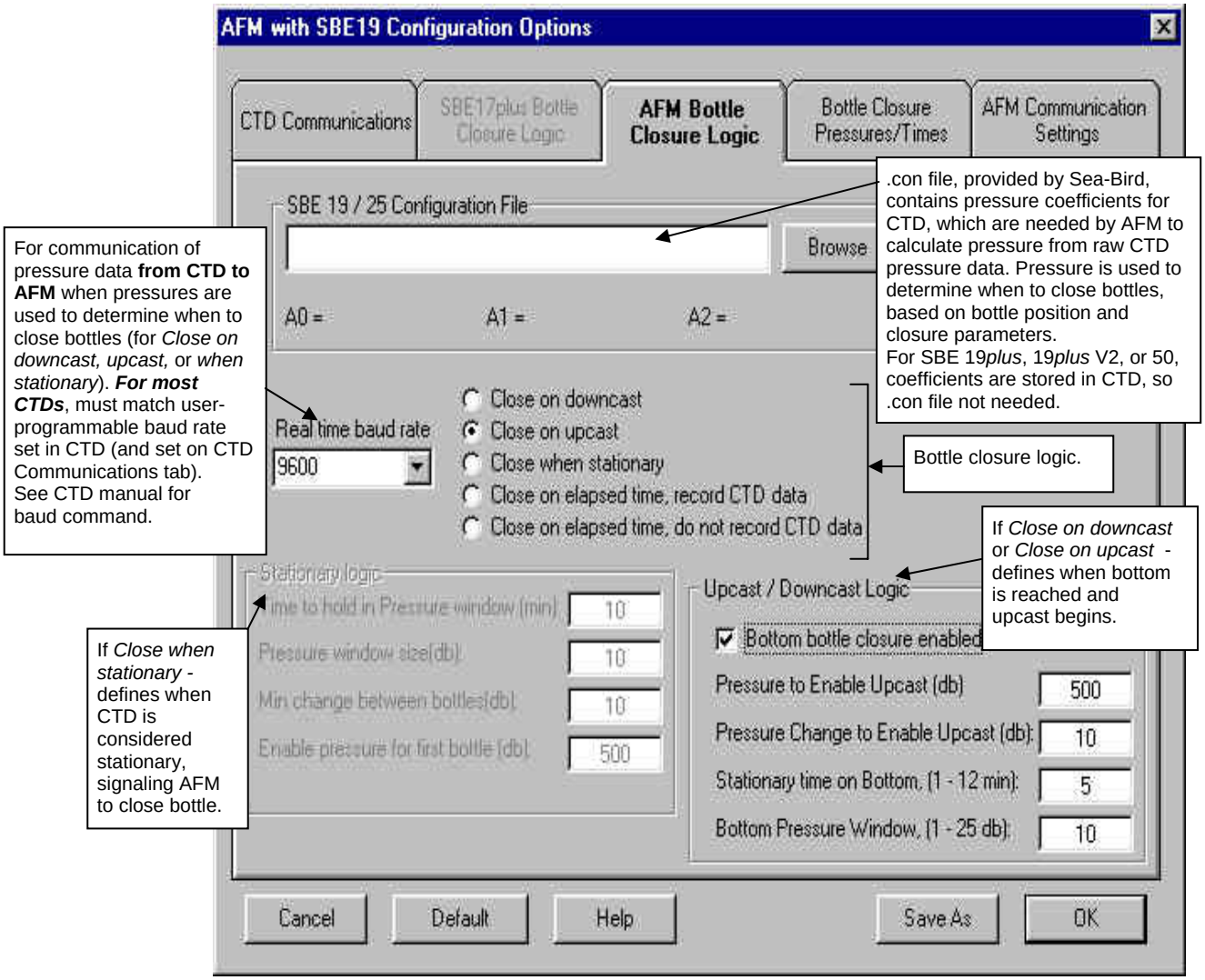
Defines header information included with uploaded data from **AFM** memory:

- Prompt for header information (default) – Each time data is uploaded, user is prompted to fill out user-defined header form.
- Include default header form in upload file – User-defined default header form included in upload file. User is not prompted to add any information when data is uploaded.
- Don't include default header form in upload file – Header information not included in upload file.

Battery type in **AFM**.
Note: For Nickel-Metal Hydride (NiMH) batteries, select NiCad.

Make the selections on the AFM Communication Settings tab. Note that the selection for header options can be made now or when you are ready to upload data after deployment - it has no effect on system operation.

5. Click on the AFM Bottle Closure Logic tab. The dialog box looks like this:

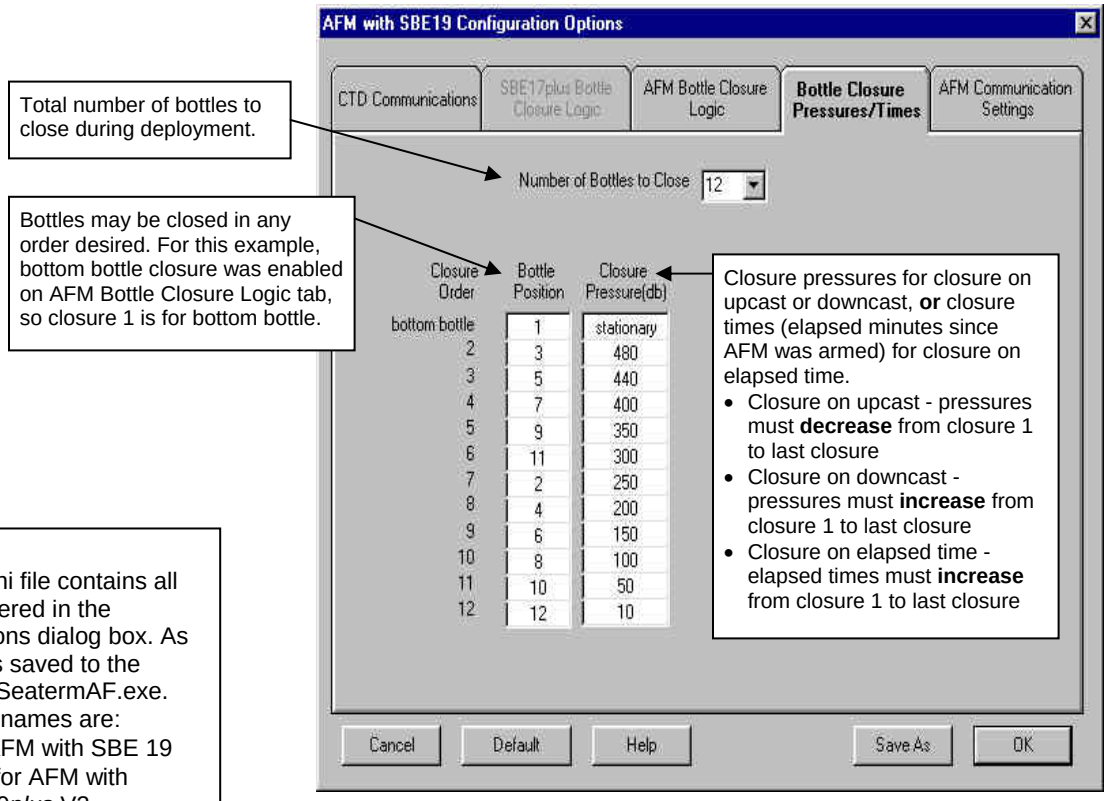


Make the selections on the AFM Bottle Closure Logic tab (see *Bottle Closure Setup Parameters*).

Notes:

- Seasave and SBE Data Processing versions 7.20a introduced .xmlcon files (in XML format). Versions 7.20a and later allow you to open a .con or .xmlcon file, and to save it to a .con or .xmlcon file. **However, SeatermAF is not currently compatible with a .xmlcon file; continue to use .con files with the ECO for compatibility with SeatermAF**.
- The .con file defines the CTD – integrated auxiliary sensors, and channels, serial numbers, and calibration dates and coefficients for all sensors (conductivity, temperature, pressure, and auxiliary sensors). For the SBE 19 (not 19*plus* or 19*plus* V2) and 25, SeatermAF uses the pressure sensor coefficients to calculate raw pressure sensor output from the user's closure pressure entries in the Configuration Options dialog box. These pressures are used to determine when to close bottles, based on user-input bottle position and closure parameters. **If the .con file does not match the actual instrument configuration, the AFM will not be able to interpret and process data correctly.**
- A new or recalibrated CTD ships with a configuration file that reflects the current configuration *as we know it*. The file is named with the instrument serial number, followed by a .con extension. For example, for a CTD with serial number 2375, Sea-Bird names the file *2375.con*. You may rename the file (but not the extension) if desired; this will not affect the results.

6. Click on the Bottle Closure Pressures/Times tab. The dialog box looks like this if *Close on upcast* was selected:



Notes:
The instrument's .ini file contains all the information entered in the Configuration Options dialog box. As a default, this file is saved to the same directory as SeatermAF.exe. The default .ini file names are:

- SBE19.ini - for AFM with SBE 19
- SBE19plus.ini - for AFM with SBE 19*plus* or 19*plus* V2
- SBE25.ini - for AFM with SBE 25
- SBE 50.ini – for AFM with SBE 50
- AFMonly.ini - for AFM with no CTD

You may want to save .ini files with unique names or in unique directories for reuse in future deployments.

Make the selections on the Bottle Closure Pressures/Times tab (see *Bottle Closure Setup Parameters*). Click OK to overwrite an existing instrument settings (.ini) file, or click Save As to save the settings as a new filename.

7. Click Connect AFM on the Toolbar. The display looks like this:

```
A>
```

This shows that correct communications between the computer and AFM have been established.
If the system does not respond as shown above:

- Click Connect AFM again.
- Verify the COM port is correct on the AFM Communication Settings tab in the Configuration Options dialog box.
- Check cabling between the computer and AFM.
- Check the AFM battery voltage - see *Replacing/Recharging Batteries* in *Section 5: Routine Maintenance*

Notes:
- *90208* in the status reply is the part number of a standard AFM (aluminum housing and glass-reinforced epoxy connectors); the 90491 AFM (aluminum housing and wet-pluggable connectors) uses the same firmware, and has the same status reply.
- The AFM has a 2-hour timeout algorithm designed to conserve battery energy if too much time elapses between commands. If the system does not appear to respond, click Connect AFM on the Toolbar to reestablish communications.
- The AFM's response to low voltage varies, depending on battery type. For **Ni-Cads**, the AFM turns off power when voltage drops below 7.3 volts or is less than 10 volts and voltage drop is greater than 1 volt/minute. This reduces battery load to quiescent current once the first cell in the battery pack is exhausted. For **alkalines**, the AFM turns off power when voltage drops below 7.3 volts.

8. Display AFM status information by clicking Status on the Toolbar. The display looks like this:

```
90208 AFM V2.0 SERIAL NO. 9999 11 Mar 2008 08:49:08
Main battery = 13.3
Lithium battery = 6.6
AFM is NOT ARMED
```

   Looking at the status display, verify the following:
   - Main battery voltage is sufficient (> 10.2 volts) - If not, replace/recharge the batteries before proceeding (see *Replacing/Recharging Batteries* in *Section 5: Routine Maintenance*).
   - Date and time are correct - If not, set the date and time (**DateTime=mmddyyyyhhmmss**).
   - AFM is not armed - If it is armed, type **DA** (disarm) and press the Enter key before proceeding. The AFM must be disarmed before it accepts the bottle closure information you input in the Configuration Options dialog box.

9. Click Program on the Toolbar to send all the bottle closure information from the Configuration Options dialog box to the AFM. SeatermAF sends a number of commands to the AFM, transmitting the bottle closure parameters in the format required by the AFM.

10. Click Connect CTD on the Toolbar. The display looks like this:

```
Connected successfully . . .
S>
```

    This shows that correct communications between the computer and CTD (through the AFM) have been established.
    If the system does not respond as shown above:
    - Click Connect CTD again.
    - Verify the correct CTD was selected in the Configure menu and the CTD communication settings were entered correctly on the CTD Communications tab in the Configuration Options dialog box.
    - Check cabling between the computer, AFM, and CTD.
    - Check the SBE 19, 19*plus*, 19*plus* V2, or 25 CTD battery voltage.

Notes:
- **AFM with SBE 25:** If you want to close bottles on upcast, verify that the SBE 25 configuration entered with **CC** is *Stop CTD on upcast (y/n)? = NO*.
- **AFM with SBE 19*plus* or 19*plus* V2:** SeatermAF automatically sets **OutputFormat=4** in the CTD when you program the AFM (click Program on Toolbar or select Program Auto Fire in Utilities menu). This is the data format required for real-time communication of pressure data to the AFM.
- **AFM with SBE 50:** SeatermAF automatically sets **AutoRun=Y**, **NAvg=16**, and **OutputFormat=7** in the SBE 50 when you arm the AFM (click Arm on Toolbar or select Arm Auto Fire in Utilities menu). These parameters are required for real-time communication of pressure data to the AFM. It then sends **Start** to the SBE 50, to start sampling.

11. Display CTD status information by clicking Status on the Toolbar. The display looks like this for an SBE 19*plus*:

```
SeacatPlus V 1.5  SERIAL NO. 4000    30 Mar 2008  14:02:13
vbatt = 9.6, vlith = 8.6, ioper = 61.2 ma, ipump = 25.5 ma,
iext01 = 76.2 ma
status = not logging
number of scans to average = 1
samples = 5000, free = 376300, casts = 1
mode = profile, minimum cond freq = 3000, pump delay = 60 sec
autorun = no, ignore magnetic switch = no
battery type = ALKALINE, battery cutoff = 7.3 volts
pressure sensor = strain gauge, range = 1000.0
SBE 38=no, Gas Tension Device = no
Ext Volt 0=yes, Ext Volt 1=no, Ext Volt 2=no, Ext Volt 3=no
echo commands = yes
output format = converted decimal
output salinity = no, output sound velocity = no
```

12. Review the information in the status display. As desired, send commands to the CTD to change the instrument setup (see CTD manual).

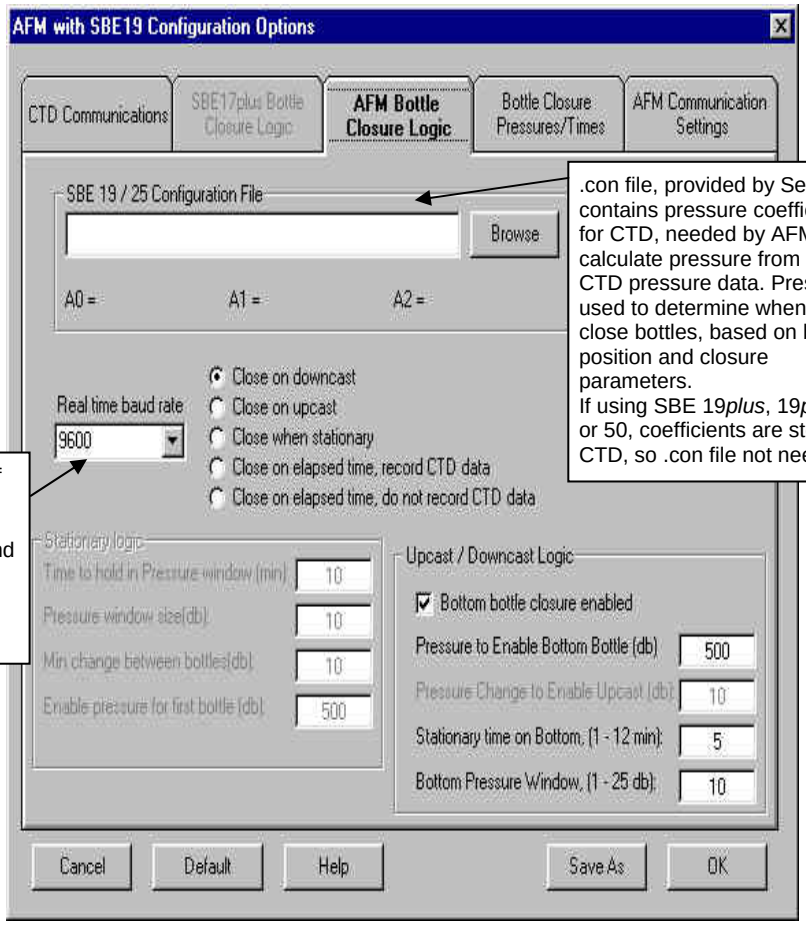
Bottle Closure Setup Parameters

Notes:
- After entering and saving information in the Configuration Options dialog box, you must *program* the AFM to send the bottle closure information to the AFM. With the AFM *connected*, click Program on the Toolbar; SeatermAF sends a number of commands to the AFM, transmitting the required information.
- A new or recalibrated CTD ships with a configuration file that reflects the current configuration *as we know it*. The file is named with the instrument serial number, followed by a .con extension. For example, for a CTD with serial number 2375, Sea-Bird names the file *2375.con*. You may rename the file (but not the extension) if desired; this will not affect the results.

The AFM closes bottles on downcast, on upcast, when stationary, or based on elapsed time. Descriptions of each closure type follow.

Close on Downcast

If you select *Close on downcast* on the AFM Bottle Closure Logic tab, the AFM closes bottles on downcast only. Upcast/Downcast Logic parameters on the AFM Bottle Closure Logic tab define the conditions of pressure and time that indicate that the bottom has been reached and upcast has begun, allowing closure of a *bottom* bottle if desired.



.con file, provided by Sea-Bird, contains pressure coefficients for CTD, needed by AFM to calculate pressure from raw CTD pressure data. Pressure is used to determine when to close bottles, based on bottle position and closure parameters.
If using SBE 19*plus*, 19*plus* V2, or 50, coefficients are stored in CTD, so .con file not needed.

Baud rate for communication of pressure data **from CTD to AFM**. ***For most CTDs***, must match baud rate set in CTD (and on CTD Communications tab). See CTD manual for baud command.

Bottom Bottle Closure not Enabled
The Upcast/Downcast Logic parameters are not applicable.

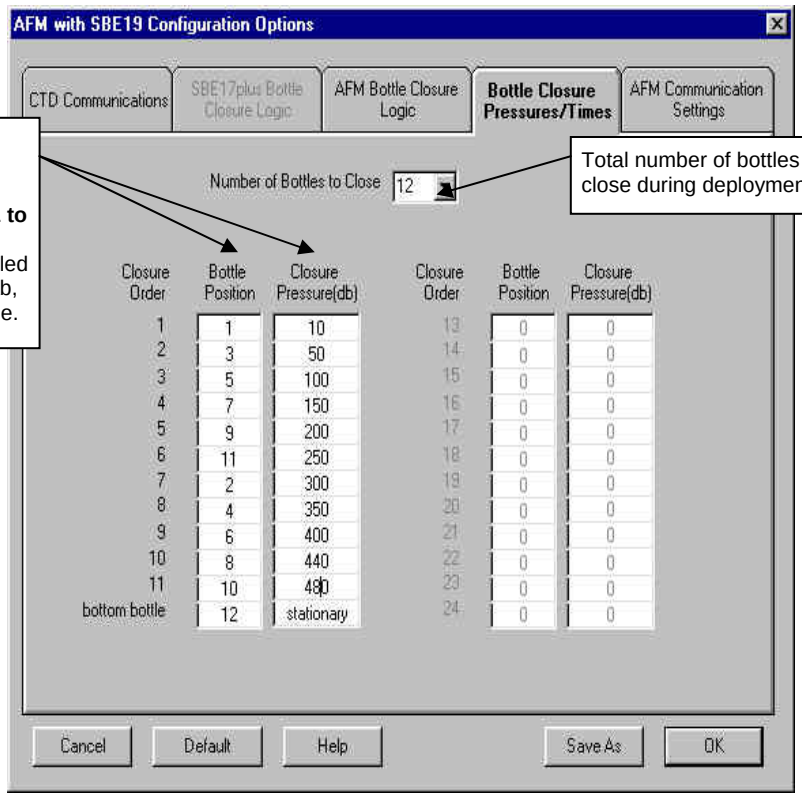
Bottom Bottle Closure Enabled
The bottom bottle closes when the AFM determines that the bottom of the cast has been reached. This occurs when the pressure is at least *Pressure to Enable Bottom Bottle*, **and** the pressure remains within *Bottom Pressure Window* for *Stationary Time on Bottom*.

Surface

Bottom Pressure Window - bottom bottle closes if pressure remains within this window for *Stationary Time on Bottom* after *Pressure to Enable Bottom Bottle* is reached. Set *Bottom Pressure Window* greater than peak-to-peak ship heave.

Pressure to Enable Bottom Bottle - set close to expected maximum cast depth

The Bottle Closure Pressures/Times tab defines the number of bottles to close, closure order, and closure pressures.



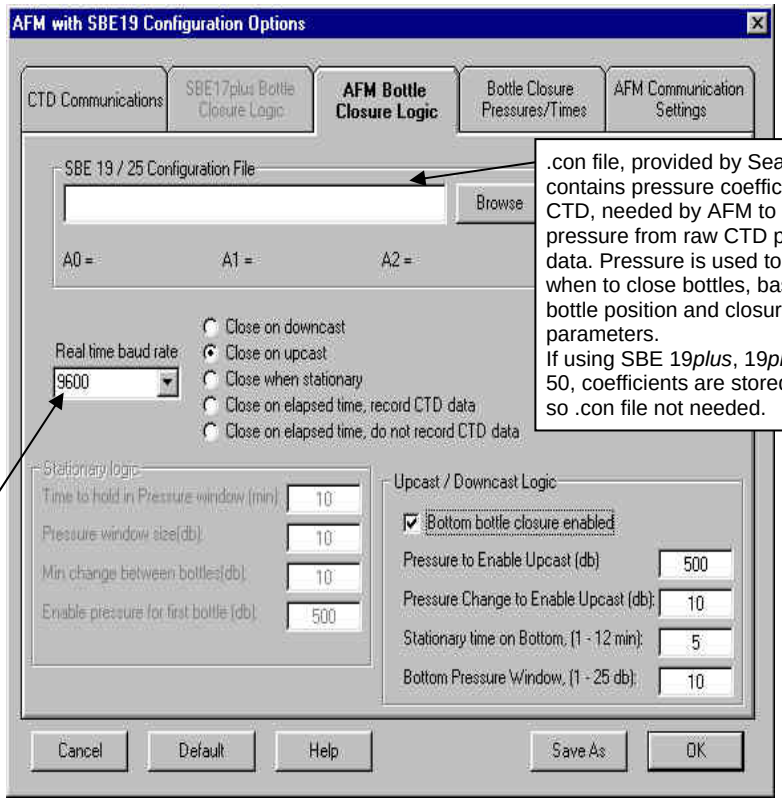
Bottles may be closed in any order desired. **For closure on downcast, closure pressure must increase from closure 1 to last closure**. For this example, bottom bottle closure was enabled on AFM Bottle Closure Logic tab, so closure 12 is for bottom bottle.

Total number of bottles to close during deployment.

Note:
AFM with SBE 25: If you want to close bottles on upcast, verify that the SBE 25 configuration entered with **CC** is *Stop CTD on upcast (y/n)? = NO*.

Close on Upcast

If you select *Close on upcast* on the AFM Bottle Closure Logic tab, the AFM closes bottles on upcast only; it does not begin to close bottles until it determines that upcast has begun. Upcast/Downcast Logic parameters on the AFM Bottle Closure Logic tab define the conditions of pressure and time that indicate that the bottom has been reached and upcast has begun.

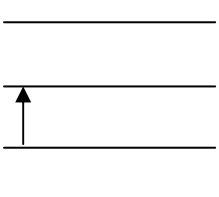


.con file, provided by Sea-Bird, contains pressure coefficients for CTD, needed by AFM to calculate pressure from raw CTD pressure data. Pressure is used to determine when to close bottles, based on bottle position and closure parameters.
If using SBE 19*plus*, 19*plus* V2, or 50, coefficients are stored in CTD, so .con file not needed.

Baud rate for communication of pressure data **from CTD to AFM**. ***For most CTDs***, must match baud rate set in CTD (and on CTD Communications tab). See CTD manual for baud command.

Bottom Bottle Closure not Enabled

Upcast is enabled (has begun) when the pressure is greater than *Pressure to Enable Upcast* **and** the pressure decreases more than *Pressure Change to Enable Upcast*. The AFM does not close a *bottom* bottle when upcast is enabled.



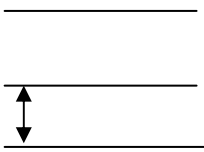
Pressure Change to Enable Upcast - upcast is enabled if pressure decrease exceeds this value. Set greater than peak-to-peak ship heave, to avoid closing bottles before upcast actually begins.

Pressure to Enable Upcast - set close to expected maximum cast depth

Bottom Bottle Closure Enabled

Upcast is enabled **and** the bottom bottle closes when the AFM determines that the bottom of the cast has been reached. The AFM enables upcast when the pressure is at least *Pressure to Enable Upcast*, **and**

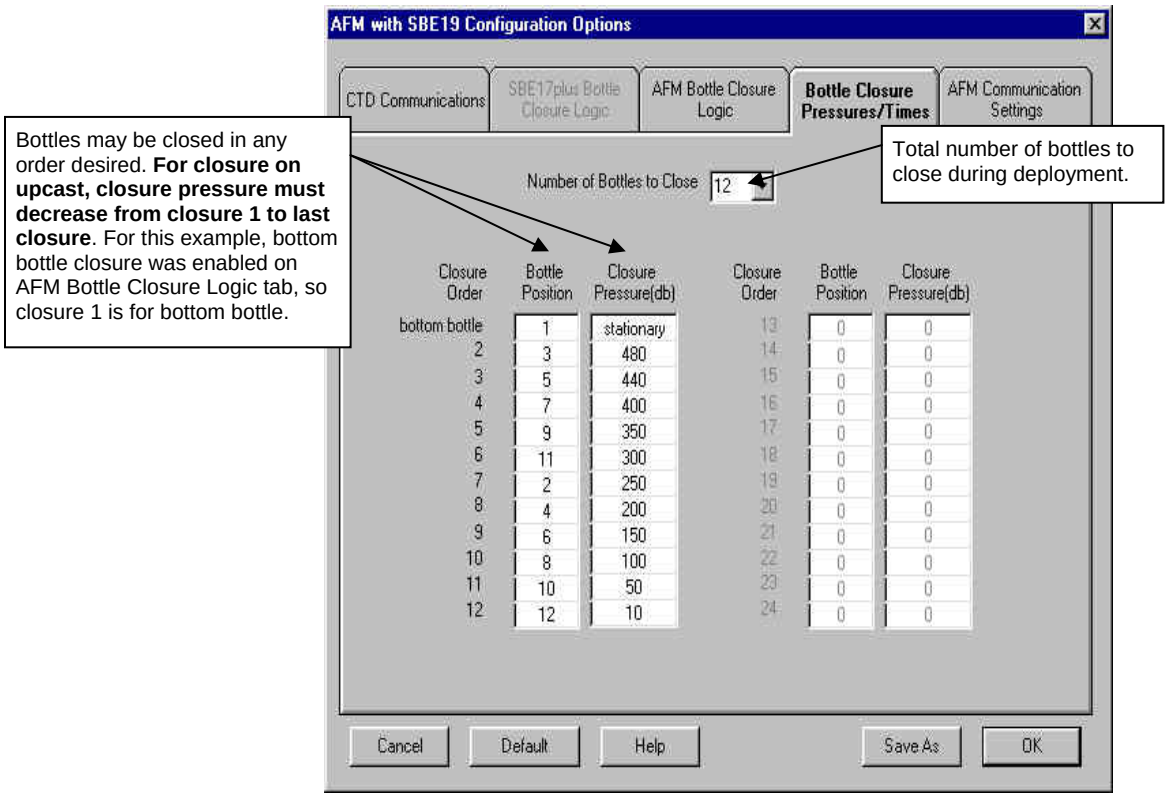
- the pressure remains within *Bottom Pressure Window* for *Stationary Time on Bottom*, **or**
- the pressure decreases by *Pressure Change to Enable Upcast*.



Bottom Pressure Window - bottom bottle closes if pressure remains within this window for *Stationary Time on Bottom* after *Pressure to Enable Upcast* is reached. Set *Bottom Pressure Window* greater than peak-to-peak ship heave.

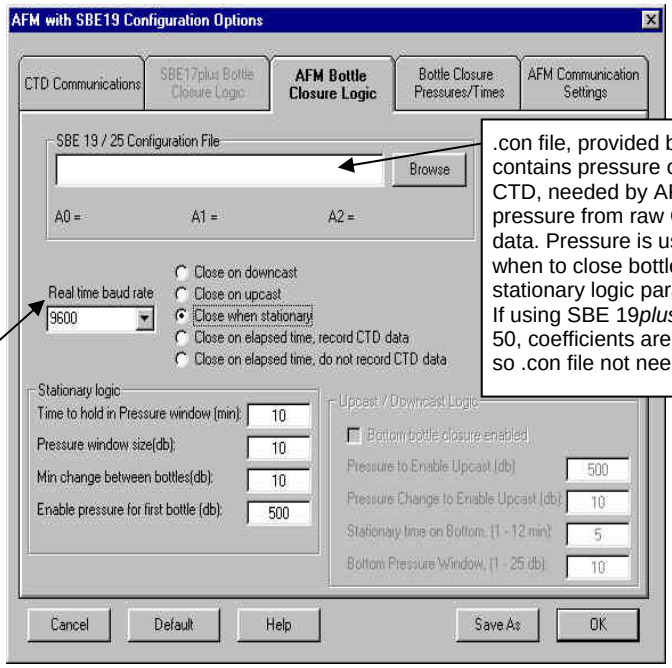
Pressure to Enable Upcast- set close to expected maximum cast depth

The Bottle Closure Pressures/Times tab defines the number of bottles to close, closure order, and closure pressures.



Close when Stationary

If you select *Close when stationary* on the AFM Bottle Closure Logic tab, Stationary Logic parameters on the AFM Bottle Closure Logic tab define when the CTD is considered stationary, signaling the AFM to close a bottle. The AFM closes bottles **on upcast** when using stationary logic.



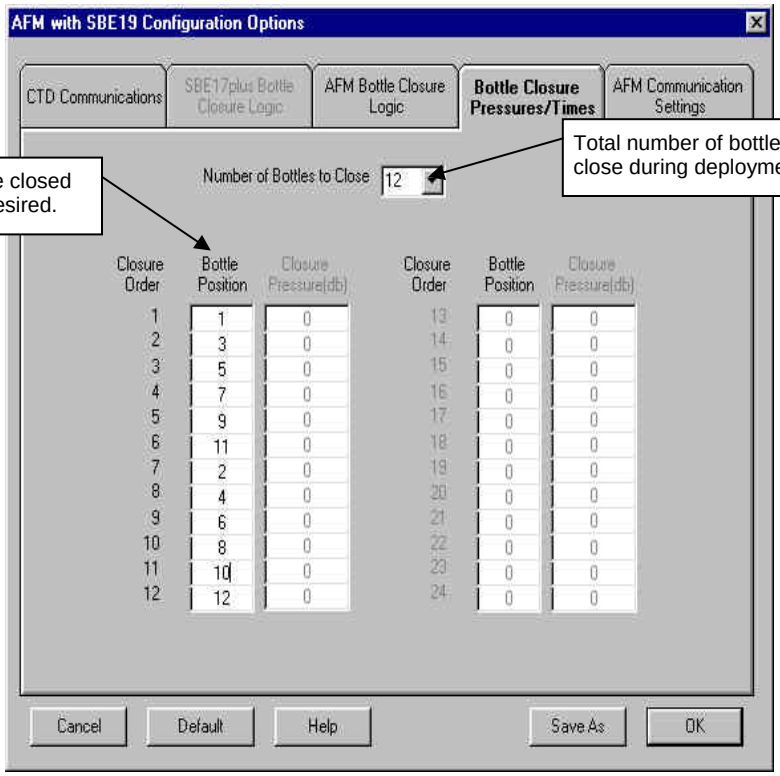
.con file, provided by Sea-Bird, contains pressure coefficients for CTD, needed by AFM to calculate pressure from raw CTD pressure data. Pressure is used to determine when to close bottles, based on stationary logic parameters.
If using SBE 19*plus*, 19*plus* V2, or 50, coefficients are stored in CTD, so .con file not needed.

Baud rate for communication of pressure data **from CTD to AFM**. ***For most CTDs***, must match baud rate set in CTD (and on CTD Communications tab). See CTD manual for baud command.

- Once the CTD reaches *Enable pressure for first bottle*, a bottle is closed each time the pressure remains within *Pressure window size* for *Time to hold in Pressure window*.
- *Min change between bottles* is the minimum pressure change between two consecutive bottles to enable the next bottle closing. This prevents the AFM from closing multiple bottles at approximately the same pressure.

Note:
If *Min change between bottles* is 0 (i.e., you **want** to close all bottles at the same pressure), there is a delay of approximately 15 seconds between each bottle closing to ensure the Carousel capacitor has enough time to recharge between bottle closings.

The Bottle Closure Pressures/Times tab defines the number of bottles to close and the bottle closure sequence.

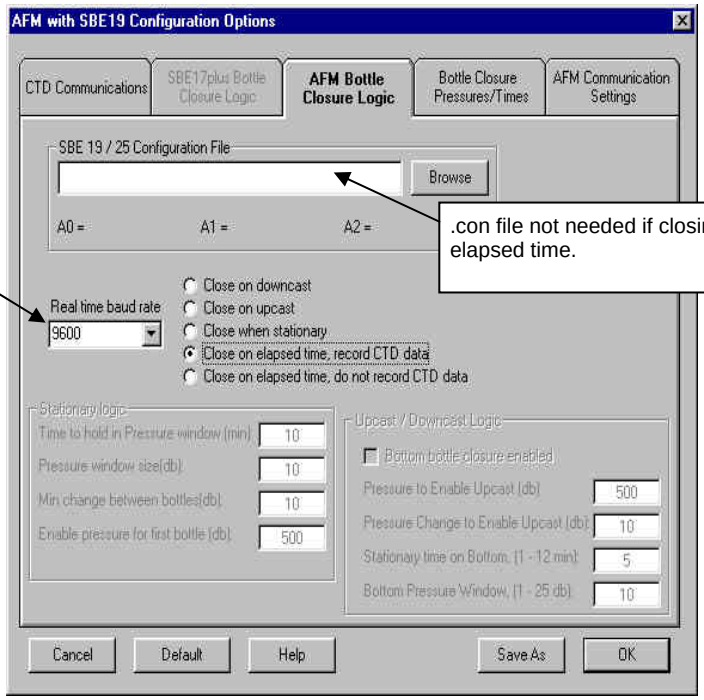


Total number of bottles to close during deployment.

Bottles may be closed in any order desired.

Close on Elapsed Time - Record or Do Not Record CTD Data

If you select *Close on elapsed time* on the AFM Bottle Closure Logic tab, the AFM closes bottles based on the elapsed time from when the AFM is armed (AFM is armed by pressing ARM on Toolbar, selecting ARM Auto Fire in Utilities menu, or sending **Arm** from keyboard).



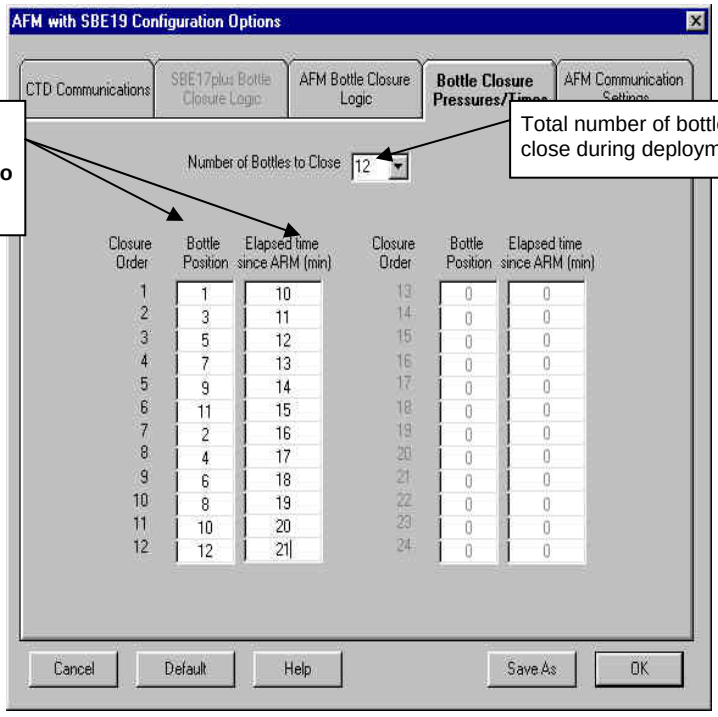
Baud rate for communication of pressure data **from CTD to AFM** if AFM recording 5 scans of CTD data each time a bottle is closed. ***For most CTDs***, must match baud rate set in CTD (and on CTD Communications tab). See CTD manual for baud command.

.con file not needed if closing on elapsed time.

Note:
If you selected *AFM with no CTD* in the Configure menu, the AFM Bottle Closure Logic tab is grayed out, because bottle closure logic is automatically set to *Close on elapsed time, do not record CTD data*.

- Close on elapsed time, **record CTD data** - AFM records 5 scans of CTD data each time a bottle closes, providing a CTD record for each water sample.
- Close on elapsed time, **do not record CTD data** - AFM does not record any CTD data. This option is most often used for an AFM and water sampler system operating without a CTD.

The Bottle Closure Pressures/Times tab defines the number of bottles to close, closure sequence, and elapsed time for each bottle.



Bottles may be closed in any order desired. **Elapsed time must increase from closure 1 to last closure**.

Total number of bottles to close during deployment.

Deploying System

Notes:
- **Upload existing data from the AFM before redeploying**. On redeployment, the AFM overwrites any data in its memory.
- The AFM automatically disarms itself after 24 hours.
- **AFM with SBE 19*plus* or 19*plus* V2:** SeatermAF automatically sets **OutputFormat=4** in the CTD when you program the AFM (click Program on Toolbar or select Program Auto Fire in Utilities menu). This is the data format required for real-time communication of pressure data to the AFM.
- **AFM with SBE 50:** SeatermAF automatically sets **AutoRun=Y**, **NAvg=16**, and **OutputFormat=7** in the SBE 50 when you arm the AFM (click Arm on Toolbar or select Arm Auto Fire in Utilities menu). These parameters are required for real-time communication of pressure data to the AFM. It then sends **Start** to the SBE 50, to start sampling.

1. Double click on SeatermAF.exe. The main screen appears.

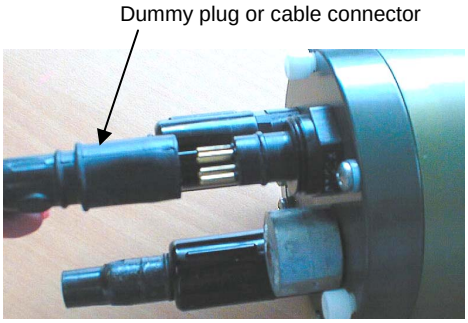
2. Ready the **AFM** for deployment by programming and arming it:
   A. In the File menu, select Open Instrument Configuration. In the dialog box, select the previously saved settings (.ini) file.
   B. Click Connect AFM to establish communications with the **AFM.**
   C. Click Program, sending the input closure parameters to the **AFM**.
   D. Click ARM, enabling the **AFM** to close bottles.

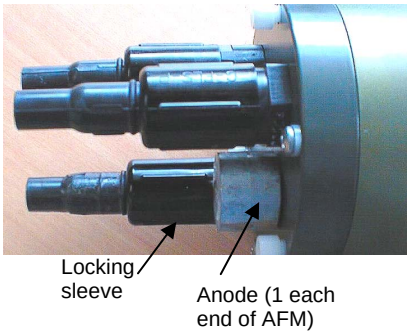
3. Ready the **CTD** for deployment:
   A. Click Connect CTD to establish communications with the **CTD**.

4. Deployment **starting the CTD with its magnetic switch** (SBE 19, 19*plus*, 19*plus* V2, or 25):
   A. Verify the CTD's magnetic switch is in the Off position.
   B. Send **QS** to put the CTD in quiescent (sleep) state.
   C. Exit SeatermAF.
   D. Disconnect the I/O cable from the **AFM**. Place the dummy plug and locking sleeve on the AFM's bulkhead connector (see Step 6).
   E. Turn on the CTD's magnetic switch to start logging. Data will be recorded after existing data in the CTD.

5. Deployment **starting the CTD with a computer command**:
   A. Start sampling/logging -
      - SBE 19 or 25: Turn on the CTD's magnetic switch, and then send **GL** (overwrite existing data in CTD) or **RL** (do not overwrite existing data in CTD).
      - SBE 19*plus* or 19*plus* V2: Send **StartNow** (do not overwrite existing data in CTD).
      - SBE 50: Do not send any commands. SeatermAF automatically sent a command to the SBE 50 to start sampling when you armed the AFM.
   B. Click Connect AFM to establish communications with the **AFM**.
   C. Verify that pressure numbers from each CTD scan are displaying on the screen (see the CTD manual for data format details).
      - SBE 19 or 25: displayed pressures are raw values. For SBE 19, the first pressure number is not displayed until reference scans are received.
      - SBE 19*plus* or 19*plus* V2: AFM automatically set CTD to **OutputFormat=4**; displayed pressures are decibars.
      - SBE 50: AFM automatically set SBE 50 to **OutputFormat=7**; displayed pressures are decibars.
   D. Exit SeatermAF.
   E. Disconnect the I/O cable from the AFM. Place the dummy plug and locking sleeve on the AFM's bulkhead connector (see Step 6).

CAUTION:
Do not use WD-40 or other petroleum-based lubricants, as they will damage the connectors.





6. Verify that a cable connector or dummy plug is installed for every connector on the AFM, CTD, and Carousel:
   A. Lightly lubricate the inside of the cable connector or dummy plug with silicone grease (DC-4 or equivalent).
   B. **Standard Connector** - Install the cable connector/plug, aligning the raised bump on the side of the connector/plug with the large pin (pin 1 - ground) on the instrument. Remove any trapped air by burping or gently squeezing the connector/plug near the top and moving your fingers toward the end cap. **OR**
   MCBH Connector – Install the cable connector/plug, aligning the pins.
   C. Place the locking sleeve over the connector/plug. Tighten the locking sleeve finger tight only. Do not overtighten the locking sleeve and do not use a wrench or pliers.
7. Verify that the anodes have not eroded away.
8. Verify that the hardware and external fittings are secure.
9. Deploy the system.

Recovery

WARNING!
If the AFM, CTD, or Carousel stop working while underwater, are unresponsive to commands, or show other signs of flooding or damage, carefully secure the instruments away from people until you have determined that abnormal internal pressure does not exist or has been relieved. Pressure housings may flood under pressure due to dirty or damaged o-rings, or other failed seals. When a sealed pressure housing floods at great depths and is subsequently raised to the surface, water may be trapped at the pressure at which it entered the housing, presenting a danger if the housing is opened before relieving the internal pressure. Instances of such flooding are rare. However, a housing that floods at 5000 meters depth holds an internal pressure of more than 7000 psia, and has the potential to eject the end cap with lethal force. A housing that floods at 50 meters holds an internal pressure of more then 85 psia; this force could still cause injury.
If you suspect the AFM is flooded, point the AFM in a safe direction away from people, and loosen the 4 screws on the connector end cap about ½ turn. If there is internal pressure, the end cap will *follow* the screws out, and the screws will not become easier to turn. In this event, loosen 1 bulkhead connector very slowly, at least 1 turn. This opens an o-ring seal under the connector. Look for signs of internal pressure (hissing or water leak). If internal pressure is detected, let it bleed off slowly past the connector o-ring. Then, you can safely remove the end cap.

Physical Handling

Rinse the CTD and auxiliary sensors, AFM, and Carousel Water Sampler with fresh water, and dry thoroughly.

Uploading Data

Note:
You must upload data from the AFM before redeploying. On redeployment, the AFM overwrites any data in its memory.

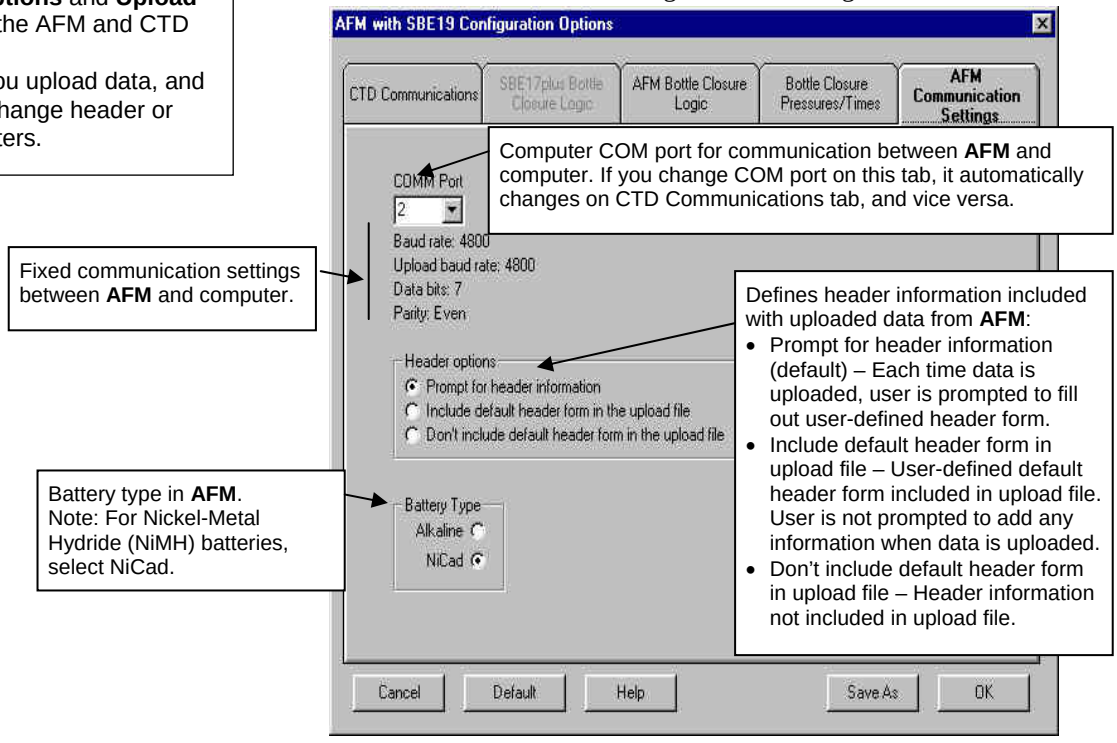
1. If you have not already done so, stop CTD logging/sampling:
   - SBE 19 or 25: Move the magnetic switch to the Off position.
   - SBE 19*plus* or 19*plus* V2:
     Move the magnetic switch to the Off position. **OR**
     If set up to start and stop logging on command and ignore the magnetic switch position - connect the AFM to the computer, establish communications with the CTD through the AFM, and send **Stop** to stop logging.
   - SBE 50: Connect the AFM to the computer, establish communications with the SBE 50 through the AFM, and send **Stop** to stop sampling.

2. If you have not already done so, connect the AFM to computer:
   A. By hand, unscrew the locking sleeve from the AFM's I/O connector. **If you must use a wrench or pliers, be careful not to loosen the bulkhead connector instead of the locking sleeve**.
   B. Remove the dummy plug from the AFM's I/O connector by pulling the plug firmly away from the connector.
   C. **Standard Connector** - Install the I/O cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the AFM. **OR**
      MCBH Connector – Install the I/O cable connector, aligning the pins.
   D. Connect the I/O cable connector to your computer's serial port.

3. In SeatermAF's File menu, select Open Instrument Configuration. In the dialog box, select the settings (.ini) file you previously saved.

Note:
Set up **Header options** and **Upload data options** for the AFM and CTD (Steps 4 and 5):
- The first time you upload data, and
- If you want to change header or upload parameters.

4. In the Configure menu, select the AFM with the applicable CTD. Click on the AFM Communication Settings tab. The dialog box looks like this:

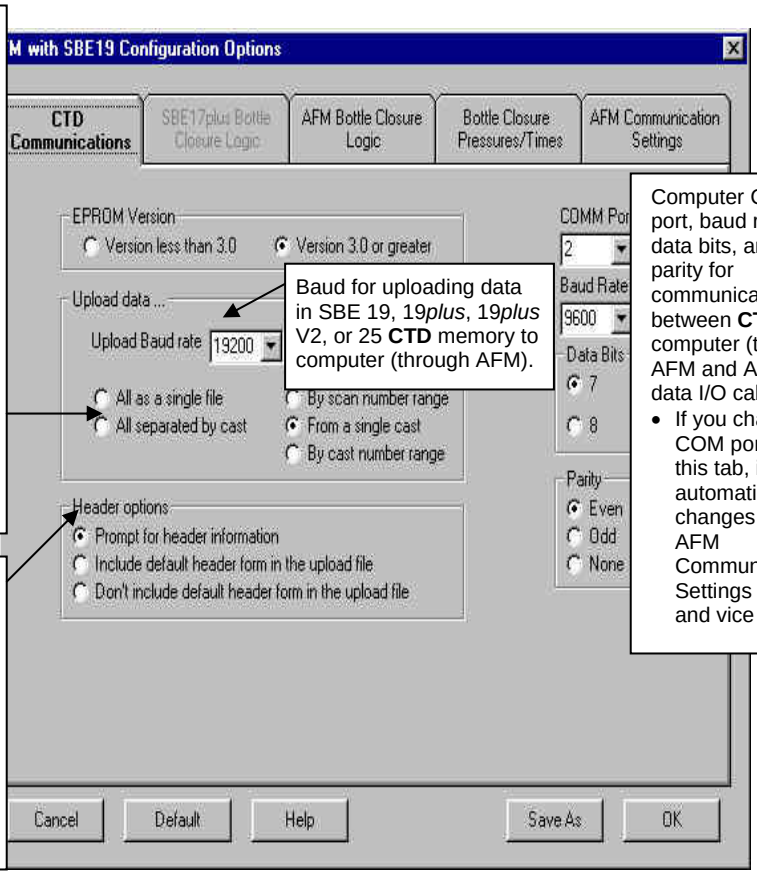


Make the selection for Header options. Skip to Step 6 if you are using the AFM with no CTD or with an SBE 50.

5. Click on the CTD Communications tab. The dialog box looks like this:

Data upload type from SBE 19, 19*plus*, 19*plus* V2, or 25 **CTD** memory (through AFM) when using Upload on Toolbar or Upload Data in Data menu:
- All as single file – All data uploaded into 1 file.
- All separated by cast - All data uploaded. Separate file written for each cast, with 3-digit cast ID (001, etc.) appended to user-selected file name
- By scan number range – SeatermAF prompts for beginning and ending scan (sample) numbers, and uploads all data within range into 1 file.
- From a single cast - SeatermAF prompts for cast number, and uploads all data from that cast into 1 file.
- By cast number range - SeatermAF prompts for beginning and ending cast numbers, and uploads data within that range. Separate file written for each cast, with 3-digit cast ID (001, etc.) appended to user-selected file name.

Defines header information included with uploaded data from SBE 19, 19*plus*, 19*plus* V2, or 25 **CTD**:
- Prompt for header information (default) – Each time data is uploaded, user is prompted to fill out user-defined header form.
- Include default header form in upload file – User-defined default header form included in upload file. User is not prompted to add any information when data is uploaded.
- Don't include default header form in upload file – Header information not included in upload file.



Baud for uploading data in SBE 19, 19*plus*, 19*plus* V2, or 25 **CTD** memory to computer (through AFM).

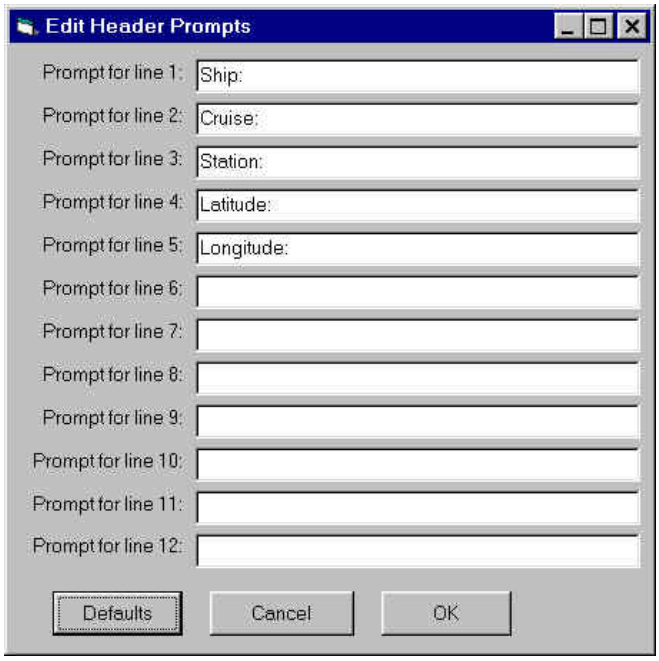
Computer COM port, baud rate, data bits, and parity for communication between **CTD** and computer (through AFM and AFM data I/O cable).
- If you change COM port on this tab, it automatically changes on AFM Communication Settings tab, and vice versa.

Make the selection for Upload data and Header options.

6. Click OK to overwrite an existing settings (.ini) file, or click Save As to save the settings as a new filename.

Upload Data from AFM

7. In the Configure menu, select Header Form to customize the header for the AFM. The dialog box looks like this (default prompts are shown):



The entries are free form, 0 to 12 lines long. This dialog box establishes:
- header prompts that appear for the user to fill in when uploading data, if *Prompt for header information* was selected on the AFM Communication Settings tab in the Configuration Options dialog box (Step 4)
- header included with the uploaded data, if *Include default header form in upload file* was selected on the AFM Communication Settings tab in the Configuration Options dialog box (Step 4)

Enter the desired header/header prompts. Click OK.

8. Click Connect AFM on the Toolbar to begin communications with the AFM. The display looks like this:

   A>

   This shows that correct communications between the computer and AFM have been established.
   If the system does not respond as shown above:
   - Click Connect AFM again.
   - Verify the COM port is correct on the AFM Communication Settings tab in the Configuration Options dialog box.
   - Check cabling between the computer and AFM.
   - Check the AFM battery voltage - see *Replacing/Recharging Batteries* in *Section 5: Routine Maintenance*.

9. Disarm the AFM by sending **DA** (the AFM responds with #A> if it is already disarmed).

Note:
90208 in the status reply is the part number of a standard AFM (aluminum housing and glass-reinforced epoxy connectors); the 90491 AFM (aluminum housing and wet-pluggable connectors) uses the same firmware, and has the same status reply.

10. Display AFM status information by clicking Status on the Toolbar. The display looks like this:

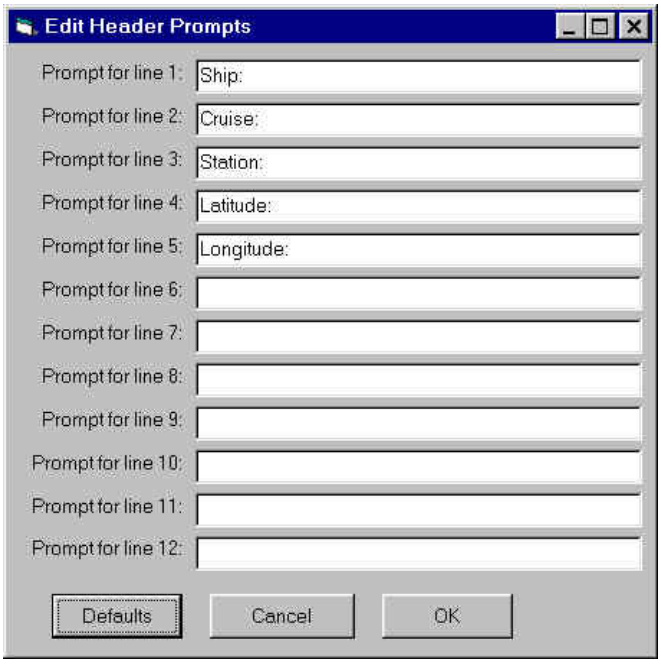
```
90208 AFM V2.0 SERIAL NO. 9999 11 Mar 2008 08:49:08
Main battery = 13.3
Lithium battery = 6.6
AFM is NOT ARMED
```

11. Click Upload on the Toolbar to upload data from the AFM. SeatermAF responds as follows:
    A. SeatermAF sends **DS**, displays the status response, and writes the command and response to the upload file.
    B. **If you selected *Prompt for header information* on the AFM Communication Settings tab in the Configuration Options dialog box (Step 4)** – a dialog box with the header form appears. Enter the desired header information, and click OK.
    C. In the Open dialog box, enter the desired upload file name and click OK. SeatermAF automatically adds the .afm file extension.
    D. SeatermAF sends the data upload command (**DD**), and writes the response to the upload file.

Notes:
- If `Warning: Low Battery Voltage` displays while uploading data, replace or recharge the batteries before proceeding (see *Replacing/Recharging Batteries* in *Section 5: Routine Maintenance*).
- Uploaded data files from the AFM and CTD must have the same name (different extensions) and be in the same directory for processing by SBE Data Processing.

Upload Data from CTD (not applicable to SBE 50)

12. In the Configure menu, select Header Form to customize the header for the CTD. The dialog box looks like this (default prompts are shown):



The entries are free form, 0 to 12 lines long. This dialog box establishes:

- header prompts that appear for the user to fill in when uploading data, if *Prompt for header information* was selected on the CTD Communications tab in the Configuration Options dialog box (Step 5)
- header included with the uploaded data, if *Include default header form in upload file* was selected on the CTD Communications tab in the Configuration Options dialog box (Step 5)

Enter the desired header/header prompts. Click OK.

13. Click Connect CTD on the Toolbar to begin communications with the CTD. The display looks like this:

```
Connected successfully . . .
S>
```

This shows that correct communications between the computer and CTD has been established.

If the system does not respond as shown above:

- Click Connect CTD again.
- Verify the correct **CTD** was selected in the Configure menu and the CTD communication settings were entered correctly in the Configuration Options dialog box.
- Check cabling between the computer, AFM, and CTD.

Notes:
- If `Warning: Low Battery Voltage` displays while uploading data, replace or recharge the batteries before proceeding. See *Section 5: Routine Maintenance* for replacement / recharging of AFM batteries; see CTD manual for replacement / recharging of CTD batteries.
- Uploaded data files from the AFM and CTD must have the same name (different extensions) and be in the same directory for processing by SBE Data Processing.

14. Click Upload on the Toolbar to upload data from the CTD. SeatermAF responds as follows:
    A. SeatermAF sends the status (**DS**) and header (**DH**) commands, displays the responses, and writes the commands and responses to the upload file. These commands provide information regarding the instrument setup, number of samples in memory, cast number, etc.
    B. **If you selected *By scan number range, From a single cast,* or *By cast number range* on the CTD Communications tab in the Configuration Options dialog box** (Step 5) – a dialog box requests the range/cast number. Enter the desired value(s), and click OK.
    C. SBE 19*plus* or 19*plus* V2 only: SeatermAF sends **OutputFormat=0** to the CTD. This sets the CTD format to raw hexadecimal data, which is required for data that will be processed with SBE Data Processing.
    D. **If you selected *Prompt for header information* on the CTD Communications tab in the Configuration Options dialog box (Step 5)** – a dialog box with the header form appears. Enter the desired header information, and click OK.
    E. In the Open dialog box, enter the desired upload file name and click OK. SeatermAF automatically adds the .hex file extension.
    F. SeatermAF sends the data upload command (**DDb,e**) to the CTD through the AFM, and writes the response to the upload file.
    G. SBE 19*plus* or 19*plus* V2 only: SeatermAF sends **OutputFormat=4** to the CTD. This sets the CTD format back to pressure in decibars, so it is ready to provide real-time pressure data to the AFM for the next deployment.

Review Data from AFM and CTD

15. Ensure all data has been uploaded from the **AFM** and **CTD** by reviewing the data. Use **SBE Data Processing** to process the files; see *Section 4: Processing Uploaded Data*.

AFM Command Descriptions

Notes:
- When connected to the **AFM**, SeatermAF displays an A> prompt. When connected to the **CTD through the AFM**, SeatermAF displays an S> prompt.
- For CTD command descriptions, see the applicable CTD manual.

When entering commands for the **AFM**:

- **Verify that the computer is talking to the AFM, not the CTD** (check the left side of the status bar at the bottom of SeatermAF's window). If it is not, click Connect AFM on the Toolbar.
- Input commands to the AFM in upper or lower case letters and register commands by pressing the Enter key.
- The AFM sends `invalid command` if an invalid command is entered.
- If the system does not return an A> prompt after executing a command, press the Enter key to get the A> prompt.
- If a new command is not received within 2 hours after completion of a command, the Command/Data Echo Area indicates **time out** and the AFM returns to quiescent (sleep) state to prevent battery exhaustion.
- If in quiescent state, re-establish communications by clicking Connect AFM on the Toolbar to get an A> prompt.

Note:
90208 in all the status replies is the part number of a standard AFM (aluminum housing and glass-reinforced epoxy connectors); the 90491 AFM (aluminum housing and wet-pluggable connectors) uses the same firmware, and has the same status replies.

Status Commands

GetSD

Get and display status data.
List below includes, where applicable, command used to modify parameter:
- Device type, serial number, date and time [**DateTime=**]
- Main battery voltage
- back-up lithium battery voltage
- AFM armed status [**Arm** or **DA**]

Example: (user input in bold, command used to modify parameter in parentheses)

```
A>getsd
90208 AFM V 2.0  SERIAL NO. 9999  11 Mar 2008 10:00:01      [DateTime=]
main battery = 11.47 volts
lithium battery =  2.86 volts
AFM is NOT ARMED                                            [Arm or DA]
```

GetHD

Get and display hardware data, which is fixed data describing AFM:
- Device type, firmware version, firmware date
- Firmware loader information (information used by software only when updating firmware)

Example: (user input in bold)

```
A>gethd
90208 AFM V 2.0 created 29 February 2008
SBE 90208 FirmwareLoader V 1.0
```

Status Commands (*continued)*

GetEC

Get and display event counter data, which can help to identify root cause of a malfunction. Event counter records number of occurrences of common timeouts, power-on resets, etc. Can be cleared with **ResetEC**. Possible events that may be logged include:

- WDT reset - CPU watchdog timer reset the CPU
- PON reset - CPU woke up after power was applied or the external watchdog timer expired, this will occur every time batteries are changed
- ErrorPowerFail - Low Voltage comparitor detected low voltage, this may occur when batteries are changed
- ErrorADC12TimeOut – Analog to digital converter error
- ErrorUART0TimeOut – UART 0 error
- ErrorUART1TimeOut – UART 1 error
- PON ARM - CPU woke up after power was applied or external watchdog timer expired and AFM was in ARMed state. In this case, AFM rearms itself.

Example (user input in bold, command used to modify parameter in parentheses)

```
A>getec
number of events = 4                                    [can clear with ResetEC]
  WDT reset 1
  PON reset 2
  ErrorPowerFail 1
```

ResetEC

Delete all events in event counter (number of events displays in **GetSD** response, and event details display in **GetEC** response).

DS

Display operating status and setup parameters. List below includes, where applicable, command used to modify parameter:

- firmware version, serial number, date and time [**DateTime=**]
- main battery voltage
- back-up lithium battery voltage
- AFM armed status [**Arm** or **DA**]

Equivalent to Status on Toolbar.

Example: (user input in bold, command used to modify parameter in parentheses)

```
A>ds
90208 AFM V2.0 SERIAL NO. 9999 11 Mar 2008 08:49:08          [DateTime=]
Main battery = 13.3
Lithium battery = 6.6
AFM is NOT ARMED                                                  [DA]
```

or

```
A>ds
ARMED
```

Status Commands *(continued)*

DC

Display bottle closure parameters.
- CTD description
  (note: SBE 19*plus* applies to 19*plus*, 19*plus* V2, or 50)
- Battery type
- CTD pressure sensor type
- CTD baud rate
- number of bottles to fire
- bottle closure sequence
- bottle closure pressures
- bottle closure elapsed times
- closure mode - downcast, upcast, elapsed time with no CTD data, stationary, or elapsed time with CTD data
- upcast/downcast logic - bottom bottle enabled, pressure to enable upcast, pressure change to enable upcast, stationary time on bottom, bottom pressure window
- stationary logic - minimum time to hold in pressure window to enable bottle closure, pressure window size, minimum change in pressure between bottles to enable next bottle closing, enable pressure for first bottle

Equivalent to Closure Parameters AFM on Toolbar.

Example: (user input in bold).

```
A>DC
CTD type = SBE 19plus
battery type = rechargeable
pressure sensor type = positive
CTD baud rate = 9600
number of bottles to fire = 6
bottle fire order = 0 ,1 ,2 ,3 ,4 ,5
bottle pressures = 50 ,100 ,150 ,200 ,250 ,300
bottle times = 2 ,3 ,4 ,5 ,6 ,7
fire mode = close on downcast
upcast / downcast logic:
   bottom bottle closure disabled
   pressure to enable upcast = 200
   pressure change to enable upcast = 10
   stationary time on bottom = 2
   bottom pressure window = 10
stationary logic:
   time to hold in pressure window = 2
   pressure window size = 20
   min change between bottles = 20
   enable pressure for first bottle = 500
```

Date and Time Command

DateTime=mmddyyyyhhmmss Set real-time clock month, day, year, hour, minute, second.

Example: Set current date and time to 05 March 2008 12:05:00 (user input in bold).

```
A>datetime=03052008120500
```

WARNING!
If testing the Carousel with lanyards rigged on the bottles and attached to the latches: **bottles close rapidly and with great force, which can cause injury**. Verify no one is near the Carousel before beginning testing.

Auto Fire: ***Testing*** Commands

Test before arming and deploying the system to verify that the Carousel is operating properly. Before testing, cock the release mechanisms by pushing against each trigger until it clicks and locks in place (see the SBE 32 Carousel Water Sampler manual for details).

Notes:
If using the SBE 50 with the AFM and Carousel:
- **32POn** or **POn** switches on power to the Carousel **and** to the SBE 50, which are powered from the same pin.
- You have 2 hours to communicate with the SBE 50 before the AFM goes to sleep and shuts off power to the SBE 50. If you need more time to perform SBE 50 setup, wake up the AFM and send **32POn** or **POn** again.
- (If you selected *AFM with SBE 50* in Configure menu) When you click Connect CTD on the Toolbar, SeatermAF automatically
  1. Connects to AFM.
  2. Sends **POn** to the AFM to provide power to the SBE 50.
  3. Connects to SBE 50.

32POn or **POn** Turn on power to Carousel for testing purposes; used to charge Carousel storage capacitor prior to firing. Wait for 1 minute after sending command before test firing a bottle.

32POff or **POff** Turn off power to Carousel when testing is complete. If you do not send this command, AFM automatically turns off power to Carousel after 2 hours.

FireN Fire bottle **N** (**1**, **2**, **3**, etc.). AFM replies `fire confirmed` or `no confirm`.

If **32POn** or **POn** was not sent before this command, AFM replies `wait 10 seconds for capacitor to charge` and then fires bottle after 10 seconds. However, you may not get a fire confirmed reply when operating this way.

Example: Test bottles 1 through 3.

```
A>32pon      (wait for 1 minute after sending command)
A>fire1
A>fire2
A>fire3
A>32poff
```

Auto Fire: *Arm/Disarm* Commands

Arm before deploying to enable the Carousel to take water samples. Disarm to disable the Carousel from taking water samples; the CTD (SBE 19, 19*plus*, 19*plus* V2, or 25) can still log data.

Arm	Arm (enable) auto fire to close bottles. AFM automatically disarms after 24 hours. Equivalent to ARM on Toolbar.
DA	Disarm (disable) auto fire to close bottles.

Data Upload Command

Stop CTD logging/sampling before uploading data.

DD	Upload raw data from **AFM**. For each bottle fired: • Bottle sequence and number, date and time, firing confirmation, battery voltage, scan number of first of 5 CTD scans, and 5 scans of CTD data, or • (if used without a CTD) Bottle sequence and number, date and time, firing confirmation, and battery voltage.

Notes:
- **Use Upload on the Toolbar or Upload Data in the Data menu to upload data that will be processed by SBE Data Processing.** Manually entering the data upload command does not produce data with the required header information for processing by our software. These commands are included here for reference for users who are writing their own software.
- To save data to a file, click Capture on the Toolbar before entering **DD**.
- See *AFM Data Output Formats* in *Section 4: Processing Uploaded Data*.

Commands Not Typically Sent by User

The user does not typically send the remaining commands, which are included here for reference only. These involve:

- Turning on power to an SBE 50 Pressure Sensor.
- Setting up auto fire parameters, which are more easily set up in the Configuration Options dialog box (select the AFM with the applicable CTD in the Configure menu). SeatermAF automatically sends many of these commands (with **calculated** values based on entries in the dialog box) to the AFM when the user clicks on the Toolbar's Program button. **Sea-Bird highly recommends using the Configuration Options dialog box to set up the AFM** instead of using these commands**.**

General Setup Commands

BTx — Select AFM battery type:
x=0: Nickel-Cadmium (Ni-Cad) **or** Nickel-Metal Hydride.
x=1: Alkaline.

ITx — Select CTD:
x=0: SBE 19
x=1: SBE 25 with firmware version < 2.0
x=2: SBE 25 with firmware version ≥ 2.0
x=3: SBE 19*plus*, 19*plus* V2, or 50

BRx — **x=** 76800 / (CTD real-time data baud rate) (see CTD configuration sheet for baud rate).

Auto Fire: ***General Setup*** Commands

BLx — Set bottle closure logic:
x=0: Close on downcast.
x=1: Close on upcast.
x=2: Close on elapsed time, and do not record CTD data in AFM.
x=3: Close when stationary.
x=4: Close on elapsed time, and record CTD data in AFM.

BNx — **x=** total number of bottles to be closed.

BAnm — AFM allows bottles to be fired out of numerical sequence. Bottle closure **n** closes bottle number **m**. Repeat for each bottle.

PTx — Select pressure polarity (see configuration sheet for CTD - SBE 19 or SBE 25 - used with AFM):
x=0: Negative polarity (increasing pressures give decreasing pressure numbers)
x=1: Positive polarity (increasing pressures give increasing pressure numbers)

Notes:
- n = sequence, single character = (sequence number - 1) + '0'
- m = bottle number, single character = (bottle number - 1) + '0'
- t = time in minutes, long integer value between 0 and 2,147,483,648
- p = raw pressure sensor pressure number, integer value between -4095 and +4095. SeatermAF computes p using the calibration coefficients in the specified configuration (.con) file.

Auto Fire: ***Downcast and Upcast Logic Setup*** Commands

These commands set up closure parameters for closure on downcast or upcast (applicable if **BL0** or **BL1** was sent)

BBx	**x=Y:** Enable bottom bottle closure - close a bottle when pressure remains within **BBP** for **BBT**. **x=N:** Disable bottom bottle closure.
BBPp	**p=** bottom bottle pressure window size.
BBTt	**t=** bottom bottle time.
BUPp	**p=** pressure to signal upcast.
BUDp	**p=** pressure decrease from maximum to signal upcast.
PAnp	Perform bottle closure **n** at pressure **p**. Repeat for each bottle.

Auto Fire: ***Time-Based Logic Setup*** Commands

These commands set up closure parameters for closure based on elapsed time (applicable if **BL2** or **BL4** was sent).

TAnt	Perform bottle closure **n** at elapsed time **t**. Repeat for each bottle.

Auto Fire: ***Stationary Logic Setup*** Commands

These commands set up closure parameters for closure based on elapsed time (applicable if **BL3** was sent).

BSTt	**t=** time to hold in pressure window.
BSPp	**p=** pressure window size.
BSGp	**p=** change in pressure to switch from stop to go.
BSMp	**p=** minimum pressure to enable first bottle.

Section 4: Processing Uploaded Data

This section covers data output formats, and provides information on how to process the data files.

AFM Data Output Formats

When data is uploaded from the AFM using Upload on the Toolbar or Upload in the Data menu, the data is written to a file with a .afm extension. The data consists of:

Note:
Each line of the AFM header starts with *.

- Header providing the .afm file name, SeatermAF software version, upload time, and AFM status

- For each bottle that was *fired*:
  - bottle closing information, in the following format -
    a b mm/dd/yy hh:mm:ss.s xxxxxxxxx cc.c dd
    where

Parameter	Description
a	Bottle sequence
b	Bottle position
mm/dd/yy	Date
hh:mm:ss.s	Time
xxxxxxxxx	Closure confirmation message: • confirmed = OK • user cmd = disarm command received • low volt = low battery voltage • cell fail = battery failure • no confirm = current through latch magnet not sufficient • invalid bn = bottle number received was invalid • no reply = no reply from Carousel
cc.c	Battery voltage
dd	Scan number of first of 5 CTD scans recorded with this bottle, **counting scans from when AFM was armed**. May not correspond to scan number in CTD file, where scan number is number of scans since last time memory pointer was reset to beginning of memory. Note: dd is 1 if no CTD was used.

  - (if used with a CTD) 5 scans of CTD data in hex format (see CTD manual for data format details; the parameters included and the order of the parameters varies for each type of CTD).
    - SBE 19 or 25: The AFM records the entire data scan from the CTD, including any auxiliary sensor data.
    - SBE 19*plus*, 19*plus* V2, or 50: The AFM records only the pressure and scan number, ppppssssss, *where*
    pressure [decibars] = pppp (converted from hex to decimal) – 100;
    ssssss = scan number (converted from hex to decimal).

Note:
SBE 19*plus*, 19*plus* V2, or 50: The first scan number dd for each bottle may not match the scan number ssssss because of differences in how scans are counted. dd is the number of scans counted by the AFM since the AFM was armed.
- SBE 19*plus* or 19*plus* V2: ssssss is the number of scans counted by the CTD since the last time **InitLogging** or **SampleNumber=0** was sent to the CTD to reset logging to the beginning of memory.
- SBE 50: ssssss is the number of scans counted by the SBE 50 since power was applied and sampling began. See *Processing .afm Files from AFM when Used with SBE 50*.

Shown below is an example .afm file for an AFM used with an SBE 25 CTD; two bottles were closed.

Note:
90208 in the status reply is the part number of a standard AFM (aluminum housing and glass-reinforced epoxy connectors); the 90491 AFM (aluminum housing and wet-pluggable connectors) uses the same firmware, and has the same status reply.

```
* Sea-Bird SBE 25 Data File:
* FileName = \JOBS\J9\9498\25test.AFM
* Software Version 1.17
* System UpLoad Time = Mar 11 2008 16:34:06
* ds
* 90208 AFM V 2.0  11 Mar 2008  16:30:50.0
* Main battery = 13.2
* Lithium battery = 6.5
* AFM is NOT ARMED
* A>

*END*

dd
1  1  03/11/05  16:23:02.7  confirmed   13.0  65
    25F0D40B300B0D991C90B806005E0000000FFF
    25F2A40B30080D971CB0B806105E0000000FFF
    25F49E0B300B0D971CC0B806005E0000000FFF
    25F6540B30130D951CE0B806005E0000000FFF
    25F7A00B30100D951CF0B806005E0000000FFF
2  2  03/11/05  16:23:25.7  confirmed   12.9  88
    2607A80B30130C6D1E80B906005C0000000FFF
    2608410B300E0C561E90B806005C0000000FFF
    2609040B300A0C341EA0B906005C0000000FFF
    2609CA0B300A0C2C1EC0B806005C0000000FFF
    260A930B300B0C2C1ED0B906005C0000000FFF
```

CTD Data Output Formats

Note:
Each line of the CTD header starts with *.

When data is uploaded from the CTD (either through the AFM or directly from the CTD) using Upload on the Toolbar or Upload in the Data menu, the data is written in hex format to a file with a .hex extension. The data consists of a header and the CTD data. See the CTD (SBE 19, 19*plus*, 19*plus* V2, or 25) manual for details on the CTD data output format.

Processing .afm Files from AFM and .hex Files from SBE 19, 19*plus*, 19*plus* V2, or 25

Notes:
- **These instructions do not apply to the SBE 50.** See *Processing .afm Files from AFM when Used with SBE 50*.
- *Basic* instructions are provided for processing the data using SBE Data Processing. See the SBE Data Processing manual / Help files.

The AFM's .afm file is processed in SBE Data Processing in two steps:

1. **Data Conversion** module - The .hex file from the CTD and .afm file from the AFM are processed at the same time by Data Conversion. Data Conversion creates:
   - .cnv file (from .hex file) - CTD data converted from raw hexadecimal to engineering units.
   - .ros water bottle file (from .hex and .afm files) - data converted from raw hexadecimal to engineering units. The .ros file contains the CTD data for the 5 scans associated with each bottle firing as well as additional data for a user-selected range of scans before and after each bottle firing.

2. **Bottle Summary** module - The .ros file created by Data Conversion is processed by Bottle Summary, which creates a bottle data summary .btl file. The .btl file includes:
   - Bottle position, optional bottle serial number, and date and time.
   - User-selected derived variables, computed for each bottle from mean values of input variables (temperature, pressure, conductivity, etc.).
   - User-selected averaged variables, computed for each bottle from input variables.

The use of Data Conversion and Bottle Summary is described below (see the SBE Data Processing manual/Help files for details).

Data Conversion

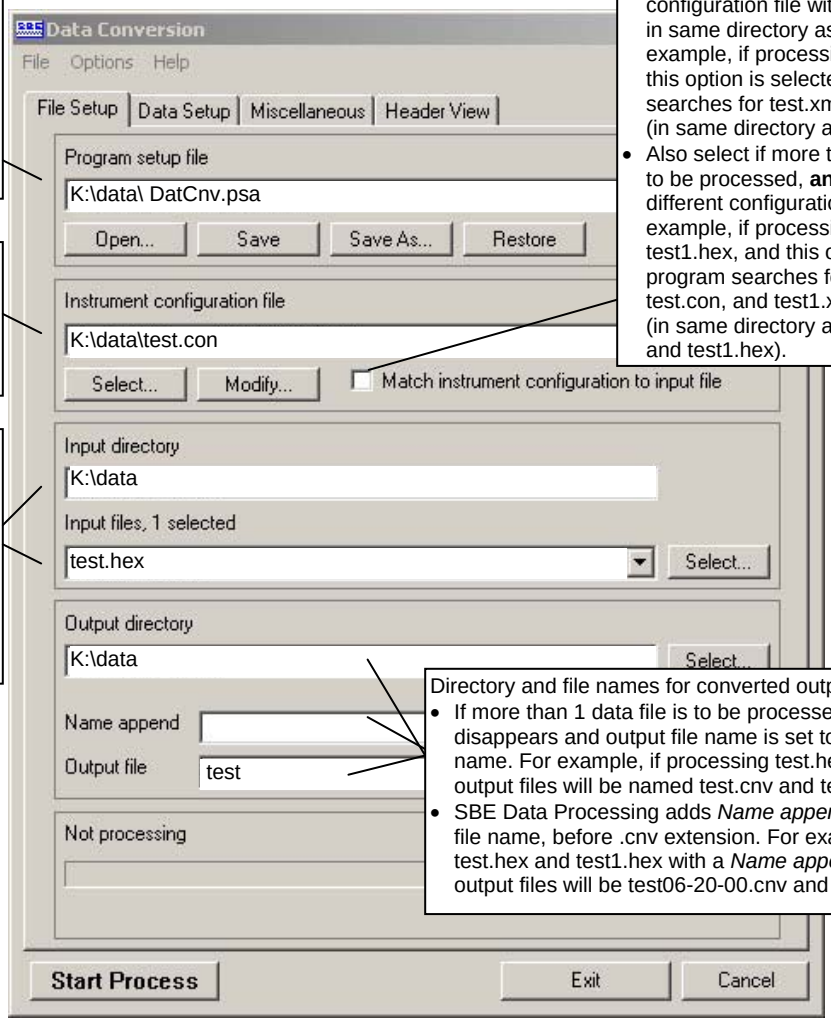
In SBE Data Processing's Run menu, select Data Conversion. The input files for Data Conversion are the .afm file from the AFM, the .hex file from the CTD, and the CTD configuration (.xmlcon or .con) file. The File Setup tab in the dialog box looks like this:

Location to store all information input in File Setup and Data Setup tabs. **Open** to select a different .psu file, **Save** or **Save As** to save current settings, or **Restore** to reset all settings to match last saved version.

Instrument configuration (.xmlcon or .con) file location. **Select** to pick a different file, or **Modify** to view and/or modify configuration.

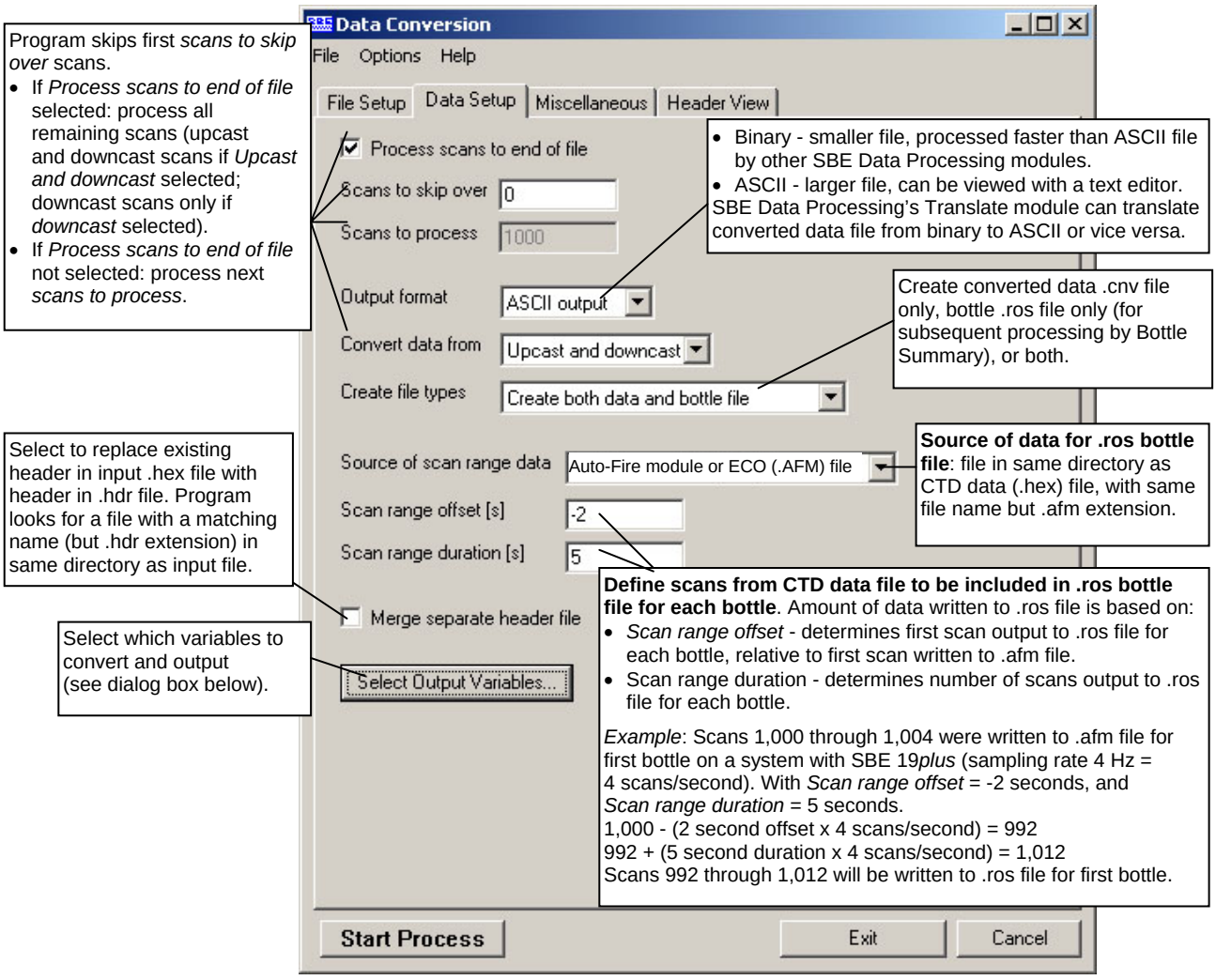
Directory and file names for raw data (.hex) from **CTD**. **Select** to pick a different file. To process multiple raw data files from same directory:
1. Click **Select**.
2. In Select dialog box, hold down Ctrl key while clicking on each desired file.

- Select to have program find configuration file with same name and in same directory as data file. For example, if processing test.hex and this option is selected, program searches for test.xmlcon or test.con (in same directory as test.hex).
- Also select if more than 1 data file is to be processed, **and** data files have different configuration files. For example, if processing test.hex and test1.hex, and this option is selected, program searches for test.cmlxon or test.con, and test1.xmlcon or test1.con (in same directory as test.hex and test1.hex).

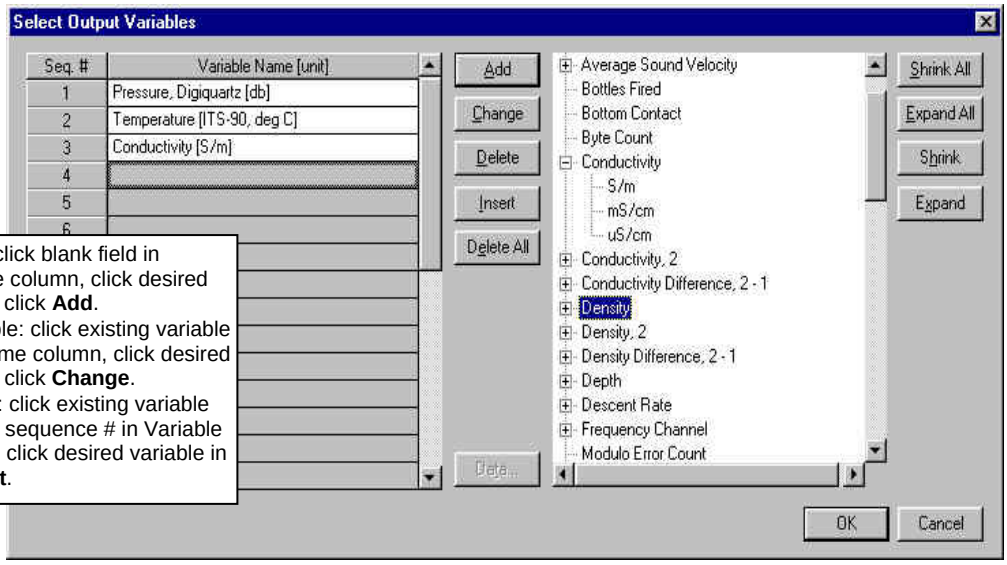


Directory and file names for converted output (.cnv) data.
- If more than 1 data file is to be processed, *Output file* field disappears and output file name is set to match input file name. For example, if processing test.hex and test1.hex, output files will be named test.cnv and test1.cnv.
- SBE Data Processing adds *Name append* to (each) output file name, before .cnv extension. For example, if processing test.hex and test1.hex with a *Name append* of 06-20-00, output files will be test06-20-00.cnv and test106-20-00.cnv.

The Data Setup tab in the dialog box looks like this:



The Select Output Variables dialog box (which appears when you click **Select Output Variables** on the Data Setup tab) looks like this:



Output variables selected here will be put in both the .cnv and .ros files.

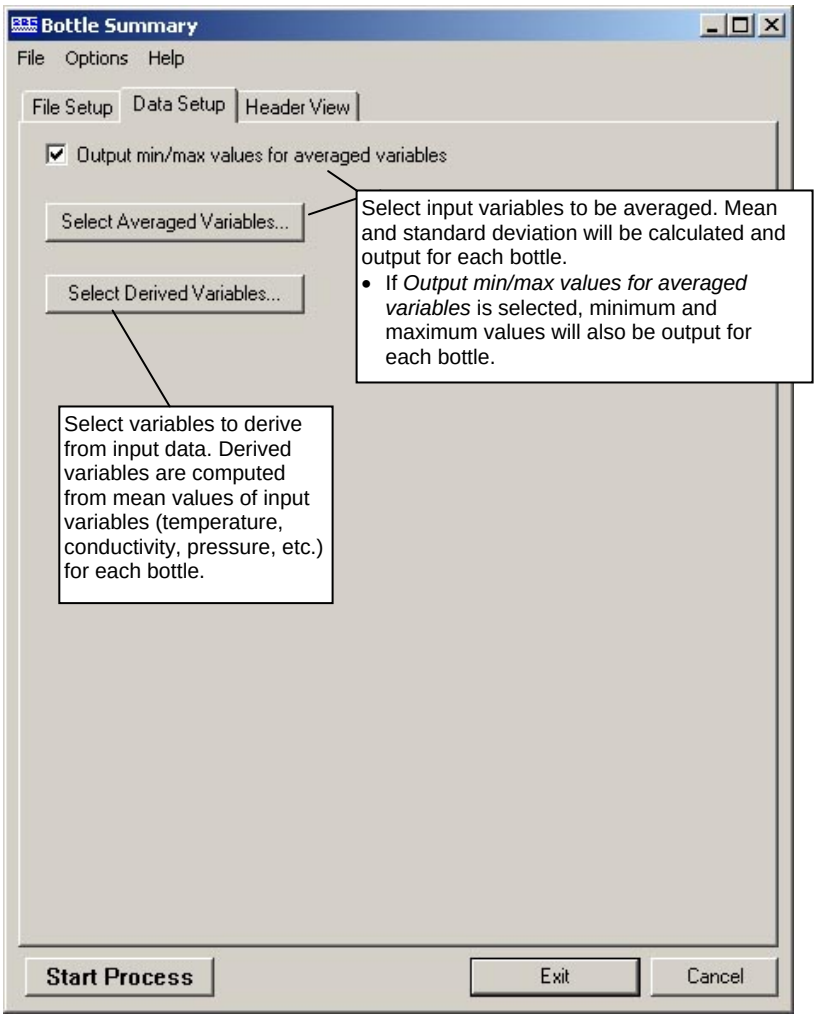
Bottle Summary

In SBE Data Processing's Run menu, select Bottle Summary. The File Setup tab in the dialog box is similar to the one shown and described for Data Conversion above. The input files for Bottle Summary are the .ros file (created in Data Conversion) and the CTD configuration (.xmlcon or .con) file.

Note:
You can create a .sn file in a text editor.

- Additionally, if a .sn file (same name as input .ros file, with .sn extension) is found in the input file directory, bottle serial numbers are inserted between the bottle position and date/time columns in the .btl file output. The format for the .sn file is:
  Bottle position, serial number (with a comma separating the two fields)

The Data Setup tab in the dialog box looks like this:



Other Processing Modules

See the SBE Data Processing manual/Help files for information on additional processing that can be performed on the converted CTD data (.cnv). file.

Processing .afm Files from AFM when Used with SBE 50

Notes:
- **These instructions do not apply to the SBE 19, 19*plus*, 19*plus* V2, or 25.** See *Processing .afm Files from AFM and .hex Files from SBE 19, 19plus, 19plus V2, or 25*.
- *90208* in the status reply is the part number of a standard AFM (aluminum housing and glass-reinforced epoxy connectors); the 90491 AFM (aluminum housing and wet-pluggable connectors) uses the same firmware, and has the same status reply.

Sea-Bird software cannot be used to process data from the AFM when it is used with the SBE 50. See *AFM Data Output Formats* above for a description of each line. An example .afm data file for an SBE 50 and AFM is shown below (two bottles were closed) along with an example calculation of pressure and scan number, to assist you in automating any data processing.

```
* Sea-Bird SBE50 Data File:
* FileName = H:\jobs\J36\36695\AFM-0084\afm1.afm
* Software Version 1.17
* Temperature SN =
* Conductivity SN =
* System UpLoad Time = Mar 11 2005 12:36:49
* 90208 AFM V 2.0  11 Mar 08  12:36:36.1
* Main battery = 14.0
* Lithium battery = 6.0
* AFM is NOT ARMED

*
* S>

*END*

1  1  03/11/08  10:17:23.4  confirmed   13.7  481
   0063000436
   0063000437
   0063000438
   0063000439
   006300043A
2  3  03/11/08  10:18:23.4  confirmed   13.7  577
   0063000496
   0063000497
   0063000498
   0063000499
   006300049A
```

Example: Calculate pressure and scan number for first scan recorded with first bottle firing in example data file.
First scan is 0063000436 = ppppssssss.

Pressure = pppp = 0063 (99 decimal)
pressure (decibars) = 99 - 100 = -1 decibars

Scan number = ssssss = 000436 (1078 decimal)
scan number = 1078 (see note)

Note:
In the example, the scan number *1078* from the SBE 50 hex data does not match the scan number *481* in the line above it. The scan number in the first line is the **number of scans counted by the AFM since the AFM was armed**. The scan number from the SBE 50 hex data is the **number of scans counted by the SBE 50 since power was applied to the SBE 50**. These may differ, but the offset (in this example, 1078 – 481 = 597) is constant for each bottle firing.
Checking the second bottle firing,
496 hex = 1174 decimal;
1174 – 577 (first line for 2nd bottle) = 597.

Note that the calculated pressures may be off by as much as 1 decibar from the actual measured value, because of truncation. See the example below:

Example: SBE 50 measures pressure as -0.01 db. When outputting with **OutputFormat=7** (for use with AFM), SBE 50 adds 100 to measured pressure, then truncates result and converts it to hex before transmitting data to AFM (i.e., -0.01 + 100 = 99.99, truncated to 99, converted to 63 Hex). Looking at result in .afm file, you convert 63 hex to 99 decimal, and subtract 100 to get -1 db (shown in example above). Therefore, for this example, actual measured pressure is -0.01 db, but calculated pressure from .afm file is -1 db.

Section 5: Routine Maintenance

This section reviews corrosion precautions, connector mating and maintenance, and replacement/recharging of the batteries.

Corrosion Precautions

Rinse the AFM with fresh water after use and prior to storage. Periodically (yearly), remove the AFM from the mounting clamps to rinse the entire housing surface with fresh water.

Avoid direct attachment of metal objects to the AFM housing to prevent corrosion. **Insulate the stainless steel clamps used with the AFM's mounting bracket with Teflon tape.**

All stainless steel screws that are exposed to salt water have been generously lubricated at the factory with Blue Moly™. After each cruise, remove these screws and re-lubricate them. **This compound is electrically conductive, so use care to ensure it does not get on circuit boards.**

A large zinc anode is screwed in each end cap. Check the anodes periodically to verify that they are securely fastened and have not been eaten away.

Connector Mating and Maintenance

Note:
See *Application Note 57: Connector Care and Cable Installation*.

CAUTION:
Do not use WD-40 or other petroleum-based lubricants, as they will damage the connector.

Clean and inspect connectors, cables, and dummy plugs before every deployment and as part of your yearly equipment maintenance. Inspect connectors that are unmated for signs of corrosion product around the pins, and for cuts, nicks or other flaws that may compromise the seal.

When remating:

1. Lightly lubricate the inside of the cable connector with silicone grease (DC-4 or equivalent).

2. **Standard Connector** - Install the cable connector, aligning the raised bump on the side of the cable connector with the large pin (pin 1 - ground) on the AFM. Remove any trapped air by *burping* or gently squeezing the connector near the top and moving your fingers toward the end cap. **OR MCBH Connector** – Install the cable connector, aligning the pins.

3. Place the locking sleeve over the cable connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

Verify that a cable or dummy plug is installed for each connector on the system before deployment.

Replacing/Recharging Batteries

Leave the batteries in place when storing the AFM to prevent depletion of the back-up lithium batteries by the real-time clock. Even *exhausted* main batteries will power the clock (30 microamps) almost indefinitely. If the AFM is to be stored for long periods, **replace alkaline batteries yearly to prevent battery leakage** (which could damage the AFM).

Alkaline D-cell
(MN1300, LR20)

Replacing Alkaline Batteries

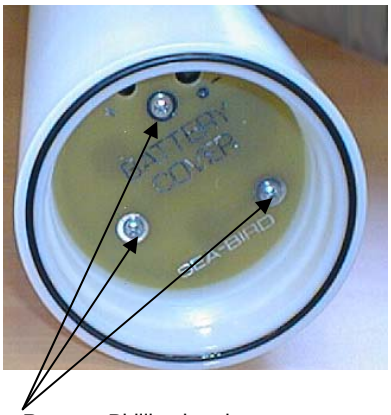
1. Remove the battery end cap (end cap without connectors):
   A. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
   B. Using a wrench on the white plastic bar, unthread the end cap, rotating counter-clockwise.
   C. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue.
   D. Put the end cap aside, being careful to protect the O-ring from damage or contamination.

Unthread cap by rotating counter-clockwise

2. Remove the battery cover plate from the housing:
   A. Remove the 3 Phillips-head screws and washers from the battery cover plate inside the housing.
   B. The battery cover plate will pop out. Put it aside.

3. Turn the AFM over and remove the batteries.

4. Install the new batteries, with the + terminals against the flat battery contacts and the - terminals against the spring contacts.



Remove Phillips-head screws and washers

5. Reinstall the battery cover plate in the housing:
   A. Align the battery cover plate with the housing. The posts inside the housing are not placed symmetrically, so the cover plate fits into the housing only one way. Looking at the cover plate, note that one screw hole is closer to the edge than the others, corresponding to the post that is closest to the housing.
   B. Reinstall the 3 Phillips-head screws and washers, while pushing hard on the battery cover plate to depress the spring contacts at the bottom of the battery compartment. **The screws must be fully tightened, or battery power to the circuitry will be intermittent**.

6. Check the battery voltage at BAT + and BAT - on the battery cover plate. It should be approximately 13.5 volts with fresh batteries.

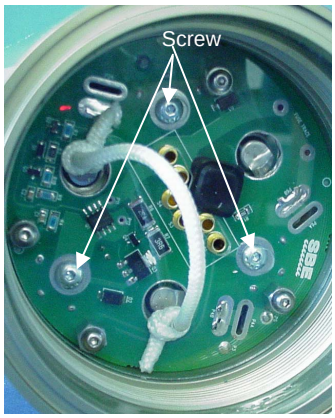
7. Reinstall the battery end cap:
   A. Remove any water from the O-rings and mating surfaces with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-rings and mating surfaces.
   B. Carefully fit the end cap into the housing and rethread the end cap into place. Use a wrench on the white plastic bar to ensure the end cap is tightly secured.

Recharging NiMH Batteries

See the *NiMH Battery Charger and Battery Pack* manual for complete details on charging, error messages, battery specifications, etc.

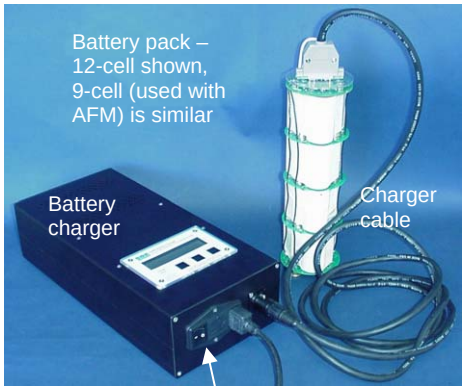
1. Remove the battery end cap (end cap without connectors):
   A. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
   B. Using a wrench on the white plastic bar, unthread the end cap, rotating counter-clockwise.
   C. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue.
   D. Put the end cap aside, being careful to protect the O-ring from damage or contamination.

Note:
If desired, you can recharge the battery pack while it is in the housing. Skip Steps 2 and 4 if recharging in the housing.



Battery pack

2. Remove the battery pack from the housing:
   A. The protective plastic plate over the battery cover plate prevents you from completely removing the cap screws that connect the battery pack to the AFM battery posts in one step. Each of the screws is 12 mm (1/2 inch) long, but the clearance between the cover plate and plastic plate is only 6 mm (1/4 inch). Unscrew each of the 3 cap screws **just until they hit the bottom of the protective plastic plate**. The battery pack will *walk* out of the housing approximately 6 mm (1/4 inch) because of the spring contacts at the bottom of the battery compartment. Unscrew the cap screws again. The battery pack will *walk* out of the housing again, and should now be disconnected from the battery posts.
   B. Pull on the cord to remove the battery pack from the housing.



WARNING!
Do not disconnect the battery while the Charger Active lamp is on. Doing so may cause a small spark.

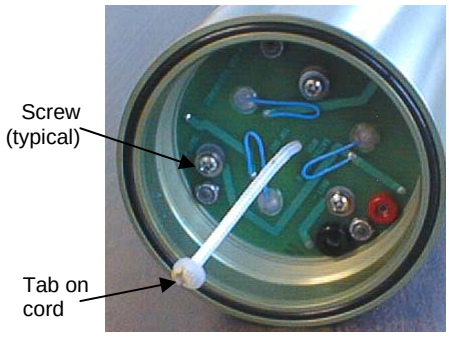
Note:
The NiMH battery pack fits tightly in the AFM housing. When placing a battery pack in the AFM, align it carefully and slowly insert it straight into the housing. If not careful, the battery pack shrink wrap can be torn.

3. Recharge the batteries:
   A. Plug the battery charger into a suitable power source and turn on power to the charger.
   B. Connect the charger cable to the battery pack and charger. The LED should show `READY`, and display the battery type and measured voltage.
   C. Press the **Discharge** button. The LED should show `DISCHARGE`. This starts the discharge cycle, which discharges any remaining battery capacity. Repeatedly charging without discharging may damage the battery pack. The Discharge cycle takes approximately 110 minutes. When discharging is complete, the LED should show `EMPTY`.
   D. Press the **Charge** button. The LED should show `Fast Charge` (it may also show `WARM-UP CHARGE`, `REFILL CHARGE`, and/or `TOP OFF` during the charge cycle). The Charge cycle takes approximately 2 hours. When charging is complete, the LED should show `BATTERY FULL`.
   E. Turn off power to the charger.
   F. Disconnect the battery pack from the charger and the charger from the power source.

4. Reinstall the battery pack in the housing:
   A. Align the battery pack with the housing. The posts inside the housing are not placed symmetrically, so the battery pack fits into the housing only one way. Looking at the bottom of the battery pack, note that one tube is closer to the edge than the others, corresponding to the post that is closest to the housing.
   B. Reinstall the 3 cap screws until they are snug against the top plate. While pushing hard on the protective plastic plate to depress the spring contacts at the bottom of the compartment, continue to tighten the cap screws. Repeat until all 3 cap screws are tightened and the battery pack cannot be pushed further into the housing. **The screws must be fully tightened, or battery power to the circuitry will be intermittent.**

5. Reinstall the end cap:
   A. Remove any water from the O-rings and mating surfaces with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-ring and mating surfaces.
   B. Carefully fit the end cap into the housing and rethread the end cap into place. Use a wrench on the white plastic bar to ensure the end cap is tightly secured.

Recharging Ni-Cad Batteries



CAUTION:
Do not recharge the battery pack while it is in the housing. If you do so, you may damage the AFM electronics.

1. Remove the battery end cap (end cap without connectors):
   A. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
   B. Using a wrench on the white plastic bar, unthread the end cap, rotating counter-clockwise.
   C. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue.
   D. Put the end cap aside, being careful to protect the O-ring from damage or contamination.

2. Remove the battery pack from the housing:
   A. Remove the 3 Phillips-head screws and washers from the battery cover plate inside the housing.
   B. Pull on the plastic tab on the center cord to remove the battery pack from the housing.

3. Recharge the batteries:
   A. Connect the battery charger leads to the battery cover pin jacks, matching black-to-black and red-to-red (the pin jacks are different sizes to prevent cross-wiring).
   B. Plug the battery charger into a suitable AC mains power source.
   C. The red **Charge** LED on the charger comes on. Recharging takes approximately 15 hours. When recharging is complete, the yellow **Trickle** LED comes on, indicating the charger is providing a maintenance level charge.
   D. Disconnect the battery pack from the charger and the charger from the power source.
   E. Check the voltage at BAT + and BAT – on the battery cover plate. It should be approximately 10.8 volts.

4. Reinstall the battery pack in the housing:
   A. Align the battery pack with the housing. The posts inside the housing are not placed symmetrically, so the battery pack fits into the housing only one way. Looking at the battery bottom cover plate, note that one circular cutout is closer to the edge than the others, corresponding to the post that is closest to the housing.
   B. Reinstall the 3 Phillips-head screws and washers, while pushing hard on the top of the battery pack to depress the spring contacts at the bottom of the compartment. **The screws must be fully tightened, or the battery power to the circuitry will be intermittent.**

5. Reinstall the battery end cap:
   A. Remove any water from the O-rings and mating surfaces with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-rings and mating surfaces.
   B. Carefully fit the end cap into the housing and rethread the end cap into place. Use a wrench on the white plastic bar to ensure the end cap is tightly secured.

Section 6: Troubleshooting

This section reviews common problems in operating the AFM/Carousel/CTD system, and provides the most likely causes and solutions.

Problem 1: Unable to Communicate with AFM

The A> prompt indicates that communications between the AFM and computer have been established. Before proceeding, try to establish communications again by clicking Connect AFM on SeatermAF's toolbar.

Cause/Solution 1: The I/O cable connection may be loose. Check the cabling between the AFM and computer for a loose connection.

Cause/Solution 2: The instrument type and/or communication settings may not have been entered correctly in SeatermAF. Select the AFM with the applicable CTD in the Configure menu and verify the AFM communication settings in the Configuration Options dialog box.

Cause/Solution 3: The I/O cable may not be the correct one. The I/O cable supplied with the AFM (with blue tape on both ends) uses the Data Terminal Ready (DTR) line from the computer to control internal switches in the AFM. These switches allow the terminal program (SeatermAF) to communicate with the AFM or CTD without switching cables or COM ports (SeatermAF sets the DTR line high to select the AFM and low to select the CTD). This I/O cable permits connection to the DB-9P input connectors used on standard RS-232 interfaces.

Problem 2: Unable to Communicate with CTD through AFM

The S> prompt indicates that communications between the CTD and computer (through the AFM) have been established. Before proceeding, try to establish communications again by clicking Connect CTD on SeatermAF's toolbar. The steps below are based on the assumption that you are able to communicate with the AFM from the computer. If not, see Problem 1 above.

Cause/Solution 1: The cable connection may be loose. Check the cabling between the AFM and CTD for a loose connection.

Cause/Solution 2: The instrument type and/or communication settings may not have been entered correctly in SeatermAF. Select the AFM with the applicable CTD in the Configure menu and verify the CTD communication settings in the Configuration Options dialog box. The CTD settings should match those on the CTD Configuration Sheet.

Cause/Solution 3: The cable from the AFM to the CTD may not be the correct one.

Problem 3: No Bottles Closed / No Data Recorded in AFM

Cause/Solution 1: The AFM may not have been *armed* before it was deployed. After you set up the AFM and CTD, you must:
1. Connect to the AFM by clicking Connect AFM on the Toolbar.
2. Program the AFM by clicking Program on the Toolbar (this *sends* all the bottle closure setup parameters to the AFM).
3. Arm the AFM by clicking ARM on the Toolbar.

Verify that the AFM is armed by sending **DS** (Status on Toolbar).

Problem 4: Nonsense or Unreasonable CTD Data

Note:
Each CTD (SBE 19, 19*plus*, 19*plus* V2, or 25) is shipped with a configuration (.con) file that matches the instrument configuration (number and type of auxiliary sensors, etc.) and includes the instrument calibration coefficients.

The symptom of this problem is an uploaded file that contains nonsense values (for example, 9999.999) or unreasonable values (for example, values that are outside the expected range of the data).

Cause/Solution 1: An uploaded data file with nonsense values may be caused by an incorrect instrument configuration (.xmlcon or .con) file. Verify that the settings in the .xmlcon or .con file match the CTD Configuration Sheet.

Cause/Solution 2: An uploaded data file with unreasonable (i.e., out of the expected range) values for temperature, conductivity, etc. may be caused by incorrect calibration coefficients in the instrument configuration (.xmlcon or .con) file. Verify the calibration coefficients in the .xmlcon or .con file match the CTD Calibration Certificates.

Problem 5: Program Corrupted

Note:
Using the reset switch erases the AFM's memory (data in memory as well as user-programmable parameter values). Reenter all user-programmable parameters after using the reset switch.

Cause/Solution 1: In rare cases, the program that controls the AFM's microprocessor can be corrupted by a severe static shock or other problem. This program can be initialized by using the reset switch. Proceed as follows to initialize:
1. Open the battery end cap and remove the batteries (see *Replacing/Recharging Batteries* in *Section 5: Routine Maintenance*).
2. There is a small, two-position switch on the battery compartment bulkhead, which is visible after the main batteries are removed. The switch is used to disconnect the internal lithium batteries from the electronics. Move the switch to the reset position and leave it there for 5 minutes, allowing several capacitors to drain. Then move the switch back to the on position.
3. Reinstall or replace the main batteries, and close the battery end cap.
4. Establish communications with the AFM (see *Section 3: Deploying and Operating System*). Reenter all user-programmable parameters.

Glossary

AFM – Carousel **A**uto **F**ire **M**odule. The AFM is available in two models:
- PN 90208 with standard aluminum housing and standard glass-reinforced epoxy connectors
- PN 90491 with standard aluminum housing and optional wet-pluggable (MCBH) connectors

Battery – nine alkaline D-cells (Duracell MN1300, LR20) standard. Available with optional rechargeable NiMH or Ni-Cad battery pack.

Carousel Water Sampler – Sea-Bird's SBE 32.
The AFM is compatible with the SBE 32 (full-size), SBE 32C (compact), or SBE 32SC (sub-compact) Carousel.

CTD – profiling instrument for measuring **C**onductivity, **T**emperature, and **D**epth (pressure); some CTDs can be integrated with auxiliary sensors to measure oxygen, pH, etc. The AFM is compatible with the SBE 19 SEACAT CTD, SBE 19*plus* SEACAT CTD, SBE 19*plus* V2 SEACAT CTD, and SBE 25 SEALOGGER CTD as well as the SBE 50 Digital Oceanographic Pressure Sensor.

PCB – Printed Circuit Board

SBE Data Processing – Sea-Bird's Win 2000/XP data processing software, which calculates and plots temperature, conductivity, pressure, auxiliary sensor parameters, and derived variables such as salinity and sound velocity.

Scan – One data sample containing (for example) temperature, conductivity, pressure, and optional auxiliary sensor data.

SEASOFT V2 –Sea-Bird's complete Win 2000/XP software package, which includes software for communication, real-time data acquisition, and data analysis and display. SEASOFT V2 includes ***SeatermAF*** and ***SBE Data Processing***.

SeatermAF – Sea-Bird's Win 95/98/NT/2000/XP software used to communicate with the AFM and with a CTD (SBE 19, 19*plus*, 19*plus* V2, or 25 CTD or SBE 50 Pressure Sensor) connected to the AFM.

Super O-Lube – Silicone lubricant used to lubricate O-rings and O-ring mating surfaces. Super O-Lube can be ordered from Sea-Bird, but should also be available locally from distributors. Super O-Lube is manufactured by Parker Hannifin (www.parker.com/ead/cm2.asp?cmid=3956).

Appendix I: Functional Description

Battery Wiring and Power Supply

The AFM's main battery is a series connection of D-cells that drop into the battery compartment as a cluster of three end-to-end pairs. The positive battery connections are contact areas on double-thick printed circuit disks that form the internal bulkhead and battery retainer plates. Battery negative contacts are heavy beryllium-copper springs. The three cell pairs are aligned by plastic insulated aluminum spacers which also serve as electrical interconnects. The battery - circuit card connection is via a Molex-type PCB connector.

The Analog PCB contains two series-connected lithium cells (Panasonic BR 2/3 A non-hazardous) that are diode OR'd with the main battery. The lithium supply is capable of maintaining data in memory, and permits orderly shut-down in the event of a failed or exhausted main battery.

Analog PCB

- U2 provides continuous 5 volts to power the RAM, real-time clock, and wake-up circuitry.
- Q1 switches power to the main 5 volt logic.
- Q6 switches power to the DC/DC converter (U3 and TR1) that powers the Carousel Water Sampler.

Digital PCB

- U11 is the RS-232 interface. U15 is a multiplexer:
  If DTRPC (Data Terminal Ready line from the PC) is greater than 2 volts, the PC is connected to the AFM. If DTRPC is less than 1 volt, the PC is connected to the CTD (SBE 19, 19*plus*, 19*plus* V2, 25, or 50).
- U16 and U17 are the UARTS; U12 and U13 form a watchdog timer.
- U14 is the real-time clock. It generates pulses every 0.5 seconds while the AFM is armed and powered.

Real-Time Clock

To minimize battery current drain, a low power *watch* crystal is used as the real-time-clock frequency source.

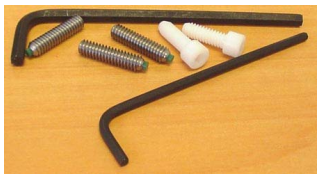
Memory

The AFM has a 64 KB static RAM memory for data storage. The on-board lithium cells maintain data in memory even if the main battery runs down or is removed. If power is completely removed by performing a reset (removes power from both main battery and lithium cells), data in memory will be lost. If power is completely removed by performing a reset, the clock resets to 1 January 1980. Upon power restoration, the clock resumes normal operation.

Appendix II: Electronics Disassembly/Reassembly

Disassembly

Jackscrew kit



Sea-Bird provides a jackscrew kit with the AFM, to assist in removal of the connector end cap. The kit contains:

- 2 Allen wrenches
- 3 jackscrews
- 2 spare plastic socket hex-head screws

Remove the connector end cap and attached electronics PCB assembly as follows:

Remove plastic hex head screws and install jackscrews in their place

Remove 4 Phillips-head screws

This Phillips-head screw does not connect to housing - do not remove

1. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
2. Remove the four Phillips-head screws securing the end cap to the housing.
3. Remove the 3 plastic hex head screws from the end cap using the larger Allen wrench. Insert the 3 jackscrews in these 3 holes in the end cap. When you begin to feel resistance, use the smaller Allen wrench to continue turning the screws. Turn each screw 1/2 turn at a time. As you turn the jackscrews, the end cap will push away from the housing. When the end cap is loosened, pull it and the PCB assembly out of the housing.
4. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue.
5. Disconnect the Molex connector connecting the PCB assembly to the AFM.
6. Remove the jackscrews from the end cap.

Reassembly

Note:
Before delivery, a desiccant package is inserted in the housing and the electronics chamber is filled with dry Argon gas. These measures help prevent condensation. To ensure proper functioning:

1. Install a new desiccant bag each time you open the electronics chamber. If a new bag is not available, see *Application Note 71: Desiccant Use and Regeneration (drying)*.
2. If possible, dry gas backfill each time you open the housing. If you cannot, wait at least 24 hours before redeploying, to allow the desiccant to remove any moisture from the housing.

Note that opening the battery compartment does not affect desiccation of the electronics.

1. Remove any water from the O-ring and mating surfaces with a lint-free cloth or tissue. Inspect the O-ring and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-ring and mating surfaces.
2. Reconnect the Molex connector to the PCB assembly.
3. Carefully fit the PCB assembly into the housing, aligning the holes in the end cap and housing
4. Reinstall the 4 Phillips-head screws to secure the end cap to the housing.
5. Reinstall the 3 plastic hex head screws in the end cap.

Appendix III: Replacement Parts

Part Number	Part	Application Description	Quantity in AFM
22018	Alkaline D-cell battery, Duracell MN 1300	Power AFM	9
41124B	Battery cover plate	For alkaline batteries	1
80256	Ni-Cad battery pack	Rechargeable 9-battery pack	1
90226	Ni-Cad battery charger (90/240 VAC)	Charging Ni-Cad battery pack	-
22009	Panasonic BR 2/3 A back-up lithium batteries	Permits orderly shut-down in event of failed or exhausted main battery	2
60021	Spare battery end cap hardware and o-ring kit	O-rings and hardware, including: • 30145 Screw, 6-32 x 1/2" Phillips-head, stainless steel (secures battery cover plate to battery posts for alkaline batteries; secures battery pack to battery rods for Ni-Cad battery pack) • 30242 Washer, #6 flat, stainless steel (for screw 30145) • 30816 Parker 2-234E603-70 (battery end cap to housing piston seal) • 30090 Parker 2-153N674-70 (battery end cap to housing face seal)	-
30164	Screw, 8-32 x 1 1/8" Phillips-head, stainless steel	Secures connector end cap to housing	4
50121	SEACAT Mount Kit	For mounting AFM or CTD (SBE 19, 19*plus*, 19*plus* V2, or 25) to Carousel	1
50092	SBE 16/19 Jackscrew Kit	For removing AFM connector end cap	1
17821 or 17884	RMG-4FS to RMG-3FS, 1.2 m (4 ft) or 1.8 m (6 ft) *	From AFM (3-pin) to SBE 19, 19*plus*, 19*plus* V2, or 25 data I/O connector (4-pin)	1
171846	MCIL-4FS to MCIL-3FS, 1.8 m (6 ft)	From AFM (3-pin) to SBE 19, 19*plus*, 19*plus* V2, or 25 data I/O connector (4-pin) with wet-pluggable connectors	1
171730	RMG-3FS and AG-206 to AG-206 and RMG-4FS *	Double Y-cable (AFM 3-pin and 6-pin to Carousel 6-pin and SBE 50 4-pin)	1
171991	MCIL-3FS and MCIL-6FS to MCIL-6FS and MCIL-4FS	Double Y-cable (AFM 3-pin and 6-pin to Carousel 6-pin and SBE 50 4-pin) for wet-pluggable connectors on SBE 50, SBE 32, and AFM	1
17168 or 17198	AG-206 to AG-206, 1.1 m (3.7 ft) or 2 m (6.6 ft) *	From AFM to Carousel	1
171798 or 171741	MCIL-6FS to MCIL-6FS, 1.0 m (3.3 ft) or 2 m (6.6 ft)	From AFM to Carousel for wet-pluggable connectors	1
801436	RMG-4FS to DB-9S I/O, 20 m (66 ft) *	AFM to computer	1
801460	MCIL-4FS to DB-9S I/O, 20 m (66 ft)	AFM with wet-pluggable connectors to computer	1
171888	DB-25S to DB-9P cable adapter	For use with computer with DB-25 connector	1

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Note:
SBE 19s and 25s configured with a pump, and all SBE 19*plus* V2s, have a 6-pin data I/O - pump connector. These CTDs are supplied with a Y-cable (6-pin to SBE CTD, 4-pin data I/O, 2-pin pump); connect the AFM-CTD cable (17821, 17884, or 171846) to the 4-pin data I/O connector on the Y-cable.

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Part Number	Part	Application Description	Quantity in AFM
171220	6-pin AG-206 to 6-pin AG-206 to 6-pin AG-206 Y-cable *	From SBE 35 to AFM and SBE 32 Carousel Water Sampler	-
171995	6-pin MCIL-6FS to 6-pin MCIL-6FS to 6-pin MCIL-6FS Y-cable	From SBE 35 to AFM and SBE 32 Carousel Water Sampler (all with wet-pluggable connectors)	-
17045.1	3-pin RMG-3FSD dummy plug with locking sleeve *	Connector protection for 3-pin connector	1
17046.1	4-pin RMG-4FSD dummy plug with locking sleeve *	Connector protection for 4-pin connector	1
17047.1	6-pin AG-206 dummy plug with locking sleeve *	Connector protection for 6-pin connector	1
17043	Locking sleeve *	Locks cable / dummy plug in place	3
171500.1	3-pin MCDC-3-F dummy plug with locking sleeve	Connector protection for 3-pin wet-pluggable connector	1
171398.1	4-pin MCDC-4-F dummy plug with locking sleeve	Connector protection for 4-pin wet-pluggable connector	1
171498.1	6-pin MCDC-6-F dummy plug with locking sleeve	Connector protection for 6-pin wet-pluggable connector	1
171192	Locking sleeve	Locks cable / dummy plug in place for wet-pluggable connectors	3
30044	Anode, 1 inch diameter	For AFM end caps (for corrosion prevention)	2

** For standard connectors.*

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