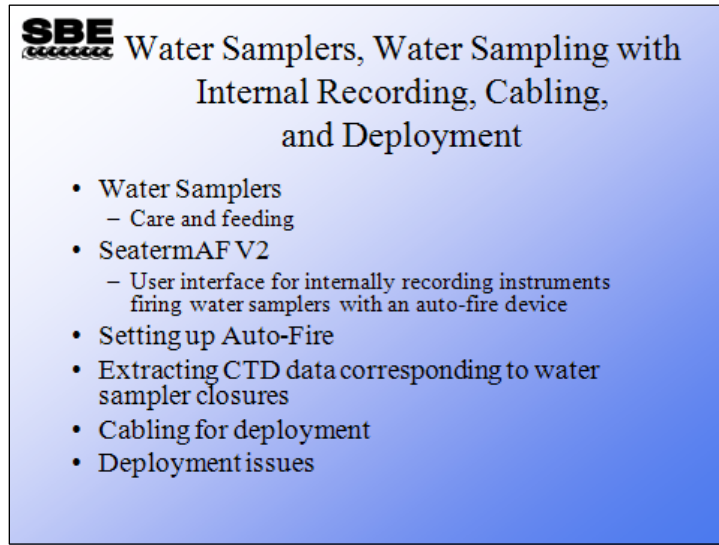


## **Module 4**

# **Water Sampling and Deployment**

## Overview



**SBE** Water Samplers, Water Sampling with Internal Recording, Cabling, and Deployment

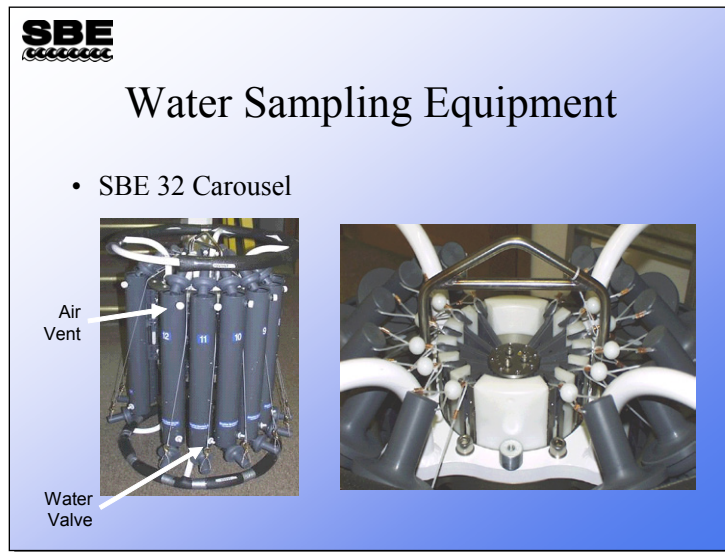
- Water Samplers
  - Care and feeding
- SeatermAF V2
  - User interface for internally recording instruments firing water samplers with an auto-fire device
- Setting up Auto-Fire
- Extracting CTD data corresponding to water sampler closures
- Cabling for deployment
- Deployment issues

We are going to discuss the workings of water samplers and techniques for collecting water samples with internally recording instruments. SeatermAF V2, the user interface for water sampling with an auto-fire device, will be presented. We will also cover deployment issues, cabling, and preparation of the instrument package to go over the side of the ship.

When we finish this module you should be able to:

- Maintain your SBE 32 Carousel or SBE 55 ECO water sampler.
- Use SeatermAF V2 to set up your auto-fire device.
- Create data summary tables that correspond to water samples.
- Cable your instrument from your computer room to the instrument on deck.
- Maintain your underwater connectors.
- Plumb your sensors properly.
- Prepare your instrument to make measurements in the ocean.

## Water Sampling Components



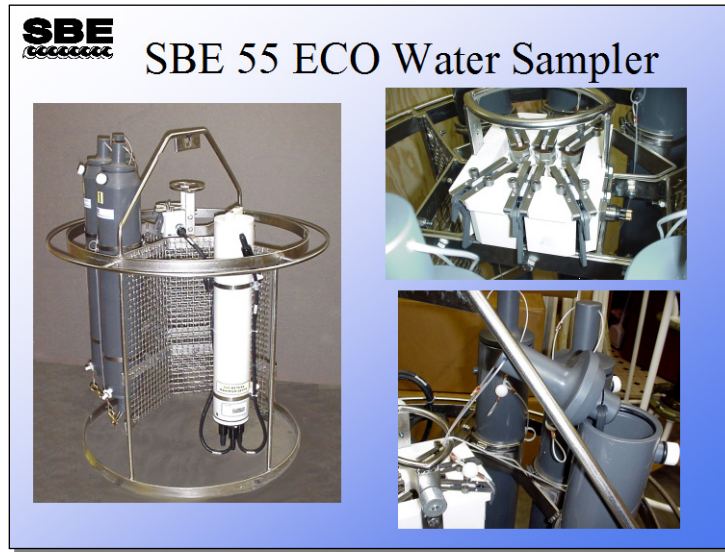
Here are pictures of water sampling equipment.

The SBE 32 Carousel water sampling package consists of:

- water sample bottles with their lanyards
- trigger mechanism
- upper and lower pylons that hold the bottle on the frame
- upper and lower frame that protects the package from collision with the side of the ship


The Carousel trigger mechanism is an electro-mechanical device. It operates by energizing a solenoid magnet that pulls a mechanical trigger, releasing the nylon lanyards that hold the top and bottom caps of the water sampler open.

## Water Sampling Components






The SBE 55 is a small, 3- or 6-bottle water sampler, intended for sampling in depths to 600 meters. Its trigger mechanism operates in the same way as the mechanism on the Carousel, and its electronics are similar.

## Autonomous Water Sampling with Internally Recording Instruments



**Autonomous Water Sampling with Internally Recording Instruments**

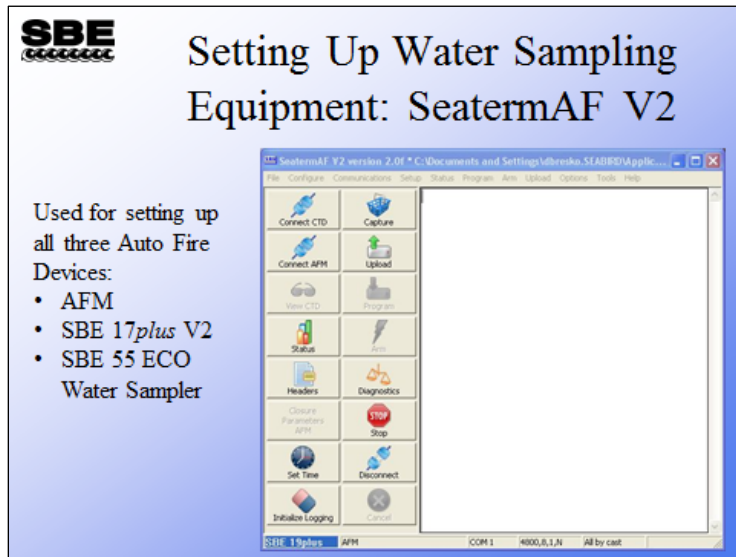
- Auto Fire Module (AFM) with SBE 32 Carousel
  - AFM receives pressure information from SBE 19, 19*plus*, 19*plus* V2, 25, 25*plus*, or 50
- SBE 17*plus* Version 2 Searam with SBE 32 Carousel
  - SBE 17*plus* V2 receives pressure information from SBE 9*plus*
  - SBE 17*plus* V2 also provides battery power and internal data recording (16 Mbyte of memory) for SBE 9*plus*
- SBE 55 ECO Water Sampler
  - Receives pressure information from SBE 19, 19*plus*, 19*plus* V2, 25, 25*plus*, or 50
  - Built-in capability similar to SBE 32 Carousel integrated with AFM
- All receive closure protocol from user via SeatermAF V2

Sea-Bird offers several products for closing water sampler bottles remotely. These products receive pressures from the CTD and are programmed to close bottles on operator-chosen criteria.

- The AFM / SBE 32 Carousel system is compatible with several CTDs, as well as with an SBE 50 Pressure Sensor. The AFM closes bottles on downcast (descending), upcast (ascending), when the instrument package is stationary, or on elapsed time. For all options except elapsed time without CTD, the AFM must receive data from the CTD. If using the elapsed time option, you may record CTD data in the AFM each time a bottle is closed or you may use the AFM by itself, without a CTD.
- The SBE 17*plus* / SBE 32 Carousel system is much more straightforward to use, because there are fewer options. The SBE 17*plus* only closes bottles on the upcast, and is only used with one type of CTD, the SBE 9*plus*.
- The SBE 55 ECO Water Sampler has built-in auto-fire capability similar to that of an AFM integrated with an SBE 32 Carousel.

## Setting up Water Sampling Equipment with SeatermAF V2



SeatermAF V2 includes a simple interface for entering bottle closure parameters, and transfers that information to the auto-fire equipment. It is also used to set up the SBE 19, 19plus, 19plus V2, 25, 25plus, or 50 for operation, and to upload data from the auto-fire equipment (AFM, SBE 17plus V2, or SBE 55 ECO Water Sampler) and CTD.

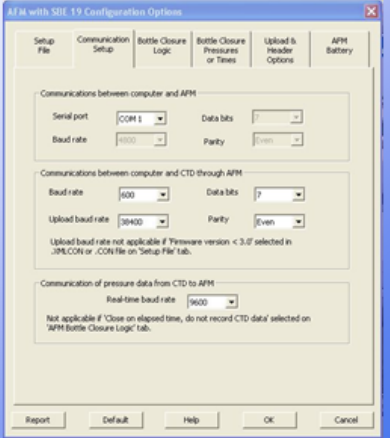
## SeatermAF V2: Setting Up CTD Communications

**SBE**  
*SeatermAF*

### Setting Up CTD Communications

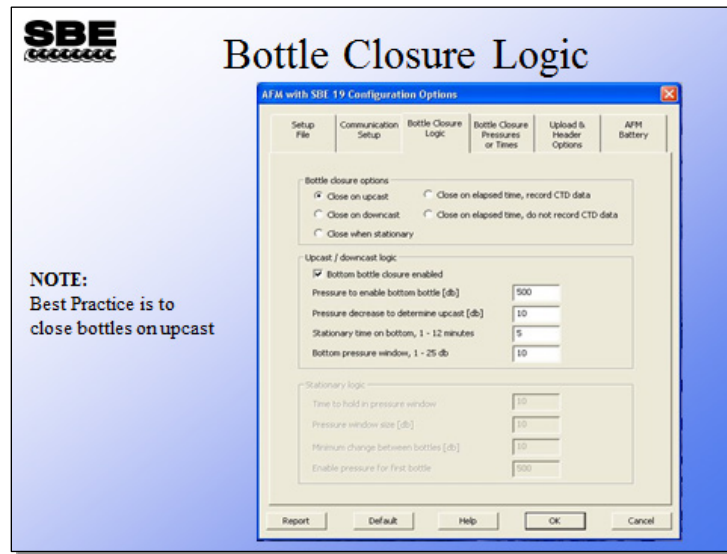
- To access this dialog box, Click on the Configure menu bar, and select the CTD and water sampling equipment you are using.
- Example:

AFM with SBE 19 configuration



The CTD communications form allows you to select the communications parameters for your instrument as well as data transfer protocol and header options. Instruments with older firmware revisions are not able to change baud rate during data transfers.

## SeatermAF V2: Setting up Sampling Protocol



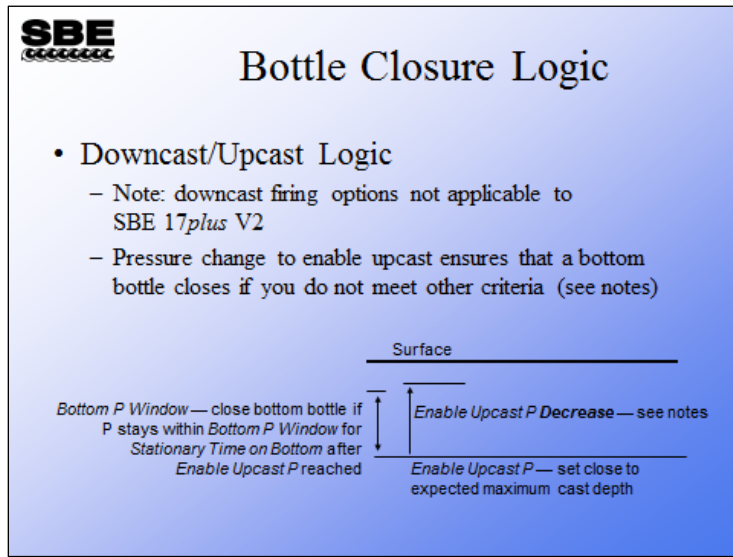
The bottle closure logic tab contains almost all the information that the AFM, SBE 17*plus* V2, or SBE 55 ECO need to close water sample bottles based on the closure protocol you select.

- AFM or SBE 55 ECO Water Sampler - you have the choice of closing bottles during downcast, during upcast, when the instrument package is stationary, or on time elapsed since the auto-fire was armed.
- SBE 17*plus* V2 - you can close bottles on the upcast only.

The closure logic follows.



## SeatermAF V2: Setting up Sampling Protocol (continued)

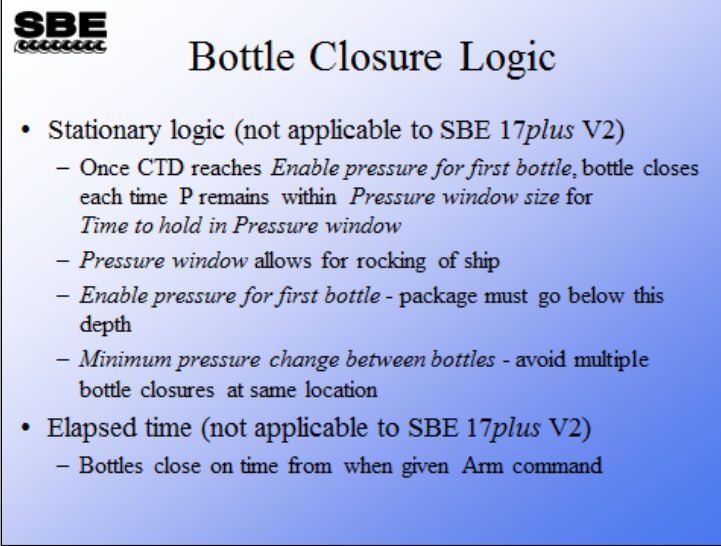


The AFM, SBE 17*plus* V2, and SBE 55 ECO can all collect water samples during **upcast** (as the instrument package is rising). Click *bottom bottle closure enabled* to take a sample at the deepest part of the cast. To collect a bottom bottle, you must specify a pressure to enable the bottom bottle, a length of time you will hold the package stationary on the bottom, and the pressure window within which the package will be considered stationary. In addition, you must specify *pressure decrease to determine upcast*. Interpretation of the parameters varies slightly, depending on the instrument.

- AFM and SBE 55: *pressure decrease to determine upcast* ensures that a bottom bottle is closed if you do not hold the package stationary for a sufficient length of time.
- 17*plus* V2: *pressure decrease to determine upcast* overrides the pressure to enable the bottom bottle. In other words, if the package does not go as deep as anticipated, this ensures that a bottom bottle is closed.

The AFM and SBE 55 ECO can also collect water samples during **downcast** (instrument package is falling); parameters similar to those required for collecting on upcast define the closure logic. Click *bottom bottle closure enabled* to take a sample at the deepest part of the cast. To collect a bottom bottle, specify a pressure to enable the bottom bottle, a length of time you will hold the instrument package stationary on the bottom, and the pressure window within which the instrument package will be considered stationary.

## SeatermAF V2: Setting up Sampling Protocol (continued)

A blue rectangular slide with a white border. In the top left corner is the SBE logo. The title "Bottle Closure Logic" is centered at the top. Below the title is a bulleted list of logic rules for bottle closure.

**SBE**


### Bottle Closure Logic

- Stationary logic (not applicable to SBE 17plus V2)
  - Once CTD reaches *Enable pressure for first bottle*, bottle closes each time P remains within *Pressure window size* for *Time to hold in Pressure window*
  - *Pressure window* allows for rocking of ship
  - *Enable pressure for first bottle* - package must go below this depth
  - *Minimum pressure change between bottles* - avoid multiple bottle closures at same location
- Elapsed time (not applicable to SBE 17plus V2)
  - Bottles close on time from when given Arm command

With an AFM (and SBE 32 Carousel Water Sampler) or with an SBE 55 ECO Water Sampler, samples can be collected when the instrument package is held stationary. The stationary logic dictates what constitutes stationary: how long to hold the package still and how large the pressure window is. You must set the pressure window size to allow for the rocking of the ship and set the time that you will hold the instrument in that window. You must also set an enable pressure; the package must go below this depth before the AFM or ECO will close any bottles. Also, you must specify the minimum pressure change between bottles to avoid multiple closures at essentially the same location.


With an AFM or SBE 55 ECO Water Sampler, samples can be collected on elapsed time. The AFM and ECO have an internal clock and close water bottles on time from when they were given the Arm command.

## SeatermAF V2: Setting up Sampling Protocol (continued)



### Auto-Fire Setup

- AFM
  - With SBE 19, 25: SeatermAF V2 converts user-input closure parameters in decibars to raw pressure numbers using configuration file coefficients, CTD transmits raw pressure data to AFM
  - With SBE 19*plus*, 19*plus* V2, 25*plus*, 50: Instrument transmits data in decibars to AFM
- SBE 17*plus* V2
  - SBE 9*plus* transmits raw pressure data, SBE 17*plus* V2 converts raw pressure data to decibars, using configuration file coefficients
- SBE 55 ECO Water Sampler
  - Operation similar to AFM



There is an entry for the configuration (.con or .xmlcon) file on the Setup File tab.

- For the SBE 19 and SBE 25, the configuration file (which includes pressure calibration coefficients) is required because the AFM receives raw data from the CTD. Rather than require the AFM to process the CTD pressure data, SeatermAF V2 calculates what the raw pressure sensor output would be for the user-input closure pressures; these raw numbers are used by the AFM to determine when to close a bottle.
- The SBE 19*plus*, 19*plus* V2, 25*plus*, and SBE 50 send pressure in decibars to the AFM, so a configuration file is not required.
- For the SBE 9*plus*, the configuration file (which includes pressure calibration coefficients) is required because the SBE 17*plus* V2 receives raw data from the CTD. The SBE 17*plus* V2 calculates pressures in decibars as data is received from the 9*plus*, and compares these pressures to the user-input closure pressures to determine when to close a bottle.
- Operation with the SBE 55 ECO Water Sampler is similar to that of an AFM with an SBE 32 Carousel Water Sampler.

## SeatermAF V2: Setting up Sampling Protocol (continued)

**SBE** *Seatec* **Bottle Closure Pressures or Times**

- AFM, SBE 17*plus*, and SBE 55 ECO close bottles on pressure
- AFM and SBE 55 ECO can also close bottles on elapsed time in minutes from when armed

Bottom bottle	Closure order	Bottle position	Closure pressure(db)
1	1	1	500
2	2	2	400
3	3	3	400
4	4	4	400
5	5	5	350
6	6	6	300
7	7	7	250
8	8	8	200
9	9	9	150
10	10	10	100
11	11	11	50
12	12	12	10

Closure pressures must decrease from closure 1 to last bottle.

Once you have defined the governing bottle closure logic – on upcast, on downcast, when stationary, or on elapsed time – you need to enter the number of bottles to close and which bottle to close when. Bottles may be closed in any order desired.

- If closing on downcast, closure pressures must increase from closure 1 to the last closure (e.g., 10 db, 20 db, 50 db, etc.).
- If closing on upcast, closure pressures must decrease from closure 1 to the last closure (e.g., 500 db, 400 db, 350 db, etc.).
- If closing on elapsed time (time since AFM or SBE 55 ECO was armed), closure times must increase from closure 1 to the last closure (e.g., 2 minutes, 5 minutes, 10 minutes, etc.).

---

## Data Recorded in Auto Fire Instrument



### Data Recorded in Auto Fire Instrument

- AFM
  - 5 CTD scans are recorded in AFM at time of each bottle closure
- SBE *17plus* V2
  - Since *17plus* V2 is also memory module for SBE *9plus*, all *9plus* CTD data is recorded in *17plus* V2
  - Bottle closure bit in status byte is set for 36 scans to indicate time of each bottle closure
- SBE 55 ECO Water Sampler
  - 5 CTD scans are recorded in ECO at time of each bottle closure

## Real-Time Data and Water Samples from an Internally Recording Instrument

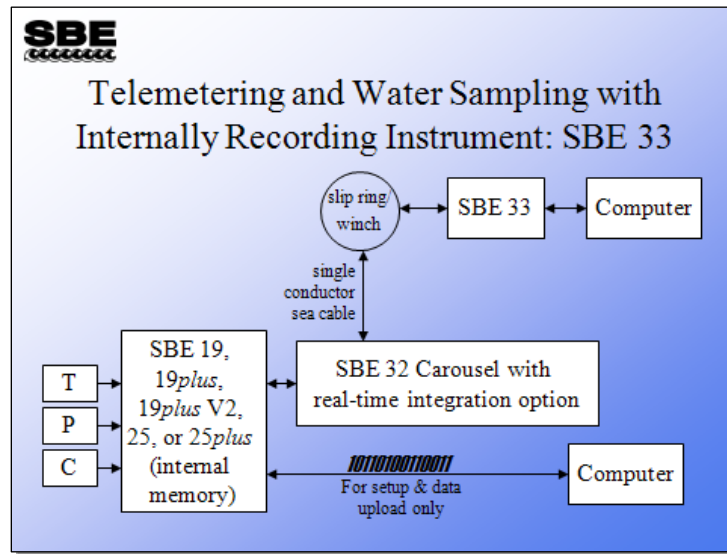
**SBE**  
*seabird*

### Telemetry and Water Sampling with Internally Recording Instrument: SBE 33

- Real-time interface SBE 32 Carousel:
  - receives power from SBE 33
  - converts it to power for SBE 19, *19plus*, *19plus V2*, *25*, or *25plus*
  - telemeters data to deck
- Real-time interface SBE 55 ECO:
  - Operation with SBE 33 similar to that of SBE 32 Carousel with SBE 33

The SBE 33 provides power and telemetry for internally recording instruments. Telemetry capability is over 10 km of sea cable.

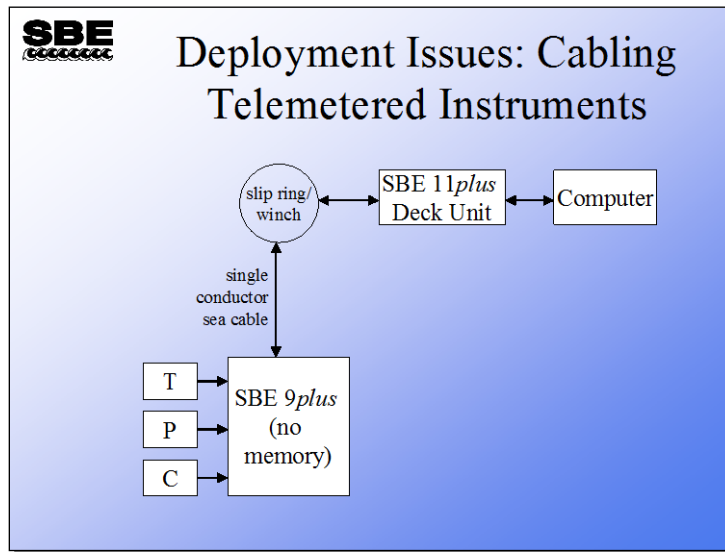
## Cabling for the SBE 33



This setup can also be used with an SBE 49 FastCAT CTD, which has no internal memory.

The diagram also applies to a standard SBE 55 ECO Water Sampler (serial data integration capability is built into the standard ECO).

## Deployment Issues





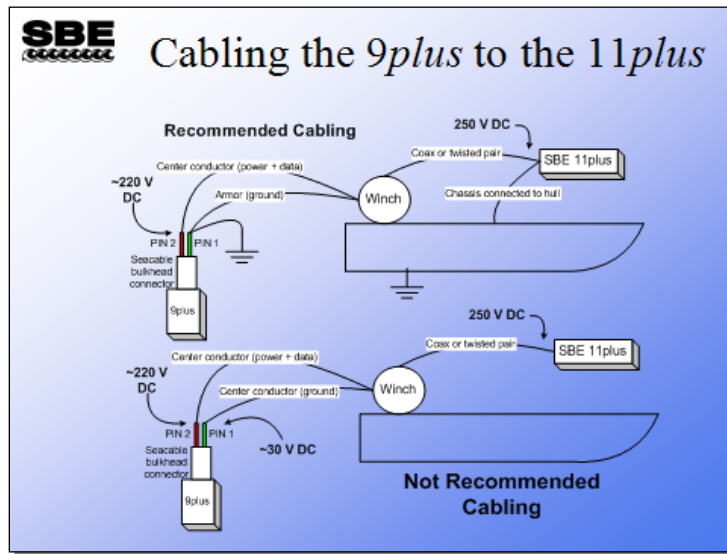
## Cabling the *9plus* to the *11plus*



### Cabling the *9plus* to the *11plus*

- Use #20 twisted pair or coax to cable between SBE *11plus* and winch
- Seacable is typically single or multi-conductor armored cable up to 10,000 meters, with less than 350 ohms resistance
- Grounding considerations
  - Use armor of sea cable for ground
  - Remember, salt water conducts, ship is metal (usually)
  - Ground chassis of your deck unit to hull of ship


## Cabling the 9plus to the 11plus (continued):



The slide above illustrates the recommended cabling for the SBE 9plus and the 11plus as well as a *not* recommended method. The primary difference between the two is that the recommended method utilizes the seacable armor as the return or ground for the SBE 9plus. This ensures that the underwater instrument package will be at the same potential, presumably ground, as the ship's hull. If the *not* recommended method is used, there is the possibility that the instrument package will be at a higher potential than the ship's hull and may cause injury to the crew that handles the over-the-side equipment.

## Deployment: Instrument Plumbing

**SBE**  
Plumbing for Success

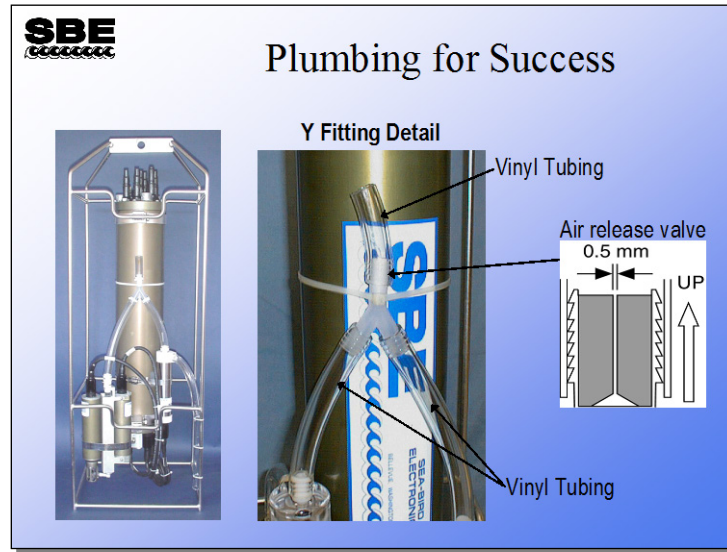


- Sea-Bird conductivity cells and oxygen plenums rely on water passing through them, usually via a pump
- Pump is magnetically coupled impeller type, not self-priming
- Arrange tubing on instrument package to allow all air to escape from plumbing

Sea-Bird CTDs use a pump to maintain a constant flow of water through the conductivity cell and past the oxygen electrode. While this technique complicates the instrument package, it pays off in data quality. The tubing that connects the pump and the sensors must be arranged to allow all the air that is in the system while it is on deck to escape quickly when it is submerged. Failure to allow a path for the air to escape causes problems in the first 10 meters of data collection. Beyond 10 meters, the bubbles usually collapse sufficiently for the system to operate correctly. If bubbles collect in the pump, it will fail to prime. If bubbles are caught in the conductivity cell, the pump will fail to turn on. If bubbles are caught in the dissolved oxygen plenum, the dissolved oxygen signal will be in error.

Note: For additional information on self-priming vs non-self-priming pumps, see [www.pumpstoreusa.com/knowledgebase/selfpriming](http://www.pumpstoreusa.com/knowledgebase/selfpriming)

## Deployment: Plumbing Examples

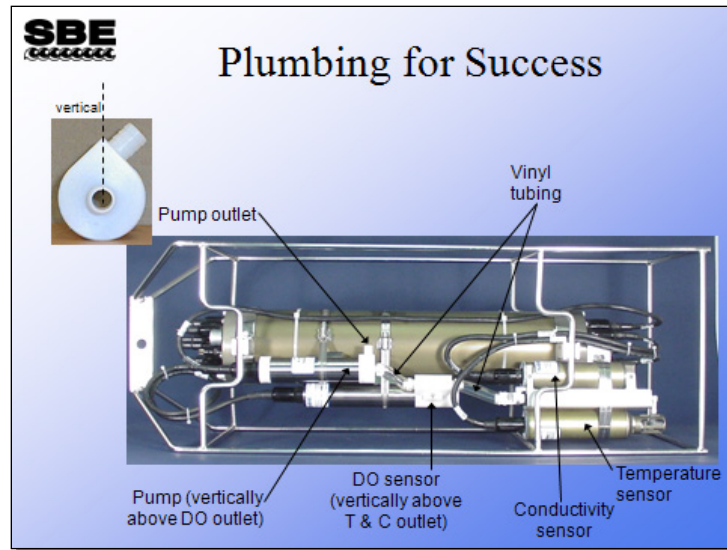


This slide shows the proper way to run the tubing for an instrument in a cage meant to be deployed vertically. Note the highest point in the plumbing is the top of the *Y*; there is a fitting with a small hole in the top of the *Y* that allows the air in the tubing to vent as the instrument goes into the water.

For the SBE *9plus*, an exhaust tube runs from the pump outlet down the side of the cage, stopping at the same height as the T-C duct inlet. This equalizes pressure at the plumbing inlet and outlet, eliminating any acceleration / deceleration of water in the plumbing (which can cause small errors in the measurements). The exhaust tube is usually omitted for the SBE 19 and 25 families of instruments, due to the lower accuracy of those systems.

Periodically clean the air release valve with a 0.4 mm diameter wire (you can use #26 AWG wire), and blow through it to ensure it is open. A clogged air release valve can trap air, preventing the pump from functioning properly; this will affect the data quality.


## Deployment: Plumbing Examples (*continued*)



Instruments meant for horizontal deployment are easier to plumb. The pump is oriented so that the outlet is the highest point on the plumbing. Care must be taken to ensure there are no loops in the plumbing that would trap air. Because this system is meant to be deployed horizontally, there is no *sloshing* effect and no requirement for the SBE *9plus* that the inlet and outlet be at the same height.

*Application Note 64-1: Plumbing Installation – SBE 43 DO Sensor and Pump on a CTD* on the website provides more details on both the vertical and horizontal plumbing schemes.

## Deployment: Failed Underwater Connections Deployment: Be Neat!



**Make a Neat Underwater Package**

- Cable tie or tape all loose cabling to frame of package
  - Loose cables flap as package rises or drops, resulting in fatigue
- Make sure no cables are in path of inlet to temperature sensors
- Instrument with aluminum housing: check zinc anodes occasionally; grounding problems can cause them to disappear


Neatness counts! Secure all your loose cables. When you lower your instrument package at 1 meter per second, any loose cabling will flap. This sort of repetitive motion will fatigue the cables and shorten their working life.

## Deployment: Final Preparation

**SBE**  
*ocean*

### What Do You Mean, *Soak the Fish?*


- This is not done in the galley!
- Soaking means putting the instrument package over the side and into water at a safe but shallow depth (like 10 meters)
- Soaking tip: use 2 display types
  - Fixed or scrolled text display to check all sensors and other parameters on deck and during soak
  - Multi-line plot for the cast



As you prepare to take a cast, it is considered good practice to place the instrument package in the water and allow it to equilibrate. This allows several good things to happen. The whole package comes to the surface temperature rather than the air temperature on deck, the conductivity cell wets with seawater, and the oxygen sensor comes to surface temperature (and in the case of older sensors, the oxygen sensor polarizes). Further, if you are working in real-time, you can quickly confirm the operation of the instrument and all the sensors. This is a great idea because nothing irritates the deck crew more than starting the cast only to bring the instrument package back aboard a few minutes later.

If you are using a real-time system, use 2 different display types in Seasave: a text display (fixed and/or scrolled) for deck and surface soak checkout, and a plot for the cast. The text display will tell you that the sensors are working and when the pump comes on.

## Deployment: Final Preparation (*continued*)



### Using Your CTD in Very Cold Places

- Glass conductivity cell is subject to breakage due to water freezing in cell
- Remove all water from conductivity cell
  - Repeated ice formation (film or droplets) on electrodes will degrade calibration at 0.001 - 0.020 PSU level
- Make a solution of 1% triton in sterile seawater
  - Use 0.5 micron filtered seawater or boiled seawater
- **Never use anti-freezes like glycol or alcohol**
- SBE 43 Oxygen Sensor – prevent freezing

Another option in place of a Triton solution for the conductivity cell is the use of a brine solution (distilled seawater or homemade salt solution that is higher than 35 psu in salinity), as salty water depresses the freezing point. However, there is still a risk of forming ice inside the conductivity cell if deploying through frazil ice on the surface, if the freezing point of the salt water is the same as the water temperature.


- If no surface frazil ice is present, rinse the conductivity cell in the 1% Triton solution or in a brine solution to prevent freezing during deployment. But this does not mean you can store the cell in this solution outside...it will freeze!
- If surface frazil ice is present, it is best to deploy the conductivity cell in a dry state.

Commercially available alcohol or glycol antifreezes contain trace amounts of oils that will coat the conductivity cell and the electrodes, causing a calibration shift, and consequently result in errors in the data. **Do not use alcohol or glycol in the conductivity cell!**

For the SBE 43 Dissolved Oxygen Sensor, avoid prolonged exposure to freezing temperatures, including during shipment. Do not store the SBE 43 with water, Triton solution, alcohol, or glycol in the plenum. The best precaution is to keep the SBE 43 indoors or in some shelter out of the cold weather.



## Correlating CTD Data with Water Samples




### Correlating CTD Data with Water Samples

- Water sampler closure events are captured in data
  - GO 1015 systems mark the *9plus* data stream with a status bit
  - SBE 32 Carousel and SBE 55 ECO systems use a list of scan numbers created by Seasave, *.bl* file
- This information is used by *Data Conversion* module to extract CTD data at time of water sampler closure into a *.ros* file
- Extracted data may be summarized into a table by *Bottle Summary* module

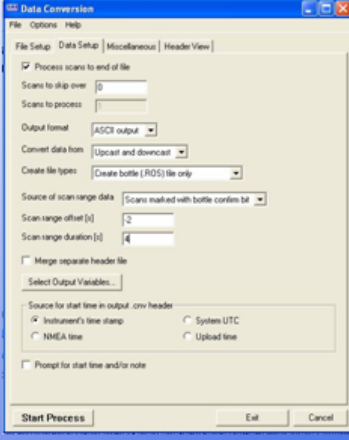
Water samples are typically used in analyses that cannot be performed *in-situ*, usually of a chemical or biological nature. These analyses are much more useful when they can be combined with CTD measurements made at the time of the water sample. There are two steps to providing a table of CTD data that corresponds to water samples. The *Data Conversion* module creates a *.ros* file that contains CTD data scans from the data logged at the time the water sample was collected. The *Bottle Summary* module creates averages and standard deviations from this data, rendering the data into a format that can be easily used by spreadsheets or other applications.

## Extracting CTD Data for Water Samples with Data Conversion



### Extracting CTD Data with Data Conversion

- You may create a *.cnv* and/or a *.ros* file
- The source of the data is your *.hex* or *.dat* file
- The indicator of what data to extract is a status bit in the data or a file of type *.bl*, *.afm*, or *.bsr*
- Data written to the *.ros* file is specified in the output variable selection dialog




The Data Conversion module creates a *.ros* file containing the same variables that the *.cnv* file contains, with scans logged around the moment a water sample was collected. For real-time water sampling, Data Conversion determines when the water sample was taken by:

- a status bit in the SBE *9plus* data stream when a G.O. 1015 is used to collect samples, or
- a *.bl* file that is created by Seasave when the instrument package is equipped with an SBE 32 Carousel or SBE 55 ECO, or
- a *.bsr* file created with a text editor

For autonomous water sampling, Data Conversion determines when the water sample was taken by:

- a status bit in the uploaded data from the SBE *17plus*, or
- a *.afm* file uploaded from the AFM, or
- a *.afm* file uploaded from the SBE 55 ECO Water Sampler. The SBE 55 ECO's built-in electronics perform the same function as the AFM.

## Extracting CTD Data for Water Samples with Data Conversion (*continued*)

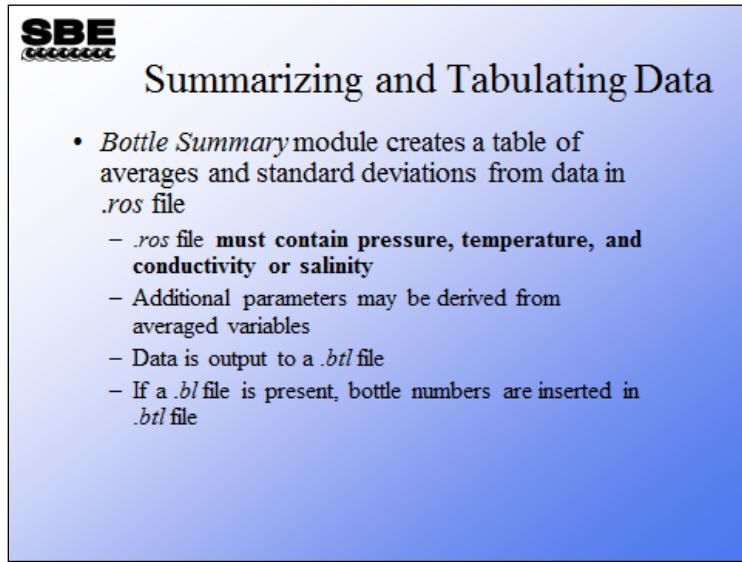


### Specifying How Much Data Per Bottle Closure

- Data extraction is referenced to the time of closure
- Scan range offset is how many seconds before the bottle closure to begin extracting data
- Scan range duration is how many seconds total to extract data

The range of data to copy out of the .cnv file into the .ros file is specified in seconds. You may copy a maximum of 1440 scans per bottle closure. For an SBE *9plus* system operating at 24 Hz, 4 seconds of data is 96 scans. For an SBE 19 operating at 2 Hz, 4 seconds of data is only 8 scans.

## Bottle Summary: Summarizing Water Sample Data



**SBE**  
Summarizing and Tabulating Data

- *Bottle Summary* module creates a table of averages and standard deviations from data in *.ros* file
  - *.ros* file **must contain pressure, temperature, and conductivity or salinity**
  - Additional parameters may be derived from averaged variables
  - Data is output to a *.btl* file
  - If a *.bl* file is present, bottle numbers are inserted in *.btl* file

The *.ros* file created by *Data Conversion* contains a set of data scans for each water sample taken. The *Bottle Summary* module takes the process one step further by averaging the scans for each water sample into a single line of data that contains averages and standard deviations for each of the parameters in the *.ros* file. In addition, you may add derived parameters to this list. The derived parameters are calculated from the averages of the data contained in the *.ros* file.

## Bottle Summary: Summarizing Water Sample Data (continued)

**SBE**

### Bottle Summary

- Variables created by *Data Conversion* may be selected for inclusion in the *.btl* file

Variable Name [unit]	Average	Select All
Pressure, Digiquartz [db]	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Temperature [ITS-90, deg C]	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Salinity [PSU]	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Density [sigma-theta, Kg/m <sup>3</sup> ]	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Voltage 2	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Voltage 4	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Scan Count	<input type="checkbox"/>	<input type="checkbox"/>

## Bottle Summary: Summarizing Water Sample Data (continued)

**SBE**

### Bottle Summary, Deriving Parameters

- Parameters derived from the averages may be added to the .bt1 list

The screenshot displays the 'Bottle Summary' software interface. The main window has a menu bar with 'File', 'Options', and 'Help'. Below the menu bar are tabs for 'File Setup', 'Data Setup', and 'Header View'. A checkbox labeled 'Output min/max values for averaged variables' is present. Below this are two buttons: 'Select Averaged Variables...' and 'Select Derived Variables...'. There is also an 'Oxygen' section with an 'Apply Tau correction' checkbox. In the foreground, a 'Select Derived Variables' dialog box is open. It features a table with 15 rows, each with a 'Seq #' and a 'Variable Name [unit]'. To the right of the table are buttons for 'Add', 'Change', 'Delete', 'Insert', and 'Delete All'. Further right is a list of variables: Density, Nitrogen Saturation, Oxygen Saturation, Potential Temperature, Sound Velocity, and Specific Volume Anomaly (10<sup>-6</sup> m<sup>3</sup>/K/g). To the right of this list are buttons for 'Show All', 'Expand All', 'Strike', and 'Expand'. At the bottom of the dialog are 'OK' and 'Cancel' buttons. Below the dialog box, in the main window, are 'Start Process', 'Exit', and 'Cancel' buttons.

---

## Activity: Create .ros and .bti Files

1. In SBE Data Processing, run *1. Data Conversion* to create a .ros file:
  - A. File Setup tab - C:\Data\Module4\Hawaii.dat and Hawaii.con
  - B. Data Setup tab -
    - Upcast and downcast
    - Create .ros file only
    - Use .bti file as source of scan range
    - Scan range offset -2
    - Scan range duration 4
    - Output Variables pressure, temperature, salinity
  - C. Click *Start Process*.
  - D. File Setup tab – Save Program setup file (.psa) to same directory as output file
  
2. In SBE Data Processing, run *8. Bottle Summary* to create a .bti file:
  - A. File Setup tab - C:\Data\Module4\Hawaii.ros and Hawaii.con
  - B. Data Setup tab –
    - Click *Select Averaged Variables*. In dialog box, click *Select All* and click *OK*.
    - Click *Select Derived Variables*. In dialog box,
      - Click the first Variable name line.
      - Click *Density* ->  $\sigma\text{-}t$ ,  $\text{Kg/m}^3$ .
      - Click *Add*.
      - Click *OK*.
    - *Apply Tau correction* has no effect (no oxygen data in this activity).
  - C. Click *Start Process*.
  - D. File Setup tab – Save Program setup file (.psa) to same directory as output file
  
3. Check your results with Notepad.

