National Reference Station Biogeochemical Sampling
Pre-Run Check and Field Sampling CTD Procedural Guide v. 1.3
November 2011

Tim Ingleton
New South Wales Department of Environment and Heritage, Sydney

Brad Morris
University of New South Wales, Kensington, Sydney
Sydney Institute of Marine Science, Chowder Bay, Sydney

Lindsay Pender
CSIRO Marine and Atmospheric Research,
Hobart, Tasmania
Why a Standardised CTD Acquisition, Processing and Quality Control procedure for Australian National Moorings Network (ANMN) and the Integrated Marine Observing System (IMOS)?

In 2008 IMOS purchased a series of SeaBird 19+ SEACAT CTD (Conductivity-Temperature-Depth) profilers. This was to enable the IMOS node Bio-Geochemical (BGC) samplers to collect water column profile data during monthly-quarterly sampling at each of the National Reference Station sites. While a manual is provided with the SBE CTD unit there are numerous ways that data may be collected and then treated in the post-collection processing phase. Thus, a need to standardise the way CTD data are collected, processed and QAQC-ed was identified to provide robust, precise, accurate and comparable CTD datasets for the research community. This data is ultimately delivered to the public through the IMOS web portal.

The development of procedures for improved QAQC for IMOS CTDs (Profilers and Water Quality Monitors (WQMs) began with a summit in Hobart (25-26 August, 2011) with representatives from each of IMOS ANMN. The institutions involved include the Commonwealth Scientific and Industrial and Research Organisation (CSIRO), South Australian Research and Development Institute (SARDI), Australian Institute of Marine Science (AIMS) and Sydney Institute of Marine Science (SIMS). The procedures for Profiling CTDs, detailed here, is a draft version of Part 1 of the guide: covering Pre-Run CHECKS and Field Acquisition only. A version of Part 1 v.1.1 of the procedural guide was first posted to the IMOS website for access by the IMOS community on 15 October 2011.

The performance of a series of regular and systematic “checks” on the various sensors installed on each of the SEACATs provides data to fulfil two main objectives:

1) develop an temporal understanding of individual sensor pathologies
2) determine if sensors are performing within an expected range prior to deployment.

When a sensor appears to be acting outside a agreed pre-determined range then this should be the point where it should be considered that the sensor is unreliable and must be sent for re-calibration.

SeaBird™ CTDs

The SeaBird (WA, USA) range of CTDs are a series of widely used water quality instruments used for the high resolution measurement, either internally or externally in real-time, of conductivity, temperature, pressure (depth) in the ocean. These systems are often fitted with additional sensors, such as those to measure dissolved oxygen (DO) and fluorometers, measuring a suite of parameters up to depths of 7000 m. IMOS SEACAT Profiling CTDs are depth rated to 600 m with plastic housing.

Conductivity, Temperature and Depth (Pressure)

The SeaBird range of CTDs have been used extensively across the marine research community as they provide stable high resolution conductivity (resolution 0.00005 S/m and accuracy 0.0005 S/m equivalent to an approximate salinity resolution of 0.0004 PSU and accuracy 0.004 PSU) and temperature (resolution 0.0001 ºC and accuracy 0.005 ºC) for the characterisation of coastal and open ocean water masses. The determination of conductivity, temperature and pressure calibration coefficients can only be achieved by specialised laboratories that possess equipment able to resolve conductivity (and hence salinity), temperature and pressure at a finer scale than the SBE sensors themselves. For
ANMN and IMOS such a facility is provided by CSIRO CMAR in Hobart or by SeaBird Electronics in the USA.

Each CTD that is actively used for the collection of profiles as part of the IMOS BGC sampling has entered an agreement with CMAR and is able to access the calibration facility in Hobart. It is recommended that all sensors for each of the IMOS Profiling CTDs (including dual sensors) be sent to the CMAR (Hobart - Robert Kay) facility for an annual calibration.

The procedures detailed in the following procedures manual are CHECKS only! The values diagnostic values determined during the CHECKS are a means of providing VALIDATION of sensor performance against the annual FACTORY CALIBRATION.

The IMOS SBE19+ SEACAT Profiler CTDs are fitted with the following auxiliary sensors:

**WET Labs (Oregon, USA) FLNTU**

The Wetlabs FLNTU fluorometer and turbidity sensor detects inferred chlorophyll-a (theoretical range of 0.04-50 µgL⁻¹) from fluorescence at a wavelength of 470 nm provided as an output voltage to the SBE CTD. The voltage is then converted to a Fluorometry value (as µg L⁻¹ chlorophyll-a) using a factory determined scale factor determined from a Dark Count and a Chlorophyll Equivalent Concentration (CEC). The values are entered into the SBE calibration file. The CEC is obtained from an equivalent unit Voltage when the sensor was exposed to a 25µg L-1 culture of *Thalassiosira weisflogii*.

\[
\text{Scale Factor} = \frac{25 \text{ µg L}^{-1}}{(\text{Chlorophyll Equivalent Concentration} - \text{Dark Count})}
\]

For turbidity, the sensor detects back-scatter across an inferred range of 0-25 ntu at a wavelength of 700 nm. Calibration constants are used to convert the voltage to an equivalent Nephelometric Turbidity Unit (NTU) using a scale factor calculated from a Dark Count AND a known FORMAZIN* concentration standard (xx).

\[
\text{Scale Factor} = \frac{xx}{(\text{meter output} - \text{dark counts})}
\]

These are the factory calibrated values shipped with each of the FLNTU units. Localised determination of these values is highly recommended to enable a more “realistic” determination of relative chl-a concentrations and turbidity from the sensor voltage outputs at each node site. At the ANMN QAQC workshop (CMAR Aug 2011), however, it was agreed that for Fluorescence (Chl-a), all data should be reported as Fluorometry and not Chl-a.

Using the factory default scale factor within the SBE configuration file provides a Fluorometer inferred µg L⁻¹ value output within the CTD data file. A biological sensor working group is to address these issues further and is to be driven by Dr Martina Doblin, UTS. The FLNTU sensors are calibrated at the CMAR facility based on Dark Counts, FORMAZIN standard and a Fluorescent disc (as opposed to the manufacturer’s provided fluorescent stick). Calibration/scale factor values entered into SEACAT configuration (.CON) files for Fluorometry post calibration will thus result in SEACAT datafile outputs for Fluorometry inferred Chl-a (µgL⁻¹) based on this “Fluoro-disc” value not the relative to *T. weisflogii*.

*NOTE: FORMAZIN is a hazardous substance and its handling should be treated with caution as per the MSDS that is provided in Appendix A

**SeaBird SBE43 - dissolved oxygen sensor**

The SBE43 is an in-line sensor plumbed in to the CTD pump and Y-valve flow-thru system and lies down stream of the CT-cell. The sensor provides dissolved oxygen (DO)
concentrations in mL L$^{-1}$ and % saturation. The DO sensor can also be calibrated at the CMAR-Hobart facility.

**CTD sensor validation/checks**

At the QAQC summit in Hobart (August 2011) a minimum 2-point sensor check was agreed as the preferred option for validation of sensor performance pre and post deployment for WQMs. While this may be relatively easy and achievable for conductivity, turbidity and fluorometry, some problems ensue for DO and temperature.

For DO, obtaining a 0% solution using chemical additives is not practical in large volumes. Thus a 2-point DO check is limited to a 1) mixed and air bubbled solution and 2) mixed and non-bubbled (or pre-bubbled) or nitrogen-gas bubbled solution, from within the CHECK tank. Achieving a representative sample of DO from the tank and then matching it to a representative sample of data from the SEACAT data stream requires some additional considerations to be made with respect to timing and data time stamping. The ability to perform manual Winkler-titrations also needs to be achieved. DO samples can not be forwarded to facilities such as CMAR in Hobart due to issues with DO and pressure changes during transport (Terhell, pers. comm.).

For temperature, a steady-low end temperature is not achievable without the purchase of specialised expensive temperature baths. A single-point ambient T point check may be achievable with a well mixed calibration tank. The precision of the readings, however, will be limited and likely be significantly less (~0.05 °C) than the sensor resolution. Use of a calibrated benchtop digital thermometer of adequate resolution would provide a reasonable CHECK (0.05 - 0.1 °C). Only a DUAL CTD (i.e. a second calibrated SBE CTD of similar accuracy and resolution) or alternatively a DUAL SENSOR (2$^{nd}$ sensor plugged into the same CTD on an auxiliary channel) in a well mixed bath could achieve a temperature comparison of adequate resolution to gain an understanding of sensor behaviour. Ideally a SEACAT, other SEABIRD CTD (i.e. SBE25 or Microcat) could be used for a DUAL CTD comparison for all sensor CHECKS. For the SBEs, the temperature probes are highly stable (Pender, pers. comm.) and drift between factory calibrations (1-2 years) is expected to be relatively small for profiling CTDs.
1. **SBE19+ SEACAT Profiler CTD**

**Software**

There are three main Windows-based programs used with the SEACAT SBE19+ Profiler

1. **SeaTermV2:** a terminal emulation (communications) program used to change settings, enter offsets, download data and check the SEACAT status.

2. **SBEDataProcessing-Win32:** the post-processing program for handling the raw data once it has been uploaded from the SEACAT.

3. **SeaSave-Win32:** a program that can be used to view data in real-time such as when performing pre-run checks and calibrations.

Updates of the software can be obtained from the SeaBird website at [www.seabird.com](http://www.seabird.com) by choosing “Software” and then navigating to the FTP download site.

**Maintenance – Bi-monthly to quarterly**

1. Disconnect each Seacon connector cable from each port and, in turn, clean and regrease using high quality silicone grease (e.g. DowCorning 111). Apply silicone grease sparingly as excess grease can induce other problems and hinder electrical transmission.

2. Inspect cables for damage and seek to replace damaged parts.

3. Establish SEACAT communications and run a Status Check in SeaTermV2 to determine battery, date/time and memory status (summary of the method for communicating with the SEACAT is provided in the following section on Pre-Run Checks).


5. Ensure that plumbed (connected to pump apparatus) CT-cell is filled with deionised water to the point of the bottom of the DO sensor (air release valve). The CT-cell should be stored dry if storage conditions may reach freezing. The CT-cell needs to be soaked in deionized (DI) water for 1 hr prior to use. See SeaBird Application Note 2D. The DO sensor should be stored in humid conditions but not wet/submerged. A humid environment for the DO sensor can be maintained by plugging the end of the tubing with a piece of a clean dampened sponge. See SeaBird Technical Note: 64. Avoid long-term exposure to Triton-X solution.

6. Ensure that the FLNTU cap is not damaged and in place over the sensor window. Check sensor window for scratches.

7. Establish communications with the SEACAT and check battery status. Replace if necessary.
2. Pre-Run Checks

In the week leading up to CTD deployment (in this case the SEACAT Profiling CTD) the following pre-run checks should be conducted to ensure that the SBE19+ SEACAT is in good working order.

1. Check physical status
   
   CHECK SEACAT switch is in the off position and bolts, hex head screws and sensors are secure. CHECK cage and cables for damage and ensure battery cap is secure. CHECK the CT-cell tubing is filled with deionised water and the cell has been soaking prior to pre-field checks and field data collection. NOTE: The CT-cell can be stored dry, however, it is recommended that the cell be “soaked” in deionized water for 1 hour prior to use.

2. Connect to the SEACAT
   
   USING the supplied COMMS cable, connect the SEACAT to the laptop ensuring that the broad pin is aligned correctly. CAUTION - if the pins are not aligned correctly and the connection is forced you could bend or break the pins and the unit will have to be sent back for REPAIR. Use a serial to USB converter for newer laptops without serial RS-232 ports.

3. Start SeaTermV2
   
   Select SBE19plus V2 - the SEACAT should be found and the program cause it to wake-up automatically once connected. Communication settings are baud 9600, none, 1, none. If the SEACAT does not wake up then check connections and baud rate and communications settings and try again. If there is no communication with the instrument the batteries may be exhausted, comms cable faulty - see troubleshooting in SEACAT manual.

4. Check SEACAT status
   
   SELECT and execute the STATUS command from the command menu. Select COMMANDS>STATUS>DISPLAY STATUS AND CONFIGURATION PARAMETERS. Alternatively you can open a terminal window and type the command “DS” and then hit <CR>.

5. Check battery power
   
   CHECK the battery voltage by looking for the value following the text “vbatt” in the terminal display window. Batteries should be replaced once the voltage drops below 11.2 V where standard alkaline cells are in use. An alternative is to replace batteries on a regularised schedule, i.e. 6 months/12 months depending on SEACAT use.

6. Set SEACAT time and date
   
   SET DATE and TIME to UTC using the command SET DATE AND TIME. Alternatively you can type the command “ST” in the terminal window. ENTER the UTC time and date in the format dd/mm/yy:hh/mm/ss and then hit <CR>. You must enter both DATE and TIME values when performing this command.

7. Clear memory
   
   CHECK there is adequate memory available. A SEACAT cast lasting 3-4 minutes to a depth of
1 to 100 m is unlikely to use in excess of 80-90 KB of memory and the SEACAT can store many casts. Casts may be retained in SEACAT memory as a backup. Initialise logging if you wish to clear the memory by sending the command “IL”. Once initialised the SEACAT will return to quiescent Sleep Mode.

8. **Exit SeaTermV2**

SHUT DOWN the SEACAT by sending the command QS in a terminal window. Alternatively you can disconnect the Computer-SEACAT comms cable from the SEACAT connector (The SEACAT will automatically return to quiescent mode should no communication with the instrument be attempted within several mins).

9. **Replace dummy connector**

ENSURE that you align the dummy plug nipple and broadest pin (PIN 1) on the SEACAT connector cable; Connector pins can be easily bent if the dummy plug is forced incorrectly; listen for air pocket “pop” as dummy plug engages; screw down the plastic securing cap.

ADDITIONAL CHECKS: Check SEACAT cable pins, rubber surfaces and components for damage that may facilitate water egress; clean connections and apply small amounts of silicone grease to maintain water tightness.
3. Pre-Run Checks – Salinity, Temperature, Dissolved Oxygen, Turbidity and Fluormetry (Chl-a).

In the week leading up to a BGC sampling run the following SEACAT Pre-Run Checks should be conducted to obtain pre-run QAQC status of the sensors.

Following the initial setup of the “Pre-Run Check” workspace, preparation leading up to the day of the CHECK should only require some 10-20 minutes of your time. Should additional salinity bottles, filters or reagents be required from CMAR then additional coordination in the week leading up to a CHECK may also be required.

Once the protocols are established and you are familiar with the process it is envisaged that the CHECK procedure should take less than 1-2 hours. A secondary (low) Dissolved Oxygen point CHECK, if required, would take <5 minutes but would be performed ~2 hours after the air bubbler has been switched off. Processing and analysing the Pre-Run CHECK file (using SBEDataProcessing DATCNV sub-program) should require an additional ½ - 1 hour of your time.

Results of these CHECKS are to be RECORDED in the SEACAT CTD Pre-Run Checklist (Appendix 1). This is to be submitted along with the other field sheets via the IMOS portal once additional analyses are completed (salinity, DO). NOTE: the procedure detailed below asks for you to fill in some of the data as you go. At the end of the procedure, however, you will be required to download the data file, process it and then calculate mean values and Coefficients of Variance (COV). This new mean will replace the “rough” value first entered into the CHECKLIST and be the FINAL mean value.

The following items are required to conduct the suite of Pre-Run Calibration Checks in the laboratory.

Setup Pre-Run CHECK workspace - 1 off requiring several days to weeks

- Access to a laboratory space with a sink (large enough to sit CTD in) and/or adjacent draining board or alternative wet area. The space should be in a part of the laboratory where the air temperature is relatively stable. Floor space to accommodate a large tank/vessel and adequate bench space in an area where blinds can be drawn and fluorescent lights can be switched off. There must be enough ambient light to work safely but exposure of the workspace and CTD to direct sunlight when conducting checks with the FLNTU should be avoided.
- Insulated vessel/tank with pump/stirrer ability - The tank will need to be ~200L (to potentially fit 2 CTDs side-by-side) and is to be filled with seawater of adequate depth to submerge the SEACAT (and 2nd CTD - i.e. a DUAL SENSOR) to the depth of the air bleed Y-valve. For Dissolved Oxygen calibrations the tank water must be bubbled with air (at a depth <10cm to prevent super-saturation) and mixed thoroughly for a minimum of 12 hours prior to calibration.
- Air bubbler, tubing and air stone or bubble curtain (as purchased for fish tanks from pet and department stores).
- Nitrogen gas
- Tygon tubing and syringe for soaking the CT-cell
- Deionised water (DI) or alternatively high purity Milli-Q water
- Seawater (SW) - sufficient volume of collected seawater to fill calibration tank. This is assuming that ANMN facilities have access to relatively clean seawater for use in the calibration using ~200-300 L at a time.
- Bulk-seawater Standard (SWSTD) - volume of collected seawater for which the salinity has been determined using a laboratory salinometer. (methods for developing seawater standard - advice to be provided by Dave Terhell)
- 1% solution Triton-X or equivalent cleaning solution
- 500-1000 ppm bleach solution
- Calibrated benchtop thermometer with minimum 0.05 ºC resolution
✓ Turbidity standard solution of 10 or 25 ntu (most commonly used solution is Formazin*) and turbidity calibration cell. Turbidity check range should cover a similar range expected in the area of CTD operation - generally, in relatively clear coastal waters a value of >10 would be considered unusual.
✓ Sample bottle for Winkler titration - optional alternative calibrated electronic Dissolved Oxygen sensor.
✓ Winkler titration method, equipment and chemicals (and MSDSs).
✓ Fluorescence cap/disc? Or Fluoro-stick (supplied with FLNTU at purchase - discs to be developed by Robert Kay).
✓ Black electrical tape for FLNTU sensor Dark Count
✓ Most recent SEACAT configuration file
✓ Calibration file constants loaded into SEACAT CPU
✓ DUAL CTD or DUAL sensors - a second calibrated SeaBird or other CTD with equivalent sampling frequency and resolution. Alternatively, secondary sensors could be used plugged into auxiliary channels of the same CTD. If you are recording CHECK data then ensure that the time stamps of the two CTDs are set to the same using the ST command in SEATERM software. A secondary CTD could be run either in real-time (requiring a second laptop, software and cable) or be run autonomously and the file downloaded at the end of the procedure.

2-3 weeks prior to CHECK - 1-2 times a year
✓ Obtain a sample of clean offshore seawater (30-40 L) to use as a bulk SW standard to be kept in the laboratory. This standard will be used as a consistent salinity point during monthly/quarterly Pre-Run Checks. A sample of the SWSTD should be analysed using a salinometer initially and then a 6-monthly sample as a CHECK of the SWSTD value. The SWSTD should be kept in a cool stable temperature environment out of direct sunlight. The vessel should have a tight fitting lid (fitted with an o-ring) to prevent evaporation and alteration of the standard’s salinity. When a new SWSTD is required, operators should consider an overlap period, using both the new and older SWSTD for a minimum of 1 Pre-Run Check.

1 day prior to CHECK - ½ an hour
✓ Fill the tank with clean seawater, turn on the air bubbler and pump/stirrer to ensure that the tank has been bubbled with air for a full 12 hours.

Day of CHECK - <½ a day
✓ The total CHECK should require no more than a 1-2 hours to complete once operators are familiar with the CHECK sequence.
3.1 Zero Point Conductivity/Salinity

1. Connect to the SEACAT
   USING the supplied COMMS cable, connect the SEACAT to the laptop. Use a serial to USB converter for newer machines without serial RS-232 ports. ENSURE that the CT-cell has been “soaked” adequately prior to use.

2. Start SeaTermV2
   OPEN the program and select the option SBE19plus V2 from the automatically displayed drop-down menu - once selected the comms settings are automatically chosen by the program, a connection is established and SEACAT is woken up. Communication settings for SBE19plus system are:- baud> 9600, parity> none, stop bits> 1, flow control> none. If the SEACAT does not wake up then check connections and baud rate and communications settings and try again. If there is no communication with the instrument the batteries may be exhausted, comms cable faulty - see troubleshooting in SEACAT manual.

3. Check SEACAT status
   Use the appropriate command or DS to check the SEACATs general setup. Enter details of the setup and battery voltage in the SEACAT Pre-Run CHECKLIST.

4. Fill CT-cell with DI water
   FLUSH the CT-cell once with deionised water, remove tubing, drain and then refill the Tygon tubing and syringe and CT-cell with deionised water a 2nd time.

5. Pre-Wash Conductivity
   SELECT - COMMANDS->TESTING-> MEASURE CONDUCTIVITY, OUTPUT CONVERTED DATA or send a TC command in a terminal window and hit <CR>. A single column of scrolling data should appear. Allow 1 minute for the data stream to stabilise. Record a rough conductivity reading in the “PRE-WASH” column of SEACAT Pre-Run CHECKLIST (see DATA POINT 1 in Checklist) - you will determine a mean value at a later stage. Cut and paste ~ 1 minute of data from the scrolling text-log window to an Excel spreadsheet or equivalent program. You can calculate a mean and Coefficient of Variance (COV) now or leave it until later on. The scrolling text may alternatively be saved as a log file.

   *The COV is a ratio of the standard deviation to the mean* that is a normalised measure of dispersion of a probability distribution for the dataset in question.

6. Clean with Triton-X
   DRAIN DI water, fill syringe and tubing with 5% solution of TRITON-X and back flush the CT-cell by moving the syringe plunger until the Triton-X becomes bubbly and creates a scouring effect. ENSURE the CT-cell is filled with TRITON-X and leave to soak for 1 minute.

7. Fill CT-cell with DI water
   DRAIN TRITON-X from the CT-cell, syringe and tubing. Reattach Tygon tubing and syringe and FLUSH the CT-cell once with a minimum of 1 L of
8. Post-Wash Conductivity

ENSURE that the value is ≤0.001 and record the value in the “POST-WASH” column of the SEACAT Pre-Run CHECKLIST. If the value is not ≤0.001 ms cm⁻¹ then repeat the washing process until this value is achieved - allowing 1 minute for the data stream to stabilise, recording the conductivity readings for a period of 1 minute and re-entering a mean value in the “POST-WASH” column of the SEACAT Pre-Run CHECKLIST.

9. DUAL sensor

If using a DUAL CTD repeat steps 1-9 for that unit.

10. Sample “0” Conductivity

SAMPLE the zero conductivity water using a CSIRO brown SALINITY bottle and retain for analysis by CMAR. Note the time sampled and salinity bottle number and enter these data on the SEACAT Pre-Run CHECKLIST. (this step may be considered unnecessary could be dropped from further interations of the manual if that is the consensus of the working group- TIM)
### 3.2 Salinity, temperature, dissolved oxygen, turbidity and fluorescence CHECK.

11. **Connect to the SEACAT**
   - CONNECT the SEACAT to the laptop using the supplied COMMS cable and a serial to USB converter if you have not done so already. Place the SEACAT upright in the sink or on the sink’s drainboard.

12. **Start SeaTermV2**
   - ESTABLISH communications with the SEACAT and check SEACAT status. In order to record CHECK data using a DUAL CTD ensure that both instruments are sampling at the same rate i.e. number of scans per second. Also ensure that time stamps are synchronised as this will make life easier when comparing data streams later on - you will need to establish the START TIME for LOGGING of both instruments - this should be noted down (hh:mm:ss), however, can be extracted later from the Header Information in the RAW DATA FILE *.hex.

   **NOTE:** TIMES will be crucial when you attempt to match up the SAMPLE times with the DATA in the SEACAT file. SEACAT times may be in UTC and may differ from COMPUTER times - if you can not SYNCH SEACAT and computer clocks then make note of the time differences between each and you will have to back correct. Synching at least the minutes and seconds (if not the hour) will be advantageous. It will also be useful to have the COMPUTER CLOCK DISPLAY window open and in view - or use an alternative digital display clock as your timing reference point.

13. **Start SeaSave-Win32**
   - OPEN SeaSave-Win32 and ensure that your previously established SETUP file is selected in the bar at the top of WINDOW. The first time SeaSave-Win32 is used you will need to create a SETUP file selecting a SEACAT CON file and choosing PLOT, FIXED and/or SCROLLED display windows to view the real-time data. The last used SETUP file should open automatically the next time the program is opened. In the Scrolled Display ensure that Time, Scan, Cond, Temp, Sal, DO, Fluor, V (Fluor), NTU and V (NTU) are selected for display.

14. **Salinity SWTSTD**
   - CONNECT and fill the Tygon tubing and syringe with your BULK SEAWATER STANDARD (SWTSTD) - Flush/rinse the CT-cell and then discard the seawater 3-times. Refill the Tygon tubing and syringe with SWTSTD and fill the CT-cell. Secure the syringe, without the plunger, to the CTD frame at a point higher than the y-valve. Ensure you have 500 - 1000 mL of the SWTSTD at hand ready to feed into the syringe casing once the pump is activated.

15. **Start Real-Time data**
   - SELECT the option START from the REAL TIME DATA drop down menu. CREATE a data file name using the SELECT OUTPUT DATA FILE NAME radio button option - save the data file using a quasi-ANMN
naming convention, i.e. PHB2011013101SBECAL using site name, date and run number. (It is yet to be decided if CHECK and CAL data are to also be uploaded to the IMOS website.) SELECT CONFIGURE INPUTS radio button and select the most recent SEACAT “CON” (Configuration file i.e. XXXSSSYYYYMMDD [serial number, Site Code and date of calibration/creation of CONFIGURATION file] with the extension *.con) for your SEACAT. Hit START and fill in the Header Information as applicable for your site.

16. **Turn on the SEACAT**

   ACTIVATE the SEACAT by moving the magnetic switch to the ON position (engage upwards) when prompted by the program, i.e. when “Turn on the SBE 19plus using the magnetic switch” appears. The SEACAT will detect the conductivity is above the pre-set threshold and the pump will activate in ~50 s - 1 minute.

17. **Record a SWTSTD value**

   Record a rough salinity value for the bulk SWTSTD in the SEACAT pre-run checklist.

18. **DUAL sensor**

   If using a DUAL sensor CTD repeat setup steps 11-17 for that unit using a separate laptop and comms cable.

19. **Submerge the SEACAT**

   Once your 1 minutes worth of data is obtained, remove the syringe and tygon tubing and SAFELY handle the SBE(s) into the CALIBRATION TANK. CONFIRM that data from the sensors are streaming in and scrolling down the computer screen. Also ENSURE that the PUMP is still on (in the PUMP dialog window) - i.e. water is being pumped through the in-line sensors. NOTE: It is advised to limit the amount of time the pump and auxiliary sensors remain un-submerged as they are usually cooled by the ambient water environment. The PUMP is ambient water cooled, however, it can be lubricated by the introduction of water into the plumbing system at the pump exhaust port, for short periods. If significant time is to elapse before you proceed to the next step it may be advised to turn the SEACAT off at the magnetic switch and create a new file when you are ready to proceed to the next step.

20. **Connect sampling TUBE**

   ENSURE that both CT-cell intakes are as near to each other as possible in the TANK. ALL CHECKS from this point onwards can be repeated in parallel with the DUAL sensor CTD. With the tubing from the CT-cell removed, seawater within the tank can now be pumped through the CTD system. CONNECT a length of tubing (~1m) to the outlet valve of the pump. This will be used to enable sampling of the outlet water during the CHECK process. The tubing will need to be long enough to reach from the pump to outside of the tank.
3.2.1 Dissolved Oxygen – 100% saturation

21. In SeaSave-Win32 ENSURING that the PUMP is still ON, observe the Dissolved Oxygen sensor reading in the display window. After 2-3 minutes or once the DO reading has stabilised READ the dissolved oxygen (mg L⁻¹) value from the SeaSave scrolling data window and note it on the SEACAT Pre-Run CHECKLIST. According to the manufacturer’s instructions for performing DO calibrations by Winkler titration - after 1-2 minutes initial equilibration, approximately 10 seconds of CTD data is required. Bottle sampling should be conducted around the mid-way point of data collection, i.e. after 5 seconds.

22. Compare the DO value PRE-RINSE a DO bottle three times using the water from the PUMP OUTLET sample hose. OBTAIN a bottle sample from the PUMP OUTLET sample hose making sure that the water flow does not contain any air bubbles. Secure the bottle lid and note the sample time and bottle number on the SEACAT Pre-Run CHECKLIST. Note the precise TIME OF COLLECTION as hh:mm:ss.

23. Retain DO sample Treat sample for later manual Winkler-titration.

24. SWITCH off TURN OFF the air bubbler apparatus but maintain tank stirring/pumping.

3.2.2 Temperature (ºC) - ambient

25. In SeaSave-Win32 Allow the temperature to stabilise. Read the temperature value from the SeaSave window and note the value in the CHECKLIST. NOTE: if you are using SeaSave then the values will be relative to the CON file selected in the SeaSave menu. Alternatively, you can view the sensor TEMPERATURE VALUE in SEATERMV2 by sending the command TT and then <CR> or TESTING>MEASURE TEMPERATURE< OUTPUT CONVERTED DATA. However, be aware that this value will be the corrected temperature value relative to the calibration constants held within the SBE CPU memory.

26. Using a thermometer PLACE the probe of the CALIBRATED BENCHTOP thermometer next to and at a similar depth in the water as that of the CT-cell intake point. Let the thermometer stabilise and then note the value. ENTER the CALIBRATED THERMOMETER temperature value in the SEACAT Pre-Run CHECKLIST. Collect 1 minute of data if the system allows you to.

27. RECORD details Also record the BENCHTOP thermometer type and serial number, and date of its last factory calibration.
3.2.3 Salinity – HIGH point

28. **In SeaSave-Win32** RECORD 1 minutes uninterrupted data. Record a rough salinity from the scrolling data window in the SEACAT Pre-Run CHECKLIST.

29. **Bottle sample** PRE-RINSE a glass salinity bottle three times using the stirred seawater in the seawater bath (as per the BGC sampling protocols). OBTAIN a bottle sample from the PUMP outlet sample hose making sure that the water flow does not contain any air bubbles. Secure the bottle lid and note the sample time and bottle number on the SEACAT Pre-Run CHECKLIST.

3.2.4 Salinity – MID point

30. **Bottle sample** ADD a volume of DI water (5-10% - i.e. 1 bucket of 20L to a 200 L tank) to the calibration tank and allow the tank to mix thoroughly for 10-15 minutes.

31. **In SeaSave-Win32** PRE-RINSE a glass salinity bottle three times using the stirred seawater in the seawater bath (as per the BGC sampling protocols). RECORD 1 minutes uninterrupted salinity data from the DUAL sensors and record salinity values in the SEACAT Pre-Run CHECKLIST.

32. **Bottle sample** OBTAIN a bottle sample of the bath water from as close to the CT-cell intake(s) as possible by inverting the bottle to trap the air and then moving the bottle into the upright position at the required depth and allowing it to fill. Secure the bottle lid and note the sample time and bottle number on the SEACAT Pre-Run CHECKLIST.

3.2.5 Fluorometry – inferred chlorophyll-a (µg L⁻¹)

33. **SEACAT on the bench** Remove the SEACAT from the TANK, place it on its side on the bench and carefully dry the FLNTU sensor body and window. CHECK the FLNTU sensor for scratches. ENSURE that the laboratory lights are off (particularly fluorescent lights) and window blinds are drawn/closed.

34. **In SeaSave-Win32** USING black electrical tape cover the end of the FLNTU sensor window. Fill the CT-cell with seawater and secure the syringe, without the plunger, on the SEACAT frame at a point higher than the y-valve. Have a volume of 500-1000 mL of seawater at hand for topping up the syringe casing once the pump has been activated. This is only to ensure that the pump does not run dry - the FLNTU is not plumbed in-line. However, auxillary sensors will only activate after 1 minute when the pump is activated. Turn on the SBE19+ and wait for the voltages to stabilise - an initial spike to 5 V will occur on power-up, however, the values will stabilise within a short period. Note a rough voltage and inferred chl-a concentration, and ENTER the
values in the SEACAT Pre-Run CHECKLIST. An alternative to filling the CT-cell with seawater may be to deactivate the pump or reduce the conductivity for PUMP TURN on to zero (see manual for these commands).

35. **USING the Fluoro-stick**

EMBED one end of the fluorescence stick in a piece of Blu-Tac and attach it at 0 cm on the ruler. Holding on to the ruler place the fluorescence stick in the beam of the fluorometer against the sensor window (i.e. 0 cm distance from sensor). Avoid placing your finger or part of your hand in the path of the light. **NOTE** the Fluorometry inferred Chl-a value (µg L⁻¹) and Raw Voltage value (V) and ENTER the values in the Pre-Run SEACAT CTD Checklist. REPEAT the process using the fluorescence stick at 5 cm and 10 cm and enter the values in the SEACAT Pre-Run CHECKLIST.

**NOTE:** this method is likely to change with the development of coloured discs by Robert Kay at CMAR and discussions within the biological sensors working group.

### 3.2.6 Turbidity (ntu)

36. **SEACAT on the bench**

ENSURE that you are wearing appropriate lab safety glasses, labcoat, shoes and gloves for the handling of FORMAZIN. Familiarise yourself with the MSDS for FORMAZIN - see link to MSDS. PLACE the SEACAT upright in the sink or adjacent draining board. ENSURE that the laboratory lights are off (particularly fluorescent lights) and window blinds are drawn/closed.

37. **In SeaSave-Win32**

RINSE the turbidity calibration cap thoroughly with DI water. Fill the cap with DI/Milli-Q water avoiding the production of bubbles within the vessel and place over the sensor. With the CT-cell filled with seawater (as above) activate the CTD and wait 1 minute for the auxiliary sensors to power up. Once the voltages have stabilised note a rough value for the ZERO turbidity voltage and ENTER the values in the SEACAT Pre-Run CHECKLIST.

38. **USING FORMAZIN**

RINSE the turbidity calibration cap and FLNTU sensor face with a small volume of the TURBIDITY standard you have made (i.e. 10 or 25 ntu) FORMAZIN standard solution. Fill the cap with the X ntu standard solution water avoiding the production of bubbles within the vessel and place over the sensor. Note the turbidity (NTU) reading and ENTER the value in the SEACAT Pre-Run CHECKLIST. Collect 1 minute of uninterrupted turbidity data.

39. **WASH THOROUGHLY**

RINSE the sensor thoroughly avoiding splashing. DISPOSE of the FORMAZIN into a dedicated waste vessel. FORMAZIN is a hazardous substance and needs to be treated appropriately. SEEK advice from your local State authority for its disposal.
3.2.7 Dissolved Oxygen – <100% saturation (1-2 hours later)

With the bubbler turned off some of the dissolved oxygen content of the tank water will be lost to the atmosphere and the DO %saturation of the tank will have dropped over a period of several hours. Even though the concentration is not likely to be very low (i.e. still in the realm of 80-90%) it is expected that a DO %sat concentration similar to or within the lower end of the range (can be determined from a site by site climatology) of that expected for coastal systems will be achieved. Alternatively, the tank may be bubbled with nitrogen gas to displace oxygen within the tank water and drop the DO saturation value more rapidly.

40. **In SeaSave-Win32**

   Observe the Dissolved Oxygen sensor reading in the display window. Assuming you can achieve a reasonably stable DO reading over a 10 s period (the period for DO sampling), take a READING of the dissolved oxygen (mg L⁻¹) value from the SeaSave window and note it on the SEACAT Pre-Run CHECKLIST. According to the manufacturer’s instructions for performing DO calibrations - after 1-2 minutes initial equilibration, approximately 10 seconds of data is required. Bottle sampling should be conducted around the mid-way point of data collection, i.e. after 5 seconds. *(using a sample hose attached to the PUMP outlet the time from sensor to bottle may be somewhat longer depending on pumping rates - need to estimate it - Tim_I).*

41. **Compare the DO value**

   COLLECT a sample of the bubbled tank water from the PUMP outlet sample hose. **Note the precise TIME OF COLLECTION.** Pinch off the top of the tubing and retrieve the water-filled silicone tubing and then dispense into a prepared glass bottle until overflowing. ALTERNATIVELY, use a small NISKIN bottle fired at the depth of the CT-cell intake. A comparative DO value may also be obtained using a calibrated bench top dissolved oxygen sensor. ENTER the DO value in the SEACAT Pre-Run CHECKLIST. ENTER DO sensor details and date of last calibration.

42. **Retain DO sample**

   Treat sample for later manual Winkler-titration.

From the SBE file you have created, process the file using the most recent configuration file using the DATCNV subprogram in the SBE-DataProcessing software. Calculate 1 minute means and coefficients of variation for each sensor and each step of the pre-run check procedure - correct and/or enter the values in the Pre-Run checklist.
4. Post-Check Assessment

Does the Pre-Run Check indicate that the SEACAT performance is suitable for it to be used to profile?

This section is yet to be developed in consultation with the Profiling CTD working group.

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Range</th>
<th>Resolution</th>
<th>Initial Accuracy</th>
<th>Stability</th>
<th>Potential drift b/w annual cals + resolution + acc</th>
<th>Flag sensor issue (?)</th>
<th>3% rel diff b/w DUAL sensors or</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure (strain gauge)</td>
<td>0 – full scale range (IMOS?)</td>
<td>0.0025% of range</td>
<td>0.1 % of full scale range/year</td>
<td>0.1 % of full scale range/year</td>
<td></td>
<td></td>
<td>0.25 m</td>
</tr>
<tr>
<td>Salinity (Conductivity)</td>
<td>(0-9 S/m)</td>
<td>0.0004 PSU (0.00005 oceanic)</td>
<td>0.0005</td>
<td>(0.0003 S/month)</td>
<td>(0.0037) ~ 0.0296PSU</td>
<td>0.1 PSU</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>-5 – 35 C</td>
<td>0.0001°C</td>
<td>0.005</td>
<td>0.0002/mo nth</td>
<td>0.0026</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Dissolved Oxygen V</td>
<td>0-120 % sat</td>
<td>0.1% sat</td>
<td>2 % sat</td>
<td>0.5 % / 1000hrs operation</td>
<td>5 %</td>
<td></td>
<td>10 %</td>
</tr>
<tr>
<td>Optical Fluorescence V</td>
<td>0-5 V (0-25 µg/L)</td>
<td>0.01 V (0.025 µg/L)</td>
<td>Not provided</td>
<td>Not provided</td>
<td>-</td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>Optical Turbidity ntu</td>
<td>0-25 ntu</td>
<td>0.01 ntu</td>
<td>Not provided</td>
<td>Not provided</td>
<td>-</td>
<td></td>
<td>0.5</td>
</tr>
</tbody>
</table>

Adapted from the SBE19+ manual
5. Field Sampling

For the first-time user, make sure that you are familiar with the operation of the SEACAT and have examined the manuals, various modes of operation and method for downloading and viewing data before using the CTD in the field for the first time.

The following items are required to conduct a CTD cast from your research vessel:

- Winch with cable marked at 5m intervals or cable counter
- Davit (for smaller vessels without A-frame setup)
- Stainless shackle-swivel-shackle and shifting spanner
- SBE19+ SEACAT
- CT-cell Tygon tubing and syringe
- Safety equipment: life vest, harness, eye protection, steel cap boots & hard hat

1. Secure SEACAT to cable  USE shackle-swivel-shackle combination connection.
2. Remove Tygon tubing  ALLOW the distilled water to drain from the CT-cell. Remove FLNTU protective cap.
3. Flush CT-cell  FILL Tygon tubing and syringe apparatus with seawater and connect to CT-cell and flush cell several times: this will flush any deionised water from the internal workings of the cell and prime the cell for the cast.
4. Remove Tygon tubing  ALLOW the flush water to drain from the CT-cell.
5. Turn on the SEACAT  ACTIVATE logging by moving the magnetic switch to the ON position (engage upwards).
6. Deploy the SEACAT  SAFELY handle the SEACAT over the side of the vessel; lower the SEACAT to a point where the entire cage is sitting below the water surface accounting for vessel surge.
7. SEACAT surface “soak”  SOAK the SEACAT by maintaining it at a point just below the surface for a minimum of 120 seconds (a 3 minute soak may be preferable to allow extra time for sensor stabilisation especially when the there is more than a few degrees difference between the air and water temperature on the day of sampling. The SOAK allows for SEACAT PUMP activation (60s) based upon a minimum value to be sensed by the SEACAT conductivity sensor. This is also necessary to allow the sensors to equilibrate, flush the tubing of air bubbles and ensure that adequate surface data is obtained before the cast commences.
8. Commence profiling  PLAY out the winch cable at a rate no greater than 0.5 m s\(^{-1}\) to achieve a minimum sensor scan rate of 8 scans m\(^{-1}\) (vertically) (maximum sample rate 4Hz). Keep count of the depth markers (or CABLE OUT) to a length equivalent to the vessel sounder depth less 5m. ENSURE that the SEACAT does not come into contact with the seabed as an impact...
could damage the CT-cell. This 5m rule is to minimise impact risk to the SEACAT accounting for vessel surge. Line angle associated with vessel drift is also likely to ensure that the CTD does not impact with the seabed. REAL-TIME setups using a SEAcable, SBE11 Deckbox (with rosette sampler) allow casting to be conducted to a true depth and not an “apparent” depth assumed (CABLE OUT) with blind casting.

9. Retrieve the SEACAT

Once the SEACAT has achieved the required sample depth/cable OUT (i.e. sounder depth minus 5m) retrieve the SEACAT by reeling in the winch cable and return the SEACAT to the surface.

10. Bring SEACAT onboard

SAFELY bring the SEACAT back onboard - timing the winch motion appropriately with vessel heave to minimise potential damage to the SEACAT and handlers/operators. Once onboard, secure the SEACAT and switch off.

11. POST cast

RECONNECT Tygon tubing and syringe apparatus, flush and fill the CT-cell with deionised water - do not store the DO cell wet. Replace FLNTU protective cap.

12. BOOT up the Laptop

Connect the SEACAT to the laptop, download and CHECK the data has been acquired. If for some reason the SEACAT has not obtained any data then you will need to re-run the cast. When the download and examination of cast data onboard is unsafe, data download should be conducted as soon as sea conditions allow the vessel enters sheltered waters or returns to the home port.

NOTE: Sea-Bird recommend that CTD users FLUSH the CT-cell with deionised water between each cast, especially where multiple casting is being conducted in coastal areas affected by estuarine discharges (turbid environments).

NOTE: Additional casts (START and END casts at NRS sites) may be considered if on-site times are long (hours) and/or vessel drift (1-2 NM) is considered significant. Additional casts will allow users to quantify and assess the significance of small scale spatial and temporal variability in water column structure at NRS locations.
5. **Post Field sampling**

**Preliminary clean**

At the lab WASH SEACAT thoroughly - ideally the CTD should be soaked in a bath of freshwater for 5-10 minutes post-run. FLUSH CT-cell with Triton-X solution and let it soak for several minutes. FLUSH the CT-cell and tubing with at least 1 L of DI water to remove suds and then fill with DI water for storage until next run. Avoid exposing the DO sensor (above the CT-cell and next in-line within the SEACAT plumbing system) to TRITON-X solution.

**DOWNLOAD**

If data has not been downloaded previously, connect the SEACAT to the laptop using the COMMS cable and a serial to USB converter. Open SeaTermV2 and connect to SBE19plus. Once communication is established check SEACAT Status using the DS command. Take note of the date:time, voltage and the number of casts saved within the memory. The DATE and TIME of collection of each cast will also be detailed in the downloaded information on the SEACAT “STATUS” within the text display window. Choose UPLOAD from the dropdown menu and identify the cast # for the files you wish to upload from the scrolling text window. Note the CAST NUMBER(s) of the cast(s) you wish to download from the SEACAT’s memory. Then in the SAVE FILE AS menu window enter a cast data FILENAME using the IMOS naming convention (see [http://www.imos.org.au](http://www.imos.org.au/)) and hit OK. You will also be prompted to enter any additional header information to be inserted into the header of each file at this time. At this point you can choose to SELECT for an upload of an INDIVIDUAL CAST or multiple casts by ticking on UPLOAD BY CAST NUMBER RANGE. Hit OK and the program will commence the download and a progress tab will be displayed in the bottom of the window. The SEACAT can be put to sleep using the command QS <CR> or by simply EXITING the program SeaTermV2.

**POST-RUN**

**Preparation for storage:**

DO sensor - It is OK to flush the plumbing system of the SEACAT with Triton-X solution, however, long-term exposure to Triton-X and or low concentration bleach (both used in the post-use cleaning process) can damage the DO sensor. It is recommended to FLUSH the CTD for 1 min with 1% Triton-X solution, then 1 min 500-1000 ppm bleach solution then 5 min thorough rinse with warm (not hot) freshwater - DO NOT store the DO sensor wet long-term. If you keep the CT-cell wet then ensure that the water level does not sit higher than the bottom of the DO sensor (i.e. not as high as the bleed Y-valve allows). A humid environment for the DO sensor can be maintained by plugging the end of the tubing with a piece of a clean dampened sponge. See SeaBird Technical Note: 64

CT-cell - historically the CT cells were stored wet with adequate soaking required prior to operation. Recent revisions of the effects of dry storage indicate that there is no harm in leaving CT-cells dry for extended periods. Leaving cells dry is advised, especially, in cases where external conditions may be unpredictable (such as during transport) and could potentially reach freezing. In cases where the cell is to be stored dry, the Tygon tubing should be connected to prevent the entry of contaminants to the cell and other in-line sensors. NOTE: the cell should be soaked for a period of 1 hour prior to use. See SeaBird Application Note 2D. [http://www.seabird.com/pdf_documents/ApplicationNotes/appnote2DOct10.pdf](http://www.seabird.com/pdf_documents/ApplicationNotes/appnote2DOct10.pdf)
FLNTU - remove protective cap and flush sensor window and cap of salt water. Inspect window for scratches and replace cap for sensor protection. If scratched seek manufacturers advice for repolishing surface - WETLABS FLNTU windows can be repaired.

**BI-MONTHLY - QUARTERLY**

PUMP Check - Disconnect the Tygon tubing, unscrew the pump head and inspect the impellor. Remove salt crust and check for rust that may be effecting functioning of the unit.

INSPECT, disconnect, clean, regrease and reconnect all connectors.

**PROCESSING>**

See manual on ANMN SBE Profiler processing protocols at http://www.imos.org.au/......

**ARCS UPLOAD>**

Log on to ARCs website and upload your raw and processed data files.

**QUATERLY-BI-ANNUAL CHECKS>**

A 3-6 monthly cast of DUAL sensors (SBE CTDs) and a third party P-sensor (e.g. Aquatech PT-520) would provide data for quantitative analysis of sensor precision and performance under field conditions.

6-12 monthly calibrations of DUAL sensors - secondary CTDs should receive regular factory calibrations similar to that of the IMOS SEACAT CTDs. The DUAL sensor is also subject to drift and using it with monthly Pre-Run checks merely provides a PRECISION comparison and a means to determine that something is amiss with one or other of the sensors, i.e. one of the sensors is “Out-of-Range”. Bottle samples and use of other standards analysed at CMAR provide a comparison for ACCURACY assuming that the CMAR calibrations and analyses are the golden STANDARD.

3-6 monthly Cross validation of the fluorometer inferred chl-a data with HPLC determined Chl-a field sample values - determine a correction factor OR obtain a chl-a series (up to 6 samples) from discreet bottle depths (in addition to the WC PHYPIG sample) covering a range of Chl-a concentration (capturing horizontal/vertical variability) naturally occurring during both Spring bloom, summer and winter conditions. (Discussions to be had by Biolog. Sensor WG).

A cross-validation of the dissolved oxygen sensor could be completed with a field calibration exercise competed quarterly/bi-annually...... (Discussions to be had by Biolog. Sensor WG).
REFERENCES>


SeaBird Electronics Application Note 2D: Instructions for Care and Cleaning of Conductivity Cells, October 2010.


SeaBird Electronics Application Note 31: Computing Temperature and Conductivity Slope and Offset Correction Coefficients from Laboratory Calibrations and Salinity Bottle Samples, February 2010.


SeaBird Electronics http://www.seabird.com

Wetlabs FLNTU sensor http://www.wetlabs.com
### Appendix 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Monthly</th>
<th>Method</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Check 1</td>
<td>Check 2</td>
<td>Check 3</td>
<td>Check 4</td>
<td>Bottle</td>
<td>DUAL</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Salinity</strong></td>
<td>0</td>
<td>SWTSTD</td>
<td>HIGH -35</td>
<td>MID -31-33</td>
<td>x (3-4)</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dissolved Oxygen</strong></td>
<td>100%sat</td>
<td>&lt;100%sat (&gt;80)</td>
<td>x (2)</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fluorescence (chl-a)</strong></td>
<td>Dark</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Turbidity</strong></td>
<td>0</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Ambient: x (thermom)*

*STANDARD, filter*
# Pre-Run SEACAT CTD Checklist

<table>
<thead>
<tr>
<th>NRS Site Code</th>
<th>SEACAT/CTD Serial Number (Primary Instrument)</th>
<th>DUAL CTD Serial Number (Secondary Instrument)</th>
<th>Date of CHECK</th>
<th>Operators NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments: note any damage or replacement of parts

## SEACAT/CTD Sensor Details

<table>
<thead>
<tr>
<th>SeaTermV2 battery V</th>
<th>Change Batteries?</th>
<th>If No, date of last change</th>
<th>If Yes, note new battery voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y / N</td>
<td>/ /</td>
<td>V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of Most recent SEACAT Factory Cal. configuration file</th>
<th>Date of Factory Calibration</th>
<th>Offsets entered in SBE memory</th>
<th>Name of Con file in SBE memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>.con</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
</tbody>
</table>

Last Calibration included factory cal for which of the following sensors?

<table>
<thead>
<tr>
<th>Y / N PRES</th>
<th>Y / N COND</th>
<th>Y / N TEMP</th>
<th>Y / N DO</th>
<th>Y / N FLUR</th>
<th>Y / N NTU</th>
</tr>
</thead>
</table>

## DUAL CTD Sensor Details - Secondary Instrument or Sensors

<table>
<thead>
<tr>
<th>SeaTermV2 battery V</th>
<th>Change Batteries?</th>
<th>If No, date of last change</th>
<th>If Yes, note new battery voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y / N</td>
<td>/ /</td>
<td>V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of Most recent SEACAT Factory Cal. configuration file</th>
<th>Date of Factory Calibration</th>
<th>Offsets entered in SBE memory</th>
<th>Name of Con file in SBE memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>.con</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
</tbody>
</table>

Last Calibration included factory cal for which of the following sensors?

<table>
<thead>
<tr>
<th>Y / N PRES</th>
<th>Y / N COND</th>
<th>Y / N TEMP</th>
<th>Y / N DO</th>
<th>Y / N FLUR</th>
<th>Y / N NTU</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Serial Numbers</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>

Real-time data collection using SeaTermV2 and the CT command; and SeaSave-Win32

Note: rinse with 5% TRITON-X between DI water FLUSHES

<table>
<thead>
<tr>
<th>Conductivity</th>
<th>PRE-WASH Initial FLUSH Value</th>
<th>POST-WASH or FINAL FLUSH Value</th>
<th>COEFF of Var. (COV) for FINAL FLUSH data</th>
<th>No. of flushes required if &gt;2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZERO salinity sample collected</td>
<td>Time Sampled (LOCAL/ UTC)</td>
<td>Bottle #</td>
<td>Salinometer value</td>
<td>SWSTD value</td>
</tr>
<tr>
<td>Pre-Run Check Filename =&gt;</td>
<td>.hex</td>
<td>CON file used in SEASAVE =&gt;</td>
<td>Same as OR alt. con file filename</td>
<td>SEACAT value RECEIVED for SWSTD</td>
</tr>
<tr>
<td>Dissolved Oxygen mg L⁻¹ =&gt;</td>
<td>-100% sat SEACAT value</td>
<td>COV</td>
<td>Dual SENS</td>
<td>Wnkl titr/ other &lt;100% sat SEACAT value</td>
</tr>
<tr>
<td>If a desktop DO sensor is used enter the details here =&gt;</td>
<td>Type &amp; SN &gt;</td>
<td>Cal Date &gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature °C =&gt;</td>
<td>SEACAT value</td>
<td>COV</td>
<td>Calibrated Thermometer</td>
<td>Dual SENSOR value and COV</td>
</tr>
<tr>
<td>Salinity =&gt;</td>
<td>-35 SEACAT value</td>
<td>COV</td>
<td>Bottle #</td>
<td>Bottle salinity &lt;35 SEACAT value</td>
</tr>
<tr>
<td>Fluorometry raw Voltage =&gt;</td>
<td>Mean SEACAT Raw V value @ 0 cm and COV</td>
<td>Mean SEACAT Raw V value @ 5 cm and COV</td>
<td>Mean SEACAT Raw V value @ 10 cm and COV</td>
<td>Dark Count Value and COV</td>
</tr>
<tr>
<td>Turbidity NTU =&gt;</td>
<td>DI/HIGH Purity water SEACAT value and COV</td>
<td>NTU value EXPECTED</td>
<td>Mean SEACAT value RECEIVED</td>
<td>COV</td>
</tr>
</tbody>
</table>