## REVISION NOTICE TABLE

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| --- | --- |
| DATE | DESCRIPTION OF REVISION |
|  |  |

## PROCESSING NOTES

Cruise: 2021-033

Agency: ESD

Location: BC Coast

Project: PIES

Chief Scientist: Boldt J.

Platform: Sir John Franklin

Date: 4 July 2021 – 9 July 2021 (Survey terminated due to ship mechanical failure.)

Processed by: Germaine Gatien

Date of Processing: 21 February 2022 – 11 March 2022

Number of HEX files: 2 Number of CTD files processed: 2

Number of bottle casts processed: 2

# INSTRUMENT SUMMARY

An SBE911+ CTD #0506 was mounted in a rosette and attached were a SBE 43 DO sensor (#1119) mounted on the primary pump, a SeaPoint Fluorometer (#3419) on the secondary pump, an unpumped ECO fluorometer (#2215) and an altimeter (#76341).

Seasave version 7.26.7.121 was used for acquisition.

The data logging computer was #103.

The deck unit was a Seabird model 11+.

A Guildline model 8400B Autosal serial # 73274 was used to analyze salinity samples.

An IOS rosette with 24 10L bottles was used.

# SUMMARY OF QUALITY AND CONCERNS

Due to a problem with the ship’s propulsion, this cruise was cancelled after only 2 stations had been occupied.

The Daily Science Log Book and rosette log sheets lacked a list of scientific personnel, but that was available in the cruise report.

The file names were changed to standard format; there were only 3 digits for the event number.

A Niskin bottle was lowered to about 10m on a separate line just above an RBR duo which provided pressures. BOT files were prepared which contain a combination of analysis results for samples taken from the Niskin bottle (salinity, extracted chlorophyll and nutrients) and CTD data extracted from downcasts at the level taken from the RBR (pressure, temperature, conductivity, dissolved oxygen and salinity). The CTD was moving at the level of bottle firing and the data were noisy, so this is a rough estimate provided for the convenience of users.

There was some evidence that pressure might be reading high by about 1.5db from this cruise, another Franklin cruise and a lab test at IOS. However, there is a good deal of evidence that pressure was accurate during a Vector cruise in December 2021 using the same sensor; that evidence came from observations when the CTD was in water and when it moved through the sea surface at the beginning and end of casts.

The SeaPoint fluorometer malfunctioned. The ECO fluorometer had values that were way out of line with one extracted chlorophyll sample and has values much too high in deep water. A test run using different scale/offset still produced unreasonably high values at depth. Both fluorescence channels were removed.

The sampling from this cruise is not suitable for a study of calibration errors. The only other 2021 cruise that used this CTD and included a little salinity sampling was 2021-078. Those data have only been through preliminary processing at this time, but suggest that errors in salinity are likely within ±0.005psu. No recalibration was applied to salinity.

There was no calibration sampling for the dissolved oxygen sensor during this cruise or any other cruises that used the sensor in 2021. No recalibration was applied. It is likely that values are low by 2 to 4% based on typical drift found for this type of sensor.

There was evidence from 2021-048 that either the sounder or the altimeter or both were not well calibrated. The altimeter has been used for other cruises before and after this one on two other ships (Vector and Tully) with no evidence of significant errors. The problem is more likely with the sounder; the speed of sound may not have been set appropriately.

# PROCESSING SUMMARY

##### Seasave

This step was completed at sea; the raw data files have extension HEX.

##### Preliminary Steps

* The configuration file used at sea was correct. One file was saved as 2021-033-ctd.xmlcon.
* The Log Book and rosette log sheets were obtained.
* Nutrients, extracted chlorophyll and salinity data were obtained in QF spreadsheet format from the analysts.
* The cruise summary sheet was completed.
* The histories of the pressure sensor, conductivity and dissolved oxygen sensors were checked. They all were used during 2 previous cruises since the last factory recalibration but there was no calibration sampling available. The sensors were used on a later cruise that has been processed, again with no calibration sampling. One other cruise in December had 5 salinity samples, but has only had preliminary processing.

##### Conversion of Full Files from Raw Data

All files were converted using 2021-033-ctd.xmlcon.

The Tau function was selected but not the hysteresis function since there was no deep sampling. Depth was included in the conversion.

The casts were examined. The descent rates are high with moderate noisy level. The 2 fluorescence channels look odd – the SeaPoint has excursions to unbelievable values – and the ECO has high values below 80m whereas the SeaPoint does not. Oxygen looks normal.

The T and C pairs were reasonably close during downcasts with upcasts noisy.

##### WILDEDIT

Program WILDEDIT was run to remove spikes from the pressure, depth, conductivity & temperature only in the full cast files (\*.CNV).

Parameters used were: Pass 1 Std Dev = 2 Pass 2 Std Dev = 5 Points per block = 50

The parameter “Keep data within this distance of the mean” was set to 0 so all spikes would be removed.

Spikes noted in cast #1 were resolved by this step; small spikes in upcast conductivity were not removed.

##### ALIGN DO

A few casts were examined; both temperature channels were noisy during upcasts so the tests were not easy to interpret, but using +2.5s certainly improves the alignment and overall looks like a good choice for both sensors. That setting has worked well for many SBE DO sensors in recent years.

ALIGNCTD was run on all casts using +2.5s.

##### CELLTM

The noise in the upcast data makes tests for the best parameters for this routine very difficult to interpret. In the past when upcast data were not so noisy, the default setting of (α = 0.0245, β=9.5) was generally found to be the best choice. A few casts were checked for this cruise and the default setting does improve the data. CELLTM was run using (α = 0.0245, β=9.5) for both the primary and secondary conductivity.

##### DERIVE and Channel Comparisons

Program DERIVE was run on all casts to calculate primary and secondary salinity and dissolved oxygen concentration.

DERIVE was run a second time on the casts to find the differences between the pairs of temperature, conductivity and salinity channels. The shaded values come from 1 other 2021 cruise using these sensors.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cast # | Press | T1-T0 | C1-C0 | S1-S0 | Descent Rate |
| 2021-048-0001 | 230 | ~0 | -0.00035 | -0.0067 | High, Steady |
| 2021-048-0019 | 230 | -0.0004 | -0.00050 | -0.0045 | High, Steady |
| 2021-048-0106 | 230 | -0.0005 | -0.00055 | -0.0055 | High, Steady |
| 2021-033-0002 | 85 | -0.0007 | -0.00052 | -0.0054 | High, Moderate |
| 2021-033-0008 | 100 | ~0 XN | -0.00054 | ~0.006 XN | High, Moderate |
| 2021-018-0047 | 235 | -0.0004 | -0.00060 | -0.0062 | High, X Noisy |
| 2021-018-0071 | 280 | -0.0002 | -0.00065 | -0.0067 | High, Steady |
| 2021-018-0120 | 220 | -0.0005 | -0.00068 | -0.0067 | Mod, Steady |

The casts are shallow and differences are noisy. Differences are small, but the conductivity and salinity differences may suggest a small drift. A preliminary look at 2021-076 looks similar to 2021-018.

##### Pressure Study

Notes in the log book indicate that the deck pressure was 2.2 to 3db before event #8 and that the surface pressure read 3db when it should have been 1db - 1.5db. during the soak at roughly 10m, it read 14db.

A few observations relevant to pressure arranged according to time order:

* For 2021-017 (May/June, Vector) the minimum pressure on the upcast was ~1db and the CTD was clearly in water. There were very few data with pressure < 2db.
* The data from 2021-048 (June, Franklin) show deck pressure readings that appear to be too high by 2.4db before the cast and by 1.4db afterwards. One cast had pumps running at the end and the CTD does appear to be at the surface at about 1.3db.
* For 2021-033 (June/July, Franklin) a check of the full profiles show that at the end of acquisition with pumps on salinity was ~32.3psu at 2.6db from one cast and 31.7 at 2.8db from the other. These are reasonable results, but would also be reasonable if the pressure is reading high by 1db.
* The log entries for maximum cast pressure recorded in the log are each about 10db lower than the maximum in the data files. Where the log pressure entries came from is unknown. The maximum pressure recorded by the RBR during net casts that followed are close to those entries. Having pressure off by 10db at the bottom suggests a very large error. And the bottom depths in the log are each about 10m shallower than calculated from CTD maximum depth plus bottom altimetry.
* From 2021-033 there was 1 salinity sample taken at about 9.4db (pressure from the RBR CTD) during cast #2; the sample salinity was 32.383psu. Allowing for an error of ±0.006psu in CTD salinity, values within the range 32.377 to 32.389psu were found in the downcast data. The CTD data are very noisy around 9db. The pressures associated with that salinity range were between 9.2db and 10.2db for the primary salinity which was extremely noisy, and between 9.7db and 10.2db for the secondary salinity. So the CTD pressure looks to be close to that of the RBR. At 14db the salinity is about 32.390psu. The salinity data are too noisy to conclude much, but there is no evidence of a large difference between RBR and SBE pressure, though the SBE could be low by ~1db.
* For 2021-018 (October, Vector) the only records with pressure <1.5db are spiky; most have “in-water” conductivity, while 1 did not. When a comparison was made between the sum of maximum CTD depth in the files + altimetry at the bottom, that sum did differ from the water depth recorded from the sounder, but in a random way, sometimes higher, sometimes lower. This was not surprising in a region where shoaling during casts is common.
* 2021-076 (December, Vector) was the only one of these cruises where acquisition started before the 10m soak. There is evidence of the CTD being in water when pressure read 0.2db at the beginning of casts, with conductivity rising even with pumps off. The CTD also appears to come out of the water at 0.2db to 0.4db, as evidenced by a sudden increase in transmissivity. So the near-surface pressure looks fine.
* From 2021-076 9 casts ranging from 87m to 650m deep were checked to see how the bottom CTD depth plus altimetry compared to the water depth recorded from a sounder.

The CTD read low for most casts by from 1 to 4m while it read a little high for 3 casts shallower than 325m by from 1 to 3m.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sounder depth | CTD Depth | Altimetry | CTD + ALT | Sounder-CTD Depth |
| 329.0 | 316.6 | 10.6 | 327 | 1.8 |
| 193.0 | 182.8 | 12.0 | 195 | -1.8 |
| 87.0 | 83.3 | 5.0 | 88 | -1.3 |
| 309.0 | 304.5 | 7.5 | 312 | -3.0 |
| 568.0 | 556.4 | 7.4 | 564 | 4.2 |
| 359.0 | 352.6 | 5.0 | 358 | 1.4 |
| 478.0 | 465.9 | 8.9 | 475 | 3.2 |
| 503.0 | 494.7 | 5.1 | 500 | 3.2 |
| 650.0 | 640.4 | 5.7 | 646 | 3.9 |

These data show that the surface pressure was reliable in December, and while there could be some pressure dependence, it appears that would lead to low values at depth, not high ones. The pressure dependence in the differences is more likely to be from the sounder being imperfectly tuned than to be from the altimeter or CTD. In any case, the differences are small and do not resemble the issues noted during 2021-033.

* A reading taken in a lab at IOS in February 2022 gave a pressure value of 1.25db.
* The 10,000db range of this sensor means the initial accuracy and stability rating is ~1.5dbThe evidence is confusing.

Pressure may be reading high for this cruise and 2021-048 but likely by no more than 1.4db. Given the excellent results for 2021-076 and the potential errors being within the accuracy rating for this sensor, no recalibration is justified. If a post-cruise calibration suggests there was a larger drift, this can be revisited.

##### BOTTLE FILE PREPARATION

Niskin bottles were fired on a line with an RBR attached to establish the depth of the sample.

The RBR data were used to establish the depth when the messenger was sent to close the Niskin bottle. See document “2021-033 Niskin Depth from RBR 08220.xlsx”.

For Event #2 the pressure was 9.3811db and depth 9.3046m.

For Event #8 the pressure was 10.7840db and depth 10.6961m.

In order to create bottle files that would mimic CHE files, a “bl” file was prepared for each of the two casts. A scan was identified to match the depths above in the CNV files and a BL file was created with a range of 36 scans (the usual choice) around those depths. The times were also available in the RBR spreadsheet.

The ROS files were created using files 2021-033-ctd.xmlcon and choosing downcast data from a variety of window choices until the average pressure was close to the RBR record. At this level there are significant vertical gradients even over 1s especially for salinity for cast #2, so for cast #2 a 0.5s window was chosen.

They were converted to IOS Header format with extension \*.IOS.

The IOS files were put through CLEAN to create BOT files.

Temperature and salinity were plotted for all BOT files to check for outliers. None were found.

A preliminary header check was run and no problems found.

The BOT files were bin-averaged on bottle number. The average pressure was compared with the RBR-derived pressures. A return was made to the ROS creation stage and the timing of the window fine-tuned to achieve an average pressure close to the desired pressures. (For event #2 the window chosen was 0.3s to 0.8s and for event #8 it was 0.1s to 1.1s.

The output was used to create file ADDSAMP.csv. First, the file was sorted on event number and Bottle Position order. Then sample numbers were added based on the rosette logs.

The file was sorted on sample number.

The ADDSAMP file was adjusted and used to add sample numbers to the BOT files – output \*.SAM.

The SAM files were bin-averaged on bottle # and called SAMAVG. Standard deviations were included to assist in assessing the comparisons with bottle samples.

The addsamp.csv file was converted to CST files, which will form the framework for the bottle files.

Next, each of the analysis spreadsheets were examined to see what comments the analysts wanted included in the header file. These were used to create file 2021-033-bot-hdr.txt which will be updated as needed during processing.

EXTRACTED CHLOROPHYLL

Extracted chlorophyll and phaeo-pigment data were obtained in file QF2021-033\_CHL QF\*.xlsx. The file included comments and flags and a precision study. A simplified version of the spreadsheet was prepared and saved as 2021-033chl.csv. The csv file was then converted to individual CHL files.

SALINITY

Salinity analysis was obtained in file QF2021-033\_SAL.xlsx which included a precision study. The analyses were carried out in a temperature-controlled lab within 21-42 days of collection. The files were simplified and saved as 2021-033sal.csv. That file was then converted to individual SAL files.

NUTRIENTS

The nutrient data were obtained in spreadsheet QF2021-033\_NUTS\*.xlsx. The file was simplified, saved as 2021-033nuts.csv and converted to individual NUT files.

The SAL, CHL and NUT files were merged with CST files in 3 steps.

The files were then put through CLEAN to reduce the headers to File and Comment sections only.

These files are ordered on sample number, but the SAMAVG files are ordered on bottle number, so the MRGCLN1 files were reordered on Bottle\_Number and saved as \*. MRGCLN1s.

The MRGCLN1s files were then merged with SAMAVG files using merge channel Bottle\_Number.

There were no cases where salinity < 25psu, so no nutrient corrections are needed.

##### Compare

The Niskin bottle was not mounted with the CTD, but was on a line with an RBR CTD. The target pressure was 10db. The RBR data were used to establish the depth when the messenger was sent to close the Niskin bottle.

Salinity

There was only one salinity sample with salinity = 32.3830 and it was from 9.38db according to the RBR record.

The primary downcast CTD at 9.29db is 32.3781psu (std dev 0.0154psu); the secondary is 32.3714psu (std dev 0.0106psu).

Those values are lower than the bottle by 0.0049psu and 0.0116psu. There would likely be some contamination by shed wakes with lower salinity water passing by the CTD and the Niskin. Given the variability and probably some mismatch in pressure, these are reasonably good matches.

The difference between the 2 CTD salinity channels (0.0067psu) is similar to the difference noted during cruises 2021-048 and 2021-018 which occurred in June/July and October 2021. In October the secondary was lower than the primary salinity by 0.0062psu to 0.0067psu at about 250db.

Fluorescence

Extracted Chlorophyll samples were available for both casts at about 10m.

For event #2 the Seapoint fluorescence is lower than the CHL sample while the ECO fluorescence is higher.

For event #8 the SeaPoint fluorescence is close to the CHL value while the ECO is much higher.

The upcast data are very noisy but rough estimates were made based on upcast plots.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Event # | Extracted CHL | SeaPoint FL ↓ | ECO FL ↓ | SeaPoint FL ↑ | ECO FL ↑ |
| 2 | 4.47 | 2.99 | 6.13 | ~2.2 | ~5.7 |
| 8 | 7.38 | 7.37 | 17.35 | ~2.1 | ~4.7 |

Full profile plots were examined.

* Both casts show that there was a problem with the SeaPoint fluorometer during downcasts. Values swing between ones that are believable and others that look much too high for the depths. Deep values look reasonable, but the data are unreliable so should be removed. This channel also malfunctioned during 2021-048.
* The SBE fluorometer10m value for event #2 looks believable while that for event #8 seems higher than expected as this type of fluorometer usually reads lower than CHL when CHL > 5ug/L.
* For the ECO fluorometer, the downcast values look much too high and the deep values are also too high. This could be an error in the scale setting, so a test was done using scale factor 12 and offset 0.023. This produced values 3.0 and 8.3ug/L which look very reasonable at 10m but the deep values still look too high. Choosing scale factor 6 and offset 0.051 produced very bad results. This channel appears to be unreliable and should be removed. This problem was not noted during the previous cruise, 2021-048.

Since CHL data are available and the fluorescence data are not trusted, no fluorescence data will be entered in the BOT files.

At this point a second pass through Bin Average and MERGE was made without standard deviations being derived.

##### Conversion to IOS Header Format

The IOSSHELL routine was used to convert SEA-Bird 911+ CNV files to IOS Headers.

CLEAN was run to add event numbers and to replace pad values in the pressure channel with interpolated values based on record number.

##### Checking Headers

* The cross-reference check and header check were run and no problems were found.
* Surface check was run and found an average of 3.1db.
* A cruise track was plotted and look fine; it was added to the end of this report.

The altimeter and water depth readings from the headers of the CLN files were exported to spreadsheets. A check value was calculated as follows:

CHECK VALUE = Max Depth Sampled + (Altimetry Header – 1) - Water Depth from Header

The altimetry averages over 2m so the header values are likely high by ~1m.

There are bound to be small variations due to water depth changes through the cast, but those changes should be fairly random. We expect values ~+\-4m.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Event # | Water depth from Log | Max Cast Pressure from Log | Altimetry Header | Max Depth Sampled from File | Check Value | Est water depth |
| 2 | 88 | 78 | 9.8 | 88.0 | 8.8 | 96.8 |
| 8 | 101 | 90 | 10.3 | 101.9 | 10.2 | 111.2 |

Where the maximum cast pressure value came from is unknown, unless someone decided that the CTD pressure was too high by 10db, or simply subtracted the altimetry minimum reading from the sounder value. This would be unusual.

So it appears that either the sounder or the altimeter or both were not well calibrated. The altimeter has been used for other cruises before and after this one on two other ships (Vector and Tully) with no evidence of significant errors. The problem is more likely with the sounder; it may not have been set to local speed of sound. The water depth entries were also found to be suspicious during 2021-048, also on the Franklin.

The water depths in the headers were replaced with the sum (Maximum Depth Sampled + Altimetry – 1).

##### Shift

Fluorescence

This step is usually run on the SBE fluorescence channel, but the sensor malfunctioned.

Dissolved Oxygen

The Dissolved Oxygen voltage channel was aligned earlier. A few casts were checked to see if the alignment looked ok, and it did. No further alignment is needed for the DO concentration channel,

Conductivity

Tests were run during 2021-048 and the choices made for that cruise were applied to this one.

SHIFT was run using settings of -0.8 records for both the primary and secondary conductivity. Salinity was recalculated for both channels.

##### DELETE

The following DELETE parameters were used:

Surface Record Removal: Last Press Min

Maximum Surface Pressure (relative): 10.00

Surface Pressure Tolerance: 1.0 Pressure filtered over 15 points

Swells deleted. Warning message if pressure difference of 2.00

Drop rates < 0.30m/s (calculated over 11 points) will be deleted.

Drop rate applies in the range: 10db to 10db less than the maximum pressure

Sample interval = 0.042 seconds. (taken from header)

COMMENTS ON WARNINGS: There were no warnings.

##### Other Comparisons

Experience with these sensors since last factory service –

Since the previous factory calibration temperature, conductivity and dissolved oxygen sensors had been used during 2021-017 and 2017-048 before this cruise and 2017-018 after this one - there was no calibration sampling for those cruises. Salinity differences were roughly ~0.003psu, ~0.006 and ~0.006psu for those cruises.. There were 5 salinity samples taken during 2021-078 in December. Preliminary processing was done; the primary salinity was higher than the secondary by ~0.006psu The primary salinity was closer to bottle values but even slight inefficiency in flushing of Niskin bottles would suggest that the secondary is really closer to the bottles.

Historic ranges – Profile plots were made with 3-standard deviation climatology ranges of T and S superimposed. Both casts were well within the climatology.

Post-Cruise Calibration – There were no post-cruise calibrations available.

##### DETAILED EDITING

The secondary channels have been selected for archival for other cruises using this CTD in 2021 so were selected for this data set as well.

CTDEDIT was used to remove records that appear to be corrupted by shed wakes. Salinity was cleaned to remove spikes that appear to be due to small misalignment.

The edited files were copied to \*.EDT.

After editing T-S plots were examined. A few slightly unstable features remain but from areas where some unstable features are expected and could be real. No further editing was done.

##### Corrections to Pressure, Salinity and Dissolved Oxygen Concentration

Based on studies from 2021-048 no recalibration was applied to pressure or salinity.

Salinity is considered ±0.005psu.

The % saturation of dissolved oxygen at 3m was about 85% near Brooks Peninsula and 99% in Johnstone Strait. We expect some calibration drift towards lower values, so the dissolved oxygen value may be reading low by 2 to 4%. There is insufficient evidence to justify recalibration.

##### Fluorescence Processing

This step was skipped since the SBE Fluorescence channel will be removed.

##### BIN AVERAGE of CTD files

The following Bin Average values were applied to the FIL files (output AVG):

Bin channel = pressure Averaging interval = 1.000 Minimum bin value = .000

Average value will be used. Interpolated values are NOT used for empty bins.

On-screen T-S plots were examined. There are some small unstable features but from this region of active mixing they may well be real.

Profile plots were examined to see if there any problems. No problems were noted.

##### Final CTD File Steps (REMOVE and HEADEDIT)

REMOVE was run to remove the following channels:

Scan\_Number, Temperature:Primary, Conductivity:Primary, Oxygen:Voltage:SBE, Descent\_Rate, Status:Pump, Altimeter, Salinity:T0:C0, Fluorescence:URU:Seapoint, Fluorescence:URU:Wetlabs:ECO-AFL and Flag.

A second SBE DO channel (with umol/kg units) was added.

REORDER was run to get the two DO channels together.

HEADER EDIT was used to fix formats and channel names and to add the comments about processing.

The Standards Check routine was run and no problems were found.

The Header Check was run; no problems were found.

Profile and T-S plots were examined. No problems were found.

The sensor history was updated.

##### Dissolved Oxygen Study

As a final check of dissolved oxygen data, % saturation was calculated and plotted. See results in 16.

##### Final Bottle Files

MRGSORT was run to get files in pressure order.

REMOVE was run to remove the following channels:

Scan\_Number, Temperature:Primary, Conductivity:Primary, Oxygen:Voltage:SBE, Descent\_Rate, Status:Pump, Altimeter, Salinity:T0:C0, Fluorescence:URU:Seapoint, Fluorescence:URU:Wetlabs:ECO-AFL and Flag.

A second SBE DO channel with mass units was added for both the CTD DO and titrated DO and REORDER was run to get the pairs of DO channels together.

HEADER EDIT was run to add comments to the headers.

A Header Check turned up some header errors which were corrected by rerunning Header Edit until all problems were resolved.

A Standard Check was run and no problems were found.

The track plot looks ok.

**Particulars - Notes from Daily Science Log and Sampling Notes**

8. Deck pressure 2.2-3db. When in water at surface read 3db when should be 1-1.5db. With 10m wire out reads 14db.

Cruise aborted after event 9

**Cross-Reference List**

Filename Event Station Latitude Longitude Date Time

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2021-033-0002.ctd 0002 7422 50 0.04 N 127 41.09 W UTC 2021/07/06 01:08

2021-033-0008.ctd 0008 11044 51 2.61 N 127 47.50 W UTC 2021/07/07 00:12

**2021-033**

**CRUISE SUMMARY – CTD**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CTD#** | **Make** | **Model** | | **Serial#** | | **Used with Rosette?** | | **CTD Calibration Sheet Competed?** | | |
| **1** | **SEABIRD** | **911+** | | **0506** | | **Yes** | | **Yes** | | |
| **Sensor** | | | | | **Pre-Cruise** | | | | **Post Cruise** | | |
| **Name** | | | **S/N** | | **Date** | | **Location** | | **Date** | **Location** | |
| **Temperature** | | | **2374** | | **03Feb2021** | | **Factory** | |  |  | |
| **Conductivity** | | | **3184** | | **03Mar2021** | | **Factory** | |  |  | |
| **Secondary Temp.** | | | **4883** | | **04Feb2021** | | **Factory** | |  |  | |
| **Secondary Cond.** | | | **4395** | | **03Mar2021** | | **Factory** | |  |  | |
| **SBE 43 DO sensor** | | | **1119** | | **5Feb2021** | | **Factory** | |  |  | |
| **Wet Labs ECO Fluor.** | | | **2215** | | **27Nov2018** | | **Factory** | |  |  | |
| **SeaPoint Fluor.** | | | **3949** | |  | | **Factory** | |  |  | |
| **Pressure Sensor** | | | **0506** | | **29Jan2021** | | **Factory** | |  |  | |
| **Valeport Altimeter** | | | **76341** | | **10Feb2021** | | **Factory** | |  |  | |

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