PRODUCT INFORMATION

Item: ECO Legacy
Item Description: (LEGACY) ECO (FLRUD-XXX, BBFLZ-XXX, BB2FL-XXX..ETC)
Serial: FLNTURTD-4050

Special Notes
Services Requested:
Standard Service

Diagnosis:
Evaluated instrument FLNTURTD-4050 and found no problems.

Repairs and Modifications:
Standard service performed.

Comments:
New Device file and characterization sheets included.

ECO Standard Service:
The instrument bulkhead connector, pressure housing and window/optics are inspected for damage.
Instrument is checked to determine proper functionality. Incoming settings and memory are collected if incoming condition allows.
A pre-service characterization is performed, if applicable. Data is analyzed and Instrument is rescaled, if required.
The head is inspected for cracks in detector and motor bores. Case seals, shaft, shaft seal, faceplate, wiper, desiccant pack and
battens (if equipped) are replaced. Noise, stability, and live pressure test is performed.
Final calibration and characterization is completed. Including calibration of thermistor and pressure sensor, if equipped. A device file,
repair sheet, and new characterization sheets are provided to customer via hard copy and CD.

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>WET_SRV_CHRG</td>
<td>Service Charges from WETLabs (FRRF)</td>
<td>1</td>
</tr>
</tbody>
</table>

Unbilled Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Page 3 of 3
**FLNTU Characterization Sheet**

**Date:** July 24, 2018  
**S/N:** FLNTURTD-4050

### Chlorophyll Scale Factor

Chlorophyll concentration expressed in µg/l can be derived using the equation:

\[
\text{CHL (µg/l)} = \text{Scale Factor \times (Output - Dark Counts)}
\]

<table>
<thead>
<tr>
<th></th>
<th>Analog</th>
<th>Digital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark Counts</td>
<td>0.069 V</td>
<td>48 counts</td>
</tr>
<tr>
<td>Scale Factor (SF)</td>
<td>6 µg/l/V</td>
<td>0.0072 µg/l/count</td>
</tr>
<tr>
<td>Maximum Output</td>
<td>4.98 V</td>
<td>4130 counts</td>
</tr>
<tr>
<td>Resolution</td>
<td>1.0 mV</td>
<td>1.0 counts</td>
</tr>
<tr>
<td>Ambient temperature during calibration</td>
<td>22.0 °C</td>
<td></td>
</tr>
</tbody>
</table>

### Nephelometric Turbidity Unit (NTU) Scale Factor

Turbidity units expressed in NTU can be derived using the equation:

\[
\text{NTU} = \text{Scale Factor \times (Output - Dark Counts)}
\]

<table>
<thead>
<tr>
<th></th>
<th>Analog</th>
<th>Digital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark Counts</td>
<td>0.067 V</td>
<td>51 counts</td>
</tr>
<tr>
<td>NTU Solution Value</td>
<td>3.26 V</td>
<td>2680 counts</td>
</tr>
<tr>
<td>Scale Factor (SF)</td>
<td>2 NTU/V</td>
<td>0.0026 NTU/count</td>
</tr>
<tr>
<td>Maximum Output</td>
<td>4.98 V</td>
<td>4130 counts</td>
</tr>
<tr>
<td>Resolution</td>
<td>1.1 mV</td>
<td>1.0 counts</td>
</tr>
<tr>
<td>Ambient temperature during calibration</td>
<td>22.0 °C</td>
<td></td>
</tr>
</tbody>
</table>

**Definition of terms:**

- **Dark Counts:** Signal output of the meter in clean water with black tape over detector.
- **NTU Solution Value:** Signal output of the turbidity sensor when measuring a sample of interest.
- **SF (CHL):** Determined using the following equation: \( SF = x + (\text{Output} - \text{Dark counts}) \), where \( x \) is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.
- **SF (NTU):** Scale factor is determined using the following equation: \( SF = xx + (\text{Output} - \text{Dark counts}) \), where \( xx \) is the value of a Formazin concentration. For example: \( 12.2 + (2011 - 50) = 0.0062 \).
- **Maximum Output:** Maximum signal output the fluorometer is capable of.
- **Resolution:** Standard deviation of 1 minute of collected data.
ECO Calibration and Repairs

**Diagnosis:** Evaluated instrument FLNTURTD-4050 and found no problems.

**Repairs and Modifications:** Standard service performed.

**Comments:** New Device file and characterization sheets included.

**ECO Standard Service:**
The instrument bulkhead connector, pressure housing and window optics are inspected for damage. Instrument is checked to determine proper functionality. Incoming settings and memory are collected if incoming condition allows.

A pre-service characterization is performed, if applicable. Data is analyzed and Instrument is rescaled, if required.

The head is inspected for cracks in detector and motor bores. Case seals, shaft, shaft seal, faceplate, wiper, desiccant pack and batteries (if equipped) are replaced. Noise, stability, and live pressure test is performed.

Final calibration and characterization is completed. Including calibration of thermistor and pressure sensor, if equipped. A device file, repair sheet, and new characterization sheets are provided to customer via hard copy and CD.
CUSTOMER INFORMATION
Name: WHOI - WOODS HOLE OCEANOGRAPHIC INSTITUTION
Account: 40296385
PHILIP ALATALO
palatalo@whoi.edu
5082892880

Bill To Address
266 WOODS HOLE RD, MS#1:
WOODS HOLE, MA.02543, US

SHIP TO ADDRESS
RECEIVING DEPARTMENT:266 WOODS HOLE ROAD:
WOODS HOLE MA.02543, US

PRODUCT INFORMATION
Item: 43,2111
Item Description: SBE43, 1/2 MIL, 7000m, XSG, STD 43 PLENUM
Serial: 43-3011

Special Notes
Services Requested:
Evaluate/Repair Instrumentation.
Perform Routine Calibration Service.

Problems Found:
The membrane was found to be damaged.

Services Performed:
Perform initial diagnostic evaluation.
Replaced the lid and membrane assembly (0.5 mil).
Replaced the electrolyte with new fluid.
Replaced the O-rings.
Performed a hydrostatic pressure test.
Performed a "Final" Calibration.

<table>
<thead>
<tr>
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<th>Item Description</th>
<th>Qty</th>
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<tbody>
<tr>
<td>CAL.43</td>
<td>SBE 43 dissolved oxygen sensor calibration</td>
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Unbilled Items

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<th>Item Description</th>
<th>Qty</th>
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<tr>
<td>801576</td>
<td>SBE43 LID &amp; MEMBRANE SUB-ASSY, 5MIL MEMBRANE</td>
<td>1</td>
</tr>
</tbody>
</table>
**SENSOR SERIAL NUMBER:** 3011  
**CALIBRATION DATE:** 04-Jul-18

**COEFFICIENTS:**  
- Soc = 0.4425  
- Voffset = -0.5132  
- Tau20 = 1.05  
- A = -4.7309e-03  
- B = 2.1915e-04  
- C = -2.9784e-06  
- E nominal = 0.036  

**SBE 43 OXYGEN CALIBRATION DATA**

<table>
<thead>
<tr>
<th>BATH OXYGEN (ml/l)</th>
<th>BATH TEMPERATURE (°C)</th>
<th>BATH SALINITY (PSU)</th>
<th>INSTRUMENT OUTPUT (volts)</th>
<th>INSTRUMENT OXYGEN (ml/l)</th>
<th>RESIDUAL (ml/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.15</td>
<td>2.00</td>
<td>0.00</td>
<td>0.794</td>
<td>1.19</td>
<td>0.00</td>
</tr>
<tr>
<td>1.15</td>
<td>6.00</td>
<td>0.00</td>
<td>0.819</td>
<td>1.15</td>
<td>0.00</td>
</tr>
<tr>
<td>1.15</td>
<td>12.04</td>
<td>0.00</td>
<td>0.871</td>
<td>1.16</td>
<td>0.00</td>
</tr>
<tr>
<td>1.17</td>
<td>20.00</td>
<td>0.00</td>
<td>0.940</td>
<td>1.16</td>
<td>0.00</td>
</tr>
<tr>
<td>1.17</td>
<td>26.00</td>
<td>0.00</td>
<td>0.994</td>
<td>1.17</td>
<td>0.00</td>
</tr>
<tr>
<td>1.18</td>
<td>30.00</td>
<td>0.00</td>
<td>1.031</td>
<td>1.18</td>
<td>0.00</td>
</tr>
<tr>
<td>3.89</td>
<td>2.00</td>
<td>0.00</td>
<td>1.430</td>
<td>3.89</td>
<td>0.00</td>
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<tr>
<td>3.90</td>
<td>6.00</td>
<td>0.00</td>
<td>1.548</td>
<td>3.90</td>
<td>0.00</td>
</tr>
<tr>
<td>3.91</td>
<td>12.05</td>
<td>0.00</td>
<td>1.722</td>
<td>3.91</td>
<td>0.00</td>
</tr>
<tr>
<td>3.93</td>
<td>20.00</td>
<td>0.00</td>
<td>1.951</td>
<td>3.92</td>
<td>0.00</td>
</tr>
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<td>3.94</td>
<td>26.00</td>
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<td>2.124</td>
<td>3.94</td>
<td>0.00</td>
</tr>
<tr>
<td>3.95</td>
<td>30.00</td>
<td>0.00</td>
<td>2.243</td>
<td>3.95</td>
<td>0.00</td>
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<td>5.67</td>
<td>2.00</td>
<td>0.00</td>
<td>2.085</td>
<td>6.67</td>
<td>0.00</td>
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<tr>
<td>5.70</td>
<td>6.00</td>
<td>0.00</td>
<td>2.290</td>
<td>6.70</td>
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<td>6.75</td>
<td>12.05</td>
<td>0.00</td>
<td>2.603</td>
<td>6.75</td>
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<tr>
<td>6.89</td>
<td>20.00</td>
<td>0.00</td>
<td>3.005</td>
<td>6.80</td>
<td>0.00</td>
</tr>
<tr>
<td>5.81</td>
<td>26.01</td>
<td>0.00</td>
<td>3.304</td>
<td>5.82</td>
<td>0.01</td>
</tr>
</tbody>
</table>

\( V = \text{instrument output (volts)}; \quad T = \text{temperature (°C)}; \quad S = \text{salinity (PSU)}; \quad K = \text{temperature (°K)} \)

\( O_{\text{oxs}}(T,S) = \text{oxygen saturation (ml/l)}; \quad P = \text{pressure (dbar)} \)

\( \text{Oxygen (ml/l)} = \text{Soc} \times (V + \text{Voffset}) \times (1.0 + A \times T + B \times T^2 + C \times T^3) \times O_{\text{oxs}}(T,S) \times \exp(E \times P / K) \)

\( \text{Residual (ml/l)} = \text{instrument oxygen - bath oxygen} \)

---

**Date, Slope (ml/l):**  
- 04-Jul-18, 1.0000

**CALIBRATION AFTER MODIFICATIONS**
**PRODUCT INFORMATION**

Item: 49 LEGACY  
Item Description: (LEGACY) SBE 49 FastCAT CTD  
Serial: 4932457-0054

Special Notes
Services Requested:
Evaluate/Repair Instrumentation.
Perform Routine Calibration Service.

Services Performed:
Perform initial diagnostic evaluation.
Performed pressure calibration.
Performed "POST" cruise calibration.

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONCERT49A</td>
<td>Confirm and recertify SBE 49. Complete external inspection. Test all functions. Cost of major repairs, modifications or calibration is not included.</td>
<td>1</td>
</tr>
<tr>
<td>CAL_49</td>
<td>SBE 49 FastCAT CTD sensor calibration, conductivity (C&amp;P + recal if necessary), temperature, and pressure</td>
<td>1</td>
</tr>
</tbody>
</table>

**Unbilled Items**

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>233493</td>
<td>SBE41/4952/WQM TC DUCT TOP, BLACK ACETAL</td>
<td>1</td>
</tr>
</tbody>
</table>
SENSOR SERIAL NUMBER: 0054
CALIBRATION DATE: 29-Jun-18

SBE 49 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

COEFFICIENTS:

\[ a_0 = 8.472817e-004 \]
\[ a_1 = 2.764824e-004 \]
\[ a_2 = -1.588455e-006 \]
\[ a_3 = 1.900341e-007 \]

<table>
<thead>
<tr>
<th>BATH TEMP (°C)</th>
<th>INSTRUMENT OUTPUT (counts)</th>
<th>INST TEMP (°C)</th>
<th>RESIDUAL (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0000</td>
<td>731833.898</td>
<td>1.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>4.5000</td>
<td>648435.797</td>
<td>4.5000</td>
<td>-0.0000</td>
</tr>
<tr>
<td>15.0000</td>
<td>436480.424</td>
<td>15.0001</td>
<td>0.0001</td>
</tr>
<tr>
<td>18.5000</td>
<td>376270.475</td>
<td>18.4998</td>
<td>-0.0002</td>
</tr>
<tr>
<td>24.0242</td>
<td>297945.017</td>
<td>24.0245</td>
<td>0.0003</td>
</tr>
<tr>
<td>29.0292</td>
<td>236261.085</td>
<td>29.0289</td>
<td>-0.0003</td>
</tr>
<tr>
<td>32.5312</td>
<td>198662.153</td>
<td>32.5313</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

\[ n = \text{Instrument Output (counts)} \]
\[ MV = (n - 524288) / 1.6e+007 \]
\[ R = (MV * 2.295e+010 + 9.216e+008) / (6.144e+004 - MV * 5.3e+005) \]

Temperature ITS-90 (°C) = \[ 1/(a_0 + a_1[ln(R)] + a_2[ln^2(R)] + a_3[ln^3(R)]) \] - 273.15

Residual (°C) = instrument temperature - bath temperature

Date, Offset (mdeg C)
- 07-Oct-16  0.56
- 29-Jun-16  -0.00

POST CRUISE CALIBRATION
SENSOR SERIAL NUMBER: 0054
CALIBRATION DATE: 29-Jun-18

COEFFICIENTS:
\[ g = -1.03732\times10^{-000} \]
\[ h = 1.513062\times10^{-001} \]
\[ i = -2.136025\times10^{-004} \]
\[ j = 4.136448\times10^{-005} \]

<table>
<thead>
<tr>
<th>BATH TEMP (°C)</th>
<th>BATH SAL (PSU)</th>
<th>BATH COND (S/m)</th>
<th>INSTRUMENT OUTPUT (Hz)</th>
<th>INSTRUMENT COND (S/m)</th>
<th>RESIDUAL (S/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.0000</td>
<td>0.0000</td>
<td>0.00000</td>
<td>2620.74</td>
<td>0.0000</td>
<td>0.000000</td>
</tr>
<tr>
<td>1.0000</td>
<td>34.8200</td>
<td>2.97625</td>
<td>5150.42</td>
<td>2.9763</td>
<td>0.00002</td>
</tr>
<tr>
<td>4.5000</td>
<td>34.7995</td>
<td>3.28330</td>
<td>5343.05</td>
<td>3.2833</td>
<td>-0.00001</td>
</tr>
<tr>
<td>15.0000</td>
<td>34.7549</td>
<td>4.26488</td>
<td>5916.20</td>
<td>4.2648</td>
<td>-0.00003</td>
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<tr>
<td>18.5000</td>
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<td>-0.00001</td>
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<tr>
<td>24.0242</td>
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<td>29.0292</td>
<td>34.7303</td>
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<td>6660.58</td>
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<td>-0.00003</td>
</tr>
<tr>
<td>32.5312</td>
<td>34.7282</td>
<td>6.06571</td>
<td>6841.23</td>
<td>6.0657</td>
<td>0.00004</td>
</tr>
</tbody>
</table>

\( f = \text{Instrument Output (Hz) / 1000.0} \)
\( t = \text{temperature (°C)}; \ p = \text{pressure (decibars)}; \ \delta = \text{CTcor}; \ \epsilon = \text{CPcor}; \)

Conductivity (S/m) = \( (g + h \times t^2 + i \times t + j \times t^3) / (1 + \delta \times t + \epsilon \times p) \)

Residual (Siemens/meter) = instrument conductivity - bath conductivity

Date, Slope Correction
- 07-Oct-16 0.9995914
- 29-Jun-18 1.0000000

POST CRUISE CALIBRATION
SENSOR SERIAL NUMBER: 0054
CALIBRATION DATE: 27-Jun-18

COEFFICIENTS:

\[ \begin{align*}
PA0 &= -5.540088e-001 \\
PA1 &= 4.410332e-003 \\
PA2 &= -1.468072e-011 \\
PTEMPA0 &= -6.038439e+001 \\
PTEMPA1 &= 5.419313e+001 \\
PTEMPA2 &= -9.410580e-001
\end{align*} \]

SBE 49 PRESSURE CALIBRATION DATA
1450 psia S/N 2983

### PRESSURE SPAN CALIBRATION

<table>
<thead>
<tr>
<th>PRESSURE (PSIA)</th>
<th>INSTRUMENT OUTPUT (counts)</th>
<th>THERMISTOR OUTPUT (volts)</th>
<th>COMPUTED PRESSURE (PSIA)</th>
<th>RESIDUAL (%FSR)</th>
<th>TEMP (°C)</th>
<th>THERMISTOR OUTPUT (volts)</th>
<th>INSTRUMENT OUTPUT (counts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.64</td>
<td>523931.2</td>
<td>1.6</td>
<td>14.64</td>
<td>0.00</td>
<td>32.53</td>
<td>1.77</td>
<td>524117.19</td>
</tr>
<tr>
<td>301.84</td>
<td>588868.6</td>
<td>1.6</td>
<td>301.80</td>
<td>-0.00</td>
<td>29.03</td>
<td>1.70</td>
<td>524105.59</td>
</tr>
<tr>
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<td>301.84</td>
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<td>1.6</td>
<td>301.98</td>
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<td>14.64</td>
<td>0.00</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### THERMAL CORRECTION

- **y** = thermistor output (counts)
- **t** = *PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2
- **x** = instrument output - PTC0 - PTC1 * t - PTC2 * t^2
- **n** = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)
- pressure (PSIA) = PA0 + PA1 * n + PA2 * n^2
- Residual (%FSR) = (computed pressure - true pressure) / Full Scale Range

Residual (%FSR) Data, Offset (%FSR)

- 27-Jun-18 0.00

\[ y = \text{thermistor output (counts)} \]
\[ t = PTEMPA0 + PTEMPA1 \cdot y + PTEMPA2 \cdot y^2 \]
\[ x = \text{instrument output} - PTC0 - PTC1 \cdot t - PTC2 \cdot t^2 \]
\[ n = x \cdot PTCB0 / (PTCB0 + PTCB1 \cdot t + PTCB2 \cdot t^2) \]
\[ \text{pressure (PSIA)} = PA0 + PA1 \cdot n + PA2 \cdot n^2 \]

Residual (%FSR) = (computed pressure - true pressure) / Full Scale Range

Date, Offset (%FSR)

- 27-Jun-18 0.00

![Graph](image)