Deepwater Horizon Oil Spill (DWHOS)
Water Column Technical Working Group

NRDA CTD Data Processing Plan
May 23, 2012

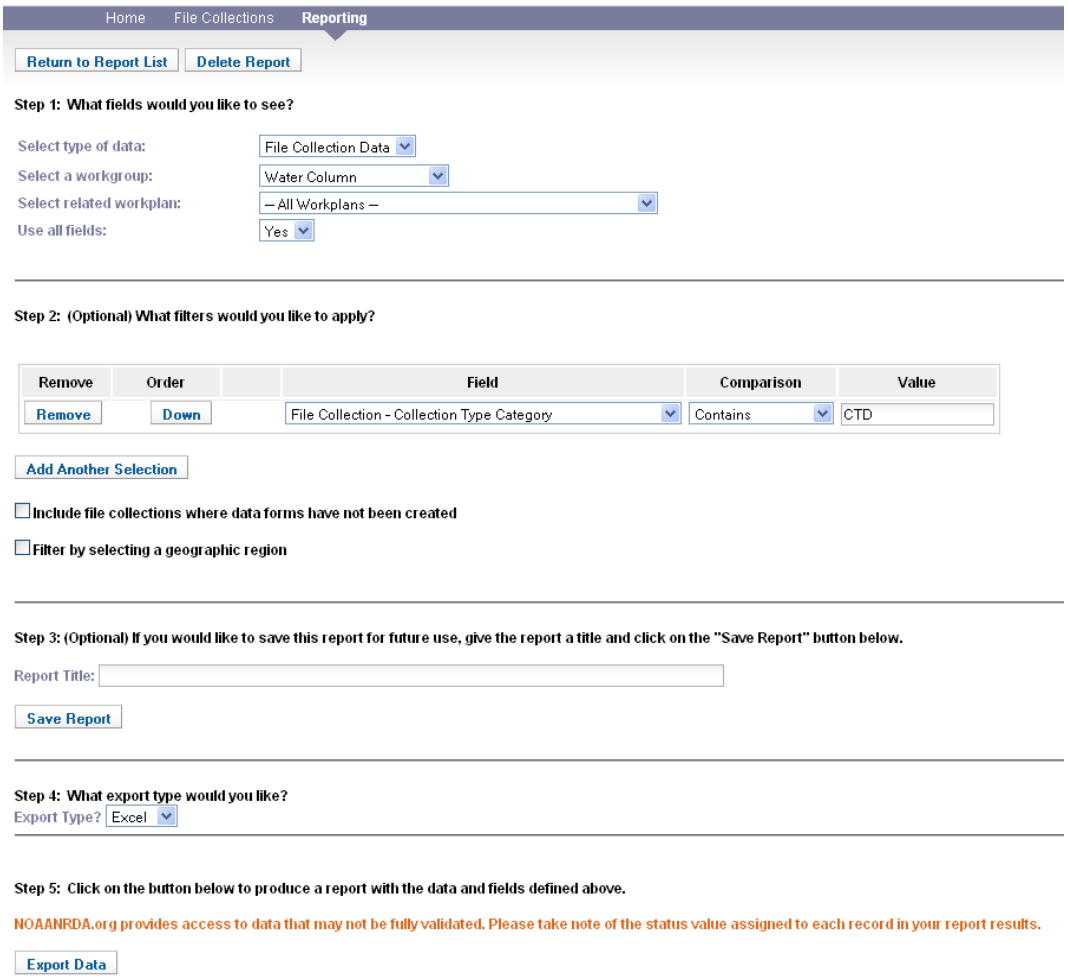
Attachment 2. NODC CTD Data Processing Standard Operating Procedures

These Standard Operating Procedures will be completed on each individual CTD cast for which data are discovered. Three sections are described: Data download from www.noaanrda.org, Seabird Processing, and Conversion to NetCDF file format. All data will be made available via the NOAA NRDA Data Content Management System.

Data download from noaanrda.org

1) Go to www.noaanrda.org, log in, and then download a new CTD report
   - Under "Reports" go to: View/Edit All Reports
   - Either create a new report, or open a previously saved one and export the data.

If creating a report for the first time, the most important option is a filter for CTD data under 'Step 2'. Under *Field* select *File Collection - Collection Type Category*, under *Comparison* select *Contains*, and under *Value* type *CTD*. A simple example of a CTD report setup from www.noaanrda.org is shown below:



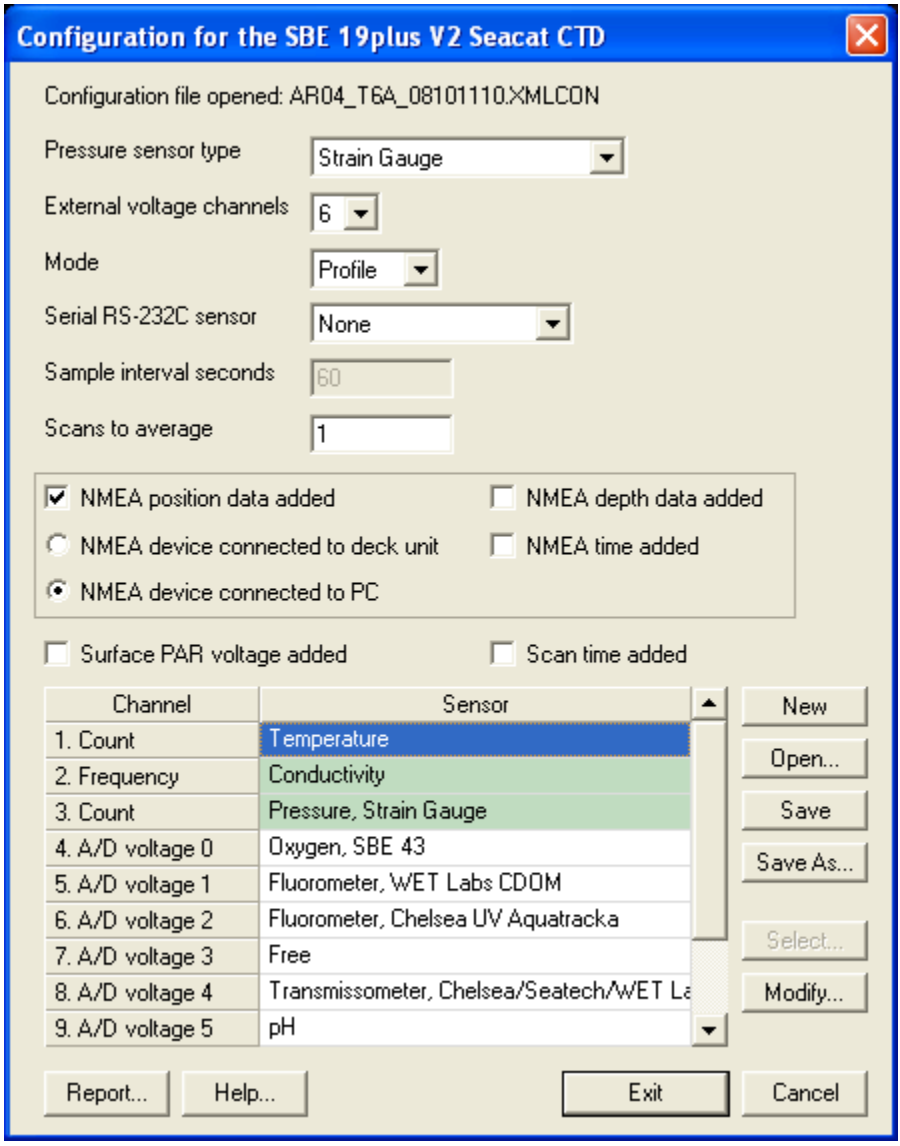
2) Download the newest files from file collections

- In the exported Excel file, find the new data you are interested in (you can sort by the *File Collection - Uploaded Date* to help you find new files)
- Go to the column *File Collection - Link To File Collection*, and click the link next to the file of interest. (This will bring you back to www.noaanrda.org to the specific file collection page you specified.)
- Scroll down to the *Attached Observation Files* section and click the link to download the *Raw Instrument Data*:

3) Un-zip & sort them into proper location on the server

Sea-Bird Processing

For CTD processing, Sea-Bird software is used. The processing steps are: Sensor Discovery > Data Conversion > Align CTD > Wild Edit > Filter > Cell Thermal Mass > Bottle Summary > Derive > Split > ASCII Out



Steps for Processing CTDs using Sea-Bird software:

<u>Sensor Discovery</u>

1. Double click on the configuration file (either the .xmlcon or the .con file)
2. Record all the sensors listed, this will be used to make sure all sensors on the rosette package will be processed. Click on the 'Report…' button to bring up a Configuration Report, then choose 'Save and exit…' to save a copy of the report as a text file in the working directory Drive letter:\<ship>\<cruise>\1-data\CTD\<station>\
3. Start SBEDataProcessing-Win32 software

<u>Data Conversion – Converts Raw data to engineering units and stores data in a .cnv and .ros file.</u>

4. Click 'Run'
5. Select '1. Data Conversion'
6. Click 'OK'

In FILE SETUP MENU tab

7. Under instrument configuration file, click 'Select'
8. Choose folder Drive letter:\<ship>\<cruise>\0-data\CTD\<station>\… until reaching a folder with the appropriate.con file and select that file
9. Under Input directory, click 'Select'
10. Choose .hex or .dat file (it should come up to the same folder chosen in step 8)
11. If it asks if you want the output directory to match, click 'No.'
12. Under Output directory, click 'Select'

13. Choose folder: “Drive letter:\<ship>\<cruise>\1-data\CTD\<station>\”
    Note: (If this folder structure does not exist, create it first)

In HEADER VIEW tab

14. If the Header indicates that a NMEA value was used, skip to step 16.
15. Mark down Latitude value in Header (e.g. 28 42.95 = 28.72). Note: to convert from ddmm.ss to dd: (mm.ss/60 + dd = dd).

In DATA SETUP tab

16. Check spreadsheet in Drive letter:\<ship>\<cruise>\0-data\CTD\Documentation to see if you should use System Upload time. If not, use NMEA time, and if that’s not available (check header), use the Instrument’s time stamp.
17. Under ‘Convert data from’, select ‘upcast and downcast’
18. Under ‘Create file types’, select ‘create both data and bottle file’
19. Under ‘Source of scan range data’, select Bottle log (.bl) file
20. Click ‘Select Output Variables’ button
21. Select ‘Time, Elapsed - julian days’
22. Select ‘Scan Count’
23. Select ‘Latitude [deg]’
24. Select ‘Longitude [deg]’
25. Select ‘Temperature’, ‘ITS-90’ (deg C), click ‘Add’
26. Select ‘Pressure, Digiquartz’ (db) OR ‘Pressure, Strain Gauge’ (db), click ‘Add’
27. Select ‘Conductivity, S/m’, click ‘Add’
28. Select ‘Oxygen raw, SBE 43 [V]’, click ‘Add’ (note to set hysteresis ‘on’)
29. Select and add each sensor that records any kind of fluorescence, click ‘Add’ on each
30. Select all other sensors that were discovered from the configuration file in the sensor discovery and add them to the list
31. Select ‘Voltage Channel’. Click on each voltage, then click ‘Add’. Do this for all voltages, even if no sensor is present on that Voltage Channel.
32. Click ‘OK’
33. Click ‘Start Process’ (Note: if you get a “Processing Stopped” message after clicking ‘Start Process,’ go back to Step 17 and select ‘create converted data (CNV) file only’ and then try to Process again. If the data still will not process, go back to Step 16 and for the ‘Convert data from’ option, choose ‘downcast’.)
34. Click ‘Exit’
35. Do you want to save? Yes

Align CTD – Aligns parameter data in time, relative to pressure, so that all measurements are made from the same parcel of water.

36. Click ‘Run’
37. Select ‘3. Align CTD’

In FILE SETUP tab

38. Under Input directory, click ‘Select’
39. Choose Drive letter:\<ship>\<cruise>\1-data\CTD\<station>\xxx.cnv
40. It will ask you if you want the output directory to be the same. Say ‘Yes’

In DATA SETUP tab

41. Click ‘Enter Advance Values’
42. Using the tables below (see SBE Data Processing Manual v 7.21 Pgs. 79-81 for details), enter the appropriate values for the CTD Model being processed. Temperature and raw oxygen will be the variables receiving advancement.

Instrument	Advance of Temperature Relative to Pressure (s)
9*plus*	0
19, 19*plus*, or 19*plus* V2	+.5
25	0
49	+.0625

Instrument	Advance of Oxygen Relative to Pressure (s)
9*plus*	+3
19*plus* or 19*plus* V2	+3
19	+3
25	+3

Instrument	Advance of Conductivity Relative to Temperature (s)
9*plus*	N/A
19, 19*plus*, or 19*plus* V2	N/A
25	+0.1
49	N/A

43. Once the appropriate values for Temperature and Oxygen are entered, click ‘ok’.
44. Insert ‘edit’ before the extension in the output file name
45. Click ‘Start Process’
46. Click ‘Exit’
47. Do you want to save? Click ‘Yes’

Wild Edit – Marks wild points in the data by replacing the data value with *badflag*.

48. Click ‘Run’
49. Select ‘11. Wild Edit’

IN FILE SETUP TAB

50. Under Input directory, click ‘Select’
51. Choose Drive letter:\<ship>\<cruise>\1-data\CTD\<station>\xxx_edit.cnv
52. It will ask you if you want the output directory to be the same. Say ‘Yes’

IN DATA SETUP TAB

53. Click ‘Select Wild Edit Variables’
54. Click ‘Clear All’
55. Check the boxes next to Temperature, Pressure and Conductivity only.
56. Click ‘OK’
57. Confirm settings:
    i. Standard deviation for pass one: 2
    ii. Standard deviation for pass two: 20
    iii. Scans/block: 100
    iv. Keep data within this distance of the mean: 0
    v. Exclude scans marked bad: yes (check)
58. Click ‘Start Process’
59. Is it ok to overwrite xxx_edit.cnv? Click ‘yes’
60. Click ‘Exit’
61. Do you want to save? Yes

Filter – Runs a zero phase, low-pass filter on the pressure data to remove any high frequency digital noise.

62. Click ‘Run’
63. Select ‘2. Filter’
64. In FILE SETUP tab Under Input directory, click ‘Select’
65. Choose Drive letter:\<ship>\<cruise>\1-data\CTD\<station>\xxx_edit.cnv
66. It will ask you if you want the output directory to be the same. Click ‘Yes.’

In DATA SETUP tab

67. In the box for ‘Low Pass Filter A, time constant [s]’, enter in the time constant that coincides with the model number of the CTD being processed. Values for this can be found in the table below (see SBE Data Processing Manual v 7.21 Pgs. 92-94 for details)

Instrument	Pressure Time Constant (s)
SBE 9*plus*	.15
SBE 19*plus* or 19*plus* V2	1
SBE 19	2
SBE 25	.5
SBE 49	.25

68. In the box for ‘Low Pass Filter B, time constant [s]’, enter in the time constant that coincides with the model number of the CTD being processed. This time constant will be used to filter Temperature and Conductivity for the SBE 19plus and SBE19 models only, and values for this can be found in the table below (Values taken from correspondence with Sea-Bird representative Carol Janzen)

Instrument	Temperature and Conductivity Time Constant (s)
SBE 9*plus*	N/A
SBE 19*plus* or 19*plus* V2	.5

SBE 19	.5
SBE 25	N/A
SBE 49	0.085

69. Click ‘Specify Filters’
70. Find ‘Pressure, Strain Gauge [db]’ or ‘Pressure, Digiquartz [db]’ under the ‘Variable Name’ list. Under ‘Filter Type’, select ‘Low pass filter A’. If not processing an SBE 19plus or SBE 19, please skip to step 72.
71. Find ‘Temperature [ITS-90, deg C]’ and ‘Conductivity [S/m]’ under the ‘Variable Name’ list. Under ‘Filter Type’, select ‘Low pass filter B’
72. Click ‘Start Process’
73. Is it ok to overwrite xxx_edit.cnv? Click ‘yes’
74. Click ‘Exit’
75. Do you want to save? Click ‘Yes’

Cell Thermal Mass – Uses a recursive filter to remove conductivity cell thermal mass effects from the measured conductivity.

76. Click ‘Run’
77. Select ‘4. Cell Thermal Mass’

In FILE SETUP tab

78. Under Input directory, click ‘Select’
79. Choose Drive letter:\<ship>\<cruise>\1-data\CTD\<station>\xxx_edit.cnv
80. It will ask you if you want the output directory to be the same. Say ‘Yes’

In DATA SETUP Tab

81. For ‘Temperature sensor to use’, ensure that ‘Primary’ is selected for the top box. If there are two conductivity and two temperature sensors present on the CTD, click ‘Correct secondary conductivity values’. Then, select ‘Secondary’ for the second ‘Temperature sensor to use’ in correcting the secondary conductivity sensor.
82. Enter in the ‘Thermal anomaly amplitude [alpha]’ and ‘Thermal anomaly time constant [1/beta]’ values that correspond with the CTD model being processed. Values for these constants can be found in the table below (Please see SBE Data Processing Manual v 7.21 Pgs. 87-88 for details)

Instrument	Alpha	1/beta
SBE 9*plus*	.03	7
SBE 19*plus* or 19*plus* V2	.04	8
SBE 19 with TC duct and 2000 rpm pump	.04	8
SBE 19 with no pump	.042	10
SBE 25	.04	8
SBE 49	.03	7

83. Click ‘Start Process’

84. Is it ok to overwrite xxx_edit.cnv? Click ‘yes’
85. Click ‘Exit’
86. Do you want to save? Click ‘Yes’

Bottle Summary – Reads a .ros file created in “Data Conversion” and writes a bottle data summary to a .btl file.

87. If there is no .ros file present, or there is only downcast data, skip to step 110.
88. Click ‘Run’
89. Select ‘8. Bottle Summary’

In FILE SETUP tab

90. Under Instrument configuration file, click ‘Select’
91. Choose folder “Drive letter:\<ship>\<cruise>\0-data\CTD\<station>\… until you get to a folder with a .con file and select that file
92. Under Input directory, click ‘Select’
93. Choose Drive letter:\<ship>\<cruise>\1-data\CTD\<station>\xxx.ros
94. It will ask you if you want the output directory to be the same. Say ‘Yes’

In DATA SETUP tab

95. Click ‘Select Averaged Variables’
96. Click ‘Select All’
97. Click ‘OK’
98. Click ‘Select Derived Variables’
99. Click ‘Expand All’
100. Add ‘Density, Kg/m^3’
101. Add ‘Oxygen Saturation, Weiss, ml/l’
102. Add ‘Oxygen Saturation, Weiss, mg/l’
103. Add ‘Oxygen, SBE 43, mg/l’
104. Add ‘Oxygen, SBE 43, ml/l’
105. Add ‘Potential Temperature, ITS-90, deg C’
106. Add ‘Salinity, Practical [PSU]’
107. Add ‘Sound Velocity, Chen-Millero, m/s’
108. Click ‘OK’
109. Click ‘Start Process’
110. Click ‘Exit’
111. Do you want to save? Yes

Derive – Uses pressure, temperature, and conductivity from the input .cnv file to compute user-defined oceanographic parameters.

112. Click ‘Run’
113. Select ‘6. Derive’

In FILE SETUP tab

114. Under Instrument configuration file, click ‘Select’

115. Choose folder Drive letter:\<ship>\<cruise>\0-data\CTD\<station>\… until you get to the folder with the previously used .con file and click ‘select’
116. Under input directory, click ‘Select’
117. Choose Drive letter:\<ship>\<cruise>\1-data\CTD\<station>\xxx_edit.cnv
118. It will ask you if you want the output directory to be the same, click ‘yes’
119. In the ‘Name Append’ box, enter _derive

In DATA SETUP tab

120. Click ‘Select Derived Variables’
121. Select the following output variables:
122. Descent Rate (m/s)
123. Enter in a window size equal to the real time sample interval. (Can be found in the header view tab)
124. Depth (salt water, ft)
125. Enter Latitude acquired in step 15
126. Depth (salt water, m)
127. Enter in the same Latitude as step 15
128. Potential Temperature (ITS-90, ºC)
129. Salinity, Practical (PSU)
130. Density (Sigma-t, kg/m3)
131. Density (Sigma-theta, kg/m^3)
132. Sound Velocity (Chen-Millero, m/s)
133. Average Sound Velocity (Chen-Millero, m/s)
134. Specific Volume Anomaly ($10^{-8}m^3$/kg)
135. Oxygen, SBE 43 (mg/l)
136. Check ‘Tau Correction’ with a window size of 2s
137. Oxygen, SBE 43 (ml/l)
138. Check ‘Tau Correction’ with a window size of 2s
139. Oxygen Saturation, Weiss (mg/l)
140. Oxygen Saturation, Weiss (ml/l)
141. Click ‘Start Process’
142. Click ‘Exit’
143. Do you want to save? Click ‘yes’

Split – Separates the data from an input .cnv file into upcast (pressure decreasing) and downcast (pressure increasing) files.

144. Click ‘Run’
145. Select ’16. Split’

In FILE SETUP tab

146. Under Input directory, click ‘Select’
147. Choose Drive letter:\<ship>\<cruise>\1-data\CTD\<station>\xxx_edit_derive.cnv

In DATA SETUP tab

148. Under ‘Output Files’, select ‘Downcast and Upcast’

149. Check ‘Exclude scans marked bad’
150. Click ‘Start Process’
151. Click ‘Exit’
152. Do you want to save? Yes

ASCII Out – Outputs the header portion and/or the data portion of a .cnv file to an ASCII file.

153. Click ‘Run’
154. Select ‘14. ASCII out’

In FILE SETUP tab

155. Under Input directory, click ‘Select’
156. Choose Drive letter:\<ship>\<cruise>\1-data\CTD\<station>\dxxx_edit_derive.cnv and Drive letter:\<ship>\<cruise>\1-data\CTD\<station>\uxxx_edit_derive.cnv

In DATA SETUP tab

157. Under label columns, Select “Top of file”
158. Click ‘Start Process’
159. Click ‘Exit’
160. Do you want to save? Yes

The CTD Processed directory folder for the station you are processing should have the following files when complete:
Station.txt
Station.cnv
Station_edit.cnv
Station.ros
Station.btl
Station_edit_derive.cnv
dStation_edit_derive.cnv
uStation_edit_derive.cnv
dStation_edit_derive.hdr
dStation_edit_derive.asc
uStation_edit_derive.hdr
uStation_edit_derive.asc

Conversion to NetCDF File Format

Using a script, *dStation_edit_derive.hdr, dStation_edit_derive.asc, uStation_edit_derive.hdr, and uStation_edit_derive.asc* are converted into the NetCDF format. The script also completes the automated GTSPP QC procedures, and valid range checks on the auxiliary sensors as outlined in the main processing plan.

From the asterisk-prepended section of the header of the cnv file the script parses values from the lines:

* Temperature SN = <Temperature SN>
* Conductivity SN = <Conductivity SN>
* System UpLoad Time = <Date/Time>
** Station: <Station>

and reads the coordinates from the lines

** Lat: <User-Entered Latitude>
** Lon: <User-Entered Longitude>

or

* NMEA Latitude = <System Set Latitude>
* NMEA Longitude = <System Set Longitude>

depending on availability.

From the hash-prepended section of the header the script parses the column names of the data, and maps these names to the variable name, sensor, long name, standard name, and unit attributes that will appear in the NetCDF.

ex: from "# name 9 = sal00: Salinity, Practical [PSU]" the script reads "sal00" and recognizes that the tenth column of data (the name fields start counting from 0) has the standard name 'sea_water_salinity' with units 1e-3, etc.

The script goes on to read each line of data and sort them into lists by column, where they can be written to the NetCDF by variable.

Running the scripts from the command line uses the syntax "python thescript.py <anything, previously path to xml file to be included><name of output cruise-level file><.cnv input file 1> [<.cnv input file 2><.cnv input file 3> ...<.cnv input file n>]"

The script creates one NetCDF file for each .cnv file, dimensioned by scan count and the start time.