STANDARD OPERATING PROCEDURE FOR CALIBRATION AND FIELD MEASUREMENT PROCEDURES FOR THE YSI MODEL 6-SERIES SONDES AND DATA LOGGER (INCLUDING: TEMPERATURE, pH, SPECIFIC CONDUCTANCE, TURBIDITY, DISSOLVED OXYGEN, CHLOROPHYLL , RHODAMINE WT, ORP, AND BARAMETRIC PRESSURE).

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Revision Page

Date	Rev#	Summary of Changes	Sections
4/23/02	0	Initial Approval	
5/31/02	1	Changed DO requirement to < 1.0mg/l	5.5.1.8
7/18/02	2	Added Oxygen Solubility Table - Billie Gould	11.0 (added)
1/9/03	3	Conductivity from .15% to 15% (WP problem - thanks C. Porfert)	Table 7.2
7/9/03	4	Added values to Oxygen Solubility Table and Sonde Calibration Form - Kosuke Kawai Changed zero DO criterion from 1.0 mg/l to 0.5mg/l – TF	11.0 5.5.1.8
7/25/03	5	Updated App. B, and parameter updates - TF	App. B, 5.5.1.7, 5.3.1
8/5/04	6	Updated calibration information & cal. form - TF	App. B, 5.0
6/07/05	7	General update and added parameters – BB, TB, TF	all

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1.0 Scope and Application

The purpose of this standard operating procedure (SOP) is provide a framework for calibrating sondes used to measure water quality parameters for ground water and surface water. Water quality parameters include temperature, pH, dissolved oxygen, conductivity/specific conductance, turbidity, and chlorophyll, oxidation/reduction potential and rhodamine.

This SOP is written specifically for the YSI model 6-Series Sondes (which include the 600R, 600XL, 600XLM, 6820, 6920 and 6600 models), the YSI 650 MDS (Multi parameter Display System) display/logger, and YSI EcoWatch software. The general calibration processes discussed herein are applicable to other manufactures sondes and displays/loggers. Consult the manufacture's instruction manuals for specific procedures.

2.0 Summary of Methods

This document describes a process for calibrating and performing water quality field measurements using YSI 6-Series Sondes.

3.0 Health and Safety Warnings

3.1 All proper personal protection clothing and equipment is to be worn.

3.2 The standard solutions for calibrating conductivity contain Iodine and Potassium Chloride. When using the standards, avoid inhalation, skin contact, eye contact or ingestion. If skin contact occurs remove contaminated clothing immediately. Wash the affected areas thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, consult the Material Data Safety Sheets (MSDS) for prompt action, and in all cases seek medical attention immediately.

3.3 The standard solutions for calibrating turbidity contain Styrene divinylbenzene copolymer spheres. While the material is not volatile and has no known physical effects on skin, eyes, or on ingestion, general health and safety precautions should be adopted to minimize unnecessary contact. If skin contact occurs remove contaminated clothing immediately. Wash the affected areas thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, consult the MSDS for prompt action, and in all cases seek medical attention immediately

3.4 The standard solutions for calibrating pH contain deionized water, potassium acid phthalate, inert dye, potassium phosphate, sodium phosphate, potassium chloride, and preservatives (no mercury or formaldehyde). Avoid inhalation, skin contact, eye contact or ingestion. If skin contact occurs remove contaminated clothing immediately. Wash the affected areas thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, consult the MSDS for prompt action, and in all cases seek medical attention immediately.

3.5 The Zero DO solution contains sodium sulfite and in some cases a trace amount of cobalt chloride.

This solution should be handled with care; the cobalt chloride is a suspected carcinogen. If skin contact occurs remove contaminated clothing immediately. Wash the affected areas thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, consult the MSDS for prompt action, and in all cases seek medical attention immediately.

3.6 Rhodamine WT dye should be handled with care. The active indgredient in this dye is trimettlic acid. Very little is known about its long term effects on humans so it should be handled with care. If contact occurs, wash the affected areas thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, consult the MSDS for prompt action, and in all cases seek medical attention immediately.

3.7 The Zobell solution used for calibrating ORP contains potassium chloride, potassium ferrocyanide (trihydrate), and Potassium ferricyande. If contact occurs, wash the affected areas thoroughly with large amounts of water. Cyanides in general are often considered toxic to humans. For more info, see the MSDS.

3.8 Follow the most updated Boat Safety SOP when conducting sampling from a boat.

4.0 Equipment and Supplies

4.1 NIST traceable thermometer (only needed once per year)
4.2 pH Standards of 4, 7, and 10
4.3 Conductivity standards (concentration dependent upon expected field conditions)
4.4 Turbiditiy standards (concentration dependent upon expected field conditions)
4.5 Deionized and tap water
4.6 Calibration cups
4.7 YSI Sonde with attached pH/ORP, Conductivity, Dissolved Oxygen, Turbidity, Chlorophyll, and Rhodamine probes
4.8 YSI 650 MDS Multiparameter Display System (display logger)
4.9 Sonde communications cable
4.10 Notebook
4.11 Pen
4.12 Disposable gloves, goggles and safety glasses
4.13 Zobell Solution
4.14 Rhodamine WT dye
4.15 (Access to) Princo Mercury Barometer
4.16 N.I.S.T. traceable thermometer
4.17 Batteries

5.0 Calibration

Check the display/logger to determine the battery level in the display/logger to see if recharging or new batteries are necessary. Prior to calibration, all instrument probes on the sonde must be

cleaned according to the manufacture's instructions. Failure to perform this step can lead to erratic measurements. The probes must also be cleaned by rinsing with deionized water before and after immersing the probe in a calibration solution. For each of the calibration solutions provide just enough volume so that the probe and the temperature sensor are sufficiently covered. When done with the calibration solutions do not return it to the original bottle, save solution in separate container or dispose of it properly. When using the Sonde for long-term deployment and using the "Autosleep RS232, and Autosleep SDI12" functions, the instrument must be calibrated in these modes. For manual measurements this function should be turned off (see section 5.5.1.3) prior to calibration.

5.1 Temperature

For instrument probes that rely on the temperature sensor (pH, dissolved oxygen/specific conductance, and oxidation-reduction potential), the sonde temperature sensor needs to be checked for accuracy against a thermometer that is traceable to the National Institute of Standards and Technology (NIST). This accuracy check should be performed at least once a year, and the date and results of the check kept on file. Below is the verification procedure.

5.1.1 Once a year, the accuracy of the instrument must be verified by checking the endpoints of the desired temperature range. For example, if the desired temperature range is 0°C to 40.0°C, the instrument must be with in the +/-0.15°C of both end points.

5.1.2 Place a thermometer that is traceable to the NIST into the water and wait for both temperature readings to stabilize.

5.1.3 Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer within the accuracy of the sensor (+/- 0.15°C). If the measurements do not agree, the instrument may not be working correctly and the manufacturer should be contacted.

5.2 pH

The pH of a sample is determined electrometrically using a glass electrode. Choose the appropriate standards that will bracket the expected values at the sampling locations. For this procedure three standards will be used (pH 4, pH7, & pH10). If the probe is slow to response refer to the section 6.0 Troubleshooting.

5.2.1 Rinse probe with deionized water and shake off excess water. Allow the buffered samples to equilibrate to the ambient temperature.

5.2.2 Place the probes (at least pH and temperature probes) on the sonde into the pH 7 buffer.

5.2.3 On the display/logger use the up/down arrow keys to highlight the "Calibrate" option and

press the enter key.

5.2.4 Highlight the "pH" option and press enter.

5.2.5 Highlight the "3-point" option and press enter.

5.2.6 Input the value of the buffer, which is 7.00 and press enter.

5.2.7 Wait for the value of pH to stabilize and then press enter. Wait for "Calibrated" message. If an "Out of Range" message appears, do not accept, check the probe and refer to operator's manual or section 6.0 Troubleshooting.

5.2.8 Place the pH probe into a pH 4.00 buffer.

5.2.9 Press enter key to continue calibration

5.2.10 When prompted, enter the pH of the second buffer, "4.00". Wait for "Calibrated" message, and press any key to continue.

5.2.11 Rinse probe with deionized water and shake off excess water

5.2.12 Place the pH probe into a pH 10.00 buffer.

5.2.13 Press enter key to continue calibration

5.2.14 When prompted, enter the pH of the third buffer, "10.00". Wait for "Calibrated" message, and press any key to continue.

5.2.15 Rinse probe with deionized water and shake off excess water.

5.2.16 Exit the calibration menu and go to the "Sonde Run" mode. Insert probe into pH 7 buffer and make sure it is reading correctly ($\pm$ 0.05). If buffer reading is not correct, repeat the calibration procedure.

5.3 Specific Conductance

Conductivity is used to measure the ability of an aqueous solution to carry and electrical current. Specific conductance is the conductivity value corrected at 25°C.

5.3.1 Place the cleaned probes into the specific conductivity standard solution, making sure that the specific conductivity probe is **fully submerged.** For studies where conductivity is a critical parameter (non-critical parameters will be identified in the QAPP), the accuracy of the instrument must be verified by checking the endpoints of the desired conductivity range

to insure linearity. Calibrate with one of the standards (the high standard) and check the instrument with a low standard. At the end of the monitoring period check the instruments with both standards. If you are using a small amount of calibration solution or standards that are easily contaminated first rinse the probe(s) with the conductivity standard. Where conductivity is a non-critical measurement you can check and calibrate the instrument with one calibration solution.

5.3.2 Return to the display/logger main menu and select "Calibrate" and press enter.

5.3.3 Select "Conductivity" and press enter.

5.3.4 Select "SpCond" and press enter.

5.3.5 Enter the standard concentration in mS/cm and press enter. The standard concentration should be just above the highest concentrations you expect to measure.

5.3.6 After the specific conductivity reading has stabilized press enter to calibrate. Wait for the "calibrated" message to appear. If the Sonde should report "Out of Range" do not override the error message, instead recheck the standard and go to the section 6.0 Troubleshooting for more help.

5.3.7 Exit the calibration menu and go to the "Sonde Run" mode and record the concentration (make sure it is reading with in 5% of standard value).

5.3.8 To check the calibration with a second standard (low), rinse probe with deionized water and insert probe in second standard and make sure it is reading with in 10%. A second standard is used to check the calibration at the low range and to bracket the expected concentrations. This must be performed when conductivity is a critical measurement.

5.4 Turbidity

The turbidity method is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference solutions. Critical to the instrument's operation is that the lens covering the detection unit is kept clean both during calibration and field use. The turbidity probes used on the YSI 6-Series sondes include an automated optics wiper. This wiper can be activated using the display/logger. The calibration and post calibration check should be performed in the laboratory before and after sampling

The following procedure is specified for the YSI 6136 Probe. (Note there is a different procedure for the older YSI 6026 Probe). With the use of the 6136 probe you **must** use the extended probe guard and the black bottom calibration cup. Use only YSI (or a certified equivalent) calibration standard, for more information refer to the owners manual.

5.4.1 Check to make sure the turbidity probe and wiper are clean and free from any material.

5.4.2 Activate the wiper to make sure it is wiping and parking correctly.

5.4.3 Allow the standard samples to equilibrate to the ambient temperature.

5.4.4 Clean all of the probes on the sonde with deionized water. Shake off excess water.

5.4.5 Place the sonde in the black bottom calibration cup containing the 0.0 NTU standard (which can be deionized water).

5.4.6 Using a stand to hold the sonde separate the calibration cup from the bottom of the Sonde by a distance equal to the width of 3 fingers (two inches). (The distance from the threads on the sonde to the bottom of the calibration cup should be equal to the length of the extended probe guard.)

5.4.7 From the "Calibrate" Menu, on the display/logger, select the "Turbidity" option and press enter.

5.4.8 Select the "2-point" option and press enter.

5.4.9 Enter "0.0" as the first calibration standard and press enter.

5.4.10 Select the "clean optics" option to activate the automated wipers. Once the cleaning process is completed, wait for the turbidity measurement to equilibrate, and then press the enter key.

5.4.11 Place the probe in the second standard (10 NTU or 11.3 NTU is the common standard solution). This second standard should be slightly above the highest concentration that is expected to be measured in the field. It is not necessary to clean the probe before placing into the second standard. Shake off excess DI water.

5.4.12 Press enter to continue calibration.

5.4.13 Enter the concentration of the second calibration standard (10 NTU or 11.3 NTU is the common solution of use) and press enter.

5.4.14 Again, select the "clean optics" option to activate the automated wipers. Once the cleaning process is completed, wait for the turbidity measurement to equilibrate, and then press the enter key.

5.4.15 Exit the "calibration" mode and enter the "Sonde Run" mode. Make sure it is reading with in +/- 10 % of the original concentration. If the buffer reading is not correct, repeat the

calibration procedure.

5.5 Dissolved Oxygen

Dissolved oxygen (DO) content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be inspected for any damage or air bubbles prior to calibration. If air bubbles or damage are present, replace the membrane according to manufacturer suggestions. (After changing the membrane, for accurate measurements, you must wait 6 - 12 hours before use to allow the membrane to equilibrate) YSI 6-Series DO probe must be calibrated using the calibration cup provided with the sonde or by wrapping the sonde probe guard with a wet towel.

The DO is calibrated in the field prior to taking measurements and the final post calibration (verification) check should also be performed in the field before the instrument is turn off and after all measurements are taken.

When calibrating DO and not using the auto sleep function the instrument must be turned on (warmed up) for 15 minutes prior to calibration. When calibrating the DO for unattended sampling and using the auto sleep function, the instrument should not be warmed up before calibrating (it should be calibrated when the instrument is cool, since it is cool when the instrument is taking readings).

Calibration of the DO probe requires inputting the current barometric pressure. The YSI 650 display/logger has a barometer within the unit and automatically provides this during the calibration procedure. Other display/loggers may not supply the barometric pressure, in this case you will need a separate barometer.

Two calibration procedures are listed below for dissolved oxygen, one for sampling applications and one for long-term monitoring applications.

5.5.1 Calibration Procedure for Discrete Sampling (non deployment) Applications

The dissolved oxygen probe is calibrated each day prior to use. An initial inspection and calibration should be performed the day before to assure the membrane is in good shape the instrument is working properly. Follow the procedure below to calibrate.

5.5.1.1 Clean all of the probes on the sonde with tap (or clean ambient water) water. Shake off excess water.

5.5.1.2 Place approximately 1/8 inch of water in the bottom of the calibration cup. Place the probe end of the sonde into the cup. Engage only 1 or 2 threads of the calibration cup to insure the DO probe is vented to the atmosphere. [An equivalent alternative method is to wrap the probe guard (which is attached to the sonde) with

a wet towel and place the sonde in a 5 gallon bucket with 1 inch of water in it.] Make sure that the DO and temperature probes are NOT immersed in water and that the Sonde cup is not in direct sunlight. Wait approximately 10 minutes for the air in the calibration cup to become water saturated and for the temperature to equilibrate.

5.5.1.3 For manual sampling applications the dissolved oxygen probe is continuously pulsing, therefore the "Autosleep RS232" function should be deactivated. (The "Autosleep SDI12" does not effect the manual sampling and can remain on.) From the "Main" menu on the display/logger, select the "System Setup" option and press enter. Then select the "Advanced" option and press enter. Select the "Autosleep RS232" option and press enter to obtain the "off" setting. Then press the "ESC" button until returning to the main menu.

5.5.1.4 From the calibration menu select the "Dissolved Oxy" option, then the DO% option (Note: For the YSI 6-Series Sondes, calibration of dissolved oxygen by the DO% procedure also results in the calibration of the DO mg/l mode and vice versa.)

5.5.1.5 Enter the current barometric pressure in mm of Hg. The correct pressure will automatically apear, double check this value with the reading provided in the lower right hand corner of the display.

5.5.1.6 Press enter and then wait for the DO% reading to equilibrate. Press enter to accept the calibration. Press enter again to return to the calibration menu.

5.5.1.7 Immediately enter the "Sonde Run" mode and record the temperature, dissolved oxygen in mg/l and %, and the barometric pressure used for calibrating. The DO should be with in $\pm$ 0.2 of saturation value. If not, go to section 5.5.1.4 to recalibrate.

5.5.1.8 For critical DO (non-critical parameters will be identified in the QAPP) applications verify the probe with a zero DO solution.

1) Place the probe in a zero DO solution.
2) Verify the probe reads < 0.5mg/l (or to the range specified in QAPP)
3) Rinse probe and store the probe in tap water.

5.5.1.9 Fill the calibration cup half way with tap water and screw on to the sonde. The sonde is now ready for use.

5.5.2 Calibration Procedure for Continuous Monitoring (deployment) Applications

When the instrument will be used for long term monitoring applications, the "Autosleep RS232, and Autosleep SDI12" function must be activated before calibration. After making sure this function is on, follow steps 5.5.1.1-5.5.1.9 (skip 5.5.1.3 and turn the instrument on after 5.5.1.2) in

"Calibration Procedure for Sampling Applications". If the instrument has been in the run mode, switch to a different mode or turn off the instrument and allow the instrument to cool for 10 minutes before calibrating the DO.

5.6 Chlorophyll

Note: This procedure is under development and is draft.

Chlorophyll is found in nature in various forms bound within biological matter. It is a key component in the photosynthesis process and is measured because of its correlation with the suspended phytoplankton in the water, which provides an assessment of the overall quality of the water. The classical method of determining chlorophyll in the environment is a labor-intensive and time-consuming process that needs to be completed in the laboratory. The probe utilizes a property of chlorophyll that it fluoresces, meaning it emits a higher wave length (lower energy) light when irradiated with light of a particular wavelength. This method is not intended to replace the far more accurate method of calculating chlorophyll in the laboratory, but provide an estimate of chlorophyll concentrations in an efficient manner.

The most accurate estimates require having standards of with known amounts of phytoplankton, determined in the laboratory, but this method of calibration will determine relative fluorescence which will later be paired with a few grab samples to provide an estimate of the concentrations of chlorophyll with the minimal lab work.

This calibration method requires corresponding grab samples to be analysed by the laboratory to provide meaningful chlorophyll a values. It is a two point calibration to determine the relative fluorescence of the sample and to see if there is any drift in the fluorescence value throughout the sampling process. The first standard is deionized water and the second standard can be an Acridine Orange, Rhodemine B or Rhodemine WT dye. This methodology will used Rhodamine WT. See page 5-23 in YSI operation manual for preparation of standard and approximate chlorophyll values.

5.6.1 Check to make sure the chlorophyll probe and wiper are clean and free from any material.

5.6.2 Activate the wiper to make sure it is wiping and parking correctly.

5.6.3 Allow the standard samples to equilibrate to the ambient temperature.

5.6.4 Clean all of the probes on the sonde with deionized water. Shake off excess water.

5.6.5 Place the sonde in the calibration cup containing the deionized water.

5.6.6 From the "calibrate" Menu, on the display/logger, select the "chlorophyll" option and press enter.

5.6.7 Select the "2-point" option and press enter.

5.6.8 Enter "0.0" as the first calibration standard and press enter.

5.6.9 Select the "clean optics" option to activate the automated wipers. Once the cleaning process is completed, wait for the chlorophyll measurement to equilibrate, and then press the enter key.

5.6.10 Place the probe in 0.5mg/l Rhodemine WT dye standard (see page 5-23 of the operation manual for the correct value to enter). It is not necessary to clean the probe before placing into the second standard. Shake off excess DI water.

5.6.11 Press enter to continue calibration.

5.6.12 Select the "clean optics" option to activate the automated wipers. Once the cleaning process is completed, wait for the chlorophyll measurement to equilibrate, and then press the enter key.

5.6.13 Exit the "Calibration" mode and enter the "Sonde Run" mode make sure it is reading with in +/- 20 % of the second concentration. If the standard reading is not correct, repeat the calibration procedure.

5.7 Rhodamine WT (dye tracking)

Rhodamine WT is a fluorescent dye traditionally used to track water flow. It has a similar property to chlorophyll, in that it fluoresces; it emits a lower energy, higher wavelength light when it is irradiated by a particular wavelength of light. The probe emits light at a particular wavelength that can determine the concentration of the Rhodamine in the water by collecting the lower energy light beams that are reemitted.

This method of calibration will utilize deionized water and up to two additional standards. The standards used should bracket the expected concentration range. The probe has the ability to determine concentration up to 200 ppb. It is important that the standard and sensor are in thermal equilibrium for calibration.

5.7.1 Check to make sure the Rhodamine WT probe and wiper are clean and free from any material.

5.7.2 Activate the wiper to make sure it is wiping and parking correctly.

5.7.3 Allow the standard samples to equilibrate to the ambient temperature.

5.7.4 Clean all of the probes on the sonde with deionized water. Shake off excess water.

5.7.5 Place the sonde in the calibration cup containing the deionized water.

5.7.7 From the "Calibrate" Menu, on the display/logger, select the "Rhodamine WT" option and press enter.

5.7.8 Select the "2-point" or "3-point" option and press enter.

5.7.9 Enter "0.0" as the first calibration standard and press enter.

5.7.10 Place the probe in DI water and select the "clean optics" option to activate the automated wipers. Once the cleaning process is completed, wait for the rhodamine measurement to equilibrate, and then press the enter key.

5.7.11 Shake off excess DI water and place the probe in the second standard.

5.7.12 Press enter to continue calibration.

5.7.13 Enter the concentration of the second calibration standard and after Rhodamine concentration has equilibrated press enter.

5.7.14 Again, select the "clean optics" option to activate the automated wipers. Once the cleaning process is completed, wait for the Rhodamine measurement to equilibrate, and then press the enter key.

5.7.15 Wash the probe in DI water and shake off excess water before placing probe in third standard (if necessary) and press Enter.

5.7.16 Enter the concentration of the third standard. After Rhodamine has equilibrated, press enter.

5.7.15 Exit the "calibration" mode and enter the "Sonde Run" mode. Make sure it is reading with in +/- 5 % or 1 ug/l (which ever is greater) of the second concentration. If the reading is not correct, repeat the calibration procedure.

5.8 Oxidation Reduction Potential (ORP)

ORP is measuring the difference in potential between two electrodes, one a chemically inert electrode and the other a reference electrode. This measurement is made by a combination pH/ORP probe. Though ORP varies greatly with temperature, there is no temperature based correction program installed in the sonde or data logger. For the Zobell solution that will be used for this method of calibration, consult the chart on page 5-3 of the YSI operation manual. Temperature also must by taken into account when reporting ORP.

5.8.1 Allow the Zobell solution to equilibrate to the ambient temperature.

5.8.2 Clean all of the probes on the sonde with deionized water. Shake off excess water.

5.8.3 Place the probes (at least pH/ORP and temperature probes) in the Zobell solution.

5.8.4 Wait for temperature to stabilize. On the display/logger use the up/down arrow keys to highlight the "Calibrate" option and press the enter key.

5.8.5 Look up the millivolt (mv) value at this temperature from the millivolt versus temperature correction table found in the YSI manual or with the standard. Enter the temperature-corrected ORP value into the instrument.

5.8.6 Enter the sonde run menu. The value should be unchanged. If not, refer to operator's manual or section 6.0 Troubleshooting.

5.9 Barometric Pressure

Barometric Pressure is measured by the 650 MDS data logger and used for depth and dissolved oxygen calculations. It needs to be standardized to a NIST traceable barometer at least once a year. The procedure involves using the mercury barometer located in room 172.

5.9.1 Determine the uncorrected height of the column of mercury in mmHg by twisting the cistern adjusting screw to place triangular pin to barely touch the surface of mercury in the cistern reservoir.

5.9.2 The height of mmHg must be adjusted for temperature based on the thermal expansion of mercury. Using the thermometer hanging from the front of the barometer, the temperature of the mercury can be determined and then translated in the thermal expansion in mmHg using the chart in room 172.

5.9.3 The value in mmHg must further be adjusted to compensate for latitude. OEME is located at 42.6 degrees North. For this latitude: at a temperature corrected 700 mmHg, the latitude adjustment would subtract .23 mmHg, while at a temperature corrected 800 mmHg, the latitude adjustment would subtract .26 mmHg. For temperature corrected values in between those two points, interpolate linearly for an approximate value.

5.9.4 Once the temperature-and-altitude-corrected value has been determined, the 650 MDS should be powered on. In the main menu, select system set up and press enter.

5.9.5 Using the down arrow, scroll down to calibrate barometer. Press enter.

5.9.6 Record the Baro offset value.

5.9.7 While the mmHg value is still highlighted, press enter. Key in the local barometric pressure. Press enter. Record the new Baro offset. The barometric pressure calibration is complete.

6.0 Troubleshooting

6.1 Occasionally problems are encountered during a calibration and the instrument must be uncalibrated to return the instrument to factory settings. Uncalibration can be performed following these steps.

6.1.1 Access the desired parameter to uncalibrate in the calibrate menu.

6.1.2 When prompted to input a number for a standard, hold the enter key down and press the "esc" key. Highlight the "yes" key and press enter.
(Please note: This procedure is the equivalent of entering the command "uncal" from the YSI 610 logger at the numeric calibration prompt.)

6.2 pH

6.2.1 Refer to the Sonde Performance Worksheet

6.2.1 If a probe is slow to respond, recondition the probe according to the "Sonde Care and Maintenace Section" of the users manual.

6.2.2 To check the condition of the probe record the millivolts for each buffer. The millivolt output is the unprocessed pH output, the acceptable tolerance for each buffer is shown below:

Buffer 4 = +180 +/- 50 mv
Buffer 7 = 0 +/- 50 mv
Buffer 10 = -180 +/- 50 mv

When the probe is new, the ideal number are close to 0 and 180, then as the probe begins to age, the numbers will move and shift to the higher side of the tolerance.

6.2.3 After recording the pH millivolts for the calibration points determine the slope of the sensor. This is the difference between the two calibration points. For example, if we recorded a + 5 mv for buffer 7 and a -175 for buffer 10 the slope would be 180. The acceptable range for the slope is 165 to 180. Once the slope drops below 165, the sensor should be replaced

6.3 Conductivity

6.3.1 Refer to the Sonde Performance Worksheet

6.3.2 When the calibration has been accepted, check the conductivity cell constant which can be found in the sonde's "Advanced Menu" under "Cal Constants". The acceptance range is 4.55 to 5.45. Numbers outside this range usually indicated a problem in the calibration process or a contaminated standard was used.

6.4 Turbidity

6.4.1 To confirm that the turbidity probe wiper is functioning properly follow the procedure below

6.4.2 The output of the probe should increase when you place your fingers in front of the optics. If this doesn't happen replace the probe or check with the manufacture

6.4.2 The wiper should be parked at approximately 180 degrees opposite of the optics. The wiper should reverse directions during the wipe cycle. If the wiper does not park correctly on reverse direction then make sure that the bottom edges of the wiper are clean and free of mud, sediment, or other fouling, replace the wiper if needed. If this doesn't not help replace the probe or contact the manufacturer.

6.5 Dissolved Oxygen

6.5.1 Refer to the Sonde Performance Worksheet

6.5.2 Go to the Sondes "Report" menu and enable the "DO Charge". Now go to the "Run" menu and start the sonde in the "Sonde Run" mode. Record the DO Charge after about 5 minutes. The number should be between 25 and 75. If this is not true contact the manufacturer or replace the probe.

6.5.3 When the calibration is complete go to the sonde's "Advanced Menu" and to the "Cal Constants" and record the "DO Gain". The gain should be between 0.7 and 1.4. If this is not true contact the manufacturer or replace the probe.

6.6 Chlorophyll, Rhodamine WT, ORP

For these parameters, see Principles of Operation located in the operation manual.

6.7 For additional troubleshooting refer to the operations manual or call YSI technical support at 1-800-897-4151 and ask for technical support.

7.0 Measurements

Sondes can be used for either discrete sample measurements or be deployed for a period of time to record measurements. Each of these types of measurements requires different configurations of the sonde memory and display logger. Each procedure for configuration and operation of the sondes is discussed below. The procedures described below involving using the sonde memory to log data. Display/loggers can be used to store data, however this requires the display/logger to remain with the sonde during monitoring.

7.1 Discrete sample measurements

7.1.1 From the main menu select the "Sonde Run" option and press enter.

7.1.2 Place the Sonde into the water to be analysed, and watch the variations in the desired parameters.

7.1.3 After a few minutes or when the variations are less than:

0.1°C temperature
0.02su pH
0.02mg/l D.O.
5 uS/cm conductivity
0.5 NTU Turbidity

Log the measurements in the project's log book.

7.1.4 If the measurement is to be logged in the sonde memory, the select the "Log one sample" option from the Sonde Menu, and press enter.

7.1.5 If a series of measurements from one site is to be logged in the sonde memory, select the "Start Logging" option from the Sonde Menu and press enter. After a pre-determined amount of time select the "Stop Logging" option to stop logging measurements.

7.2 Deploying Sonde for Unattended Logging

When calibrating the DO for unattended sampling and using the auto sleep functions the instrument should **not** be warmed up before calibrating (it should be calibrated when the instrument is cool, since it is cool when the instrument is taking readings). If the instrument has been in use, turn the instrument off and allow the instrument to cool for 10 minutes before calibrating the DO.

While similar to discrete sampling in operation of the sonde, unattended logging requires setting up the memory of the sonde to record data.

7.2.1 Be sure the data logger is not powering the sonde and there are batteries in good condition in the sonde. As you precede the battery life in days will be displayed.

7.2.2 From the Sonde menu select the "Run/Unattended sample" option and press enter.

7.2.3 Follow the prompts on the screen to prepare the sonde for unattended sampling including:
- sample interval time
- logging start date
- logging start time
- logging duration (days)
- file name to store data (no more than 8 characters)
- Site name (associated with file name but not critical)
- battery life (check to make sure it will cover length of time sampling)
- memory space
- View parameters to log

7.2.4 Once these items have been reviewed and are correct, toggle down to "Start Logging" and hit enter, it should then display "stop logging".

7.2.5 The sonde will now begin logging parameters at the next sample interval. If not already attached, place the probe protector on the sonde. Turn the display/logger off and disconnect the communications cable sonde. Place the communications port plug on the sonde. Place the sonde in the desired sample location and securely anchor sonde using the bail provided on top of the sonde.

7.2.6 The sonde is now in place and will continue to record until reaching the specified end time of logging.

8.0 Post Sampling Verification and Data Evaluation

During use of the sondes in the field, the instrument probes experience "drift" and may operate outside of their excepted range. To determine the amount of drift the probes must be checked against their calibration standards.

8.1 Dissolved Oxygen post sampling verification

The dissolved oxygen should be checked in the field at approximately every 5 stations or every couple of hours and after the last sampling point. It should be checked before the instrument is powered off.

8.1.1 Clean all of the probes on the sonde with tap (or clean ambient water) water. Shake off excess water.

8.1.2 Place approximately 1/8 inch of water in the bottom of the calibration cup. Place the probe end of the sonde into the cup. Engage only 1 or 2 threads of the calibration cup to insure the DO probe is vented to the atmosphere. [An equivalent alternative method is to wrap the probe guard (which is attached to the sonde) with a wet towel and place the sonde in a 5 gallon bucket with 1 inch of water in it.] Make sure that the DO and temperature probes are NOT immersed in water and that the Sonde cup is not in direct sunlight. Wait approximately 10 minutes for the air in the calibration cup to become water saturated and for the temperature to equilibrate.

8.1.3 Record the temperature, dissolved oxygen in mg/l and %, and the barometric pressure. The dissolve oxygen value should be within $\pm$0.5 mg/l or of the saturation value (which is based on barometric pressure and temperature and can be found in Table 11). If the data does not meet this requirement it should not be reported or reported as estimated data in the final report.

8.1.4 For critical (non-critical parameters will be identified in the QAPP) DO applications verify the probe with a zero DO solution. This can be performed in the laboratory after sampling

1) Place the probe in a zero DO solution.
2) Verify the probe reads < 0.5mg/l (or to the range specified in QAPP)
3) Rinse probe and store the probe in tap water.

8.2 pH, conductivity, turbidity post sampling verification

8.2.1 Allow the standards equilibrate to the ambient temperature.

8.2.2 Clean all of the probes on the sonde with deionized water. Shake off excess water.

8.2.3 Place sonde instrument probes in reference standard solution of the particular parameter (eg. pH, specific conductivity, etc.).

8.2.4 From display/logger main menu, select the "run" option and press enter. Allow measurements to equilibrate, then write down result of measurement in log book.

8.2.5 Before and after placing the probes in the standard clean all of the probes on the sonde with deionized water and shake off excess water. Repeat for each reference standard solution.

8.2.6 These results should be compared with the below quality control goals. Data not meeting these criteria should be deleted or reported as estimated.

Table 8.1: Quality Control Goals for Sondes

PARAMETER	Post Calibration check accuracy goals
pH	±0.3 with pH 7 buffer and other bracketing buffer (pH4 or pH10)
Conductivity	± 10% of standard or 20 uS/cm (which ever is greater)
Dissolved Oxygen	± 0.5 mg/l of sat. value
Turbidity	± 20% or +/-2 NTU (which ever is greater) For zero +/-1 NTU
ORP	± 10 mV
Rhodamine WT	± 10% or 1 ug/l (which ever is greater)

8.3 Adjacent Measurement Check (for deployed sondes)

8.3.1 When sondes are deployed adjacent measurement checks shall be performed with a second instrument. The number of adjacent measurement check will depend on the quality of the monitored water and the project objectives. At a minimum these shall be performed during sonde retrieval. Adjacent measurements shall be measured at the depth of the sonde and at the surface. (Surface reading are taken to assess stratification that may exist).

8.3.2. At the same depth, the difference between the adjacent measurement and the recorded values by the sonde should not be less than the below quality control goals. Data not meeting this criterion should be deleted or reported as estimated.

Table 8.2: Quality Control Goals between the Adjacent Measurements and Deployed Sonde

PARAMETER	Adjacent Measurements accuracy goals
Temperature	0.5 °C
pH	0.5
Conductivity	15%
Dissolved Oxygen	+/-0.7 mg/l
Turbidity	30% or 3 NTU (which ever is greater)
Rhodamine WT	20% or 5 ug/l (which ever is greater)

9.0 Data Management and Records Management

All results of calibration must be documented and kept in a project's log book. At a minimum the following should be kept as part of the documentation: the instrument's manufacture model number, instrument identification number, standards used to calibrate the instruments, calibration date, the instrument readings, and the analyst.

10.0 References

United States Geological Survey, National Field Manual for the Collection of Water-Quality Data Techniques of Water-Resources Investigations, Book 9. Last update 1998.
http://water.usgs.gov/owq/FieldManual/index.html

Wagner J.W., and others, 2000, Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting U.S. Geological Survey Water-Resources Investigation Report 00-4252

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11.0 Appendix A: Oxygen Solubility in Water

Table 11.1: Oxygen Solubility in Water (oxygen values are in mg/L)

(from Ch. 6 of the USGS, National Field Manual for the Collection of Water-Quality Data.)

Temp.	Pressure (mmHg)																		
(°C)	**795.0**	**790.0**	**785.0**	**780.0**	**775.0**	**770.0**	**765.0**	**760.0**	**755.0**	**750.0**	**745.0**	**740.0**	**735.0**	**730.0**	**725.0**	**720.0**	**715.0**	**710.0**	**705.0**
0.0	15.3	15.2	15.1	15.0	14.9	14.8	14.7	14.6	14.5	14.4	14.3	14.2	14.1	14.0	13.9	13.8	13.7	13.6	13.5
0.5	15.1	15.0	14.9	14.8	14.7	14.6	14.5	14.4	14.3	14.2	14.1	14.0	13.9	13.8	13.7	13.6	13.5	13.4	13.3
1.0	14.8	14.7	14.7	14.6	14.5	14.4	14.3	14.2	14.1	14.0	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.2	13.2
1.5	14.6	14.5	14.5	14.4	14.3	14.2	14.1	14.0	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.2	13.2	13.1	13.0
2	14.4	14.3	14.3	14.2	14.1	14.0	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.3	13.2	13.1	13.0	12.9	12.8
2.5	14.2	14.2	14.1	14.0	13.9	13.8	13.8	13.6	13.5	13.5	13.4	13.3	13.2	13.1	13.0	12.9	12.8	12.7	12.6
3.0	14.1	14.0	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.3	13.2	13.1	13.0	12.9	12.8	12.7	12.6	12.5	12.5
3.5	13.9	13.8	13.7	13.6	13.5	13.4	13.3	13.3	13.2	13.1	13.0	12.9	12.8	12.7	12.6	12.6	12.5	12.4	12.3
4.0	13.7	13.6	13.5	13.4	13.3	13.3	13.2	13.1	13.0	12.9	12.8	12.7	12.6	12.6	12.5	12.4	12.3	12.2	12.1
4.5	13.5	13.4	13.3	13.3	13.2	13.1	13.0	12.9	12.8	12.7	12.7	12.6	12.5	12.4	12.3	12.3	12.2	12.1	12.0
5.0	13.3	13.3	13.2	13.1	13.0	12.9	12.8	12.7	12.7	12.6	12.5	12.4	12.3	12.2	12.2	12.1	12.0	11.9	11.8
5.5	13.2	13.1	13.0	12.9	12.8	12.7	12.7	12.6	12.5	12.4	12.3	12.3	12.2	12.1	12.0	11.9	11.8	11.7	11.7
6.0	13.0	12.9	12.8	12.8	12.7	12.6	12.5	12.4	12.3	12.3	12.2	12.1	12.0	11.9	11.8	11.8	11.7	11.6	11.5
6.5	12.8	12.8	12.7	12.6	12.5	12.4	12.4	12.3	12.2	12.1	12.0	11.9	11.9	11.8	11.7	11.6	11.5	11.5	11.4
7.0	12.7	12.6	12.5	12.4	12.4	12.3	12.2	12.1	12.0	12.0	11.9	11.8	11.7	11.6	11.6	11.5	11.4	11.3	11.2
7.5	12.5	12.4	12.4	12.3	12.2	12.1	12.0	12.0	11.9	11.8	11.8	11.7	11.6	11.5	11.4	11.3	11.3	11.2	11.1
8.0	12.4	12.3	12.2	12.1	12.1	12.0	11.9	11.8	11.7	11.7	11.6	11.5	11.4	11.3	11.3	11.2	11.1	11.0	11.0
8.5	12.2	12.1	12.1	12.0	11.9	11.8	11.8	11.7	11.6	11.5	11.4	11.4	11.3	11.2	11.1	11.1	11.0	10.9	10.8
9.0	12.1	12.0	11.9	11.8	11.8	11.7	11.6	11.5	11.5	11.4	11.3	11.2	11.2	11.1	11.0	10.9	10.8	10.8	10.7
9.5	11.9	11.9	11.8	11.7	11.6	11.6	11.5	11.4	11.3	11.3	11.2	11.1	11.0	10.9	10.9	10.8	10.7	10.6	10.6
10.0	11.8	11.7	11.6	11.6	11.5	11.4	11.3	11.3	11.2	11.1	11.0	11.0	10.9	10.8	10.7	10.7	10.6	10.5	10.4
10.5	11.7	11.6	11.5	11.4	11.4	11.3	11.2	11.1	11.1	11.0	10.9	10.8	10.8	10.7	10.6	10.5	10.5	10.4	10.3
11.0	11.5	11.4	11.4	11.3	11.2	11.2	11.1	11.0	10.9	10.9	10.8	10.7	10.6	10.6	10.5	10.4	10.3	10.3	10.2
11.5	11.4	11.3	11.2	11.2	11.1	11.0	11.0	10.9	10.8	10.7	10.7	10.6	10.5	10.4	10.4	10.3	10.2	10.2	10.1
12.0	11.3	11.2	11.1	11.0	11.0	10.9	10.8	10.8	10.7	10.6	10.5	10.5	10.4	10.3	10.3	10.2	10.1	10.0	10.0
12.5	11.1	11.1	11.0	10.9	10.8	10.8	10.7	10.6	10.6	10.5	10.4	10.4	10.3	10.2	10.1	10.1	10.0	9.9	9.9
13.0	11.0	10.9	10.9	10.8	10.7	10.7	10.6	10.5	10.4	10.4	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.7
13.5	10.9	10.8	10.7	10.7	10.6	10.5	10.5	10.4	10.3	10.3	10.2	10.1	10.1	10.0	9.9	9.8	9.8	9.7	9.6
14.0	10.8	10.7	10.6	10.6	10.5	10.4	10.4	10.3	10.2	10.1	10.1	10.0	9.9	9.9	9.8	9.7	9.7	9.6	9.5
14.5	10.6	10.6	10.5	10.4	10.4	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.4
15.0	10.5	10.5	10.4	10.3	10.3	10.2	10.1	10.1	10.0	9.9	9.9	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3
15.5	10.4	10.4	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.2
16.0	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.1
16.5	10.2	10.1	10.1	10.0	9.9	9.9	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.4	9.3	9.2	9.2	9.1	9.0
17.0	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9
17.5	10.0	9.9	9.9	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.8
18.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.7
18.5	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.8	8.8	8.7	8.7
19.0	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6
19.5	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.9	8.8	8.7	8.7	8.6	8.5	8.5
20.0	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.5	8.4
20.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.9	8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3
21.0	9.3	9.2	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.5	8.4	8.4	8.3	8.2
21.5	9.2	9.2	9.1	9.0	9.0	8.9	8.9	8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.3	8.2	8.1

Table 11.1: Oxygen Solubility in Water (oxygen values are in mg/L) -continued

Temp.	Pressure (mmHg)																		
	795	**790**	**785**	**780**	**775**	**770**	**765**	**760**	**755**	**750.0**	**745**	**740**	**735**	**730**	**725**	**720**	**715**	**710**	**705**
22	9.1	9.1	9.0	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.3	8.2	8.2	8.1
22.5	9.0	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.5	8.4	8.3	8.3	8.2	8.2	8.1	8.0	8.0
23.0	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.3	8.2	8.2	8.1	8.0	8.0	7.9
23.5	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.5	8.4	8.4	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.8
24.0	8.8	8.8	8.7	8.6	8.6	8.5	8.5	8.4	8.3	8.3	8.2	8.2	8.1	8.1	8.0	7.9	7.9	7.8	7.8
24.5	8.7	8.7	8.6	8.5	8.5	8.4	8.4	8.3	8.3	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.7	7.7
25.0	8.6	8.6	8.5	8.5	8.4	8.3	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.7	7.7	7.6
25.5	8.5	8.5	8.4	8.4	8.3	8.3	8.2	8.2	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6
26.0	8.5	8.4	8.4	8.3	8.3	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.6	7.6	7.5	7.5
26.5	8.4	8.3	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4
27.0	8.3	8.3	8.2	8.2	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4
27.5	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.5	7.5	7.4	7.4	7.3	7.3
28.0	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.2
28.5	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.1
29	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1
29.5	8.0	7.9	7.9	7.8	7.8	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7.0
30	7.9	7.8	7.8	7.8	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7.0	7.0
30.5	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9
31	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.1	7.1	7	7	6.9	6.9	6.8
31.5	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8
32	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7
32.5	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7	6.7
33	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7	6.7	6.6
33.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7	6.7	6.6	6.6
34	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7.0	7.0	6.9	6.9	6.8	6.8	6.7	6.7	6.6	6.6	6.5	6.5
34.5	7.3	7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7	6.7	6.6	6.6	6.5	6.5	6.5
35	7.3	7.2	7.2	7.1	7.1	7	7	6.9	6.9	6.8	6.8	6.7	6.7	6.6	6.6	6.5	6.5	6.4	6.4

Appendix B: Performance check Work sheet

Date of Calibration: _____ Performed by: _____ Sonde ID: _____

DO membrane changed? Y N

Note: Should wait 6 to 8 hours before final DO calibration, run sensor for 15 minutes in Discrete Run to accelerate burn-in. Note: Change wiper if probe will not park correctly.

Turbidity wiper changed? Y N

Wiper parks 180° from optics? Y N

Record battery voltage: _____

Record the following diagnostic numbers after calibration.

Record Calibration Values

			Actual	Sonde after cal
Conductivity cell constant	_____	*Range 5.0 ± .45*	Temperature	_____	_____
pH MV Buffer 4	_____	*Range +180 ± 50 MV*	Conductivity	_____	_____
pH MV Buffer 7	_____	*Range 0 MV ± 50 MV*	pH 4	_____	_____
pH MV Buffer 10	_____	*Range -180 ± 50 MV*	pH 7	_____	_____
			pH 10	_____	_____
DO charge	_____	*Range 50 ± 25*	Turbidity(0)	_____	_____
DO gain	_____	*Range -0.7 – +1.5*	Turbidity(10)	_____	_____
			DO	_____	_____

Note:
Span between pH 4 to 7 and 7 to 10, MV numbers should be **165 to 180 MV**

Turbidity Standards used in the calibration _____ Manufacturer and PN_____

DISSOLVED OXYGEN SENSOR OUTPUT TEST (after DO calibration probe in saturated air)

The following tests will confirm the proper operation of your DO sensor. The DO charge and gain must meet spec before proceeding.

650 Datalogger	PC w/ Ecowatch
Turn off 650	Stop discrete and unattended sampling
wait 60 seconds	Confirm that auto-sleep RS-232 is enabled (found in Advanced Menu under Setup)
Power up 650	Wait 60 seconds
go to the Run mode	Start discrete sampling at 4 seconds
watch the DO % output	Watch the DO % output, it must display a positive number and decrease with each 4 second sample, eventually stabilizing to the calibration value in approximately 40 to 60 seconds
	Note: it must display a positive number and decrease with each 4 second sample, eventually stabilizing to the calibration value in approximately 60 to 120 seconds

Note: You can disregard the first two samples, they can be affected by the electronics warm-up.

The **ACCEPT/REJECT** criteria is as follows:

The DO output in % must start at a positive number and decrease during the warm up.
Example: 117, 117, 114, 113, 110, 107, 104, 102, 101, 100, 100.
Should the output display a negative number or start at a low number and climb up to the cal point, the probe is rejected and must not be deployed.

Notes: _____ **ACCEPT** _____ **REJECT**

Downloaded file name and location: _____

Rev 1.0 5/16/05 TB

Appendix C: Sonde Calibration & Verification Form (Rev. 7; 6/07/05)

Survey Name _____
YSI 650 # _____

Initial Calibration

Date _____ Time _____ Performed by _____

	DO					pH				SpCond			Turbidity		
Model/ Instrument#	Temp (C)	B.P. (mmHg)	Sat. Value (mg/L)	Sat. Value (%)	Zero DO (mg/L)	pH 7	pH 4	pH 10	Check w/pH 7	____	____	Check w/____	0 (NTU)	____ (NTU)	Check w/ ____
Accept.Criteria			+/- 0.2		(<0.5)	✓	✓	✓	+/- 0.05	✓	✓	+/-5%	✓	✓	+/-10%

Post Verification

Date _____ Time _____ Performed by _____

	DO						pH				SpCond.			Turbidity		
Model/ Instrument #	Temp (C)	B.P. (mmHg)	Sat. Value Table (mg/L)	DO (mg/L)	ZeroDO (mg/L)	Met Criteria	pH 7	pH 4	pH 10	Met Criteria	____	____	Met Criteria	0 (NTU)	____ (NTU)	Met Criteria
Accept.Criteria				+/-0.5	<0.5	Yes or no	+/-0.3	+/-0.3	+/-0.3	Yes or no	+/-10% or 20uS/cm	+/-10% or 20uS/cm	Yes or no	+/-1	+/-20% or +/-2	Yes or no

Note: A DO calibration check should be performed before, during and after the survey.

Document No.:	***PP0010-005***
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Title:	Environmental Technician II
Date:	July 28, 2004

1. Scope and Application

1.1. This method is applicable to the analysis of drinking, surface and saline waters in the range of 0 to 1000 nephelometric turbidity units (NTU).
1.2. More turbid samples should be diluted prior to analysis.

2. Summary of Method

2.1. The method is based upon a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions.
2.2. The higher the intensity of scattered light, the higher the turbidity.
2.3. StablCal standard suspensions are used to create a calibration curve.
2.4. Samples are transferred to sample cells that are carefully wiped free of dust and moisture.
2.5. Cuvettes are inserted into the chamber with a consistent orientation.
2.6. Turbidity units are recorded according to results. (See Results, p.5)

3. Comments

3.1. NTU's are considered comparable to the previously reported Formazin Turbidity Units (FTU) and Jackson Turbidity Units (JTU).
3.2. Dark glass sample cell should be handled by the securely fastened lid.
3.3. Store StablCal standards at room temperature, preferably in drawer labeled Turbidity in 29 Palms Laboratory.
3.4. Keep lit closed when not in use.
3.5. Make sure that there are no air bubbles in sample cell before placing into Turbidimeter.
3.6. Wipe sample cell well with Kimwipe to remove any fingerprints, and apply a drop of silicone oil to exterior of cell to mask any minor imperfections in the surface.
3.7. A Formazin calibration should done once every 3 months

4. Sample Handling and Preservation

4.1. Preservation of the sample is not practical; analysis should begin as soon as possible.
4.2. Refrigeration or icing to 4^{o}C, to minimize microbiological decomposition of solids is recommended.

5. Interferences

5.1. Coarse floating debris that settles out rapidly will give unstable low readings.
5.2. Presence of color in sample water due to dissolved substances that absorb light will cause turbidities to be low.
5.3. Air bubbles will cause higher turbidity readings.

6. Apparatus

6.1. Portable Turbidimeter, Model 2100P
6.2. Silicone Oil
6.3. Oiling cloth
6.4. Quick reference card
6.5. Four AA batteries

7. Reagents

7.1. Reagent Water (NanoPure)

7.2. StablCal Turbidity Standards: ≤0.1-NTU, 20-NTU, 100-NTU, 800-NTU

8. Procedure

8.1. Turn instrument on

8.2. Calibrate the meter.

8.2.1. Insert the "0.1" turbidity sample cell calibration standard into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment.

8.2.2. Close shield.

8.2.3. Press CAL and the CAL and S 0 icons will be displayed with the "0" will be flashing.

8.2.4. Press READ on keypad.

8.2.4.1. The instrument will count from 60 to 0, read the blank and use it to calculate a correction factor for the next standard measurement. The display will automatically increment to the next standard.

8.2.5. Remove sample cell.

8.2.6. The display will show S 1 with the "1" flashing and the 20 NTU value.

8.2.7. Insert the "20" cell into the well compartment and close cover.

8.2.8. Press READ.

8.2.8.1. The instrument will count from 60 to 0, read the blank and use it to calculate a correction factor for the next standard measurement. The display will automatically increment to the next standard.

8.2.8.2. If the value is incorrect, edit the value by pressing the → key to scroll to the correct number.

8.2.8.3. Repeat sample reading with new 20 NTU standard.

8.2.9. Remove sample cell.

8.2.9.1. The display will show the S 2 with the "2" flashing.

8.2.10. Insert "100" NTU standard sample into the well compartment.

8.2.11. Press READ.

8.2.11.1. The instrument will count from 60 to 0, read the blank and use it to calculate a correction factor for the next standard measurement. The display will automatically increment to the next standard.

8.2.11.2. If the value is incorrect, edit the value by pressing the → key to scroll to the correct number.

8.2.12. Remove calibration sample cell.

8.2.12.1. The display will show the S 3 with the "3" flashing and 800 NTU for the next sample.

8.2.13. Place 800 NTU calibration sample cell into well compartment.

8.2.14. Press READ.

8.2.14.1. The instrument will count from 60 to 0.

8.2.14.2. The display will then increment back to SO.

8.2.15. Remove calibration sample cell.

8.2.16. Press CAL to accept the calibration.

8.3. Preform Calibration Curve

8.3.1. Place a known standard in cell compartment

8.3.2. Press READ
8.3.3. Record Value
8.3.4. Place different known standard into cell well.
8.3.5. Press READ
8.3.6. Record Value
8.3.7. Repeat 8.3.1 three more times for a total of five recorded values.
8.3.7.1. Proceed to section 9.0 for calculations

8.4. Take sample readings.
8.4.1. Fill sample cell to white horizontal line with sample.
8.4.2. Wipe sample cell well with Kimwipe and lightly oil with silicone and wipe off.
8.4.3. Insert sample cell with vertical line forward.
8.4.4. Close lid.
8.4.5. Press READ
8.4.6. Record value of sample in NTU's.

9. Calculation

9.1. Using Excel graph the difference between the expected NTU value and the recorded actual value to find the slope. (See section 12.0 for Calibration Curve)

9.2. If created diluted sample.
9.2.1. Multiply sample readings by appropriate dilution to obtain final reading.
9.2.2. Sample calculation: If sample is diluted in half (1:1), the turbidity result would be the value displayed multiplied by two.
9.2.2.1.Diluted sample turbidity reading: 5.4.
9.2.2.2.Turbidity (NTU)= 5.4 x 2 = 10.8 NTU
9.2.2.3.Reported as 11 NTU (See Results p.5)

10. Results

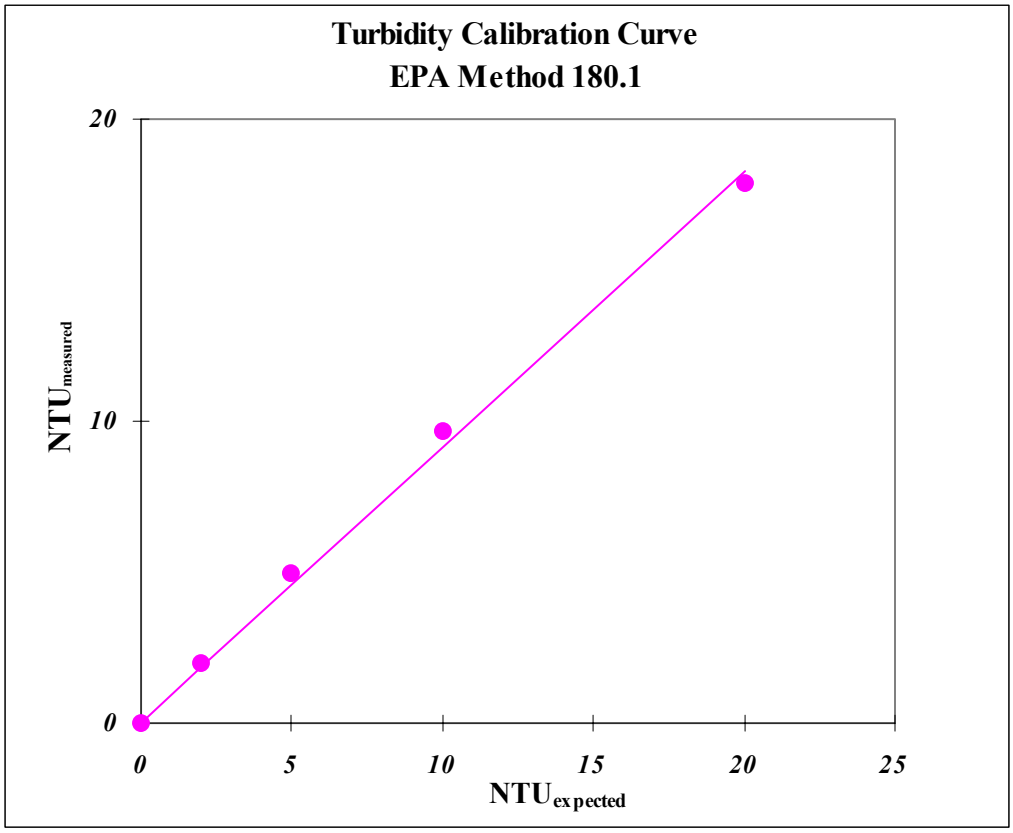
10.1. Report results as follows:

NTU	Record to nearest:
0.0-1.0	0.05
1-10	0.1
10-40	1
40-100	5
100-400	10
400-1000	50

11. Bibliography

11.1. Hach Company Manual for Portable Turbidimeter, Model 2100P (Cat. No. 46500-88)
11.2. EPA Method 180.1
11.3. Hach Quick Reference Card for Portable Turbidimeter.

12. Calibration Curve



Turbidity Expected (NTU)	Measured Turbidity (NTU)	RF	
0.00	0.00	-	Average RF =0.964
2.00	2.00	1.000	Std. Dev. =0.0492
5.00	4.97	0.994	Relative % Std. Dev. =5.10
10.00	9.68	0.968	R^2 =0.997
20.00	17.86	0.893	m =0.913
			y-intercept =0.00