

Ozarks Environmental and Water Resources Institute (OEWRI)  
Missouri State University (MSU)

Standard Operating Procedure for:

**The Measurement of Dissolved Oxygen,  
Temperature, Specific Conductance, and  
pH Using the YSI Professional Plus  
Handheld Multiparameter Meter**

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### **Identification of the method**

The YSI Professional Plus (YPP) multiparameter meter is used to collect water temperature, specific conductance (SC), pH, and dissolved oxygen (DO) in streams and impoundments.

### **Scope of the method**

This standard operating procedure provides OEWR laboratory personnel with a protocol for collecting field-based water chemistry parameters, laboratory calibration procedures, instrument troubleshooting, and maintenance.

### **Summary of method**

This instrument is used to collect field-based water temperature, SC, pH, and DO. The instrument must be calibrated prior to going into the field using appropriate procedures to verify accuracy. At least one field duplicate shall be collected to verify precision during each sampling trip. Data and calibration notes are downloaded from the instrument using the communications saddle and Data Manager software provided and exported into a database format. Finally, the instrument should be cleaned and stored properly according to the manufacturer's recommendations.

### **Definitions**

- 1) Field Duplicate (FD): Two samples taken at the same time and placed under identical circumstances that are treated identically throughout field and laboratory procedures. Analysis of field duplicates indicates the precision associated with sample collection, preservation, and storage as well as laboratory procedures.
- 2) Method Detection Limit (MDL): The lowest level at which an analyte can be detected with 99 percent confidence that the analyte concentration is greater than zero. The MDL is defined by the instrument manufacturer and is the lowest value of the instrument's detection range (see Table 1).

### **Health and safety**

When wading in streams where water depths  $\geq 1$  m, wear a life jacket and/or remove hip boots or chest waders. Be sure to wash your hands with bacteria disinfectant soap after wading in streams. This is particularly important for streams that drain livestock areas, sewage treatment plant effluents, and other obvious pollution sources. Wear protective gloves if necessary to avoid waterborne illness. Read SDS information before using or preparing standard solutions or buffers.

### **Personnel qualifications**

Water chemistry parameters using the YSI instrument will be collected by OEWRI field personnel who have received appropriate training from experienced personnel, prior coursework, and field experience regarding the collection of water parameter data and proper care and use of the instrument.

### **Equipment and supplies**

- 1) YSI Professional Plus Instrument (Serial Numbers: Sonde 1 – 14H100274; Sonde 2 – 14H100273)
- 2) Hard sided carrying case
- 3) 4 meter quarto cable with:
  - a. pH probe
  - b. Dissolved oxygen probe
  - c. Temperature and specific conductance probe
- 4) Probe storage cap
- 5) Probe protective cap
- 6) Cable management kit
- 7) Cable weight
- 8) 2 C-batteries

### **Reagents and Standards**

- 1) 1,000  $\mu\text{S}/\text{cm}$  Conductivity Calibration Solution
- 2) pH 4.0 Standard Buffer Solution
- 3) pH 7.0 Standard Buffer Solution
- 4) pH 10.0 Standard Buffer Solution
- 5) Deionized water

### **Calibration and Standardization**

Calibration of the instrument should be carried out prior to use in the field, ideally the day before or the day of use. During periods of infrequent use, the probe should be calibrated once per month.

The calibration order is as follows:

1. Dissolved oxygen
2. Specific conductance
3. pH

### **Calibration Steps**

Fill out the appropriate calibration bench sheet as the calibration is performed. Prior to calibration, allow the instrument to warm-up for 15 minutes. Press the **Probe** button, highlight **Setup**, and press enter.

### a) Dissolved Oxygen

Dissolved oxygen is calibrated using a 1-point calibration method with water saturated air. Deionized (DI) water is used to calibrate the probe to 100% dissolved oxygen. The DO probe requires a 15-minute warmup time prior to calibration to provide accurate readings. While the instrument warms up, check the DO probe membrane for any wrinkles or tears. If necessary, replace the DO membrane.

- 1) Rinse the probe sensor using DI water.
- 2) Add a small amount of DI water (1/8 inch) into the plastic storage cap and attach it to the probe.
- 3) Unscrew the cap 1-2 threads to ensure the container is completely saturated with oxygen.
- 4) Ensure the DO and temperature membranes are NOT immersed in the water.
  - a. Any water droplets present on the membrane should be removed with a Kimtech wipe.
- 5) Power the instrument on and allow the probe to stabilize for 10-15 minutes.
- 6) Once the “Actual Readings” for DO% and temperature have stabilized, highlight **Accept Calibration** on the meter and press enter followed by the **Cal** button.
- 7) Table 6.2-6 from the USGS National Field Manual (USGS, 2013) lists the oxygen solubility values for specific temperature and barometric pressure combinations. Find the DO value for the temperature and barometric pressure readings taken at the time of calibration and record the value on the Calibration Log Sheet.
- 8) The measured value with the probe still in the storage cup should be within 5% of this published value.

### b) Specific Conductance

Specific conductance is calibrated using a 1-point calibration method using a 1,000  $\mu\text{S}/\text{cm}$  conductivity calibration standard solution that is purchased from a laboratory supply company and used without modification.

- 1) Press the **Cal** button, highlight **Sp. Conductance**, and press enter.
- 2) Highlight **SPC-  $\mu\text{S}/\text{cm}$**  and press enter.
- 3) Highlight Calibration Value and press enter to input the value of the calibration standard (1,000  $\mu\text{S}/\text{cm}$ )
- 4) Rinse the SC probe and plastic storage cup, first using DI water and following with the calibration solution.

- 5) Fill the plastic storage cup with the 1,000  $\mu\text{S}/\text{cm}$  conductivity calibration solution, ensuring the entire SC sensor is submerged in the solution (or else the instrument will read approximately half of the expected value).
- 6) Once the temperature and SC readings stabilize, record the pre-calibration value on the Calibration Log Sheet, highlight **Accept Calibration** on the instrument, and press enter.
- 7) Leave the probe in the calibration solution and record the post-calibration reading on the Calibration Log Sheet.

### c) pH

pH is calibrated using a 3-point calibration method using pH 4, 7, and 10 buffer solutions purchased from a laboratory supply store and used without modification.

- 1) Press **Cal**, highlight **ISE1 (pH)** and press enter. The message line should show that the instrument is “**Ready for point 1.**”
- 2) Rinse the sensor and plastic storage cup with pH 7 buffer solution before filling the storage cup 2/3 full of the pH 7 buffer solution.
- 3) The instrument should automatically recognize the buffer value and display it at the top of the calibration screen.
  - a. If the calibration value is incorrect, the auto buffering recognition setting in the ‘**Sensor Setup**’ menu may be incorrect. Highlight Calibration Value and press enter to input the correct value.
- 4) Once the pH and temperature readings stabilize, record the pre-calibration values, highlight **Accept Calibration** and press enter to accept the first calibration point. The message line will then display, “**Ready for Point 2.**” Retain the buffer solution for the post-calibration reading.
- 5) Rinse the probe with the pH 4 buffer solution and fill the storage cup 2/3 full of the pH 4 buffer solution. Ensure the Calibration Value is correct and adjust if necessary.
- 6) Once the pH and temperature readings stabilize, record the pre-calibration values, highlight **Accept Calibration** and press enter to accept the second calibration point. Retain the buffer solution for the post-calibration reading.
- 7) Rinse the probe and storage cup twice with pH 10 buffer solution and fill the storage cup 2/3 full of pH 10 buffer solution. Ensure the Calibration Value is correct and adjust if necessary.
- 8) Once the pH and temperature readings stabilize, record the pre-calibration values, highlight **Accept Calibration** and press enter to accept the third calibration point.
- 9) Finalize the calibration by pressing the **Cal** button.

- 10) Record the post-calibration readings of each pH buffer solution, rinsing with the measured buffer solution between each measurement.

### Data Collection Procedure

- 1) Turn the meter on 15 minutes before taking measurements to allow the DO meter to acclimate. The meter will be in **Run Mode**.
- 2) Place the probe in the sampling location and gently stir until readings stabilize.
- 3) Press **Log One Sample** to open the Submenu.
  - a) To select sites or folders to save your sample to, select the appropriate site name and folder (project), highlight **Sites** or **Folders**, and press enter.
  - b) To create a new site or folder, scroll to the end of the current option list and press **Add new**. Use the meter controls to label. Select the enter button to save.
- 4) Press **Log Now!** to capture results. The instrument will confirm successful data capture.
- 5) If logging samples at specific time intervals (rather than a single data point), press the **System** key (top left), scroll down to **Logging**, press enter, enable **Continuous Mode**, and adjust the appropriate time interval.
  - a) The run screen will now show **Start Logging** rather than **Log one Sample**.
  - b) Once a continuous log has started, the **Start Logging** option is replaced with **Stop Logging**.

### Data Acquisition, Calculations, and Reporting

- 1) Install Data Manager software to computer. The appropriate USB drivers will automatically be installed as well.
- 2) Connect the Pro Plus instrument to the Communications Saddle before connecting the saddle to the computer USB port.
- 3) During the first connection, Windows may prompt through the 'New Hardware Found' wizard to complete the USB driver installation.
- 4) Open Data Manager and turn on the Pro Plus instrument.
- 5) In Data Manager, select the correct instrument under the **'Select Instrument'** heading, click the **Retrieve Instrument Data** tab, and check **Data, GLP, Site List, Configuration, or Select All** to retrieve data. Click **Start**.
- 6) Once the file transfer is finished, that data can be viewed, printed, and exported from Data Manager.
- 7) If desired, the data can be deleted from the Pro Plus instrument. On the instrument, press the **File** key (top right) and select **Delete Data** If you do not wish to keep the data on the instrument.

## **Computer Hardware and Software**

The Data Manager software, communication saddle, and USB cable for the instrument are provided by YSI.

## **Method Performance**

See Table 1 for system specifications from the manufacturer.

## **Pollution Prevention**

All wastes from these procedures shall be collected and disposed of according to existing waste policies within the MSU College of Natural and Applied Sciences. Volumes of reagents made should mirror the number of samples being analyzed. These adjustments should be made to reduce waste.

## **Data Assessment and Acceptable Criteria for Quality Control Measures**

- 1) The analyst reviews all data to ensure that it is correct.
- 2) Relative percent difference (RPD) should be calculated for pairs of duplicate measurements to determine precision.
- 3) The desired precision is  $\pm 20\%$ .
- 4) The completed Calibration Log is reviewed by the laboratory manager and the OEWR QA coordinator.

## **Corrective Actions for Out-of-control or Unacceptable Data**

- 1) The results for precision and blank data are compared to the acceptable values for this analysis ( $\pm 20\%$  and 0, respectively) for all analytes.
  - a. If the data are out of acceptable range, the instrument should be recalibrated and RPD should be recalculated.
- 2) If the data obtained are unacceptable for any reason, the analyst should review their technique prior to conducting the analysis again.
- 3) The instrument may require the following troubleshooting techniques if the data are unacceptable:
  - a. Clean the probes with DI water.
  - b. If present, remove any contaminants from the probes.
  - c. Replace defective sensors.
  - d. Replace the instrument batteries.
  - e. Perform routine maintenance as recommended by the manufacturer.
- 4) If a repair is required, the instrument should be sent to the manufacturer.



## **Waste Management**

The wastes generated in this method are not hazardous. Only a small volume of standards are required and can be discarded in the laboratory sink.

## **References**

USGS, United States Geological Survey. National Field Manual for the Collection of Water-Quality Data A6-6.2-6. 2013.

[https://pubs.usgs.gov/twri/twri9a6/twri9a62/twri9a6\\_6.2\\_ver3.pdf](https://pubs.usgs.gov/twri/twri9a6/twri9a62/twri9a6_6.2_ver3.pdf)

YSI, Yellow Springs Instruments. YSI Professional Plus User Manual. 2009.

<https://www.ySI.com/file%20library/documents/manuals/605596-ysi-proplus-user-manual-revd.pdf>

## **Tables, Diagrams, and Flowcharts**

1. See Table 1 for system specifications for the YSI Professional Plus system from the manufacturer.
2. See below for the YSI Calibration log. The analyst should make a copy of this log when calibrating the instrument.

**Table 1. YSI Professional Plus System Specifications (Cables and Sensors)**

| <b>YSI Professional Plus System Specifications (Cables and Sensors)</b> |                             |                             |  |   |                    |   |
|---|-----------------------------|-----------------------------|--|---|--------------------|---|
| <b>Parameter</b>  | <b>Sensor Type</b>          | <b>Range</b>                | <b>Accuracy</b>  | <b>Resolution</b>   | <b>Units</b>       | <b>Calibration</b>  |
| Dissolved Oxygen (%)  | Polarographic or Galvanic   | 0 to 50 mg/L                | 0 to 20 mg/L ( $\pm 2\%$ of reading or 0.2 mg/L, whichever is greater) 20 – 50 mg/L ( $\pm 6\%$ of reading)  | 0.1 or 0.01 mg/L (user selectable); 0.1% air saturation   | mg/L, ppm          | 1 point   |
| Temperature (field rugged cables)                                       |                             | -5 to 70 °C                 | $\pm 0.2^\circ\text{C}$  | 0.1°C   | °C, °F, K          | N/A   |
| Conductivity  | Four Electrode Cell         | 0 to 200 mS/cm (auto range) | $\pm 0.5\%$ of reading or 0.001 mS/cm, whichever is greater (1-, 4-m cable) $\pm 1\%$ of reading or 0.001 mS/cm, whichever is greater (20-m cable) | 0 to 0.500 mS/cm = 0.001<br>0.501 to 50.00 mS/cm = 0.01<br>50.01 to 200 mS/cm = 0.1 (range dependent) | $\mu\text{S}$ , mS | 1 point   |
| pH  | Glass Combination Electrode | 0 to 14 units               | $\pm 0.2$ units  | 0.01 units  | mV, pH units       | 1, 2, 3, 4, 5, or 6 point (user selectable); US, NIST or Custom Buffers |

## YSI Calibration Log

Date of Calibration: \_\_\_\_\_ Analyst: \_\_\_\_\_

Instrument Number: \_\_\_\_\_

DO membrane Checked? Y N    DO membrane Changed? Y N

### Record the following calibration values:

#### DO

Barometric Pressure at time of calibration (mmHg) \_\_\_\_\_

Air Temperature at time of calibration (°C) \_\_\_\_\_

DO of oxygen saturated air Post Calibration (mg/L) \_\_\_\_\_

Solubility of oxygen in freshwater at time of calibration (USGS Table) (mg/L) \_\_\_\_\_

Conductivity ( $\mu\text{S}/\text{cm}$ ) – Pre \_\_\_\_\_ Post \_\_\_\_\_ Lot# \_\_\_\_\_

#### pH

pH 7 Pre \_\_\_\_\_ pH mV value \_\_\_\_\_ Post \_\_\_\_\_ Lot # \_\_\_\_\_

pH 4 Pre \_\_\_\_\_ pH mV value \_\_\_\_\_ Post \_\_\_\_\_ Lot # \_\_\_\_\_

pH 10 Pre \_\_\_\_\_ pH mV value \_\_\_\_\_ Post \_\_\_\_\_ Lot # \_\_\_\_\_

NOTE: Span between pH 4 and 7, and 7 and 10 mV values should be  $\approx$  165 to 180 mV. 177 is the ideal distance or 59 mV per pH unit.

### Record the following diagnostic numbers after calibration, by viewing the .glp file and reading the values for the day's calibration.

Conductivity Cal Cell Constant \_\_\_\_\_ Range 5.0 +/- 1.0 acceptable

DO Sensor Value ( $\mu\text{A}$ ) \_\_\_\_\_ (Membrane dependent, see DO Cal Tips)

pH Slope \_\_\_\_\_ ( $\approx$  55 to 60 mV/pH, 59 ideal)

pH Slope % of ideal \_\_\_\_\_