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## **INSTRUMENT OPERATING PROCEDURE**

### **INSTRUMENT:**

Multiparameter Water Quality Instrument

### **MODEL:**

- Pro Plus Meter (6050000)
- Quatro Cable (605790)
- Probes: temperature/conductivity (5560), pH (1001 or 1001A), DO (2003), ammonium (1004)

### **MANUFACTURER:**

Yellow Springs Instrument Co., Inc. (YSI)

### **PRECAUTIONS:**

#### **POTENTIAL INTERFERENCES**

##### *General –*

- Greatest accuracy is achieved if the actual samples to be measured are within 10 °C of the calibration solutions.
- Longer cable lengths introduce more error into the readings.

*Dissolved oxygen –*

- Chlorine, sulfur dioxide, nitric oxide, and nitrous oxide can affect readings by behaving like oxygen at the membrane.
- Static electricity may affect readings.
- Gold Cathode - The gold cathode on the sensor must be textured properly. It may become tarnished or plated with silver after extended periods of use.
- Bubbles under the membrane cap will affect readings.
- Excessive water in calibration/storage sleeve will affect calibration.

*pH –*

- Do not measure pH in metal containers.
- Water currents in streams can cause unstable readings.
- pH measurements will drift if the sample is not stirred.
- Do not expose the meter or probe to freezing temperatures.
- High humidity and cold temperatures may affect meter operation.
- Be sure that the temperature sensor is immersed in the sample.
- Buffers degrade from exposure to light - change daily

*Ammonium –*

- Ammonium sensors should only be used at DEPTHS OF LESS THAN 55 FEET (17 METERS). Use of the sensors at greater depths is likely to permanently damage the sensor membrane.
- Ammonium sensors should only be used in FRESHWATER.
- Temperature and pH sensors must be installed, calibrated and functioning correctly in order for accurate ammonia values to be calculated from ammonium sensor measurements.
- Exposure to the high ionic content of pH buffers can cause a significant, but temporary, drift in the ammonium sensors. Therefore, when calibrating the pH sensor, remove ammonium sensor from the cable bulkhead and plug the port. After pH calibration is complete, replace the ISE sensors and proceed with ammonium calibration. Alternatively, the ammonium sensor may be covered with a tightly fitting rubber cap during pH calibration. Failure to follow this protocol will result in ammonium calibration times of SEVERAL HOURS.

**SAFETY**

No special precautions

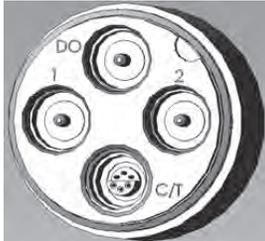
**PROCEDURES:**

I. Configuration – The YSI Pro Plus instrument is capable of simultaneous measurement of multiple water chemistry parameters including temperature, conductivity, pH, dissolved oxygen, ammonium, chloride, and nitrate. This IOP is limited to the parameters typically measured by the SLCP (temperature, pH, dissolved oxygen, and ammonia). Information on additional capabilities of the Pro Plus instrument are available in the User Manual and Calibration Tips documents available from YSI.

A. Instrument overview

1. Meter – The YSI Pro Plus handheld meter includes internal hardware and software for calculation of parameters, a display screen, and a keypad for data entry and screen navigation. The meter includes an internal barometer.
2. Cable – The instrument cable connects the meter to the sensors. The SLCP uses the quatro cable which has a four sensor capacity.

3. Sensors – Four sensors are required to measure all of the water chemistry parameters indicated above. Sensors are installed in the quatro cable bulkhead ports indicated below to ensure proper function. If measurement of one or more parameters is not required, the corresponding sensor(s) may be removed and replaced with a sensor port plug. Accurate calculation of ammonia from measured ammonium requires installed and properly calibrated pH and temperature sensors.



- a. temperature/conductivity sensor (5560) installed in “TC” port
- b. pH sensor (1001) installed in ISE port 1
- c. ammonium sensor (1004) installed in ISE port 2
- d. polarographic dissolved oxygen sensor (2003) installed in “DO” port

II. Pro Plus Key Pad Functions

Key	Description
	<b>System</b> - Opens System Menu from any screen. Use to adjust system settings.
	<b>Sensor</b> - Opens Sensor Menu from any screen. Use to enable sensors and display units.
Cal	<b>Calibrate</b> - Opens Calibrate Menu from any screen. Use to calibrate all parameters except temperature.
	<b>File</b> - Opens File Menu from any screen. Use to view data and GLP files, set up site and folder lists, and delete data.
	<b>Backlight</b> - Press to turn the instrument backlight on and off and to adjust the display contrast when pressed with the left or right arrow key.
	<b>Right Arrow</b> - Use to navigate right in alpha/numeric entry screens. Can be pressed simultaneously with Backlight key to increase display contrast.
	<b>Down Arrow</b> - Use to navigate through menus and to navigate down in alpha/numeric entry screens.
	<b>Power</b> - Press to turn the instrument on or off.
?	<b>Help</b> - Press to receive hints & tips during operation.
ENTER 	<b>Enter</b> - Press to confirm selections, including alpha/numeric key selections.
	<b>Left Arrow</b> - Use to navigate left in alpha/numeric entry screens. Press to return to previous menu in all screens except alpha/numeric entry. Can be pressed simultaneously with Backlight key to decrease display contrast.
Esc	<b>Exit/Escape</b> - Exits back to Run Screen. When in alpha/numeric entry screen, escapes to previous menu.
	<b>Up Arrow</b> - Use to navigate through menus and to navigate up in alpha/numeric entry screens.

III. Meter preparation and maintenance

A. Battery installation and replacement

1. Use a screwdriver to remove the 4 screws securing the battery chamber cover.
2. Lift off the battery chamber cover.
3. Install two alkaline C-size batteries according to the inscribed battery symbols on the inside of the battery chamber. Make sure batteries are in correct polarity.
4. Close the battery chamber cover and secure with the 4 screws.
5. Press and release the **Power** button (⏻) on the keypad. The LCD will come on; if not, consult the trouble shooting guide in the Pro Plus User Manual.
6. A battery meter is visible in the lower right corner of the display and should indicate a full charge after the installation of new batteries. Typical battery life is 80 hours of run time.
7. If the batteries are removed for longer than 2 minutes the instrument clock will reset. If the clock resets, the instrument will automatically bring up the Date/Time menu the next time it is powered on. The date and time should always be set correctly if data logging is used.

B. Instrument software setup

1. Press the Power key to turn the instrument on. The instrument will briefly display the splash screen with the YSI logo then go directly to the main run screen. The first time the instrument is powered up or if the instrument has had a battery change (with batteries removed for more than 2 minutes), you will need to set the **date and time**.
  - a. Highlight Date/Time from the System menu.
  - b. Press enter to select.
  - c. Date Format – Highlight and press enter to open a sub menu for selecting the preferred date format: MM/DD/YY.
  - d. Date – Highlight and press enter to use the numeric entry screen to set the correct date.
  - e. Time Format – Highlight and press enter to open a submenu to select the 24-hour time format.
  - f. Time – Highlight and press enter to use the numeric entry screen to set the correct time.
2. Setup Sensors
  - a. Press *Sensor* button, highlight *Setup*, press *enter*.
  - b. **pH sensor**
    - 1) Highlight *ISE1*. Press *enter*.
    - 2) Highlight *Enabled* and press *enter* to enable () the ISE port.
    - 3) Highlight *pH* and select it (⊙).
    - 4) Press ◀ to return to the previous menu.
  - c. **Ammonium sensor**
    - 1) Highlight *ISE2*. Press *enter*.
    - 2) Highlight *Enabled* and press *enter* to enable () the ISE port.
    - 3) Arrow down to *NH4* and press enter to select it (⊙).
    - 4) Press ◀ to return to the previous menu.

- d. **Dissolved oxygen sensor**
    - 1) Highlight *DO*. Press *enter*.
    - 2) Highlight *Enabled* and press *enter* to enable () the DO port.
    - 3) Highlight *Sensor Type* and press *enter*.
    - 4) Highlight *Polarographic* (default) and press *enter* to confirm.
    - 5) Highlight *Membrane* and press *enter*.
    - 6) Highlight *1.25 PE Yellow* and press *enter* to confirm.
    - 7) Be sure that *Local DO* and *LDS* are not enabled ()
    - 8) Press **◀** to return to the previous menu.
  - e. **Conductivity**
    - 1) Highlight *Conductivity*. Press *enter*.
    - 2) Highlight *Enabled* and press *enter* to disable it ()
    - 3) Press **◀** to return to the previous menu.
  - e. **Salinity**
    - 1) Press **◀** to return to the previous menu.
    - 2) Highlight *Salinity*. Press *enter*.
    - 3) Use the numeric entry screen to enter a value of 0.1 and then store the value.
    - 4) Press *Esc* when finished.
3. Setup display
- a. Press *Sensor* button, highlight *Display*, press *enter*.
  - b. **pH sensor**
    - 1) Highlight *ISE1(pH)*. Press *enter*.
    - 2) Highlight *pH* and press *enter* to enable it ()
    - 3) Highlight *pH mV* and press *enter* to enable it ()
    - 4) Press **◀** to return to the previous menu.
  - c. **Ammonium sensor**
    - 1) Highlight *ISE2(NH4)*. Press *enter*.
    - 2) Highlight *NH4-N mg/l* and press *enter* to enable it ()
    - 3) Highlight *NH4 mV* and press *enter* to disable it ()
    - 4) Highlight *NH3-N mg/l* and press *enter* to enable it ()
    - 5) Press **◀** to return to the previous menu.
  - d. **Dissolved oxygen sensor**
    - 1) Highlight *DO*. Press *enter*.
    - 2) Using the **▲** and **▼** arrows to move between the lines and *enter* to toggle, enable () *DO mg/l* and disable () *DO %L* and *DO ppm*.
    - 3) Press **◀** to return to the previous menu.
  - e. **Barometer**
    - 1) Highlight *Barometer*. Press *enter*.
    - 2) Highlight *None* and press *enter*.
    - 3) Press **◀** to return to the previous menu.
  - f. **Temperature**
    - 1) Highlight *Temperature*. Press *enter*.
    - 2) Highlight *°C* and press *enter* to select it ()
    - 3) Press **◀** to return to the previous menu.
- C. Sensor Installation (This section can be skipped if not installing or replacing any sensors.)
1. Remove/unscrew the metal guard or calibration cup if installed.
  2. Remove the red rubber port caps if the instrument was being stored without

sensors installed. Ensure that both the sensor connector and sensor port on the cable are clean and dry and stay that way during this entire procedure.

3. Install the conductivity/temperature sensor as follows:
  - a. Locate the C/T port and, if replacing, remove the old sensor using the installation tool to loosen the stainless steel retaining nut. Once the stainless steel retaining nut has been completely unscrewed from the bulkhead, remove the old sensor from the bulkhead by pulling the sensor straight out of the bulkhead.
  - b. Apply a thin coat of o-ring lubricant to the o-rings on the new sensor.
  - c. Align the connectors of the new sensor and the port and push the sensor in towards the bulkhead until you feel the sensor seat in its port. You will experience some resistance as you push the sensor inward.
  - d. Gently rotate the stainless steel sensor nut clockwise with your fingers. Do not use the tool. The nut must be screwed in by hand. If the nut is difficult to turn, STOP, as this may indicate cross threading. If you feel resistance or cross threading at any point, unscrew the nut and try again until you are able to screw the nut down completely without feeling any resistance. Damage to your cable/sensor may occur if you force the parts together.
  - e. Once completely installed, the nut will seat flat against the bulkhead. At this point, use the included tool to turn the nut an additional  $\frac{1}{4}$  to  $\frac{1}{2}$  turn. DO NOT overtighten. Refer to the sensor installation sheet that is included with the conductivity/temperature sensor for detailed instructions.
  
4. Install the 1001 pH sensor in port 1 as follows:
  - a. If an old sensor is installed, remove it by twisting counter-clockwise.
  - b. Apply a dab of grease to the new sensor o-rings.
  - c. Unscrew the cap from the sensor storage bottle to relieve tension on the o-ring and then remove the bottle. Replace the cap on the storage bottle with the full cap that came with the new sensor to prevent spilling the storage solution. Pat the sensor dry with a kim wipe.
  - d. Push the sensor into the connector on the cable until it is properly seated and only one o-ring is visible. Failure to properly seat the probe may result in damage.
  - e. Twist the sensor clockwise to engage threads and finger tighten. Do not use a tool. This connection is waterproof. Refer to the sensor installation sheet included with each sensor for detailed instructions.
  
5. Install the 1004 ammonium sensor in port 2 as follows:
  - a. If an old sensor is installed, remove it by twisting counter-clockwise.
  - b. Apply a dab of grease to the new sensor o-rings.

- c. Unscrew the cap from the sensor storage bottle to relieve tension on the o-ring and then remove the bottle. Replace the cap on the storage bottle with the full cap that came with the new sensor to prevent spilling the storage solution. Pat the sensor dry with a kim wipe moistened with water to dissolve any deposits.
  - d. Push the sensor into the connector on the cable until it is properly seated and only one o-ring is visible. Failure to properly seat the probe may result in damage.
  - e. Twist the sensor clockwise to engage threads and finger tighten. Do not use a tool. This connection is waterproof. Refer to the sensor installation sheet included with each sensor for detailed instructions.
6. Install the 2003 DO sensor in the DO port as follows:
- a. If an old sensor is installed, remove it by twisting counter-clockwise.
  - b. Apply a dab of grease to the new sensor o-rings.
  - c. Grasp the sensor with one hand and the sensor connection end of the cable (bulkhead) in the other.
  - d. Push the sensor into the connector on the cable until it is properly seated and only one o-ring is visible. Failure to properly seat the probe may result in damage.
  - e. Twist the sensor clockwise to engage threads and finger tighten. Do not use a tool. This connection is waterproof. Refer to the sensor installation sheet included with each sensor for detailed instructions.
7. Install the 2003 DO sensor membrane as follows:
- a. Change membrane and oxygen probe electrolyte solution every 30 days.
  - b. Remove the metal sensor guard.
  3. If installing a membrane for the first time, remove the protective cap or remove the old membrane cap by unscrewing it with the probe upside down.
  - c. Examine the gold cathode at the tip of the sensor and silver anode along the shaft of the sensor. If either the silver anode is black in color or the gold cathode is dull (tarnished), the sensor needs maintenance or replacement. Refer to the Pro20 Instruction Manual, GENERAL MAINTENANCE, of polarographic sensor (Model # 605203).
  - d. Rinse the sensor with de-ionized water.
  - e. Fill a new membrane cap (5908 Kit - Yellow, 1.25 mil polyethylene) with oxygen probe electrolyte Solution. Do not touch the membrane surface.
  - f. Tap the side of the membrane cap to release air bubbles.
  - g. Thread the membrane cap onto the sensor with the probe upside down.
  - h. Replace the metal sensor guard.

D. Cable Attachment

1. Align the keys in the cable connector to the slots in the meter connector.
2. Push together and twist the outer ring clockwise until it locks into place.
3. To remove the cable, twist the outer ring until keys and slots are aligned and

then pull apart the connectors.

IV. pH sensor calibration

**IMPORTANT:** Exposure of an ammonium sensor to the pH buffers will cause extremely long ammonium calibration times. If an ammonium sensor is installed, cover it with a tight rubber seal or remove it and insert a port plug before calibrating the pH sensor.

- A. Press **Cal**. Select **None**. Highlight **ISE (pH)** and press **enter**. The message line will show the instrument is “Ready for point 1”. The pH calibration allows up to six calibration points.
  
- B. Place the sensor in a pH 7 buffer solution. The instrument should automatically recognize the buffer value and display it at the top of the calibration screen. If the calibration value is incorrect, the auto buffer recognition setting in the Sensor Setup menu may be incorrect. If necessary, highlight the Calibration Value and press enter to input the correct buffer value. After 5 minutes and once the pH and temperature readings stabilize, highlight **Accept Calibration** and press **enter** to accept the first calibration point. The message line will then display “Ready for point 2”.
  
- C. Rinse and place the sensor in the second buffer solution. The instrument should automatically recognize the second buffer value and display it at the top of the screen. If necessary, highlight the Calibration Value and press enter to input the correct buffer value. After 5 minutes and once the pH and temperature readings stabilize, highlight **Accept Calibration** and press **enter** to confirm the second calibration point. The message line will then display “Ready for point 3” and you can continue with the 3<sup>rd</sup> calibration point if desired. If you do not wish to perform a 3<sup>rd</sup> calibration point, press **Cal** to complete the calibration.

V. Ammonium sensor calibration

The calibration procedures for ammonium, nitrate, or chloride are similar to pH. The only differences are the calibration solutions. If the ammonium sensor was capped in order to calibrate the pH sensor, remove the cap before beginning the ammonium sensor calibration.

- A. Place the proper amount of 1 mg/L Ammonium standard into the pre-rinsed calibration cup. Carefully immerse the sensor into the solution. Allow at least 1 minute for temperature equilibration before proceeding.
  
- B. Press **Cal**. Select **None**. Highlight **ISE (Ammonium)** and press **enter**. The message line will show the instrument is ready for the 1st calibration point. The instrument will display the calibration value at the top of the screen. If necessary, highlight the Calibration value and press enter to input the correct value. After 5 minutes and once the ammonium and temperature readings stabilize, highlight **Accept Calibration** and press **enter** to accept the first calibration point. The message line will then display “Ready for point 2”.
  
- C. Rinse the sensor with clean water, then dry it before placing it in the 100 mg/L calibration standard. Allow at least 5 minutes for temperature equilibration before

proceeding. The instrument will display the second calibration value at the top of the screen. If necessary, highlight the Calibration value and press enter to input the correct buffer value. Once the readings stabilize, highlight **Accept Calibration** and press **enter** to confirm the second calibration point. The message line will then display “Ready for point 3”. Press **Cal** to complete the calibration.

VI. DO sensor calibration

- A. The supplied sensor storage container (a grey sleeve) can be used for DO calibration purposes. Moisten the sponge in the storage sleeve or plastic cup with a small amount of clean water. The sponge should be clean since bacterial growth may consume oxygen and interfere with the calibration. If using the cup and you no longer have the sponge, place a small amount of clean water (1/8 inch) in the sleeve instead. Make sure there are no water droplets on the DO membrane or temperature sensor. Then install the storage sleeve over the sensors. The storage sleeve ensures venting to the atmosphere. Make sure that DO and temperature sensors are not immersed in water.
- B. Turn the instrument on and wait 15 minutes for the storage container to become completely saturated and to allow the sensors to stabilize.
- C. Press **Cal**. Select **None**. Highlight **DO %** and press enter to confirm.
- D. The instrument will use the internal barometer during calibration and will display this value in brackets at the top of the display. Highlight **Barometer** and press **enter** to adjust it if needed. If the barometer reading is incorrect, it is recommended that you calibrate the barometer. Note - the barometer should be reading “true” barometric pressure (see Barometer section of Instrument Manual for more information on “true” barometric pressure). If the value is acceptable, there is no need to change it or perform a barometer calibration.
- E. Wait for the temperature and DO% values under “Actual Readings” to stabilize, then highlight **Accept Calibration** and press enter to calibrate. The message line at the bottom of the screen will display “Calibrating Channel...” and then “Saving Configuration...”.

VII. Measurements

- A. Ensure the cable and sensors are tightly connected to the meter.
- B. Be sure the meter has been calibrated.
- C. Place the sensors in the sample to be measured.
- D. Shake the probe in the sample to release air bubbles.
- E. Allow temperature reading to stabilize.
- F. Stir the sample water with the probe at a moderate pace. You must provide 6 inches of water movement per second across the DO sensor membrane to obtain an accurate reading. Be careful not to create a vortex which allows air bubbles to pass against the DO membrane.
- G. After at least 5 minutes once values stabilize, record the measurement. The ProPlus meter is capable of storing measurements in addition to a site name, but that procedure is outside the scope of this protocol.

IIX. Sensor storage

A. Short term storage

The cable assembly is supplied with a sensor storage container, or sleeve, that attaches to the cable. The container is used for short-term storage (less than 7 days). Be sure to keep a small amount of moisture (tap water) in the container during storage. This is done to maintain a 100% saturated air environment which is ideal for short-term sensor storage. The sensors should not be submersed in water. The intent is to create a humid air storage environment.

B. Long term storage

1. Temperature sensor - No special storage is required. The temperature sensor can be stored dry or wet as long as solutions in contact with the thermistor are not corrosive (for example, chlorine bleach).
2. Conductivity sensor - No special storage is required. Sensors can be stored dry or wet as long as solutions in contact with conductivity electrodes are not corrosive (for example, chlorine bleach). However, it is recommended that the sensor be cleaned with the provided brush prior to and after long term storage.
3. Dissolved oxygen sensor - Dissolved oxygen sensors should be stored in a dry state for long term storage. First, remove the membrane cap and thoroughly rinse the sensor with clean water. Next, either blow it dry with compressed air or allow to air dry completely. Install a clean, dry new membrane cap over the sensor to keep it dry and to protect the electrodes. After storing the sensor for a long period of time, it is necessary to "condition" the sensor by putting a new membrane with electrolyte solution on the sensor and then turning the instrument on to allow the sensor sufficient time to stabilize.
4. pH sensor - The key to pH sensor storage, short or long-term, is to make certain that the sensor does not dry out. Sensors which have been allowed to dry out due to improper storage procedures may be irreparably damaged by the dehydration and will require replacement. You can try to rehydrate the sensor by soaking it (preferably overnight) in a potassium chloride solution or a pH 4 buffer before attempting to calibrate. To store the sensor, remove it from the cable and seal the vacant port with a port plug. Fill the original shipping/storage vessel (plastic boot or bottle) with buffer 4 solution and then submerge the sensor into the solution. The sensor should remain submerged in the solution during the storage period; therefore, make certain that the vessel is sealed to prevent evaporation and periodically check the vessel to ensure the sensor does not dry out.
5. Ammonium sensor - The key to ISE sensor storage, short or long-term, is to make certain that the sensor does not dry out. Sensor junctions that have been allowed to dry out due to improper storage procedures may be irreparably damaged by the dehydration and will require replacement. You can attempt to rehydrate the sensor by soaking it (preferably overnight) in the sensor's high calibration solution before attempting to calibrate. The recommended storage of these sensors is in moist air. Remove the sensor from the cable and seal the vacant port with the provided plug. Place the sensor in its original shipping storage vessel (plastic boot or bottle) with a small amount of tap water or its high calibration standard. The vessel should remain a saturated air environment. The sensor only needs to be kept in moist air, not submerged. Make certain that the vessel is sealed to prevent evaporation.

**MAINTENANCE:**

See User Manual and Calibration Tips.

**REFERENCE:**

User Manual for YSI Professional Plus Multiparameter Water Quality Meter  
Calibration Tips for YSI Professional Plus Multiparameter Water Quality Meter  
Quick Start Guide for YSI Professional Plus Multiparameter Water Quality Meter

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This procedure has been reviewed and approved by the undersigned representatives of the U.S. Fish and Wildlife Service and Fisheries and Oceans Canada.

REVIEWED/APPROVED \_\_\_\_\_ DATE \_\_\_\_\_  
Field Supervisor (U.S.)

REVIEWED/APPROVED Mike Spivak DATE 05 MAY 2020  
Program Manager (Canada)