



Environmental Analysis Program

Pomona College
Biogeochemistry Laboratory

SOP-F209

Dissolved Oxygen Meter (Field)

Standard Operating Procedure

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1. Purpose

This SOP describes the calibration, field operation, and maintenance of standalone handheld dissolved oxygen (DO) meters for in situ measurement of dissolved oxygen concentration and percent saturation in surface waters. Dissolved oxygen is a fundamental indicator of water quality and

aquatic habitat condition (APHA et al., 2012). This SOP covers both optical (luminescent) and electrochemical (polarographic and galvanic) DO probes operated as standalone instruments, separate from multiparameter sondes.

2. Scope

- **Applies to:** Handheld DO meters (e.g., YSI Pro20i, YSI ProSolo, Hach HQ40d with LDO probe, Extech DO600) used for in situ DO measurements at EA Program surface water field sites
- **Does not apply to:** DO measured by the Eureka Manta2 multiprobe (see [SOP-F200](#)); Winkler titration (laboratory method); BOD₅ analysis (see [SOP-L306](#)); continuously deployed sondes
- **Location:** All EA Program surface water field sites

3. Responsibilities

Role	Responsibility
PI / Field Lead	Approve instrument selection; review QC data
Trained Personnel	Calibrate and operate the meter per this SOP
New Students	Complete training before independent use

4. Definitions

- **Barometric pressure correction:** Adjustment of the 100% saturation calibration point for the ambient atmospheric pressure; oxygen solubility decreases with decreasing pressure (increasing altitude); entered in mmHg or hPa at the time of calibration (APHA et al., 2012).
- **DO percent saturation (%sat):** The measured DO concentration expressed as a percentage of the equilibrium saturation concentration at the same temperature and pressure; 100% indicates equilibrium with the atmosphere; supersaturation (> 100%) indicates net photosynthesis; values well below 100% indicate high oxygen demand or poor reaeration (APHA et al., 2012).
- **Electrochemical (polarographic/galvanic) probe:** A DO sensor in which oxygen diffuses through a gas-permeable membrane and is reduced at the cathode, generating a current proportional to DO concentration; requires periodic membrane and electrolyte replacement and is flow- dependent (needs water movement past the membrane) (APHA et al., 2012).
- **KCl electrolyte:** The potassium chloride solution filling the electrode cavity of polarographic DO probes; must be replaced when the membrane is changed or when readings become erratic.
- **LDO (luminescent dissolved oxygen) probe:** An optical sensor that measures DO by the quenching of luminescence from a ruthenium-dye sensing element by oxygen molecules; requires no electrolyte or membrane, no warm-up time, and no stirring (Hach Company, 2023).

- **Membrane (DO probe):** The gas-permeable Teflon or polyethylene film covering the electrode of an electrochemical DO probe; must be free of bubbles, tears, or debris; replace if damaged or if readings are erratic.
- **Sensing cap:** The replaceable luminescent element on an optical DO probe; replace when the cap expires (typically 1–2 years) or when readings become erratic (YSI Inc., 2022).
- **Winkler titration:** The reference wet-chemical method for DO determination; used to verify DO meter accuracy and required for calibration validation in some regulatory programs (APHA et al., 2012).
- **Zero-oxygen calibration:** A secondary calibration point using an oxygen-free solution (sodium sulfite with cobalt chloride catalyst) to verify the zero response of the DO probe; recommended when expected DO values are below 2 mg/L.

5. Safety and Hazards

Hazards

- **Physical:** Measuring DO requires placing the probe in or near water. Slip, fall, and drowning hazards apply. Work in pairs at stream sites.
- **Chemical:** Polarographic DO probes use KCl electrolyte solution, a mild irritant. Sodium sulfite (used for zero-oxygen calibration) is a mild irritant and reducing agent.
- **Biological:** Water may contain pathogens. Avoid ingestion; wash hands after field work.

5.1. Required PPE

- ☐ Closed-toed shoes or wading boots
- ☐ Nitrile gloves (especially for impaired waters)
- ☐ Sun protection (hat, sunscreen)

5.2. Emergency Procedures

Refer to [SOP-F001 Field Safety](#).

6. Instrument Types

6.1. Optical (Luminescent) DO Probes

Optical probes (e.g., Hach HQ40d with LDO101 probe, YSI ProSolo ODO) measure DO by detecting luminescence quenching. They require no electrolyte, no warm-up time, no stirring, and no membrane replacement (Hach Company, 2023).

Advantage	Limitation
No membrane or electrolyte	Higher initial cost

Advantage	Limitation
No stirring required Fast stabilization Lower maintenance	Sensing cap has finite lifespan (1–2 yr)

6.2. Electrochemical (Polarographic / Galvanic) DO Probes

Electrochemical probes (e.g., YSI Pro20i) measure DO through an oxygen-permeable membrane (YSI Inc., 2022).

Advantage	Limitation
Lower initial cost Well-established method Widely available	Requires membrane and electrolyte replacement Needs 5–15 min warm-up Flow-dependent (stirring or moving water needed)

7. Equipment and Materials

Item	Notes
Handheld DO meter with probe	Fully charged; confirm calibration supplies
Water-saturated air calibration chamber	Wet sponge in probe storage cap
Barometric pressure reference	Built into some meters; otherwise Kestrel or phone app
Spare membranes and electrolyte	For electrochemical probes
Spare sensing cap	For optical probes; replace when expired or erratic
Thermometer (for verification)	Most DO probes include temperature sensor
DI water (squeeze bottle)	For rinsing the probe
Lint-free wipes	For drying the probe before calibration
Field notebook	Per SOP-F003
Spare batteries	Matched to meter model

8. Procedure

8.1. Calibration

Calibrate the DO meter before each field day using the **water-saturated air** method.

Water-saturated air calibration:

1. Ensure the calibration chamber (probe storage cap with damp sponge) is moist but not dripping; the probe tip must not touch the sponge.

2. Turn on the meter. Allow electrochemical probes to warm up for 5–15 minutes (see instrument manual) (YSI Inc., 2022).
3. Enter the current barometric pressure (mmHg or hPa). Verify the displayed value against a Kestrel or weather station.
4. Place the probe in the calibration chamber; wait for the reading to stabilize (1–3 min for optical; 5–10 min for electrochemical).
5. Press **Cal** per the instrument prompts; the meter sets 100% saturation at the current temperature and pressure.
6. Record in the field notebook: calibration date, time, barometric pressure, temperature, and whether calibration was accepted.

Zero-oxygen calibration (optional – low-DO environments):

1. Dissolve excess sodium sulfite in DI water with a pinch of cobalt chloride catalyst.
2. Immerse the probe and wait for the reading to stabilize.
3. Calibrate the zero point per meter instructions.

8.2. Field Measurement

1. Immerse the probe to mid-depth at the sampling location. For electrochemical probes, maintain a minimum flow of 0.3 m/s past the membrane (gently move the probe in still water). Optical probes do not require flow (Hach Company, 2023).
2. Wait for the reading to stabilize.
3. Record in the field notebook:
 - DO concentration (mg/L) and percent saturation (%)
 - Water temperature (°C) as reported by the probe
 - Date, time, sample ID, and measurement depth
 - Flow conditions (riffle, pool, still water with manual stirring)
4. For depth profiles, lower the probe in 0.5 or 1.0 m increments and allow stabilization at each depth.

8.3. Post-Field Care

1. Rinse the probe with DI water after each use.
2. For electrochemical probes, check the membrane for tears, bubbles, or deposits; replace membrane and electrolyte if damaged (YSI Inc., 2022).
3. For optical probes, gently wipe the sensing cap with a soft, damp cloth if biofouling is visible; do not use solvents.
4. Store the probe in the calibration chamber with a moist sponge (not submerged).
5. Turn off the meter; remove batteries if storing for more than one month.

9. Data Interpretation

DO concentrations are influenced by temperature, atmospheric pressure, salinity, photosynthesis, respiration, and reaeration (APHA et al., 2012).

DO (mg/L)	Condition
> 8	Well-oxygenated; suitable for most aquatic life
5–8	Adequate for many species; marginal for cold-water fish
2–5	Stressful for most fish; hypoxic conditions
< 2	Severe hypoxia; lethal to most aquatic organisms

10. Quality Control

- Calibrate at the start of each field day.
- At the end of the field day, check calibration by returning the probe to the water-saturated air chamber; reading must be within $\pm 2\%$ of 100% saturation. If drift exceeds 5%, note it and recalibrate.
- When possible, verify against a second DO meter or the Eureka Manta2; readings should agree within ± 0.5 mg/L.
- For long field days (> 6 hours), perform a mid-day calibration check.
- Record all QC results in the field notebook (APHA et al., 2012).

11. References

- APHA et al. (2012)
- Hach Company (2023)
- YSI Inc. (2022)

APHA, AWWA, & WEF. (2012). *Standard methods for the examination of water and wastewater* (22nd ed., p. 1360). American Public Health Association.

Hach Company. (2023). *HQ40d portable multi-parameter meter: User manual*. <https://www.hach.com/hq40d-portable-multi-parameter-meter/product?id=7640196365>

YSI Inc. (2022). *Pro20i portable dissolved oxygen instrument: User manual*. <https://www.ysi.com/pro20i>

12. Related SOPs

SOP	Title	Relationship
F001	Field Safety	Required prerequisite
F200	Eureka Manta2 Multiprobe	Multiprobe includes DO sensor
F300	Surface Water Sampling	Sampling context
F304	Stream Physical Habitat	Habitat characterization

13. Training Record

Before using DO meters independently, personnel must:

1. Read this SOP in full
2. Demonstrate a complete water-saturated air calibration
3. Perform supervised DO measurements at one field site
4. Demonstrate membrane inspection and replacement (electrochemical probes) or sensing cap inspection (optical probes)
5. Be signed off by the PI or field lead