INSTRUCTION MANUAL
YSI MODEL 58
DISSOLVED OXYGEN METER

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PRICE INCLUDING HANDLING $5.00

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GENERAL DESCRIPTION

The YSI Model 58 Dissolved Oxygen Meter is intended for field or laboratory use for dissolved oxygen and temperature measurement in water and wastewater applications, but is also suitable for use in certain other fluids. (See "Measuring Oxygen in Fluids Other Than Water," page 21.) The meter may be used with any of the YSI 5700 Series probes. Dissolved oxygen is indicated in mg/l (1 mg/l ≈ 1 part per million) or in % air saturation; the % air saturation feature is discussed below in detail. Display sensitivity in the mg/l mode may be selected to read in tenths or in hundredths of a mg/l. Temperature is indicated in °C from -5°C to +45°C with 0.1°C resolution. The mg/l mode is automatically temperature compensated for changes in solubility of oxygen in water and for permeability of the probe membrane; the % air saturation mode is compensated for permeability of the membrane. A salinity compensation control allows direct determination of mg/l of dissolved oxygen in oceanic or estuarine waters. Batteries provide complete portability; a battery eliminator feature bypasses the instrument batteries for extended line powered use (not including stirrer). Instrument batteries are carried internally in one holder while a second holder allows internal installation of batteries for powering a submersible stirrer for use in the field.

The probes use Clark-type membrane covered polarographic sensors with built-in thermistors for temperature measurement and compensation. A thin, permeable membrane stretched over the sensor isolates the sensor elements from the environment, but allows oxygen and certain other gases to enter. When a polarizing voltage is applied across the sensor, oxygen that has passed through the membrane reacts at the cathode, causing a current to flow.

The membrane passes oxygen at a rate proportional to the pressure difference across it. Since oxygen is rapidly consumed at the cathode, it can be assumed that the oxygen pressure inside the membrane is effectively zero. Hence, the force causing the oxygen to diffuse through the membrane is proportional to the absolute pressure of oxygen outside the membrane. If the oxygen pressure increases, more oxygen diffuses through the membrane and more current flows through the sensor. A lower pressure results in less current.

% AIR SATURATION

The % air saturation feature of this instrument allows quick determination of the degree of air saturation occurring in fresh or saline water. This feature also allows measurement in fluids of unknown oxygen solubility (see "Measuring Oxygen in Fluids Other than Water").

The % air saturation displayed in this mode is the saturation which would occur if the sample were saturated with air under a normal barometric pressure of 1013 millibars (760 mm Hg, or 29.92 inches Hg). Results reported from such measurements should be noted as % air saturation corrected to "standard pressure."

This feature also makes possible a simple and quick calibration procedure which eliminates the need to determine exact probe temperature or to calculate the barometric pressure effect on the calibration value. To calibrate the Model

58, the function switch is set to the % air saturation mode with the probe in moist air; then the O_2 **CALIB** control is adjusted to obtain a meter reading corresponding to the calibration value for the local altitude. Charts for quickly determining calibration values are conveniently located on the instrument's back cover.

This simple procedure accurately calibrates the meter for readings in both the mg/l and the % air saturation modes. The instrument may be switched from one mode to the other without losing its calibration. (Other methods of calibration are also possible and are discussed in detail in this manual.)

SPECIFICATIONS

INSTRUMENT

Oxygen Measurement

MODES:
- 0 to 20.0 mg/l dissolved oxygen
- 0 to 20.00 mg/l dissolved oxygen
- 0 to 200.0% air saturation

ACCURACY:
- ± .03 mg/l in 0 to 20.00 mg/l mode
- ± 0.3% air saturation

TEMPERATURE COMPENSATION:
- The mg/l modes are automatically temperature compensated to an accuracy of ± 1% of the dissolved oxygen reading between 5° and 45°C; and to an accuracy of ± 2% between 0° and 5°C. *Note:* See "Temperature Sensitivity" in probe specifications.
- The % air saturation mode is automatically temperature compensated to an accuracy of ± 1% of the oxygen reading between 5° and 45°C; and to an accuracy of ± 1.5% between 0° and 5°C. *Note:* See "Temperature Sensitivity" in probe specifications.

SALINITY COMPENSATION:
- Salinity range: 0 to 40 parts per thousand
- Accuracy: ± 0.3% of reading ± 1 digit

MODE TO MODE ACCURACY (mg/l to % air saturation)
- ± 0.5% of reading, ± 2 least significant digits (in the 0.01 mg/l mode)

Temperature Measurement

RANGE: -5° to +45°C

ACCURACY: ± 0.3°C, plus probe interchangeability

Recorder Output

VOLTAGE: 0 to 1 volt, full scale

ACCURACY: ± 0.4% of full scale, ± 1 least significant digit (in the 0.01 mg/l mode)

MINIMUM LOAD IMPEDANCE: 50KΩ

Instrument Environment

AMBIENT TEMPERATURE RANGE FOR SPECIFICATION PERFORMANCE: 0° to 45°C.

WATER RESISTANCE: With REC'D OUT and BATT ELIM (and STIRRER) receptacles capped, every case opening is gasketed to resist the entry of water.

Power Supplies

INSTRUMENT:
- 4 D size batteries, or battery eliminator
- ~ 1000 hours battery life
- Low battery indicator signal (LOBAT) appears automatically when approximately 50 hours of battery life remain.

STIRRER (OPTIONAL):
- A holder is provided for 4 additional D size batteries to power the optional field stirrer (YSI 5795A).
- Battery life for the stirrer is typically 100 hours.
- The stirrer battery status can be checked by front panel control. LOBAT signal appears while STIRRER switch is held on BATT CHK position when approximately 5 hours of stirrer battery life remain.

PROBE (YSI Models 5739, 5720A or 5750)

CATHODE: Gold

ANODE: Silver

MEMBRANE: .001" FEP Teflon, YSI 5775, standard
.0005" FEP Teflon available, YSI 5776

ELECTROLYTE: Half-saturated KCl with Kodak Photo-Flo

TEMPERATURE SENSITIVITY:

When measuring oxygen, the probe output current increases approximately 3.5% per 1°C of increase in temperature. The circuitry automatically compensates for this effect in a typical probe. However, the exact temperature sensitivity of an individual probe may vary slightly according to its condition. Therefore, a probe should be calibrated at a temperature as close as possible to the measurement temperature in order to minimize the possible effect of such variation.

TEMPERATURE SENSOR ACCURACY: ± 0.2°C

PRESSURE COMPENSATION:

Effective 0.5% of reading with pressures to 100 psi (230 feet sea water)

POLARIZING VOLTAGE: 0.8 volts nominal

PROBE CURRENT: Air at 30°C, 19 microamps nominal
Nitrogen at 30°C, .15 microamps or less

PROBE RESPONSE TIME:

Typical response for temperature and dissolved oxygen readings is 90% in 10 seconds at a constant temperature of 30°C with YSI 5775 Membrane. D.O. response at low temperature and low D.O. is typically 90% in 30 seconds. YSI 5776 High Sensitivity Membranes may be used to improve response at low temperature and D.O. concentrations.

ACCESSORIES AND REPLACEMENT PARTS

YSI 5720A Self-Stirring BOD Bottle Probe
YSI 5750 Non-Stirring BOD Bottle Probe
YSI 5739 Oxygen Temperature Probe for field use. Combine with one of the following cables for desired lead length:

Detachable leads for use with YSI 5739

YSI 5740 - 10	10' Cable
YSI 5740 - 25	25' Cable
YSI 5740 - 50	50' Cable
YSI 5740 - 100	100' Cable
YSI 5740 - 150	150' Cable
YSI 5740 - 200	200' Cable

YSI 5401 Battery Eliminator (115 VAC)
YSI 5402 Battery Eliminator (230 VAC)
YSI 5795A Submersible Stirrer. With power cable and probe cable. Requires 5739 probe.
YSI 5075A Calibration Chamber for field use with 5739 probe.
YSI 5890 Carrying Case
YSI 5775 Membrane and KCl kit, Standard. Includes two 15-membrane packets (.001" thick standard membranes) and a 30 ml applicator bottle of KCl electrolyte with Kodak Photo-Flo.
YSI 5776 Membrane and KCl kit, High Sensitivity. Includes two 15-membrane packets (.0005" thick high sensitivity membranes) and a 30 ml bottle of KCl electrolyte with Kodak Photo-Flo.
YSI 5945 O-ring Pack. Includes six O-rings for each YSI dissolved oxygen probe.
YSI 5486 Beater Boot Kit. Includes a beater tip and a beater boot assembly. Use with the YSI 5720A probe.
YSI 5986 Diaphragm Kit. For use only with the YSI 5739 probe. Includes diaphragm, plug and nylon washer.
YSI 58024 Model 58 Dissolved Oxygen Meter Service Manual
YSI 5680 Probe Reconditioning Kit

OXYGEN PROBES AND EQUIPMENT

Three different YSI oxygen probes may be used with the Model 58 meter. The Model 5739 probe is designed for field use and may be used with or without a stirrer. A 5740 probe cable is required for use with the 5739 probe, except when using the 5795A Submersible Stirrer. The 5795A has a dual purpose cable to which both stirrer and probe are connected. The Models 5720A and 5750 are BOD bottle probes: the 5720A is self-stirring; the 5750 is not.

For sample stirring with the 5739 probe, the 5795A has a dual purpose cable to which both stirrer and probe are connected.

YSI 5739 DISSOLVED OXYGEN PROBE

The YSI 5739 probe is illustrated in Figure 1.

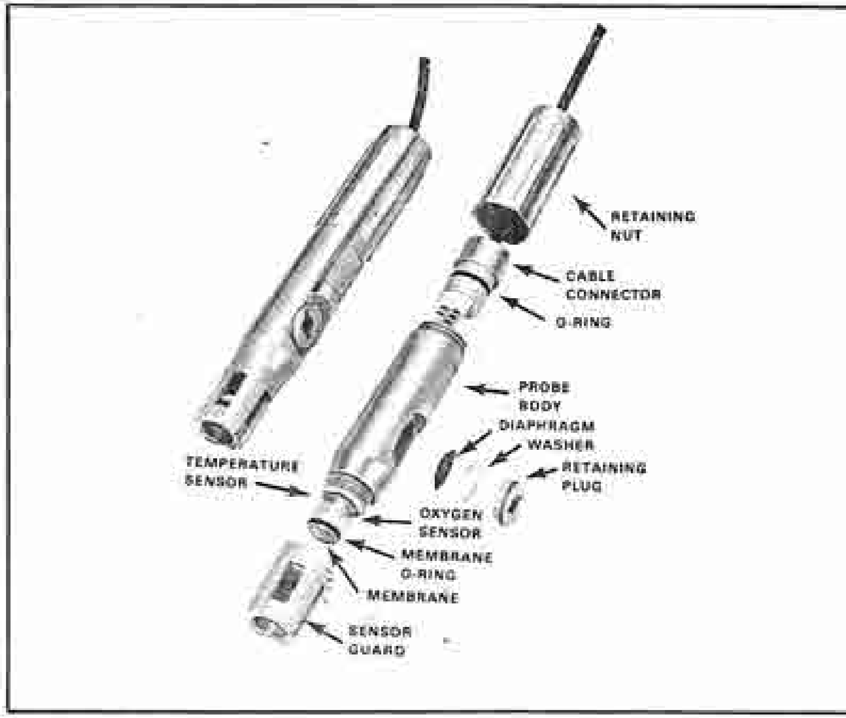

Figure 1. The YSI Model 5739 Dissolved Oxygen Probe — used with YSI 5740 Cable or with YSI 5795A Stirrer and Cable combination.

For user convenience the probe is equipped with a disconnecting cable to facilitate changing cable lengths and replacing damaged cables or probes. The probe and cable assembly is held together with a threaded retaining nut. The connection is *not* designed for casual disconnection and should only be disconnected when necessary.

To disconnect the cable, unscrew the retaining nut and slide it down the cable to expose the connector. Pull gently on the cable and connector until the connector comes away from the probe body.

To reassemble, inspect the connector and O-ring for cleanliness. If the O-ring is frayed or damaged, remove it by squeezing it in the groove causing it to bulge, then roll it out of the groove and off the connector. A replacement O-ring is supplied with the cable.

Push the connector into the probe body, rotating it until the two halves mate. A light coating of vaseline or silicone grease on the O-ring will make reassembly easier. Air trapped between the connector halves which may cause them to spring apart slightly, is normal. Screw on the retaining nut, *hand tight only.*

NOTE: If erratic readings are experienced, disconnect the cable and inspect for water. If water is present, dry out and reconnect, replacing the O-ring.

Pressure Compensation

The vent on the side of the probe is part of a unique pressure compensating system that helps assure accurate readings at great depths of water. Pressure compensation is effective to 0.5% of reading with pressures to 100 psi (230 ft. water). The quantity of air bubbles trapped under the membrane determines how serious the pressure error will be, which is why proper preparation of the probe is essential. (See OPERATING PROCEDURES.) The system is designed to accommodate a small amount of trapped air and still function properly, but the amount should be kept to a minimum.

The compensating system normally does not require servicing and should not be taken apart. However, if electrolyte is leaking through the diaphragm or if there is an obvious puncture, the diaphragm must be replaced. A spare is supplied with the probe. Using a coin, unscrew the retaining plug and remove the washer and the diaphragm, flush any salt crystals from the reservoir, install the new diaphragm (ridged side in), replace the washer, and screw in the retaining plug.

YSI 5720A BOD BOTTLE PROBE

The YSI 5720A BOD Bottle Probe (see Figure 2) is used for measuring dissolved oxygen and temperature in standard 300 ml BOD bottles. It is provided with an integral agitator for stirring the sample solution, and is available in versions for 117 VAC (95 to 135 VAC, 50 to 60 Hz) or for 230 VAC (190 to 250 VAC, 50 to 60 Hz) operation.

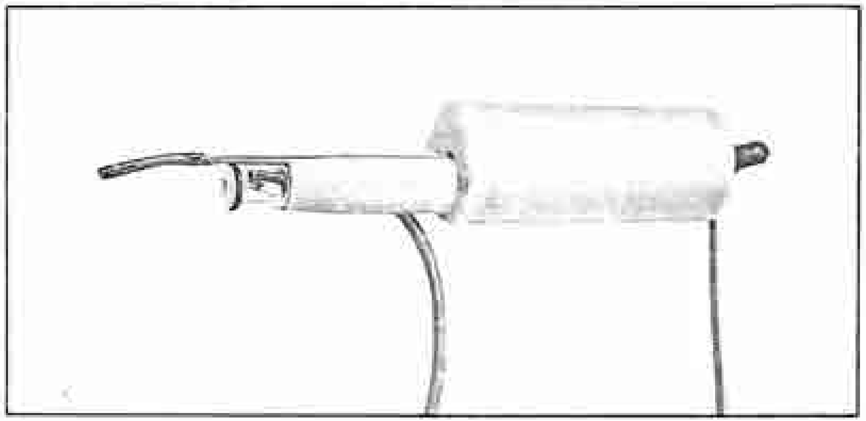

Figure 2. The YSI Model 5720A BOD Bottle Probe with integral agitator and stirrer boot.

When using the probe, plug the agitator power supply into line power and the probe plug into the instrument. With the agitator turned off, place the tapered probe end into the BOD bottle and switch on the agitator with the switch on top of the probe. The probe should be operated with a minimum of trapped air in the BOD bottle. A slight amount of air in the unstirred region at the top of the bottle may be neglected, but there should be no bubbles around the thermistor or oxygen sensor.

Stirrer Boot

The probe uses a flexible stirring boot to transmit motion from the sealed motor housing to the sample. If the boot shows signs of cracking or other damage likely to allow leaking into the motor housing, the boot must be replaced.

In fresh water applications, boot life is normally several years, but this period may be lessened by exposure of the boot to hydrocarbons, moderate to strong acids or bases, ozone, or direct sunlight. For maximum life, rinse the boot after use whenever it has been immersed in contaminated samples. The boot is shown in Figure 3.

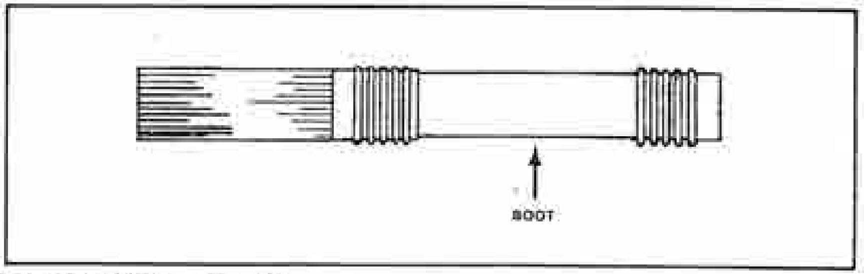

Figure 3. Boot Assembly

To replace the boot, follow these steps:

1. Pull off old assembly and clean the shaft.
2. Slide on the new assembly, making sure that the back spring is seated on the grooved area of the shaft. A small amount of rubber cement may be used to secure the boot.
3. Ascertain that there is sufficient clearance between the tip of boot assembly and the end of the agitator shaft to permit turning without binding.

YSI 5750 BOD BOTTLE PROBE

The Model 5750 probe (see Figure 4) is similar to the 5720A, except that it does not have a stirrer. Agitation of the sample must be provided by other means, such as a magnetic stirrer.

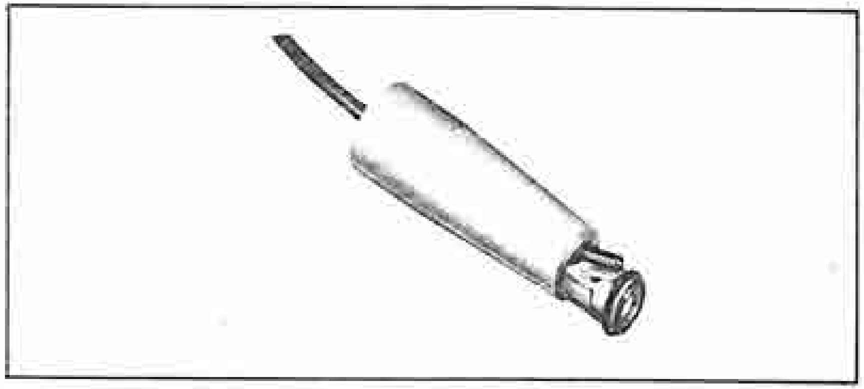

Figure 4. The YSI Model 5750 BOD Bottle Probe.

YSI 5795A SUBMERSIBLE STIRRER

The YSI 5795A Stirrer features a single cable for both probe and stirrer to permit convenient manipulation and storage.

When a stirrer and probe are assembled, the stirrer agitates the sample directly in front of the sensor by means of a rotating eccentric weight which causes the spring-mounted, sealed motor housing to vibrate. An impeller on the end of the motor housing flushes the fluid being assayed across the sensor surface. (See sales literature and Stirrer instruction sheets for further information.)

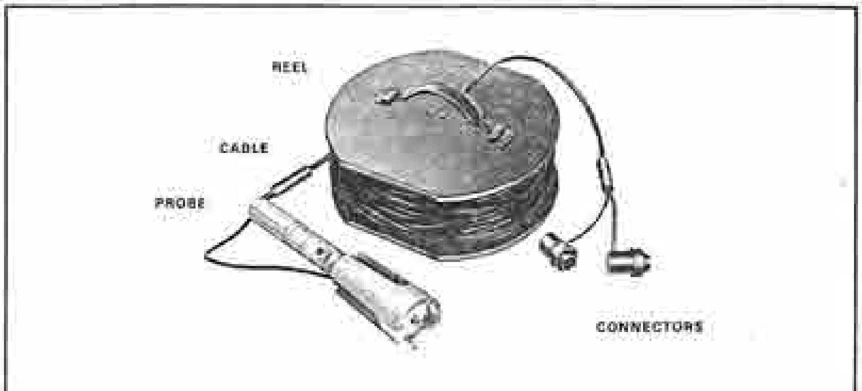

Figure 5. YSI 5795A Submersible Stirrer with reel and cable; YSI 5739 probe attached.

The stirrer is powered by four D size carbon-zinc batteries housed in the lower battery compartment inside the Model 58. When the stirrer will not be used for an extended period, these batteries should be removed from the instrument.

YSI 5401 (115 VAC) AND 5402 (230 VAC) BATTERY ELIMINATORS

For exclusive or long-term laboratory use, the Model 58 may be powered by the 5401 or 5402 Battery Eliminator. When the battery eliminator is in use, batteries may be removed from the instrument battery compartment (upper compartment). Note, however, that the battery eliminator ***does not*** power the 5795A Field Stirrer, which operatoes only when there are batteries in the stirrer battery compartment (lower compartment).

YSI 5075A CALIBRATION CHAMBER

See page 18.

OPERATING PROCEDURES

A brief summary of these procedures is printed on the back panel of the instrument, and reproduced on the back cover of this manual. The operator should be thoroughly familiar with the contents of this manual, however, before using the instrument.

CHOOSING THE CORRECT MEMBRANE

An extremely thin membrane increases O_2 permeability and probe signal current, and hastens a probe's response; but it achieves this at the expense of ruggedness. The membrane normally used with the Model 58 is the 1 mil (.001") membrane. (Order YSI 5775 Membrane and KCl kit, Standard.) This 1 mil membrane represents a compromise between quickness of response and membrane strength and integrity.

For special circumstances, an 0.5 mil (.0005") membrane is available. (Order YSI 5776 Membrane and KCl kit, High Sensitivity.) This half-thickness membrane hastens response at low temperatures and helps suppress background current at very low dissolved oxygen levels. (When data is routinely collected with sample temperatures below 15°C and at D.O. levels below 20% air saturation, the low signal current resulting from the use of the standard membranes tends to magnify the probe's inherent constant background signal. Using the high sensitivity membranes in this situation will decrease the percent error due to the probe's background current.)

For long-term monitoring situations only, a half-sensitivity, double-thickness 2 mil (.002") membrane is available. (Order the YSI 5675 Monitoring Probe Service Kit, which includes membranes, electrolyte, probe service tool and monitor service instructions for the 5739 probe.) For further details on the use of the Model 58 for monitoring, consult the factory.

A selector switch inside the Model 58 modifies the circuit for the membrane in use. See Figure 6. THIS SWITCH MUST BE SET TO THE POSITION CORRESPONDING TO THE MEMBRANE IN USE. Facing the back of the instrument, with the back cover removed, the switch will be found on the top, right corner of the main pc board. Its positions are labeled **.5**, **1** and **2 MIL**. (Also, see "Oxygen Measurement In Fluids Other Than Water" for use of this switch in special measurement circumstances.)

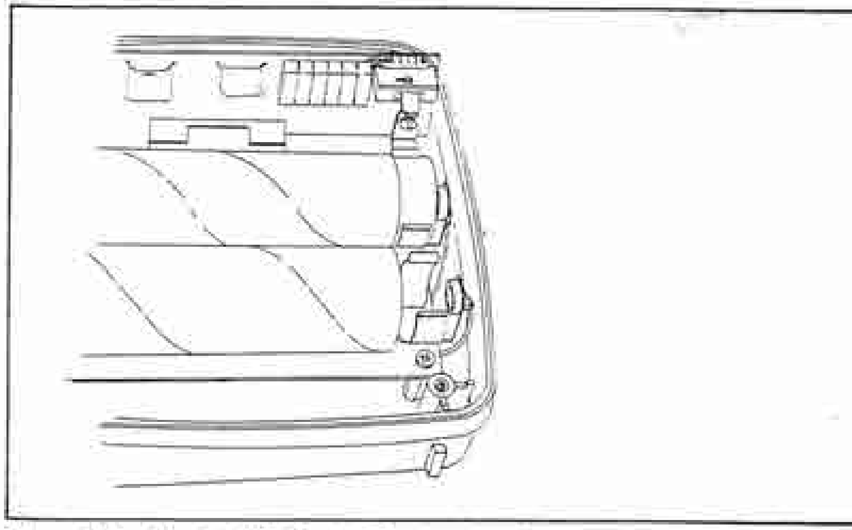

Figure 6. Inside the YSI Model 58, showing the membrane selector switch and the instrument and stirrer battery compartments.

PREPARING THE PROBE

All YSI 5700 Series Probes have similar sensors and should be cared for in the same way. They are precision devices and require careful treatment if measurements of high accuracy are to be made. Prepare the probes as described below. ALL PROBES ARE SHIPPED DRY. YOU MUST FOLLOW THESE INSTRUCTIONS.

1. Prepare the electrolyte by dissolving the KCl crystals in the dropper bottle with distilled water. Fill the bottle to the top.
2. Remove the O-ring and membrane (after unscrewing the sensor guard in the case of the YSI 5739 probe). Thoroughly rinse the sensor with electrolyte solution.
3. Fill the probe with electrolyte and install the membrane as follows (letters A through H refer to illustrations in Figure 7):
   A. Grasp the probe in your left hand. When preparing the YSI 5739 probe, the pressure compensating vent should be to the right. (A left-handed operator may choose to reverse hands and vent direction.) Successively fill the sensor body with electrolyte, then pump the diaphragm with the eraser end of a pencil or with some similar soft, blunt tool. Continue filling and pumping until no more air bubbles appear. (With practice, you can hold the probe and pump the diaphragm with one hand while simultaneously pouring electrolyte into the sensor body with the other.)

      When preparing the YSI 5720A or the YSI 5750 probes, simply fill the sensor body until no more air bubbles appear.
   B. Secure the membrane under your left thumb. Add more electrolyte to the probe until a large meniscus completely covers the gold cathode.

      NOTE: Handle membrane material with care, keeping it clean and dust free, touching it only at the ends.
   C. With the thumb and forefinger of your other hand, grasp the free end of the membrane.
   D. Using a continuous motion, *stretch* the membrane *UP, OVER* and *DOWN* the other side of the sensor. Stretching forms the membrane to the contour of the probe.
   E. Observe that the membrane is stretched tightly enough to deform it as shown in the illustration.
   F. Secure the end of the membrane under the forefinger of the hand holding the probe.
   G. Roll the O-ring over the end of the probe. There should be no wrinkles in the membrane or trapped air bubbles. Some wrinkles may be removed by lightly tugging on the edges of the membrane beyond the O-ring.
   H. Trim off excess membrane with scissors or sharp knife. Check that the stainless steel temperature sensor is not covered by excess membrane.
4. Shake off excess electrolyte and, on the YSI 5739 probe, reinstall the sensor guard.
5. A plastic bottle without a bottom is provided with the YSI 5739 probe for convenient calibration and probe storage. Place a small piece of moist towel or sponge in the bottle and insert the probe into the open end. This ensures 100% humidity for accurate calibration and helps protect the probe against drying out in storage. The YSI 5720A and 5750 probes can be stored in a BOD bottle containing about 1" of water.

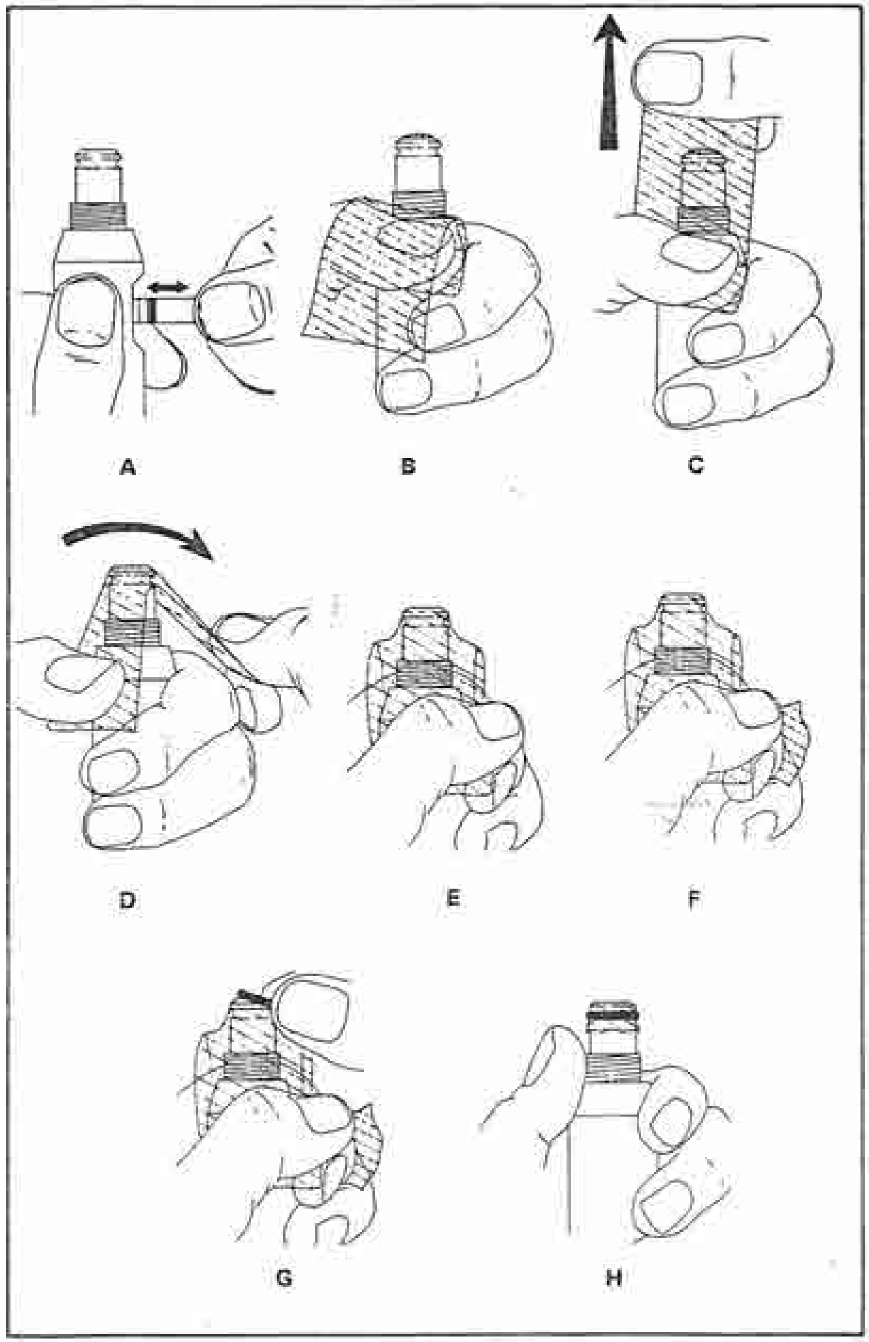

Figure 7. Filling the sensor body with electrolyte and installing the membrane. The 5739 probe is illustrated: installing the membrane is the same on the other oxygen probes.

6. Membrane life depends on usage. Average replacement is 2-4 weeks. However, should the electrolyte be allowed to evaporate and an excessive amount of bubbles form under the membrane, or the membrane become damaged, thoroughly flush the reservoir with electrolyte and install a new membrane.
7. Also replace the membrane if erratic readings are observed or calibration is not stable.
8. Electrolyte can be prepared by making a saturated solution of reagent grade KCl and distilled water, and then diluting the solution to half strength with distilled water. Adding two drops of Kodak Photo Flo per 100 ml of solution assures good wetting of the sensor, but is not absolutely essential.
9. **The gold cathode should always be bright and untarnished. If it is tarnished (which can result from contact with certain gases) or plated with silver (which can result from extended use with a loose or wrinkled membrane), return it to the factory for service or else clean it with the YSI 5680 Probe Reconditioning Kit. Never use chemicals or any abrasive other than that supplied with this kit.**
10. **It is also possible that the silver anode may become contaminated, which will prevent successful calibration. Try soaking the probe overnight in a 3% ammonia solution; rinse with deionized water, recharge with electrolyte, and install a new membrane. If still unable to calibrate, return the probe for service.**
11. Hydrogen sulfide, sulphur dioxide, halogens, neon, and nitrous and nitric oxide are interfering gases. If you suspect erroneous readings, it may be necessary to determine if these are the cause. These gases have been tested for response:

100% Helium	None	100% Carbon Dioxide	About 1%
100% Ethylene	None	100% Nitrous Oxide	1/3 O_2 response
100% Carbon Monoxide	Less than 1%	100% Nitric Oxide	1/3 O_2 response
100% Hydrogen	Less than 1%	100% Chlorine	2/3 O_2 response

PREPARING THE INSTRUMENT

The Model 58 may be used in a vertical, horizontal or tilted position, it may be carried or moved during use without affecting its accuracy or stability of measurement.

Connect the prepared probe to the **PROBE** receptacle and screw the retaining ring finger tight.

Zero the instrument. Set the function switch to **ZERO** and adjust the display to read **00.0** with the O_2 **ZERO** control.

Connect stirrer, if it is to be used. Check stirrer battery condition by turning the **STIRRER** switch to its spring-loaded **BATT CHK** position. The warning **LOBAT** will show on the display when approximately 5 hours of battery life remain.

Wait at least 15 minutes for the probe to stabilize. A wait is necessary whenever the meter has been **OFF** or the probe has been disconnected.

CALIBRATION

Calibration consists of exposing the probe to a known oxygen concentration such as air at 100% relative humidity or water of a known oxygen content, and then adjusting the O_2 **CALIB** control so the display shows a reading that matches the O_2 concentration of the known sample.

In the discussion of calibration, below, instructions for Air Calibration are given for calibrating in the % air saturation mode; while instructions for Air Saturated Water Calibration are given for calibrating in the mg/l mode. Take note that *either* calibration technique can be performed in *either* mode. Use of the % air saturation mode is normally easier since the instrument automatically compensates for temperature variation in that mode. The operator may nevertheless elect to calibrate in the mg/l mode if he intends to make measurements in that mode, since doing so will eliminate any possible mode-to-mode error. See final "NOTE" under both Air Calibration and Air Saturated Water Calibration.

Air Calibration

Air calibration is the quickest and by far the simplest calibration technique. Experience has shown it to be quite reliable; it is recommended by YSI for the Model 58. Two other calibration techniques will also be discussed.

Air calibrate the Model 58, with any 5700 series probe, as follows:

1. Set function switch to **%** mode.
2. To calibrate the 5739 probe, place a moist sponge or a piece of cloth in the plastic calibration bottle. Loosen the bottle lid about 1/2 turn and slip the bottle over the probe guard up to the body. Place the probe in a protected location where temperature is not changing, or wrap it in a cloth or other insulator. Alternatively, calibrate with the 5075A Calibration Chamber (see page 18).

   The BOD probes can be placed in a BOD bottle containing about 1" of water to provide a 100% relative humidity calibration environment.

   Remember that the highest accuracy of measurement is achieved when the probe is zeroed and calibrated at a temperature as close as possible to the temperature of the sample to be measured.
3. Set function switch to **ZERO** and readjust display to read **0.00**. Switch back to % air saturation mode.
4. When the display reading has stabilized, unlock the O_2 **CALIB** control locking ring and adjust the display to the CALIB VALUE indicated in the **pressure/altitude** chart in Table A (also printed in the instructions on the back of the meter and reproduced on the back cover of this manual). Relock the locking ring to prevent inadvertent changes.

NOTE: The oxygen content of air is affected by water vapor content. The use of air at 100% relative humidity assures proper calibration. Moreover, air at less than 100% relative humidity can cause evaporation of moisture from the probe's temperature sensor, producing a local cooling effect. Errors of up to 8% can result from calibrating in dry air.

NOTE: Should the user elect to air calibrate in the mg/l mode, Air Saturated Water Calibration procedures 2 through 5 should be followed.

PRESSURE Inches Hg	mm Hg	kPa	ALTITUDE FT.	m	CALIB. VALUE
30.23	768	102.3	-276	-84	101
29.92	760	101.3	0	0	100
29.61	752	100.3	278	85	99
29.33	745	99.3	558	170	98
29.02	737	98.3	841	256	97
28.74	730	97.3	1126	343	96
28.43	722	96.3	1413	431	95
28.11	714	95.2	1703	519	94
27.83	707	94.2	1995	608	93
27.52	699	93.2	2290	698	92
27.24	692	92.2	2587	789	91
26.93	684	91.2	2887	880	90
26.61	676	90.2	3190	972	89
26.34	669	89.2	3496	1066	88
26.02	661	88.2	3804	1160	87
25.75	654	87.1	4115	1254	86
25.43	646	86.1	4430	1350	85
25.12	638	85.1	4747	1447	84
24.84	631	84.1	5067	1544	83
24.53	623	83.1	5391	1643	82
24.25	616	82.1	5717	1743	81
23.94	608	81.1	6047	1843	80
23.62	600	80.0	6381	1945	79
23.35	593	79.0	6717	2047	78
23.03	585	78.0	7058	2151	77
22.76	578	77.0	7401	2256	76
22.44	570	76.0	7749	2362	75
22.13	562	75.0	8100	2469	74
21.85	555	74.0	8455	2577	73
21.54	547	73.0	8815	2687	72
21.26	540	71.9	9178	2797	71
20.94	532	70.9	9545	2909	70
20.63	524	69.9	9917	3023	69
20.35	517	68.9	10293	3137	68
20.04	509	67.9	10673	3253	67
19.76	502	66.9	11058	3371	66

Table A. Calibration Values for various atmospheric pressures and altitudes. Normal barometric variations are equivalent to ~ ± 500 feet at sea level.

Winkler Titration

An alternative to air calibration is to calibrate the probe to a method such as Winkler Titration. This is done as follows:

1. Draw a volume of nearly air saturated water from a single source and divide it into four samples. Determine the oxygen in three samples using the Winkler Titration technique, and average the three values. If one of the values differs from the other two by more than 0.5 mg/l (ppm), discard that value and average the remaining two.
2. Place the probe in the fourth sample and stir.
3. Set the **SALINITY** control to **0 (FRESH)** or to the appropriate value of the sample.
4. Readjust zero if necessary.
5. Switch to the **0.01 mg/l** mode and while continuing to stir the sample, allow the probe to remain in the sample for at least two minutes; then set the **O_2 CALIB** control to the average value determined above. Leave the probe in the sample for an additional two minutes to verify stability. Readjust if necessary.

Air Saturated Water Calibration

A third technique for calibration is by means of air saturated water. This has proven an uncertain method, as it is difficult to secure precise and stable saturation. Proceed as follows:

1. Air saturate a volume of water by aerating for at least 15 minutes at a constant temperature.
2. Place the probe in the sample and stir. Switch the function switch to **TEMP**. From the **solubility of oxygen** chart in Table B, below (also printed on the

SOLUBILITY OF OXYGEN IN WATER EXPOSED TO WATER SATURATED AIR AT 760 mm Hg PRESSURE

1 mg/l = 1 PPM

Temp °C	Solubility mg/L	Temp °C	Solubility mg/L	Temp °C	Solubility mg/L
0	14.62	17	9.67	34	7.07
1	14.22	18	9.47	35	6.95
2	13.83	19	9.28	36	6.84
3	13.46	20	9.09	37	6.73
4	13.11	21	8.92	38	6.62
5	12.77	22	8.74	39	6.52
6	12.45	23	8.58	40	6.41
7	12.14	24	8.42	41	8.31
8	11.84	25	8.26	42	6.21
9	11.56	26	8.11	43	6.12
10	11.29	27	7.97	44	6.02
11	11.03	28	7.83	45	5.93
12	10.78	29	7.69	46	5.84
13	10.54	30	7.56	47	5.74
14	10.31	31	7.43	48	5.65
15	10.08	32	7.31	49	5.56
16	9.87	33	7.18	50	5.47

Derived from 17th Edition, *Standard Methods for the Examination of Water and Wastewater.*

back panel of the Model 58 and reproduced on the back cover of this manual), record the mg/l value corresponding to the temperature indicated.

3. Determine local altitude or the "true" atmospheric pressure. (Note that "true" atmospheric pressure is as read on a mercury barometer. Weather Bureau reporting of atmospheric pressure is corrected to sea level.) Using the pressure/altitude chart (Table A), determine the correct CALIB. VALUE for your pressure or altitude.
4. Multiply the mg/l value from the solubility of oxygen table by the CALIB. VALUE from the pressure/altitude table and divide by 100 to determine the correct mg/l oxygen content of the saturated sample.

   EXAMPLE: Temperature 21°C: oxygen value at sea level or 760 mm Hg pressure = 8.92 mg/l

   Altitude 1400 ft.: calibration value: 95

   $$\text{Corrected calibration value} = \frac{8.92 \times 95}{100} = 8.47 \text{ mg/l}$$

5. Readjust zero if necessary.
6. Check that the **SALINITY** knob is set at **0**. Adjust the **O_2 CALIB** control to the calibration value determined in the foregoing step. Wait two minutes to verify stability; readjust if necessary.

NOTE: Obviously, if calibration is performed in the % air saturation mode, the operator need not calculate for temperature; but will simply set the display to read the CALIB. VALUE for the **pressure/altitude** table according to the local altitude or the true barometric pressure at the point of measurement.

Calibration Frequency

Daily calibration is generally appropriate. Calibration can be disturbed by physical shock, touching the membrane, fouling of the membrane or drying out of the electrolyte. Check calibration after each series of measurements, and in time you will develop a realistic schedule for recalibration. When probes are not in use, store them according to the procedures recommended under "Preparing the Probe," step 5, page 12.

Calibration Chamber

The YSI 5075A Calibration Chamber is an accessory that helps obtain optimum air calibration in the field. It is also a useful tool for measuring at shallow depths (less than 4') and in rapidly flowing streams. It is used only with the YSI 5739 probe, and is illustrated in Figure 8.

It consists of a 4-1/2' stainless steel tube (1) attached to the calibration chamber (2), the measuring ring (3), and one solid and one hollow rubber stopper (4 and 5).

Set it up for use as follows: Insert the solid stopper (4) into the bottom of the calibration chamber (2). Push the oxygen probe (6) through the hollow stopper (5) until the small end of the stopper is situated at about the top of the notch where the pressure compensation unit is located (7). It is important that this stopper be positioned so that a water-tight seal is formed when stopper and probe are inserted into the calibration chamber.

Use the assembly as follows: First place the probe in the measuring ring (3) and immerse for five minutes in the sample; this permits the probe to come to the same temperature as the sample. Wet the inside of the calibration chamber with fresh water to create a 100% relative humidity environment for calibration. Drain excess water from the chamber, shake any droplets from the probe membrane, and promptly insert the probe into the calibration chamber. Place the chamber in the sample for an additional five minutes for final thermal equilibration. Calibrate the probe as described in the air calibration procedure. Keep the handle above water at all times.

After calibration, return the probe to the measurement ring for shallow measurements. Move the probe up and down, or horizontally, approximately one foot a second while measuring. In rapidly flowing streams (greater than 5 feet per second) install the probe in the measuring ring with the pressure compensating diaphragm towards the chamber.

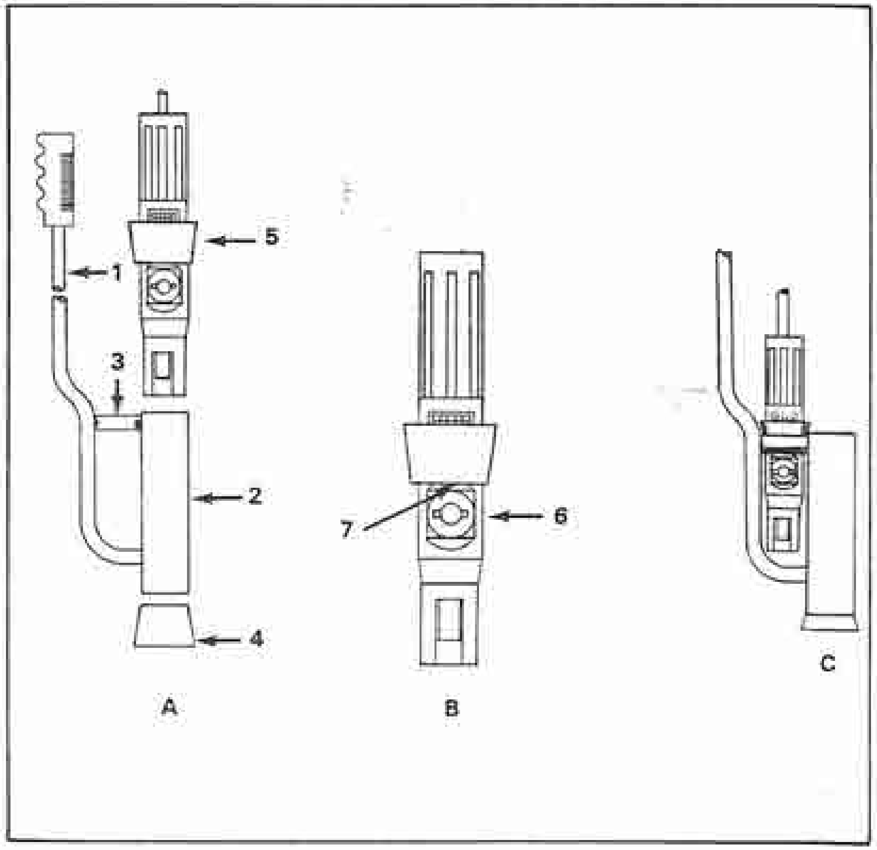

Figure 8. The YSI 5075A Calibration Chamber

DISSOLVED OXYGEN MEASUREMENT

For accurate measurement, water movement of 1 foot per second or more is required so that the oxygen-depleted layer of the sample at the membrane surface is flushed away and replenished. A moving stream can provide this motion; alternatively, the probe can be moved through the sample by hand. The YSI 5795A Submersible Stirrer supplies the necessary stirring for the 5739 probe. The YSI 5720A BOD probe has its own line powered stirrer for laboratory use. When the 5750 BOD probe is used, stirring must be provided — as with a magnetic stirrer.

1. With the instrument prepared for use, and the probe calibrated, place the probe in the sample. If the 5795A stirrer is to be used, connect it and turn the **STIRRER** switch to **ON**. Connect recorder, if used.
2. Adjust the **SALINITY** control to the salinity of the sample. (Not required when reading % air saturation.)
3. Turn the function switch to **O_2 ZERO** and readjust if necessary.
4. Turn the function switch to the desired readout mode and read the dissolved oxygen value in mg/l or in % air saturation when the meter reading has stabilized.

Environmental Considerations

- Erroneous readings will be made in any environment where the probe's Teflon membrane will become rapidly coated with oxygen consuming or oxygen evolving organisms. In some cases, the YSI 5795A Submersible Stirrer can provide adequate cleaning action due to its high turbulence.
- Erroneous readings will be made in any environment where heavy residue may coat the probe's membrane. In such instances, problems generally can be eliminated by more frequent probe service and/or cleaning.
- Erroneous readings will be made in any environment where dissolved gases are present which will chemically interfere with the probe's electrochemistry. Known interfering gases are hydrogen sulfide, sulphur dioxide, halogens, neon, nitrous oxide and nitric oxide. (See list on page 14.)
- Also avoid any environment that contains substances that may attack the probe materials. Some of these substances are concentrated acids, caustics and strong solvents. The probe materials that come in contact with the sample include FEP Teflon, acrylic plastic, ABS plastic, EPR rubber, stainless steel, epoxy and the polyurethane cable covering.
- Long-term use, as for monitoring, in certain applications can magnify the effect of factors which impair probe accuracy.

MEASURING OXYGEN IN FLUIDS OTHER THAN WATER

The Model 58 is normally used for measuring the oxygen content of naturally occurring waters and of wastewaters. The % air saturation feature of the instrument additionally permits O_2 measurement in some non-water fluids including air, most gases, foods and some non-aqueous liquids.

Suitable fluids for measurement are those which do not attack the sensor materials and are of sufficiently low viscosity to permit sample stirring across the probe's membrane. Strong acids and solvents capable of swelling or dissolving the probe's ABS plastic body or EPR O-rings must be avoided. (Also see list of interfering gases under "Preparing the Probe," page 14.)

The % air saturation of any fluid not excluded in the description above may be measured directly. The instrument is calibrated by the customary air calibration technique and measurement is carried out just as in natural waters.

In measuring non-aqueous liquids, the mg/l mode should not be used. Such samples may have an oxygen solubility or Bunsen coefficient significantly different from that automatically programmed in the mg/l mode for water.

Calibrating to Display Oxygen Partial Pressure in mm Hg

For some liquid measurements, and for most gas phase measurements, it may be desirable to read the meter in oxygen partial pressure units such as millimeters of mercury (mm Hg). To calibrate the % air saturation mode to mm Hg units (0 to 200.0 mm Hg range), proceed as follows:

1. Remove the back cover and move the membrane selector switch to the **2 MIL** position (see Figure 6). BUT DO NOT CHANGE THE MEMBRANE. THE STANDARD 1 MIL MEMBRANE IS USED IN THIS MEASUREMENT. Replace the back cover.
2. Place the probe in a constant temperature room air environment. Determine the room's oxygen partial pressure (Dry air at 760 mm Hg total pressure has an O_2 partial pressure of 20.94% of the total pressure, or 159.1 mm Hg.*)
   EXAMPLE: 760 mm Hg x 0.2094 = 159.1 mm Hg
3. Adjust the **O_2 CALIB** control until the meter reading (read as mm Hg instead of the marked %) matches the oxygen partial pressure of the room air.

Once calibrated, oxygen partial pressure may be measured in any gas environment between 0° and 45°C, and at any pressure from atmospheric to 100 p.s.i. (7 atmospheres). Vacuum conditions should be avoided because the probe's internal electrolyte can outgas and cause membrane distortion.

CAUTION: When making gas phase measurements with a 5700 Series O_2 probe, the operator must avoid rapid temperature fluctuations. The thermal sensor located in the stainless steel tube on the oxygen sensor operates to compensate automatically for changes in membrane permeability caused by variations in temperature. However, the thermal response of this sensor is much slower in air or gas than the membrane's response to a change in gas temperature. Therefore, rapid temperature fluctuations are liable to prevent that automatic compensation which is necessary for accurate measurement. This is not a problem in liquid measurements.

*L. Machta, "Atmospheric Oxygen in 1967 to 1970," *Science*, Volume 168, June 26, 1970, pp 1582-1594.

RECORDER OUTPUT

Output at full scale is 1 VDC. (0.0005 V = 1 digit)

Use a recorder with input impedance of at least 50KΩ, and operate it with the terminals ungrounded. (The YSI Models 80A and 81A strip chart recorders are compatible with this system for laboratory use.)

A recorder output plug (Figure 9) is provided. Cable for connecting the recorder must be supplied by the user.

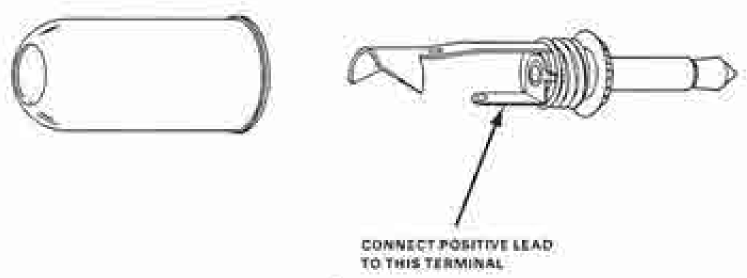

Figure 9. Recorder plug for YSI Model 58

CARE AND MAINTENANCE

BATTERIES

Instrument batteries are in the upper holder. Four D size carbon-zinc batteries are used. The **LOBAT** warning shows on the display when about 50 hours of use remain. This warning reminds the operator to change batteries at his earliest convenience. Batteries may be removed when the instrument will be used on a long-term basis for laboratory measurement powered by the YSI 5401 or 5402 battery eliminator.

Stirrer batteries fit in the lower battery holder. Four D size carbon-zinc batteries are used. When about 5 hours or less of battery life remain, the **LOBAT** warning will show on the display when the **STIRRER** control is held at the spring-loaded **BATT CHK** position. (Instrument must be turned on.) Batteries are needed only when the YSI 5795A Submersible Stirrer will be used.

PROBE

Probe Membrane: Replace the membrane every two weeks of operation, or whenever a large bubble forms in the electrolyte, or whenever the membrane has become fouled or damaged. Inspect the gold cathode when changing the membrane; it should be bright and untarnished. See "Preparing the Probe."

Probe Performance Check: Every month when the probe is in daily use (less frequently otherwise), or whenever probe response is slow or calibration is unstable, check probe performance.

1. Speed of Response
   - Prepare and calibrate the probe.
   - With probe in air, switch to the % air saturation mode.
   - Immerse the probe in a 25°C O_2-depleted sample. (An O_2-depleted sample may be prepared by adding approximately 1 gram of sodium sulfite to half a liter of water.)
   - A properly functioning probe will respond down scale to 10% air saturation in 20 seconds or less.
2. Background Current
   - After performing the Speed of Response steps, leave the probe in the depleted sample for approximately 5 minutes. The reading should fall below 1% air saturation.
3. Calibration Stability
   - Carefully calibrate the probe in moist air inside the calibration bottle with the instrument set in the % air saturation mode.
   - Allow the instrument to operate for 1 hour.
   - A properly functioning probe will hold calibration within ± 1% for 1 hour, after the first hour of operation.

Probe Service: If the probe fails any of the three tests above, check for:
- Damaged or wrinkled membrane. Change the membrane and retest.
- Fouled or silver coated cathode. Clean as instructed in "Preparing the Probe," **step 9, page 14.**
- Fouled anode. Soak for 24 hours in 3% ammonia (NH_3); rinse thoroughly with distilled water and retest.
- Damaged cable or connector. Inspect and replace if needed.

If these steps do not restore specification performance, return the probe to the factory for service.

DESICCANT CANNISTER

Moving the Model 58 from a warm, moist room or vehicle into cold air may cause condensation inside the instrument. A desiccant cannister is available to protect against condensation from this cause or any other potential 100% humidity situation. The desiccant is packaged in a bag which must be removed before use.

The window in the cannister should show blue desiccant. The blue color indicates that it is dry. After several weeks of use, the desiccant will turn pink or white as it picks up moisture. At this time, the desiccant should be placed in a 95° to 120° C (200° to 250° F) oven for several hours to drive off excess water. When it is dry, the desiccant is blue and ready for use. Desiccant cannisters are available from the YSI Service Department. (Order YSI item number 004612.)

The desiccant cannister is to be installed in the case *below* the lower battery holder; *do not place it elsewhere.* (See Figure 10.) Do not leave the desiccant cannister in the instrument permanently.

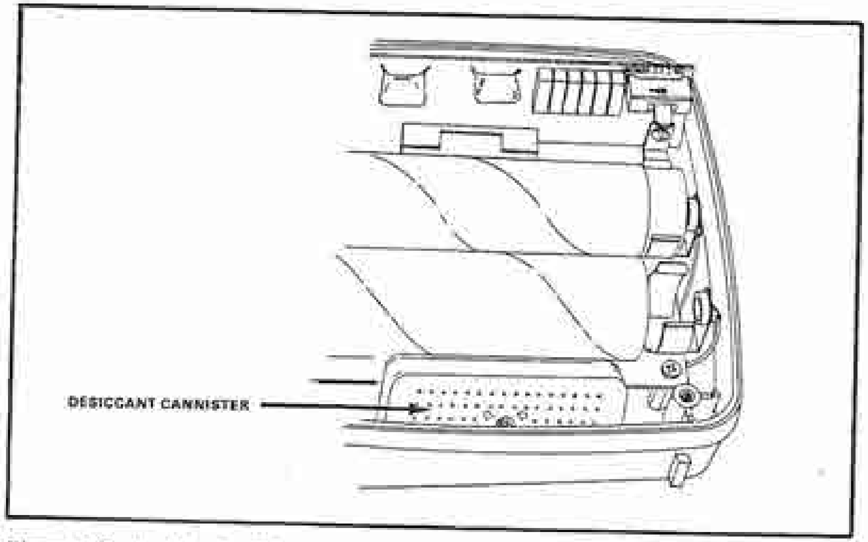

Figure 10. Inside the YSI Model 58, showing the position of the desiccant cannister when in use.

THE CASE

Each opening of the case is gasketed to resist entry of water. When the case has been opened for any reason, be sure that the main case gasket is accurately seated between both halves of the case, and that the four case screws are drawn down securely (but not so tightly as to deform the rubber feet).

DISCUSSION OF MEASUREMENT ERRORS

The major sources of error affecting any determination of dissolved oxygen are the accuracy of the instrument components, the accuracy of the probe, and the user's ability to calibrate the system precisely. Most errors can be reduced substantially by calibration at D.O. levels and probe temperatures as close as possible to the expected measurement D.O. levels and temperatures.

In the following, individual sources of error are listed along with the equations for calculating their effect on a reading of dissolved oxygen. These calculations will yield an estimate of the maximum possible error for any particular D.O. reading. By calculating the root-mean-squared sum of these individual uncertainties (usually less than half the *possible* error), the user can estimate the *probable* error in any reading.

Note that not all types of errors discussed are necessarily even potentially present in a given situation. Whenever the instrument is calibrated in the same mode in which readings are to be taken, any mode to mode error is, of course, eliminated. Likewise, if salinity compensation is not used, no salinity compensation error need be considered. If calibration is to a Winkler Titration sample, calibration errors (III. below) are replaced by the Winkler uncertainty.

I. INSTRUMENT COMPONENT ERRORS

A. Meter Linearity
Error = ± 0.15% of full scale

B. Salinity Compensation
Error = ± 0.3% of D.O. reading ± 1 least significant digit (in 0.01 mg/l mode)

C. Mode to Mode (in the mode other than the one in which calibration was done)
Error = ± 0.5% of D.O. reading ± 2 least significant digits (in 0.01 mg/l mode)

D. Temperature Compensation
Error = ± 1% of D.O. reading between +5° and +45°C
± 2% of D.O. reading between 0° and +5°C (in mg/l mode)
± 1.5% of D.O. reading between 0° and +5°C (in % air saturation mode)

II. PROBE RELATED ERRORS

A. Probe Background Signal Effects

Error = Background Factor† x (1 - Cal. Value/Std. Cal. Value) x Meter Reading in mg/L

†probe temperature	0	10	20	30	40
background factor (%)	2.3	1.5	1.0	.8	.6

B. Errors due to probe non-linearity: ±0.3% of reading

C. Variation from nominal response to sample temperature

Error = ±0.2% of D.O. reading per °C of the temperature difference between the temperature of the sample and the temperature at which the probe was calibrated.

III. CALIBRATION RELATED ERRORS

A. Sample Temperature Uncertainty
Error = ± 1% of D.O. reading. This error is zero when calibrating in the % air saturation mode or when calibrating to a Winkler Titration sample.

B. Barometric Pressure Uncertainty (± 13 mm Hg)
Error = ± 1.7% of reading

C. Altitude Uncertainty (± 500')
Error = ± 1.8% of reading

EXAMPLE

Measurement Related Data:

Calibration:	Method	air calibration in % air saturation mode
	Temperature	24°C
	Altitude	600 feet
	Calibrated to	8.24 mg/L
Measurement:	Mode	0.01 mg/l mode
	Temperature	20°C
	Salinity	33 parts per thousand
	Dissolved Oxygen	7.26 mg/l

IA ±.0015 x 20.00 mg/l	=	±.03 mg/l
IB (±.003 x 7.26 mg/l) ±.01 mg/l	=	±.03 mg/l
IC (±.005 x 7.26 mg/l) ±.02 mg/l	=	±.06 mg/l
ID ±.01 x 7.26 mg/l	= +	±.07 mg/l
SUB TOTAL		±.19 mg/l
IIA $\pm .01 \times \left(1 - \left(\frac{8.24}{9.09}\right)\right) \times 7.26$ mg/l	=	±.01 mg/l
IIB ±.003 x 7.26 mg/l	=	±.02 mg/l
IIC (24°C - 20°C) x 0.002 x 7.26 mg/l	= +	±.06 mg/l
SUB TOTAL		±.09 mg/l
IIIA .00 x 7.26 mg/l	=	±.00 mg/l
IIIB .017 x 7.26 mg/l	=	±.12 mg/l
IIIC .018 x 7.26 mg/l	= +	±.13 mg/l
SUB TOTAL		±.25 mg/l

Total of type I, II and III Errors: 0.53 mg/l

This is the worst case error possible for the specified calibration and measurement. The reported D.O. value would be 7.26 ±.5 mg/l. An estimate of the *probable* error would require a Root Mean Square (R.M.S.) analysis as follows:

$$\text{R.M.S. Error} = \sqrt{(IA)^2 + (IB)^2}$$

For the example above.

$$\text{R.M.S. Error} = \sqrt{(.03)^2 + (.03)^2 + (.06)^2 + (.07)^2 + (.02)^2 + (.02)^2 + (.06)^2 + (.12)^2 + (.13)^2}$$

$$= \sqrt{.046}$$

$$= \pm .21 \text{ mg/l}$$

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