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Nolan M.E.; Spring, R.J.; Howell, R.B.; Shirley, E.C.

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Sacramento, California 95819

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This report was accomplished under the State sponsored research project entitled "Highway Impact on Water Quality".

16. ABSTRACT

In performing water quality studies for highway projects, certain equipment and instruments must be used. In order to insure that results from the use of this equipment and instruments are correct, they must be calibrated and maintained properly. This report discusses the maintenance and calibration procedures for equipment typically used by District Environment Units.

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DIVISION OF CONSTRUCTION
TRANSPORTATION LABORATORY
RESEARCH REPORT

WATER QUALITY EQUIPMENT CALIBRATION AND MAINTENANCE

INTERIM REPORT

CA-TL-7108-78-08

March 1978

Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

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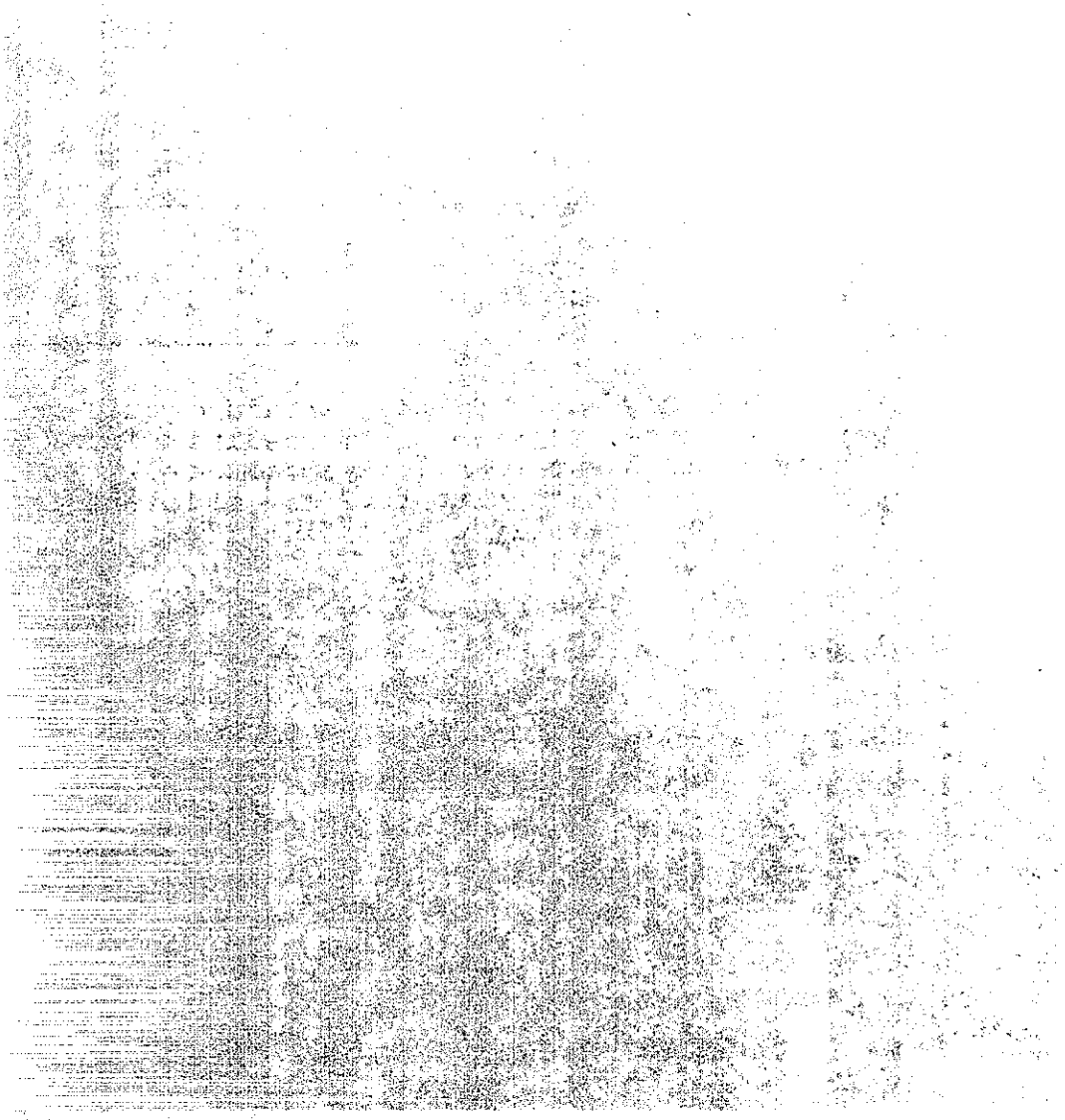


STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF CONSTRUCTION
OFFICE OF TRANSPORTATION LABORATORY

March 1978

TL No. 657108

Mr. C. E. Forbes
Chief Engineer

Dear Sir:

I have approved and now submit for your information this interim research project report titled:

WATER QUALITY EQUIPMENT CALIBRATION AND MAINTENANCE

Study made by . . . . . Enviro-Chemical Branch

Under the Supervision of . . . . . Earl C. Shirley, P.E.

Principal Investigator . . . . . Richard B. Howell, P.E.

Co-Investigator . . . . . Richard J. Spring, P.E.

Report Prepared by . . . . . Martin E. Nolan

Very truly yours,

George A. Hill

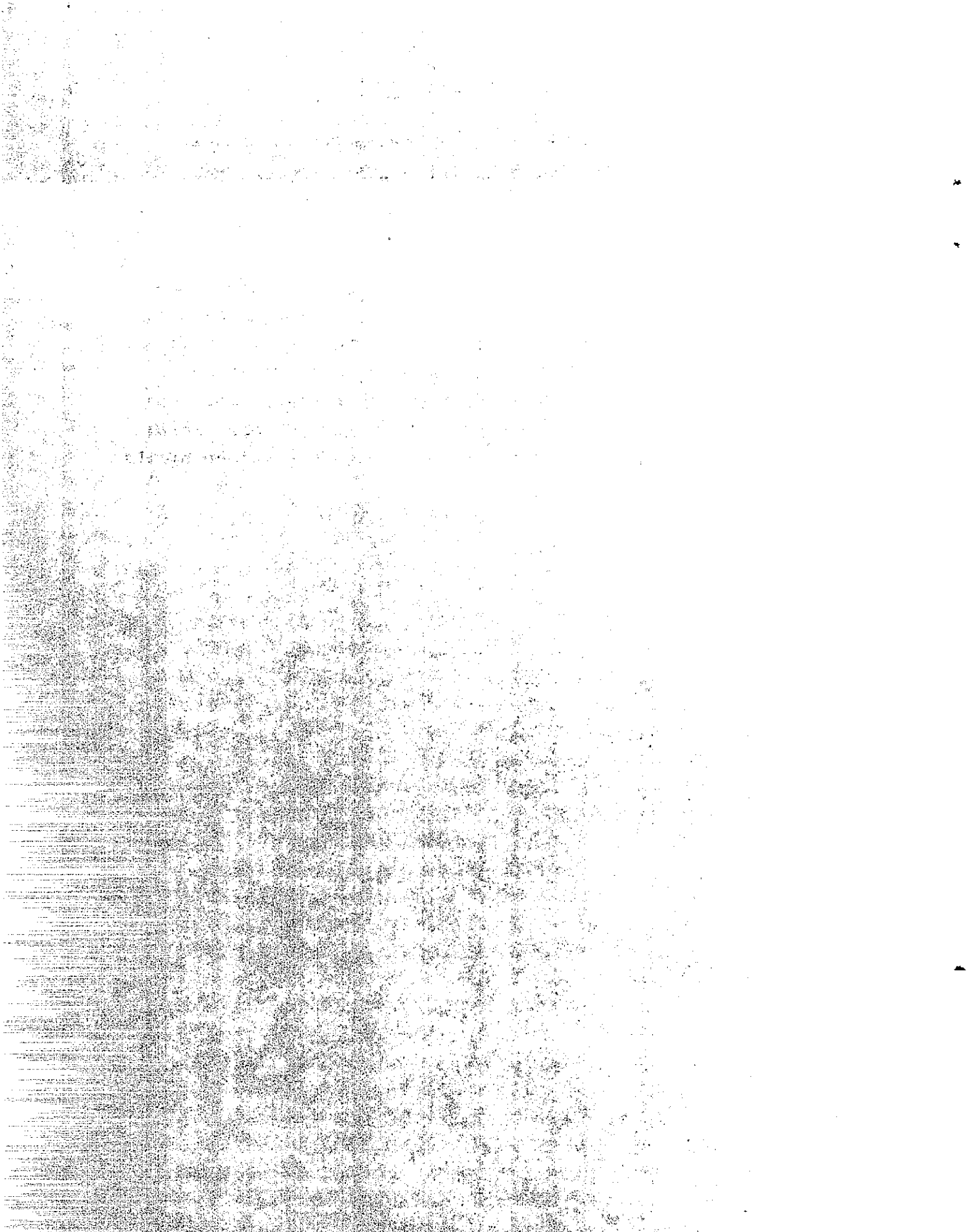
GEORGE A. HILL
Chief, Office of Transportation Laboratory

Attachment
MEN:cj

ACKNOWLEDGMENT

The assistance of several district environmental and materials department personnel in providing information on equipment calibration and maintenance is appreciated.

The contents of this report reflect the views of the Transportation Laboratory which is responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California. This manual does not constitute a standard, specification or regulation. The State of California does not endorse products or manufacturers. Trade or manufacturers' names appear herein only because they are considered essential to the object of this document.



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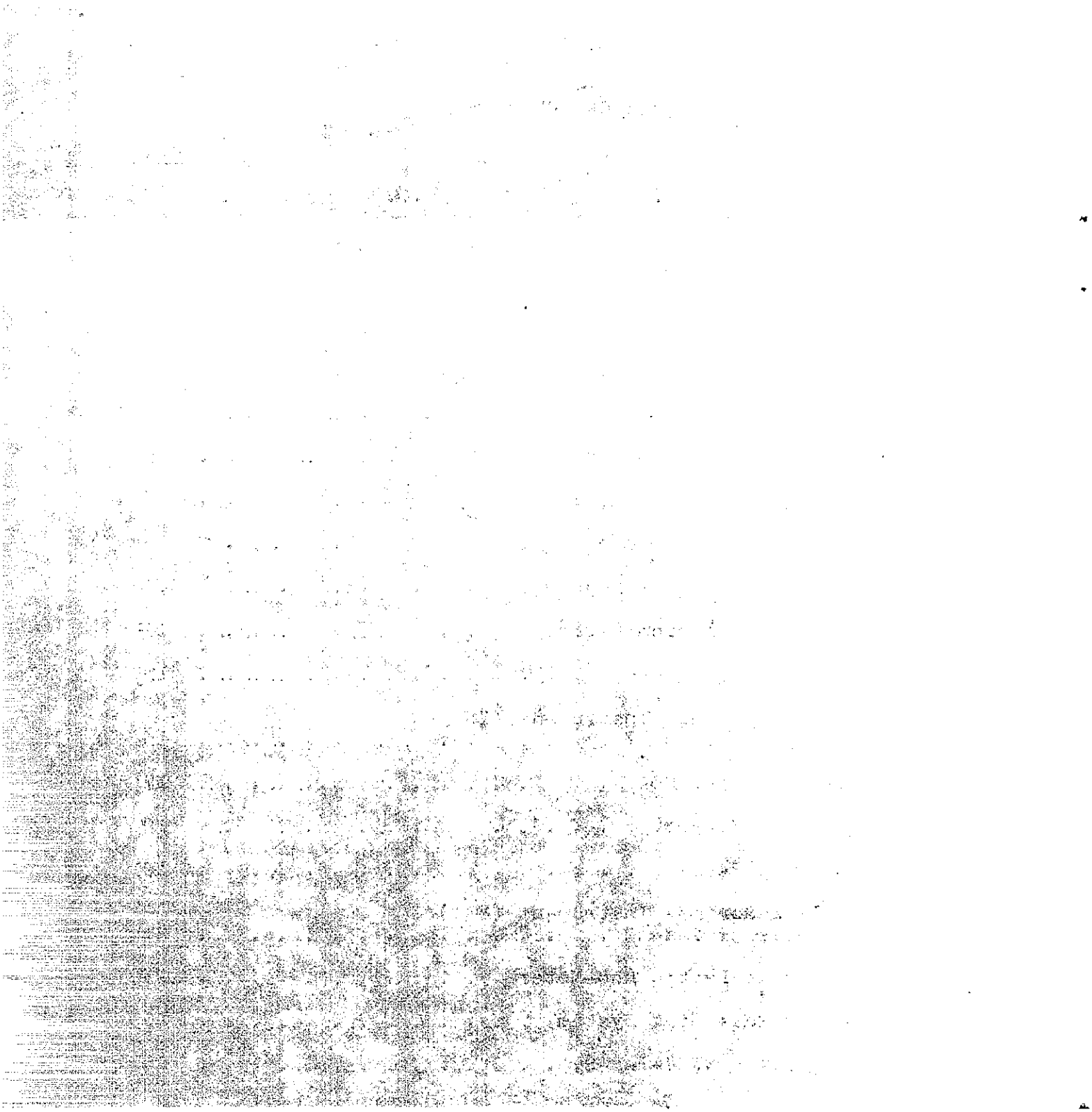

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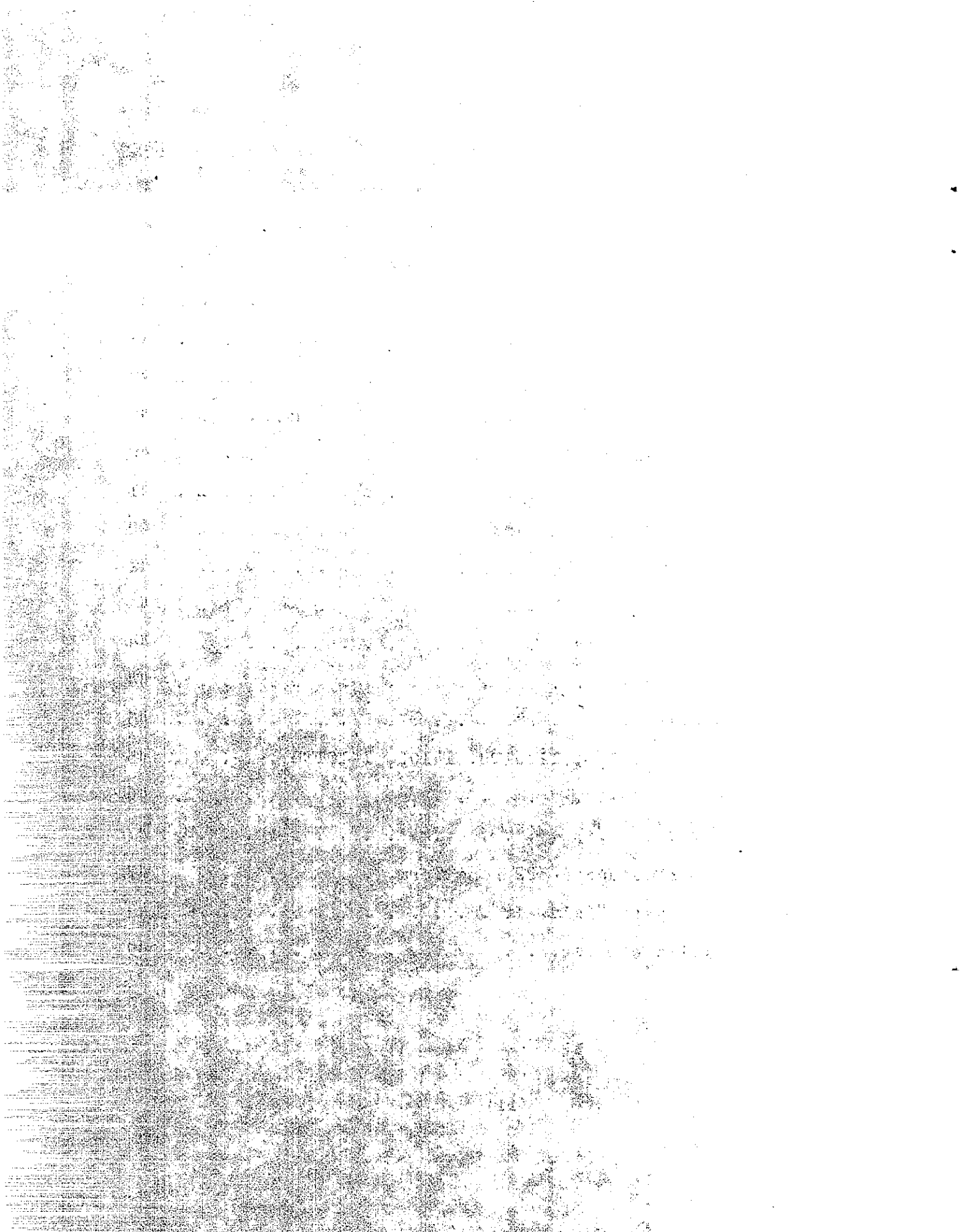

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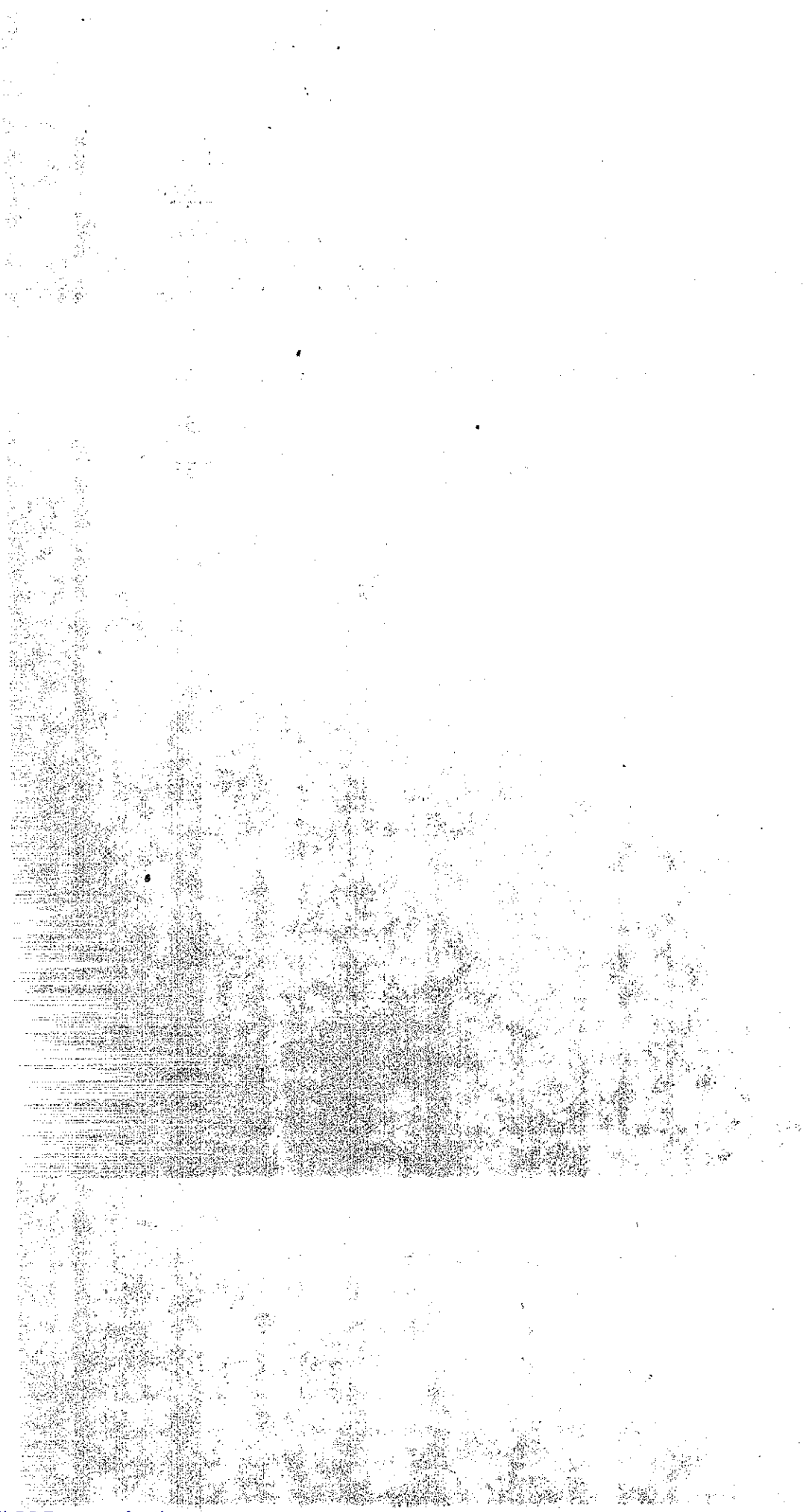


INTRODUCTION

One of the functions of the Transportation Laboratory (Translab) is to carry out a Quality Assurance Program (QAP) for water quality testing.In order to meet the standards set forth in the QAP, all testing of water must be conducted following approved test methods. Also, equipment must be serviced and calibrated on a regular basis in order to assure reliability of results. Records pertaining to any servicing or calibration are kept on all equipment in order to verify that the equipment was maintained in good working order and properly calibrated.

The purpose of this report is to assist the district water quality specialist to determine if testing equipment is properly functioning and providing reliable results. The instructions present a simple step by step procedure that allows a consistent and rapid means for ascertaining this information. In most cases, the maintenance and calibration procedures follow the instrument manufacturer's recommendation.

In addition, a suggested form for use in recording pertinent maintenance information is shown. It is also recommended that a "calibration" sticker be attached to the instrument showing the equipment I.D. number, district, date of the calibration and the name of the person performing the calibration.

These instructions will be updated by Translab from time to time as additional equipment is acquired or as suggested calibration/ maintenance procedures change. Any changes, suggestions, or requests for assistance and information are welcome. Direct your comments and requests to Translab in Sacramento, attention Water Quality Section.

CONCLUSIONS AND RECOMMENDATIONS

During the course of reviewing district water quality field sampling and testing procedures, it was found, in several instances, that equipment had not been calibrated or checked on a regular basis to see that it remained in calibration. This finding led to the development of this report. It is recommended that the districts follow the prescribed calibration and maintenance procedures described.

IMPLEMENTATION

Copies of this report will be distributed to appropriate personnel in the districts. Translab Water Quality Section personnel will be available to assist district personnel in calibrating and maintaining their equipment. Periodic checks will be made to determine if equipment is being maintained.

This document will also be referred to in the Quality Assurance Program (QAP) for water quality testing. Translab will use this information in conducting training courses for district personnel.

EQUIPMENT CALIBRATION

Equipment and instruments used in water quality studies should be calibrated periodically in order to supply the user with accurate and reliable data. Besides the need for calibration, routine maintenance also should be performed. This includes cleaning the equipment, changing the batteries, changing or replacing necessary chemicals, keeping probes moist, and generally keeping the equipment in good operating condition.

When a piece of equipment is to be stored, batteries and chemicals should be removed, adequate moisture maintained around probes, and the instrument enclosed in a clean storage container.

Form TL-742 (Figure 3 in Appendix) should be filled out for every piece of water quality equipment. An entry should be made on the form when the piece of equipment is calibrated, repaired, modified, or has maintenance performed. Also a calibration sticker (Figure 4 in Appendix) should be filled out and attached to the equipment whenever a calibration is made (except pH meters).

The following is an item by item procedure for calibrating standard water quality testing equipment.

pH METERS

Model: Leeds and Northrup Model 4717

Calibration Procedure:

1. Adjust meter needle to read 7.00 by rotating the meter adjustment screw at the bottom of the meter.

2. Turn "Function Switch" to BATTERY CHECK, meter should read to the right of dot at 10.5 on top scale. If the batteries are low or defective, replace with two 1.4 volt (Eveready E9 or equivalent) and two 9 volt (Eveready 246 or equivalent) batteries.

3. Turn "Function Switch" to STANDBY and plug electrode into meter.

4. Rinse electrode with distilled water and wipe dry.

5. Set temperature of 7.00 buffer solution on the "Temperature C." control.

6. Turn "pH-mV" switch to pH.

7. Place electrode into buffer solution and turn "Function Switch" to MEASURE.

8. Allow meter to come to equilibrium and then turn "Standardize" control until meter reads 7.00.

9. If samples are to be in a higher or lower range, an appropriate buffer solution should be used in step 4.

Materials Needed:

1. Screwdriver, 1/4" blade
2. pH buffer solutions of 4.00, 7.00 and 10.00
3. Wash bottle, 250 ml
4. Distilled water
5. Calibrated thermometer, range 0-50°C
6. Batteries, two 1.4 volt (Eveready E9) and two 9 volt (Eveready 246)

Accuracy: ±0.05 pH Units

Frequency of Calibration:

Several times during testing period depending on the number of tests and time between tests. Instrument should be calibrated at least daily during low volume test periods.

Reference: Leeds and Northrup
1700 South El Camino Real
San Mateo, California 94402
(415) 349-6656

Model: Beckman Digital

Calibration Procedure:

1. Depress STANDBY pushbutton.

2. Turn FUNCTION switch to pH.

3. Select a standard buffer solution with a pH near the estimated sample pH. Put enough buffer into a small beaker to cover electrode tips.

4. Uncover filling hole in reference electrode. Add KCl filling solution as necessary.

5. Rinse electrode tips with distilled water and blot dry with soft tissue.

6. Immerse electrode tips and thermometer in buffer solution.

7. Set "Temperature Compensation Control" for buffer temperature.

8. Depress READ Button.

9. Adjust "Standardize Control" so digital display indicates pH of the buffer, then tighten locking ring.

10. Depress STANDBY Pushbutton.

11. Remove electrode and rinse with distilled water, wipe dry.

Materials Needed:

1. pH buffer solutions 4.00, 7.00 and 10.00
2. Wash bottle, 250 ml
3. Distilled water
4. Soft tissue paper
5. Beaker, 100 ml
6. Calibrated thermometer, range 0-50°C

Accuracy: ±0.01 pH units

Frequency of Calibration:

Several times during testing period depending on the number of tests and time between tests. Instrument should be calibrated at least daily during low volume test periods.

Reference: Beckman Instruments, Inc.
Scientific Instruments Division
Irving, California 92664
(714) 833-0751

Model: Beckman Electromate

Calibration Procedure:

1. Turn "Function Switch" to STANDBY.

2. Uncover filling hole in electrode, add KCl fill solution as necessary (Beckman #3502).

3. Depress "Battery Test" Button, if meter needle does not deflect to beyond Battery OK mark, replace with two 9.45 volt batteries (Beckman #853367).

4. Select a buffer solution of pH value near the estimated pH of sample.

5. Pour buffer solution into a small beaker to cover tip of electrode.

6. Measure temperature of buffer solution and set "Temperature °C" Control to the measured temperature of the buffer solution.

7. Rinse electrode with distilled water and wipe dry.

8. Place electrode into buffer solution to at least 1" depth.

9. Turn "Function Switch" to pH.

10. Adjust "Standardize Control" so that needle reads the value of the buffer solution.

Materials Needed:

1. pH buffer solutions of 4.00, 7.00 and 10.00
2. Beaker, 100 ml
3. Wash bottle, 250 ml
4. Calibrated thermometer, range 0-50°C
5. Distilled water
6. Soft tissue paper
7. Two 9.45V batteries

Accuracy: ±0.08 pH units

Frequency of Calibration:

Several times during testing period depending on the number of tests and time between tests. Instrument should be calibrated at least daily during low volume test periods.

Reference: Beckman Instruments, Inc.
Scientific Instruments Division
Irvine, California 92664
(714) 833-0751

Model: Corning Models 7 and 10

Calibration Procedure:

1. Set "Function Switch" to the STANDBY position.

2. Adjust the meter to zero by using the "Mechanical Zero Adjuster" at the bottom of the meter.

3. Plug the pH Glass and Reference Electrodes into the Input and Reference Connectors on the rear of the instrument.

4. Rinse both electrodes with distilled water and wipe dry.

5. Place both electrodes into a buffer solution with a pH value of 7.00.

6. Set the "Manual Temperature Compensator" to the temperature of the buffer solution.

7. Set the "Function Switch" to the pH position (Pull out to EXPAND on Model 10).

8. Adjust the "Calibration Control" until the meter reads 7.00.

9. If samples to be tested are more than 3 pH units away from 7.00, then an appropriate buffer solution near the estimated pH value should be used in step 4.

Materials Needed:

1. Calibrated thermometer, range 0°-50°C
2. Screwdriver, 1/4" blade
3. pH buffer solution of 4.00, 7.00 and 10.00
4. Soft tissue paper
5. Wash bottle, 250 ml
6. Distilled water

Accuracy: ±0.5 pH units

Frequency of Calibration:

Several times during testing period depending on the number of tests and time between tests. Instrument should be calibrated at least daily during low volume test periods.

Reference: Corning Scientific Instruments
Laboratory Products Department
Corning Glass Works
Medfield, Massachusetts 02052
(617) 359-2341

Model: Brinkman Metrohm E488

Calibration Procedure:

1. Turn "Selector Switch" to BAT. COND. If batteries are low, they must be recharged by plugging line cord into a 115-125 volt A.C. power source for a maximum of 14 hours.

2. Turn "Selector Switch" to pH.

3. Place thermometer in buffer solution and allow to come to equilibrium.

4. Turn "Temperature Compensating Control" to read indicated temperature of buffer solution.

5. Rinse pH electrode with distilled water and wipe dry with a soft tissue.

6. Place electrode in buffer solution of pH 7.00 and turn "Selector Switch" to pH. Allow meter to come to equilibrium.

7. Turn "Calibration Control" until meter reads 7.00.

8. Turn "Selector Switch" to STANDBY. Remove electrode and rinse with distilled water. Wipe dry with soft tissue paper.

9. Place electrode in buffer solution of 4.00 pH and turn "Selector Switch" to pH. Allow meter to come to equilibrium.

10. Turn "Calibration Control" until meter reads 4.00.

11. Turn "Selector Switch" to STANDBY and remove electrode, rinse with distilled water and wipe dry with soft tissue.

12. Place electrode in buffer solution of pH 7.00 and turn "Selector Switch" to pH. Allow meter to come to equilibrium. Meter should read 7.00 ±0.1. If not, probe may be damaged and need replacement or meter is malfunctioning. See trouble shooting section of instruction manual.

Materials needed:

1. Wash bottle, 250 ml
2. Soft tissue paper
3. Distilled water
4. Buffer solution, pH 7.00 and 4.00
5. Calibrated thermometer, range 0°-50°C

Accuracy: ±0.1 pH

Frequency of Calibration:

Several times during testing period depending on the number of tests and time between tests. Instrument should be calibrated at least daily during low volume test periods.

Reference: Brinkman Instruments, Inc.
Cantiague Road
Westbury, New York 11590
(516) 334-7500

DISSOLVED OXYGEN METERS

Model: Yellow Springs Instrument (YSI) Models 54 and 57

Calibration Procedure:

1. Check sensor for damaged members and replace if needed according to manufacturers instructions.

2. With the meter turned off, the pointer should indicate zero. Adjust the needle with the screw on the meter case if needed.

3. Fill a five gallon bucket with tap water and let stand for 20 minutes.

4. Obtain a 300 ml sample of tap water from the bucket. Be careful not to entrain air into the sample.

5. Run a dissolved oxygen determination on the 300 ml sample using the Modified Winkler Method (California Standard Test Method 733).

6. Plug sensor cable into meter, securing both jacks. On model 57, set "Salinity Control" to zero or appropriate salinity value of sample.

7. Place sensor into bucket filled with tap water.

8. Turn "Function Switch" to RED LINE and adjust meter pointer to cover the red line on the scale by turning the "Red Line Control".

9. Turn "Function Switch" to TEMP. and record the temperature.

10. Turn "Function Switch" to ZERO and adjust "Zero Control" for meter pointer to read ZERO.

11. Turn "Function Switch" to 0-20. Adjust "Cal Control" for the meter pointer to read value determined by the modified Winkler Method (California Standard Test Method 733) in Step 5.

Materials Needed:

1. Bucket, 5 gallon, plastic

2. Service Kit, Yellow Springs Instrument No. 5034. Includes membranes, KCl solution and "O" rings.

3. Dissolved Oxygen Field Kit, Modified Winkler Method

4. Screwdriver, 1/4 inch blade

Accuracy:

$\pm$0.1 ppm on 0-10 scale
$\pm$0.2 ppm on 0-20 scale

Frequency of Calibration:

Before using each day. May want to calibrate more frequently when running several tests or when test period extends over several hours.

Reference: Yellow Springs Instrument Co.
P.O. Box 279
Yellow Springs, Ohio 45387
(513) 767-7241

Model: Martek Model DOA

Calibration Procedure:

1. Check sensor for damaged membrane and replace if needed according to manufacturers instructions.

2. Refill sensor with KCl electrolyte as needed.

3. Check batteries in stirring mechanism case and replace if needed (four "D" cells, 1-1/2 volts each).

4. Turn "Range Switch" to OFF and "Function Switch" to O_2 positions.

5. Plug sensor cable into meter case.

6. Turn "Range Switch" to ZERO position and wait at least one minute for meter to warm up.

7. Remove calibration compartment cover by turning the two hold down screws.

8. Adjust "O_2 Zero" calibration potentiometer so that meter needle points at 0.

9. Place sensor into 5 gallon bucket of tap water and wait a minimum of 20 minutes.

10. Remove a 300 ml sample of tap water from bucket and run a dissolved oxygen determination by the Modified Winkler Method (California Standard Test Method 733).

11. Turn "Range Switch" to the lowest scale which contains the value as determined in Step 10.

12. Adjust the "O_2 Cal" potentiometer until meter reads the dissolved oxygen value as determined by the Modified Winkler Method (California Standard Test Method 733) in Step 10.

Materials Needed:

1. Bucket, plastic, 5 gallon
2. Membranes, Teflon, Martek Part No. 400019
3. Electrolyte, KCl
4. Batteries, "D" cells
5. Screwdriver, 1/4" blade
6. Dissolved Oxygen Field Kit, Modified Winkler Method

Frequency of Calibration:

Before using each day. May want to calibrate more frequently when running several tests or when test period extends over several hours.

Accuracy: $\pm$0.2 ppm on 0-20 scale

Reference: Martek Instruments Inc.
17302 Daimler Street
Irvine, California
(714) 540-4435

CONDUCTIVITY METERS

Model: Beckman RA-2A

Calibration Procedure:

1. Connect "Blue" conductivity cell to the two post on the meter panel. Inspect the cell to see that it is free of dirt or any other foreign substance.

2. Depress the button marked "Press to Cal".

3. Rotate the "Calibrate" knob until the meter needle is at the zero "CAL" line on the right-hand side of the scale.

4. If meter cannot be adjusted, batteries must be replaced. Replace with two "AA" cells (Burgess No. AL9 or equivalent).

5. Place the cell into a solution of known conductivity. Immerse the cell to a point at least 1/2" above the air vents on the cell.

6. Press the "READ" button while holding down the "CAL" button and read the meter.

7. The meter should read the value of the known solution.

8. If the meter does not, indicate the value of the known solution and the value read. The following checks should be made and the proper action taken to correct the problem:

   a) Cell may be chipped or cracked (Replace cell).

b) Electrode and walls of cell may have deposits of crusted salts. To clean, place cell in 10% hydrochloric acid solution for a few minutes.

c) Check the cell cable and rubber sleeve. If broken, replace as needed.

d) Vent holes may be clogged, clean as needed.

9. After deficiencies have been corrected, steps 2 thru 6 should be repeated.

10. Replace cell with white cell (Factor of 0.1). Repeat steps 2 thru 7.

Materials Needed:

1. Beaker, 100 ml
2. Solution of known conductivity, 100 ml
3. Batteries, 2 "AA" cells

Accuracy: ±2% of full scale

Frequency of Calibration: Before using daily.

Reference: Beckman Instruments, Inc.
Scientific Instruments Division
Irvine, California 92664
(714) 833-0751

Model: Yellow Springs Instrument (YSI) Models 31 and 33

Calibration Procedure:

A. Meter

1. Remove the 2 slotted head screws from the sides of the instrument and 4 similar screws from the bottom and then lift the instrument out of the case.

2. Plug the instrument into a power supply, set the "Function Switch" to the 60 Hz position, and allow 5 minutes warm-up.

3. Set the "Range Switch" to the x 1000 ohms position and the "Sensitivity Control" to its maximum setting (full clockwise).

4. Connect precision resistors to the HI and LO Terminals of the instrument.

NOTE: A high precision resistance box, such as a General Radio (GR) or Electric Scientific Ind. (ESI), is recommended for accurate calibration. If this is not available, resistors of 2K, 10K, 20K at $\pm$.25% accuracy may be used for basic calibration.

5. Adjust the "Drive Control" for a dial indication of 2.0.

6. Set 2000 ohms on the decade resistance.

7. Adjust the LO control on the rear of the assembly until the shadow on the indicator tube is at maximum.

8. Adjust the "Drive Control" for a dial indication of 20.0.

9. Set 20,000 ohms on the decade resistance.

10. Adjust the HI control on the rear of the assembly until the shadow on the indicator tube is at maximum.

11. Repeat steps 6 through 10 until the shadow is at maximum for both settings.

12. Set 10,000 ohms on the decade resistance.

13. Adjust the "Drive Control" until the shadow on the indicator tube is at maximum - the dial should be reading within 1/2 minor division of 10.0.

14. If the dial reading is not correct, re-check calibration steps 6 through 10.

B. Cell Calibration and Standard Solutions

The YSI #3400 series cells are calibrated to absolute accuracy of ±1% based on a standard solution (.01 demal KCl solution).

The solution is prepared by diluting .745 grams pure dry KCl with distilled water until the solution weight is 1 kilogram. The table below shows the values of conductivity this solution would have if the distilled water were non-conductive. However, since even high purity distilled water is slightly conductive, the measured conductivity will be higher by an amount equal to the conductivity of the water.

Temperature (°C)	Conductivity (Absolute Micromhos/cm)
15	1141.5
16	1167.5
17	1193.6
18	1219.9
19	1246.4
20	1273.0
21	1299.7
22	1326.6
23	1353.6
24	1380.8
25	1408.1
26	1435.6
27	1463.2
28	1490.9
29	1518.7
30	1546.7

The operator may use the standard solution and the table to check accuracy of a cell's constant or to determine an unknown constant. The formula is shown below:

$$K = \frac{R(C_1 + C_2)}{10^6}$$

Where: K = Cell constant

R = measured resistance in ohms

C_1 = conductivity in absolute micromhos/cm

C_2 = conductivity in absolute micromhos/cm of the distilled water used in making solution.

R, C_1 and C_2 must either be determined at the same temperature or corrected to the same temperature to make the equation valid.

Materials Needed:

1. Screwdriver, 1/4" blade

2. Precision resistors, 1 each 2,000 ohm, 10,000 ohm and 20,000 ohm ±0.25% accuracy

3. Pure Potassium Chloride (Dry)

4. Beaker for mixing

5. Distilled water

6. Calibrated thermometer, range 0-50°C

Accuracy: ±1%

Frequency of Calibration:

Re-calibrate meter when a known solution does not have the correct value when tested or once a year minimum.

Reference: Yellow Springs Instruments Co., Inc.
Yellow Springs, Ohio 45387
(513) 767-7241

Model: Lab-Line Lectro Mho-Meter

Calibration Procedure:

1. Turn "Range Selector" to TEST.

2. Depress the ON button.

3. If meter pointer deflects to the center or balance point, instrument is in calibration.

4. An indecisive balance or partial deflection of the needle when cell is empty indicates battery needs to be replaced.

Materials Needed: Battery, Eveready PP4 or Equivalent

Frequency of Calibration: Before using

Accuracy: ±2% of full scale

Reference: Electronic Switchgear Ltd.
London, England

SONIC FLOW MEASURING SYSTEM

Model: Uni-Sonic WF-4-I-R-S

Calibration Procedure:

1. Measure distance from sensor to bottom of flume.

2. If distance is not 2.59 feet exactly, sensor position must be adjusted to obtain proper distance.

3. Sensor must be in a perpendicular position to the flume. Move sensor if needed to obtain perpendicular and then re-check vertical distance.

4. With the flume dry and empty the output voltage should be "0" volts. (Meter located on Controller Panel)

5. If voltage is not "0", open panel door and adjust "ZERO" Potentiometer until a zero reading is obtained (see Figure 1).

6. If there is water in the flume, measure depth and adjust "ZERO" Potentiometer to give measured depth on meter.

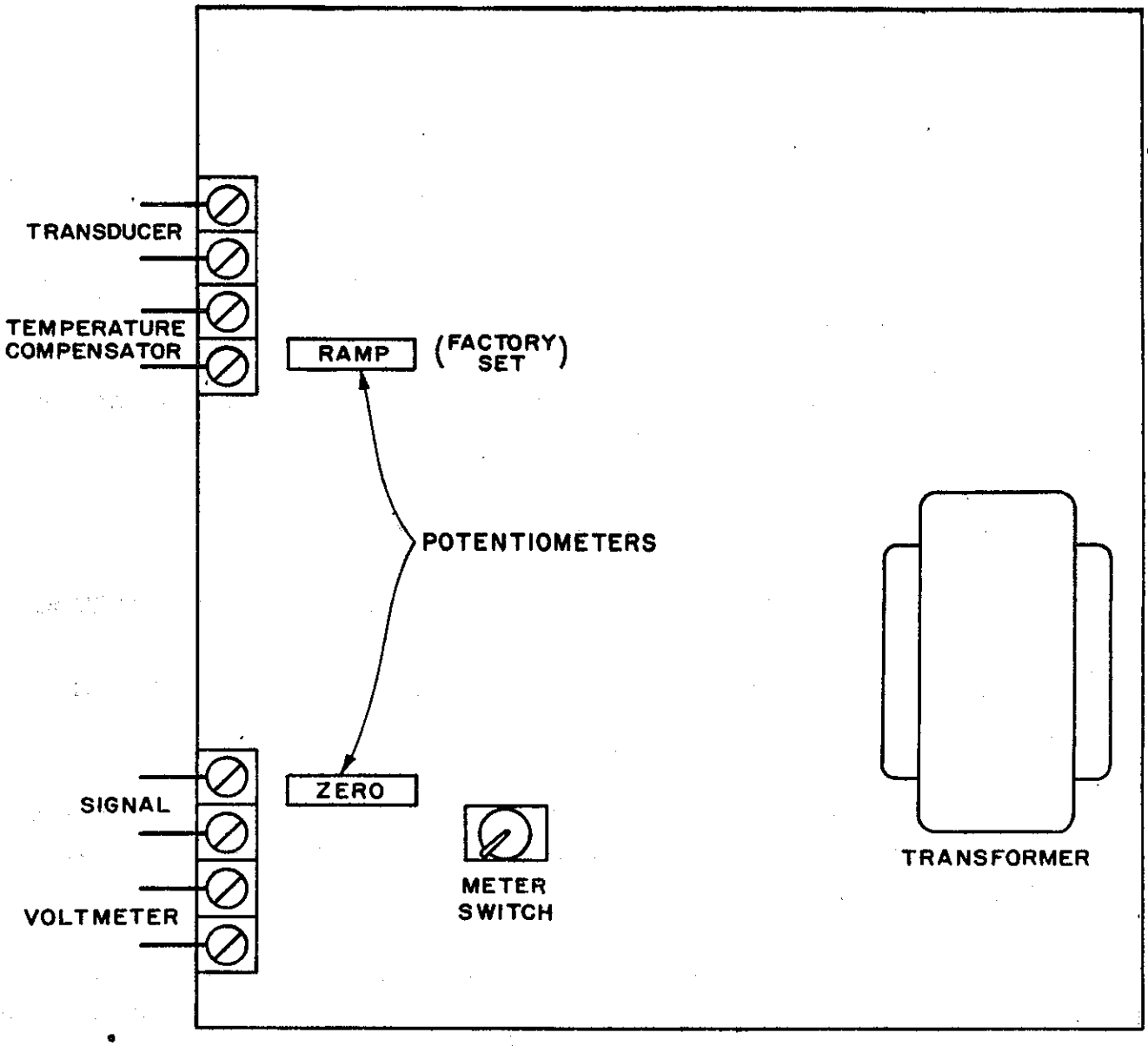
Materials Needed:

1. Screwdriver, 1/4" blade
2. Measuring tape, 10 feet long

Frequency of Calibration: Once a year and/or after installation.

Accuracy: ±1% of full scale

Reference: Inventron Industries, Inc.
4005 West Jefferson Boulevard
Los Angeles, California 90016
(213) 731-2507



SONIC FLOW MEASURING SYSTEM
MAJOR COMPONENT LAYOUT

FIGURE 1

PRECIPITATION GAGES

Model: WeatherMeasure P511-P, P511-E, P501-I

Calibration Procedure:

1. Remove cover, but leave gage in place and level.

2. Apply coat of light silicone oil to bucket and mercury switch pivots.

3. Set a buret (0.1 ml graduations) in a holder over the intake orifice.

4. Record water level in buret.

5. Start letting water out of the buret into the orifice.

6. Allow the buckets to tip 4 times. Record amount of water used.

7. For every 8.0 ml of water, the bucket should tip once, representing 0.01 inch of rainfall. When buckets have tipped 4 times, 32.0 ml of water should have been used.

8. If the recorded amount of water used is between 31.7 ml and 32.3 ml, gage is within usable limits (±1% error). No adjustments are necessary.

9. If amount of water used is outside of these limits, gage is out of calibration and must be adjusted.

10. To adjust, loosen the lock nuts on the calibration screws. Move the screws up to hold less water (readings above 32.0 ml) or down to hold more water (readings below 32.0 ml). Both screws must be turned the same amount (Figure 2).

11. Repeat steps 5 and 6.

12. Procedure is repeated until gage is within acceptable limits (32.0 ml ±0.3 ml).

13. Check recorder chart for proper pen movement.

14. If gage is operational, mark beginning and ending of calibration on chart paper.

15. On gage P511-P flame on burner should be approximately 3/4" high, adjust regulator if needed.

Materials Needed:

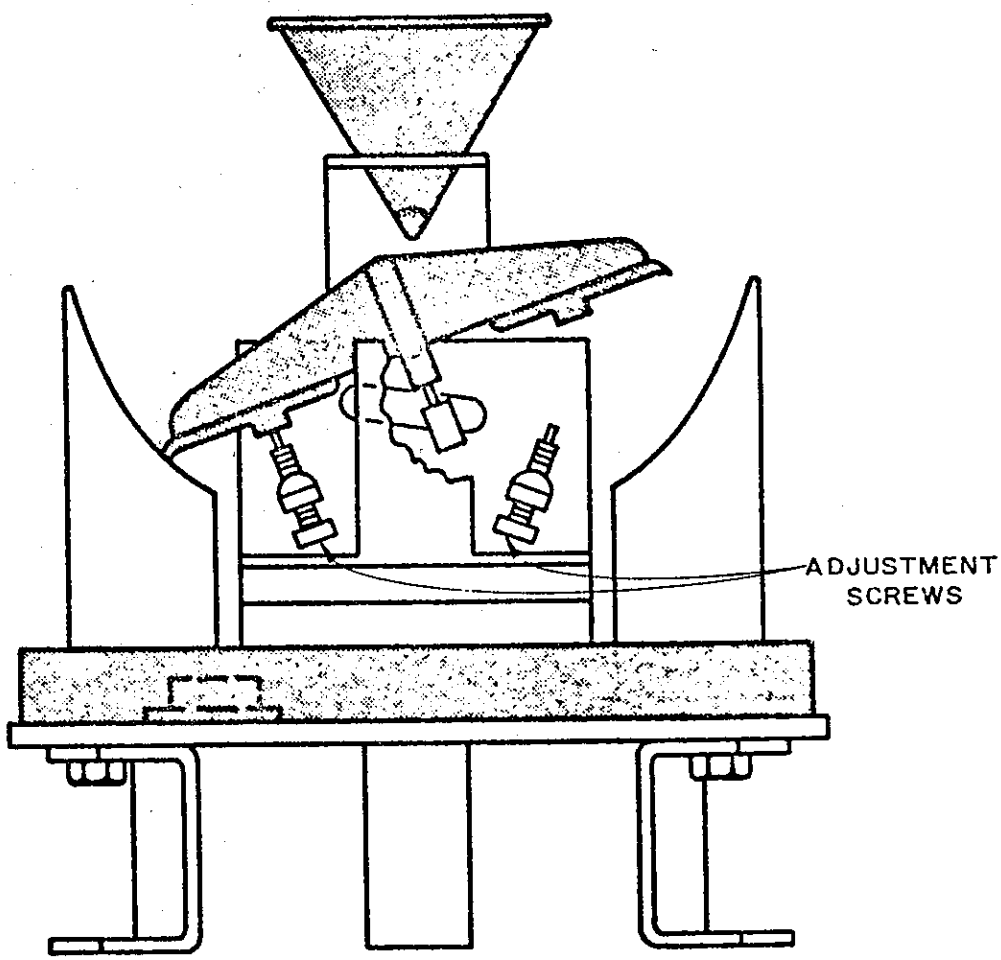
1. Buret, 50+ ml capacity (0.1 ml graduations)
2. Buret holder and stand
3. Long nose pliers
4. Set of Allen wrenches
5. Light silicone oil (Dow-Corning 704)
6. Small level
7. Water supply

Accuracy: ±1%

Frequency of Calibration:

Minimum of once a year at the start of the rainy season.

Reference: WeatherMeasure Corp.
P.O. Box 41257
Sacramento, California 95841
(916) 481-7565



TIPPING BUCKET MECHANISM FOR
RECORDING RAIN GAGE

FIGURE 2

Model: Meteorology Research Inc., Model 304

Calibration Procedure:

1. Remove cover, but leave gage in place and level the gage, adjusting as necessary.

2. Set a buret (0.1 ml graduations) in a holder over the intake orifice.

3. Fill buret with water and record level.

4. Start letting water out of the buret slowly into the orifice.

5. Allow the buckets to tip 4 times. Record the amount of water used.

6. For every 8.0 ml of water the bucket should tip once, representing 0.01 inch of rainfall. When the buckets have tipped 4 times, 32.0 ml of water should have been used.

7. If the recorded amount of water used is between 31.7 ml and 32.3 ml, the gage is within acceptable limits (±1%). No adjustments are necessary.

8. If the recorded amount of water used is outside of the limits, the gage is out of calibration and must be adjusted.

9. To adjust, release the lock screws on the limit travel studs on the back side of the gage.

10. Adjust the eccentric limit travel studs. Move studs up to hold less water (readings above 32.0 ml) or down to hold more water (readings below 32.0 ml). Both screws must be moved the same amount.

11. Repeat steps 3 through 7.

12. Procedure is repeated until gage is within acceptable limits (32.0 ml $\pm$0.3 ml).

13. Check recorder chart for proper movement of marking arm assembly.

Materials Needed:

1. Buret 50+ ml capacity (0.1 ml graduations)
2. Buret holder and stand
3. Screwdriver, 3/8" blade
4. Water supply

Frequency of Calibration:

Minimum of once a year, before the start of the rainy season.

Reference: Meteorology Research, Inc.
464 West Woodbury Road
Altadena, California 91001

WATER QUALITY ANALYZER

Model: Martek Mark V

Calibration Procedure:

The manufacturer has available at the manufacturers address a calibration service for this instrument including the individual sensing devices built into the probe for measuring pH, electrical conductivity, temperature and dissolved oxygen.

If calibration must be performed in the field, the following instructions, taken from the manufacturers manual, must be followed:

1.0 Power Check

1.1 Apply AC power. (Omit if battery power only)

1.2 "Power Switch" to ON.

1.3 Place "Function Switch" in BATTERY position. The digital panel meter (DPM) should indicate 10.5 to 13.0 volts. If below 10.5 volts, charge the batteries until it reads 10.5 volts or above, otherwise inaccurate data will be monitored.

2.0 Temperature Calibration

2.1 Prepare ice and 45°C temperature bath to set the zero and span potentiometers. Temperatures other than 45°C may be used.

2.2 Place "Function Switch" in TEMP position.

2.3 Place temperature sensor in ice bath and stir solution to ensure uniform temperature range.

2.4 Adjust Temperature Potentiometer (Ø) on front panel to provide 0.00 reading on digital panel meter (DPM).

2.5 Place temperature sensor in high temperature bath (45°C or other temperature range) and allow sensor to reach equilibrium by constantly stirring.

2.6 Place accurate and calibrated laboratory thermometer (at least ±0.01°C) in temperature bath and adjust Temperature Calibration Potentiometer (CAL) to provide the same reading on the DPM as the thermometer.

3.0 Conductivity Calibration

3.1 Place "Function Switch" in COND. position.

3.2 Disconnect sensor cable from data readout module, and adjust Conductivity Calibration Potentiometer (Ø) on the front panel to read 0.00 on the DPM.

3.3 Connect Sensor cable

3.4 Prepare known conductivity solution. Refer to "Standard Methods for the Examination of Water and Waste Water", 14th edition, Method No. 205 for details for solution preparation and temperature correction.

3.5 Adjust Conductivity Calibration Potentiometer (CAL) to provide reading on DPM equal to millimhos/cm or micromhos/cm conductivity value of calibration solution.

4.0 Dissolved Oxygen Calibration

4.1 Place "Function Switch" in D.O. position.

4.2 Connect sensor cable.

4.3 Moisten membrane on dissolved oxygen probe.

4.4 Place DO sensor in oxygen-free atmosphere or solution. Adjust Dissolved Oxygen Calibration Potentiometer (Ø) to read 0.00 on the DPM. If it is inconvenient to obtain oxygen-free environment, disconnect the sensor cable and place a 30.0 KOHM resistor in Pins G and K of the sensor (J-2) connector on the data readout module and then adjust for zero.

4.5 Place sensor in solution of known dissolved oxygen concentration such as determined by the Winkler Method, and adjust Dissolved Oxygen Calibration Potentiometer (CAL) to read appropriate value on DPM.

4.5.1 For a faster calibration technique, the sensor can be exposed to air and fanned sufficiently to move air past the membrane. Adjust the DO calibration potentiometer (CAL) to read 9.00 ppm on the DPM. The maximum error of using this technique is ±3.0%.

NOTE: For DO concentrations lower than 2.00 ppm, more accurate calibration techniques are required.

5.0 pH Calibration

5.1 Place "Function Switch" in pH position.

5.2 Disconnect sensor cable. Adjust pH Calibration Potentiometer (CAL) to read 7.00 on DPM.

5.3 Connect sensor cable and immerse pH probe in buffer solution of 7.00 pH.

5.4 Adjust pH Calibration Potentiometer (Ø) to read 7.00 on DPM.

5.5 Remove pH sensor and rinse well with distilled water.

5.6 Immerse pH sensor in buffer solution of 4.0 pH and adjust pH Calibration Potentiometer (GAIN) to read 4.00 on DPM.

5.7 Rinse sensor which is now ready for use.

Expected Accuracy - Reliability of the Instrument:

Parameter	Range	Accuracy
Temperature	-5° to +45°C	±0.1°C
Conductivity	0-1000 micromhos/cm	±10.0 micromhos/cm
Dissolved Oxygen	0-20 ppm(mg/liter)	±0.05 ppm(mg/l)
pH	0-12 pH	±0.03 pH

Materials Needed for Field Calibration:

1. Crushed Ice - 5 pounds minimum

2. Source of heat for establishing elevated temperature bath, for second calibration point (step 2.5)

3. Potassium chloride solution, 1 quart (0.01 molar) for electrical conductivity calibration

4. Buffered pH solutions - 1 pint each of 7.00 and 4.00 pH solutions

5. Calibrated thermometer, Range 0° to 50°C

6. Screwdriver, 1/4" blade

Recommended Frequency of Calibrating: Minimum of once a year.

Reference: Instruction Manual, Martek Mark V
Water Quality Analyzer, Part No. 116
with revisions dated July 1, 1975

Martek Instruments, Inc.
17302 Daimler Street
Irvine, California
(714) 540-4435

THERMOMETERS

Model: Various

There are several different types of thermometers that are available for use. For a complete discussion of these various types, refer to the U. S. Geological Survey report "Water Temperature - Influential Factors, Field Measurements, and Data Presentation", Book 1, Chapter D1, 1975.

Calibration Procedure:

1. Place thermometer into a container filled with ice and allow it to reach equilibrium.

2. Read thermometer and record reading.

3. Place thermometer into a container filled with boiling water over a heat source.

4. Read thermometer and record reading.

5. Place the thermometer into two or three other containers filled with water of different temperatures.

6. Read the thermometer and record reading.

7. Into the same containers of varying temperatures, place a thermometer certified by the National Bureau of Standards.

8. Read calibrated thermometer and record readings.

9. Make a calibration chart by plotting readings of known and true temperatures and readings for the thermometer being calibrated.

10. When taking a temperature, the chart is then used to obtain a correction factor. Apply it to the reading to get a true temperature.

Materials Needed:

1. Thermometer certified by the National Bureau of Standards, range 0-100°C (Available at Translab).

2. Heat source (Bunsen Burner, Hot Plate, etc.)

3. Metal container large enough for thermometer to be placed into a water or ice bath of uniform temperatures.

4. Ice (enough to fill container)

5. Water supply

Accuracy: Accuracy for this method has not been determined. (Reference EPA Manual of Methods for Chemical Analysis of Water and Waste, pg. 286, STORET No. 00010)

Frequency of Calibration: Once a year

Reference: National Bureau of Standards
Washington, D.C.

THERMOGRAPH

Model: WeatherMeasure T611

Calibration Procedure:

1. Place calibrated thermometer along side of thermograph and allow to stabilize.

2. Rotate "Temperature Adjustment Knob" until pen on thermograph indicates the value of the thermometer.

Materials Needed:

1. Calibrated thermometer, range 32°-100°F
2. Chart Papers (WeatherMeasure #C611-W-HF)

Accuracy: ±1%

Frequency of Calibration: Every 6 months

Reference: WeatherMeasure Corp.
P.O. Box 41257
Sacramento, California
(916) 481-7565

EQUIPMENT MAINTENANCE

Equipment should be inspected for damage, malfunctions and/or wear caused by misuse, improper handling, improper storage and normal wear and tear. Equipment should be inspected before using and before storing.

Form TL-742 (Figure 3 in the Appendix) should be completed when a piece of equipment is purchased and entries made as the equipment is repaired or modified or when a complete inspection is performed.

The following is a listing of the various pieces of equipment and their maintenance procedures. Other maintenance procedures are listed under the calibration section.

SUSPENDED-SEDIMENT SAMPLERS

Model: US DH-48 and US DH-59

Inspection Procedure:

Check the following and clean, repair or replace as needed:

1. Intake nozzles
2. Gasket that seals lip of sample bottle
3. Spring tension of pull-rod assembly
4. Air vent opening

Frequency of Inspection: Before using

Reference: Product Manufacturing Co.
327 York Avenue
St. Paul, Minnesota 55101
(612) 776-1575

Model: US D-49

Inspection Procedure:

Check the following and repair, clean or replace as needed:

1. Brass intake nozzles
2. Gasket that seals lip of sample bottle
3. Air vent opening
4. Head hinge

Frequency of Inspection: Before using

Reference: Product Manufacturing Co.
327 York Avenue
St. Paul, Minnesota 55101
(612) 776-1575

BED MATERIAL SAMPLERS

Model: BMH-60, BM-54

Inspection Procedure:

Check the following items and clean, repair or replace as needed:

1. Spring loaded trap
2. Cocking device
3. Overall cleanliness

Frequency of Inspection: Before using

Reference: Product Manufacturing Co.
327 York Avenue
St. Paul, Minnesota 55101
(612) 776-1575

WATER SAMPLERS

Model: Kemmerer 1200B, 1200TTB, 1410B, 1410TTB

Inspection Procedure:

Check the following items and clean, repair or replace as needed:

1. Spring loaded closing device
2. Rubber plugs
3. Valve used to empty sampler

Frequency of Inspection: Before using

Reference:

Wildlife Supply Co.
1200 South Hamilton Street
Saginaw, Michigan 48602
(517) 799-8100

Model: Lab-Line 4199

Inspection Procedure:

1. Check intake tube for obstructions - clear when needed.
2. Check threads on cap - clean and/or repair when needed.

Inspection Frequency: Before Using

Reference: Lab-Line Instruments, Inc.
Lab-Line Plaza
Melrose Park, IL 60160
(312)345-7400

RECORDER

Model: WeatherMeasure P-522 Long Term

Inspection Procedure:

1. Pen should register 50 divisions or clicks in a complete cycle across the chart paper.

2. Pen should stop and start at edges of chart paper. If it doesn't, pen position can be adjusted by turning the adjusting screw with a screwdriver at top of recorder.

3. All batteries should be changed every 90 days.

4. Chart paper has to be changed at least once every 90 days.

5. Silica gel that keeps moisture inside the case at a low level, should be changed when the chart paper is changed or when gel turns pink. Oven drying the moist gel rejuvenates it for use again.

6. Refill ink well as needed (approximately every 6 months).

7. Clean pen, by use of piano wire, when needed.

8. Chart papers should be checked for correctness of clock drive. Timing adjustment may be made by turning the small screw above the red button on the clock housing. This adjustment should be made in the laboratory where accurate time can be kept and checked against the clock drive on the instrument.

Materials Needed:

1. Screwdriver, 1/4" blade

2. Batteries, one "D" cell and one 6-volt (Eveready No. 510S) on old models; five "D" cells on new models

3. Silica gel

4. Chart paper (WeatherMeasure C 522)

5. Ink

6. Piano wire for cleaning pen

Frequency of Inspection: At least once every 90 days

Reference: WeatherMeasure Corp.
P.O. Box 41257
Sacramento, California 95841
(916) 481-7565

DISSOLVED OXYGEN FIELD KIT

Model: Modified Winkler

The Modified Winkler Dissolved Oxygen Field Kit was designed and fabricated at Translab.

Inspection Procedure:

Check the following and clean, repair or replace as needed:

1. Overall condition of kit housing
2. Complete supply of fresh chemicals
3. Chemical containers dated when opened and received
4. Completeness of kit, bottles, flasks, etc.
5. Cleanliness of equipment

Frequency of Inspection: Before each use.

Reference: Transportation Laboratory
Enviro-Chemical Branch
Water Quality Section
5900 Folsom Boulevard
Sacramento, California 95819
(916) 444-4870

WATER LEVEL RECORDER

Model: Leupold & Stevens 71

Inspection Procedure:

Check the following items and clean, repair or replace as needed:

1. Clock is operating correctly
2. Pen or pencil
3. Float and connecting tape
4. Recording chart and staff gage are reading the same level

Frequency of Inspection: Every 6 months or when chart is changed.

Reference: Leupold & Stevens Inc.
P.O. Box 688
Beaverton, Oregon 97005
(503) 646-9171

CURRENT METERS

Model: Price AA, Pygmy, WeatherMeasure F583 and F584

Inspect For:

1. No apparent damage.

2. Cups spin freely, no signs of sticking.

3. Cups rotate for at least 1-1/2 minutes when meter is held down and given a very hard spin.

4. Meter gives proper amount of "clicks" when cups are rotated.

Calibration Procedure:

When meter has been damaged and repaired or when meter is suspected of improper operation, send meter to the Water Quality Section of the Enviro-Chemical Branch of the Transportation Laboratory. It will be field checked against a calibrated meter. If a discrepancy shows in the meter in question, the district will be notified. The meter may be shipped to the National Bureau of Standards in Washington, D.C. for final calibration.

Frequency of Inspection: Before using

Reference:

For Price AA and Pygmy Meters: Scientific Instruments of Wisconsin
518 West Cherry Street
Milwaukee, Wisconsin 53212

For WeatherMeasure F583 and F584 Meters: WeatherMeasure Corporation
P.O. Box 41257
Sacramento, CA 95841

APPENDIX

Form TL-742 and Calibration Sticker

Whenever a piece of water quality testing equipment is purchased, a Translab Form TL-742 (Figure 3) should be filled out to identify the equipment and to establish a permanent record of service, calibration, repair, etc. When any work is performed on this piece of equipment, an entry is entered on this form. Entry should include location of equipment were service occurred, date, person performing the service, indicate type of service and any pertinent information that pertains to the operation of said equipment.

Also, whenever an instrument is calibrated, a calibration sticker (Figure 4) should be filled out and attached to the instrument.

WATER QUALITY EQUIPMENT MAINTENANCE
Laboratory and Field Calibration

Instrument _____

Manufacturer _____

Date Purchased _____ Serial No. _____

CHC _____

Remarks: _____

Location	Date	*	By	Remarks

*Initial Calibration (IC)
Field Check (FC)
Routine Maintenance (RM)
Instrument Malfunction (IM)
Recalibration (RC)
Laboratory Check (LC)

TL-742 (Orig. 3/78)

Figure 3

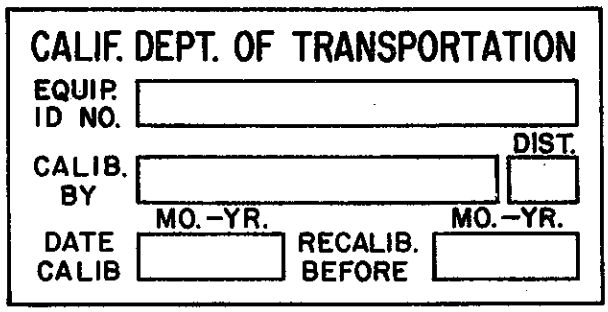


Figure 4