INSTRUCTION MANUAL

Turbidimeter

PLEASE BE ADVISED

In order to determine the true value of the secondary (sealed) standards, you MUST initially calibrate your turbidimeter with primary calibration standards. The secondary standards are tested to be within ± 10% of the indicated value. (The testing to obtain this value was not done on your instrument.)

Due to slight variations in instruments (sample holder, lamp age, cuvettes, environment) and technique, the true value of the sealed standards must be established in YOUR instrument. This procedure will also test for any damage to standards due to shipping.

LIMITED ONE YEAR WARRANTY

Manufacturer warranties all instruments (excluding batteries, damage caused by batteries, probes, standards, buffers) against defects in materials and workmanship for one year from date of original purchase. During this warranty period, the manufacturer will repair or at their option, replace at no charge a product which proves to be defective, provided the product is returned, shipping prepaid to the manufacturer's service center.

This warranty does not apply to damage caused by accident or misuse or as a result of service or modification by other than an authorized service center. No other express warranty is given. Repair or replacement of product is your exclusive remedy. In no event shall the manufacturer be liable for consequential damages.

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17.0 BATTERIES (PORTABLE UNITS)

17.1 The portable turbidimeter uses a 8 AA-cell rechargeable NiCd batteries. When the batteries have become discharged below a useful level, the letters, **BAT**, will be displayed in the upper left-hand corner of the display. The batteries should be recharged.

***** CAUTION *****
Failure to recharge the batteries could result in premature aging of the batteries.

Follow the Meter Setup instructions in Sections 4.0.1 thru 4.0.3 to activate the recharger. The power switch may be in either the on or off position. Use of the portable turbidimeter may continue while the batteries are recharging.

The battery charger (wall plug adaptor) will recharge the batteries in about 12 hours. It will not overcharge. No damage will result if the charger is connected indefinitely. The meter may be stored with the charger connected.

17.2 Battery Life

Fully charged batteries will operate the portable turbidimeter for about 3 hours. As the batteries age, this operating time may decline. End of life usually occurs after 1000 discharge/recharge cycles or when recharging does not result in significant operating time. At this point, replace batteries.

17.3 Replacing The Batteries

17.3.1 Turn power off. Disconnect the wall adaptor.
17.3.2 Remove screws on front panel.
17.3.3 Hold the turbidimeter upside down and carefully lift the back case off. Carefully set the unit down
17.3.4 At the bottom of the case is a bracket holding the battery packs. Disconnect battery packs.
17.3.5 Remove bracket by loosening wing nut.
17.3.6 Remove all old batteries.
17.3.7 Install new AA-cell rechargeable NiCd batteries, noting polarity. Press battery packs into the connectors.
17.3.8 Verify operation by turning power switch on.
17.3.9 Turn the power switch off.
17.3.10 Place batteries under bracket. Tighten wing nut.
17.3.11 Carefully reassemble unit.
17.3.12 Recharge batteries overnight.

15.2.7 Apply a small amount of glue in the gap surrounding the lamp and optical block.
15.2.8 Solder the wires onto the circuit board.
15.2.9 Proceed to section 16.0 Adjusting The Lamp Voltage.

16.0 ADJUSTING THE LAMP VOLTAGE

16.1 Tools Needed: phillips screwdriver
tweaker (small standard screwdriver)
10 NTU secondary standard

16.2 Procedure:

16.2.1 Turn the turbidimeter off. Unplug power jack or disconnect the batteries.
16.2.2 Remove the shroud (for lab models) or black case (for portable models).
The circuit board is located underneath the display. Locate trim pot R3 near the top of the circuit board.
16.2.3 Set the turbidimeter down on a flat surface. Plug the power jack into the unit or reconnect batteries and turn unit on.
16.2.4 Set the NTU range switch to 0-20. Adjust the SET/CAL knob to its middle position. Allow the turbidimeter to warm up for at least 5 minutes.
16.2.5 Clean the 10 NTU secondary standard. Insert cuvette into the test well and align the cuvette with the test well. Note the calibrated NTU value of the standard. Cover with the light shield.
16.2.6 Adjust trim pot R3 with tweaker until the display reads the approximate calibrated NTU value of the 10 NTU sealed standard. If the maximum display reading is less than the calibrated NTU value, adjust trim pot R3 to get the highest display reading. Then turn the SET/CAL knob clockwise. If the display reading cannot be adjusted to the calibrated NTU value of the 10 NTU secondary standard, the lamp needs to be replaced. See section 15.0.
16.2.7 After the lamp has been adjusted, turn the unit off. Unplug the power jack or disconnect the battery.
16.2.8 Put the turbidimeter back together.

1.0 INTRODUCTION

Your new turbidimeter measures the turbidity or cloudiness, of water. Light scattering particles suspended in the water cause this cloudiness. Turbidity is a key indicator of water quality and can be a key determinant of chemicals needed to reduce suspended solids.

2.0 THEORY OF OPERATION

Turbidity refers to a lack of clarity in a liquid. It is described as haze, milkiness, or cloudiness. Turbidity in water is caused by suspended matter such as clay, silt, organic matter, bacterial colonies, or plankton.

This turbidimeter detects light scattered by a process called nephelometry. A strong light beam shines up from the bottom of the sample well through the sample. The particles in the water cause the light to be scattered in all directions. The light scattered at 90° angles is detected by three photodiodes placed symmetrically around the well.

The amount of light scattered can then be directly related to the concentration of the particulate matter. The amount of light transmitted or scattered is affected by size, color, shape and concentration of the impurities. If size and shape are relatively constant, then measuring the light scattered and/or transmitted can be related to the concentration of the impurities; however, turbidity measurement is not an exact count of the mass of suspended impurities. It is a measurement of the amount of light scattered by the presence of impurities.

The unit of measurement, the nephelometric turbidity unit (NTU), is arbitrary. Therefore, it is essential to calibrate the measuring instrument (turbidimeter) to known standards before sample testing. For water testing, the known standards are formazin or styrene divinylbenzene polymer standards.

3.0 SPECIFICATIONS

Readout:	$3^1/_2$ digit LCD
Ranges:	0-2 NTU, 0-20 NTU, 0-200 NTU
Resolution:	0.1% of Range
Accuracy:	±2% of full scale
Light Source:	5,000 hour Tungsten bulb
Sample Well:	1" (25 mm) diameter
Size:	
Bench	5"H x 8"W x 8"D
Portable	5"H x 12"W x 8"D
Weight:	
Bench	4 lbs (1.8 Kg)
Portable	6 lbs (2.7 Kg)
Power:	
Bench	110 or 220 VAC
Portable	8 AA-cell rechargeable NiCd batteries
Battery Life (Portable):	
Operating	3 Hours
Recharge/Charge	1000 cycles

4.0 ACCESSORIES

4.1 Sample Cuvettes - two 1" diameter glass cuvettes with caps for sample measurements. Each cuvette is marked approximately 1" from bottom of cuvette with a white dot for alignment and sample level indication.

4.2 Cuvette Caps - two silicone caps are provided for placing on the top of the sample cuvettes after a standard or sample is poured in. Caps prevents contamination and reduce internal reflections during sample measurements.

4.3 Light Shield - is placed over the cuvette when taking measurements to prevent stray light from entering the test well.

14.5 Readings are inconsistent.

a. Using the light shield?
b. Is the cuvette aligned?
c. Is the same cuvette being used for primary standards and samples?
d. Are the cuvette sides or bottom scratched?...try another cuvette
e. Is the cuvette clean?...the cuvette must be cleaned with alcohol and a lint free cloth in order to remove fingerprints,dust, grease, and other debris.

14.6 Bouncing readings are due to the 3rd digit ($^1/_{1000}$ place) sensitivity. In the best lab setting, the 0-2 NTU range may vary ±.002 max. For general use, the 0-2 NTU range may vary ±.005, but will be well within regulatory requirements.

15.0 INSTALLING A NEW LAMP

15.1 Tools needed: phillips screwdriver
pliers
cyanoacrylate (super glue)
soldering iron
replacement lamp

15.2 Procedure:

15.2.1 Turn the unit off and unplug the power jack or disconnect the batteries.
15.2.2 Remove the shroud (for lab models) or black case (for portable models).
15.2.3 Locate the two lamp wires coming out of the circuit board near the word ‘lamp’.
15.2.4 Use a soldering iron to remove the lamp wires from the circuit board.
15.2.5 Grab the lamp body sticking out of the optical block with the pliers. Twist to break the glue seal and pull out. Scrape excess glue off the optical block.
15.2.6 Clean the new lamp lens with alcohol and insert into the optical block. Push the lamp in gently until it stops against the IR filter.

13.3.3 If the IR filter (the blue glass at the bottom of the sample well) becomes dirty, clean it using the following procedure:

a. Remove the retaining clip with snap ring pliers.
b. Cup one hand over the test well and slowly turn the turbidimeter upside down to allow the collimator ring and IR filter to fall into your hand. Shake the turbidimeter lightly if necessary to dislodge the IR filter.
c. Turn the turbidimeter right side up.
d. Wipe the collimator clean and clean the IR filter with glass cleaner and a soft tissue. Touch the IR filter only around the edge.
e. Put the IR filter back at the bottom of the test well and cover with the collimator.
f. Replace the retaining clip.

14.0 TROUBLESHOOTING GUIDE

14.1 Blank Display

a. Power switch on?
b. Are the batteries (portable unit only) charged?... Plug re-charger/adaptor in. Batteries will recharge while meter is in use. Recharge overnight to insure batteries are completely charged.
c. Wall plug adaptor plugged in?... Pull out and push in to verify the plug is in correctly.
d. Wall outlet has power?... Plug a lamp or radio into outlet to verify it has power.

14.2 Display reads 1.

a. Cuvette covered with light shield?
b. NTU range to low?...Switch to a higher range.

14.3 Readings are way off and only change when the light shield is removed.

a. Lamp burnt out?...see Installing A New Lamp.
b. Batteries dead?...Try wall plug adapter and recharge.

14.4 Set control won't adjust high enough to calibrate.

a. Test well dirty?...see Maintenance.
b. Lamp output not high enough?...see Installing A New Lamp.

When the turbidimeter is not in use, the light shield will prevent dust from accumulating at the bottom of test well.

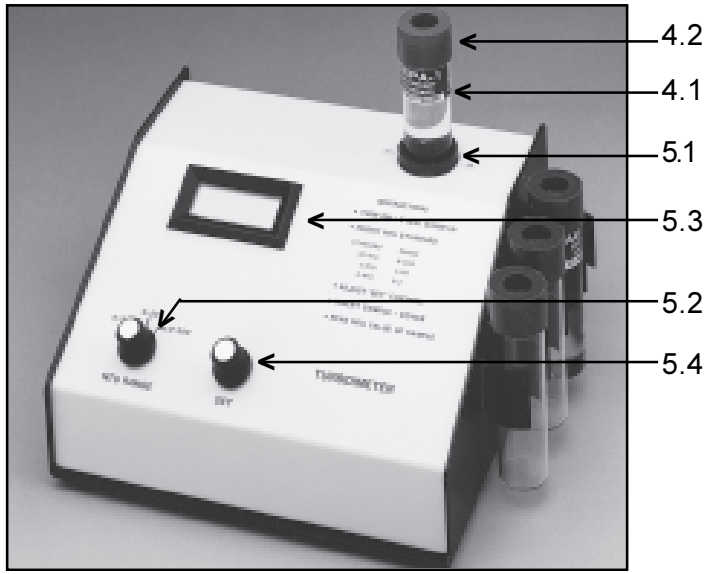
4.4 Secondary Standards - 0.5 and 10 NTU polymer standards are sealed in glass cuvettes with cuvette caps. The values are approximately the stated value. The operator must calibrate the secondary standards following the procedures in section 7.0 to determine the exact value.

4.5 Primary Standards - 60 ml bottles of 0.5 and 10 NTU polymer turbidimeter standards are provided for use in calibrating the instrument and the secondary standards.

DO NOT ALLOW STANDARDS TO FREEZE!

4.6 Light Block - used to zero the meter during calibration.

5.0 METER FAMILIARITY



5.1 Test Well - one inch diameter well into which a sample cuvette or sealed standard is placed. A notch is provided at the front of the test well for cuvette alignment.

5.2 NTU RANGE - three position switch to select turbidity range, 0-2, 0-20, or 0-200 NTU.

5.3 Digital Readout - displays NTU readings. If there are no digits displayed except for a 'one' on the far left, the reading is higher than the selected NTU range. Select a higher range.

5.4 SET or CAL - allows calibration to the standard being used. Bench models are screened SET. Portable are screened CAL.

5.5 ZERO ADJUST - used to zero the meter. Located on the back of the bench models and the front of the portable units.

5.6 POWER - allows input of the wall plug adaptor.

5.7 ON/OFF Switch - applies power to the turbidimeter.

6.0 OPERATION

6.1 Meter Setup

6.1.1 Place the turbidimeter on a flat, stable surface away from vibrations and direct sunlight.

6.1.2 Push the wall plug adaptor plug into the jack on the turbidimeter and plug the wall plug adaptor into an AC outlet. When using the portable unit, skip this step.

6.1.3 Turn the turbidimeter on with the power switch. A five minute warm-up is recommended for accurate and stable readings. However, this may be impractical for field measurements with the portable unit. Measurements within ±5% can be made with a 30 second warm-up.

6.2 Cuvette Preparation

6.2.1 Cleaning Cuvette Interior

a. Pour at least 5 ml of sample (Approx. 1/2 inch) into the cuvette.
b. Cover with a cuvette cap.
c. Tilt the cuvette to rinse the entire inside surface of the cuvette and cap.
d. Pour the liquid out. Shake out remaining liquid.
e. Repeat at least one more time.

12.0 TWO POINT CALIBRATION

Two point calibration may be used if greater accuracy is required than obtained with the linearity calibration curves in Section 11.0.

12.1 This calibration method is for samples all falling within one range, i.e. all will be tested in the 0 - 2 range.

12.2 Example: samples are between 0.5 and 1.0 NTU.

12.2.1 Prepare sample cuvette with 1.0 NTU standard. Insert into test well and cover with light shield.
12.2.2 Using the SET/CAL knob, display is set to read 1.0.
12.2.3 Remove cuvette and empty.
12.2.4 Rinse cuvette with 0.5 NTU standard twice and fill with 0.5 NTU standard.
12.2.5 Insert 0.5 NTU standard into test well. Cover with light shield.
12.2.6 Using ZERO ADJUST knob, set display to read 0.500.
12.2.7 Repeat steps 12.1.1 thru 12.1.6 until no further adjustments are needed.

13.0 MAINTENANCE

13.1 Primary and Secondary Standards

13.1.1 DO NOT FREEZE secondary (sealed) or primary standards. Store at room temperature.
13.1.2 Store the secondary standards in a place where they will not be scratched or broken.

13.2 Cuvettes

13.2.1 Rinse cuvettes with deionized or distilled water after use. Shake dry. Store cuvettes with cap on tight to keep inside clean.
13.2.2 Store cuvettes where they will not be scratched or broken.
13.2.3 Examine cuvettes for scratches periodically and replace, if necessary.

13.3 Test Well

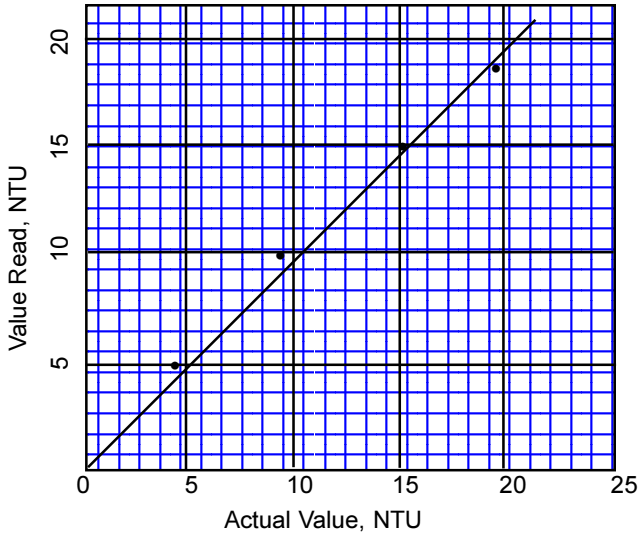
13.3.1 Keep test well covered with light shield. This will keep the test well and filter clean.
13.3.2 Use a soft tissue or cloth and glass cleaner to clean the inside of the test well.

11.0 LINEAR CALIBRATION CURVES

11.1 When high accuracy is required on a particular range, a linear calibration curve can be generated. This involves a graph with the known NTU values on the X axis and the measured NTU values on the Y axis on linear graph paper.

11.2 Plot the linear calibration curve as follows:

1. A known primary standard is measured following the proper procedures and the points plotted on graph paper.
2. Several points within the selected NTU range are plotted.
3. A straight line is connected between them. Five or more points are recommended.



11.3 The unknown water sample is measured following the proper procedures. The corrected NTU value is obtained by finding where the measured value intersects the linear calibrated curve.

11.4 Example: A test well water sample reads 5.6 NTU on a calibrated meter. From the graph above the corrected value would be 5.5 NTU.

NOTE: The linear calibration curves are essential when using the 0-2 NTU range.

6.2.2 Filling the Cuvette

a. Sample volume should be kept constant for accurate results.
b. Fill the cuvette with sample. It is recommended that the cuvette be filled completely. If the sample volume is small, the cuvette may be filled to the white dot but all measurements and calibrations should then be filled only to the dot.
c. Place cap securely on the cuvette before cleaning the outside.

6.2.3 Cleaning Cuvette Exterior

a. Cleaning the outside of the cuvette is critical.
b. Use a lint free cloth and alcohol. Avoid touching the area below the alignment mark as fingerprints will distort the turbidity reading. Using a dry tissue alone is not adequate for removing fingerprints and oils which will cause inaccurate readings.

6.3 Alignment

All cuvettes are aligned and marked at the factory, this eliminates errors due to irregularities in the sample cuvette and standard cuvette glass. Establishing the correct alignment of each cuvette in the test well insures consistent and accurate readings.

IF your cuvette loses its alignment mark, use the following procedure to realign the cuvette:

a. Fill the cuvette with approximately 5 mL of 10 NTU primary standard.
b. Place the cuvette in the test well.
c. Cover with the light shield.
d. Check the reading.
e. Remove the light shield and rotate the cuvette 90°.
f. Replace light shield and check reading again.
g. Continue rotating cuvette and checking readings, until the lowest reading is found. NTU values may vary as much as 25% by simply rotating the cuvette 5°.

NOTE: This is the spot where the cuvette glass causes the least interference with the instrument reading. Once the best alignment is established, make an alignment line or dot on the cuvette glass. The mark should be 1" or higher from the bottom of the cuvette. Use a permanent marker or nail polish.

7.0 CALIBRATING WITH PRIMARY STANDARDS

7.1 You will need: 0.5 NTU and 10 NTU primary standards
0.5 NTU and 10 NTU secondary standards
sample cuvette with cap
light block

7.2 Turn on the turbidimeter and allow to warm-up. See section 6.1.3.

7.3 Set the range switch to 0-2 NTU. Prepare the cuvette with the 0.5 NTU primary standard. See section 6.2.

7.4 Remove the primary standard and replace it with the 0.5 NTU sealed standard. Align and cover with light shield.

7.5 Record the NTU value of sealed standard on the label.

7.6 Insert light block.Cover with light shield. Using the zero adjust knob, set the display to read 0.000 $\pm$ 0.01. Remove the light block.

7.7 Insert the cuvette into test well, align the cuvette, and cover with the light shield.

7.8 Adjust the SET/CAL control until the display reads 0.5.

7.9 Pour the primary standard out of the sample cuvette. Do not reuse, Primary is now contaminated.

7.10 Prepare the sample cuvette using the 10 NTU primary standard. (Remember to rinse twice.)

7.11 Change the range switch to 0-20 NTU.

7.12 Insert the sample cuvette into the test well, align cuvette, and cover with light shield.

10.6 When sampling a distribution system or a treatment plant, allow the water to run at least 5 minutes prior to sampling. When sampling a stream, lake, reservoir, well, clarifier, or storage tank, collect at least one liter (1 quart).

10.7 If the water source is not uniform, it may be necessary to sample at several locations at varying depths. Combine the samples into a single, well-mixed composite sample prior to measurement.

10.8 A representative sample accurately reflects the true quality of the water the sample was taken from. To ensure a representative sample, gently mix every sample throughly before aliquots are taken. Do not allow the sample to settle.

10.9 Before adding a standard or sample to a cuvette, rinse the cuvette twice with the current liquid to be tested. This removes the effects of the previous liquid and any dust or foreign matter that may have found its way into the cuvette while not in use.

10.10 Gently pour the liquid to be tested down the side of the tilted cuvette. This reduces the air bubbles which distort the readings. When using standards, if air bubbles are present allow the cuvette to sit for 10 minutes and/or gently tap the side of the cuvette.

10.11 If the sample water to be tested is cold, allow it to warm up to room temperature prior to testing. Cool liquid in a warm turbidimeter chamber will cause the cuvette to fog up, distorting the reading.

10.12 Do not pour used primary standards back into the bottle. This contaminants the contents, since the used standard has been in contact with impurities in the cuvette.

10.13 High turbidity samples may be out of range. The display will read "1". The samples may be diluted but this should be avoided when possible since diluting a sample may alter the characteristics of the suspended particles and produce erroneous results.

9.6 Clean the outside of the cuvette with a lint free tissue or cloth and alcohol. Avoid touching the area below the mark as finger prints can greatly distort the turbidity reading. Using a dry tissue alone is not adequate for removing finger prints and oils and will cause inaccurate readings.

9.7 Set the range switch to 0-200 NTU, insert the sample cuvette, align the cuvette in the test well and cover with the light shield. Switch to the lowest NTU range for which there is a displayable reading and read the NTU value of the sample.

10.0 MEASUREMENT GUIDELINES

NOTE: When calibrating in the 0-2 NTU range, the 3rd digit ($^1/_{1000}$ place) may vary $\pm$0.002 in a lab setting and $\pm$0.005 outside the lab.

10.1 The 0-2 NTU range should only used for calibration procedures and “LAB” testing. Under normal use, the 0-20 NTU range should be used for all low level sample readings done in the field. The 0-20 NTU range gives acceptable readings well within EPA’s and other regulatory agencies 2% requirements.

10.2 Always use the same cuvette for the standard and the sample when calibrating with primary standard as long as it remains scratch free. Remember... no two cuvettes have identical characteristics.

10.3 Keep cuvettes clean from dust and scratches. Handle the cuvettes so that no fingerprints can get on the area below the level mark.

10.4 Make sure the cuvette is indexed (determination of alignment, see section 6.3) and aligned in test well before taking any readings.

10.5 Insure that the turbidimeter has been warmed up.

7.13 Adjust the SET/CAL so the display reads 10.0.

7.14 Remove the primary standard and replace it with the 10 NTU sealed standard. Align cuvette and cover with light shield.

7.15 Record the NTU value of the sealed standard on the label.

7.16 The secondary standards are now calibrated and can now be used for daily calibration without using primary standards.

NOTE: The preceding procedure should be performed every three months, every time a new sample cuvette is used or any time the sealed standard values are questionable. Repeated use of the sample cuvettes and sealed standard cuvettes will cause wear and scratches on the glass which will result in a change in the assigned value of the standard. It is important to realize that a change in the assigned value does not necessarily indicate degradation or deterioration of the standard.

8.0 CALIBRATING WITH SECONDARY STANDARDS (DAILY CALIBRATION)

Once a sealed standard is calibrated to a primary standard in a sample cuvette, it becomes a secondary standard.

Always clean cuvettes prior to placing in the test well. Clean the outside with a soft tissue or cloth and alcohol. Hold the cuvette by the cap and avoid touching the glass. When not being used, the secondary standards should be stored where they will not be scratched or broken.

Determine the range to be used based on the sample to be tested. Clean drinking water should be tested in the 0 - 2 NTU range. Samples with a turbidity above 1 should be tested in the 0 - 20 NTU range.

8.1 Turn on the turbidimeter and allow to warm-up. Five minutes for bench model and one minute for portable units.

8.2 Set the range switch to desired range.

8.3 When testing samples on the 0 - 2 NTU range, steps 8.3 thru 8.8 may need to be repeated until no further adjustments are needed

8.4 The turbidimeter is now calibrated to the secondary standard for this range. You can now proceed to measure unknown samples.

8.5 The turbidimeter must be recalibrated whenever the range selection is changed.

8.6 Insert the light block into test well. Cover with light shield. Set the range switch to 0-2 NTU. Insert the appropriate secondary standard into the test well and line up the alignment marks. Note the NTU value obtained when the standard was calibrated to the primary standard.

8.7 Cover the cuvette with the light shield and use the SET/CAL control to set the display to the recorded calibrated value.

8.8 Remove the standard.

NOTE: Regulatory agencies require sealed turbidity standards to be calibrated against properly prepared formazin or styrene divinylbenzene polymer standards every 3 to 4 months. (Check with your regulatory agency for the required frequency.) This allows for monitoring standard deterioration and meter adjustment for the new conditions. The calibration must be documented. Standards which have deteriorated should be replaced.

NOTE: If your turbidimeter can not be adjusted to read the recorded NTU values on the sealed standards, try recalibrating with primary standards. If meter still does not adjust, go to section 14.4 in the Troubleshooting Guide.

9.0 SAMPLE MEASUREMENT

NOTE: Condensation on the cuvette will cause false readings. If the sample is colder than the area it is being measured in, allow the temperature to equalize.

9.1 Use a clean (inside and out), aligned cuvette which has no scratches. Refer to section 6.2 for cleaning and alignment instructions.

9.2 For best results, use the cuvette which was used to calibrated the meter with primary standards. Variations in cuvettes may cause faulty readings.

9.3 Thoroughly shake the sample. Allow air bubbles to disappear and large sediment to settle prior to pouring the sample into the cuvette. Slowly pour the sample (unknown) liquid against the side of the cuvette to avoid forming air bubbles. Fill to the alignment mark.

9.4 Place the cap securely on the cuvette.

9.5 After pouring an unknown sample it is recommended, when possible, to immerse the cuvette in an ultrasonic bath, for 1 to 2 seconds, to cause complete air bubble release. Do not do this with standards.