CAT. NO. 44740-88

# PORTABLE TURBIDIMETER

## Model 2100P ISO

## Instrument and Procedure Manual

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# CERTIFICATION

Hach Company certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.

The Model 2100P ISO Portable Turbidimeter has been tested and is certified as indicated to the following instrumentation standards:

## Product Safety

**External Power Supplies Only:**
115 V ac Supply, UL Listed & CSA Certified, or
230 V ac Supply, CE Marked per 73/23/EEC, VDE Listed

## EMI Immunity:

**Instrument Tested with external 230 V, 50 Hz Power Supply:**
Per **89/336/EEC** EMC: **EN 61326:1998** (Electrical Equipment for measurement, control and laboratory use—EMC requirements) Supporting test records by Hach Company, certified compliance by Hach Company.

**Standards include:**
IEC 1000-4-2:1995 (EN 61000-4-2:1995) Electro-Static Discharge Immunity (Criteria B)

IEC 1000-4-3:1995 (EN 61000-4-3:1996) Radiated RF Electro-Magnetic Field Immunity (Criteria B)

IEC 1000-4-4:1995 (EN 61000-4-5:1995) Electrical Fast Transients/Burst (Criteria B)

IEC 1000-4-5:1995 (EN 61000-4-5:1995) Surge (Criteria B)

IEC 1000-4-6:1996 (EN 61000-4-6:1996) Conducted Disturbances Induced by RF Fields (Criteria A)

IEC 1000-4-11:1994 (EN 61000-4-11:1994) Voltage Dip/Short Interruptions (Criteria B)

## Emissions

**Instrument Tested with the external 230 V, 50 Hz Power Supply:**
Per **89/336/EEC** EMC: **EN 61326:1998** (Electrical Equipment for measurement, control and laboratory use—EMC requirements) Class “B” emission limits. Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) certified compliance by Hach Company.

## CERTIFICATION, continued

**Standards include:**
EN 61000-3-2 Harmonic Disturbances Caused by Electrical Equipment

EN 61000-3-3 Voltage Fluctuation (Flicker) Disturbances Caused by Electrical Equipment

**Additional Emissions Standard/s include:**
**EN 55011 (CISPR 11)** Class "B" emission limits

**Canadian Interference-causing Equipment Regulation, IECS-003:** Class "A" emission limits. Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01), certified compliance by Hach Company.

This Class A digital apparatus meets all requirements of the Canadian Interference-causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

**FCC Part 15:** Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01), certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be

required to correct the interference at his own expense. The following techniques of reducing the interference problems are applied easily.

1. Disconnect the external power supply or remove the batteries from the 2100P ISO Portable Turbidimeter to determine whether it is the source of the interference.
2. Move the 2100P ISO Portable Turbidimeter and its power supply away from the device receiving the interference.
3. Move the device receiving the interference to a different location.
4. Try combinations of the above.

# SAFETY PRECAUTIONS

Please read this entire manual before unpacking, setting up, or operating this instrument. Pay particular attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

## Use of Hazard Information

If multiple hazards exist, this manual will use the signal word (Danger, Caution, Note) corresponding to the greatest hazard.

***DANGER***
***Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.***

***CAUTION***
***Indicates a potentially hazardous situation that may result in minor or moderate injury.***

***NOTE***
***Information that requires special emphasis.***

## Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

 This symbol, if noted on the instrument, references the instruction manual for operational and/or safety information.

# SPECIFICATIONS

Specifications are subject to change without notice.
Operating specifications applicable at 25 °C unless noted.
Program software copyrighted by Hach Company, 1991.

**Measurement Method:** Ratio Nephelometric signal (90°) scatter light ratio to transmitted light

**Range:** 0–1000 FNU with automatic decimal point placement or manual range selection of 0–9.99, 0–99.9 and 0–1000 FNU

**Accuracy:** ± 2% of reading plus stray light from 0–1000 FNU

**Resolution:** 0.01 FNU on lowest range

**Repeatability:** ± 1% of reading or 0.01 FNU, whichever is greater (with Gelex standards)

**Response Time:** 6 seconds for full step change without signal averaging in constant reading mode

**Stray Light:** <0.04 FNU

**Standardization:** StablCal® Stabilized Formazin primary standards or Formazin primary standards

**Secondary Standards:** Gelex® Secondary Standards

**Display:** Four-digit liquid crystal; 10.16 mm (0.4 in.) high digits with custom icons

**Light Source:** T860 nm LED lamp

**Detectors:** Silicon photovoltaic

**Signal Averaging:** Operator selectable on or off

**Sample Cells:** (Height X width) 60.0 X 25 mm (2.36 X 1 in.) Borosilicate glass with screw caps, marking band and fill line

**Sample Required:** 15 mL (0.5 oz)

**Storage Temperature:** –40 to 60 °C (–40 to 140 °F) (instrument only)

## SPECIFICATIONS, continued

**Operating Temperature:** 0 to 50 °C (32 to 122 °F) (instrument only)

**Operating Humidity Range:** 0 to 90% RH noncondensing at 30 °C;
0 to 80% RH noncondensing at 40 °C;
0 to 70% RH noncondensing at 50 °C

**Power Requirements:** Four AA Alkaline cells or optional battery eliminator

**Battery Life:** Typically 300 tests with signal average mode off; 180 tests with signal average mode on

**Battery Eliminator (optional):**

For 120 V eliminator: CSA and UL approved for 120 V ac ± 10%, 60 Hz, 6 V at 800 mA dc output

For 230 V eliminator: CE (VDE) approval pending for 230 V ac ± 10%, 50 Hz, 6 V at 900 mA dc output

**Enclosure:** High impact ABS plastic

**Dimensions:** 22.2 X 9.5 X 7.9 cm (8.75 X 3.75 X 3.12 in.)

**Instrument Weight:** 520 kg (1 lb 2.5 oz)

**Shipping Weight:** 3.1 kg (6 lb 8.5 oz)

# OPERATION

### *DANGER*

***Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.***

### *DANGER*

***La manipulation des échantillons chimiques, étalons et réactifs peut être dangereuse. Lire les Fiches de Données de Sécurité des Produits (FDSP) et se familiariser avec toutes les procédures de sécurité avant de manipuler tous les produits chimiques.***

### *PELIGRO*

***La manipulación de muestras químicas, estándares y reactivos puede ser peligrosa. Revise las fichas de seguridad de materiales y familiarícese con los procedimientos de seguridad antes de manipular productos químicos.***

### *GEFAHR*

***Das Arbeiten mit chemischen Proben, Standards und Reagenzien ist mit Gefahren verbunden. Es wird dem Benutzer dieser Produkte empfohlen, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Gebrauch der Chemikalien vertraut zu machen und alle entsprechenden Materialsicherheitsdatenblätter aufmerksam zu lesen.***

### *PERIGO*

***A manipulação de amostras, padrões e reagentes químicos pode ser perigosa. Reveja a folha dos dados de segurança do material e familiarize-se com todos os procedimentos de segurança antes de manipular quaisquer produtos químicos.***

### *PERICOLO*

***La manipolazione di campioni, standard e reattivi chimici può essere pericolosa. La preghiamo di prendere conoscenza delle Schede Techniche necessarie legate alla Sicurezza dei Materiali e di abituarsi con tutte le procedure di sicurezza prima di manipolare ogni prodotto chimico.***

# SECTION 1 DESCRIPTION

## 1.1 General Description

The Hach Model 2100P ISO Portable Turbidimeter (*Figure 1*) measures turbidity from 0.01 to 1000 FNU in automatic range mode with automatic decimal point placement. The manual range mode measures turbidity in three ranges: 0.01–9.99, 10–99.9, and 100–1000 FNU. The instrument operates on four AA alkaline batteries or with an optional battery eliminator. Rechargeable nickel-cadmium cells may be used, but cannot be recharged in the instrument. The carrying case holds teh instrument, all standard accessories, and the optional battery eliminator.

**Figure 1 2100P ISO Turbidimeter and Accessories**




***Note:*** *Avoid prolonged exposure to ultraviolet light and sunlight.*

***Note:*** *When taking a reading, place the instrument on a level, stationary surface. It should not be held in the hand during measurement.*

## 1.2 Accessories

Accessories supplied with the turbidimeter include nine sample cells; three Gelex® Secondary Standards (included with 4474000 only); one sealed vial each of:
<0.1-FNU, 20-FNU, 100-FNU, and 800-FNU StablCal® Stabilized

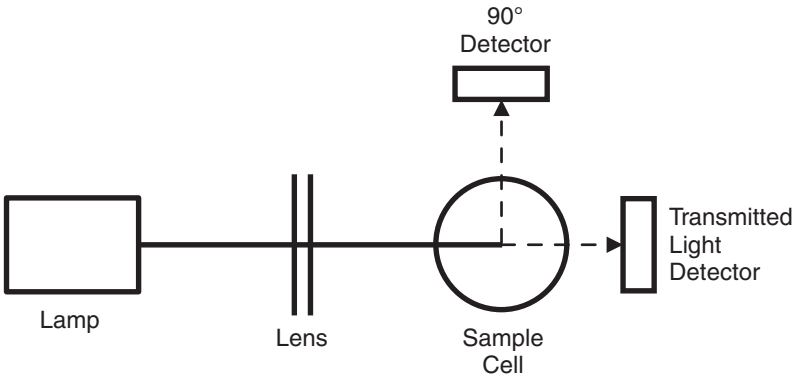
Formazin Standards; 4 AA alkaline batteries; 15 mL of silicone oil; oiling cloth; carrying case; instrument manual; and quick reference card.

## 1.3 Principle of Operation

The Model 2100P ISO Portable Turbidimeter operates on the nephelometric principle of turbidity measurement. This instrument meets the design criteria specified by ISO 7027.

The ratio optical system* (*Figure 2*) includes an LED lamp, a 90° detector to monitor scattered light, and a transmitted light detector. The microprocessor calculates the ratio of the signals from the 90° and transmitted light detector. This ratio technique corrects for interferences from color and/or light absorbing materials (such as activated carbon) and compensates for fluctuations in lamp intensity, providing long-term calibration stability. The optical design also minimizes stray light, increasing measurement accuracy.

**Figure 2 Ratio Optical System**




## 1.4 Preparation for Use

### 1.4.1 Unpacking

Remove the instrument and accessories from the shipping box and inspect for damage that may have occurred due to rough handling or

* Patent number 4,198,161; other patents pending.

extreme weather conditions. Verify the following are present (*Figure 1*):

- Model 2100P ISO Portable Turbidimeter
- Instrument Manual (with quick reference card)
- Set of StablCal Primary Standards in sealed vials, one each of:
  <0.1 FNU*
  20 FNU
  100 FNU
  800 FNU
- Standardization Kit containing Gelex Secondary Standards (included with 4474000 only), 0-10, 0-100 and 0-1000 ranges plus nine sample cells with caps.
- Silicone Oil, 15-mL (0.5 oz) dropping bottle
- Oiling Cloth
- Carrying Case
- Four AA alkaline batteries

If any of the items are missing or damaged, please contact the Customer Service Department, Hach Company, Loveland, Colorado. The toll-free number in the United States is 800-227-4224. International customers should contact the Hach office or authorized distributor serving your area. Refer to *REPAIR SERVICE* on page *63*. **Please do not return the instrument without prior authorization from Hach.**

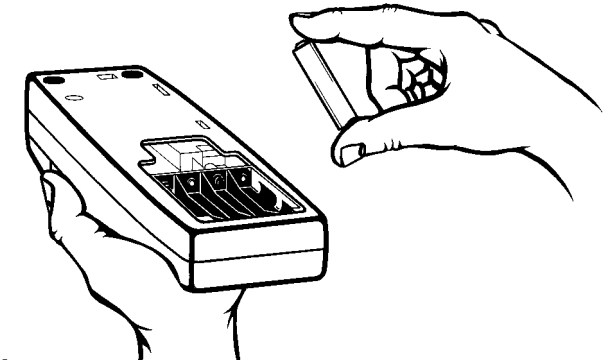
### 1.4.2 Battery Installation

The instrument is shipped without the batteries installed. Before use, install the four AA alkaline batteries (*Figure 3*) or connect the battery eliminator. For battery operation:

1. Remove the battery compartment cover on the instrument bottom.
2. Install the batteries.
3. Correct battery polarity is shown on the battery holder. Reinstall the battery compartment cover.

* Used in place of the dilution water standard when performing a calibration.

**Figure 3 Battery Installation**



### 1.4.3 Using the Battery Eliminator and Rechargeable Batteries

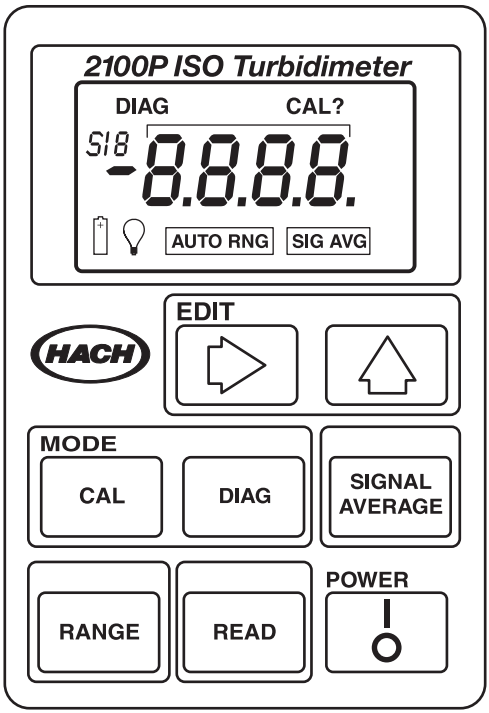
Plug the eliminator jack into the connector on the turbidimeter side. The optional battery eliminator may be used with or without the batteries installed. **The eliminator will not charge batteries.** Rechargeable batteries may be used in the instrument, but must be removed for recharging. See *HOW TO ORDER* on page *62* for ordering information. To prolong battery life, the instrument lamp turns on temporarily when the **READ** key is pressed.

### 1.4.4 Calibration

The 2100P ISO Portable Turbidimeter is calibrated with Formazin Primary Standard at the factory and **does not require recalibration before use.** See *Section 2.4* on page *22* for calibration instructions.

# SECTION 2 OPERATION

## 2.1 Operational Controls and Indicators




| Key | Description |
|---|---|
| I O | Power key turns instrument on and off. If no keys are pressed for 5.5 minutes, the instrument turns off automatically. |
| READ | Performs a measurement. To conserve battery power, the lamp turns on only when **READ** is pressed. A reading is displayed about 12 seconds after the key is pressed. After the reading is displayed, the lamp turns off and the reading continues to be displayed. After a measurement is taken, there is a 4-second recovery time before another can be started. If **READ** is pressed during the recovery time, the display will flash but the lamp will not turn on until the recovery time is complete. If no key strokes occur for 5.5 minutes, the meter turns off.<br><br>Hold this key for continuous reading if the meter is **not** in the Signal Averaging mode. After the initial delay, the reading is updated every 1.2 seconds. |

| Key | Description |
|---|---|
| CAL | Performs a calibration or review calibration data. Also terminates a calibration or calibration review and returns to the 2100P ISO measurement mode. |
|  | Edits a flashing digit in the calibration mode, or scrolls through the calibration standards (S0,S1, S2, S3) or diagnostic menu. |
|  | Moves the editing cursor to the digits being edited in the calibration mode or initiate editing of a standard value. |
| SIGNAL AVERAGE | Turns the signal averaging function on or off. |
| DIAG | Selects the diagnostic mode. |
| RANGE | Scrolls between Auto Range, Manual Range, 0.00–9.99 FNU range, 10–99.9 FNU range, and 100–1000 FNU range. The range selection cannot be changed when a reading or calibration is in progress.<br>When the meter is turned on it defaults to the last used range mode and measurement range. |

| Display Icon | Description |
|---|---|
| **DIAG** | Turns on after **DIAG** is pressed. A number displayed under the DIAG icon (1–9) indicates which diagnostic function is active. See Section 5.1 on page 55 for more information on diagnostic codes. |
| **CAL** | Turns on after **CAL** is pressed and remains on during the calibration. |
| **CAL?** | Appears after calibration if a value entered during calibration is outside an acceptable range. May indicate an operator error or possible instrument malfunction. Flashing **CAL?** indicates the default calibration coefficients are being used (even after a user-calibration has been done) or that no calibration data is currently stored. |
| **S__** | Appears during calibration. The S is followed by a number to indicate which standard value is currently being edited or displayed. The flashing number is prompting user for measurement of **S0**, **S1**, **S2** or **S3** to establish a calibration. Steady number identifies which standard value is being displayed. |
|  | Flashes when the battery voltage drops to 4.4 volts indicating to change batteries. At <4.0 volts, the instrument automatically shuts off. |

| Display Icon | Description |
|---|---|
|  | Appears constantly when the lamp is on and flashes after a reading if a marginal light level reaches the transmitted light detector. When flashing, it indicates the sample may be too turbid (not within measurement range) and needs dilution or the lamp needs replacing. |
| **SIGNAL AVERAGE** | Indicates the signal averaging mode is on. The icon turns off if signal averaging is not selected. |
| **AUTO RNG** | Indicates instrument is in automatic range mode. The icon turns off when manual range mode is selected. |
| **8888** | The 4-digit display is active when the instrument is on (measurements are displayed to three digits). After the **READ** key is pressed **- - - -** is displayed during wait periods. |

## 2.2 Signal Averaging

Signal averaging measures and averages ten measurements while displaying intermediate results. The initial value is displayed after about 11 seconds and the display is updated every 1.2 seconds until all ten measurements are taken (about 22 seconds). Afterwards, the lamp turns off, but the final measured turbidity value continues to be displayed until another key is pressed.

When signal averaging is off, the instrument takes three measurements, the microprocessor averages them, then displays the average. If the **READ** key is held during measurement, the initial value is displayed in 12 seconds and is updated every 1.2 seconds as long as the **READ** key is held.

When the instrument is turned on, the instrument defaults to the signal averaging mode which was used during the last measurement.

## 2.3 Restoring the Default Calibration

To restore and use the default calibration, turn the instrument off. Press and hold **DIAG**, then press and release **I/O**. Release **DIAG** when the software version number disappears from the display. (For models with serial number less than 920300000800, **2100** disappears). This clears any user-entered calibration from memory; the 2100P ISO will use the default calibration for measurement. **CAL?** will appear and continue to flash until a user-entered calibration is successfully completed.

For best results, a user-entered calibration should be done every three months.

## 2.4 Calibration

Calibration of the 2100P ISO Turbidimeter is based on formazin, the primary standard for turbidity. The electronic and optical design provide long-term stability and minimize the need for frequent calibration. The two-detector ratioing system compensates for most fluctuations in lamp output. A formazin recalibration should be performed at least once every three months, more often if experience dictates. When calibration is necessary, use a primary standard such as StablCal™ Stabilized Standards or formazin standards.

**For Hach turbidimeters, use only StablCal® Stabilized Formazin or formazin standards. Hach Company cannot guarantee the performance of the turbidimeter if calibrated with co-polymer styrene divinylbenzene beads or other suspensions.**

***DO NOT*** calibrate with Gelex® Secondary Standards. Gelex standards are designed for instrument verification, not calibration.

### 2.4.1 StablCal Stabilized Formazin Standards*

Most consistent results will be achieved with the use of StablCal® Stabilized Formazin Standards for calibration. Refer to *Section 2.4.1.2* and *Section 2.4.1.3* for information on preparing the standards for use.

Hach StablCal Stabilized Formazin in 20-, 100-, and 800-FNU values is packaged in sets for calibration of the 2100P ISO Turbidimeter. (See *OPTIONAL ACCESSORIES AND REAGENTS* on page *59*.)

#### 2.4.1.1 Storing and Handling StablCal Stabilized Standards

For optimum results when using StablCal Stabilized Standards, adhere to the following recommendations:

- Do not transfer the standard to another container for storage.

* StablCal Stabilized Formazin is cited as a primary standard in Hach Method 8195, an acceptable version of USEPA Method 180.1.

- Do not return standard from the sample cell back into the its original container. Standard contamination will result.
- Store standards between 0 and 25 °C.
- For long-term storage, refrigeration at 5 °C is recommended. Do not store above 25 °C.
- Allow the standard to acclimate to ambient instrument conditions before use (not to exceed 40 °C).
- Store away from direct sunlight. Store vials in their respective kit or shipping box with the cover in place.

#### 2.4.1.2 Preparing Bulk StablCal Stabilized Standards

Bulk standards that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*.

When using <0.1-FNU StablCal Standards, do not shake or invert.

1. Shake the standard vigorously for 2–3 minutes to suspend particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the bottle of StablCal 5 to 7 times.
4. Prepare the sample cell for measurement using traditional preparation techniques. This usually consists of oiling the sample cell (see Section 3.1.1 on page 35) and marking the cell to maintain the same orientation in the sample cell compartment (see Section 3.2.2 on page 39). This step will eliminate any optical variations in the sample cell.
5. Rinse the sample cell at least once with the standard and discard the rinse.
6. Immediately fill the sample cell with the standard. Cap the sample cell and let it stand for one minute. The standard is now ready for use in the calibration procedure, Section 2.4.3 on page 27.

#### 2.4.1.3 Preparing StablCal Stabilized Standards in Sealed Vials

Sealed vials that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*.

When using <0.1-FNU* StablCal Standards do not shake or invert.

1. Shake the standard vigorously for 2–3 minutes to suspend particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the vial of StablCal 5 to 7 times.
4. Prepare the vial for measurement using traditional preparation techniques. This usually consists of oiling the vial (see Section 3.1.1 on page 35) and marking the vial to maintain the same orientation in the sample cell compartment (see Section 3.2.2 on page 39). This step will eliminate any optical variations in the sample vial.
5. Let the vial stand for one minute. The standard is now ready for use in the calibration procedure, Section 2.4.3 on page 27.

### 2.4.2 Formazin Primary Standards

Perform the procedure in Section 2.4.2.1 on page 24 to prepare a 4000-FNU standard, or order a 4000-FNU stock solution (Cat. No. 2461-49). Prepare the dilutions from the 4000-FNU stock solution by following the instructions in Section 2.4.2.4 on page 26.

#### 2.4.2.1 Preparing Formazin Stock Solution

Dilute formazin standard solutions from a 4000 FNU stock solution equivalent to Hach Cat. No. 2461-49. The prepared stock solution is stable for up to one year when properly prepared. An alternative to purchasing the 4000 FNU stock solution is preparing a stock solution as follows:

1. Dissolve 5.000 grams of reagent grade hydrazine sulfate ($N_2H_4 \cdot H_2SO_4$) in 400 mL of distilled water.
2. Dissolve 50.000 grams of pure hexamethylenetetramine in 400 mL of distilled water.

3. Pour the two solutions into a 1000-mL volumetric flask and dilute to the mark with distilled water.
4. Let the solution stand for 48 hours at 25 °C (77 °F) to develop the 4000-FNU stock suspension. The standing temperature is critical for correct formation of formazin polymers.
5. Mix the 4000 FNU suspension for at least ten minutes before use. Then it can be diluted with distilled or demineralized water to achieve a solution of the desired FNU value.

Instead of diluting a formazin stock solution, StablCal Stabilized Formazin Standards may be used. (See *OPTIONAL ACCESSORIES AND REAGENTS* on page *59*.)

#### 2.4.2.2 Correcting for Turbidity of Dilution Water

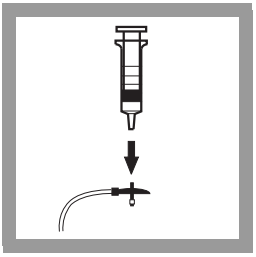
The 2100P ISO Turbidimeter automatically compensates for turbidity contributed by dilution water when calculating the true value of the lowest formazin standard. Use high quality distilled or deionized water less than 0.5 FNU. The instrument will display “E 1” after calibration if the dilution water turbidity is greater than 0.5 FNU. In this case, prepare the water as directed below.

The value of the dilution water can be arbitrarily forced to zero using the calibration procedure (see step 4 on page 31 ). This is not recommended for most applications and, if done, should be done only if the dilution water turbidity is less than 0.2 FNU.

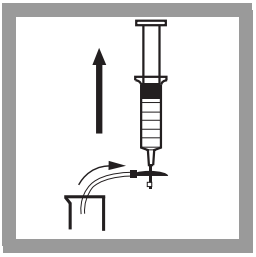
#### 2.4.2.3 Preparing Dilution Water

***Note:*** *Use the same dilution water for all dilutions and the sample blank.*

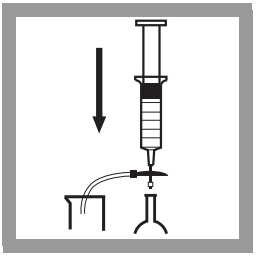
Collect at least 1000 mL of high quality dilution water (distilled or deionized water). The 2100P ISO Turbidimeter, as received from the factory, is precalibrated and may be used to check the dilution water turbidity. If the turbidity is greater than 0.5 FNU, filter the water with the Sample Filtration and Degassing Kit (Cat. No. 43975-10) or equivalent. When measuring low range turbidity, clean all glassware with 1:1 hydrochloric acid and rinse several times with dilution water. If the glassware is not used immediately, use stoppers to prevent contamination from small particles.



**1.** Attach the syringe to the 3-way valve by gently twisting the square end into the syringe tip. Attach the connector, tubing and a 0.2 micron filter (clear part faces syringe) as shown. Be sure the connections are tight.



**2.** Fill a beaker or container with the water to be filtered. Insert the tubing into the container. Slowly draw the 50 mL of water into the syringe by pulling up on the syringe plunger.



**3.** Slowly push on the plunger to force the water through the filter and into a graduated cylinder or volumetric flask. Repeat Steps 1–3 until the desired amount of water is obtained.

***Note:*** *As the filter clogs, it gets more difficult to push water through it. Discard the filter and attach a new filter.*

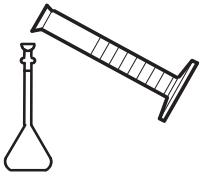
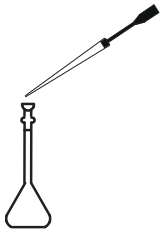
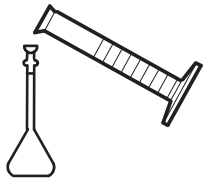
#### 2.4.2.4 Preparing Formazin Dilutions (Factory recommended)

Use 20, 100, and 800 FNU formazin standards for calibrating the 2100P ISO Turbidimeter. Dilutions with other FNU values can be prepared and used (see Section 2.4.3.1 on page 30). If problems occur when using alternate solutions, use the dilutions specified here.

Prepare all formazin dilutions immediately before use and discard after calibration. The 4000 FNU solution is stable for up to a year, but dilutions deteriorate more rapidly. Use the same high quality water (turbidity <0.5 FNU) for the dilutions and the blank.

### Preparing the 20, 100 and 800 FNU standards

**Table 1 Formazin Standard Preparation**

| | Step 1 | Step 2 | Step 3 |
|---|---|---|---|
| **Standards** |  |  |  |
| 20 FNU | Add 100 mL of dilution water to a clean **200-mL** Class A volumetric flask. | With a TenSette1 pipet, add 1.00 mL of well-mixed 4000 FNU Formazin stock solution to the 200-mL flask. | Dilute to the mark with dilution water. Stopper and mix. |
| 100 FNU | Add 100 mL of dilution water to a clean **200-mL** Class A volumetric flask. | With a TenSette pipet, add 5.00 mL of well-mixed 4000 FNU Formazin stock solution to the 200-mL flask. | Dilute to the mark with dilution water. Stopper and mix. |
| 800 FNU | Add 50 mL of dilution water to a clean **100-mL** Class A volumetric flask. | With a TenSette pipet, add 20.00 mL of well-mixed 4000 FNU Formazin stock solution to the 100-mL flask. | Dilute to the mark with dilution water. Stopper and mix. |

1 A Class A volumetric pipet may be used in place of a TenSette Pipet.

## 2.4.3 Calibrating the Turbidimeter

**NOTES**

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ**, **I/O**, **UP**, and **RIGHT** keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If "E1" or "E2" are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (E1 or E2). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If "CAL?" is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.
- To review a calibration, press **CAL** and then **UP** to view the calibration standard values. As long as **READ** is never pressed and CAL is not flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

***Note:*** *For accuracy, use the same sample cell or four matched sample cells for all measurements during calibration. Always insert the cell so the orientation mark placed on the cell during the matching procedure is correctly aligned. (See Section 3.2.3 on page 41 for matching sample cells).*

Use only StablCal® Stabilized Formazin or formazin standards for calibration. Turbidimeter performance is not guaranteed if calibrated with co-polymer styrene divinylbenzene beads or other suspensions. **DO NOT** calibrate with Gelex® Secondary Standards.

1. Rinse a clean sample cell several times with dilution water. Fill the cell to the line (about 15 mL) with dilution water or use StablCal <0.1 FNU standard.

   ***Note:*** *The same dilution water used for preparing the standards must be used in this step.*

2. Insert the sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid. Press **I/O**.

3. Choose signal average mode option (on or off) before pressing **CAL**. The **SIGNAL AVERAGE** key is not functional in calibration mode.

4. Press **CAL**. The CAL and S0 icons will appear (the 0 will flash). The 4-digit display will show the value of the S0 standard for the previous calibration. If the blank value was forced to 0.0, the display will be blank. Press the **RIGHT** key to get a numerical display.

5. Press **READ**. The meter will count from 60 to 0, (67 to 0 if signal average is on), read the blank, and use it to calculate a correction factor for the 20 FNU standard measurement. If the dilution water is ³ 0.5 FNU, E1 will appear when the calibration is calculated (See Section 2.4.2.3 on page 25 for more dilution water information). The display will automatically increment to the next standard.

6. Remove the sample cell from the cell compartment.

   The turbidity of the dilution water can be "forced" to zero by pressing the **RIGHT** key rather than reading the dilution water. The display will show "S0 FNU". Press the **UP** key to continue with the next standard.

7. The display will show "S1" (with the 1 flashing) and 20 FNU or the value of the S1 standard for the previous calibration. If the value is incorrect, edit using the arrow keys.

8. Fill a clean sample cell to the line with well mixed 20 FNU StablCal Standard or 20 FNU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

9. Press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard.

10. Remove the sample cell from the cell compartment.

11. The display will show "S2" (with the 2 flashing) and "100 FNU" or the value of the S2 standard for the previous calibration. If the value is incorrect, edit using the arrow keys.

12. Fill a clean sample cell to the line with well mixed 100 FNU StablCal Standard or 100 FNU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

13. Press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity, and store the value. The display will automatically increment to the next standard.

14. Remove the sample cell from the cell compartment.

15. The display will show “S3” (with the 3 flashing) and “800 FNU” or the value of the S3 standard for the previous calibration. If the value is incorrect, edit using the arrow keys.

16. Fill a clean sample cell to the line with well mixed 800 FNU StablCal Standard or 800 FNU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

17. Press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will increment back to the S0 display. Remove the sample cell from the cell compartment.

18. Press **CAL** to accept the calibration. The instrument will return to measurement mode automatically.

    ***Note:*** *If calibration errors occurred during calibration, error messages will appear after CAL is pressed (See Section 5.4 on page 57).*

#### 2.4.3.1 Preparing User-selected Formazin Dilutions

The formazin solutions should span the entire range of the instrument. Hach recommends preparing three standards:

- 10–30 FNU
- 90–110 FNU
- 700–900 FNU

**The standards must have a difference of at least 60 FNU.**
In addition, a blank made from the dilution water should be prepared.

Prepare the formazin standard solutions from the well mixed 4000 FNU stock solution as specified in Section 2.4.2.4 on page 26 and dilution water as specified in *Section 2.4.2.2* and Section 2.4.2.3 on page 25. Make the standards **immediately** before use and discard them after calibration is done.

### 2.4.3.2 Calibrating with User-selected Standards

For accuracy, use the same sample cell or four matched sample cells for all measurements during calibration. Always insert the sample cell with the same orientation.

1. Fill a clean sample cell to the line (about 15 mL) with dilution water.

   ***Note:*** *The same dilution water used for preparing the standards must be used in this step.*

2. Insert the sample cell into the cell compartment and close the lid. Press **I/O**.

3. Choose signal average mode option (on or off) before pressing **CAL**. The **SIGNAL AVERAGE** key is not functional in calibration mode.

4. Press **CAL**. The CAL and S0 icons will appear (the "0" will flash). The 4-digit display will show the value of the S0 standard for the previous calibration.

5. Press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the blank and use it to calculate a correction factor for the lowest standard. If the dilution water is ³ 0.5 FNU, "E1" will appear (see Section 2.4.2.3 on page 26 for more dilution water information). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

6. Thoroughly mix the 10 to 30 FNU range standard, then fill a clean sample cell to the line with the standard. Insert the sample cell into the cell compartment.

7. The display will show the S1 icon (with the "1" flashing) and 20 FNU or the value of the S1 standard for the previous calibration.

8. Edit the standard concentration using the arrow keys.

9. Press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard.

10. Remove the sample cell from the cell compartment.

11. Thoroughly mix the 90 to 110 FNU standard, then fill a clean sample cell to the line with the standard.

**12.** Insert the cell into the cell compartment.

**13.** The display will show the S2 icon (with the 2 flashing) and 100 FNU or the value of the S2 standard for the previous calibration.

**14.** Edit the standard concentration using the arrow keys.

**15.** Press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Remove the sample cell from the cell compartment.

**16.** Thoroughly mix the 700 to 900 FNU standard, then fill a clean sample cell to the line with the standard. Insert the cell into the cell compartment.

**17.** The display will show the S3 icon (with the "3" flashing) and 800 FNU or the value of the S3 standard for the previous calibration.

**18.** Edit the standard concentration using the arrow keys.

**19.** Press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The instrument will increment back to S0. Remove the sample cell from the cell compartment.

**20.** Press **CAL**. The instrument will store the new calibration data and return the instrument to the measurement mode.

***Note:*** *If calibration errors occurred during calibration, error messages will appear after CAL is pressed.*

### 2.4.4 Using Gelex® Secondary Turbidity Standards

***Note:*** *Store Gelex standards at room temperature. Do not allow to freeze or exceed 50 °C.*

Gelex Secondary Standards (included with 4474000 only) are particulate suspensions similar to formazin primary standards in light scattering characteristics. FNU values on the Gelex standards indicate the range for which they should be used. Due to minor variations in glass and individual instrument optical systems, the true value of the Gelex standards must be determined against formazin in the same instrument they will be used with for later calibration checks.

### 2.4.4.1 Assigning Values to Gelex Standards

***Note:*** *Correct cell orientation is essential to obtain accurate Gelex values. Always orient the cell so the diamond mark aligns with the orientation mark on the instrument.*

1. Calibrate the instrument with formazin.
2. Select automatic range mode using the **RANGE** key.
3. Thoroughly clean the outside of the Gelex vials and apply a thin coat of silicone oil.
4. Place the 0–10 FNU Gelex standard in the cell compartment so the diamond on the vial aligns with the orientation mark on the instrument. Close the lid.
5. Press **READ**. Record the value, remove the vial from the instrument and mark the value on the band near the top of the vial.
6. Repeat steps 3–5 for other Gelex standards. Reassign values tot he Gelex standards each time the meter is calibrated with formazin.

### 2.4.4.2 Routine Calibration Check With Gelex® Standards

The 2100P ISO Turbidimeter does not require standardization before every measurement as some turbidimeters do. Periodically, as experience dictates, check the instrument calibration using the appropriate Gelex Secondary Standard. Be sure the Gelex standards are aligned correctly when inserting them (diamond aligns with orientation mark). If the reading is not within 5% of the previously established value, recalibrate the instrument with StablCal Stabilized Formazin Primary Standard or formazin primary standard (Section 2.4.3 on page 27).

***DO NOT*** calibrate with Gelex Secondary Standards. Gelex standards are designed for instrument verification, not calibration.

# SECTION 3 TURBIDITY MEASUREMENT

## 3.1 Turbidity Measurement

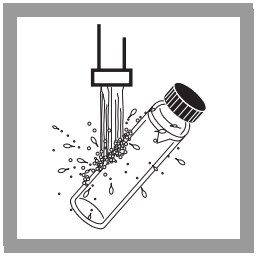
Measurements may be made with the signal average mode on or off and in manual or automatic range selection mode (Section 2.2 on page 21).

With signal average mode off, the final value is displayed after approximately 12 seconds.

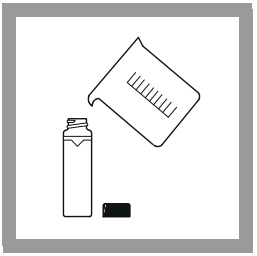
Accurate turbidity measurement depends on good measurement technique by the analyst, such as using clean sample cells in good condition and removing air bubbles (degassing). Refer to Section 3.2 on page 38 for a detailed discussion of measurement techniques.

Place the instrument on a flat, sturdy surface during measurements.

### 3.1.1 Turbidity Measurement Procedure

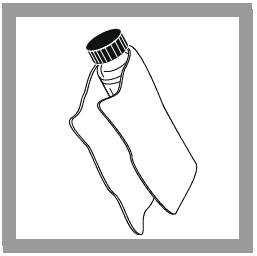


**1.** Thoroughly clean the sample cell.

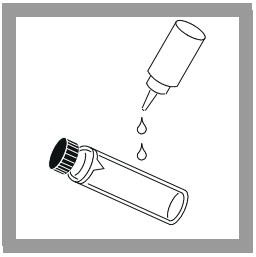


**2.** Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 mL), taking care to handle the sample cell by the top. (See Section 3.2 on page 38 for more information about collecting a representative sample).

Cap the cell.

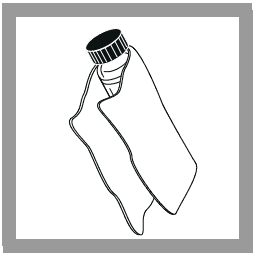


**3.** Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints.



**4.** Apply a thin film of silicone oil. Wipe with a soft, lint-free cloth to obtain an even film over the entire surface.

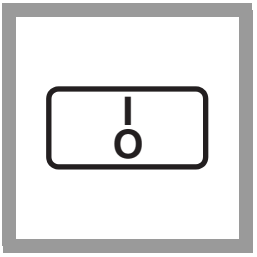
***Note:*** *Applying a thin coat of silicone oil will mask minor imperfections and scratches which may contribute to turbidity or stray light. Use silicone oil equivalent to Hach Cat. No. 1269-36, which has the same refractive index as glass.*



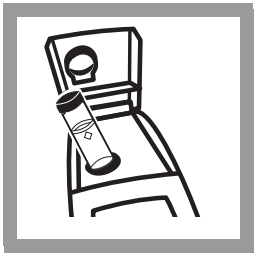
**5.** Wipe off the excess so that only a thin coat of oil is left. Excess oil may retain dirt and contaminate the instrument cell compartment.

The cell should appear nearly dry with little or no visible oil.

***Note:*** *Soft, lint-free cloth (velvet) works well for oiling. Store the oiling cloth with the sample cells and keep it free of dirt. After a few applications of oil, the cloth will contain enough residual oil that simply wiping the cell with the oiled cloth will provide a sufficient oil coat on the sample cell. Periodically, add a small amount of oil to the sample cell surface to replenish the oil in the cloth.*



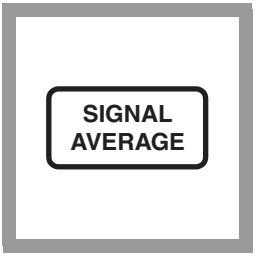

**6.** Press: **I/O**.



**7.** Insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment.
**Close the lid.**




**8.** Press: **RANGE**. Select mannual or automatic range mode.




**9.** Press: **SIGNAL AVERAGE**.




**10.** Press: **READ**

The display will show "- - - -", then the turbidity in FNU. Record the turbidity after the lamp symbol turns off.

***Note:*** *The instrument defaults to the last operating mode selected. If automatic range mode and signal averaging were used on the previous measurements, these options will automatically be selected for subsequent samples.*

### 3.1.2 Measurement Notes

- Always cap the sample cell to prevent spillage of sample into the instrument.
- When taking a reading, place the instrument on a level, stationary surface. It should not be held in the hand during measurement.
- Always close the sample compartment lid during measurement and storage.
- Always use clean sample cells in good condition. Dirty, scratched, or damaged cells can cause inaccurate readings.
- Do not leave a sample cell in the cell compartment for extended periods of time. This may compress the spring in the cell holder.
- Remove sample cell and batteries from instrument if the instrument is stored for extended time period (more than a month).
- Avoid operating in direct sunlight.
- Make certain cold samples do not “fog” the sample cell.
- Avoid settling of sample prior to measurement.
- Keep sample compartment lid closed to prevent dust and dirt from entering.

## 3.2 Measurement Techniques

Proper measurement techniques are important to minimize the effects of instrument variation, stray light, and air bubbles. Regardless of the instrument used, measurements are more accurate, precise, and repeatable if the analyst pays close attention to proper measurement techniques.

Measure samples immediately to prevent temperature changes and settling. Avoid sample dilution when possible. Particles suspended in the original sample may dissolve or otherwise change characteristics when the sample temperature changes or when the sample is diluted, resulting in a non-representative sample measurement.

### 3.2.1 Cleaning Sample Cells

Cells must be extremely clean and free from significant scratches. The glass used to make cells is easily scratched – manufacturing cells free of minor scratches and other imperfections is difficult. However, minor imperfections are effectively masked by applying silicone oil as outlined in Section 3.1.1 on page 35.

Clean the inside and outside of the cells by washing with laboratory detergent. Follow with multiple rinses of distilled or deionized water. Allow cells to air dry. Handle cells only by the top to minimize dirt, scratches, and fingerprints in the light path.

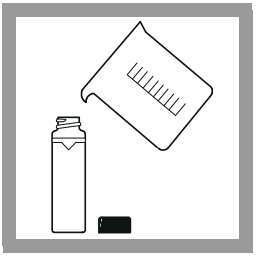
### 3.2.2 Orienting Sample Cells

***Note:*** *When orienting and matching cells, it may be more efficient to use the continuous reading mode. The instrument performs continuous readings if the* **READ** *key is pressed and held. As long as the key is held, the lamp remains on and the display is updated every 1.2 seconds. The instrument cannot be used in continuous read mode if the signal averaging mode is on.*

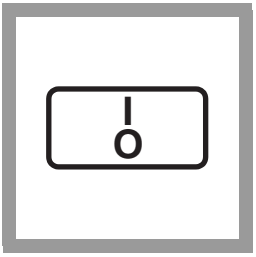
Precise measurements for very low turbidity samples require using a single cell for all measurements or optically matching the cells. Using one cell provides the best precision and repeatability. When one cell is used, an orientation mark (other than the factory-placed diamond) can be placed on the cell so that it is inserted into the instrument with the same orientation each time.

#### 3.2.2.1 Orienting a Single Cell

When using a single cell, make an index or orientation mark on the cell as follows:



**1.** Fill the clean sample cell to the line with high quality water (< 0.5 FNU). Cap and wipe with lint-free cloth. Apply silicone oil. See Section 2.4.2.2 on page 25 for more information about high quality water.




**2.** Press: **I/O**.



**3.** Insert the sample cell into the sample compartment. Close the cover.




**4.** Press: **READ**

Record the cell position in the compartment and the displayed reading.

***Note:*** *This procedure may be easier if the user holds the* **READ** *key through the whole process. This allows the lamp to remain on and make continuous readings.*



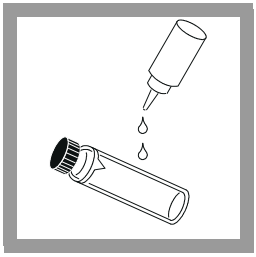
**5.** Remove the cell, rotate it slightly and reinsert it into the cell compartment. Close the cover, then press **READ**. Record the cell position and the displayed reading.



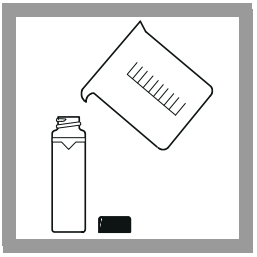
**6.** Repeat *step 5* until the lowest reading is displayed. Place an orientation mark on the cell marking band near the top of the cell so the cell can be consistently inserted in the position that yields the lowest reading. When using the cell, always place it in the instrument so the orientation mark aligns with the raised mark on the instrument.

### 3.2.3 Matching Multiple Sample Cells

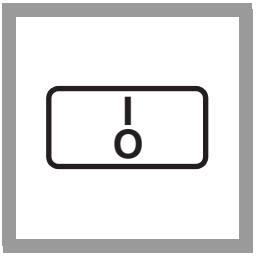
Precise measurements of very low turbidity samples require the cells be optically matched or a single cell be used for all measurements. If more than one cell is used, follow this procedure to match (index) the cells:



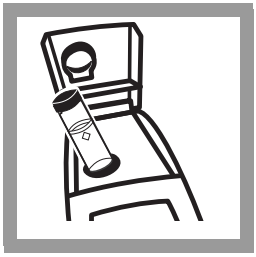
**1.** Clean and oil the sample cells as instructed in Section 3.1.1 on page 35.



**2.** Fill the clean sample cells to the line with the same sample.




**3.** Press: **I/O** to turn the instrument on.



**4.** Insert the **first** sample cell into the sample compartment and close the cover.




**5.** Press: **READ**

Record the cell position in the compartment and the displayed reading. Place an orientation mark on the cell marking band.

***Note:*** *This procedure may be easier if the user holds the* **READ** *key through the whole process. This allows the lamp to remain on and make continuous readings.*



**6.** Insert the **second** sample cell into the cell compartment and close the cover.




**7.** Press: **READ**

Record the cell position in the compartment and the displayed reading.



**8.** Remove the cell, rotate it slightly and reinsert into the cell compartment. Close the cover, then press **READ** again. Record the cell position and the displayed reading.



**9.** Repeat *step 8* until the value displayed for the second cell is within 0.01 FNU (or 1%) of the value obtained for the first cell. Place an orientation mark on the second cell marking band so it is consistently inserted in this position.

***Note:*** *Due to variability in glass, it may not be possible to match all cells.*



**10.** Repeat *step 6* through *step 9* if matching other sample cells.

### 3.2.4 Removing Bubbles (Degassing)

Before measurement, removing air and other trapped gasses from the sample is strongly recommended, even if bubbles are not visible. Four degassing methods are commonly used:

- Applying a partial vacuum.
- Adding a surfactant.
- Using an ultrasonic bath.
- Heating the sample.

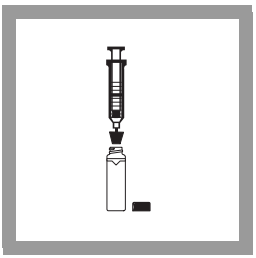
In some cases, more than one method may be necessary for effective bubble removal. For example, use of both a surfactant and ultrasonic bath may be necessary for some severe conditions. Use care with these techniques. If misused, sample turbidity can be altered.

Letting the sample stand for a period of time to remove air bubbles is not recommended. Particulates that cause turbidity may settle and the sample temperature may change, resulting in measurements not representative of the original turbidity.

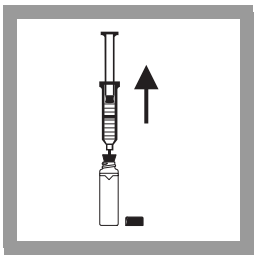
#### 3.2.4.1 Application of a Partial Vacuum

The vacuum lowers the atmospheric pressure, allowing trapped bubbles to escape into the air above the sample. Vacuum works well with non-viscous samples (such as water) that do not contain volatile components. Applying vacuum to viscous, volatile samples (paint resins) may cause the volatile components to come out of solution and aggravate the bubble problem.

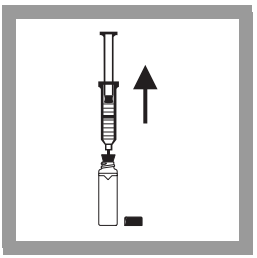
To apply a vacuum, use a sample degassing kit equivalent to Cat No. 43975-00 (Degassing Kit) or 43975-10 (Degassing and Filtration Kit). These kits contain a syringe and rubber stopper for vacuum degassing. An electric or hand-operated pump equivalent to Cat. No. 14283-00 may also be used.



**1.** Fill a sample cell to the mark with sample. Insert a #2 single-hole rubber stopper and syringe into the cell. If using a pump, insert a piece of glass tubing into the stopper.



**2.** **Slowly** apply the vacuum by carefully pulling the plunger upward, then holding it. If using a hand or electric pump, connect the tubing to the vacuum pump with vacuum hose. Apply vacuum until visible gas bubbles disappear.



**3.** **Slowly** release the vacuum. Remove the vacuum apparatus and cap the cell.

### 3.2.4.2 Adding a Surfactant

Surfactants should be limited to severe problems when other degassing methods are ineffective. This technique is very effective when the water is super-saturated with air. Surfactants change the surface tension of the water, which releases trapped gases.

1. Add one drop of a surfactant (Triton X-100, Cat. No. 14096-32 or equivalent) to the sample cell.
2. Add sample.

***Note:*** *Any turbidity contributed by surfactant addition is negligible.*

3. Mix the sample gently but thoroughly, and analyze as soon as possible after adding the surfactant.
4. Rinse the sample cells thoroughly between samples to prevent surfactant accumulation.

### 3.2.4.3 Using an Ultrasonic Bath

Ultrasonic baths effectively remove gas bubbles from most samples, especially viscous liquids. However, the ultrasonic waves which cause degassing may also alter the characteristics of the particles causing the turbidity. Turbidity depends on the size, shape, composition and

refractive index of the suspended particles. Excessive ultrasound application may alter particle size and shape, thus changing sample turbidity. In some cases, ultrasound may impede air bubble removal by fracturing the bubbles, making degassing more difficult.

The basic procedure for an ultrasonic bath is:

1. Fill a clean sample cell to the line with sample. Leave uncapped.
2. Immerse the cell ($^1/_2$ to $^2/_3$ immersed) in an ultrasonic bath and allow it to stand until visible bubbles are expelled.
3. Remove the cell and replace the cap. Thoroughly dry the cell. Apply silicone oil as directed in Section 3.1.1 on page 35.

The time necessary to expel bubbles may vary from a few seconds to a minute or more. To avoid excessive application of ultrasound:

1. Apply ultrasound until all visible bubbles are absent.
2. Measure the sample turbidity.
3. Apply ultrasound for a short time period and again measure turbidity.
4. Continue for several repetitions, noting the treatment time and turbidity readings.

If turbidity begins to increase instead of decrease, the ultrasound waves have probably started to alter the suspended particles. Note the time it takes for this to occur and record it as the maximum time limit for ultrasonic treatment.

#### 3.2.4.4 Application of Heat

Gentle heating may be helpful for degassing some very viscous samples when combined with application of vacuum or ultrasound. Heat may change the characteristics of the suspended particles and cause volatile components to come out of solution. If heat is necessary, heat the sample only until degassing occurs.

1. Prepare a warm water bath and partially immerse the filled sample cell.
2. Use the shortest time necessary for expelling visible bubbles.
3. Cool sample to original sample temperature before taking measurements.

### 3.2.5 Measuring Overrange Samples

Nephelometric turbidity measurement depends on detection of light scattered from particles suspended in the liquid. If the turbidity is very high, a significant amount of light is blocked or absorbed by the particles and only a small amount of light reaches the detector. The measured turbidity is then lower than the actual turbidity (negative interference). This condition is called “going blind”. The 2100P ISO Turbidimeter minimizes this effect and extends the instrument range. Dilution of highly turbid samples should be avoided since it may alter the characteristics of the suspended particles and produce erroneous results.

Light-absorbing particles such as activated carbon and highly colored samples may also cause an instrument to “go blind”. Dilution may not correct for these interferences. The 2100P ISO will correct for the presence of light absorbing particles and color.

### 3.2.6 Condensation (Fogging)

Condensation may occur on the outside of the sample cell when measuring a cold sample in a warm, humid environment. Condensation interferes with turbidity measurement, so wipe moisture off of the sample cell before measurement. If fogging recurs, let the sample warm slightly at room temperature, or immerse in a warm bath for a short period. After warming, mix the sample thoroughly before measurement. Warming samples can alter sample turbidity, so avoid warming before measurement if possible.

### 3.2.7 Representative Sampling

A representative sample accurately reflects the condition of the water source from which the sample was taken. To ensure a representative sample, gently but thoroughly mix every sample before aliquots are taken. Do not allow the sample to settle.

When sampling from a tap in a distribution system or treatment plant, allow the water to run for at least five minutes before sampling. When sampling from a stream, reservoir, clarifier, or storage tank, collect at least one liter (l quart) and thoroughly mix before measurement. If the water source is not uniform, it may be necessary to sample several locations at varying depths and combine the samples into a single, well-mixed composite sample before measurement.

# MAINTENANCE

**Some of the following manual sections contain information in the form of warnings, cautions and notes that require special attention. Read and follow these instructions carefully to avoid personal injury and damage to the instrument. Only personnel qualified to do so, should conduct the maintenance tasks described in this portion of the manual.**

**Certains des chapitres suivants de ce mode d'emploi contiennent des informations sous la forme d'avertissements, messages de prudence et notes qui demandent une attention particulière. Lire et suivre ces instructions attentivement pour éviter les risques de blessures des personnes et de détoriation de l'appareil. Les tâches d'entretien décrites dans cette partie du mode d'emploi doivent être seulement effectuées par le personnel qualifié pour le faire.**

**Algunos de los capítulos del manual que presentamos contienen muy importante información en forma de alertas, notas y precauciones a tomar. Lea y siga cuidadosamente estas instrucciones a fin de evitar accidentes personales y daños al instrumento. Las tareas de mantenimiento descritas en la presente sección deberán ser efectuadas únicamente por personas debidamente cualificadas.**

**Einige der folgenden Abschnitte dieses Handbuchs enthalten Informationen in Form von Warnungen, Vorsichtsmaßnahmen oder Anmerkungen, die besonders beachtet werden müssen. Lesen und befolgen Sie diese Instruktionen aufmerksam, um Verletzungen von Personen oder Schäden am Gerät zu vyyyermeiden. In diesem Abschnitt beschriebene Wartungsaufgaben dürfen nur von qualifiziertem Personal durchgeführt werden.**

**Algumas das seguintes secções do manual contêm informações em forma de advertências, precauções e notas que requerem especial atenção. Leia e siga atentamente as presentes instruções para evitar ferimentos pessoais e não danificar o instrumento. As tarefas de manutenção descritas nesta parte do manual só poderão ser executadas por pessoal qualificado.**

# SECTION 4 MAINTENANCE

## 4.1 Cleaning

Keep the turbidimeter and accessories as clean as possible and store the instrument in the carrying case when not in use. Avoid prolonged exposure to sunlight and ultraviolet light. Wipe spills promptly. Wash sample cells with non-abrasive laboratory detergent, rinse with distilled or demineralized water, and air dry. Avoid scratching the cells and wipe all moisture and fingerprints off the cells before inserting them into the instrument. Failure to do so can give inaccurate readings.
See Section 3.2.1 on page 39 for more information about sample cell care.

## 4.2 Battery Replacement

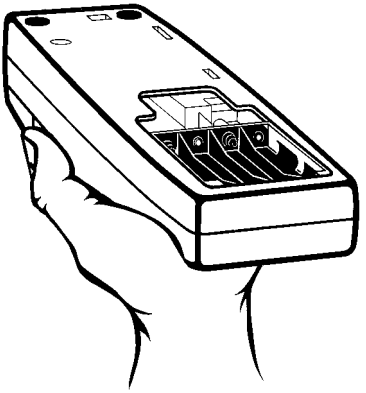
AA alkaline cells typically last for about 300 tests with the signal averaging mode off, about 180 tests if signal averaging is used.
The “battery” icon flashes when battery replacement is needed. Refer to Section 1.4.2 on page 17 for battery installation instructions. If the batteries are changed within 30 seconds, the instrument retains the latest range and signal average selections. If it takes more than 30 seconds, the instrument uses the default settings.

If the instrument will not turn off or on after changing batteries, and the batteries are good, remove the batteries and reinstall them. If the meter still does not function, contact Hach Service or the nearest authorized dealer.

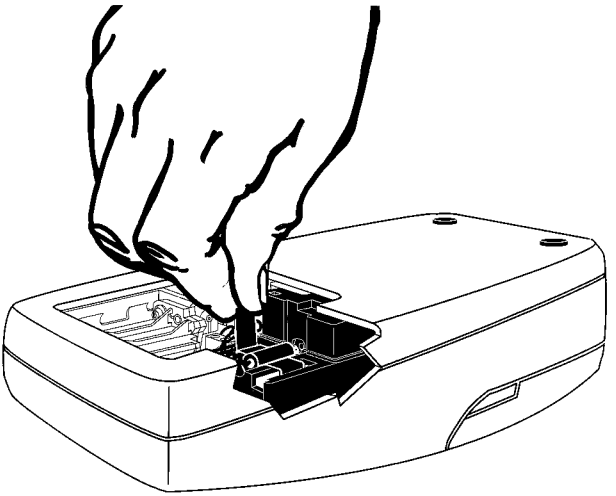
## 4.3 Lamp Replacement

The procedure below explains lamp installation and electrical connections. Use a small screwdriver to remove and install the lamp leads in the terminal block. The instrument requires calibration after lamp replacement.

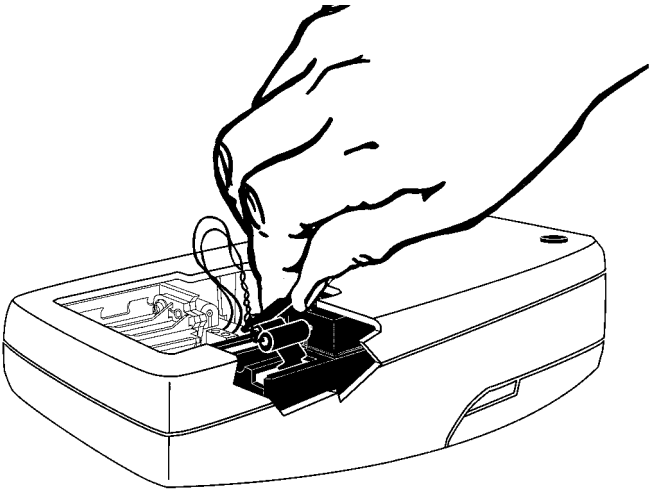
**1.** Orient the instrument so it is upside down and the top faces away from you. Remove the battery cover and at least one battery.



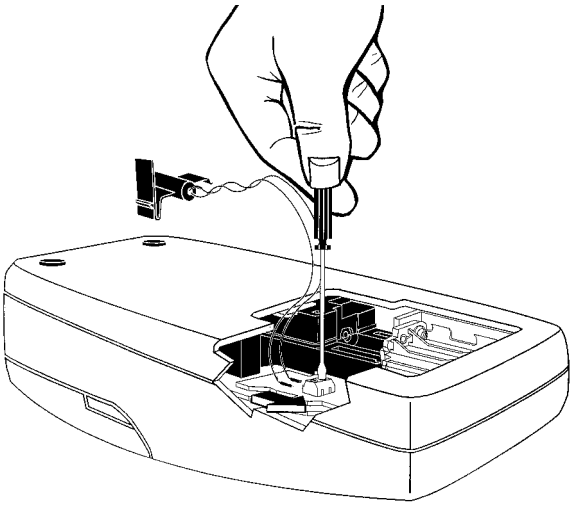
**2.** Remove the lamp assembly by grasping the tab on the left side of the assembly. Firmly, but gently, slide the assembly towards the rear of the instrument.



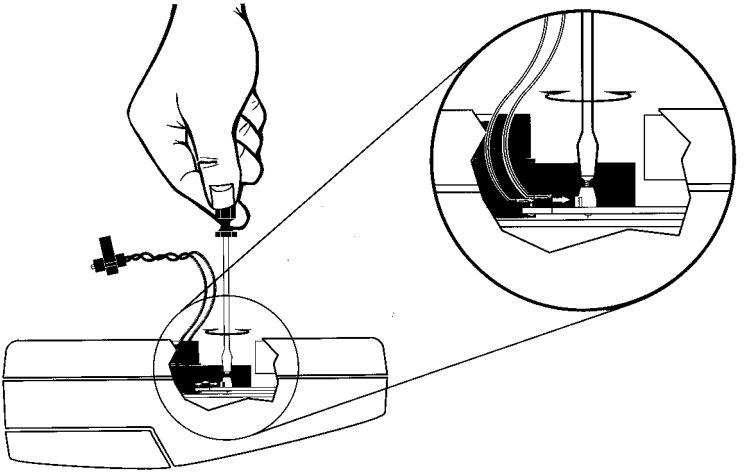
**3.** Rotate the tab towards the nearest outside edge. The assembly should release and slip out easily.



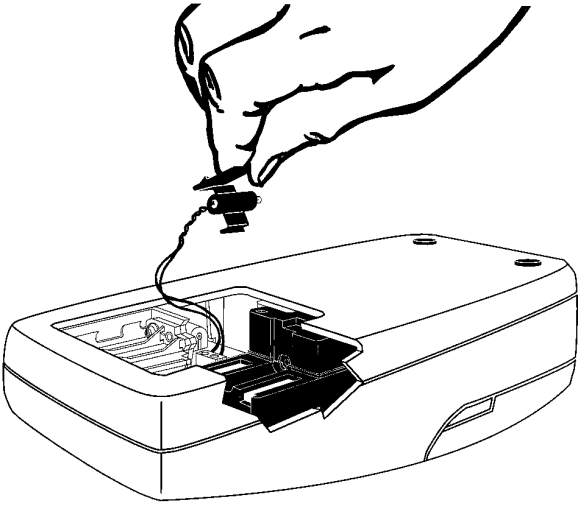
**4.** Back the terminal block screws **partially** out (1 to 2 turns) and remove the old lamp leads.



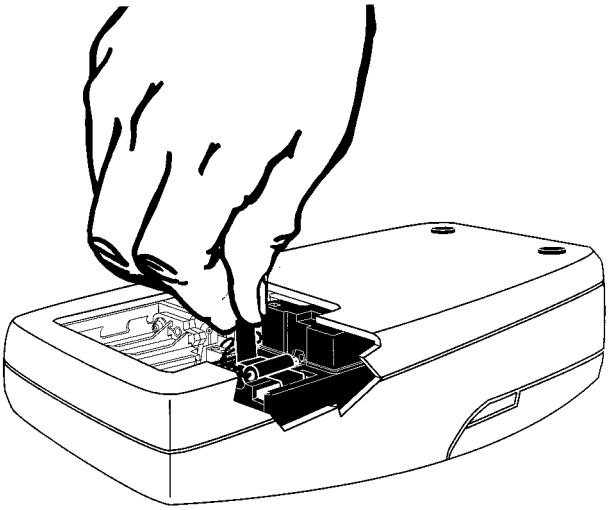
**5.** Gently bend the wires of the new lamp assembly into an "L" shape so they fit easily into the housing. Insert the leads into the terminal screws and tighten with clockwise turns. Gently tug on the wires to make sure they are connected to the terminal block.



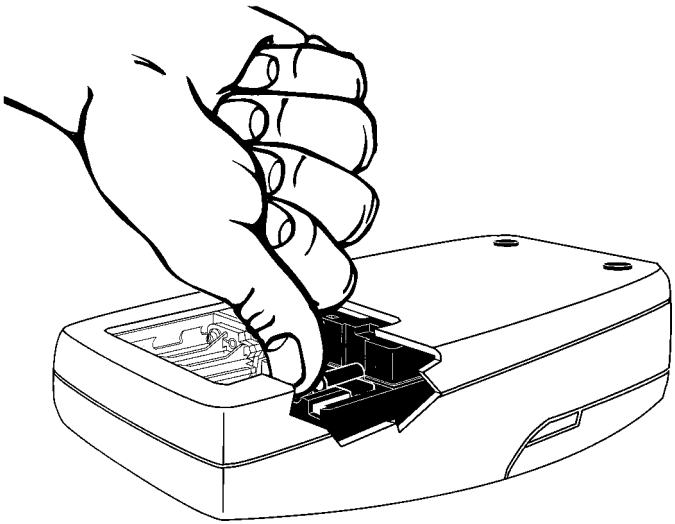
**6.** Hold the new lamp assembly by the tab with the lamp facing the tope (keyboard) of the instrument. Slide the small catch on the other side of the assembly into the black plastic slot (towards the nearest edge of the instrument).



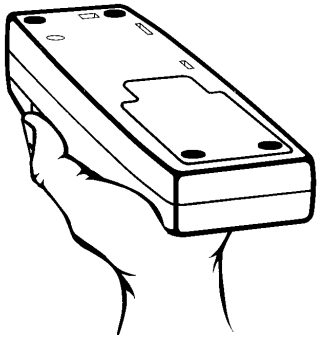
**7.** Snap the U-shaped bottom of the tab into the slot on the left side of the black plastic that holds the lamp assembly.



**8.** With your thumb, firmly slide the assembly forward until it stops. Again, push firmly against the tab to make sure the lamp is seated correctly.

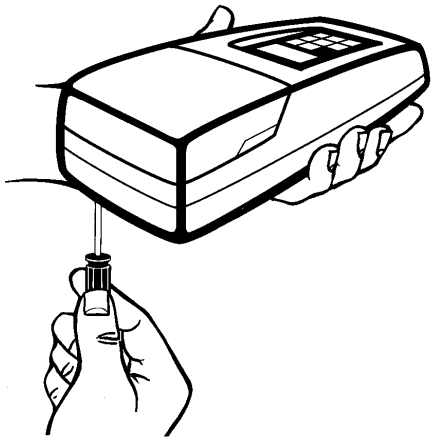


**9.** Replace the batteries and battery cover.



**10.** Insert the 800 FNU formazin standard into the sample cell. Press and hold **READ**. Then press **I/O**. Release the **READ** key after the software version number disappears from the display (for models with serial numbers less than 920300000800, **2100** disappears).

**11.** Adjust the scattered light amplifier output by inserting a small flat-blade screwdriver into the trimpot hole (located on bottom). Adjust the display to read 2.5 ± 0.3 volts (2.0 volts for models that display **2100** when turned on).



**12.** Press **I/O** to exit gain adjust mode.

**13.** Perform a formazin calibration according to Section 2.4.2 on page 24 or Section 2.4.2.4 on page 26.

# SECTION 5 TROUBLESHOOTING

## 5.1 Using the Diagnostic Functions Key

Enter the diagnostic mode by pressing the **DIAG** key. Exit this mode at any time by pressing the key again. The diagnostic mode allows access to information about instrument function which may be useful for servicing and troubleshooting.

### 5.1.1 Basic Diagnostic Codes

**Diagnostic Codes**

| Code | Description |
|---|---|
| 1 | Checks the battery voltage with the lamp on, then with the lamp off. This is a dual diagnostic code. |
| 2 | Displays calibration coefficient $a_o$ |
| 3 | Displays calibration coefficient $a_1$ |
| 4 | Displays calibration coefficient $b_o$ |
| 5 | Displays calibration coefficient $b_1$ |
| 6 | Displays the lamp voltage (about 3 volts) |
| 7 | Displays the dark voltage of the transmitted light detector amplifier with the lamp off and the detector amplifier voltage with the lamp on. |
| 8 | Displays the high gain dark voltage of the 90° detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.1 |
| 9 | Displays the low gain dark voltage of the 90° detector amplifier with the lamp off and the detector amplifier voltage with the lamp on. |

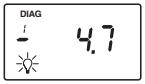
1 Samples with turbidity >10 FNU may display "- - -" for the lamp-on amplifier voltage.

## 5.2 The Diagnostic Procedure

**1.** Fill a clean sample cell to the line with clear water, cap the cell and place it in the cell compartment. Press **READ** and wait until the reading is finished.

**2.** Press: **DIAG**




The **DIAG** icon will turn on and **1** will be displayed below the icon. The instrument will measure the battery voltage with the lamp off and display the result in volts (V). Then the lamp icon will turn on and the instrument will measure the voltage with the lamp on. The value is briefly displayed before defaulting to the lamp-off reading. To repeat the measurement, press **READ**.

**3.** To continuously display the lamp-on voltage, press the **RIGHT** key. The lamp icon will flash. Press the **RIGHT** key to turn the lamp icon off (the lamp is not on during this display).

**4.** Press the **UP** key to scroll through the other diagnostics. Each press of the key increments the digit in the small numerical display below the **DIAG** icon and the result of the diagnostic measurement is then displayed. Each press of **READ** updates the value. For measurements made with the lamp off and again with the lamp on, the measurement with the lamp off is displayed when the diagnostic is entered. To see the second measurement with the lamp on, press the **RIGHT** key (only works with diagnostic codes 1, 7, 8, & 9). The lamp icon will flash and the lamp-on measurement will be displayed in volts. Press the **RIGHT** key to turn the lamp icon off.

***Note:*** *DIAG 8 will display "----" for the lamp-on voltage if a of >10 FNU is placed in the cell compartment.*

## 5.3 Other Instrument Diagnostics

### 5.3.1 Display Test

Pressing and holding the **I/O** key turns on all the display icons and elements so you can determine if all the elements and icons are functioning. The display test sequence will cycle as long as the key is held down.

## 5.4 Error Messages

Error messages indicate sample interferences and/or instrument malfunction.

### 5.4.1 Flashing Numeric Display

If the highest value in the range selected is flashing in the display, the sample is too turbid (or overrange) for the selected range. In automatic or manual range, **1000** flashes if the sample is over the instrument range. In manual range mode, select the next higher range mode if 9.99 or 99.9 flashes. See Section 3.2.5 on page 46 for measuring overrange samples. The display will stop flashing if a sample within range is inserted and read.

### 5.4.2 Error Messages

An error message indicates either an instrument failure or an operation cannot be performed. An error message can be cleared by pressing **DIAG** (display will return to previous measurement or calibration value). The meter continues to operate as best it can. If the message occurs during a calibration, calibration can continue. If the error message occurs when a calibration is being calculated, the instrument will discard the new calibration and retain the old calibration. Error messages and corrective actions are listed below.

### 5.4.3 CAL?

A flashing **CAL?** appears when the instrument is using the default calibration programmed at the factory. It will appear if the analyst has erased the user-entered calibration using the procedure to restore the default calibration or after and E4 error is cleared by pressing **DIAG**. Recalibrate as soon as possible when CAL? appears. CAL? (not flashing) appears when a calibration has questionable validity.

| Message1 | Probable Cause | Corrective Action |
|---|---|---|
| E1 | Dilution water is ≥ 0.5 FNU. | Start calibration over with better quality dilution water or use a membrane filter to filter the water before use. |
| E2 | Two standards have the same value or their difference is less than 60 FNU.<br>Not all standards were read during the calibration.<br>Standard 1 is too low (<10 FNU). | Recheck preparation of standards and repeat calibration. |
| E3 | Low light error. | Re-read measurement.<br>Check lamp2<br>Check for obstructed light path.<br>Dilution may be necessary. |
| E4 | EEPROM malfunction. | Check sum failed. Press **I/O**. If E4 reappears, call Hach service. If CAL? appears, recalibrate. |
| E5 | A/D overrange. | Check for obstructed light path.<br>Call Hach Service. |
| E6 | A/D underrange. | Check for open lid during reading and re-read. Check for obstructed light path. If persists, call Hach Service. |
| E7 | Light Leak. | Close lid before pressing **READ**. |
| E8 | Bad lamp circuit. | Reinsert lamp leads at terminal block-make sure the lead ends are not touching each other.If this fails, call Hach Service. |

1 Error messages 4, 5, and 6 may indicate a failure in the internal electronics.
2 Check lamp by inserting a pencil or piece of paper into the cell compartment and pressing **READ**. Light should be visible on the inserted object.

# Replacement Parts & Accessories

## REPLACEMENT PARTS

| Description | Cat. No. |
|---|---|
| StablCal®* Calibration Set for 2100P ISO,sealed vials, < 0.1 FNU, 20 FNU, 100 FNU, and 800 FNU | 26594-05 |
| AA Batteries, 4/pkg | 19380-04 |
| Battery Door | 46005-00 |
| Carrying Case | 46506-00 |
| Gelex® Standards, set (includes standards and 3 sample cells) | 24641-05 |
| Instrument Manual | 44740-88 |
| Lamp Assembly, LED | 44602-00 |
| Oiling Cloth | 47076-00 |
| Sample Cells, 1 inch, with cap, 6/pkg | 24347-06 |
| Silicone Oil, 15 mL | 1269-36 |

## OPTIONAL ACCESSORIES AND REAGENTS

| | |
|---|---|
| Deionized Water, 3.78 L | 272-17 |
| Bath, Ultrasonic, 2.8 L (0.75-gal), w/heater | 24895-00 |
| Battery Eliminator, 120 V | 46079-00 |
| Battery Eliminator, 230 V | 46080-00 |
| Filter, 0.2 micron, 10/pkg | 23238-10 |
| Formazin, 4000 FNU, 500 mL | 2461-49 |
| Formazin, 4000 FNU,100 mL | 2461-42 |
| Hexamethylenetetramine, 500 g | 1878-34 |
| Hydrazine Sulfate, 100 g | 742-26 |
| NiCad Rechargeable Battery (4 required) | 16077-00 |

* StablCal® is a registered trademark of Hach Company.

### OPTIONAL ACCESSORIES AND REAGENTS, continued

| Description | Cat. No. |
|---|---|
| Pipet, TenSette®*, 1-10 mL | 19700-10 |
| Pipet Tips, for 1-10 mL TenSette Pipet, 50/pkg | 21997-96 |
| Pipet Tips, for 1-10 mL TenSette Pipet, 1000/pkg | 21997-28 |
| Pipet, Volumetric, Class A, 1.00 mL | 14515-35 |
| Pipet, Volumetric, Class A, 5.00 mL | 14515-37 |
| Pump, Vacuum, Hand-Operated | 14283-00 |
| Sample Degassing Kit | 43975-00 |
| Sample Filtration and Degassing Kit | 43975-10 |
| StablCal® Calibration Set for 2100P ISO Turbidimeter | |
| <0.1, 20, 100, 800 FNU, 500 mL each | 26594-00 |
| <0.1, 20, 100, 800 FNU, 100 mL each | 26594-10 |
| <0.1, 20, 100, 800 FNU, sealed vials | 26594-05 |
| <0.1 FNU** StablCal®Stabilized Formazin Standard, 100 mL | 26597-42 |
| 20 FNU StablCal® Stabilized Formazin Standard, 100 mL | 26601-42 |
| 100 FNU StablCal® Stabilized Formazin Standard, 100 mL | 26602-42 |
| 800 FNU StablCal® Stabilized Formazin Standard, 100 mL | 26605-42 |
| Triton-X Solution, 118 mL (4 oz) | 14096-32 |
| Volumetric Flask, 100 mL | 14574-42 |
| Volumetric Flask, 200 mL | 14574-45 |

* TenSette™ is a Hach Company trademark.

** <0.1 FNU StablCal® Standard is used in place of dilution water standard when performing a calibration.

# GENERAL INFORMATION

**At Hach Company, customer service is an important part of every product we make.**

**With that in mind, we have compiled the following information for your convenience.**

# HOW TO ORDER

**By Telephone:**

6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH
(800-227-4224)
**By FAX:** (970) 669-2932

**By Mail:**

Hach Company
P.O. Box 389
Loveland, CO 80539-0389
U.S.A.

**Ordering information by E-mail:** orders@hach.com

## Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

## Technical and Customer Service (U.S.A. only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use. Specialists in analytical methods, they are happy to put their talents to work for you. Call **1-800-227-4224** or E-mail **techhelp@hach.com**.

## International Customers

Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send E-mail to **intl@hach. com** or contact:

**In Canada, Latin America, Africa, Asia, Pacific Rim:**
Telephone: (970) 669-3050; FAX: (970) 669-2932

**In Europe, the Middle East, or Mediterranean Africa:**
**HACH** Company, c/o
Dr. Bruno Lange GmbH
Willstätterstr. 11
D-40549 Düsseldorf
Germany
Telephone: +49/[0]211.52.88.0
Fax: +49/[0]211.52.88.231

# REPAIR SERVICE

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the HACH Service Center serving your location.

**In the United States:**
Hach Company
100 Dayton Avenue
Ames, Iowa 50010
(800) 227-4224 (U.S.A. only)
Telephone: (515) 232-2533
FAX: (515) 232-1276

**In Canada:**
Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
(800) 665-7635 (Canada only)
Telephone: (204) 632-5598
FAX: (204) 694-5134
E-mail: canada@hach.com

**In Latin America, the Caribbean, the Far East, the Indian Subcontinent, Africa, Europe, or the Middle East:**
Hach Company World Headquarters
P.O. Box 389
Loveland, Colorado, 80539-0389
U.S.A.
Telephone: (970) 669-3050
FAX: (970) 669-2932
E-mail: intl@hach.com

# WARRANTY

**Hach Company** warrants this product to the original purchaser against any defects that are due to faulty material or workmanship for a period of **one year from date of shipment**.

In the event that a defect is discovered during the warranty period, Hach Company agrees that, at its option, it will repair or replace the defective product or refund the purchase price, excluding original shipping and handling charges. Any product repaired or replaced under this warranty will be warranted only for the remainder of the original product warranty period.

This warranty does not apply to consumable products such as chemical reagents; or consumable components of a product, such as, but not limited to, lamps and tubing.

Contact Hach Company or your distributor to initiate warranty support. Products may not be returned without authorization from Hach Company.

**Limitations**

This warranty does not cover:

- damage caused by acts of God, natural disaster, labor unrest, acts of war (declared or undeclared), terrorism, civil strife or acts of any governmental jurisdiction
- damage caused by misuse, neglect, accident or improper application or installation
- damage caused by any repair or attempted repair not authorized by Hach Company
- any product not used in accordance with the instructions furnished by Hach Company
- freight charges to return merchandise to Hach Company
- freight charges on expedited or express shipment of warranted parts or product
- travel fees associated with on-site warranty repair

This warranty contains the sole express warranty made by Hach Company in connection with its products. All implied warranties, including without limitation, the warranties of merchantability and fitness for a particular purpose, are expressly disclaimed.

Some states within the United States do not allow the disclaimer of implied warranties and if this is true in your state the above limitation may not apply to you. This warranty gives you specific rights, and you may also have other rights that vary from state to state.

This warranty constitutes the final, complete, and exclusive statement of warranty terms and no person is authorized to make any other warranties or representations on behalf of Hach Company.

**Limitation of Remedies**

The remedies of repair, replacement or refund of purchase price as stated above are the exclusive remedies for the breach of this warranty. On the basis of strict liability or under any other legal theory, in no event shall Hach Company be liable for any incidental or consequential damages of any kind for breach of warranty or negligence.