MODEL 2100N IS
LABORATORY TURBIDIMETER

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ap/dh rev 2, 9/99

Manual Change Notice
2100 Series Laboratory Turbidimeters

Introduction

Hach Company is now supplying specially packaged StablCal® Sealed Vial sets with all 2100 Series turbidimeters. Because of this, the accessory set supplied with these instruments has been modified. This change affects the manual supplied with the instrument. Please refer to the following table and to the information that follows.

Turbidimeter Model and Part Numbers	Manual Part Number	Manual Sections Affected	Corresponding Sections in this Memo
2100N 47000-00 (115 V) and 47000-02 (230V)	47000-88	Standard Accessories (Section 1.2) Unpacking (Section 1.4.1) Calibration Check (Section 2.11) Calibration (Section 3.2) Replacement Parts and Accessories	*Section 1 Standard Accessories* *Section 2 Unpacking the Instrument* *Section 3 Calibration Check* *Section 6 Calibrating the Turbidimeter (Using StablCal® Sealed Vial Standards)* *Section 7 Replacement Parts and Accessories*
2100AN 47001-00 (115 V) and 47001-02 (230 V)	47001-88	Standard Accessories (Section 1.2) Unpacking (Section 1.4.1) Calibration Check (Section 2.3.9) Calibration (Section 3.2) Replacement Parts and Accessories	*Section 1 Standard Accessories* *Section 2 Unpacking the Instrument* *Section 3 Calibration Check* *Section 6 Calibrating the Turbidimeter (Using StablCal® Sealed Vial Standards)* *Section 7 Replacement Parts and Accessories*
2100N IS 47900-00 (115 V) and 47900-02 (230 V)	47900-18	Standard Accessories (Section 1.2) Unpacking (Section 1.4.1) Calibration Check (Section 2.3.10) Calibration (Section 3.2) Replacement Parts and Accessories	*Section 1 Standard Accessories* *Section 2 Unpacking the Instrument* *Section 3 Calibration Check* *Section 6 Calibrating the Turbidimeter (Using StablCal® Sealed Vial Standards)* *Section 7 Replacement Parts and Accessories*
2100AN IS 47901-00 (115 V) and 47901-02 (230 V)	47901-88	Standard Accessories (Section 1.2) Unpacking (Section 1.4.1) Calibration Check (Section 2.3.9) Calibration (Section 3.2) Replacement Parts and Accessories	*Section 1 Standard Accessories* *Section 2 Unpacking the Instrument* *Section 3 Calibration Check* *Section 6 Calibrating the Turbidimeter (Using StablCal® Sealed Vial Standards)* *Section 7 Replacement Parts and Accessories*

1. Standard Accessories

Accessory items supplied with the turbidimeter include six sample cells, a set of StablCal® Sealed Vial Primary Turbidity Standards, a power cord, silicone oil, sample cell oiling cloth, a dust cover, 2 rolls of printer paper (supplied with the 2100AN and 2100AN IS only) and an instrument manual.

2. Unpacking the Instrument

Remove the instrument and accessories from their shipping box and inspect them for damage that may have occurred during shipment due to rough handling or extreme weather conditions.

Verify the following items are present:

- 2100 Series Laboratory Turbidimeter
- Instrument Manual with Quick Reference Guide
- A set of StablCal Primary Standards in sealed vials with instructions:
  For 2100N —Cat. No. 26621-05;
  For 2100AN—Cat. No. 26595-05;
  For 2100N IS—Cat. No. 26621-05;
  For 2100AN IS—Cat. No. 26595-05
- USEPA Filter Assembly (installed in sample cell compartment)
  (Cat. No. 30312-00)
- Oiling Cloth—Cat. No. 47076-00
- Six Sample Cells—Cat. No. 20849-00
- Silicone Oil, 15 mL (0.5 oz.) dropping bottle—Cat. No. 1269-36
- Power Cord—Cat. No. 18010-00 (115 V North American use)
  Cat. No. 46836-00 (230 V European use)
- Dust Cover—Cat. No. 47030-00
- 2 Rolls of Printer Paper—Cat. No. 47090-00 (2100AN and 2100AN IS only)
- 455 nm Filter Assembly—Cat. No. 19998-00 (2100AN only)

If any of the items are missing or damaged, please contact the Customer Service Department, Hach Company, Loveland, Colorado. Do not return the instrument without prior authorization. In the United States, the toll-free number is 1-800-227-4224. Outside the United States, contact your nearest Hach dealer.

3. Calibration Check

Quickly and easily verify the calibration of your 2100 Series Turbidimeter using the included StablCal Sealed Vials. Simply select the vial closest to the range being measured (do not use the <0.1 NTU vial—it does not have a precisely defined NTU value).

Prepare the vial as described in Section *5 Handling StablCal® Sealed Vial Standards*. Insert the vial in the cell holder and read the value. If the value is within ±10% of the stated vial value, the instrument calibration is valid for reporting purposes. If the reading is not within ±10%, re-calibrate the instrument.

4. Calibration

The electronic and optical design of 2100 Series turbidimeters provide long-term stability and minimize the need for frequent calibration. The multi-detector ratio optical system compensates for electronic and optical system variations between calibrations.

Hach recommends calibrating the instrument before it is used for the first time. When data is used for USEPA reporting, recalibrate at least every 90 days, or as stipulated by the regulating authority. Periodically, as experience or regulating authorities indicate, verify the instrument calibration using one of the StablCal® standards supplied with the instrument. If the reading in the range of use is not within 10% of the standard's assigned value, recalibrate the instrument.

Note: *For maximum accuracy and ease-of-use, your Hach turbidimeter is supplied with a StablCal Calibration set. The set contains prepared, stabilized formazin suspensions in specially sealed vials.*

Note: *The calibration is based on a first order linear equation consisting of up to four independent variables. Unpredictable results may occur if standards other than the recommended calibration points are used. The factory suggested calibration points have been determined by Hach Company chemists and engineers to provide the best calibration accuracy. Use of standards other than StablCal, or user-prepared formazin may result in less accurate calibrations.*

5. Handling StablCal® Sealed Vial Standards

Read these steps before handling the StablCal Standards.

Important Note: *Never shake or invert the < 0.1 NTU Standard. If the standard has been mixed or shaken, wait 15 minutes before using.*

If the standards have been used often (daily to weekly), begin with step 5.

If the standards have just arrived from the manufacturer or have been sitting undisturbed for longer than one week, begin with step 1.

1. Remove the < 0.1 NTU Standard from the plastic case and set it aside. Close the case lid.

2. Leave the remaining standards in the case and shake them for 2–3 minutes.

3. Let the standards stand undisturbed for 5 minutes.

4. Skip to Step 7, below.

5. Remove the < 0.1 NTU Standard from the plastic case and set it aside. Close the case lid.

6. Leave the remaining standards in the plastic case and invert the case 10 times.

7. Thoroughly clean, rinse, and dry the outside of the vials.

8. Immediately before using each standard, apply silicone oil (Cat. No. 1269-36) to the outside of the vial.

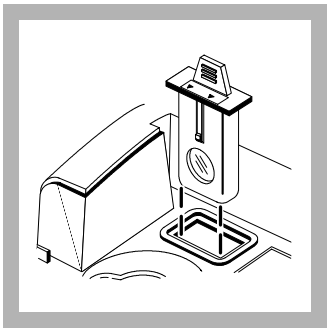
a. Apply a very thin bead of silicone oil from the top to bottom of the vial.

b. Spread the oil uniformly with the oiling cloth. Wipe off the excess so only a thin coat of oil remains. The vial should appear nearly dry with little or no visible oil.

Note: *Store the oiling cloth in a sealed plastic bag to keep it clean.*

9. Proceed with calibration.

6. Calibrating the Turbidimeter (Using StablCal® Sealed Vial Standards)



1. Insert the EPA filter module if measuring for EPA-reporting (2100N and 2100AN only).

Note: *Clean the filter before performing a primary calibration, or at least every 3 months (which is the USEPA-recommended calibration frequency).*

Note: *Clean the filter with glass cleaner, lens cleaner, or isopropyl alcohol, and a cotton-tipped swab.*

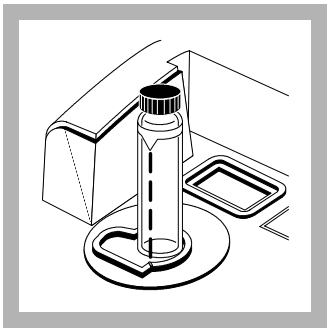
2. Press **CAL/Zero**.

The CAL mode annunciator lights, and the small green LED digits in the mode display flashes **00**. The NTU value of the dilution water used in the previous calibration is displayed.

Note: *Ratio on and Ratio off calibration data are measured and recorded simultaneously.*

Note: *Calibration for EBC and NEPH units of measure is set automatically via the NTU calibration.*

Note: *Upon entering the Calibration Mode, Automatic Range, Signal Averaging On, Ratio on and NTU units are automatically selected. Upon completion of calibration, all operational modes are restored to precalibration settings.*

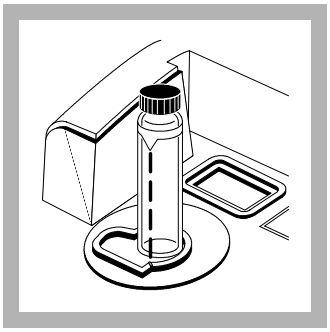


3. Select the StablCal vial labeled < 0.1 NTU. Wipe the cell clean and apply a thin film of silicone oil to its surface. Place it in the cell holder and close the cell cover. Press **ENTER**.

The instrument display counts down from **60** to **0**, and then takes a measurement. The instrument automatically increments to the next standard, the display shows 20.00 NTU, and the standard number **01** is shown in the mode display. Remove the < 0.1 NTU vial from the cell holder.

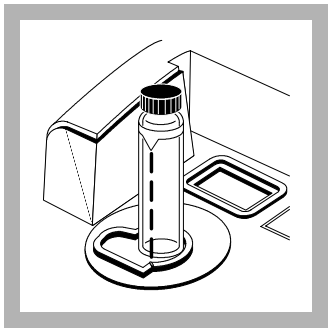
Note: *Install all StablCal vials with the orientation mark aligned with the cell holder reference mark.*

Note: *To exit the calibration procedure at any time without changing any stored value, press* **UNITS/Exit**.



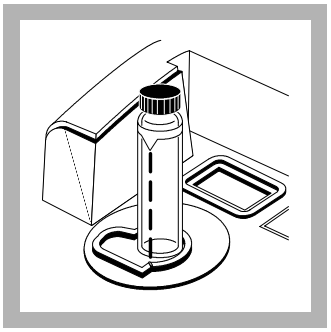
4. Select the StablCal vial labeled 20.00 NTU. Wipe the vial clean and apply a thin film of silicone oil to its surface. Place it in the cell holder and close the cell cover. Press **ENTER**.

Wait for the instrument to count down as before and display the next standard. Remove the vial from the cell holder.



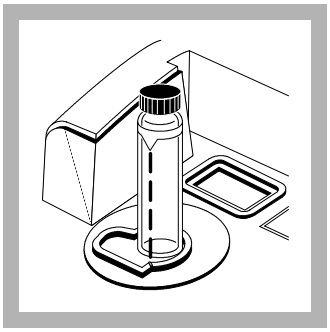
5. Select the StablCal vial labeled 200.0 NTU. Wipe the vial clean and apply a thin film of silicone oil to its surface. Place it in the cell holder and close the cell cover. Press **ENTER**.

Wait for the instrument to count down as before and display the next standard. Remove the vial from the cell holder.



6. Select the StablCal vial labeled 1000 NTU. Wipe the vial clean and apply a thin film of silicone oil to its surface. Place it in the cell holder and close the cell cover. Press **ENTER**.

Wait for the instrument to count down as before and display the next standard. Remove the vial from the cell holder.

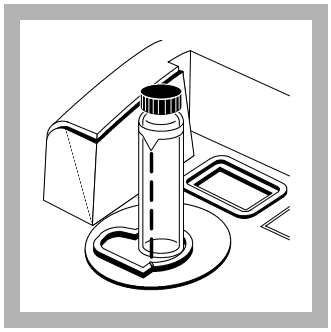


7. Select the StablCal vial labeled 4000 NTU. Wipe the vial clean and apply a thin film of silicone oil to its surface. Place it in the cell holder and close the cell cover. Press **ENTER**.

Wait for the instrument to count down as before and display the next standard. Remove the vial from the cell holder.

2100AN and **2100AN IS** instruments, complete step 8.

2100N and **2100N IS** instruments, skip to step 9.



2100 AN and 2100 AN IS instruments only:

8. Select the StablCal vial labeled 7500 NTU. Wipe the vial clean and apply a thin film of silicone oil to its surface. Place it in the cell holder and close the cell cover. Press **ENTER**.

9. Press **CAL/Zero**. The instrument makes calculations based on the new calibration data, stores the new calibration and returns to measurement mode.

Note: *If power is lost during calibration, new calibration data is lost, and the previous calibration remains in effect. To exit the calibration without saving new values, press* **UNITS/Exit**.

Note: *If* **ERR01** *or* **ERR02** *appears in the display, an error occurred during calibration. Clear the error message and proceed with measurements by pressing* **ENTER**. *The* **Cal?** *annunciator will be on, indicating a questionable calibration. Turn the* **Cal?** *annunciator off by recalibrating the instrument to remove erroneous data.*

7. Replacement Parts and Accessories

Refer to *Unpacking the Instrument* on page *2* for a list of replacement parts.

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 2100N IS has been tested and is certified as indicated to the following instrumentation standards:

Product Safety

Listed by ETL to UL 1262 (Listing # H0492805390)
Certified by ETL to CSA C22.2 No. 1010.1 (Certification # H0492805390)
Certified by Hach to EN 61010-1 (IEC1010-1), supporting test records by ETL

Immunity

EN 50081-2: 97 (European Generic Immunity Standard) **per 89/336/EEC EMC:** Supporting test records by Hach Company, certified compliance by Hach Company.

Required Standard/s include:
EN 61000-4-2 (IEC 10004-2 & IEC 801-2) Electro-Static Discharge
EN 61000-4-3 (IEC 1000-4-3 & IEC 801-3) Radiated RF Electro-Magnetic Fields
ENV 50204 Radiated Electro-Magnetic Field from Digital Telephones
EN 61000-4-4 (IEC 1000-4-4 & IEC 801-4) Electrical Fast Transients/Burst
EN 61000-4-5 (IEC 1000-4-5) Surge
EN 61000-4-6 (IEC 1000-4-6) Conducted Disturbances Induced by RF Fields
EN 61000-4-11 "1994" (IEC 1000-4-11) Voltage Dips, Interruptions and Variations

Emissions

Radiated Emissions **per 89/336/EEC EMC:** Supporting test records by Intellistor Oats (NVLAP #0369), certified compliance by Hach Company.

Required Standard/s include:
EN 55011 (CISPR 11) Emissions, Class B Limits

Additional Standard/s include:
EN 61000-2 (IEC 1000-3-2) Harmonic Disturbances Caused by Electrical Equipment
EN 61000-3 (IEC 1000-3-3) Voltage Fluctuation (Flicker) Disturbances Caused by Electrical Equipment

CANADIAN INTERFERENCE-CAUSING EQUIPMENT REGULATION, IECS-003, Class A: Supporting test records by Intellistor Oats, 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, Class "A" Limits: Supporting test records by Intellistor Oats, 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 Model 2100N IS Turbidimeter from it's power source to verify that it is or is not the source of the interference.

2. If the Model 2100N IS Turbidimeter is connected into the same outlet as the device with which it is interfering, try another outlet.

3. Move the Model 2100N IS Turbidimeter away from the device receiving the interference.

4. Reposition the receiving antenna for the device receiving the interference.

5. Try combinations of the above.

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SAFETY PRECAUTIONS

Before attempting to unpack, set up, or operate this instrument, please read this entire manual. Pay particular attention to all warnings, cautions and notes. Failure to do so could result in serious injury to the operator or damage to the equipment.

Use of Hazard Information

If multiple hazards exist, the signal word corresponding to the greatest hazard shall be used.

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

SHALL

This word understood to be mandatory

SHOULD

This word understood to be advisory

Precautionary Labels

Please pay particular attention to 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.**

 **This symbol indicates this product contains a LED of sufficient energy to be an eye hazard; however, use of the product safeguards results in the product being classified as a Class 1 LED product (no user hazard).**

 **Section 1.3 Principle of Operation**

 **Section 1.4.3 Operating Power Selection**

 **Section 2.2 Measuring Turbidity**

 **Section 2.3.5.4 Application of Heat**

 **Section 5.1 Description Flow Cell System**

 **Section 5.3 Manual Flow Cell Kit (Low-Pressure)**

 **Section 6.1 RS232 Connection**

 **Section 8.2 Light Source**

SPECIFICATIONS

Specifications subject to change without notice.

Principle of Operation: Nephelometric

Configuration Modes (selectable):
Range Selection: Manual or Automatic
Signal Averaging: ON or OFF

Measurement Units: FNU and NTU (1 FNU = 1 NTU)
Ranges:
FNU Mode: 0-1000 FNU (Formazin Nephelometric Unit) with automatic decimal point placement or 0-0.999, 0-9.99, 0-99.9, 0-1,000 FNU with manual range selection
NTU Mode: 0-1000 NTU (Nephelometric Turbidity Unit) with automatic decimal point placement or 0-0.999, 0-9.99, 0-99.9, 0-1,000 NTU with manual range selection

Accuracy*: FNU: ±2% of reading or ±0.01 FNU from 0-1000 FNU

Resolution: 0.001 FNU/NTU

Repeatability: ±1% of reading or ±0.01 FNU, which ever is greater; reference conditions: 23 ±2 °C (73 °F), 50 % relative humidity noncondensing, 115/230 VAC ±17%, 50/60 Hz

Response Time: 6.8 seconds with signal averaging off or 14 seconds with signal averaging on

Standardization: Formazin Primary Standards

Display: 5-character LED, 13.7 mm (0.54 in.) high digits with custom annunciators

Light Source: 870 ±30 nm LED. Typical LED life is 10 years with continuous use

Signal Averaging: Operator selectable on or off

Sample Cells: 95 mm high x 25 mm diam. (3.74 in. high x 1 in. diameter). Borosilicate glass with rubber-lined screw caps.

Sample Required: 20 mL (0.7 oz.) minimum

Secondary Standards: Gelex® Secondary Standards (labeled in NTU units)

Temperature:
Storage Temperature (instrument only): -40 to 60 °C (-40 to 140 °F)
Operating Temperature: 0 to 40 °C (32 to 104 °F)
Sample Temperature: 0 to 95 °C

Operating Humidity Range: 0 to 90% RH noncondensing @ 25 °C; 0 to 75% RH noncondensing at 40 °C

Instrument Stabilization Time: Instantaneous

* Radiated fields of 3 V/m or greater in the range of 140 mHz to 1000 mHz can cause this product to exceed its accuracy specification by up to 0.1 FNU.

Air Purge: 0.1 scfm at 69 kPa (10 psig), hose barb connection for 1/8-inch tubing, Max 138 kPa (20 psig). Dry nitrogen or instrument grade air (ANSI MC 11.1, 1975)

Power Requirement: 115/230 Vac ±17%, 50/60 Hz, 60 VA Max

Serial I/O: RS232 serial interface via DB9 subminiature D shell connector for data output to computer or printer, and data input (command). No handshaking, 1200 baud, one stop bit, no parity, eight bit character length.

Enclosure: High-impact polycarbonate plastic

Dimensions: 30.5 x 40 x 15.6 cm (12 x 15 ¾ x 6 1/8 in.)

Instrument Weight: 3.77 kg (8 lbs., 5 oz.)

Shipping Weight (with standard accessories): 6.11 kg (13 lbs. 8 oz.)

Certification: UL 1262; CSA 22.2 No. 1010.1

Water Quality Standards: ISO 7027; DIN 38 404; NF EN 27027

OPERATION

WARNING
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.

ADVERTENCIA
La manipulación de muestras químicas, patrones y reactivos puede ser peligrosa. Antes de manipular cualquier producto químico, conviene leer las Fichas Técnicas de Seguridad y familiarizarse con los procedimientos de seguridad.

ADVERTÊNCIA
A manipulação de amostras, padrões e reagentes químicos pode ser perigosa. Reveja as necessárias Fichas Técnicas de Segurança do Material e familiarizese com os procedimentos de segurança antes de manipular quaisquer substâncias químicas.

ATTENTION
La manipulation des échantillons chimiques, étalons et réactifs peut être dangereuse. Lire les fiches de données de sécurité des produits nécessaires et se familiariser avec toutes les procédures de sécurité avant de manipuler tout produit chimique.

WARNHINWEIS
Da das Arbeiten mit chemikalischen Proben, Standards, Reagenzien und Abfällen mit Gefahren verbunden ist, empfiehlt die Hach Company dem Benutzer dieser Produkte dringend, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Gebrauch der Chemikalien oder Biogefahrgut vertraut zu machen und alle entsprechenden Materialsicherheitsdatenblätter aufmerksam zu lesen.

SECTION 1 GENERAL DESCRIPTION

1.1 Instrument Description

The Hach Model 2100N IS® Laboratory Turbidimeter* (*Figure 1*) is designed for turbidity measurement in accordance with International Turbidity Measurement Standards ISO 7027, DIN 38 404, and NF EN 27027. Measurements as high as 1000 FNU (Formazin Nephelometric Unit) can be made directly. Measure solutions with higher turbidity levels by dilution with filtered sample and a simple calculation. Refer to Section *2.3.7* for additional information.

The 2100N IS Laboratory Turbidimeter also provides direct measurements in traditional units of NTU (1 FNU = 1 NTU).

The microprocessor-based Model 2100N IS is designed for laboratory use, and employs an advanced optical and electronic design. The instrument operates on 115/230 Vac, and an RS232 output for connection to a printer, data logger, or computer.

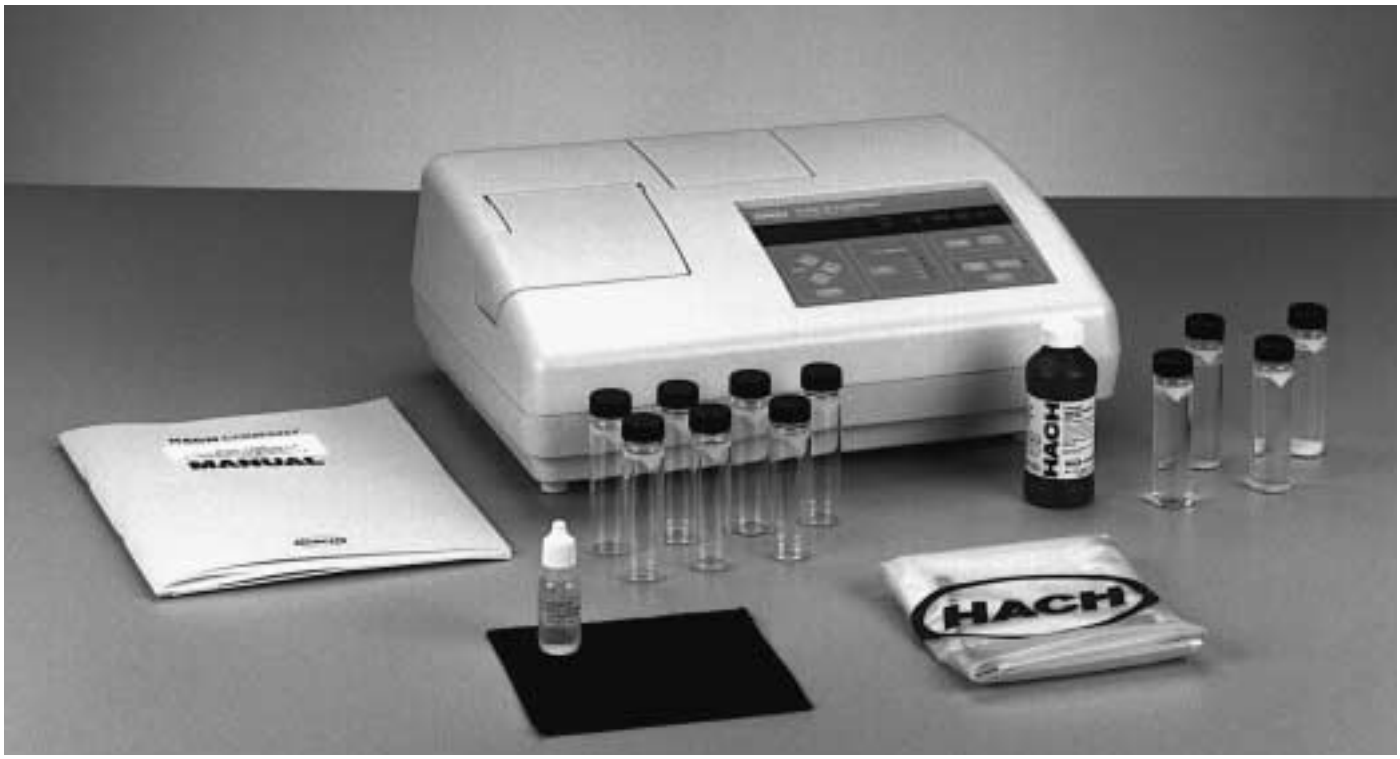
1.2 Standard Accessories

Accessory items supplied with the turbidimeter include: six sample cells, a set of four Gelex® Secondary Turbidity Standards including a stray light standard, 100 mL of Formazin Primary Standard, a power cord, silicone oil, sample cell oiling cloth, a dust cover, quick reference guide and an instrument manual.

1.3 Principle of Operation

The Model 2100N IS Laboratory Turbidimeter is a nephelometer with the capability to measure scattered light. Calibration with formazin provides the capability for direct readout in FNU units. The instrument meets design criteria specified in DIN 38 404, NF EN 27027, and ISO 7027 International Turbidity Measurement Standards.

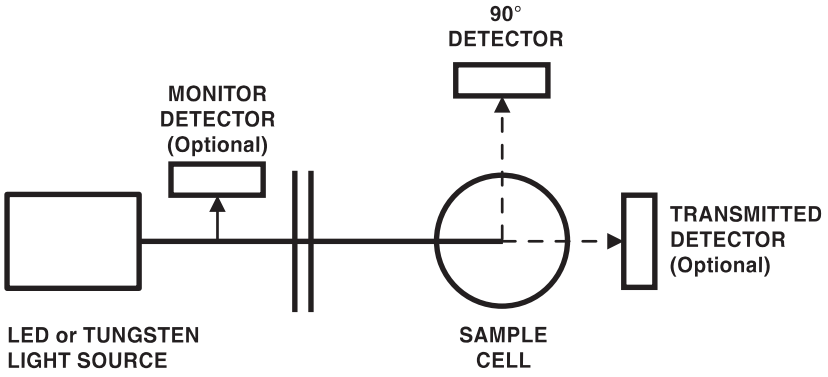
Figure 1 2100N IS Laboratory Turbidimeter



* Meets or exceeds the design and performance criteria as specified in the International Turbidity Measurement Standard ISO 7027.

The optical system* (shown in *Figure 2*) is comprised of an 870 ±30 nm light emitting diode (LED) assembly, a 90° detector to monitor scattered light, and an LED monitor detector. The instrument measures turbidity of up to 1000 units using the single 90° detector in FNU measurement mode.

Figure 2 2100N IS Laboratory Turbidimeter Optics



DANGER
Infrared light produced within this instrument is sufficient to cause eye injury. The appropriate sample cell cover must be closed or installed correctly before the infrared light source will operate.

PELIGRO
La luz infrarroja generada en este instrumento es suficiente para causar daño a los ojos. La cubierta apropriada de la célula de muestras debe ser cerrada o instalada correctamente para que se encienda la fuente de luz infrarroja.

PERIGO
A luz infravermelha produzida dentro deste instrumento é suficiente para causar lesâo aos olhos. A tampa apropriada para cela de amostias deverâo ser colocada correctamente para energizar a fonte de luz infravermelha.

DANGER
La lumière infrarouge produite dans cet appareil est suffisante pour provoquer des blessures aux yeux. Le capot du compartiment d'échantillon utilisé doit être fermé ou installé correctement pour que la source de lumière infrarouge puisse fonctionner correctement.

GEFAHR
Das in diesem Gerät erzeugte Infrarotlicht kann auf Grund seiner Intensität zu Augenverletzungen führen. Die entsprechende Lichtschutzklappe muss richtig geschlossen oder aufgesetzt werden, damit die Infrarotlichtquelle arbeitet.

1.4 Preparation for Use

1.4.1 Unpacking

After removing the instrument and accessories from their shipping box, inspect the instrument and accessories for damage that may have occurred during shipment.

Verify the following items are present:

- Model 2100N IS Laboratory Turbidimeter
- Instrument Manual
- 4000-NTU Formazin Standard, 100 mL

* Patent #4198161, other patents pending.

- Standardization Kit containing Gelex Secondary Standards for Stray Light, 0-2, 0-20, 0-200
- Oiling Cloth
- Six Sample Cells
- Silicone Oil, 15 mL (0.5 oz.) SCDB (self-contained dropping bottle)
- Power Cord
- Dust Cover
- Quick Reference Guide

If any of the items are missing or damaged, please contact the Customer Service Department, Hach Company, Loveland, Colorado. Do not return the instrument without prior authorization. In the United States, the toll-free number is 1-800-227-4224. Outside the United States, contact your nearest Hach dealer.

1.4.2 Operating Environment

Note: *The light shields used with this instrument produce a magnetic field. Do not place these sample cell light shields near electronically stored data such as computer disks because stored data could be damaged.*

Use the turbidimeter in a clean, dust-free environment on a bench or table that is free of vibration and that provides good air circulation around the instrument. Keep the areas underneath and in the back of the instrument free of materials that could obstruct air flow through the vents.

1.4.3 ⚠Operating Power Selection

The instrument is completely assembled when shipped from the factory except for connecting the power cable to the instrument body on the rear panel. Voltage selection for 115 or 230 Vac is automatic.

A power cord (Cat. No. 47900-02) suitable for European line voltage is supplied with the Model 2100N IS Turbidimeter.

Note: *The model 2100N IS Turbidimeter does not require warm up for lamp output or electronic stabilization.*

The Model 2100N IS Turbidimeter (Cat. No. 47900-00)is factory configured for U.S. and Canadian 115V line power. The power cord supplied with this model is UL/CSA approved. Use an approved UL/CSA power cord with NEMA 6-15P type cord cap in place of the 115V power cord supplied if the instrument is used with 230V line power.

SECTION 2 TURBIDITY MEASUREMENT

2.1 Operating Controls and Indicators

2100N IS Laboratory Turbidimeter controls and indicators are explained in detail in Section *3*. Also, refer to Model 2100N IS operating features illustrated in *Figure 7*.

Close the cell cover and press the **I/O** switch on the back instrument panel to turn power on. Dark detector readings are taken immediately after the instrument is switched on; error code ERR07 may be displayed if the cell cover is left open during power up.

2.2 ⚠ Measuring Turbidity

Note: *"door" appears in the LED display when the sample-cell cover is open in the measurement mode.*

Measurements may be made with **SIGNAL AVERAGE** on or off and with manual or automatic range selection. Normally, it is recommended that measurements be made with automatic range selection and **SIGNAL AVERAGE** on. When **SIGNAL AVERAGE** is on, the instrument's microprocessor compiles a number of readings and averages the result. The averaged value is calculated and displayed approximately once every second.

⚠ ***DANGER***
Infrared light produced within this instrument is sufficient to cause eye injury. The appropriate sample cell cover must be closed or installed correctly before the infrared light source will operate.

PELIGRO
La luz infrarroja generada en este instrumento es suficiente para causar daño a los ojos. La cubierta apropriada de la célula de muestras debe ser cerrada o instalada correctamente para que se encienda la fuente de luz infrarroja.

PERIGO
A luz infravermelha produzida dentro deste instrumento é suficiente para causar lesâo aos olhos. A tampa apropriada para cela de amostias deverâo ser colocada correctamente para energizar a fonte de luz infravermelha.

DANGER
La lumière infrarouge produite dans cet appareil est suffisante pour provoquer des blessures aux yeux. Le capot du compartiment d'échantillon utilisé doit être fermé ou installé correctement pour que la source de lumière infrarouge puisse fonctionner correctement.

GEFAHR
Das in diesem Gerät erzeugte Infrarotlicht kann auf Grund seiner Intensität zu Augenverletzungen führen. Die entsprechende Lichtschutzklappe muss richtig geschlossen oder aufgesetzt werden, damit die Infrarotlichtquelle arbeitet.

⚠ ***DANGER***
The 2100N IS Laboratory Turbidimeter is not intended for use with flammable samples or those containing hydrocarbons or concentrated acids that might attack the 2100N IS components. Conduct compatibility tests prior to analysis if the sample to be monitored is in question.

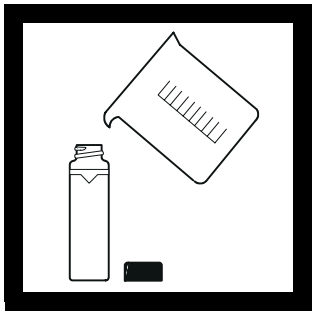
PELIGRO
El Turbidímetro de Laboratorio 2100N IS no está diseñado para usarse con muestras inflamables o que contengan hidrocarburos o ácidos concentrados que puedan atacar los componentes del 2100N IS. Ensaye antes del análisis si existe duda sobre la compatibilidad de la muestra que se intenta analizar.

PERIGO
O Turbidímetro de Laboratório 2100N IS não é feito com o fim de ser empregado com amostras inflamáveis ou aquelas que contêm hidrocarbonetos ou ácidos concentrados que possam atacar os componentes do 2100N IS. Os testes devem ser executados antes da análise se existe alguma dúvida com respeito à compatibilidade da amostra a monitorar.

DANGER
Le turbidimètre de laboratoire 2100N IS n'est pas prévu pour utilisation avec des liquides inflammables ou contenant des hydrocarbures ou acides concentrés qui pourraient attaquer les composants du 2100N IS. Effectuer des essais préalables en cas de doute sur la compatibilité de l'échantillon à contrôler.

GEFAHR
Das Labortrübungsmessgerät 2100N IS darf nicht zur Analyse entflammbarer Proben oder Proben, die Kohlenwasserstoffe oder konzentrierte Säuren enthalten, welche die Teile des 2100N IS angreifen könnten, verwendet werden. Wenn die Verträglichkeit der zu bestimmenden Probe fraglich ist, sollten vor der Analyse Tests durchgeführt werden.

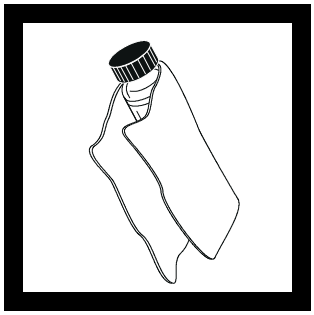
Nephelometric Measurement Procedure



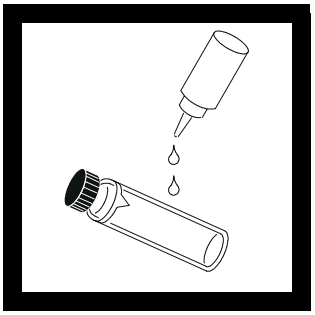
1. Collect a representative sample in a clean container. Fill the sample cell to the line (approximately 30 mL). Take care to handle the sample cell by the top. Cap the sample cell.

Note: *An instrument warm-up period is not required. Optical and electronic stabilization is instantaneous.*

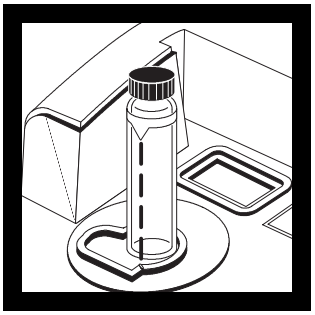
Note: *When using the Flow-Cell System, the Flow-Cell cover must be in place for the LED light source to function.*



2. Hold the sample cell by the cap, and wipe to remove water spots and finger prints.



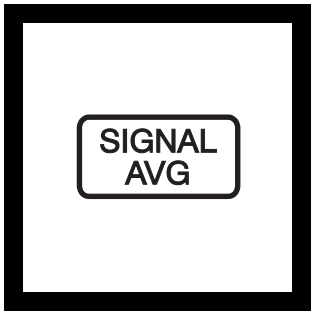
3. Apply a thin bead of silicone oil from the top to bottom of the cell—just enough to coat the cell with a thin layer of oil. Using the oiling cloth provided, spread the oil uniformly. Then, wipe off the excess. The cell should appear nearly dry with little or no visible oil. See Section *2.3.2*.



4. Place the sample cell in the instrument cell compartment and close the lid.

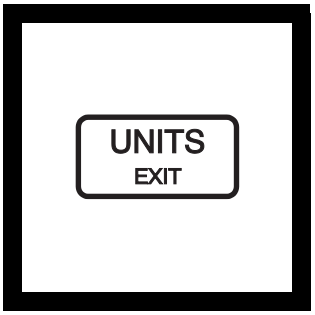
Note: *For immediate update of the display, press* **ENTER**.

5. Select manual or automatic range by pressing the **RANGE** key.

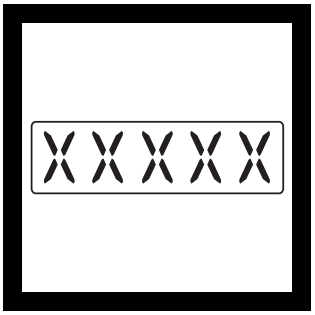


6. Select the appropriate signal averaging setting (on or off) by pressing the **SIGNAL AVG** key.

Note: *See Section 3.1.3 for more information.*



7. Select the appropriate unit (FNU or NTU) by pressing the **UNITS** key.



8. Read and record the results.

Note: *A measurement record can be printed or transmitted via RS232 by pressing the* **PRINT** *key.*

2.2.1 Measurement Notes

- Always cap the sample cell to prevent spillage of sample into the instrument.
- Always close the sample compartment lid during measurement.
- Do not leave a sample cell in the cell compartment for extended periods of time.
- Empty the cell compartment and turn off the power if the instrument is stored for extended periods of time.
- Always use clean, scratch-free sample cells and caps.
- Always apply silicone oil.
- Always observe measurement techniques described in Section *2.3*.

2.3 Measurement Techniques

Accurate and repeatable turbidity measurements depend on good, consistent measurement techniques. Measurements are more accurate and repeatable if close attention is paid to proper measurement techniques. Four important considerations are:

- Use clean sample cells.
- Use sample cells in good condition.
- Remove air bubbles (degassing).
- Apply silicone oil to the sample cell.

Measure samples immediately to prevent changes in sample characteristics due to temperature shifts and settling. Avoid dilution whenever possible; particles suspended in the original sample may dissolve or otherwise change characteristics when the temperature changes or the sample is diluted. Thus, the measurement may not be representative of the original sample.

2.3.1 Cleaning Sample Cells

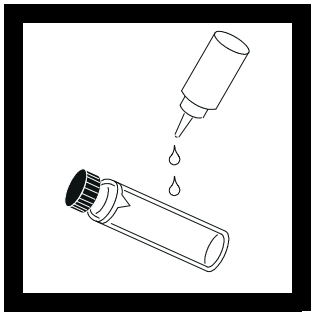
Cells must be meticulously clean and free from significant scratches. Glass imperfections and superficial scratches from manufacturing are effectively masked by the silicone oiling procedure outlined in Section *2.3.2*. Clean the inside and outside of the cells by washing thoroughly with a nonabrasive laboratory detergent. Then continue cleaning with a 1:1 HCl bath followed by multiple rinses with distilled or deionized water. Air dry the cells. Handle sample cells by the top only to minimize dirt and fingerprints.

Silicone Oil Procedure

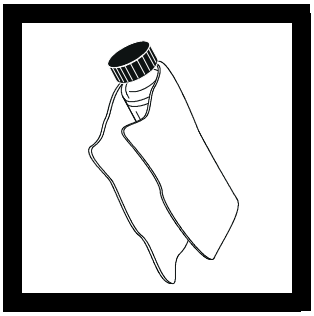
2.3.2 Applying Silicone Oil

Treat the outside of the cells with a thin coating of silicone oil to mask minor imperfections and scratches that may contribute to light scattering. Use only Hach silicone oil (Cat. No. 1269-36); it has the same refractive index as the sample cell glass. Avoid application of excess oil that may attract dirt, and contaminate the sample compartment of the instrument.

1. Thoroughly clean and rinse the sample cell as described in Section *2.3.1*.



2. Apply a thin bead of silicone oil from the top to bottom of the cell—just enough to coat the cell with a thin layer of oil.



3. Spread the oil uniformly using the oiling cloth provided. Wipe off the excess leaving only a thin coat. The cell should appear nearly dry with little or no visible oil.

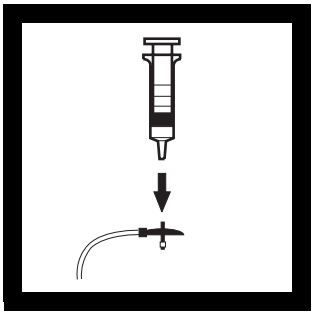
Note: *Store the oiling cloth in a plastic storage bag to keep the cloth clean.*

2.3.3 Preparing Dilution Water

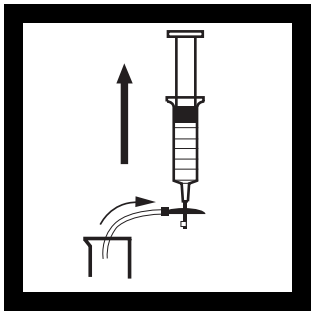
Dilution water may be required for indexing and matching sample cells, diluting over-range samples, and/or preparing formazin standards. For turbidity measurement, an overrange sample can only be diluted with a portion of filtered sample.

Collect at least 1000 mL of high quality water (e.g., distilled, demineralized, or deionized water). Check the turbidity of the dilution water before use. The 2100N IS Turbidimeter may be used to check the dilution water turbidity because the instrument is precalibrated at the factory. If the turbidity is greater than 0.5 FNU, the water may be filtered with a 0.2 micron filter using the Sample Filtration and Degassing Kit (Cat. No. 43975-10) or the equivalent. Clean all glassware with 1:1 hydrochloric acid and rinse several times with dilution water when measuring low range turbidity samples. Cap the cells to prevent small air-borne particles from contaminating the glassware if it is not used immediately.

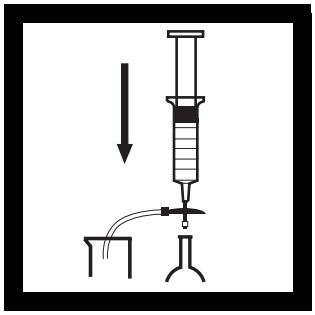
Dilution Water Filtration



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 about 50 mL 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 2 and 3 until the desired amount of water is obtained.

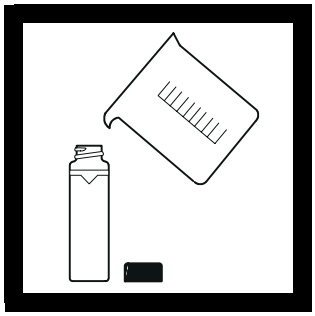
Note: *Pushing water through the filter becomes more difficult as the filter clogs. Discard a clogged filter and attach a new filter when necessary. Replacement filters are available in packages of 10 (Cat. No. 23238-10).*

2.3.4 Indexing and Matching Sample Cells

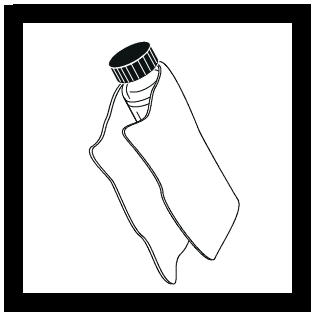
Precise measurement of multiple, low-turbidity samples requires good laboratory technique to achieve accuracy and good repeatability. Matched sample cells are required to minimize the effects of optical variation among cells. Alternatively, a single sample cell used for every measurement minimizes reading variability caused by cell-to-cell imperfections. Once cell orientation in the cell holder is established, always use the alignment indicated on the cell, regardless of sample cell choice (refer to Section *2.3.4.1*). Using a single cell provides better accuracy and precision than matched cells. A Flow-Cell System provides the best accuracy and reproducibility with the added advantage of sample pour through convenience (see Section *5*).

2.3.4.1 Indexing a Single Sample Cell

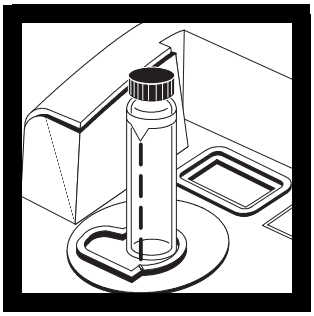
Add an orientation mark to a single sample cell as follows:



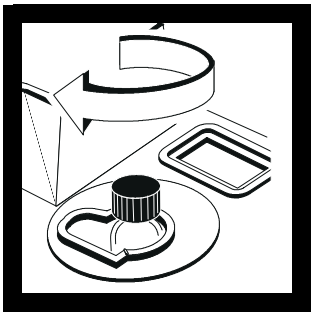
1. Fill the clean cell to the line with high-quality water, and cap the sample cell (refer to Section *2.3.3*).



2. Wipe the sample cell clean, and apply a film of silicone oil (refer to Section *2.3.2*).

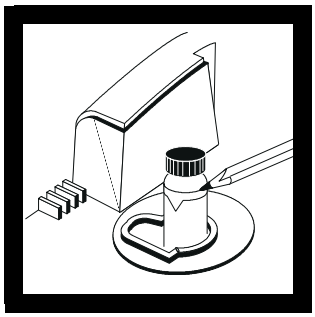


3. Insert the sample cell into the cell compartment, and close the cell cover. Record the reading.



4. Lift the cell compartment cover, rotate the sample cell (approximately 1/8 of a turn). Close the lid, press **ENTER** and record the reading. Continue this procedure until the smallest FNU reading is obtained.

Note: *"door" is displayed when the sample compartment is not covered.*



5. Place an orientation mark on the sample cell marking band adjacent to the index mark. Use this mark to align the sample cell each time a measurement is made.

2.3.5 Removing Air Bubbles (Degassing)

Remove air or other entrained gases prior to measurement. Degassing is recommended (even if no bubbles are visible). Four methods are commonly used for degassing:

- Application of a partial vacuum
- Addition of a surfactant
- Use of an ultrasonic bath
- Application of heat

In some cases more than one method may be necessary for effective bubble removal (e.g., some severe conditions may require combining use of heat with an ultrasonic bath). Use care with these techniques; sample turbidity can be altered if these methods are misused.

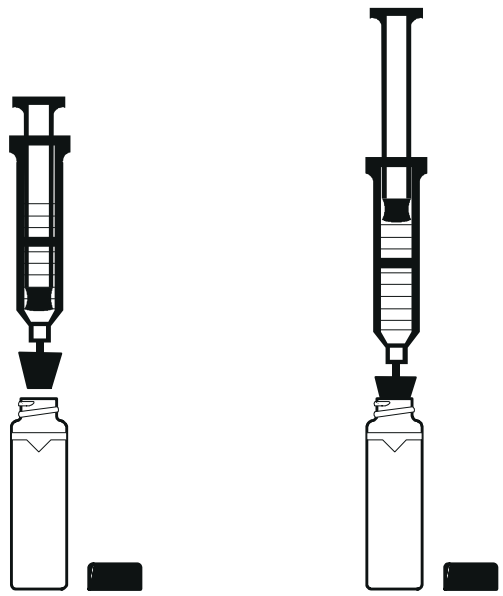
Letting the sample stand for a period of time to remove air bubbles is not recommended. Particulates that cause turbidity may settle, and the sample temperature may change. Both conditions may alter the turbidity of the sample resulting in a measurement that is not representative of the original sample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

2.3.5.1 Application of Vacuum

Apply vacuum with any convenient, clean, oil-free vacuum source. The vacuum lowers the atmospheric pressure above the sample allowing trapped gas bubbles to escape. Vacuum works well with non-viscous samples, such as water, that do not contain volatile components. Application of vacuum to viscous, volatile samples (such as paint resins) may cause volatile components to come out of solution, and intensify the bubble problem.

To apply vacuum, use a sample degassing kit equivalent to Cat. No. 43975-00 (Sample Degassing Kit) as shown in *Figure 3* or Cat. No.43975-10 (Sample Degassing and Filtration Kit). These kits contain a syringe and stopper for vacuum degassing. An electric or hand-operated pump equivalent to Cat. No. 14697-00 or 14283-00, respectively, also may be used.

Figure 3 Sample Degassing



2.3.5.2 Addition of Surfactant

Limit the use of surfactants (surface-action agents) to severe problems when other degassing techniques prove ineffective. Surfactants change the surface tension of the water causing the release of entrained gases. Hach Company recommends a surfactant such as Triton X-100 (a Rohm and Haas Product, Hach Cat. No. 14096-32) or equivalent. Add one drop of Triton X-100 in the sample cell prior to sample addition.

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

This technique is particularly effective when water is supersaturated with air. Changing the surface tension may accelerate settling of turbidity-causing particles. Mix the sample well, and measure as soon as possible. Overmixing may cause the surfactant to foam. Rinse sample cells thoroughly between measurements to prevent accumulation of residual surfactant in the cells.

2.3.5.3 Using an Ultrasonic Bath

An ultrasonic bath is effective in removing gas bubbles on most samples, especially on viscous liquids (Cat. No. 24895-00 or equivalent). However, the ultrasonic waves also may alter the characteristics of the turbidity-causing particulates. Turbidity is dependent on the size, shape, composition, and refractive index of the suspended particles. Excess application of ultrasound may alter particle size and shape, and thus change the turbidity. In some instances, use of ultrasound may compound the bubble removal task by fracturing gas bubbles, thus making degassing more difficult. Use the following ultrasonic bath procedure.

1. Fill a clean sample cell with sample. Leave the cell 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 install the cap. Thoroughly dry the cell, and apply a film of silicone oil.

The time necessary to expel bubbles may vary from a few seconds to a minute or more. Follow this simple procedure to avoid excessive application of ultrasound. First, apply ultrasound for a short period of time, and again measure turbidity. Continue for several repetitions noting the treatment time and turbidity readings. If turbidity begins to increase instead of decrease, the ultrasound waves probably have started to alter the suspended particles. Note the treatment time preceding the turbidity increase, and record it as the maximum time limit for ultrasonic treatment.

2.3.5.4 ⚠ Application of Heat

DANGER
Make sure the cap on the cell is loose. Heating a tightly-capped cell may result in an explosion.

PELIGRO
Cerciórese de que la tapa de la célula esté suelta. Calentar una célula cerrada ajustadamente puede originar una explosión.

PERIGO
Tenha certeza de que a tampa na cela esteja solta. O aquecimento de uma cela tapada apretada demais pode ocasionar uma explosão.

DANGER
Vérifier que le bouchon sur la cuvette est desserré. Le chauffage d'une cuvette bouchée hermétiquement peut provoquer une explosion.

GEFAHR
Der Verschluss muss lose auf der Küvette sitzten. Das Erhitzen einer fest verschlossenen Küvette kann eine Explosion verursachen.

Avoid use of heat to accelerate degassing whenever possible. Heat may change the characteristics of the suspended particles, and cause volatile components to come out of solution. Gentle heating may be helpful in degassing very viscous samples when combined with application of vacuum or ultrasound. If heating the sample is necessary, do so only to the extent required to accomplish degassing. Cool the sample to the original temperature before measurement.

2.3.6 Signal Averaging

The signal averaging feature provides compensation for reading fluctuations caused by random drifting particles in the sample. Signal averaging may be turned on or off at any time during measurement by pressing the **SIGNAL AVG** key. When on, the signal averaging annunciator is lighted. The display is updated approximately once every second.

Turning on signal averaging causes ten measurements to accumulate in a measurement buffer. The initial value is displayed immediately. Subsequent values are an average of readings accumulated in the buffer. After measurements are accumulated (approximately 1 measurement per second), the displayed value is a moving average of the specified number of measurements in the averaging buffer. Select signal average OFF for optimum response time. Pressing **ENTER** clears the buffer of all stored values and provides an updated display. If power is turned off and then restored, the instrument defaults to the signal averaging condition selected during the last measurement.

2.3.7 Measuring Over-Range Samples

The nephelometric method of turbidity measurement depends on light scattering from suspended particles. If turbidity is very high, significant amounts of light may be absorbed by the particles, and little light is available for scattering. This results in a negative interference; the measured turbidity is lower than the actual turbidity. This condition is called "*going blind*."

Light absorbing particles, such as activated carbon and significant amounts of true color, also may cause an instrument to "*go blind*." Dilution may not be effective in correcting for these interferences.

When too much light is absorbed by the sample matrix, sufficient light may not be available for measurement. If this condition occurs, the lamp icon on the instrument display flashes to warn the user.

2.3.8 Sample Dilution

High turbidity samples may be diluted, but avoid this when possible because dilution may alter the characteristics of the suspended particles and produce erroneous results.

When necessary, dilute the sample with a portion of filtered sample. (Diluting with distilled or deionized water may dissolve some of the turbidity.)

Filter samples with the Sample Filtration and Degassing Kit (Cat. No. 43975-10) shown in *Figure 4*. If the filters in this kit plug too rapidly, use a standard 47 mm filtration apparatus illustrated in *Figure 5* with a membrane filter (Cat. No. 13530-01), or use a glass-fiber filter (Cat No. 2530-00) for very high solids.

Figure 4 Filtering Apparatus

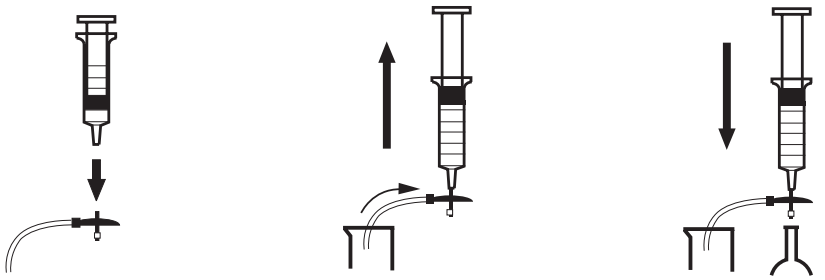
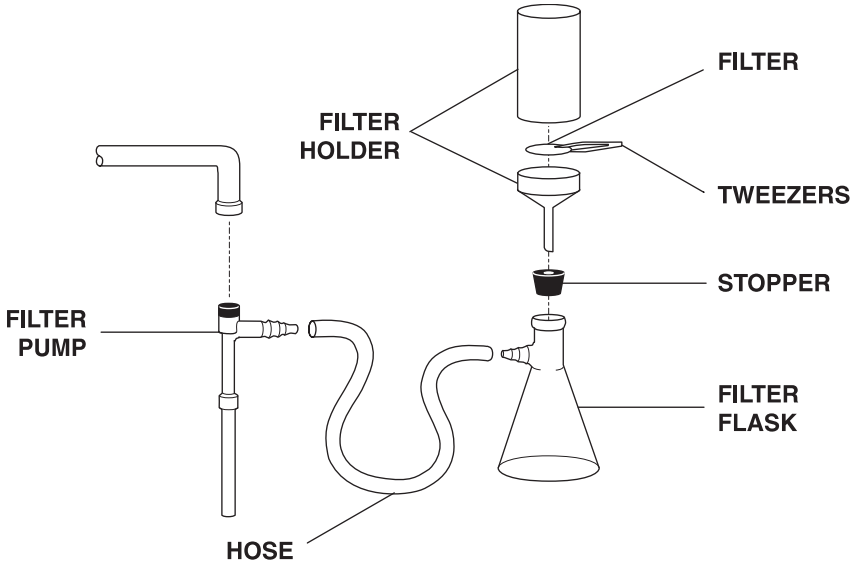


Figure 5 Sample Filtering



After dilution and measurement, calculate the actual result as follows:

1. Calculate the dilution factor:

$$\text{Dilution Factor} = \frac{\text{Total Volume}}{\text{Sample Volume}}$$

Where total volume = sample + dilution water

Example: 20 mL of sample + 80 mL of dilution water = 100 mL total

$$\text{Dilution Factor} = \frac{100}{20} = 5$$

2. Calculate the Final Turbidity Value:

$$\text{Measured Results} \times \text{Dilution Factor} = \text{Actual FNU}$$

For example, if the measured turbidity value is 250 FNU, the final turbidity value is calculated as:

$$250 \times 5 = 1250 \text{ FNU}$$

2.3.8.1 Using Cell Adapters

Cell adapters are used with the Model 2100N IS Turbidimeter when sample cells smaller than the standard 25-mm cells are required. A wide variety of test tubes, sample cells and ampules can be used with the cell adapters so smaller sample volumes can be measured. Small diameter sample cells are useful with the instrument when only a small quantity of sample is available, the sample to be measured is in an ampule and cannot be opened, or the sample is too turbid for use with the standard sample cell. A shorter light path permits measurement of high-range samples without the need for sample dilution.

Note: *The 2100N IS Turbidimeter reads slightly different with cell adapters installed because of the shorter path length associated with the smaller diameter sample cells. Refer to the instruction sheet sent with the cell adapters for additional information.*

Adapters are available for test-tube diameters of 12- to 13-mm, 16-mm and 19-mm O.D. The 12- to 13-mm adapter accommodates either 12-mm or 13-mm tubes. The minimum sample volumes that must be used are 2.5 mL for 12-mm tubes, 3.5 mL for 13-mm tubes, 5 mL for 16-mm tubes and 7 mL for 19-mm tubes.

The adapters come with a tall light shield supplied for test tubes taller than the standard cover.

Carefully select sample-cell glassware used with the adapters to be clean and free of significant scratches. The same handling and cleaning care applied to the standard 2100N IS sample cells applies to the smaller cells (including the use of silicone oil on the outside of the glass).

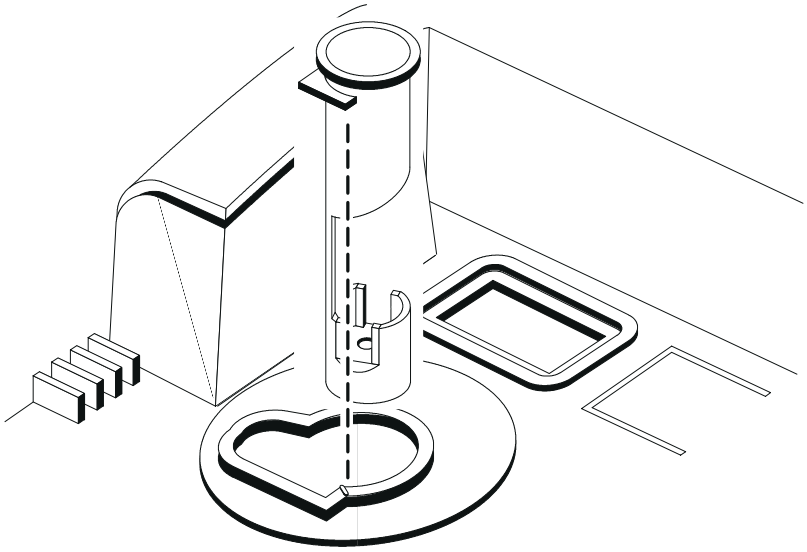
2.3.8.2 Installing and Removing Cell Adapters

Note: *Do not force the adapter out of the compartment; serious instrument damage can occur.*

Align the tab on the cell adapter toward the front of the instrument to install in the instrument's sample compartment (see *Figure 6*).

Carefully pull the adapter straight up to remove. Slowly rotate the adapter 90-degrees counterclockwise if the adapter catches.

Figure 6 Cell Adapter Installation



2.3.9 Condensation (Fogging)

Note: *Warming may alter the sample turbidity. Measure the sample without warming whenever possible.*

Condensation may occur on the outside surface of a sample cell when a cold sample is being measured in a warm, humid environment. This condensation or fogging of the sample cell interferes with turbidity measurement. Make sure all moisture is thoroughly wiped from the outside of the sample cell prior to placing the cell in the instrument for measurement. Use the air purge feature when condensation is probable. Refer to Section *4*

for instructions on connecting and using air purge. If condensation persists even with air purging, it may be necessary to warm the sample slightly by letting it stand at room temperature or by partially immersing it in a warm water bath for a short period of time. Make sure samples are well mixed before measurement.

2.3.10 Calibration Check

Use Gelex Secondary Turbidity Standards for periodic calibration checks. The instrument calibration is considered valid when the measured FNU value is within ±5% of the value assigned at the time of the previous calibration. Recalibrate the instrument when more than ±5% variation occurs. It is important that the Gelex vials are clean, free of severe scratches, prepared with silicone oil, and inserted with the proper orientation when the value first is assigned and subsequently is verified.

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

Gelex Secondary Turbidity Standards are stable suspensions of a metal oxide in a gel. The standards are labeled with the measurement range for which they are intended. 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.

Note: *Calibrated values for secondary standards are valid only with the specific instrument on which they were determined. Do not use these values for standardization checks on other instruments.*

Gelex standards remain stable when cared for properly. Handle with care, and store them in their protective box at room temperature. The Gelex suspension can separate internally if subjected to low or high temperatures. The turbidity values of scratched, chipped or pitted Gelex standards change; replace these standards when they become damaged. Wiping the vial surfaces with silicone oil (supplied with the instrument) minimizes the effects of minor scratches on the vials.

Turbidimeters must be properly calibrated with a primary standard. Hach Company recommends use of Formazin Primary Standard for turbidimeter calibration. Quarterly calibration (every 3 months) is required for U.S. Environmental Protection Agency reporting under NPDES or NPDWR permits. If data is not for regulatory reporting purposes, calibrate as experience dictates.

2.3.11 Representative Sampling

A representative sample accurately reflects the true conditions of the source from which the sample was taken. To ensure a representative sample, gently but thoroughly mix every sample before collecting aliquots (sample portions). Do not allow particles to settle before making measurements.

Note: *Mix by gentle inversion only. DO NOT SHAKE.*

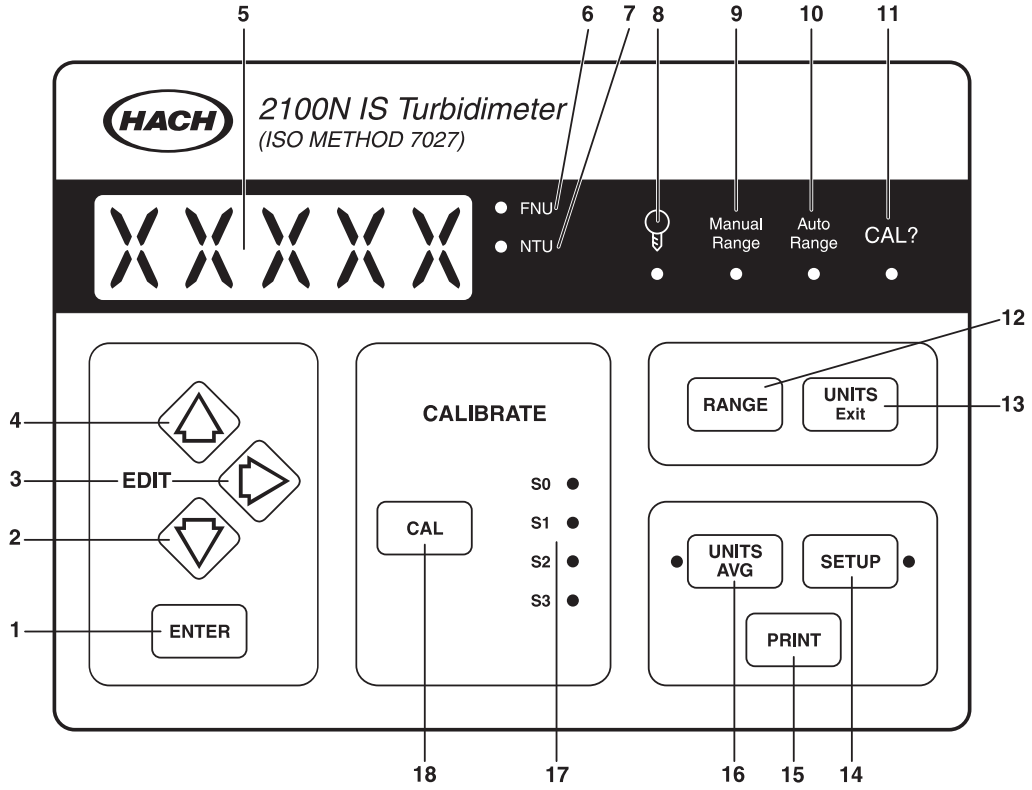
Run water for at least five minutes before sampling from a water tap in a distribution system or treatment plant. When sampling from a body of water (e.g., a stream, reservoir, clarifier or storage tank), collect at least one liter (1 quart), and thoroughly mix before taking an aliquot for measurement. If the sample 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.

SECTION 3 OPERATION

3.1 Operational Controls and Indicators

Figure 7 illustrates the locations of all controls, indicators and other operational features of the Model 2100N IS Laboratory Turbidimeter. Information on the functions of each of these features is provided in *Table 1* on page *30* and supplemented with additional details in Section *3.1.1* through *3.1.9*.

Figure 7 Model 2100N IS Operating Features



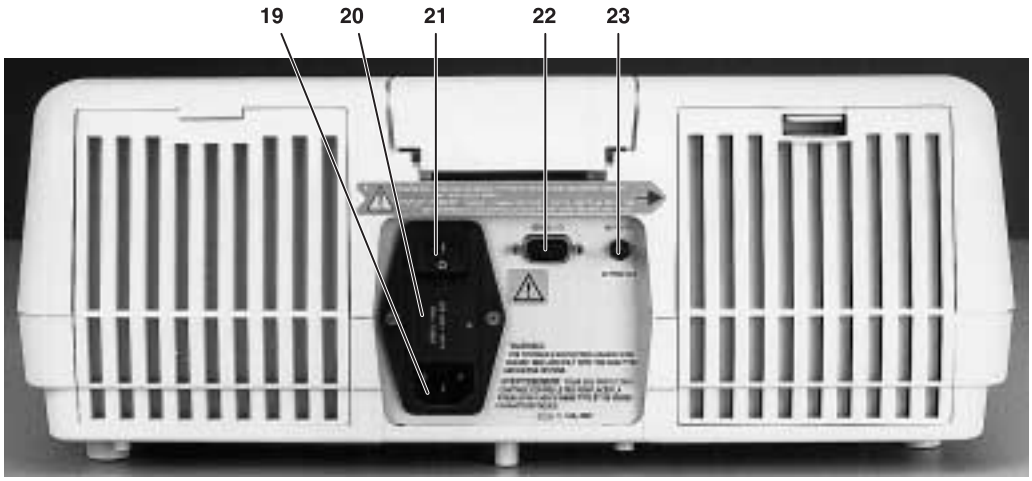


Table 1 Operating Features and Descriptions of Functions

Item	Name	Description
1	ENTER	Used in Calibration Mode to select the value of the formazin calibration standard and to initiate measurement of the standard. Pressing **ENTER** during measurement with SIGNAL AVERAGING on clears the buffer of all previous data. Selects functions during instrument setup.
2	DOWN ARROW	Same as **UP ARROW** except for direction of steps.
3	RIGHT ARROW	Advances the cursor position during calibration standard editing, instrument setup and sample number selection. Also, used to ignore dilution water turbidity during calibration (if required).
4	UP ARROW	Edits LED digits in the calibration mode and steps through calibration standards 00 through 03. Edits the "SETUP" number during the instrument setup procedure.
5	Display	Five-digit LED display.
6	FNU	Lights when the instrument is set for FNU unit of measure.
7	NTU	Lights when the instrument is set for NTU unit of measure.
8	Lamp	Lighted annunciator indicates when the instrument lamp is on. Flashes to indicate a low-level light condition.
9	Manual Range	Lighted annunciator indicates when the instrument is in the manual ranging mode.
10	Auto Range	Lighted annunciator indicates when the instrument is in the automatic ranging mode.
11	CAL?	Lights to indicate the calibration information recorded during the calibration process is outside of the acceptable range (may be an operator calibration error or an instrument malfunction). The instrument must be recalibrated if the CAL? annunciator flashes.
12	RANGE	Selects Auto Ranging or Manual Ranging. Pressing **RANGE** steps the instrument through the range options.
13	UNITS Exit	Selects unit of measure. Available units include FNU and NTU. Also, exits calibration or setup without saving new values.
14	SETUP	Initiates editing of the setup number to configure the instrument for specific operational functions (e.g., keyboard beeper on or off).
15	PRINT	Transmits the result of measurement to a computer or printer. If the instrument is in the calibration review mode, pressing **PRINT** transmits calibration data to a printer or computer. If the **PRINT** key is held during power up, a full set of diagnostic results is transmitted to a computer or printer. Pressing the **PRINT** key while editing a setup number prints a summary of the setup commands.
16	SIGNAL AVG	Turns the signal averaging function on or off. Lighted annunciator indicates Signal Averaging mode is on.
17	S0 through S3	Lights to indicate the current calibration point standard in use.
18	CAL	Initiates calibration in FNU and NTU measurement modes.
19	Power Cord Receptacle	Connection for line power cord. Must be correct rating for line voltage used.
20	Fuse Holder	Contains two time-delay, 1.6 amp, 250V fuses suitable for either 115- or 230-volt operation.
21	I/O	Power switch turns instrument on and off.
22	Serial Interface Connector	DB9 connector for RS232 cable connection.
23	Air Purge Fitting	Connection for air purge tubing. Maximum pressure 138 kPa (20 psig).
(not shown) Light Shield		Covers sample cell compartment to eliminate light that would interfere with the measurement. Must be closed during measurement, calibration and at power on; keep closed except when inserting sample cell. May cause ERR07.
(not shown) Cell Holder		Holds sample cell with solution to be measured. The reference mark is used to align the sample cell for proper orientation in the cell holder.

3.1.1 Using the RANGE Key

Refer to *SPECIFICATIONS* on page *9* for the instrument ranges. Select automatic or manual ranging by pressing the **RANGE** key. Repeated presses step the instrument from automatic range to manual range and then through each of the four manual range settings. When automatic ranging is selected, the Auto Range annunciator lights. In manual ranging, the Manual Range annunciator lights. The instrument automatically defaults to auto ranging during calibration. Range selection may be made at any time during sample measurement. If the instrument is turned off, it defaults to the last selected range setting when power is restored to the instrument.

The display flashes all 9s or all 0s when the sample being measured is over-range or under-range, respectively. Press the **RANGE** key to select the proper measurement range. If the over-range display flashes in Automatic Ranging or in the highest Manual Range, the sample is over-range for the instrument, and must be diluted prior to measurement (refer to Section *2.3.7)*.

3.1.2 Using the UNITS/EXIT Key

This key selects the unit of measure. If power is interrupted, the instrument returns to the unit of measure last selected when power is restored. Press the **UNITS** key repeatedly until the desired unit of measure is displayed.

The **UNITS** key also exits calibration without saving new values; previously stored calibrations are saved. Calibration information can be reviewed by entering the calibration mode, and then exited without changing the stored calibration data. Also, if an error is made during calibration, pressing the **UNITS** key escapes the calibration routine without saving the new data.

3.1.3 Using the SIGNAL AVG Key

Turn signal averaging on and off by pressing the **SIGNAL AVG** key. When on, the last ten measurements are averaged together to minimize the effects of random spikes in the turbidity measurement.

3.1.4 Using the PRINT Key

The **PRINT** key initializes several data transmittal activities. Press the **PRINT** key to print the displayed value and units. A calibration data report is generated by pressing the **PRINT** key when in the Calibration mode. Holding the **PRINT** key down while turning on instrument power prints a diagnostic report. Pressing the **PRINT** key while in the setup mode prints a report referencing setup functions to setup numbers. See Section *6* for more information.

3.1.5 Using the CAL Key

A calibration is initiated by pressing the **CAL** key. The measurement is automatically switched to FNU for calibration.

Pressing **CAL** at the end of a calibration sequence saves new calibration values and the instrument returns to the last-used measurement mode. Refer to Section *3.2.3* for detailed calibration instructions.

3.1.6 Using the ENTER Key

Press the **ENTER** key to accept the displayed or edited setup information or to begin measurement of a calibration standard.

Pressing the **ENTER** key clears stored data from the **SIGNAL AVERAGING** memory buffer and quickly updates the display when measuring samples. This feature is useful particularly when measuring samples with large differences in turbidity.

3.1.7 Using the Arrow Keys

The arrow keys edit the displayed value during calibration and increment through the calibration standards. They also edit the display any time an individual digit is flashing. Therefore, the arrow keys are also referred to as edit keys.

The right arrow key also can be used during calibration to ignore the dilution water turbidity standard (Standard S0). This procedure is not recommended except in special applications. Refer to Sections *3.2* through *3.2.9* for details.

3.1.8 Using the SETUP Key

Press the **SETUP** key to begin editing the setup number to configure the instrument for specific operational functions (e.g., keyboard beeper on or off). After the setup key is pressed, press the **PRINT** key to print a list of the setup numbers along with their setup commands.

3.1.9 Key Annunciator Tone (Beeper)

The key annunciator tone (beeper) is selectable on or off. When the mode is selected on, each key press is acknowledged by an audible "beep." The instrument is shipped with the tone on. To turn the tone off or on, use the following procedure:

1. Press the **SETUP** key. The annunciator lights and one of the LED digits in the display begins to flash.
2. If the display does not read **00**, use the edit keys to select **00**.
3. Press **ENTER**. The display reads **BP** (beep on) or **BP OF** (beep off).
4. Use the up or down arrow key to display the desired operational mode.
5. Press **ENTER** to accept the setting.
6. Press **SETUP** to exit the setup mode. Pressing **UNITS** at any time, prior to accepting the new setting, exits the setup mode leaving the original setting intact.

3.2 Calibration

The electronic and optical design of the 2100N IS Turbidimeter provides long-term stability and minimizes the need for frequent calibration. The monitor detector in the optical system compensates for electronic and optical system variations between calibrations.

The calibration is based on a first order linear equation. Unpredictable results may occur if standards other than the recommended calibration points are used. The factory suggested calibration points are those determined by Hach Company chemists and engineers to provide the best calibration accuracy. Use of standards other than those specified in Section *3.2.3* may result in less accurate calibrations.

Periodically, as experience or regulating authorities indicate, verify the instrument calibration using pre-calibrated Gelex Secondary Standards (refer to Section *3.2.4*). If the reading in the range of use is not within 5% of the standard's assigned value, recalibrate using formazin primary standards (refer to Section *3.2.1*).

3.2.1 Formazin Stock Solution

Make formazin dilutions used for instrument calibration from a 4000-FNU stock solution equivalent to the Hach Cat. No. 2461-42 turbidity standard supplied with the instrument. This prepared stock solution is stable for up to one year from the date received when properly stored. Thoroughly mix the 4000-FNU stock solution prior to use for making standards. If desired, 4000 FNU stock solution can be prepared using hydrazine sulfate and

hexamethylenetetramine (also available from Hach). Hach Company recommends using the prepared standard for best accuracy and long term data comparability. Preparation of 4000 FNU stock solution from raw materials is temperature and technique dependent. Prepared stock solution from Hach is manufactured under the tightest quality control standards. Formazin product purchased from Hach in the future will be equivalent to the standard delivered with the new instrument. Refer to Section *3.2.5* for preparation instructions.

3.2.1.1 StablCal™ Stabilized Formazin Standards

Optimum calibration accuracy can also be obtained using the StablCal™ Calibration Kit for the 2100N IS Turbidimeter. This kit contains prepared, stabilized formazin suspensions of <0.1-, 20-, 200-, 1000, and 4000-NTU. Order Cat. No. 26621 (500-mL each) or Cat. No. 26621-05 (ampuled).

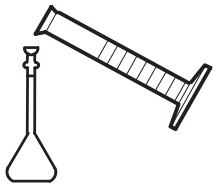
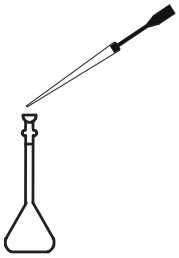
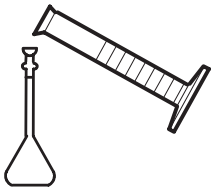
3.2.2 Dilution Water

Use high-quality, low-turbidity water (<0.5 FNU) to prepare the formazin dilutions required to calibrate the instrument. The Model 2100N IS Turbidimeter provides automatic correction for <0.5 FNU turbidity contributed by dilution water (refer to Section *3.2.3*). Distilled, deionized, or demineralized water usually is sufficient, as is most filtered tap water. If the purified water exceeds 0.5 FNU, filter it to meet the turbidity requirements as described in Section *2.3.3*.

3.2.3 Preparing Recommended Formazin Dilutions

Hach Company recommends use of 20-, 200-, and 1000-FNU formazin standards for calibration of the Model 2100N IS Turbidimeter. Prepare formazin dilutions immediately before calibration, and discard the dilutions after use. While 4000-FNU stock solutions are stable for up to one year, diluted solutions deteriorate more rapidly. Prepare dilutions of 20, 200 and 1000 FNUs according the directions in *Table 2*. The dilution water also is used to make an initial blank measurement.

Table 2 Preparing Formazin Standards

Standard	Step 1	Step 2	Step 3
			
20 FNU	Add 100 mL of dilution water to a clean 200-mL Class A volumetric flask.	With a TenSette® 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.
200 FNU	Add 50 mL of dilution water to a clean 100-mL Class A volumetric flask.	With a TenSette Pipet*, add 5.00 mL of well-mixed 4000-FNU formazin stock solution to the 100-mL flask.	Dilute to the mark with dilution water. Stopper and mix.
1000 FNU	Add 50 mL of dilution water to a clean 100-mL Class A volumetric flask.	With a TenSette Pipet*, add 25.00 mL of well-mixed 4000-FNU formazin stock solution to the 100-mL flask.	Dilute to the mark with dilution water. Stopper and mix.

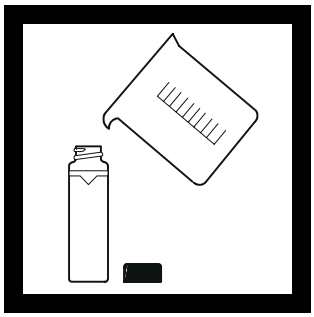
Calibrating the 2100N IS Turbidimeter (using Formazin Standards)

* Class A volumetric pipets can be used in place of a TenSette Pipet.

1. Press **CAL**. The CAL mode annunciator lights, and the S0 annunciator flashes. The FNU value of the dilution water used in the previous calibration is displayed.

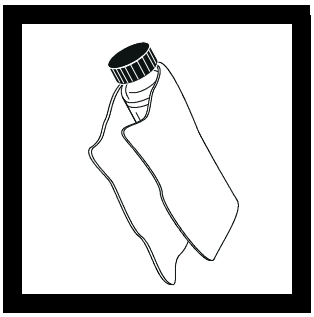
Note: *All Nephelometric calibrations are updated simultaneously using this procedure.*

Note: *When entering the Calibration Mode, Automatic Range and Signal Averaging On are automatically selected. Upon completion of calibration, all operational modes are restored to precalibration settings.*



2. Fill a clean sample cell to the line (approx. 30 mL) with dilution water.

Note: *If using StablCal Stabilized Formazin, use the <0.1-NTU standard.*

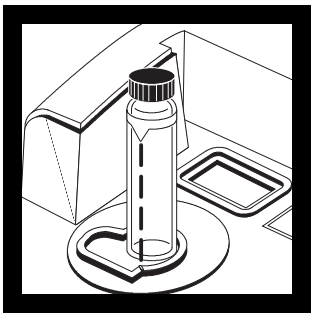


3. Wipe the sample cell clean, and apply a film of silicone oil (refer to Section *2.3.2*).

Note: *For best accuracy use matched sample cells for all measurements during calibration. An alternative may be to use the same cell for all standards.*

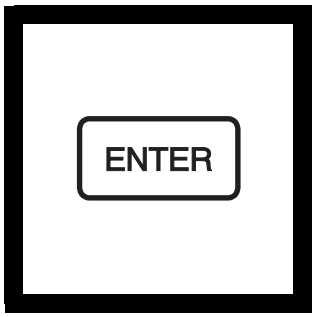
Note: *A portion of the same dilution water used for preparing standards must be used in this step.*

Note: *To exit the calibration procedure at any time without changing any stored value, press the* **UNITS** *key.*



4. Place the capped sample cell into the cell holder, and *close the cell cover.*

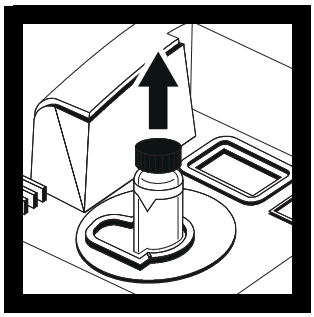
Note: *Install all matched vials with the orientation mark aligned with the cell holder reference mark.*



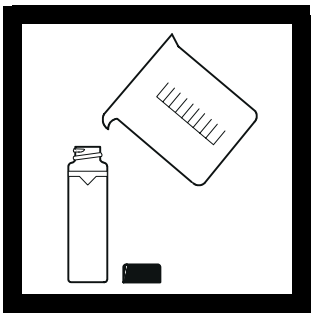
5. Press **ENTER**. The instrument display counts down from 60 to 0, and then makes a measurement. This result is stored and used to calculate a correction factor.

Note: *If reading of dilution water is >0.5 FNU, an E1 error message is displayed at the end of Step 8.*

Note: *The turbidity of the dilution water can be "ignored" rather than reading the dilution water. Refer to Section 3.2.6.*

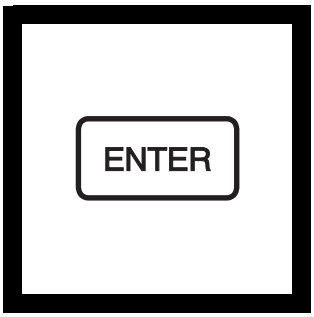


6. The instrument automatically increments to the next standard, displays the expected FNU value (e.g., 20.00 FNU), and the S1 annunciator flashes. Remove the sample cell from the cell holder.

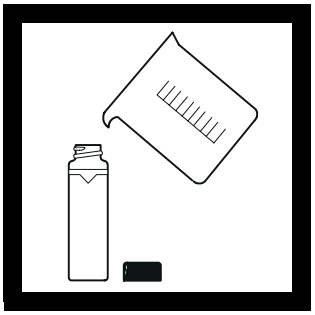


7. Fill a clean sample cell to the line with well-mixed, 20-FNU formazin standard. Wipe the sample cell clean, and apply a thin film of silicone oil on its surface. Place it into the cell holder, and *close the cell cover.*

Note: *If using StablCal Stabilized Formazin, use the 20-NTU Standard.*

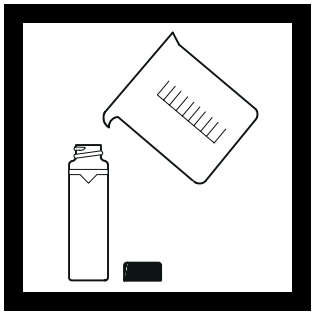


8. Press **ENTER**. The display counts down from 60 to 0, and makes a measurement. The instrument applies a correction factor to compensate for turbidity of the dilution water. The instrument automatically increments to the next standard, the display shows 200.0 FNU, and the S2 annunciator flashes. Remove the sample cell from the instrument.



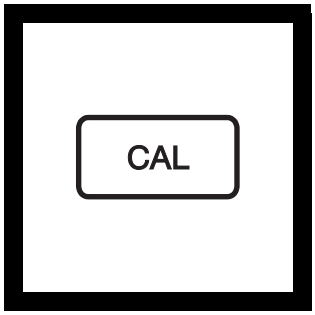
9. Fill a clean sample cell to the line with well-mixed, 200-FNU formazin standard. Wipe the cell clean and apply a thin film of silicone oil to the surface. Place it into the cell holder, and *close the cell cover.* Press **ENTER**. The instrument display counts down from 60 to 0, and then makes a measurement. The instrument automatically increments to the next standard, the display shows 1000 FNU, and the S3 annunciator flashes. Remove the sample cell from the instrument.

Note: *If using StablCal Stabilized Formazin, use the 200-FNU Standard.*



10. Fill a clean sample cell to the line with well-mixed, 1000-FNU formazin standard. Wipe the cell clean and apply a thin film of silicone oil to the surface. Place it in the cell holder and *close the cell cover.* Press **ENTER**. The instrument display counts down from 60 to 0, and then takes a measurement.

Note: *If using StablCal Stabilized Formazin, use the 1000-FNU Standard.*



11. Press **CAL**. The instrument makes calculations based on the new calibration data, stores the new calibration and returns the instrument to the measurement mode.

Note: *If power is lost during calibration, new calibration data is lost, and the old calibration remains in effect. To exit the calibration without saving new values, press UNITS.*

Note: *If error message ERR01 or ERR02 appears in the display, an error occurred during calibration (refer to* Table 5 Error Codes*). Clear the error message and proceed with measurements by pressing ENTER. However, Cal? annunciator is lighted indicating a questionable calibration. The Cal? annunciator is turned off only by recalibration, which removes erroneous data. Prepare new standards, and recalibrate the instrument. Make sure the formazin standards are fresh and well mixed. Also check to ensure dilution water is <0.5 FNU.*

3.2.3.1 Reviewing Calibration Data

To review calibration data currently in effect, press the **CAL** key, and then use the up arrow key to scroll through the standards. Pressing the **PRINT** key prints all of the calibration data in effect. Press the **UNITS** key to return to the operating mode. The stored calibration data is not affected.

3.2.4 Using Gelex® Secondary Turbidity Standards

Gelex Secondary Standards, supplied with the instrument, are metal-oxide particle suspensions formulated to correspond to formazin primary turbidity standards in their light scattering characteristics. NTU* values marked on the Gelex standards indicate the range for which they are to be used. Minor variations in glass and individual instrument optical systems dictate that the true value of the secondary standard must be determined on the instrument on which they are used. To calibrate the Gelex standards:

1. Calibrate the instrument with formazin (refer to Section *3.2*).
2. Verify that the instrument is set for the FNU mode and Automatic Ranging.
3. Thoroughly clean the outside of the Gelex vials, and apply a thin coating of silicone oil.
4. Place the lowest Gelex Standard in the sample compartment. Align the Gelex vial orientation mark with the sample cell compartment orientation mark. This ensures the best possible repeatability. *Close the cell holder cover.*
5. Press the **ENTER** key. Record the value displayed. Remove the standard from the instrument, and mark this value on the vial.
6. Repeat steps 3 through 5 for the other Gelex standards.

Note: *Reassign values to the Gelex standards each time the instrument is calibrated with formazin.*

A Stray Light Standard is included with each Gelex Secondary Standard Kit. Use of the Stray Light Standard is a mechanism to monitor the integrity of the instrument's optical system. If an optical component begins to degrade over time, the value of the Stray Light Standard will change significantly. If the value changes significantly, contact Hach Customer Service for more information.

Note: *Consistent orientation of the Gelex standards is critical each time they are used to check the instrument calibration.*

Determine the Stray Light Standard value when the instrument is first received. Clean the outside surface of the glass cell, apply silicone oil (see *Silicone Oil Procedure* on page *20.*) and measure the value in the FNU measurement mode. Make sure the sample cell is aligned in the cell holder the same way each time. Hach recommends using the vertical line that extends upward from the diamond symbol on the vial as a reference mark. Align this mark with the sample cell compartment orientation mark, and measure the value. Record this value on the sample cell. Store the Stray Light Standard at room temperature.

* Gelex Standards are labeled in NTU units. These are equivalent to FNU units (i.e., 1 NTU = 1 FNU)

3.2.5 Formulating Formazin Stock Solution

DANGER
To familiarize yourself with handling precautions, dangers and emergency procedures, always review the Material Safety Data Sheets prior to handling containers, reservoirs, and delivery systems that contain chemical reagents and standards. Protective eye wear always is recommended when contact with chemicals is possible.

PELIGRO
Para familiarizarse con las precauciones de manipulación, los peligros y los procedimientos de emergencia, siempre estudie las Hojas de Datos de Seguridad de los Materiales antes de manipular recipientes, depósitos y sistemas de entrega que contengan reactivos y patrones químicos. Siempre se recomienda el uso de protectores oculares cuando sea posible el contacto con productos químicos.

PERIGO
Para familiarizarse com as precauções de manipulação, riscos e procedimentos de emergência, examine sempre o Folheto de Dados de Segurança antes de manipular os recipientes, tanques e sistemas de distribuição que contenham reagentes químicos e outros elementos padronizados. Se recomenda sempre o uso de protetores para olhos, quando possa acontecer contato com os produtos químicos.

DANGER
Pour se familiariser avec les précautions à prendre lors de la manipulation, les dangers et les procédures d'urgence, toujours lire les Fiches de Données de Sécurité avant de manipuler les récipients, les réservoirs et les systèmes de distribution contenant les réactifs chimiques et les solutions étalons. Il est toujours recommandé de porter des lunettes de protection lorsqu'un contact avec les produits chimiques est possible.

GEFAHR
Es wird dringend empfohlen, die Sicherheitsdatenblätter vor der Handhabung von Behältern, Tanks und Zufuhrsystemen, die chemische Reagenzien und Standardsubstanzen enthalten, aufmerksam durchzulesen, damit Sie sich mit den beim Umgang mit diesen Chemikalien notwendigen Vorsichtsmaßnahmen, Risiken und Notfallschutzmaßnahmen vertraut machen. Es wird empfohlen, in allen Situationen, in denen mit einem Kontakt von Chemikalien zu rechnen ist, eine Schutzbrille zu tragen.

Note: *Preparing formazin from raw materials is not recommended. Preparation is temperature and technique sensitive. Use prepared 4000 FNU formazin stock solution to avoid handling raw materials and for the best instrument performance and analytical standard accuracy.*

1. A 4000-FNU formazin stock solution can be synthesized for making the calibration standard dilutions in place of using the prepared stock solution. Proceed as follows:
2. Dissolve 5.000 grams of reagent grade hydrazine sulfate ($(NH_2)_2 \bullet H_2SO_4$ — Cat. No. 742-26) in approximately 400 mL of demineralized water.
3. Dissolve 50.000 grams of hexamethylenetetramine (Cat. No. 1878-34) in approximately 400 mL of demineralized water.
4. Quantitatively, pour the two solutions into a 1-liter volumetric flask, and dilute to volume with demineralized water. Mix well.
5. Allow the solution to stand for 24 hours at 25 ±3 °C (77 ±5 °F). The suspension develops during this time.

3.2.6 Ignoring Dilution Water

During calibration, the turbidity of the dilution water can be ignored by pressing the right arrow key rather than measuring the dilution water for standard S0. The display shows **"-----"**. Then, press the up arrow key to advance to the next standard. Ignoring the dilution water is not recommended for most applications because it may result in significant errors for measurements below 100 FNU. Use it only in situations where you know your dilution water is particle free.

3.2.7 Editing Calibration Data Points

When using formazin standard dilutions other than the recommended 20-, 200-, and 1000-FNU standards during calibration, edit these data points as they occur in the display in the calibration procedure to agree with the actual turbidity of the substituted standards.

The calibration is based on a first order linear equation consisting of up to four independent variables. Unpredictable results may occur if standards other than the recommended calibration points are used. The factory suggested calibration points are those determined by Hach Company chemists and engineers to provide the best calibration accuracy. Use of formazin standards other than those specified in Section *3.2.3* may result in less accurate calibrations.

For example: If during the calibration procedure in Section *3.2.3* a 25-FNU standard is placed in the instrument in Step 6 instead of the 20-FNU standard, the 20.00 in the display is edited to show the value of the new standard before the **ENTER** key is pressed to initiate the measurement.

1. Press the right arrow key to access the editing mode. The decimal point will flash.
2. Use the right arrow key to move the decimal point to the appropriate location. Pressing **ENTER** accepts the new decimal location and causes the **2** to flash.
3. Because the **2** is correct as is, press the right arrow key again to ready the second digit for editing. The Up arrow key increments the flashing digit to read step 5 for the corrected display of **25.00**.
4. Press **ENTER**. The display counts down from 60 to 0 as the measurement is made and corrected to compensate for the turbidity of the dilution water. The instrument automatically increments to the next standard and annunciator S02 flashes.
5. Continue with the calibration, repeating the editing function for any other substituted standards.

3.2.8 Preparing Formazin Dilutions - User Selected

Hach Company recommends using 20, 200, and 1000-FNU formazin standards for calibrating the 2100N IS Turbidimeter. Other dilutions can be prepared and used, but if problems occur when using these alternative solutions, use the dilutions specified in Section *3.2.3*.

Prepare formazin dilutions from well-mixed, 4000-FNU stock solution as specified in Section *3.2.3* and dilution water as specified in Section *3.2.2.* Prepare formazin dilutions to span the entire range of the instrument. Three standards are required; the following are suggested: one in the range of 10 to 30 FNU, one in the range of 180 to 220 FNU, and one in the range of 900 to 1,000 FNU. Standards must have a difference of at least 60 FNU. In addition, make a blank measurement using the same dilution water used in making the formazin dilutions, and entered as the S0 calibration point. Prepare standard solutions immediately before use, and discard the standards when calibration is complete.

3.2.9 Calibrating the 2100N IS (user selected standards)

Instrument calibration is accomplished as described in Section *3.2* with two exceptions:

- Standards are values other than those used in Steps 5, 8, 9, 10, and 11.
- Before pressing **ENTER** to measure each standard, edit the displayed value (reflecting the previous calibration) to agree with the actual turbidity of the standard. This is done by using first the right arrow key to get into the editing mode and then using the arrow keys to edit the number.

Note: *For best accuracy, use the same sample cell or four matched sample cells for all measurements during calibration. Abort the calibration procedure at any time without changing any stored value by pressing the* **UNITS** *key.*

SECTION 4 AIR PURGE SYSTEM

4.1 ⚠ Air Purge Connection

An air purge system is provided to purge the optical compartment with dry air to prevent condensation on the outside of the sample cell when measuring cold samples. This system is particularly useful when using the Flow Cell assembly.

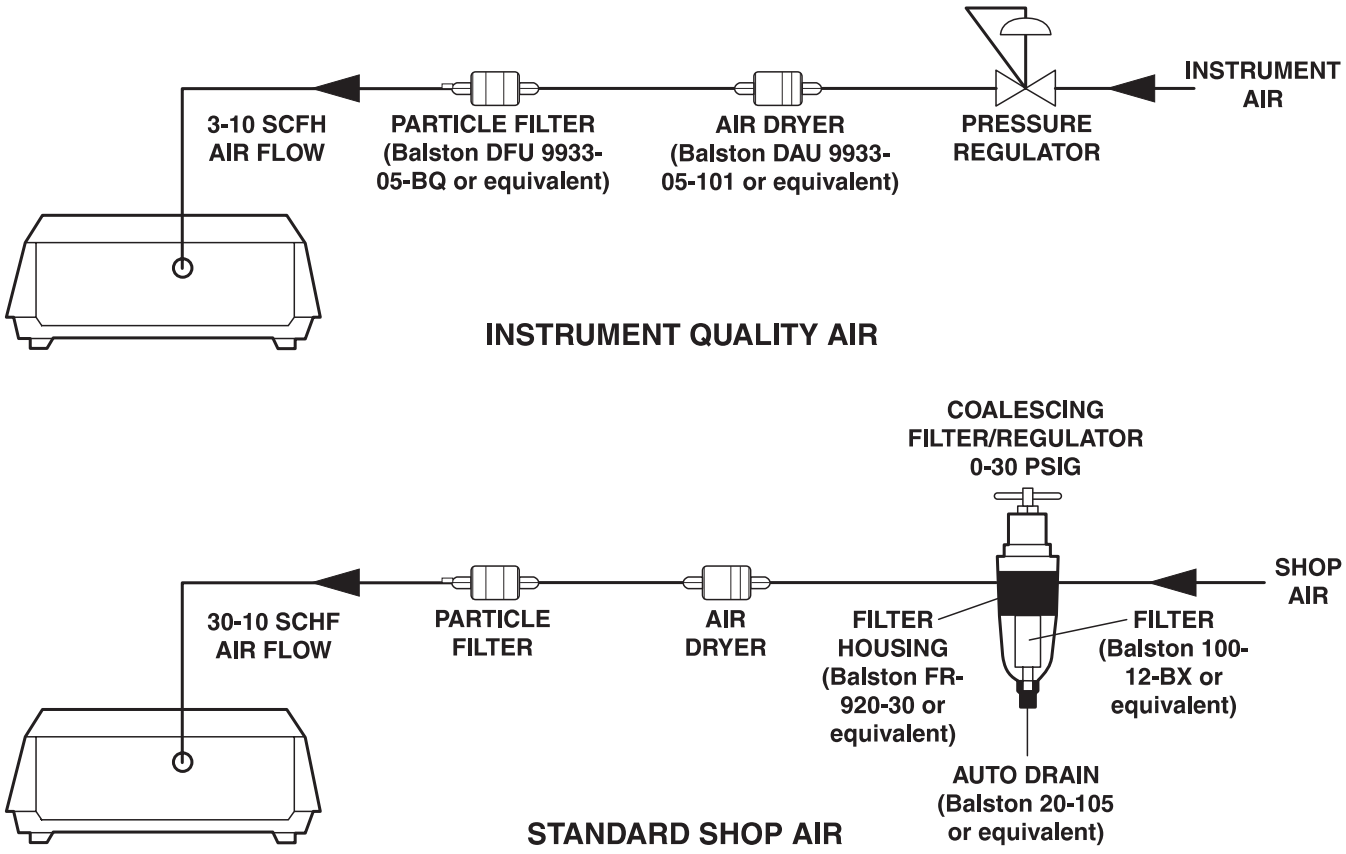
Note: *Do not exceed 138 kPa (20 psig).*

Dry nitrogen or instrument grade air (ANSI MC 11.1, 1975) up to 138 kPa (20 psig) can be used to air purge the optical housing compartment. The recommended air consumption rate is between 3 and 10 SCFH (standard cubic feet/hour). The connection is made at the **AIR PURGE** fitting on the rear panel.

When the sample temperature is expected to be near or below 2 °C (35 °F), use a desiccant dryer and particle filter to assure the dew point of the air purge is below the sample temperature. The air dryer contains silica gel desiccant that turns pink when exhausted. Life expectancy of the desiccant depends on the moisture content of the air.

If only shop air is available, use a coalescing filter with automatic drain in conjunction with a dryer and particle filter to achieve instrument quality air. Life expectancy of the coalescing filter should exceed 2000 hours. Change the particle filter at the same time as the air dryer. *Figure 8* illustrates methods of connecting the two types of air supply to the instrument. The dryer and filter are not necessary if dry nitrogen is used for the air purge.

Figure 8 Air Purge Connections



SECTION 5 USING FLOW-CELL SYSTEM APPARATUS

5.1 Description

An optional Flow-Cell kit is available for the 2100N IS Laboratory Turbidimeter and are applicable to low-pressure applications (< 34 kPa or 5psig).

Flow-Cell advantages:

- Increases speed of measurement
- Provides a single cell for all measurements (thus assuring a constant optical path)
- Eliminates the need for matched cells
- Minimizes the amount of glassware that must be purchased, stored, and cleaned

A constant optical path is the most important benefit of a Flow Cell. Variability, inherent flaws, and scratches in sample-cell glass can cause significant errors in low-level optical turbidity measurements. Hach Company recommends using a Flow Cell Assembly for low-level turbidity measurements.

⚠DANGER
Do not use the Hach Flow Cells with flammable samples or those containing hydrocarbons, solvents, concentrated acids or concentrated bases that may attack wetted parts of the cells. Conduct tests prior to use of Flow Cells if sample compatibility is questionable.

⚠PELIGRO
No use las Células de Flujo de Hach con muestras inflamables o que contengan hidrocarburos, solventes, ácidos concentrados o bases concentradas que puedan atacar las partes mojables de la célula. Experimente antes de usar las Células de Flujo, si existe duda sobre la compatibilidad de la muestra

⚠PERIGO
Não se deverá usar Celas de Fluxo Hach con amostras inflamáveis ou aquelas que contêm hidrocarbonetos, solventes, ácidos concentrados ou bases concentradas que podem atacar as partes molhadas das celas. Realize os testes antes do uso das Celas de Fluxo se é questionável a compatibilidade das amostras.

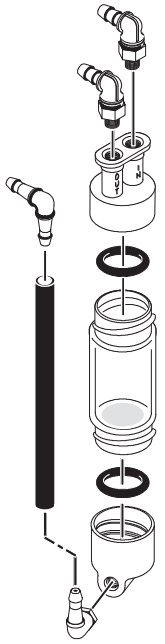
⚠DANGER
Ne pas utiliser les cuves à circulation Hach avec des échantillons inflammables ou ceux contenant des hydrocarbures, solvants, acides concentrés ou bases concentrées qui peuvent attaquer les parties au contact du liquide. Effectuer des essais avant l'utilisation des cuves à circulation si la compatibilité de l'échantillon est douteuse.

⚠GEFAHR
Durchflussküvetten von Hach dürfen nicht in Verbindung mit brennbaren Proben oder Proben, die Kohlenwasserstoffe, Lösemittel, konzentrierte Säuren oder konzentrierte Basen, die die benetzten Teile der Küvetten angreifen können, verwendet werden. Wenn die Verträglichkeit fraglich ist, sollten vor der Verwendung der Durchflussküvetten Tests durchgeführt werden.

5.2 Flow Cell Kit (Low-Pressure)

The Low-Pressure Flow-Cell system uses an innovative sample cell design* with a baffled inlet and dual outlets that minimize accumulation of entrapped air bubbles and heavy solid particles in the cell (see *Figure 9*). The glass cell is threaded on both ends to accommodate plastic end caps. The cell has an approximate volume of 22 mL when assembled. The parts disassemble easily for thorough cleaning.

Figure 9 Low-Pressure Flow Cell Assembly



Sample is introduced into the top of the cell. A baffle deflects the incoming sample to the side wall of the cell, minimizing turbulence in the light path.

Sample is discharged from top and bottom outlets. The top outlet collects and expels air bubbles and particles that tend to float. The conical-shaped bottom outlet collects settleable solids; water discharged from the bottom outlet carries the settled solids out of the cell. This novel, dual-outlet design eliminates dead volume in the cell to provide rapid, thorough flushing of the cell from one sample to the next.

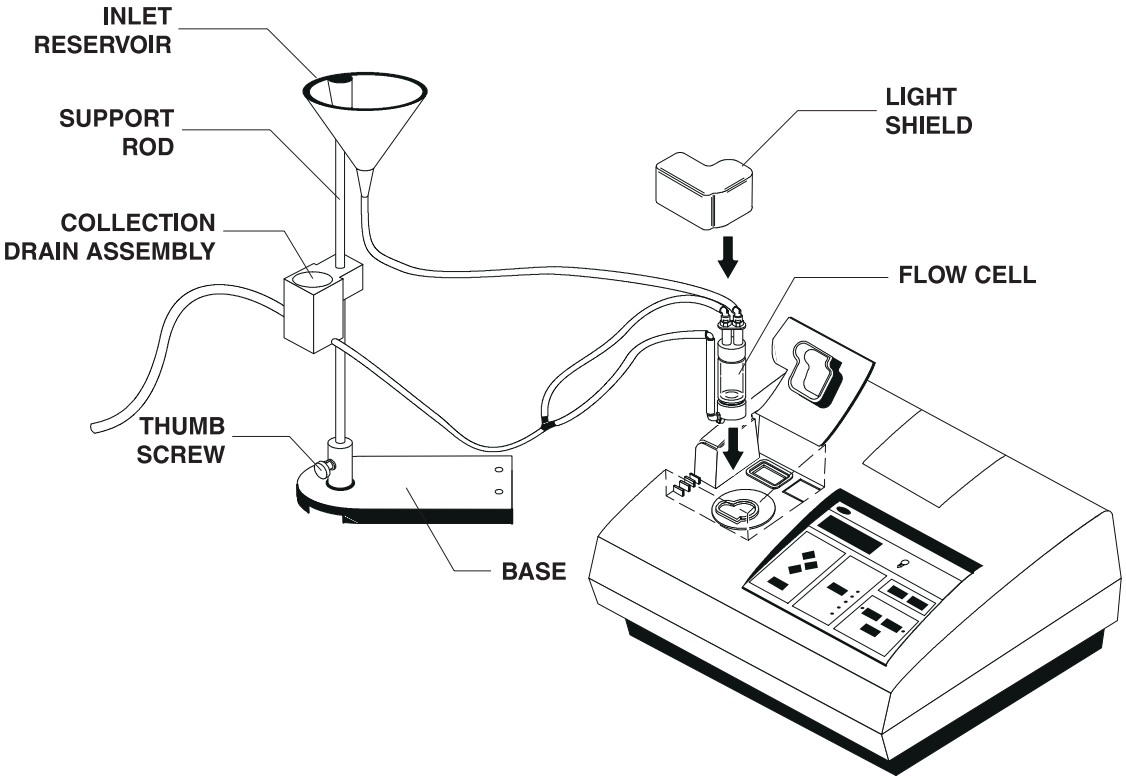
* U.S. Patent 5,475,486

5.3 Manual Flow Cell Kit (Low-Pressure)

The Manual Flow-Cell Kit (Cat. No. 47449-00) is for low pressure [<34 kPa (5 psig)] applications (see *Figure 10*).

The kit consists of a Flow-Cell Stand Assembly, a Flow-Cell Inlet Reservoir with a capacity of 350 mL, a Reservoir Cover, a Collection Drain Assembly, the Flow-Cell, interconnecting tubing, and a Flow-Cell Light Shield.

Figure 10 Manual Low-Pressure Flow Cell



⚠CAUTION
The manual and automated, Low-Pressure Flow- Cell setup is designed for low-pressure use only [<34 kPa (5 psig)].

⚠PRECAUCION
La Célula de Flujo de baja presión, tanto manual como automática, ha sido diseñada para baja presión solamente [34 kPa (5 psig - lbs/pulg.^{2} sobre la presión atmosférica)].

⚠PRECAUÇÃO
A Cela de Fluxo à baixa pressão manual e automatizada é projectada apenas para uso à baixa pressão [<34 kPa (5 libras/polegada quadrada manômetro)].

⚠PRUDENCE
La cuve à circulation basse pression, manuelle ou automatisée, est conçue pour utilisation sous faible pression uniquement [<0,34 bar (34 kPa - 5 psig)].

⚠VORSICHT
Die manuelle und die automatisierte Niederdruck-Durchflussküvette ist nur für Niederdruckanwendungen geeignet [<34 kPa (ca. 0,3 bar)].

5.3.1 Assembling the Support Stand

1. Verify the sample compartment is empty, and turn the instrument off.

Turn the instrument on its top (place it on a soft cloth to protect the instrument from marring), and install the base plate of the stand as illustrated in *Figure 11*. Tighten the screws until just snug; do not over tighten.

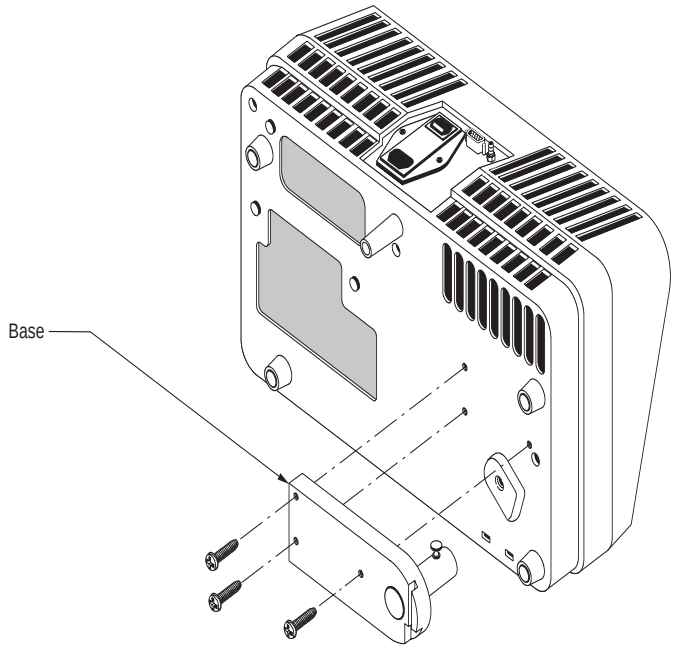
2. Place the instrument right side up. Refer to *Figure 10* for the remaining steps.

3. Install the Flow-Cell Inlet Reservoir on to the support rod.

4. Slide the Collection Drain Assembly on to the support rod.

5. Install the support rod into the base. Tighten the thumb screw to secure the rod.

Figure 11 Base Plate Installation



5.3.2 Assembling the Flow Cell

Verify the O-rings have been installed in the top and bottom end caps; then screw the caps on to the glass sample cell. Tighten the caps enough to ensure a water-tight seal, but do not over tighten.

5.3.3 Connecting Inlet and Outlet Tubing

1. Cut a 53-cm (21-inch) piece of clear, 0.32 cm ($^1/_8$ inch) I.D. Tygon tubing, and install it between the inlet reservoir and cell inlet. See *Figure 10*.

Note: Use the tubing supplied with the kit (or its equivalent). Tubing lengths are approximate. Avoid using more tubing than is recommended to avoid air locking and delays in measurement response time.

2. Cut two 23-cm (9-inch) pieces of clear, 0.32 cm ($^1/_8$ inch) I.D. Tygon tubing, and install them between the top and bottom Flow Cell drain fittings and the “Y” connector.

3. Cut a 2.5-cm (1-inch) piece of clear, 0.32 cm ($^1/_8$ inch) I.D. Tygon tubing, and install it between the "Y" connector and the Collection Drain Assembly.

4. Cut a 50-cm (20-inch) length of clear, 0.95 cm ($^3/_8$-inch) I.D. Tygon tubing for the drain line. Connect one end to the drain barb on the Collection Drain Assembly, and run the other end to a suitable drain.

The discharge end of the drain tube must be unrestricted and lower than the instrument for proper drain flow and prevention of air locking. Locate the instrument as close to the drain as is practical using the shortest length of drain tubing possible.

The kit is supplied with 152 cm (5 ft.) of 0.95 cm ($^3/_8$-inch) tubing. The system will not drain properly if this length is exceeded. If the entire 152-cm length is used, the end of the drain tubing must discharge at a point at least 46 cm (15 inches) below the center line of the instrument to ensure proper flow.

5.4 Using the Manual Flow-Cell Kit

Thoroughly clean and assemble the flow cell, tubing and stand (refer to Section *5.5*). Make sure the cell is clean, and there are no air bubbles present. Air bubbles tend to collect in areas that are not cleaned thoroughly.

Note: *Infrared light produced within this instrument is sufficient to cause eye injury. The appropriate sample cell cover must be closed or installed correctly before the infrared light source will operate.*

Fill the system with water and inspect for leaks before inserting it into the sample compartment of the instrument. Apply a thin coat of silicone oil to the outside of the flow cell (see *Silicone Oil Procedure* on page *20.*).

Install the Flow Cell in the sample compartment and press the inlet and outlet tubes into the slots provided on the instrument's top enclosure (see *Figure 10*). Cover the cell with the Flow-Cell Light Cover.

Note: *The Flow Cell Light Cover must be installed at all times when the Flow Cell is in use. The instrument's cell cover does not close when the Flow Cell is installed.*

Flow rate through the Flow Cell is controlled by adjusting the height of the Collection Drain Assembly on the Support Rod. Position the bottom of the Collection Drain Assembly a minimum of 7.5 cm (3 inches) above the support stand base. Raise the Collection Drain Assembly on the Support Rod to decrease the rate of flow. Lower the Collection Drain Assembly until it rests against the support base to purge the Flow Cell of sample.

Carefully add sample to the Inlet Reservoir to minimize entrapment of air bubbles in the sample. Air bubbles create a false positive interference in turbidity measurement. Always slowly pour sample down the inside edge of the reservoir.

5.4.1 Tips For Use of Flow-Cell Kits (Low-Pressure)

- Keep all parts of the system clean. Air bubbles tend to form around areas that are not cleaned thoroughly.
- If bubbles accumulate in the Flow Cell, gently tap the cell on a soft surface to dislodge the bubbles.
- Periodically replace all tubing to ensure the system is clean.
- Do not attempt to use the Flow Cell for samples containing large particles that may clog the system.
- Install the reservoir cover when the system is not in use to prevent contamination of the system by air-borne particles.

- Always carefully pour sample down the inside edge of the inlet reservoir to minimize agitation of the sample, which can entrain air bubbles.
- Do not use the systems for monitoring flammable solutions, solvents, strong acids or strong bases.
- Do not exceed the recommended maximum sample pressure of 34 kPa (5 psig).
- Fill the system with distilled or deionized water when it is not used for short periods of time (a few hours). This minimizes air locks and build up of residue on the components.

5.4.2 High-Pressure Flow Cell Kit

The High-Pressure Flow-Cell Kit is not designed for use with the 2100N IS Turbidimeter. The associated accessory parts will not permit the LED light source to activate.

5.5 Flow-Cell Maintenance

Periodically clean the Flow Cell kit parts. Disassemble the cells and clean the glass parts as described in Section *2.3.7*. Air dry the parts after cleaning. Clean plastic parts and tubing with laboratory detergent and warm water. Periodically replace plastic tubing because contaminants, including microbiological growths, are difficult to remove from the inside surface of the small-bore tubing. All tubing, Flow Cells, and caps in the low-pressure and high-pressure kits can be steam sterilized.

Coat the outside surface of the glass with a thin film of silicone oil before installation in the instrument (see Section *2.3.2*).

Note: *Always test the system for leaks before inserting the Flow Cell into the turbidimeter.*

Fill the system with distilled or deionized water when it is not used for short periods of time (a few hours). This minimizes air locks and build up of residue on the components.

Always disassemble, thoroughly clean, and air dry all components before long-term storage.

SECTION 6 DATA OUTPUT

6.1 ⚠ RS 232 Connection

Note: *Use of the supplied cable or equivalent is mandatory for EC compliance (a shielded cable assembly is required).*

The RS232 connection on the back panel mates with a standard RS232 connector as indicated in *Figure 12* on page *47* (also see *Table 3* below and *Figure 7* on page *29*). The factory RS232 interface output is an eight-bit data word plus one stop bit and no parity with a baud rate of 1200. It can communicate with either a serial printer or a serial communication port on a computer (see *Figure 13*). If the RS232 feature is used for a serial printer, a printer cable assembly terminated with a standard 25-pin D connector is available as an optional accessory (refer to page *59* for replacement parts). With the use of a serial-to-parallel converter, the data string transmitted from the 2100N IS Turbidimeter prints on any Epson compatible parallel printer of the type normally used with IBM compatible applications.

Data is transmitted to the printer as a 39-character string plus the line feed and carriage return.

Figure 12 Industry Standard DB-9 Male RS232 Connection

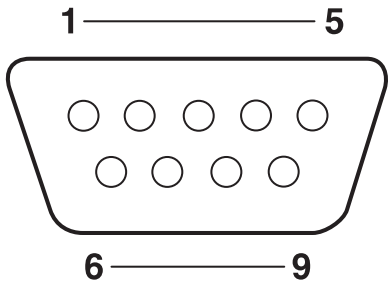


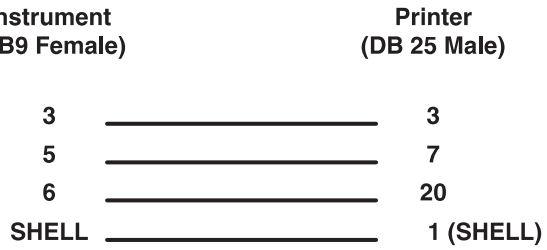
Table 3 RS232 Pin Connections

Pin	Description
2 - RXD	Receive Data
3 - TXD	Transmit Data
5 - GND	Signal Ground
6 - DSR	Data Set Ready
SHELL - FG	Frame Ground

All other pins are not connected

Pin 6 (Data Set Ready) is an optional printer handshake line, and should not be connected when using a computer.

Figure 13 Printer Cable Connections



6.2 Using a Printer

A permanent record of test results can be obtained by using the RS232 serial output to drive a printer. *Figure 14* provides a sample printout from the forty-column Citizen printer listed in the optional accessories on page *59*.

Figure 14 Printer Format Example

```
CALIBRATION DATA
UNITS: FNU
STANDARDS:
00 0.024
01 20.00
02 200.0
03 1000.
```

6.2.1 Printer Speed Selection

The 2100N IS Turbidimeter can be configured for fast or slow (2.5 second delay) print speed.

1. Press **SETUP**.
2. Use the arrow keys to edit the display to read “01.”
3. Press the **ENTER** key to activate the print speed selection mode. Use the **UP** and **DOWN** arrow keys to select the flashing “SL Pr” for slow or “FS Pr” for fast print speed.
4. Press the **ENTER** key to accept the desired setting, and exit the print speed configuration mode.

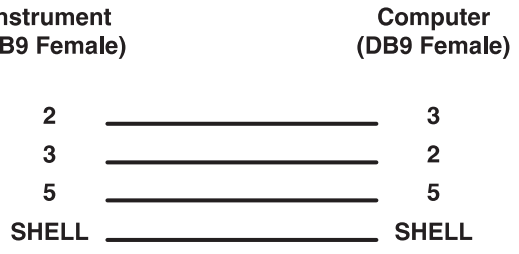
6.3 Using a Computer (RS232 Operating Commands)

A communication program such as HachLink™ or Window Terminal™ is recommended for computer operation. Configure the communication program to 1200 baud, 8 data bits, no parity, 1 stop bit.

The following RS232 command set is available when a computer is connected to the 2100N IS:

- Key in **VAL** (for value) and press enter on the computer keyboard. This action recalls the current 2100N IS measurement with the measurement units.
- Key in **LST** (for list) and press enter on the computer keyboard. This action lists the calibration standards and coefficients.

Figure 15 Computer Cable Connection



SECTION 7 CELL ADAPTERS

7.1 Using Cell Adapters

Cell adapters are used with the Model 2100N IS Turbidimeter when sample cells smaller than the standard 25-mm cells are required. A wide variety of test tubes, sample cells and ampules can be used with the cell adapters to measure smaller sample volumes. Small-diameter sample cells are useful when only a small quantity of sample is available, the sample to be measured is sealed in ampules and cannot be opened, or the sample is too turbid for use with the standard sample cell. A shorter light path permits measurement of high-range samples without the need for sample dilution.

Adapters are available for vial diameters of 12- to 13-mm, 16-mm and 19-mm O.D. The 12- to 13-mm adapter accommodates either 12-mm or 13-mm tubes. The minimum sample volumes that must be used are 2.5 mL for 12-mm tubes, 3.5 mL for 13-mm tubes, 5 mL for 16-mm tubes and 7 mL for 19-mm tubes.

The adapters come with a tall light shield supplied for test tubes taller than the standard cover.

Carefully select sample cell glassware used with the adapters to be clean and free of significant scratches. The same handling and cleaning care applied to the standard 2100N IS sample cells applies to the smaller cells (including the use of silicone oil on the outside of the glass).

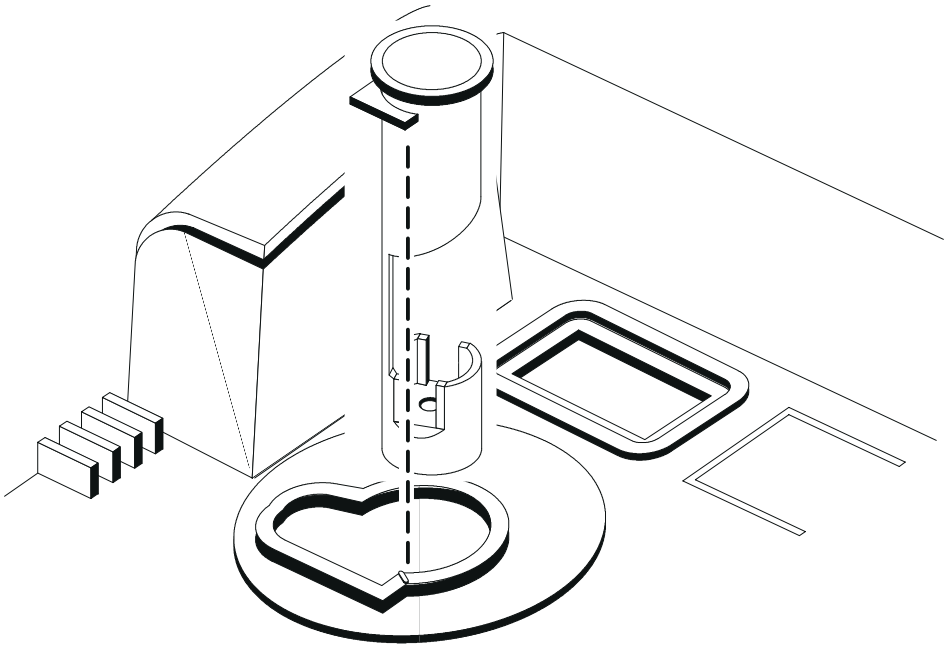
7.1.1 Installing and Removing Cell Adapters

To install a cell adapter in the instrument's sample compartment, align the tab on the cell adapter toward the front of the instrument (see *Figure 16*).

Note: *Do not force the adapter out of the compartment; serious instrument damage can occur.*

Carefully pull the adapter straight up to remove. Slowly rotate the adapter 90-degrees counter clockwise if the adapter catches.

Figure 16 Cell Adapter Installation



MAINTENANCE

DANGER

Some of the tasks in this section of the manual have safety issues associated with them. Because the potential for injury to individuals and equipment exists when these safety issues are not addressed, Hach Company strongly recommends that qualified personnel conduct the installation, and that all installation personnel review the associated instructions carefully.

PELIGRO

Algunas de las tareas comprendidas en esta sección del manual pueden ocasionar daños a las personas y al material si no se observan las medidas de suguridad. Hach Company recomienda encarecidamente que el instrumento sea instalado por un personal cualificado y que el personal encargado de la instalación lea atentamente estas instrucciones.

PERIGO

A execução de algumas tarefas previstas nesta secçao do manual pode causar ferimentos às pessoas ou estragos no equipamento se não forem observadas precauções de suranca. A Hach Company recomenda vivamente que o equipmento seja instalado por pessoal qualificado e que todas as pessoas afectadas à sua instalação leiam atentamente estas instruções.

DANGER

Certaines tâches dans ce chapitre du mode d'emploi peuvent causer des blessures aux personnes et endommager le matériel si les consignes de sécurité ne sont pas suivies. Hach Company recommande vivement que l'installation soit faite par du personnel qualifié et que toutes les personnes effectuant l'installation lisent attentivement ces instructions.

GEFAHR

Einige der Arbeiten in diesem Abschnitt des Handbuchs sind mit Sicherheitsauflagen verbunden. Da die Gefahr von Verletzungen für Personen oder Schäden am Gerät besteht, wenn diese Sicherheitsauflagen nicht beachtet werden, empfiehlt die Hach Company dringend, die Installation von qualifiziertem Personal durchführen zu lassen. Die mit der Installation befassten Personen sollten sich mit den jeweiligen Anweisungen ausführlich vertraut machen.

SECTION 8 MAINTENANCE

8.1 Cleaning

Keep the turbidimeter and accessories as clean as possible; use a mild detergent and water when necessary to clean the enclosure and keypad. Wipe up spills promptly. Wash sample cells with nonabrasive laboratory detergent, rinse with distilled or demineralized water, and air dry. Avoid scratching the glass cells, and wipe all moisture and fingerprints off of the cells before inserting them into the instrument (refer to Section *2.3.1*).

DANGER
Turn the 2100N IS Turbidimeter off and disconnect the power before cleaning the instrument.

PELIGRO
Apague el Turbidímetro 2100N IS y desconéctelo de la red eléctrica antes de limpiar el instrumento.

PERIGRO
Apague o Turbidímetro 2100N IS e desligue a corrente eléctrica antes de limpar o instrumento.

DANGER
Eteindre le turbidimètre 2100N IS et débrancher l'alimentation électrique avant de nettoyer l'appareil.

GEFAHR
Vor der Reinigung muss das Trübungsmessgerät 2100N IS abgestellt und der Netzstecker gezogen werden.

8.2 Light Source

The Light Emitting Diode (LED) light source is not a customer replaceable item. Typical LED life is more than ten years of continuous use. The unit must be sent to an authorized Hach service center for LED replacement.

DANGER
Infrared light produced within this instrument is sufficient to cause eye injury. The appropriate sample cell cover must be closed or installed correctly before the infrared light source will operate.

PELIGRO
La luz infrarroja generada en este instrumento es suficiente para causar daño a los ojos. La cubierta apropriada de la célula de muestras debe ser cerrada o instalada correctamente para que se encienda la fuente de luz infrarroja.

PERIGO
A luz infravermelha produzida dentro deste instrumento é suficiente para causar lesâo aos olhos. A tampa apropriada para cela de amostias deverâo ser colocada correctamente para energizar a fonte de luz infravermelha.

DANGER
La lumière infrarouge produite dans cet appareil est suffisante pour provoquer des blessures aux yeux. Le capot du compartiment d'échantillon utilisé doit être fermé ou installé correctement pour que la source de lumière infrarouge puisse fonctionner correctement.

GEFAHR
Das in diesem Gerät erzeugte Infrarotlicht kann auf Grund seiner Intensität zu Augenverletzungen führen. Die entsprechende Lichtschutzklappe muss richtig geschlossen oder aufgesetzt werden, damit die Infrarotlichtquelle arbeitet.

SECTION 9 TROUBLESHOOTING

9.1 Introduction

The Model 2100N IS Laboratory Turbidimeter incorporates a number of error codes and self-diagnostic functions for convenient and effective system troubleshooting.

9.2 Error Codes

Error codes may be initiated due to instrument malfunction or operator error. **ERR**"**XX**" error codes are cleared from the display by pressing the **ENTER** key. The instrument continues operating in the error condition; a calibration in progress can be continued. *Table 4* lists the error codes displayed for specific conditions.

Table 4 Error Codes

Code	Probable Cause	Corrective Action
ERR01	Dilution water is greater than 0.5 FNU	Start calibration over with better quality dilution water before use. See Sections *2.3.2* and *2.3.3*.
ERR02	Two calibration standards have the same value, or their difference is less than 60.0 FNU.	Recheck preparation of standards and repeat calibration.
ERR03	Low light error	Re-insert sample. Check that lamp is on. Check for obstructed light path. Dilution may be necessary.
ERR04	Memory malfunction	Switch instrument off and back on with the I/O key. Call Hach Service Department.
ERR05	A/D over-range	Be sure light shield is closed. Call Hach Service Department.
ERR06	A/D under-range	Check light path for obstruction. Call Hach Service Department.
ERR07	Light leak	Be sure cover is closed. Switch instrument off and back on with the I/O key.
ERR09	Printer timeout	Check that external printer is properly connected. Check that external printer is selected (on-line).
ERR10	System voltage out of range	Switch instrument off and back on with the I/O key. Call Hach Service Department.
ERR11	System loop test error.	Switch instrument off and back on with the I/O key. Call Hach Service Department.

9.3 Diagnostic and Setup Functions

The diagnostic mode accesses information about instrument operation and often is used when servicing the equipment. Enter the diagnostic mode by pressing the **SETUP** key. Exit from this mode at any time by pressing the **UNITS** key.

9.3.1 Basic Diagnostic Codes

Access the *Table 5* diagnostic information by entering the appropriate code (XXXXX) indicates a numeric result):

Table 5 Diagnostic and Setup Codes

Code	Display	Description
00	b Pon/bP of	Keyboard Beeper On/Off
01	FS Pr/SL Pr	Fast/Slow Print Device
21	Pr In	Printer Test
22	*	Display Test
23	*	Keyboard Test
24	*	Memory Test
25	XXXXX	Ninety Degree Detector Millivolts, Gain 1

Table 5 Diagnostic and Setup Codes (Continued)

Code	Display	Description
26	XXXXX	Ninety Degree Detector Millivolts, Gain 10
27	XXXXX	Ninety Degree Detector Millivolts, Gain 100
28	XXXXX	Ninety Degree Detector Millivolts, Gain 1000
44	XXXXX	A/D Reference Low Millivolts, Gain 1
45	XXXXX	A/D Reference Low Millivolts, Gain 10
46	XXXXX	A/D Reference Low Millivolts, Gain 100
47	XXXXX	A/D Reference Low Millivolts, Gain 1000
48	XXXXX	A/D Reference Medium Millivolts, Gain 1
49	XXXXX	A/D Reference Medium Millivolts, Gain 10
50	XXXXX	A/D Reference Medium Millivolts, Gain 100
51	XXXXX	A/D Reference Medium Millivolts, Gain 1000
52	XXXXX	A/D Reference High Millivolts, Gain 1
53	XXXXX	A/D Reference High Millivolts, Gain 10
54	XXXXX	A/D Reference High Millivolts, Gain 100
55	XXXXX	A/D Reference High Millivolts, Gain 1000
56	XXXXX	Ground Millivolts, Gain 1
57	XXXXX	Ground Millivolts, Gain 10
58	XXXXX	Ground Millivolts, Gain 100
59	XXXXX	Ground Millivolts, Gain 1000
60	XXXXX	+5 System Volts
61	XXXXX	-5 System Volts
62		Unused on 2100N IS
63	XXXXX	+8 System Volts

* Test results are displayed.
XXXXX indicates a numeric result.

9.3.2 Other Instrument Diagnostics

9.3.2.1 Display Segments and Icons

Determine the proper functioning of all display segments and icons by using diagnostic **22**. Press **SETUP**. Use the edit keys to change the large display to read "**22**," and press **ENTER**. Press **UNITS** to stop the display test.

9.3.2.2 Cold Start

A cold start of the instrument erases from memory any calibration data entered by the user. The instrument must be recalibrated before use. Press and hold the **CAL** key, and then turn the instrument power on to place the instrument in a cold start condition. After cold start, the **CAL?** annunciator flashes until another calibration is entered (see Section *3.2*).

9.3.2.3 Flashing 9s

If the display flashes all 9s, the sample being measured is overrange (for the selected range of measurement). If the display flashes 9s when the instrument is in the automatic range mode or the highest manual range, the sample is over the range of the instrument.

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.

REPLACEMENT PARTS AND ACCESSORIES

Description	Cat. No.
2100N IS Laboratory Turbidimeter (115/230V, approved with North American power cord and electrical fuse)	47900-00
2100N IS Laboratory Turbidimeter (115/230V, with European power cord and electrical fuse)	47900-02

REPLACEMENT ITEMS

Cover, sample cell compartment	47946-00
Dust Cover	47030-00
Formazin Primary Turbidity Stock Solution, 4000 NTU, 100 mL	2461-42
Gelex® Secondary Turbidity Standardization Kit (for 2100N IS Model only)	25893-00
Includes:	
Stray Light Standard	25891-00
0-2 NTU	25891-01
0-20 NTU	25891-02
0-200 NTU	25891-03
Instrument Manual	47900-18
Oiling Cloth	47076-00
Power Cord, 18/3 SVT, 10 A, 125 V (North American, 115 Vac, UL/CSA approved Power Cord)	18010-00
or	
Power Cord, .75 mm SQX3 conductor, (European, 230 Vac, VDE approved Power Cord)	46836-00
Quick Reference Card	47900-44
Sample Cells, 6/pkg	20849-00
Silicone Oil, 15 mL dropper bottle	1269-36

OPTIONAL REAGENTS AND ACCESSORIES

Bath, ultrasonic	24895-00
Cable, computer, DB-9 to DB-9	49502-00
Cable, for Citizen printer (Cat. No. 25933-00 and 25933-02), DB-9 to DB-25	49503-00
Cell Adapter, 12-13 mm	30334-00
Cell Adapter, 16 mm	30335-00
Cell Adapter, 19 mm	30336-00
Filter, membrane (without pad), 200/pkg	13530-01
Filter Disks, 10/pkg	23238-10
Filter Paper, glass fiber, quantitative, 47 mm	2530-00
Flask, erlenmeyer, 500 mL	505-49
Flow-Cell Kit, Manual	47449-00
Fuse for 115/230V operation, 250V, 1.6A, UL/CSA approved	30307-00
Fuse for 115/230V operation, 250V, 1.6A, IEC type, VDE approved	30306-00
Hexamethylenetetramine, 100 g	1878-26
Hexamethylenetetramine, 500 g	1878-34
Hydrazine Sulfate, 100 g	742-26
Printer, 115 V, Citizen Model iDP-562, 40-column, dot matrix	25933-00
Printer, 230 V, Citizen Model iDP-562, 40-column, dot matrix	25933-02
Printer Paper for Citizen Printer, 12 rolls/pkg	23619-00
Pump, vacuum, hand-operated	14283-00
Pump, vacuum/pressure, portable, 115V, 60 Hz, 1.3 cfm	14697-00

OPTIONAL REAGENTS AND ACCESSORIES (continued)

Description	Cat. No.
Pump, vacuum/pressure, portable, 220V, 50 Hz, 1.3 cfm	14697-02
Ribbon Cartridge, iDP-562 (for Citizen Printer Model iDP-562)	25934-00
Sample Degassing Kit	43975-00
Sample Degassing and Filtration Kit	43975-10
StablCal™ Low Level Turbidity Verification Standards (not for instrument calibration)	
0.1 NTU, 100-mL	27233-42
0.3 NTU, 100-mL	26979-42
0.5 NTU, 100-mL	26980-42
StablCal™ Stabilized Formazin Kit (contains one each of <0.1-, 20-, 200-, 1000-, and 4000-NTU standards in 500 mL bottles)	26595-00
StablCal™ Stabilized Formazin Kit (ampules)	26595-05
Surfactant, Triton X-100, 100 mL	14096-32
TenSette Pipet, 1-10 mL, for calibration dilutions	19700-10
TenSette Pipet Tips, 1-10 mL, pk/50	21997-96
Tubing, 1/4-inch OD plastic, for High-Pressure Flow Cell	42152-00
Ultrasonic Bath, Branson®	24895-00
Volumetric Flask, 100 mL, for calibration dilutions	14574-42
Volumetric Flask, 200 mL, for calibration dilutions	14574-45
Volumetric Flask, 1000 mL	14547-53
Water, Demineralized, 4 L	272-56

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(970) 669-2932

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

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Information Required

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- Billing address
- Shipping address
- Catalog number
- Quantity

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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**.

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P.O. Box 389 Loveland, Colorado, 80539-0389 U.S.A.
Telephone: (970) 669-3050; FAX: (970) 669-2932

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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,
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Loveland, Colorado, 80539-0389 U.S.A.
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FAX: (970) 669-2932
E-mail: intl@hach.com

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