Model 2100N
Laboratory Turbidimeter
Instruction Manual

For Use With Software Version 1

hm/dh 6/99 2ed
Rev. 1, 10/99

TRADEMARKS OF HACH COMPANY

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ChromaVer®
ColorQuik®
CoolTrak®
CuVer®
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DithiVer®
Dr. F. Fluent™
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Mug-O-Meter®
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OptiQuant™
OriFlow™
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PathoScreen™
PbEx®
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Pocket Colorimeter™
Pocket Pal™
Pocket Turbidimeter™
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PourRite®
PrepTab™
ProNetic™
Pump Colorimeter™
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RapidSilver™
Ratio™
RoVer®
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StillVer®
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TitraStir®
TitraVer®
ToxTrak™
UniVer®
VIScreen™
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WasteAway™
ZincoVer®

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CERTIFICATION

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

The 2100N 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 Amador Corp., Pinewood Oats (NVLAP #0271 01), 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 Amador Corp., Pinewood 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 Amador Corp., Pinewood 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 Turbidimeter from it's power source to verify that it is or is not the source of the interference.
2. If the Model 2100N Turbidimeter is connected into the same outlet as the device with which it is interfering, try another outlet.
3. Move the Model 2100N 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.

SAFETY PRECAUTIONS

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

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

Use of Hazard Information

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

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

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

NOTE
Information that requires special emphasis.

Precautionary Labels

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

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

⚠ ***Section 1.4.3 Operating Power Selection on page 17***

⚠ ***Section 2.3 Measuring Turbidity on page 20***

⚠ ***Section 4.1 Air Purge Connection on page 49***

⚠ ***Section 5.3 High-Pressure Flow-Cell Kit on page 58***

⚠ ***Section 6.1 RS232 Connection on page 63***

⚠ ***Section 7.2 Lamp Replacement on page 67***

SPECIFICATIONS

(Specifications subject to change without notice)

Principle of Operation: Nephelometric

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

Measurement Units:
Measurement Unit: NTUs, EBCs or Nephelos

Ranges (With Ratio ON)
NTU Mode: 0-4000 NTU with automatic decimal point placement or 0-0.999, 0-9.99, 0-99.9, 0-4000 with manual range selection
Nephelo Mode: 0-26,800 with automatic decimal point placement or 0-9.99, 0-99.9 and 0-26800 with manual range selection
EBC Mode: 0-980 with automatic decimal point placement or 0-0.999, 0-9.99, 0-99.9 and 0-980 with manual range selection

Ranges (With Ratio OFF)
NTU Mode: 0-40
Nephelo Mode: 0-268
EBC Mode: 0-9.8

Accuracy: ±2% of reading plus 0.01 NTU from 0-1000 NTU; ±5% of reading from 1000 to 4000 NTU based on Formazin primary standards and with Ratio ON; ±2% of reading plus 0.01 NTU from 0-40 NTU with Ratio OFF. Reference Conditions: 0 to 40 °C, 0 to 90% RH Noncondensing @ 25 °C, 115/230 Vac ±17%, 50/60 Hz.* **

Resolution: 0.001 on lowest range.

Repeatability: ±1% of reading or ± 0.01 NTU which ever is greater. Reference Conditions: 0 to 40 °C, 0 to 90% RH Noncondensing @ 25 °C, 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: Tungsten filament lamp. Lamp life 8,800 hours (typical).

Signal Averaging: Operator selectable on or off.

* Turbidity specifications determined using USEPA Filter Assembly. Use of Flow Cell is required to achieve the cited specifications.
** Intermittent electromagnetic radiation of 3 volts/meter or greater may cause slight accuracy shifts. Please see *SUPPLEMENTAL COMPLIANCE INFORMATION* on page *79*.

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: 30 mL (1 oz.) minimum

Secondary Standards: Gelex® Secondary Standards

Temperature:
Storage Temperature: -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 @ 40 °C

Instrument Stabilization Time: 30 min. with ratio on, 60 min. with ratio off; typical application leaves instrument on 24 hrs/day

Air Purge: 0.1 scfm at 69 kPa (10 psig: 0 hose barb connection for 1/8ð 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 (Automatic Power Selection)

Serial I/O: RS232C serial interface via DB9 subminiature D shell connector for data output to computer or printer, and data input (command). No handshaking. Factory set for a 1200 baud rate, 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 153/4 x 61/8 in.)

Instrument Weight: 3.43 kg (7 lbs, 9 oz)

Shipping Weight (with standard accessories): 5.58 kg (12 lbs. 5 oz.)

OPERATION

DANGER

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

DANGER

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

PELIGRO

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

GEFAHR

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

PERIGO

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

SECTION 1 GENERAL DESCRIPTION

1.1 Instrument Description

The Hach Model 2100N Laboratory Turbidimeter (*Figure 1)* is designed for measurement of turbidity from 0 to 4000 NTU (Nephelometric Turbidity Units) with automatic range selection and decimal point placement. Measure solutions with higher turbidity levels by dilution with filtered sample and a simple calculation. Refer to *Section 2.8* on page *29* for additional information.

The 2100N Laboratory Turbidimeter also provides direct display in units of Nephelos (0–26800 Nephelos) and EBCs (European Brewery Convention, 0–980 EBCs). These units are displayed using the conversion factors of 6.7 Nephelos per NTU and 0.245 EBCs per NTU.

Note: *Ratio on must be selected for measurement of samples greater than 40 NTUs, 268 Nephelos and 9.8 EBCs.*

The microprocessor-based Model 2100N is designed for laboratory use, and employs advanced optical and electronic design. The instrument operates on 115/230 Vac, and provides an RS232C output for connection to a printer, datalogger or computer.

1.2 Standard Accessories

Accessory items supplied with the turbidimeter include seven sample cells, a set of five Gelex® Secondary Turbidity Standards including a stray light standard, Formazin Primary Standard, a power cord, silicone oil, sample cell oiling cloth, a dust cover, and an instrument manual.

1.3 Principle of Operation

The Model 2100N Laboratory Turbidimeter is a Nephelometer with the capability to measure with either the Ratio on or Ratio off. The instrument meets the design criteria of the United States Environmental Protection Agency (Method 180.1) and is acceptable for compliance reporting.

The optical system* (shown in *Figure 2*) is comprised of a tungsten-filament lamp, lenses and apertures to focus the light, a 90-degree detector, forward-scatter light detector, and a transmitted-light detector.

The instrument permits turbidity measurements at less than 40 NTU to be performed utilizing only the 90 degree scattered-light detector or using the complete set of detectors (ratio). With the Ratio on, the instrument's microprocessor uses a mathematical calculation to ratio signals from each detector. The benefits of using Ratio on for measurements include excellent linearity, calibration stability and the ability to measure turbidity in the presence of color.

The optical system (shown in *Figure 2*) includes a 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.

* U.S. Patents 4198161, 0363676, and 5604590

Figure 1 2100N Laboratory Turbidimeterr

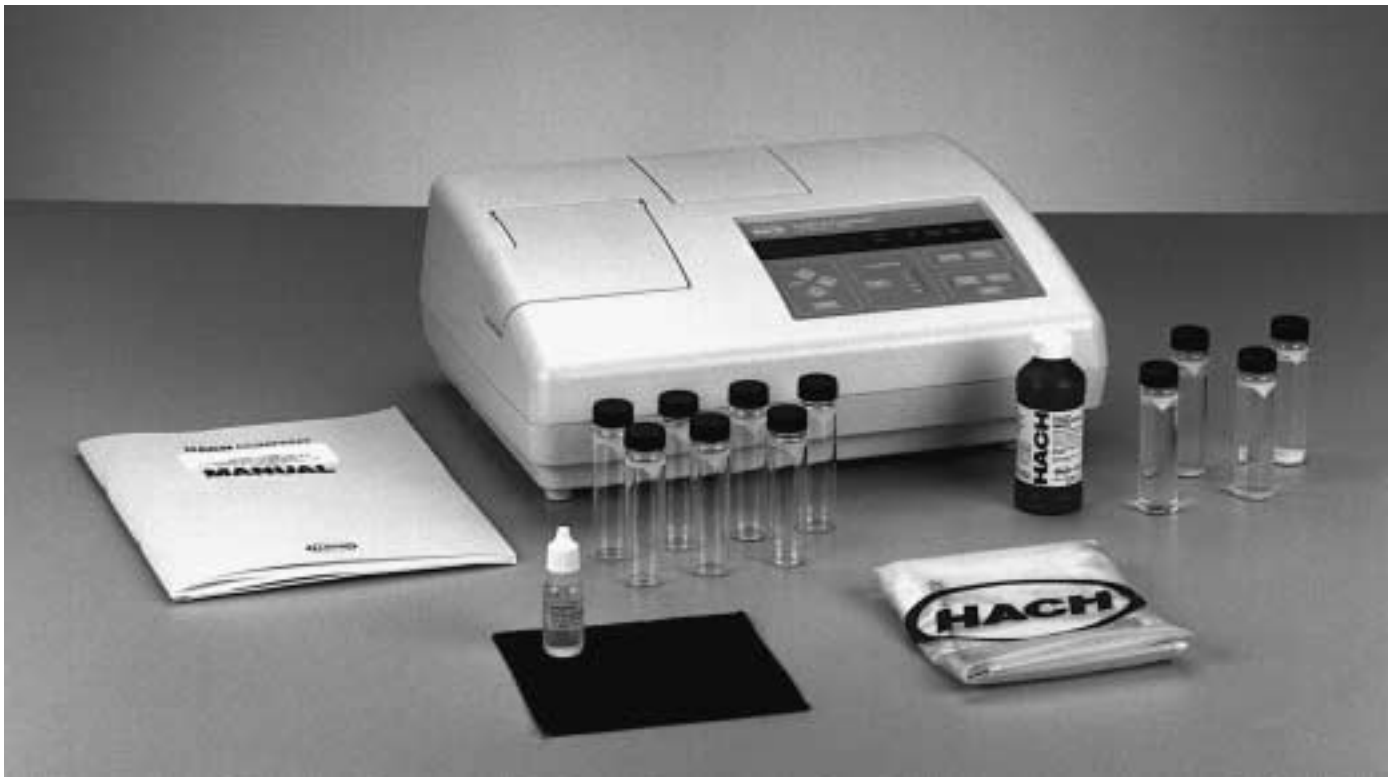
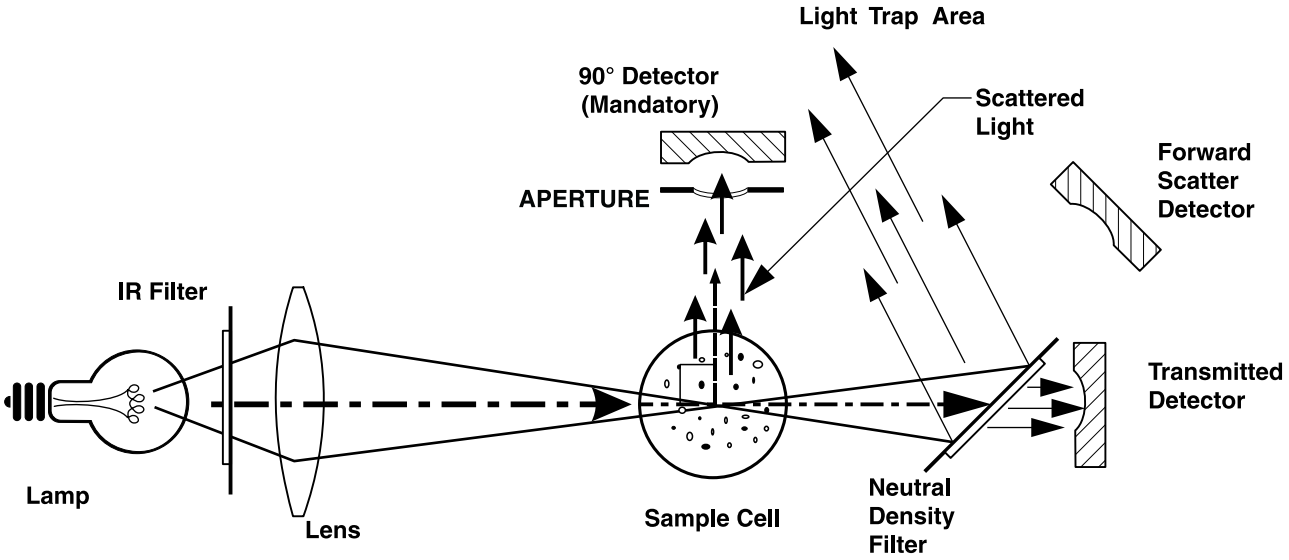


Figure 2 2100N Laboratory Turbidimeter Optics



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 due to rough handling or extreme weather conditions.

Verify the following items are present:

- Model 2100N Laboratory Turbidimeter
- Instrument Manual
- 4000-NTU Formazin Standard, 100 mL
- Standardization Kit containing Gelex Secondary Standards for Stray Light, 0–2, 0–20, 0–200, and 200–4000 ranges
- Oiling Cloth
- Seven Sample Cells
- silicone Oil, 15 mL (0.5 oz.) SCDB (Self-Contained Dropping Bottle)
- Power Cord
- Dust Cover

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

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 in the back and underneath of the instrument case 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 power cord receptacle on the rear panel. Voltage selection for 115 or 230 Vac is done automatically.

A power cord suitable for U.S. and Canadian 115 Vac line voltage is supplied with the Model 2100N (Cat. No. 47000-00). If this model is to be configured for 230 Vac, an approved UL/CSA power cord with NEMA 6-15P type cord cap must be used in place of the 115 Vac power cord supplied.

The Model 2100N (Cat. No. 47000-02) is factory configured for European 230 Vac line voltage. The power cord supplied with this model is VDE approved, and has a Continental European type plug.

SECTION 2 TURBIDITY MEASUREMENT

2.1 Operating Controls and Indicators

2100N Laboratory Turbidimeter controls and indicators are explained in detail in *SECTION 3*. Also, refer to the operating features in *Figure 8* on page *33*.

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 Filter Modules

The 2100N Turbidimeter is supplied with an insertable EPA Filter Assembly* (Cat. No. 30312-00) for turbidity measurement.

The EPA Filter Assembly is required for turbidity measurements reported for United States Environmental Protection Agency (USEPA) National Primary Drinking Water Regulations (NPDWR) or National Pollutant Discharge Elimination System (NPDES) permits.

2.2.1 Installing the Filter Assembly

1. Ensure the filter is clean and free from visible damage.

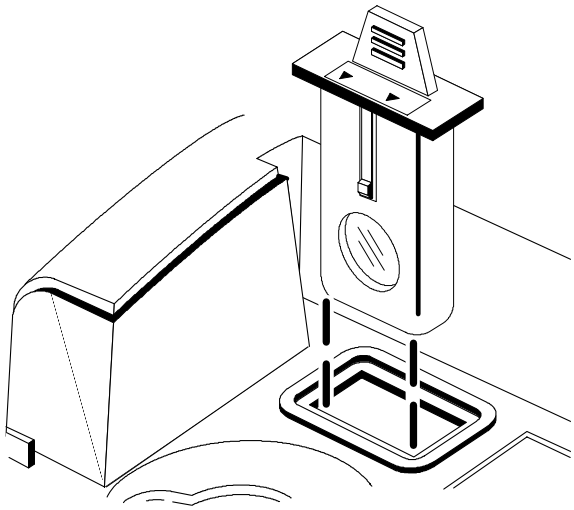
Note: *Handle the filter assembly with care; the filter installed in the assembly is fragile. Periodically inspect the filter glass for scratches or other signs of degradation. If the filter appears cloudy or dirty, clean it with lens tissue.*

2. Hold the tab on the filter assembly, and insert the filter with the arrows pointing toward the front of the turbidimeter.

3. Press the filter assembly all the way down into the housing. (See *Figure 3*.)

4. To remove the filter assembly from the instrument, grasp the tab and pull straight up. Store the filter assembly in a clean environment.

Figure 3 Inserting the Filter Assembly Into the Housing



* U.S. Patent D365682

2.3 ⚠ Measuring Turbidity

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

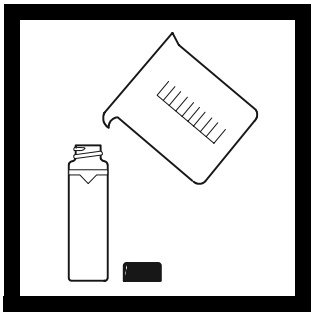
DANGER
Le turbidimètre de laboratoire 2100N n'est pas prévu pour utilisation avec des liquides inflammables ou contenant des hydrocarbures ou acides concentrés qui pourraient attaquer les composants du 2100N. Effectuer des essais préalables en cas de doute sur la compatibilité de l'échantillon à contrôler.

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

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

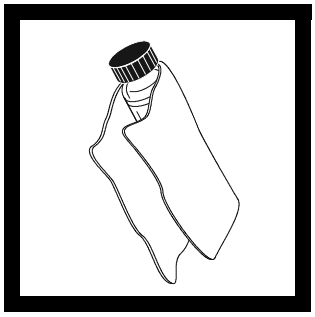
PERIGO
O Turbidímetro de Laboratório 2100N não é feito com o fim de ser empregado com amostras inflamáveis ou aquelas que contêm hidrocarbonetos ou ácidos concentrados que possam atacar os componentes do 2100N. Os testes devem ser executados antes da análise se existe alguma dúvida com respeito à compatibilidade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

2.4 Nephelometric Measurement Procedure

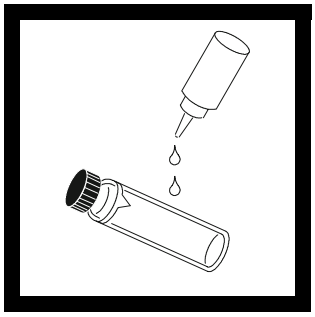


1. Collect a representative sample in a clean container. Fill the sample cell to the line (approximately 30 mL). Take care to handle the sample cell by the top. Cap the sample cell.

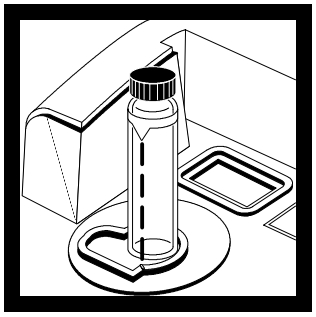
Note: *Instrument warm-up is not required. Optical and electronic stabilization is instantaneous.*



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



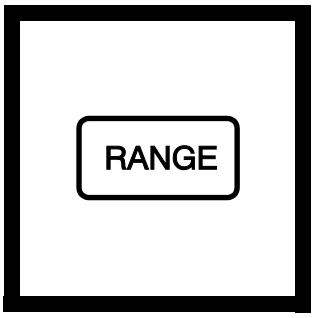
3. Apply a thin bead of silicone oil from the top to bottom of the cell—just enough to coat the cell with a thin layer of oil. Using the oiling cloth provided, spread the oil uniformly. Then, wipe off the excess. The cell should appear nearly dry with little or no visible oil. See *Section 2.6.1*.



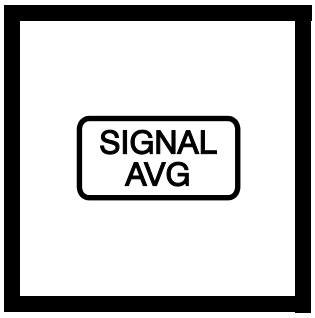
4. Make sure the filter is in place. Place the sample cell in the instrument cell compartment and close the lid.

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

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

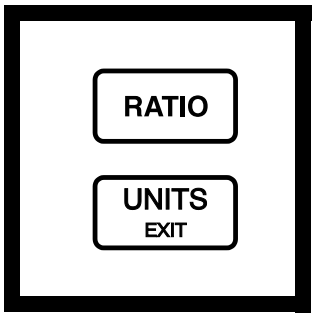


5. Select manual or automatic range by pressing the **RANGE** key.



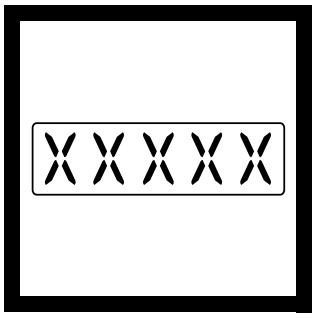
6. Select the appropriate signal averaging setting (on or off) by pressing the **SIGNAL AVG** key.

Note: *See 3.1.3 for more information.*



7. Select the appropriate Ratio setting (on or off) by pressing the **RATIO** key. Select the appropriate unit (FNU or NTU) by pressing the **UNITS** key.

Note: *Values >40 NTU require Ratio on.*



8. Read and record the results.

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

2.4.1 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 2.5*.

2.5 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.

2.5.1 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 2.6.1*. 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.

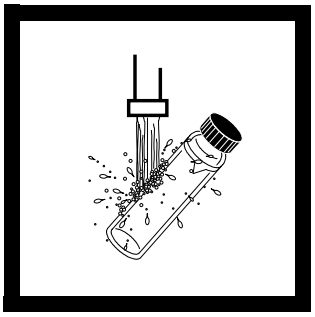
2.6 Silicone Oil Procedure

2.6.1 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 glass sample cell.

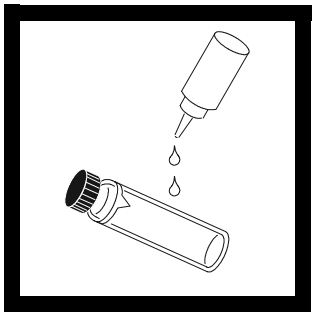
Apply a thin bead of silicone oil from the top to bottom of the cell—just enough to coat the cell with a thin layer of oil. Using the oiling cloth provided, spread the oil uniformly. Then, wipe off the excess so that only a thin coat of oil is left. The cell should appear nearly dry with little or no visible oil. Applying excess oil may attract dirt and contaminate the sample compartment of the instrument.

Silicone Oil Procedure



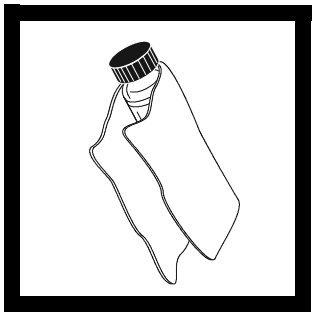
1. Thoroughly clean and rinse the sample cell.

Note: *See Section 2.5.1 on page 22.*



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.

Note: *See Section 2.6.1.*



3. Spread the oil uniformly using the oiling cloth provided. Then, wipe off the excess so that only a thin coat of oil is left. 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.*

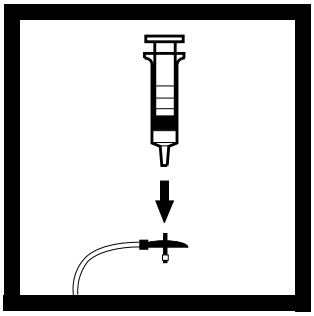
2.6.2 Preparing Dilution Water

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.

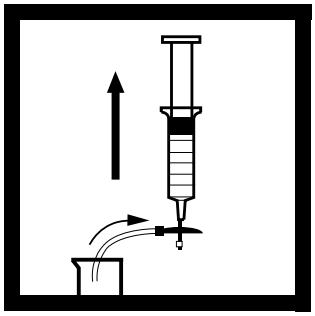
Collect at least 1000 mL of high quality water (e.g., distilled, demineralized, or deionized water). Check the turbidity of the dilution water before use. The 2100N Turbidimeter may be used to check the dilution water turbidity because the instrument is precalibrated at the factory. If the turbidity is greater than 0.5 NTU, 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.

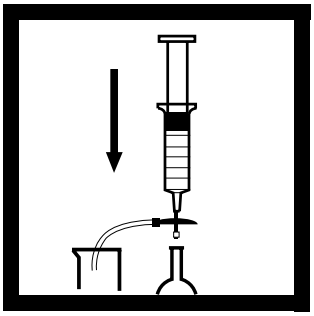
2.6.2.1 Dilution Water Filtration Procedure



1. Attach the syringe to the three-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. Draw about 50 mL of sample into the syringe. 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 enough water is collected.

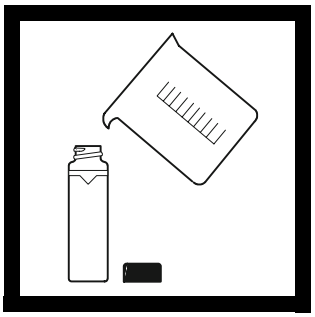
Note: *Pushing water through the filter becomes more difficult as the filter clogs. Discard a clogged filter and attach a new filter when necessary. Replacement filters are available in packages of 10 (Cat. No. 23238-10).*

2.6.3 Indexing and Matching Sample Cells

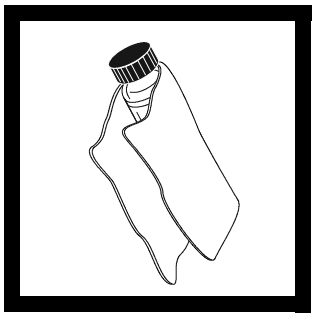
Precise measurement of multiple, low-turbidity samples requires good laboratory technique to achieve accuracy and repeatability. Matched sample cells are required to minimize the effects of optical variation among cells. Alternatively, use a single sample cell for every measurement to minimize reading variability caused by cell-to-cell imperfections. Using a single cell provides better accuracy and precision than matched cells. 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 2.6.3.1*). A Flow-Cell System provides the best accuracy and reproducibility and is more convenient (see *SECTION 5*).

2.6.3.1 Indexing a Single Sample Cell

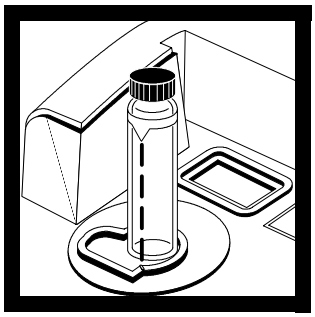
Add an orientation mark to a single sample cell as follows:



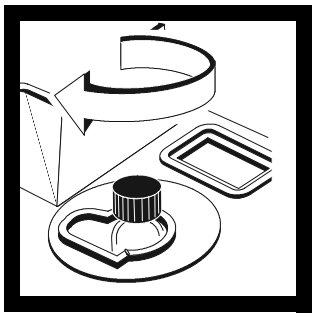
1. Fill the clean cell to the line with high-quality water, and cap the sample cell (refer to *Section 2.6.2*).



2. Wipe the sample cell clean, and apply a film of silicone oil (refer to *Section 2.6.1*).

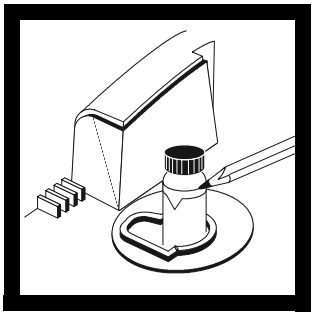


3. Make sure the filter is in place. Insert the sample cell into the cell compartment, and close the cell cover. Record the reading.



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

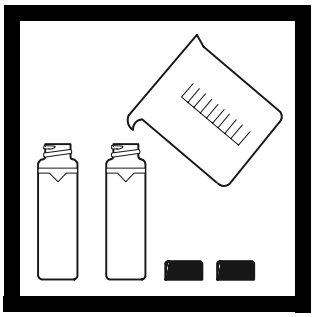
Note: *"door" is displayed when the sample compartment is not covered.*



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.

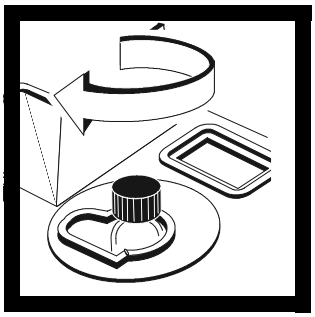
2.6.3.2 Matching Sample Cells

Index match (orientation) multiple cells using the following procedure:

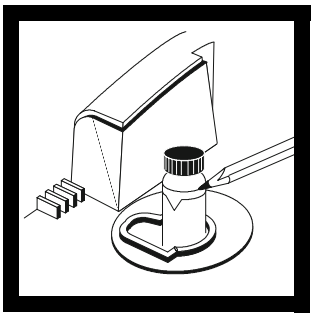


1. Add portions of the high-quality dilution water to multiple cells that are clean, and coated with silicone oil.

Note: *For more information, see:*
Section 2.5.1 Cleaning Sample Cells
Section 2.6.1 Applying Silicone Oil
Section 2.6.2 Preparing Dilution Water.



2. Make sure the filter is in place. Insert the first cell into the instrument. Rotate the cell slightly until the lowest reading is found. Note the cell orientation, record the reading, and add an index mark to the marking band of the cell.



3. Insert the second cell into the instrument, close the lid, and note the value. Rotate the cell approximately $^{1}/_{8}$ of a turn and observe the reading. Repeat $^{1}/_{8}$-turn rotations until the reading matches the first cell reading within ±0.01 NTU. Add a permanent orientation mark to the marking band of the second cell. Repeat this procedure to match other cells.

Note: *It may not be possible to match all cells due to variability in glass.*

2.6.4 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.

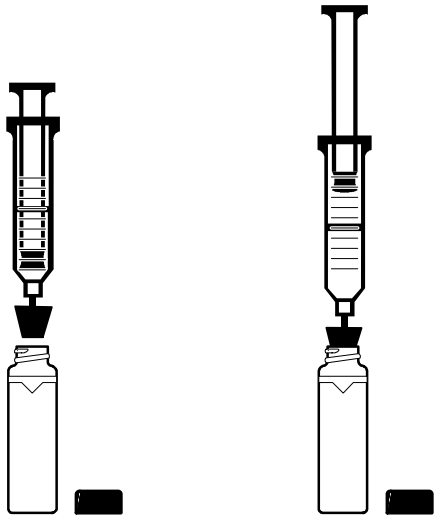
Letting the sample stand for a period of time to remove air bubbles is not recommended. Particulates that cause turbidity may settle, and the sample temperature may change. Both conditions may alter the turbidity of the sample resulting in a measurement that is not representative of the original sample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

2.6.4.1 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 4* 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 4 Sample Degassing



2.6.4.2 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.

2.6.4.3 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.

Bubble expulsion may take 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 before the turbidity increase, and record it as the maximum time limit for ultrasonic treatment.

2.6.4.4 ⚠ Application of Heat

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

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

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

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

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

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.

2.7 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, 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.

2.8 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.

2.8.1 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 5*. If the filters plug too rapidly, use a standard 47 mm filtration apparatus illustrated in *Figure 6* with a membrane filter (Cat. No. 13530-01), or use a glass-fiber filter (Cat No. 2530-00) for very high solids.

Figure 5 Filtering Apparatus

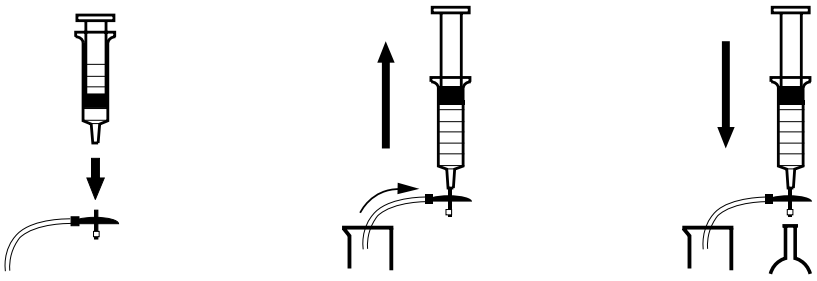
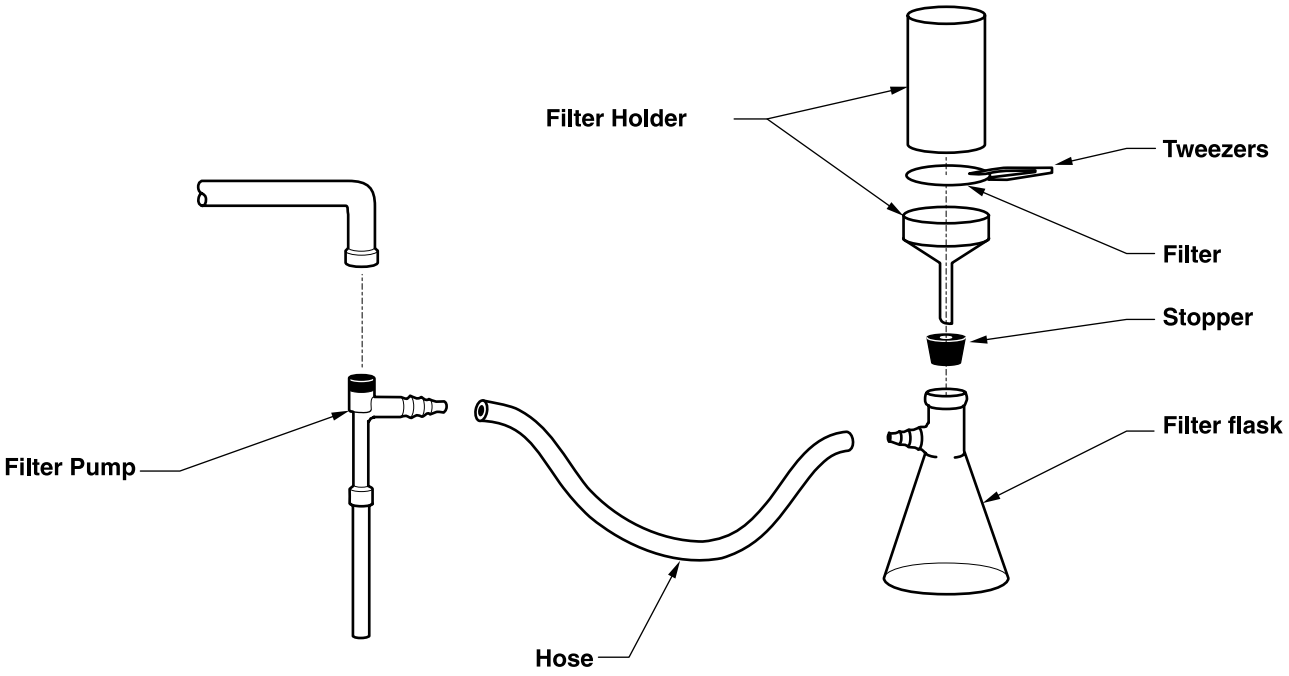


Figure 6 Sample Filtering



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:

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

For example, if the measured turbidity value is 1100 NTU, the final turbidity value is calculated as:

$$1100 \times 5 = 5500$$

2.9 Using Cell Adapters

Cell adapters are used with the Model 2100N 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 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 sample cells applies to the smaller cells (including the use of silicone oil on the outside of the glass).

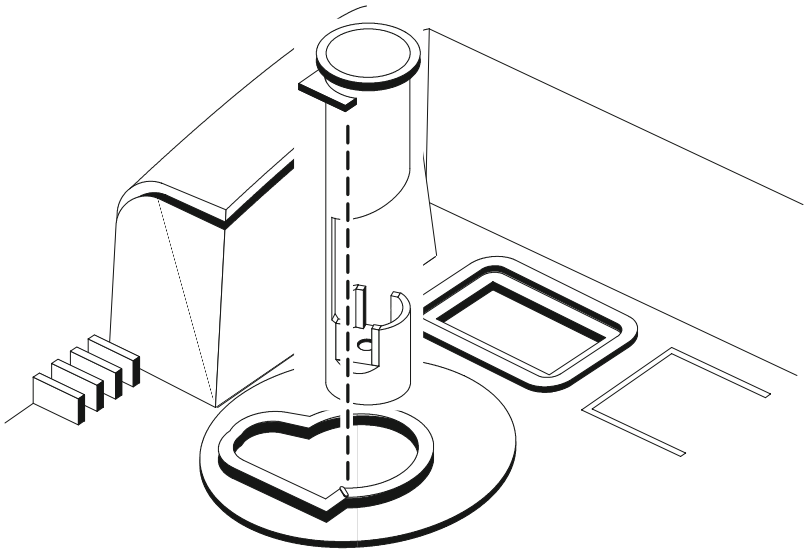
2.9.1 Installing and Removing Cell Adapters

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 7*).

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

Figure 7 Cell Adapter Installation



2.10 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.

2.11 Calibration Check

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

Use Gelex Secondary Turbidity Standards for periodic calibration checks. Please note that Gelex Secondary Turbidity Standards must be assigned values after each Formazin calibration.

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 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.

2.12 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 8 illustrates the locations of all controls, indicators and other operational features of the Model 2100N Laboratory Turbidimeter. Information on the functions of each of these features is provided in *Table 2* and supplemented with additional details in *Section 3.1.1* on page *35* through *Section 3.1.8* on page *36*.

Figure 8 Model 2100N Operating Features

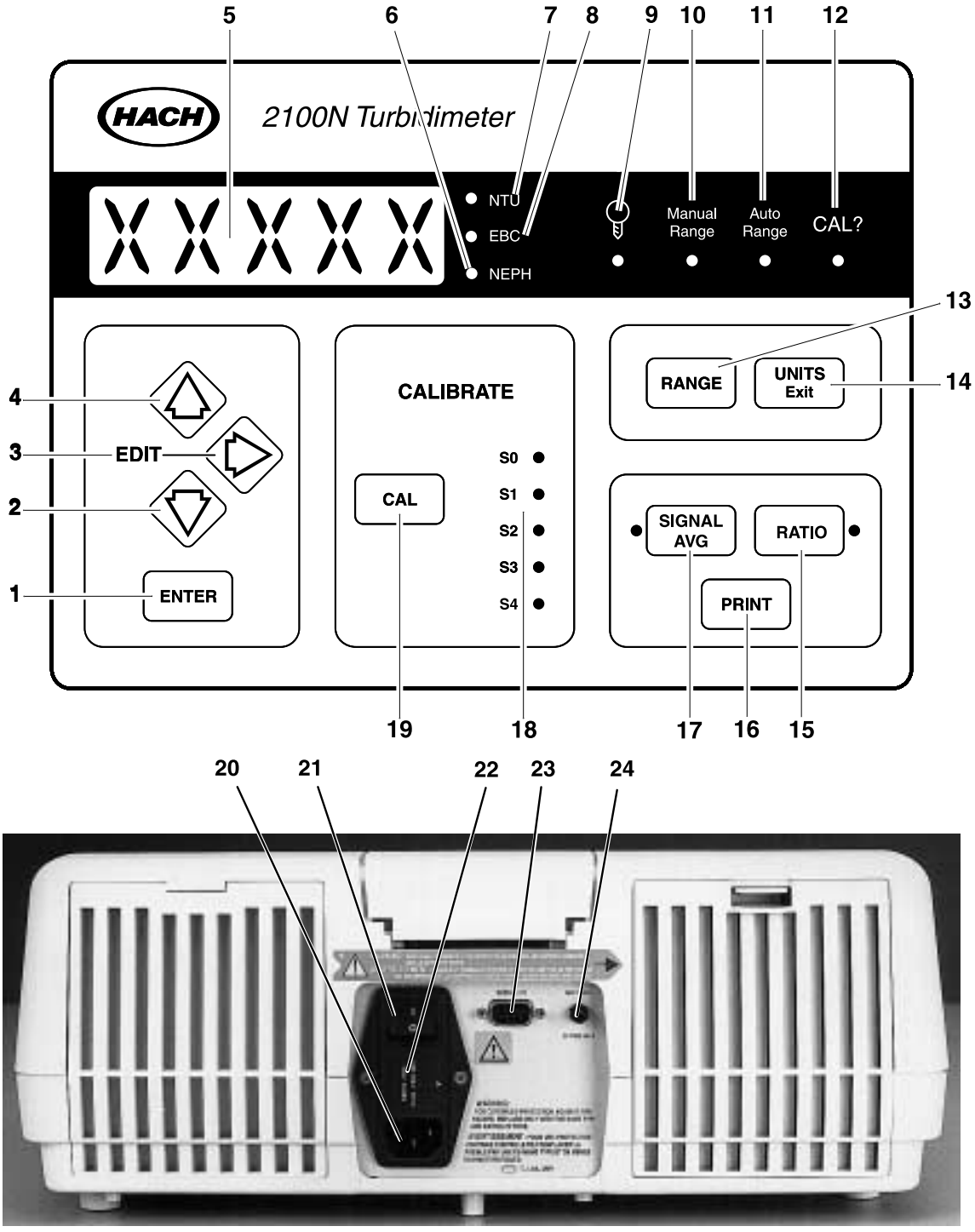


Table 1 Operating Features and Functional Descriptions

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.
2	DOWN ARROW	Edits an LED digit in the calibration mode, steps through calibration standards (S0, S1, S2, S3 or S4) when checking data points, or steps through diagnostic sequences.
3	RIGHT ARROW	Moves the editing cursor to the digits being edited in the calibration mode, or initiates editing of a standard value. Also, forces a dilution water value to zero during calibration.
4	UP ARROW	Edits an LED digit in the calibration mode, steps through calibration standards when checking data points, or steps through diagnostic sequences (opposite direction of down arrow).
5	**Display**	Five-digit LED display.
6	**NEPH**	Lights when the instrument is set for Nephelos unit of measure.
7	**NTU**	Lights when the instrument is set for NTU unit of measure.
8	**EBC**	Lights when the instrument is set for EBC unit of measure.
9	**Lamp**	Lighted annunciator indicates when the instrument lamp is on. Flashes to indicate a low-level light condition.
10	**Manual Range**	Lights when the instrument is in the manual ranging mode.
11	**Auto Range**	Lighted annunciator indicates when the instrument is in the automatic ranging mode.
12	**CAL?**	Lights to indicate that the calibration information recorded during the calibration process is outside of the acceptable range. This may indicate an operator error during calibration, or possibly an instrument malfunction. If the CAL? annunciator flashes, the instrument must be recalibrated.
13	**RANGE**	Selects Auto Ranging or Manual Ranging. Pressing RANGE steps the instrument through the range options.
14	**UNITS Exit**	Selects units of measure (i.e., NTUs, EBCs or Nephelos). Also, exits calibration without saving new values.
15	**RATIO**	Turns ratio feature on or off. Lighted annunciator indicates ratio on. Flashes to indicate over-range of 40 NTU when ratio is off.
16	**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.
17	**SIGNAL AVG**	Turns the signal averaging function on or off. Lighted annunciator indicates Signal Averaging mode is on.
18	**S0 thru S4**	Lights to indicate the current calibration point standard in use.
19	**CAL**	Initiates calibration mode in NTU units. The **CAL** key also accepts new calibration values and permits review of previous calibration points. The calibration procedure automatically sets calibration for the EBC and NEPH units of measure.
20	Power Cord Receptacle	Connection for line power cord. Must be correct rating for line voltage used.
21	I/O	Power switch turns instrument on and off
22	Fuse Holder	Contains two time-delay, 1.6 amp, 250V fuses suitable for either 115- or 230-volt operation
23	Serial Interface Connector	DB9 male connector for RS232 cable connection
24	Air Purge Fitting	Connection for air purge tubing. Maximum pressure 20 psig

3.1.1 Using the RANGE Key

Table 1 on page *34* provides 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, for the manual range selected. The Ratio annunciator flashes to indicate over-range when Ratio is off.

Press the **RANGE** key to select the proper higher or lower 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 2.8* on page *29)*.

For samples in excess of 40 NTUs, 268 Nephelos or 9.8 EBCs, the display flashes **9s** to indicate over-range if Ratio is off. Ratio must be on to measure samples above these levels.

3.1.2 Using the UNITS/EXIT Key

This key selects NTU, EBC or Nephelo measurement units. If power is turned off, the instrument defaults to the last unit selected when power is restored. Press the **UNITS/EXIT** key to select units of measure. The unit of measure selected is indicated by an annunciator next to the instrument display. It can be selected at any time.

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 (refer to *Section 2.7* on page *29*).

3.1.4 Using the RATIO key

Turn Ratio on and off by pressing the **RATIO** key. With **RATIO** on, all three detectors (90°, transmitted and forward scatter) are used to make the measurement. With **RATIO** off, only the result of measurement with the 90° detector is displayed. Measurements with Ratio on and measurements with Ratio off are equivalent for turbidity measurements less than 40 NTU if interferences due to color or light absorbing particles are not present. However, Ratio on compensates for instrumental and sample variables. Operation with Ratio on is recommended for most measurements. Refer to *Section 1.3* on page *15* for more detailed discussion of Ratio on vs. Ratio off measurements.

If the instrument power is turned off, the Ratio selection (on or off) last in use will be active when power is restored.

3.1.5 Using the PRINT Key

Transmit data through the RS232 serial port to an external device such as a printer, computer or datalogger by pressing the **PRINT** key. When the **PRINT** key is pressed during measurement, the displayed value and unit of measure are transmitted to the external device.

To review calibration data currently in affect, press the **CAL** key followed by the **PRINT** key. Press the **UNITS/EXIT** key to return to the operating mode.

Holding the **PRINT** key down while turning on instrument power transmits diagnostic information to the device.

3.1.6 Using the CAL Key

Initiate a calibration or calibration review by pressing the **CAL** key. The S0 annunciator flashes. 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 3.2.4* for detailed calibration instructions.

3.1.7 Using the ENTER Key

During measurement with Signal Averaging on, the **ENTER** key clears the measurement buffer of all previously stored measurement values and the buffer begins accumulation of new data. To begin measurement of a standard during calibration, press **ENTER** while in the calibration mode.

3.1.8 Using the ARROW Keys

The **ARROW** keys are used to edit the displayed value during calibration, and increment through the calibration standards. The **RIGHT ARROW** key also can be used during calibration to bypass the S0 measurement and force a zero value for the calibration solution dilution water. Refer to *Section*s *3.2* on page *37* through *3.2.4* on page *39* for details.

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:

1. Press and hold the **RIGHT ARROW** key for 3 seconds. If the display does not read "00," use the **ARROW** keys to edit the display until it reads “00.”

2. Press. **ENTER**. The display reads **bP on** or **bP oF**.

3. Use the **UP** or **DOWN ARROW** keys to display the desired operational mode. Press **ENTER**. The instrument executes the selection and returns to the measurement mode.

3.2 Calibration

The electronic and optical design of the 2100N Turbidimeter provides long-term stability and minimizes the need for frequent calibration. The three-detector ratioing optical system compensates for electronic and optical system variations between calibrations. When data is used for USEPA reporting, recalibrate at least every 90 days, or as stipulated by the regulating authority.

Note: *Alternately, obtain optimum calibration accuracy using the StablCal™ Calibration Kit for the 2100N Turbidimeter. This kit contains prepared, stabilized formazin suspensions of <0.1-, 20-, 200-, 1000-, and 4000-NTU. Order Cat. No. 26621-00 (500 mL each) or Cat. No. 26621-05 (ampules).*

The calibration is based on a first order linear equation consisting of up to three 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* on page *38* 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 3.2.5* on page *42*). 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 3.2.4* on page *39*).

3.2.1 Formazin Stock Solution

Make Formazin dilutions for instrument calibration from a 4000-NTU stock solution equivalent to the Hach Cat. No. 2461-49 turbidity standard supplied with the instrument. This prepared stock solution is stable for up to one year when properly stored. Thoroughly mix the 4000-NTU stock solution prior to use for making standards.

If desired, prepare a 4000-NTU stock solution from hydrazine sulfate and hexamethylene-tetramine (also available from Hach). Refer to *Section 3.2.6* on page *43* for preparation instructions.

3.2.2 Dilution Water

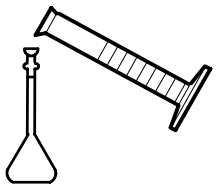
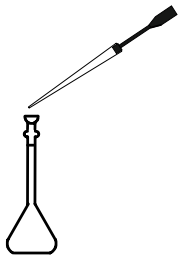
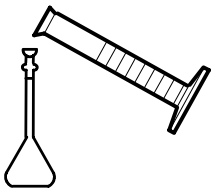
Use high-quality, low-turbidity water (<0.5 NTU) to prepare the Formazin dilutions required to calibrate the instrument. The 2100N Turbidimeter provides automatic correction for <0.5 NTU turbidity contributed by dilution water (refer to *Section 3.3.3* on page *44*). Distilled, demineralized or deionized water usually is sufficient, as is most filtered tap water. If the purified water exceeds 0.5 NTU, filter it to meet the turbidity requirements (see *Section 2.8.1* on page *29*).

3.2.3 Preparing Recommended Formazin Dilutions

Note: *Instead of diluting a formazin stock solution, StablCal™ stabilized formazin suspensions may be used. Order StablCal Calibration Kit for the 2100N Turbidimeter, Cat. No. 26621-00 (bottled) or Cat. No. 26621-05 (ampules).*

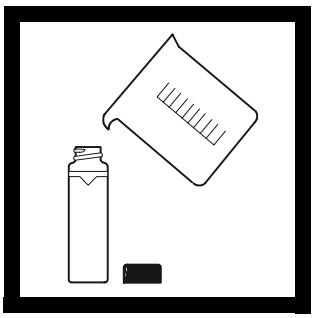
Hach Company recommends use of 20-, 200-, 1000- and 4000-NTU Formazin standards for calibration of the Model 2100N Turbidimeter. Prepare all Formazin dilutions immediately before calibration, and discard the dilutions after use. While 4000-NTU stock solutions are stable for up to one year, diluted solutions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

Table 2 Formazin Standard Preparation

Standard	Step 1	Step 2	Step 3
			
20 NTU	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 NTU	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 NTU	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.
4000-NTU	Transfer approximately 30 mL of well mixed 400-NTU Formazin stock solution to a clean sample cell. No dilution is required.		

* A class A volumetric pipet may be used in place of a TenSette Pipet.

3.2.4 Calibrating the 2100N (with Formazin standard)



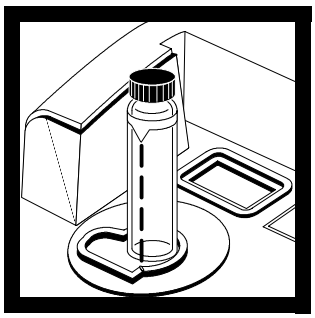
1. Fill a clean sample cell to the line (approx. 30 mL) with dilution water. Wipe the cell clean and apply a thin film of silicone oil (refer to *Section 2.6.1* on page *23*).

Note: *For best accuracy use the matched sample cells for all measurements during calibration (refer to Section 2.6.3.2 Matching Sample Cells). An alternative may be to use the same cell for all standards.*

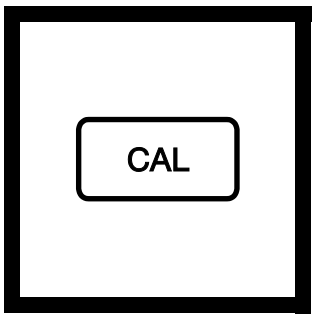
Note: *A portion of the same dilution water used for preparing standards must be used in this step.*

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

Note: *If using StablCal stabilized formazin, use the <0.1 standard.*



2. Make sure the filter is in place. Insert the sample cell into the cell holder, and *close the cell cover.*



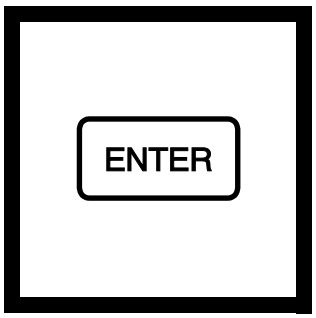
3. Press the **CAL** key.

The S0 annunciator lights. 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.*

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



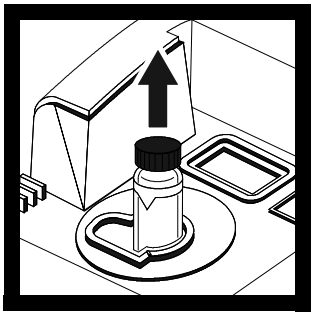
4. Press the **ENTER** key.

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 for measurement of all NTU standards.

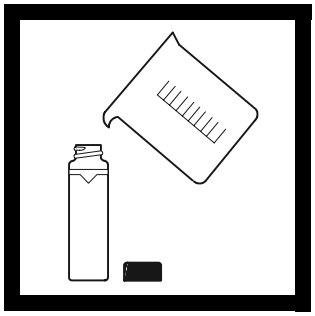
Note: *If reading of dilution is >0.5 NTU, an E1 error message is displayed at the end of step 11.*

Note: *The turbidity of the dilution water can be "forced" to zero rather than reading the dilution water. Refer to Section 3.3.1 on page 44.*

Hach Company recommends only the use of formazin or StablCal™ stabilized formazin turbidity standards for the calibration of Hach turbidimeters. Hach Company can not guarantee the performance of the turbidimeter if calibrated with co-polymer styrenedivinylbenzene beads or other suspensions.

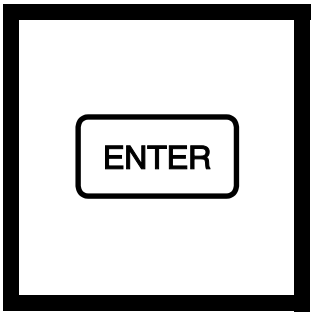


5. The instrument automatically increments to the next standard, displays the expected NTU value (e.g., 20.00 NTU), and the S1 annunciator flashes. Remove the sample cell from the cell holder.



6. Fill a clean sample cell to the line with well-mixed, 20-NTU 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.*



7. Press **ENTER**. The display counts down from 60 to 0, and displays the turbidity (compensated for dilution water turbidity).

The instrument automatically increments to the next standard, the display shows **200.0 NTU**, and the **S2** annunciator flashes.

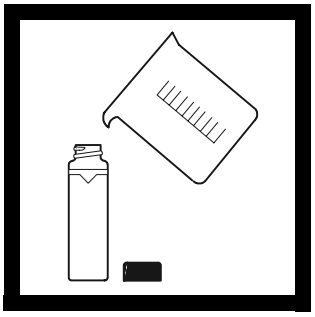
Remove the sample cell from the instrument.

8. Fill a clean sample cell to the line with well-mixed, 200-NTU formazin standard.

Repeat *steps 6* and *7*.

The instrument will display **1000 NTU**, and the S3 annunciator lights. Remove the sample cell from the instrument.

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

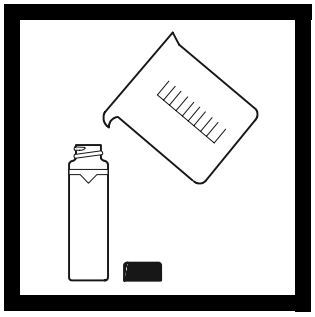


9. Fill a clean sample cell to the line with well-mixed, 1000-NTU Formazin standard.

Repeat *steps 6* and *7*.

The instrument will display **1000 NTU**, and the **S4** annunciator lights. Remove the sample cell from the instrument.

Note: *If using StablCal stabilized formazin, use the 1000 NTU standard.*

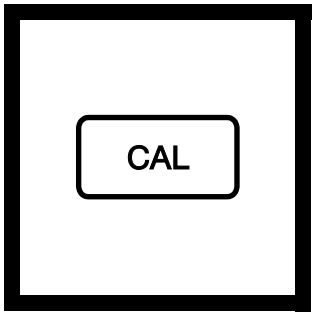


10. Fill a clean sample cell to the line with well-mixed, 4000-NTU Formazin standard.

Repeat *steps 6* and *7*.

The display automatically increments back to the dilution water standard. The **S0** annunciator lights, and the previously measured value of the dilution water is displayed.

Note: *If using StablCal stabilized formazin, use the 4000 NTU standard.*



11. Press the **CAL** key. The instrument 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 calibration without saving new values, press the* **UNITS/EXIT** *key.*

Note: *If error message E1 or E2 appear in the display, an error occurred during calibration (refer to Table 5 on page 69). You may clear the error message and proceed with measurements by pressing the* **ENTER** *key. However, the* ***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 NTU.*

3.2.4.1 Reviewing Calibration Sequence

To review calibration data currently in effect, press the **CAL** key, and then use the **UP ARROW** key to scroll through the standards. If the instrument is connected to a printer, pressing the **PRINT** key prints all of the calibration data in effect. Press the **UNITS/EXIT** key to return to the operating mode.

3.2.5 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 *3.2* on page *37*).
2. Verify that the instrument is set for the NTU mode and Automatic Ranging. Select either Ratio on or off for the 0–2 and 0–20 range standards. Choose the Ratio function that the instrument is intended to operate in. If measurements will be made with Ratio on and off, assign a separate value for each.
3. Thoroughly clean the outside of the Gelex vials, and apply a thin coating of silicone oil.
4. Place the lowest NTU Gelex Standard in the sample compartment with the triangle on the vial aligned with the index mark on the instrument sample compartment. *Close the sample-cell 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 3–5* for the other four Gelex standards.

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

An empty vial (Cat. No. 25891-00) is included with each Gelex Secondary Standard Kit. Use the vial to monitor the integrity of the instrument's optical system. If an optical component begins to degrade over time, the value of the vial will change significantly. If the value changes significantly, contact Hach Customer Service or your distributor for more information.

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

Determine the vial value when the instrument is first received. Clean the outside surface of the glass cell, apply silicone oil (*Section2.6* on page *23*) and measure the value in the NTU 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 in the RATIO on mode***. Record this value on the sample cell. Store the vial at room temperature.

3.2.6 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.

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 Sécurite avant de manipuler les récipients, les réservoirs et les systèmes de distribution contenant les réactifs chimiques et les solutions éta-lons. Il est toujours recommondé de porter des lunettes de protection lorsq'un contact avec les produits chimiques est 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.

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 Notfallschutzmaß-nahmen vertraut machen. Es wird empfohlen, in allen Situationen, in denen mit einem Kontakt von Chemikalien zu rechnen ist, eine Schutzbrille zu tragen.

PERIGO
Para familiarizar-se 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.

Note: *Preparing Formazin from raw materials is not recommended. Preparation is temperature and technique sensitive. Use prepared 4000 NTU Formazin stock solution to avoid handling raw materials, and for best instrument performance and assured analytical accuracy.*

Synthesize a 4000-NTU Formazin stock solution for making the calibration standard dilutions as follows (in place of using the prepared stock solution):

1. Dissolve 5.000 grams of reagent grade hydrazine sulfate ($N_2H_4 \bullet H_2SO_4$) in approximately 400 mL of deionzed water.
2. Dissolve 50.000 grams of reagent grade hexa-methylenetetramine in approximately 400 mL of deionzed water.
3. Quantitatively, pour the two solutions into a 1-liter volumetric flask, and dilute to volume with deionzed water. Mix well.
4. Allow the solution to stand for 24 hours at 25 ±3 °C (77 ±5 °F). The suspension develops during this time.

3.3 Special Research Applications (*Not Recommended*)

3.3.1 Ignoring Dilution Water

The turbidity of the dilution water can be ignored by pressing the **RIGHT ARROW** key rather than reading the dilution water for the S0 standard value. 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 NTU. Use it only in situations where you know your dilution water is particle free (<0.05 NTU).

3.3.2 Editing Calibration Data Points

When using Formazin standard dilutions other than the recommended 20-, 200-, 1000- and 4000-NTU 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.

Note: *The calibration is based on a first order linear equation consisting of up to three 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 Section 3.2.3 Preparing Recommended Formazin Dilutions may result in less accurate calibrations.*

For example, if during the calibration procedure (refer to *Section 3.2.4 Calibrating the 2100N*) a 2.5-NTU standard is placed in the instrument in Step 5 instead of the 20-NTU standard, the 20.000 in the display is edited to show the value of the new standard before the **ENTER** key is pressed to initiate the measurement.

Pressing the **RIGHT ARROW** key accesses the editing mode causing the "decimal point" to flash. Use the **RIGHT ARROW** key to move the decimal point to the appropriate location. Pressing the **ENTER** key accepts the new decimal location and causes the "2" to flash.

Because the "2" is correct as is, press the **RIGHT ARROW** key again to ready the second digit for editing. The **UP ARROW** increments the flashing digit to read "5" for the corrected display of 2.5000. When the **ENTER** key is pressed, 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 the S2 annunciator lights. Continue with the calibration, repeating the editing function for any other substituted standards.

3.3.3 Preparing Formazin Dilutions — User Selected

Hach Company recommends using 20, 200, 1000 and 4000 NTU formazin standards for calibrating the 2100N Turbidimeter. Other dilutions can be prepared and used, but if problems occur when using these alternative solutions, use the dilutions specified in this section.

Prepare Formazin dilutions from well-mixed, 4000-NTU stock solution as specified in *Section 3.2.3 Preparing Recommended Formazin* and dilution water as specified in *Section 3.2.2 Dilution Water.* Prepare Formazin dilutions to span the entire range of the instrument. The following Formazin standards are suggested: one in the range of 10 to 30 NTU, one in the range of 180 to 220 NTU, one in the range of 900 to 1,100 NTU and one of 4000 NTU. Standards must have a difference of at least 60 NTU. In addition, make a blank measurement using the same dilution water used in making the Formazin dilutions, and enter as the S0 calibration point. Prepare standard solutions immediately before use, and discard the standards when calibration is complete.

3.3.4 Calibrating the 2100N (User Selected Standards)

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

Instrument calibration is accomplished as described in *Section 3.2.4 Calibrating the 2100N* with two exceptions:

- Standards are values other than those used in *steps 8*, *10* and *11*.
- Before pressing the **ENTER** key 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** to get into the editing mode and then using the other **ARROW** keys to edit the number.

INSTALLATION/MAINTENANCE

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

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

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

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

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

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 Flow-Cell assemblies.

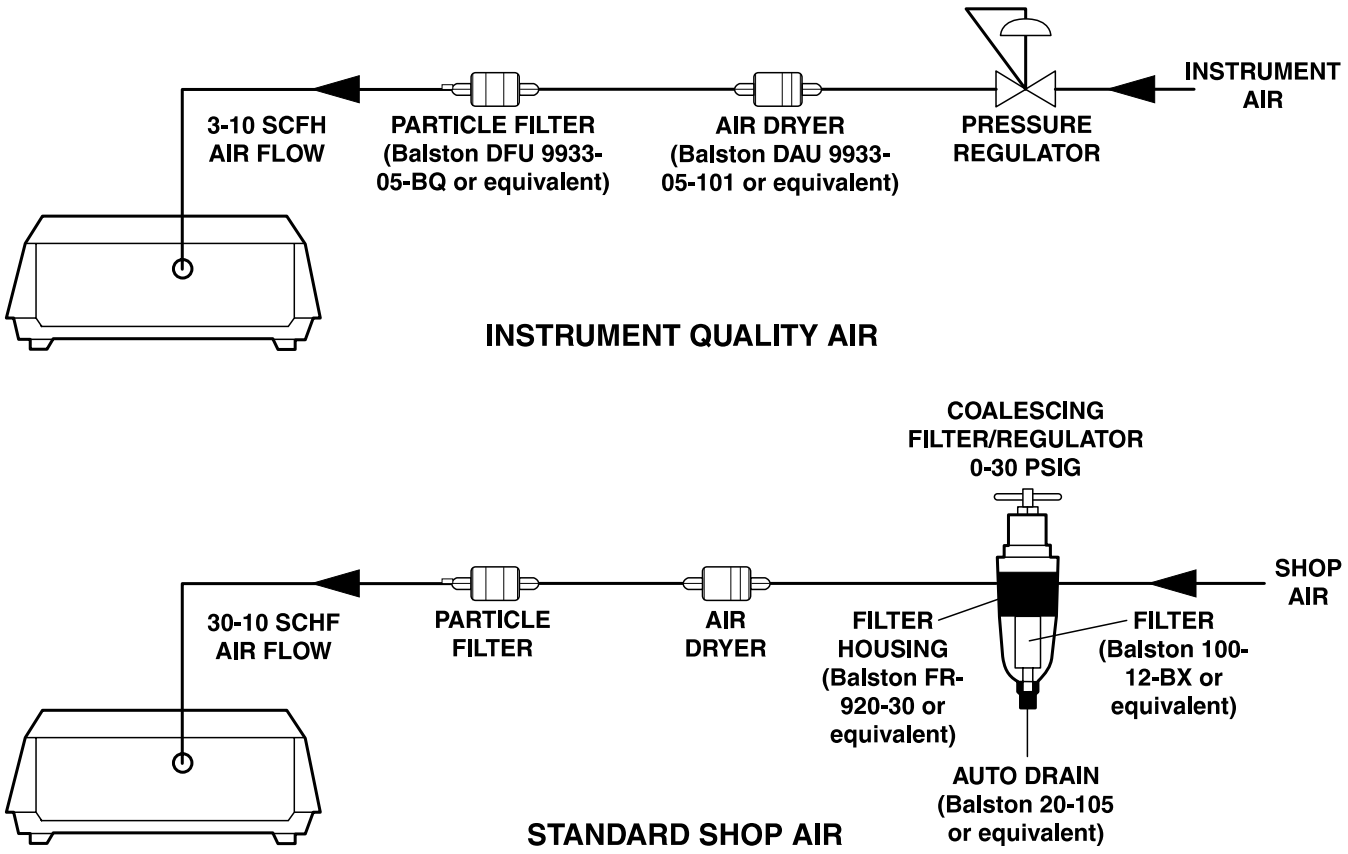
Dry nitrogen or instrument grade air (ANSI MC 11.1, 1975) up to 138 kPa (20 psig) can be used to air purge the optical housing compartment. The recommended air consumption rate is between 3 and 10 SCFH (standard cubic feet/hour). The connection is made at the **AIR PURGE** fitting on the rear panel.

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

When the sample temperature is expected to be near or below 2 °C (35 °F), use a desiccant dryer and particle filter in the air line to ensure the dew point of the air purge is below the sample temperature (see *Figure 9*).

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 9* 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 9 Air Purge Connections



SECTION 5 USING FLOW-CELL SYSTEM APPARATUS

5.1 Description

Three optional Flow-Cell kits are available for the 2100N Laboratory Turbidimeter. Two kits are available for low-pressure applications [< 34 kPa (5psig)] and one kit for high-pressure applications [< 414 kPa (60 psig)].

Flow Cell advantages:

- Increases speed of measurement
- Provides a single cell for all measurements (thus assuring a constant optical path)
- Minimizes 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 in sample cells and poor sample-cell quality (due to handling, inadequate cleaning, etc.) are the greatest sources of error in turbidity measurement.

⚠ ***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.

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 compatibi-lité de l'échantillon est douteuse.

PELIGRO
No use las Células de Flujo Flow Cells de Hach con muestras inflamables o que contengan hidtocarburos, soventes, ácidos concentrados o bases concentradas que puedan atacar las partes mojables de la célula. Experimente antes de usat las Células de Flujo, si existe duda sobre la compatibilidad de la muestra.

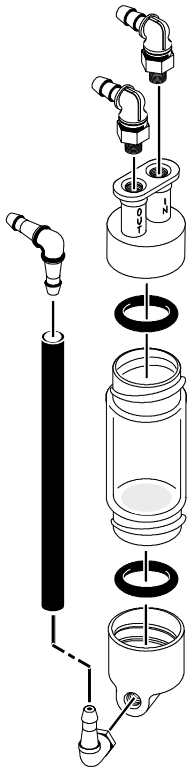
GEFAHR
Durchflußküvetten von Hach düfen nicht in Verbindung mit brennbaren Proben oder Proben, die Kohlenwasserstoffe, Lösemittel, konzentrierte Säuren oder konzentrierte Basen, die benetzten Teile der Küvetten angreifen können, verwendet werden. Wenn die Verträglichkeit fraglich ist, sollten vor der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

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.

5.2 Low-Pressure Flow-Cell Kits

The Low-Pressure Flow-Cell systems (manual or automated kits) use 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 10*). 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 10 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.

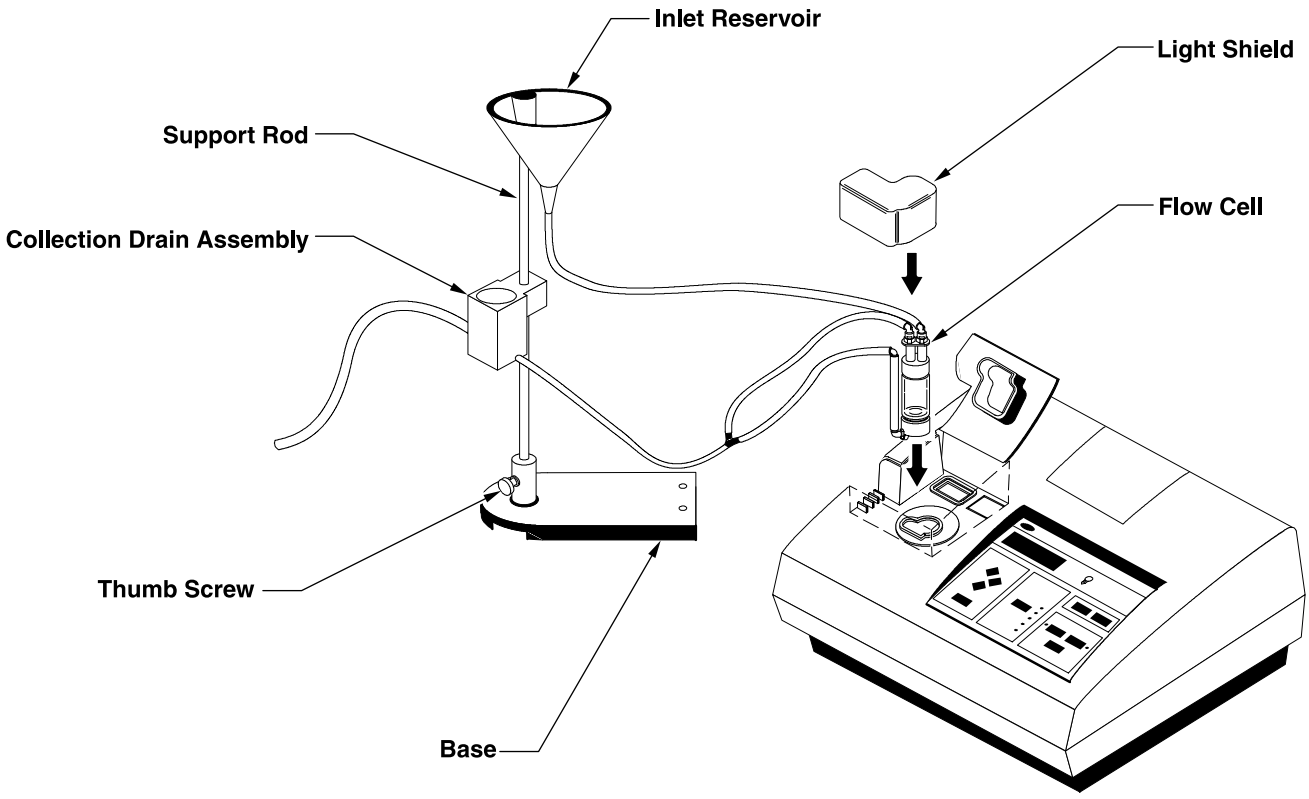
Sample is discharged from top and bottom outlets. The top outlet collects and expels air bubbles and particles that tend to float. The cone-shaped bottom outlet collects settleable solids; water discharged from the bottom outlet carries the settled solids out of the cell. This novel, dual-outlet design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

* U.S. Patents 5475486 and D358448.

5.2.1 Manual Low-Pressure Flow-Cell Kit

The Manual Flow-Cell Kit (Cat. No. 47449-00) is for low pressure [<34 kPa (5 psig)] applications (see *Figure 11*).

Figure 11 Manual Low-Pressure Flow Cell



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 Assembly, interconnecting tubing, and a Flow-Cell Light Shield.

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

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)].

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

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

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)].

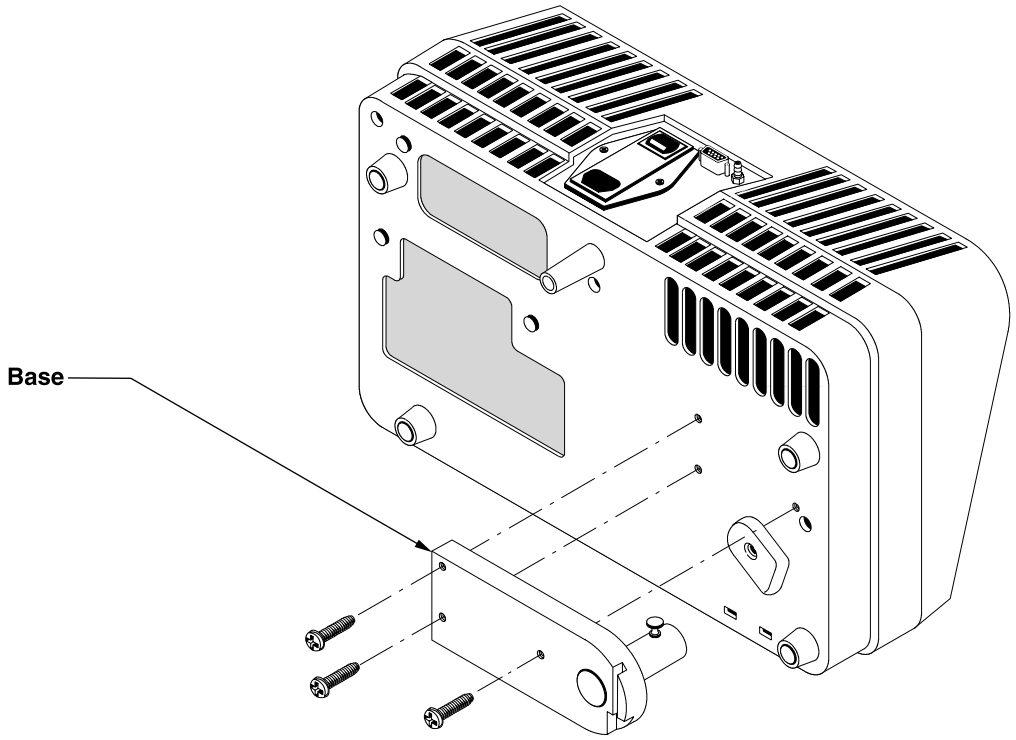
5.2.1.1 Assembling The Support Stand

1. Verify the sample compartment is empty, and turn the instrument off.
2. 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 12.* **Do not over tighten the screws.**
3. Place the instrument right side up.
4. Install the Flow-Cell Inlet Reservoir on to the support rod.
5. Slide the Collection Drain Assembly on to the support rod.
6. Place the instrument right-side up, and install the support rod into the base.

5.2.1.2 Assembling The Flow Cell

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

Figure 12 Base Plate Installation



5.2.1.3 Connecting Inlet And Outlet Tubing

Note: *Use the tubing supplied with the kit (or its equivalent). Tubing lengths are approximate. Avoid using excess tubing because it causes air locking, and delays response time of measurement.*

1. Cut a 53-cm (21 in.) piece of clear, 1/8-in. I.D. Tygon tubing, and install it between the inlet reservoir and cell inlet.
2. Cut two 23-cm (9 in.) pieces of clear, 1/8-in. 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 in.) piece of clear, 1/8-in. I.D. Tygon tubing, and install it between the "Y" connector and the Collection Drain Assembly.
4. Cut a 50-cm (20 in.) length of clear, 3/8-in. 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 3/8-in. 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 in.) below the center line of the instrument to ensure proper flow.

5.2.1.4 Using the Manual Flow-Cell Kit

Note: *Assemble the Flow Cell, tubing and stand. Then, fill the system with water to ensure all connections are water tight before inserting the Flow Cell into the sample compartment of the instrument. Once filled, inspect the system for leaks. Also, 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.*

Thoroughly clean the flow cell (refer to *Section 5.4*). Apply a thin coat of silicone oil to the outside of the flow cell (see *Section 2.6* on page *23*).

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 11*). Cover the cell with the Flow-Cell Light Cover.

Control the flow rate through the Flow Cell 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 in.) 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.

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.*

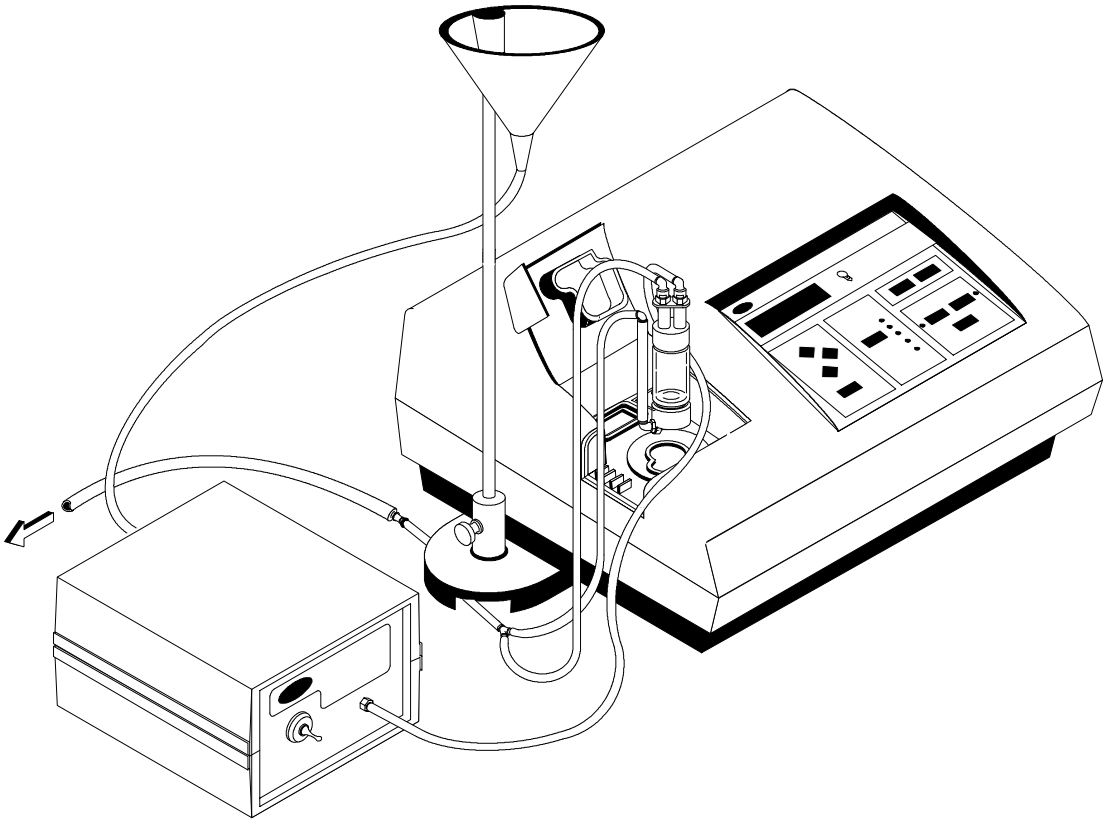
Carefully add sample to the Inlet Reservoir to minimize entrapment of air bubbles in the sample. Air bubbles create a false positive interference in turbidity measurement. Always slowly pour sample down the inside edge of the reservoir.

5.2.2 Automated Low-Pressure Flow-Cell Kit

The Automated Low-Pressure Flow-Cell Kit [Cat. No. 47450-00 (115 Vac) or 47450-02 (230 Vac)], uses a Flow Valve Module for control of sample flow (see *Figure 13*). This kit provides semi-automated operation when used with the Model 2100N Turbidimeter. The kit contains a remote control cable used with the Hach Model 2100AN Laboratory Turbidimeter for automated operation. The cable is not used with the Model 2100N Turbidimeter.

Refer to *Section 5.2.1.1* and *Section 5.2.1.2* for assembly instructions. Omit *step 5* in *Section 5.2.1.1*; the Collection Drain Assembly is not provided with the Automated Flow-Cell Kit.

Figure 13 Automated Low-Pressure Flow Cell



5.2.2.1 Connecting Inlet and Outlet Tubing

Note: *Use the tubing supplied with the kit (or its equivalent). Tubing lengths are approximate. Avoid using excess tubing because it causes air locking, and delays response time of measurement.*

1. Cut a 53-cm (21 in.) piece of clear, 1/8-in. I.D. Tygon tubing, and install it between the Flow-Cell Inlet Reservoir and Flow Valve Module inlet.
2. Cut a 31-cm (12 in.) piece of clear, 1/8-in. I.D. Tygon tubing, and install it between the Flow Valve Module outlet and the Flow-Cell inlet.
3. Cut two 25-cm (10 in.) pieces of clear, 1/8-in. I.D. Tygon tubing, and install them between the top and bottom Flow-Cell drain fittings and the "Y" connector.
4. Cut a 11-cm (4 in.) piece of clear, 1/8-in. I.D. Tygon tubing. Connect one end to the remaining "Y" connector. Pass the tubing under the support stand base as illustrated in *Figure 12*. Install the 1/8 x ¼-in. reducer on the other end of the tubing.
5. Cut a 50-cm (20 in.) piece of clear, ¼-in. I.D. Tygon tubing for the drain line. Connect one end to the 1/8 x ¼-in reducer, and run the other end to a suitable drain.

   The discharge end of the drain tube must be unrestricted and lower than the instrument to prevent air locking and ensure proper drain flow. 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 ¼-in. tubing. The system will not drain properly if this length is exceeded. If the entire 152 cm is used, the end of the drain tubing must discharge at a point at least 46 cm (15 in.) below the center line of the instrument to ensure proper flow.
6. Connect the power supply to the Power Jack on the Flow Valve Module. Plug the power supply into an appropriate wall receptacle.

5.2.2.2 Using the Automated Flow-Cell Kit

Note: *Assemble the Flow Cell, tubing and stand. Then, fill the system with water to ensure all connections are water tight before inserting the Flow Cell into the sample compartment of the instrument. Once filled, inspect the system for leaks. Also, 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.*

Thoroughly clean the Flow Cell (refer to *5.4* on page *62*), and then apply a thin coat of silicone oil to the outside of the cell (see on page *23*). 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 13*). Cover the cell with the Flow-Cell Light Cover.

Flow through the Flow Cell is controlled by using the Valve Control switch on the Flow Valve Module. The valve control is a three-position switch: *Continuous Open*, *Closed*, and *Momentary Open*. The valve is closed in the center (*Closed*) position. The valve remains open when the switch is in the up (*Continuous Open*) position until the switch is moved to the center (*Closed*) position. The down (*Momentary Open*) position must be pressed and held to open the valve; when released it automatically returns to the center (*Closed*) position.

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.*

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.

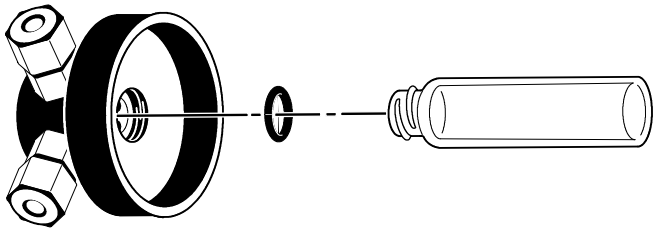
5.2.3 Tips For Use of Low-Pressure Flow-Cell Kits

- Clear the system of previous sample using a minimum 120 mL volume of new sample (this volume purges the system four times).
- Keep all parts of the system clean. Air bubbles tend to form around areas that are not cleaned thoroughly.
- 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.
- If bubbles tend to accumulate in the Flow Cell, gently tap the cell on a soft surface to dislodge the bubbles.
- Do not use the system 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.

5.3 ⚠ High-Pressure Flow-Cell Kit

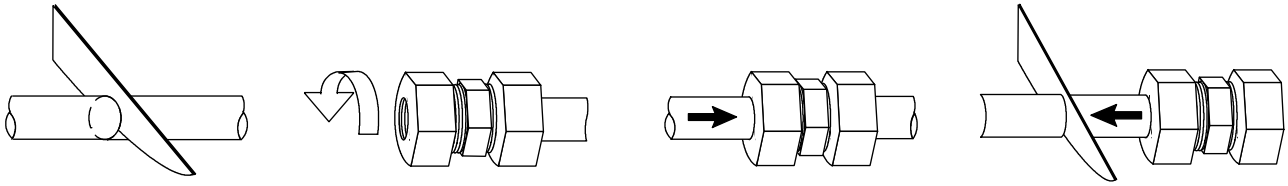
The High-Pressure Flow-Cell Kit can be used for continuous measurement of a process stream, and can accommodate up to 414 kPa (60 psig) (see *Figure 14).* It can operate continuously in temperatures up to 30 °C (86 °F), and intermittently in temperatures up to 40 °C (104 °F). All wetted parts are fabricated from materials approved by the United States Food and Drug Administration (FDA), and can be steam sterilized. Prepare the High-Pressure Flow Cell as follows:

Figure 14 High-Pressure Flow Cell



1. Connect ¼-in. O.D. tubing (of appropriate lengths for sample-in and sample-out connections) to the inlet and outlet fittings on the cap assembly as described in *steps 1, 2* and *3* of *Figure 15.* The Flow-Cell cap fittings are compression fittings suitable for ¼-in. O.D. polyethylene, metal, glass or clear vinyl tubing. Clear vinyl tubing requires an internal tube support. *Step 4* of *Figure 15* describes the method for removing tubing from this type of compression fitting (shown in the cross-section drawing in *Figure 17*).

Figure 15 Compression Fitting Connection



STEP 1
Cut the tube end at a slight angle for easy insertion. Debur metal or glass tubing to prevent O ring damage and to promote ease of assembly.

STEP 2
Loosen the nut on the fitting until about three threads are visible. Moisten the end of the tubing with water or other suitable lubricant.

STEP 3
Insert the tube into the fitting until the tube bottoms on the fitting shoulder. Hand–tighten the nut. Additional tightening is not necessary.

STEP 4
Cut the tube off behind the nut to reuse the fitting internal parts. Pull the parts off the tube stub end backwards. Replace the parts in the fitting body. Assemble the nut, and insert the new tubing (as in Step 3).

Note: *Hand-tighten the compression fitting nuts. Excessive force may damage the fitting or cap assembly (see Figure 17).*

Figure 16 illustrates a suggested hookup using a pressure regulator in the inlet line and a flow meter or flow control valve on the outlet line. The control valve is installed on the outlet side because it may introduce bubbles into the sample causing positive interference in the turbidity reading. This hookup also maintains sufficient pressure to minimize outgassing in a carbonated stream.

Figure 16 Suggested High-Pressure Installation

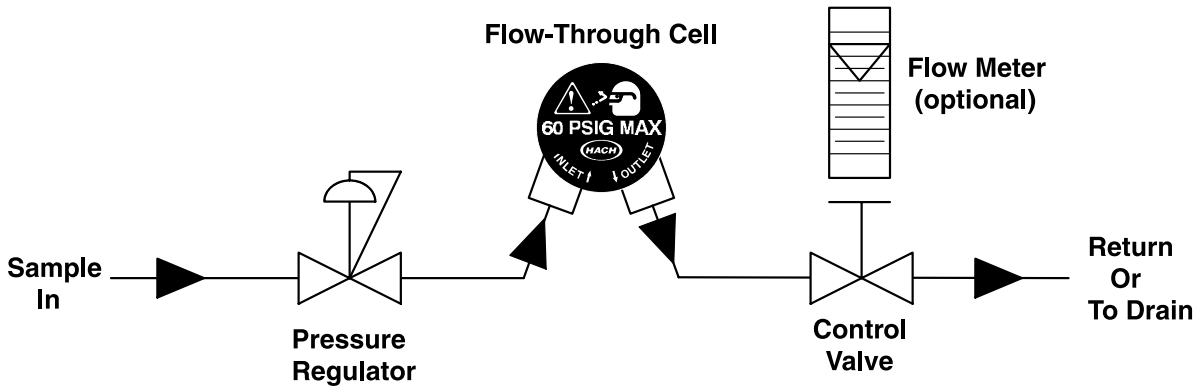
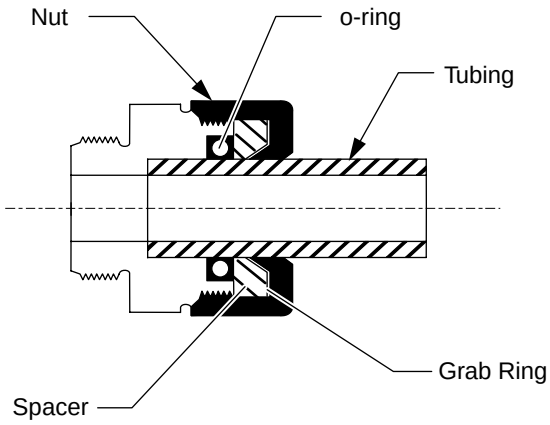


Figure 17 Compression Fitting



⚠ ***CAUTION***
Provide back-flow protection to prevent pressure surges from exceeding 60 psig in applications where sample is returned to a pressurized line.

PRUDENCE
Installer une protection anti-retour pour éviter les variations brusques de pression au-dessus de 4 bar (400 kPa, 60 psig) dans les applications où l'échantillon retourne dans une ligne sous pression.

PRECAUCION
Tome medidas para eliminar el reflujo para evitar golpes de presión que excedan 60 lbs/pulg. cuadrada en el manómetro (psig) en aplicaciones en las que la muestra retorna a una línea bajo presión.

VORSICHT
Es ist für einen Rücklaufschutz zu sorgen, um zu verhindern, daß Druckstöße bei Anwendungen, bei denen die Probe in eine unter Druck stehende Leitung zurückgeführt wird, 4,2 bar überschreiten.

PRECAUÇÃO
Dever-se-á fornecer protecção de contra-fluxo para impedir aumentos repentinos de pressão que excederem de 60 libras por polegada quadrada em aplicações em que a amostra regressar a um cano sob pressão.

2. Thoroughly clean the glass sample cell, and screw it into the cap assembly (see *Figure 14*). Make sure the O-ring is in place in the cap assembly to ensure a good seal (hand tighten). Wipe the glass surface free of fingerprints and smudges. Apply a thin, even film of silicone oil to the outside surface.

⚠ ***DANGER***
Use only glass sample cells that are screened PRESSURE TESTED, 60 PSIG. Use of any other cells may result in injury to the operator and damage to the instrument. In the event of leakage or breakage, immediately depressurize the system and disconnect power.

DANGER
Utiliser seulement les cuves en verre marquées PRESSURE TESTED, 60 PSIG (éprouvée à la pression, 60 psig # 4 bar). L'utilisation de toute autre cuve présente des risques de blessures de l'opérateur et de dommages pour l'appareil. En cas de fuite ou de bris de cuve, dépressuriser immédiatement le système et débrancher l'alimentation électrique.

PELIGRO
Use solamente células de vidrio que estén clasificadas PRESSURE TESTED, 60 PSIG. El empleo de cualquier otro tipo de célula puede resultar en lesiones al operador y daños al equipo. Si ocurrieran escapes o roturas, inmediatamente alivie la presión del sistema y desconecte la energía.

GEFAHR
Es dürfen nur Glasküvetten benutzt werden, die bis 4,2 bar druckgeschützt sind. Die Verwendung anderer Küvetten kann zu Verletzungen des Benutzers oder zu Schäden am Gerät führen. Sollten Küvetten auslaufen oder zerbrechen, muß das System sofort entlüftet und die Stromzuführung unterbrochen werden.

PERIGO
Dever-se-á usar celas de amostras em vidro que sejam pré-examinadas com PRESSÃO DE TESTE DE 60 LIBRAS/POLEGADA. O uso de quaisquer outras celas pode ocasionar lesão ao operário e estragar o instrumento. Em caso de esvazamento o ruptura, dever-se-á imediatamente soltar a pressão do sistema e desligar a corrente eléctrica.

3. Start sample flow through the system, and watch for leaks at the top of the sample cell. Adjust the pressure regulator to maintain pressure below 414 kPa (60 psig). Adjust the flow-control valve to a suitable flow rate below 500 mL/minute. Generally, low flow rates minimize signal noise caused by bubbles and particulate matter.

4. Insert the Flow Cell into the instrument cell holder.

⚠ ***DANGER***
Use eye protection and handle with extreme care when pressuring the system with the Flow Cell out of the instrument. Do not hold the unit by the glass cell. Use a protective shield between the operator and the cell.

DANGER
Porter des lunettes de protection et manipuler avec une extrême prudence lors de la pressurisation du système avec la cuve à circulation hors de l'appareil. Ne pas tenir l'ensemble par la cuve en verre. Utiliser un écran de protection entre l'opérateur et la cuve.

PELIGRO
Use protección de los ojos y manipule con extrema precaución al iniciar la presión en el sistema mientras la célula de Flujo Continuo (Flow-Thru) esté retirada del instrumento. No sostenga la unidad tomándola por la célula de vidrio. Interponga un escudo protector entre el operador y la célula.

GEFAHR
Wenn das System unter Druck gesetzt wird, während sich die Durchflußküvette nicht im Gerät befindet, ist mit äußerster Vorsicht zu arbeiten; ein Augenschutz sollte getragen werden. Die Einheit darf nicht an der Glasküvette festgehalten werden. Zwischen Küvette und Benutzer sollte ein Schutzschild aufgestellt werden.

PERIGO
Usar protecção para os olhos e manusear com muito cuidado ao pressurizar o sistema con a cela Flow-Thru fora do instrumento. Não sostenha com a mão a unidade pela cela de vidro. Usar um protector entre o usuário e a cela.

5.4 Flow-Cell Maintenance

Periodically clean the Flow Cells for the low- and high-pressure kits. Disassemble the cells and clean the glass parts as described in *Section 2.5.1* on page *22*. 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.

Coat the outside surface of the glass, Flow-Cell parts with a thin film of silicon oil before installation in the instrument (see *Section 2.6.1* on page *23)*.

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 ⚠ RS232 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 18* (also see *Table 3* and *Figure 19* on page *64*). 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 20* and *Figure 21*). 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 on page *74)*. With the use of a serial-to-parallel converter, the data string transmitted from the 2100N 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 18 Industry Standard DB-9 Male RS32 Connection

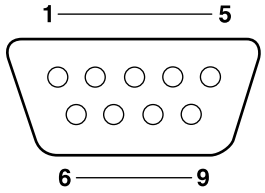


Table 3 RS232 Pin Connections

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 19 RS232 Connection

Figure 20 Typical 2100N Serial Printer Cable

Figure 21 Typical 2100N To Computer Cable

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 22* provides a sample printout from the forty-column Citizen printer listed in *Optional Accessories* on page *74*.

Figure 22 Printer Format Example

```
HACH 2100N V1.0

0.011 NTU

CALIBRATION DATA

UNITS: NTU

STANDARDS:
00  0.0354
01  20.000
02  200.00
03  1000.00
04  4000.00

COEFFICIENTS:
A0=295.06644
B0=0.0022632
B1=0.0018619
C0=0.0043631
C1=0.0007109
C2=0.000125
```

The Citizen printer requires some configuring for compatibility with the 2100N Turbidimeter. Set the switches and jumper positions on the Citizen Model iDP-562RSL II printer board as follows (see *Figure 23* and *Table 4*):

1. Set switches 6, 7, 9 & 10 to ON.

2. Set switches 1, 2, 3, 4, 5 & 8 to OFF.

3. Refer to *Setting of Preset Jumper* in the Citizen Printer Manual.

Figure 23 Citizen Printer Switch Configuration

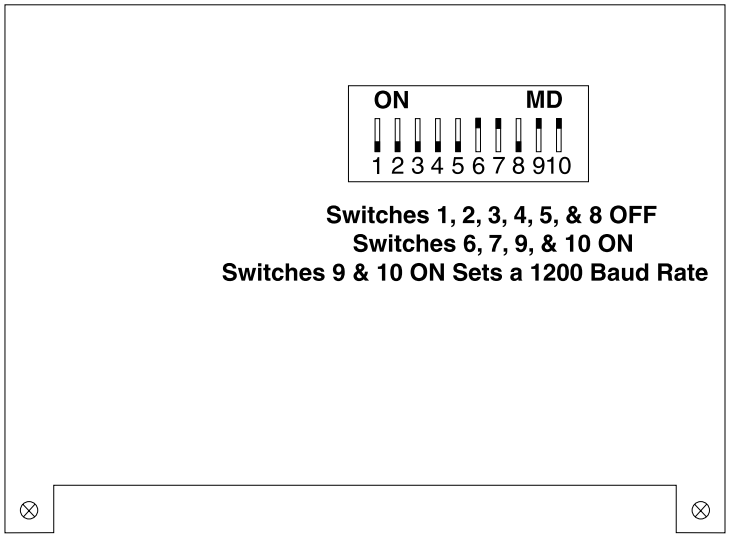


Table 4 Dip Switch Settings for the Citizen Printer

Foreign		**USA**	**Germany**	**France**	**UK**
Character	**DSW1-4**	OFF	OFF	ON	ON
Selection	**DSW1-5**	OFF	ON	OFF	ON
		ODD	**EVEN**	**NO CHECK**	
Parity	**DSW1-6**	OFF	ON	OFF	ON
Check	**DSW1-7**	OFF	OFF	ON	ON
Data	**DSW1-8**	**ON = 7 Bit**		**OFF = 8 Bit**	
		9600	**4800**	**2400**	**1200**
Baud	**DSW1-9**	OFF	OFF	ON	ON
Rate	**DSW1-10**	OFF	ON	OFF	ON

6.2.1 Printer Speed Selection

1. The 2100N Turbidimeter can be configured for fast or slow (2.5 second delay) print speed.
2. Press and hold the **RIGHT ARROW** key for 3 seconds.
3. Use the **ARROW** keys to edit the display to read **01**.
4. Press the **ENTER** key to activate the print speed selection mode.
5. Use the **UP** and **DOWN ARROW** keys to select the flashing **SL Pr** for slow or **FS Pr** for fast print speed.
6. 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 *Window Terminal* or *ProComm Plus* 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:

- Key in **VAL** (for value) and press enter on the computer keyboard. This action recalls the current 2100N 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.

SECTION 7 MAINTENANCE

7.1 Cleaning

Keep the turbidimeter and accessories clean. Use a cloth dampened with mild detergent and water when the enclosure and keypad require cleaning. 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 2.5.1 Cleaning Sample Cells*).

⚠ ***CAUTION***
Turn the 2100N Turbidimeter off and disconnect the power before cleaning the instrument.

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

PRECAUCION
Apague el Turbidímetro 2100N antes de limpiar el instrumento.

VORSICHT
Vor der Reinigung muß das Trübungsmeßgerät 2100N abgestellt und der Netzstecker gezogenwerden.

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

7.2 ⚠ Lamp Replacement

Use only the Lamp Replacement Kit (*Cat. No. 47089-00*). The lamp assembly includes the lamp with leads, the lamp retainer, and the lamp holder. Replace the lamp as follows:

1. Turn the instrument off, and disconnect the power cord from the back panel receptacle.

⚠ ***CAUTION***
The lamp must be cool before removal from the instrument.

PRUDENCE
La lampe doit être froide avant de la retirer del'appareil.

PRECAUCION
La lámpara debe dejarse enfriar antes de intentar quitarla del instrumento.

VORSICHT
Die Lampe muß vor der Entnahme aus dem Gerät abgekühlt sein.

PRECAUÇÃO
A lâmpada deverá estar esfriada antes de tirá-la do instrumento.

⚠ ***CAUTION***
Wear protective eye wear if the lamp is turned on while the lamp cover is removed.

PRUDENCE
Porter des lunettes de protection si la lampe est allumée, alors que le capot de la lampe est retiré.

PRECAUCION
Use protección de ojos cuando la lámpara esté encendida y su cubierta protectora esté fuera de posición.

VORSICHT
Wenn die Lampe bei abgenommener Lampenabdeckung brennt, ist ein Augenschutz zu tragen.

PRECAUÇÃO
Quando a Lâmpada estiver acesa e a proteção de lâmpada estiver removida, use protetor ocular.

2. Remove the cover over the lamp compartment (see *Figure 24)*. Squeeze the latch tab together, and pull out on the cover.

3. Use a small screwdriver to loosen the two screws securing the lamp leads in the lamp terminal block. Pull the leads free.

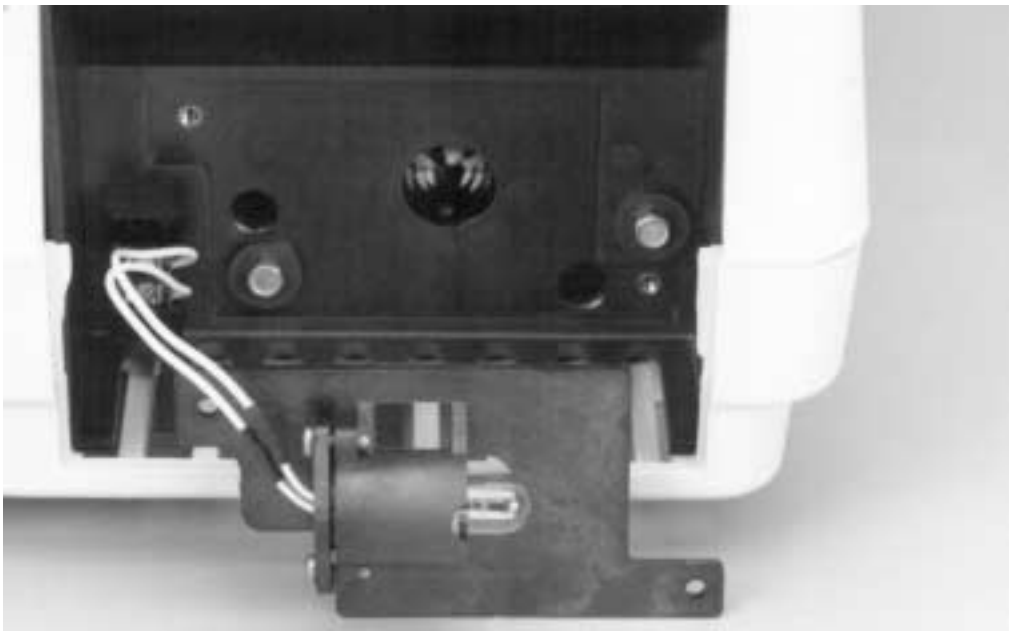
4. Remove the two Phillips-head screws securing the lamp holder in the instrument (upper left-hand corner and lower right-hand corner). Remove the entire lamp assembly.

Note: *Do not touch the lamp; oil from skin will cause damage. Clean the lamp with alcohol if necessary.*

5. Mount the new lamp assembly in the instrument.

6. Insert the lamp leads under the clamping plates in the lamp terminal block. Lamp leads are not polarized and therefore may be placed in either position on the terminal block. Tighten the terminal block screws.

Figure 24 Lamp Replacement



7. Replace the lamp compartment cover, and connect the power cord to the back panel receptacle.

8. Recalibrate the instrument as described in *Section 3.2.4* on page *39*. New turbidity stand-ards must be prepared (refer to *Section 3.2.2* on page *37* and *Section 3.2.3* on page *38*).

SECTION 8 TROUBLESHOOTING

8.1 Introduction

The Model 2100N Laboratory Turbidimeter has several self-diagnostic functions and Error Codes to permit convenient and effective system troubleshooting.

8.2 Error Messages

Error messages may be initiated due to instrument malfunction or operator error. **Errxx** error codes are cleared from the display by pressing the **ENTER** key. The meter continues operating in the error condition; a calibration in progress can be continued. Any calibration being calculated (at the time the message appears) is discarded; the old calibration is retained. *Table 5* lists the error codes displayed for specific conditions.

Table 5 Error Codes

Code	Probable Cause	Corrective Action
Err01	Dilution water calculated to be >0.5 NTU	Start calibration over with higher quality dilution water, or filter water with a membrane filter before use.
Err02	Two calibration standards have the same value, or their difference is less than 60.0 NTU. Standard 1 is too low (<10 NTU)	Recheck preparation of standards and repeat calibration.
Err03	Low light error	Reinsert 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 I/O. Call Hach Service.
Err05	A/D overrange	Contact Hach Service.
Err06	A/D underrange	Contact Hach Service.
Err07	Light leak	Close the sample cell cover. Use the I/O switch to turn the instrument off and then back on.
Err08	Bad lamp circuit	Contact Hach Service.
Err09	Printer timeout error	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 I/O. Call Hach Service.
Err11	System loop test error	Switch instrument off and back on with I/O. Call Hach Service.

8.3 Diagnostic Functions

The diagnostic mode permits access to system function information that is useful primarily when the instrument function is in doubt. Hach service technicians use the information for precise troubleshooting, speeding repairs, and avoiding unnecessary service returns.

Access diagnostic information by pressing and holding the **RIGHT ARROW** key for 3 seconds. Use the **ARROW** keys to edit the display to read the diagnostic code number of interest. Press the **ENTER** key to display the diagnostic value.

8.3.1 Basic Diagnostic Codes

Access the *Table 6* diagnostic information by entering the appropriate code:

Table 6 Diagnostic Codes

Code	Display	Description
00	bP on/bP of	Keyboard Beeper On/Off
01	FS Pr/SL Pr	Fast/Slow Print Device
21	Pr ln	Printer Test
22	*	Display Test
23	*	Keyboard Test
24	*	Memory Test
25	xxxxx	90° Detector mV, Gain 1
26	xxxxx	90° Detector mV, Gain 10
27	xxxxx	90° Detector mV, Gain 100
28	xxxxx	90° Detector mV, Gain 1000
29	xxxxx	Forward Scatter Detector mV, Gain 1
30	xxxxx	Forward Scatter Detector mV, Gain 10
31	xxxxx	Forward Scatter Detector mV, Gain 100
32	xxxxx	Forward Scatter Detector mV, Gain 1000
33	xxxxx	Transmitted Detector mV, Gain 1
34	xxxxx	Transmitted Detector mV, Gain 10
35	xxxxx	Transmitted Detector mV, Gain 100
36	xxxxx	Transmitted Detector mV, Gain 1000
37	xxxxx	Transmitted Detector mV, Gain 10,000
38	xxxxx	Transmitted Detector mV, Gain 100.000
39	xxxxx	Transmitted Detector mV, Gain 1,000,000
41	xxxxx	A/D Reference Low mV, Gain 1
45	xxxxx	A/D Reference Low mV, Gain 10
46	xxxxx	A/D Reference Low mV, Gain 100
47	xxxxx	A/D Reference Low mV, Gain 1000
48	xxxxx	A/D Reference Medium mV, Gain 1
49	xxxxx	A/D Reference Medium mV, Gain 10
50	xxxxx	A/D Reference Medium mV, Gain 100
51	xxxxx	A/D Reference Medium mV, Gain 1,000
52	xxxxx	A/D Reference High mV, Gain 1
53	xxxxx	A/D Reference High mV, Gain 10

Table 6 Diagnostic Codes (Continued)

Code	Display	Description
54	xxxxx	A/D Reference High mV, Gain 100
55	xxxxx	A/D Reference High mV, Gain 1,000
56	xxxxx	Ground mV, Gain 1
57	xxxxx	Ground mV, Gain 10
58	xxxxx	Ground mV, Gain 100
59	xxxxx	Ground mV, Gain 1000
60	xxxxx	+5 System Volts
61	xxxxx	-5 System Volts
62	xxxxx	Lamp Volts
63	xxxxx	+8 System Volts
64	xxxxx	Calibration Coefficient A0
65	xxxxx	Calibration Coefficient B0
66	xxxxx	Calibration Coefficient B1
67	xxxxx	Calibration Coefficient C0
68	xxxxx	Calibration Coefficient C1
69	xxxxx	Calibration Coefficient C2

8.3.2 Other Instrument Diagnostics

8.3.2.1 Display Segments and Icons

Determine the proper functioning of all display segments and icons by using diagnostic 22.

8.3.2.2 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 four-standard calibration is entered. The instrument initializes in the **CAL** mode.

8.3.2.3 Flashing 9s

If the display flashes all 9s, the sample being measured is over-range (for the selected range of measurement). The instrument also indicates over-range if the sample is >40 NTU (268 Nephelos or 9.8 EBCs) with the Ratio off (refer to *Section 2.8* on page *29*).

8.3.2.4 Flashing 0s

If the display flashes 0s, the measurement indicates a negative turbidity value. Recalibrate the instrument (see *Section 3.2.4* on page *39*).

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 Laboratory Turbidimeter, 110/220 V with UL and CSA approved power cord and fuse	47000-00
2100N Laboratory Turbidimeter, 110/220 V with European power cord and electrical fuse	47000-02

REPLACEMENT PARTS

Cover, lamp compartment	47032-00
Cover assembly, sample cell compartment	47713-00
Dust Cover	47030-00
Formazin Primary Turbidity Stock Solution, 4000 NTU, 100 mL	2461-42
Gelex® Secondary Turbidity Standardization Kit	25890-00
Includes:	
Empty Vial (for stray light measurement	25891-00
0–2 NTU	25891-01
0–20 NTU	25891-02
0–200 NTU	25891-03
200–4000 NTU	25891-04
Instrument Manual	47000-88
Lamp Kit, Replacement	47089-00
Oiling Cloth	47076-00
Power Cord, 18/3 SVT, 10 A, 125 V, North American, 110 V, UL/CSA approved Power Cord	18010-00
or	
Power Cord, .75 mm SQX3 conductor, European, 220 V, VDE approved Power Cord	46836-00
Quick Reference Card	47000-44
Sample Cells, 6/pkg, 2100 N	20849-00
Silicone Oil, 15 mL dropper bottle	1269-36

OPTIONAL ACCESSORIES AND REAGENTS

Bath, ultrasonic	24895-00
Cable, computer, 9-pin to 9-pin	49502-00
Cable, for Citizen printer (Cat. No. 25933-00 and 25933-02), 9-pin to 25-pin	49503-00
Calibration Kit, StablCal*® for 2100N Turbidimeter,	
<0.1-, 20-, 200-, 1000-, and 4000-NTU, 500 mL each	26621-00
<0.1-, 20-, 200-, 1000-, and 4000-NTU, sealed vials	26621-05
Cell Adpater, 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/pk	23238-10
Filter Paper, glass fiber, quantitative, 47 mm, 100/pkg	2530-00
Flask, Erlenmeyer, 500 mL	505-49
Flow-Cell Kit, Automated, Low Pressure, 110 V	47450-00
Flow-Cell Kit, Automated, Low Pressure, 220 V	47450-02
Flow-Cell Kit, Manual, Low Pressure	47449-00
Flow-Cell Kit, High-Pressure	47451-00
Flow-Cell Kit, glass	47095-00
Flow Valve Module with 110 V power supply (included with Automated Flow-Cell Kit)	47445-00
Flow Valve Module with 220 V power supply (included with Automated Flow-Cell Kit)	47445-02
Formazin Primary Turbidity Stock Solution, 4000 NTU, 500 mL	2461-49

* StablCal and TenSette are Hach Company trademarks

OPTIONAL ACCESSORIES AND REAGENTS (continued)

Description	Cat. No.
Fuse for 110 V operation, 250 V, 1.6A, UL/CSA approved	30307-00
Fuse for 220 V operation, 250 V, 1.6A, IEC type, VDE approved	30306-00
Hexamethylenetetramine, 100 g	1878-26
Hexamethylenetetramine, 500 g	1878-34
Hydrazine Sulfate, 100 g	742-26
Power Supply, Flow Valve Module, 12 Vdc, 110 Vac (included with Automated Flow-Cell Kit)	47469-00
Power Supply, Flow Valve Module, 12 Vdc, 220 Vac (included with Automated Flow-Cell Kit)	47470-00
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
Pump, vacuum, hand-operated	14283-00
Pump, vacuum/pressure, portable, 120 V, 60 Hz, 1.3 cfm	14697-00
Pump, vacuum/pressure, portable, 240 V, 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
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	547-53
Water, Deionized, 4L	272-56

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- Quantity

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SUPPLEMENTAL COMPLIANCE INFORMATION

The 2100N Turbidimeter shows an accuracy shift when exposed to radio frequency interference of 3 volts per meter. If the displayed data are not stable (within the accuracy and repeatability specifications) and other interferences are not suspected as the cause, inspect the area for portable phones, paging service tower/antennas, or any other transmitting communication device. For example, if the user of the instrument detects a measurement deviation while using a hand-held radio communication device to relay information to a base station, the interference is clearly caused by the hand-held radio communication device. To resolve the interference problem, move the hand-held radio communication device at least 3 to 4 meters from the instrument to provide isolation.

As shown below, the instrument reading may deviate slightly win the presence of specific frequencies. Any electronic instrument is sensitive to RF fields if the power is great enough. However, typical transmitting power is limited by regulatory controls, and field strengths of greater than 3 volts/meter are unusual.

Points of susceptibility for the 2100N Turbidimeter in modulated electric filed of 3V/m over a range of 27–100 MHz

Frequency (MHz)	Nominal Value (NTU)	RF Value in RF Field (NTU)	Specification Range (± 2%) (NTU)
148.0–407.0	0.095	0.070–0.091	0.093– 0.097
768.9–781.0	0.095	0.099–0.105	0.093– 0.097
901.7–969.0	0.095	0.100–0.111	0.093– 0.097

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