Hach
Model DR/2400
Portable
Spectrophotometer

HACH ®

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Safety Information

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 that 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.

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 this instruction manual for operational and/or safety information.

⚠ *Section 2.6 Sample Cell Adapters on page 26*

⚠ *Section 2.7 Inserting and Removing Samples on page 27*

⚠ *Section 2.8 Using the Optional Pour-Thru Cell on page 27*

Specifications

Wavelength Range	400 to 880 nm
Bandwidth	4 nm ± 1 nm
Wavelength Accuracy	± 1 nm
Wavelength Resolution	1 nm
Wavelength Selection	Automatic, based on method selection
Optical System	Concentric Spectrometer for multi-channel spectroscopy
Wavelength Calibration	Automatic, via internal filter
Linear Photometric Range	−2.000 to +2.000 Abs
Photometric Linearity	±0.005 Abs from 0.0 to 0.5 Abs; ±1% from 0.5 to 2.0 Abs.
Photometric Resolution	0.001 Abs, 0.1 %T
Recommended Recertification Interval	One year (See *8.8 Recertification Interval* .)
Stray Light	>2.5 A, <0.3 %T @ 430 nm using 3 mm thickness GG-475 filter
Operational Modes	Selectable; momentary (Display Lock on), or constant (Display Lock off)
Readout Modes	Transmittance, absorbance, and concentration
RS232 Port	Standard 9-pin bi-directional
Line Power	9 VDC @ 1 amp; 95 to 240 VAC; 50/60 Hz; automatic selection
Battery Power	3 "D" Cell Alkaline or Rechargeable Alkaline Batteries
Sample Compartment and Cell Compatibility:	***Note:*** *For Hach Programs, be sure to use the cell type specified for that program in the DR/2400 Portable Spectrophotometer Procedures Manual.*
No Cell Holder Required	1-in. (25.4-mm) round cells/vials, including AccuVac®
Round Cell Holder, 16-mm	COD/Test 'N Tube™ and UniCell™ vials
Metric Rectangular Cell Holder (optional)	1-cm rectangular cells
Multi-pathlength Cell Holder	Pour-Thru Cell and multi-pathlength cells
Interface	Graphic user interface 320 x 240 pixel graphic display with touchscreen
Data Storage	1000 data points (date, time, results, sample ID, user ID), 50 user calibrations
Dimensions	32.4 x 17.8 x 18.8 cm (12.75 x 7.0 x 7.4 in.)
Weight	2.1 kg (4.6 lbs)
Keypad	5 keys for power on/off, backlight on/off, contrast down, contrast up, and battery status
Printer	External serial
Pour-Thru Cell	1-inch/1-cm multi-pathlength (optional)
Report Generation	Download stored information in a standard report format. Meets GLP guidelines, including a minimum of: date, time, sample identification tag, analyst initials (3), results, and instrument serial number.
Real-time Clock	Yes
Real-time Calendar	Yes
Operating Environment	0 to 40 °C (32 to 104 °F); 90% relative humidity, non-condensing
Storage Environment	−20 to 60 °C (−4 to 140 °F); 85% relative humidity, non-condensing

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Installation

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 détérioration 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.

Alcune parti di questo manuale contengono informazioni sotto forma d'avvertimenti, di precauzioni e di osservazioni le quali richiedono una particolare attenzione. La preghiamo di leggere attentamente e di rispettare quelle istruzioni per evitare ogni ferita corporale e danneggiamento della macchina. Solo gli operatori qualificati per l'uso di questa macchina sono autorizzati ad effettuare le operazioni di manutenzione descritte in questa parte del manuale.

Section 1   Getting Started

1.1 Unpacking the Instrument

The DR/2400 Portable Spectrophotometer comes packaged with one each of the following items:

- Instrument
- Power cord
- Power supply
- Batteries
- Round sample cell holder assembly
- Procedure Manual with binder
- Instrument Manual
- CD-ROM containing the Procedure and Instrument Manuals
- Set of 6 sample cells, 10 mL/25 mL

If any of these items are missing or damaged, please contact Hach Company or a sales representative immediately.

Note: Retain the original packaging material. Instruments returned for recertification or service should be shipped in the original packaging material to protect against damage during transportation. See Section 8.8 Recertification Interval for more information.
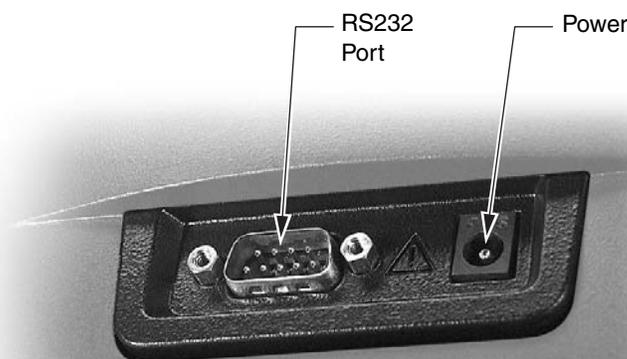
1.2 Operating Environment

Maintain an ambient temperature of 0 to 40 °C (32 to 104 °F) for proper instrument operation. The relative humidity should be less than 90%; moisture should not condense on the instrument.

1.3 Cable Connections

Figure 1 shows the cable connections on the back of the instrument.

Figure 1   DR/2400 Cable Connections

Getting Started

1.3.1 Power Connections

A UL/CSA-approved 115-VAC power cord with a NEMA 5-15P style plug is supplied with the North American DR/2400 models (Cat. No. 18010-00). A 230 VAC harmonized power cord with a Continental European plug is supplied with the European DR/2400 models (Cat. No. 46836-00).

To power the North American DR/2400 models with 230 VAC, replace the supplied 115 VAC power cord with a UL/CSA approved 230 VAC power cord with a NEMA 6-15P style plug.

Plug the power cord into the back panel of the instrument. Connect the power cord to the proper outlet and press the power key. (See *Figure 3*.)

1.3.2 Serial Printer and PC Connections

Note: Use of the specified cable or an equivalent shielded cable is mandatory for proper immunity to electromagnetic interferences.

Connect the DR/2400 Spectrophotometer to a personal computer (PC) by using the computer interface cable (Cat. No. 48129-00). The cable provides a direct connection between the DR/2400 Spectrophotometer and the 9-pin D connector used for the serial port on most personal computers. For computers with a 25-pin D connector, use a 9-pin to 25-pin adapter (available at many computer supply stores).

For proper data transfer, the communication parameters of the DR/2400 and the computer must match. Refer to *Section 2.3.4 Communications with a Printer or Computer* for selecting DR/2400 printer and computer settings.

Once the communication link is established, touch the **Send to Printer** or **Send to Computer** icon to send data to the printer or computer.

1.4   Battery Pack

The DR/2400 Spectrophotometer is equipped with 3 D-cell alkaline batteries to provide primary power for field operation. The alkaline batteries can supply the instrument with power to remain in operation for up to 200 hours.

Note: The rechargeable pack can provide power to the instrument for up to 40 hours before recharging.

Changing the Batteries

When the alkaline batteries need to be replaced, remove the battery cover on the bottom of the instrument. Remove the discharged batteries and replace with fresh D-cell alkaline batteries. Orient all three batteries so that the positive terminals point to the keyboard (front) end of the instruments. See *Figure 2 on page 15*.

The Rechargeable Battery Pack is replaced as a unit. Remove the discharged pack and replace with the fresh pack. Orient the pack so that the positive terminals point to the keyboard (front) end of the instrument.

Note: The Rechargeable Battery Pack (Cat. No. 59491-00) is available separately. The alkaline rechargeable batteries in the rechargeable pack are not individually replaceable.

Figure 2   Changing the Batteries
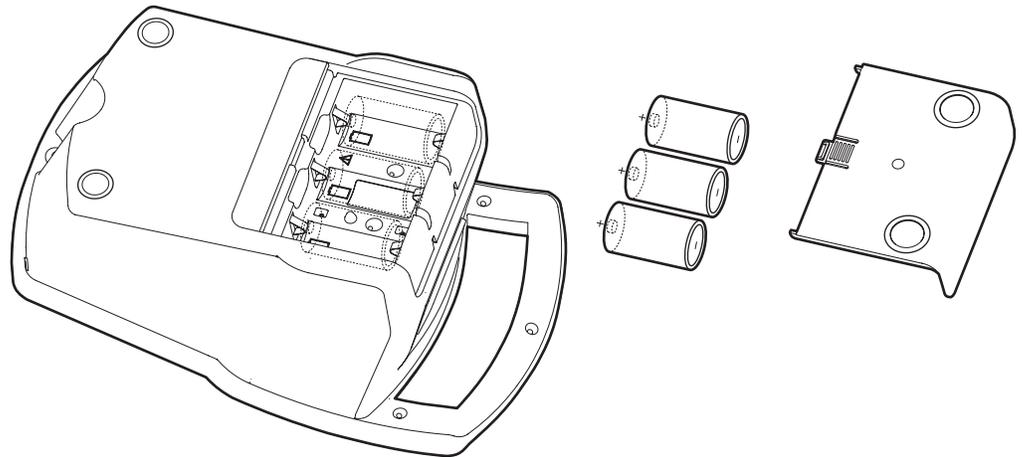
The internal clock loses its setting whenever batteries are replaced. To reset the clock, see *Setting the Time and Date on page 21*

1.5   Using the Instrument Keys

The instrument keys are shown in *Figure 3*.

Figure 3   Instrument Keys

1.5.1   Turning the Power On and Off

Turn the instrument on and off with the **Power On/Off** key (see *Figure 3*). The first time the instrument is turned on, the language selection screen will appear. Select a language and touch **OK**. At each succeeding instrument power-up, a wavelength calibration will be performed automatically, and then the Main Menu will appear.

1.5.2 Turning On the Backlight

The backlight can improve the readability of the screen in low-light conditions. Press the **Backlight** key to turn the light on or off. The light will automatically shut off 15 minutes after the last key has been pressed.

1.5.3 Adjusting the Display Contrast

Lighten or darken the contrast on the display using the **Contrast Adjustment** keys.

1.5.4 Battery Status

Press the **Battery Status** key to bring up the battery meter reading window. Press the **Battery Status** key again to return to the previous screen menu. The Battery Status reading window is not available from all screens. For more information about batteries, see *Specifications on page 9*, *Alkaline Battery Replacement on page 51*, and *Rechargeable Battery Pack Replacement/Maintenance on page 52*.

Figure 4   Battery Status–Line Power
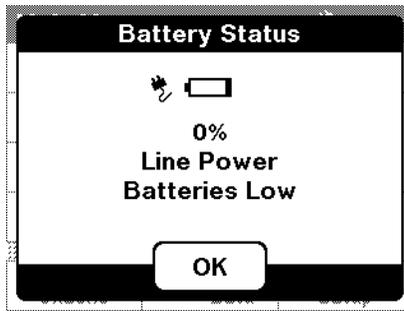
Figure 5   Battery Status–Battery Power
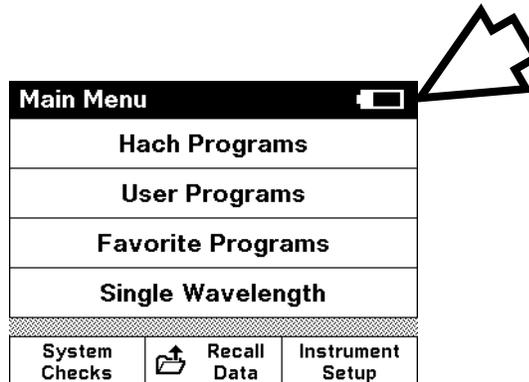
Figure 6   Battery Status–Charging
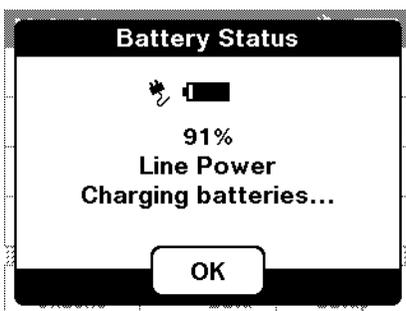
1.6   Tips for Using the Touch Screen

The entire screen is touch-activated. Spend a few minutes touching various items on the screen to see how they work.

- To make a selection, touch the screen with a fingernail, fingertip, pencil eraser, or a stylus. *(See *Figure 7.)*
- Do not touch the screen with a sharp object, such as the tip of a ball point pen!
- Touch buttons, words, or icons to select them.
- Touch buttons or check boxes to change settings.
- Use scroll bars to move up and down long lists very quickly. Touch and hold the scroll bar, then move the fingertip up or down to move through the list.
- Highlight an item from a list by touching it once. When the item has been successfully selected, it will be displayed as reversed text (light text on a dark background).

Figure 7   Different Touch Screen Navigation Options

1.7   The DR/2400 Portable Spectrophotometer Main Menu

The Main Menu appears when the instrument is turned on. *Figure 8* shows the Main Menu on the standard software package. *Figure 8* shows the Main Menu on the advanced software package.

Getting Started

Figure 8   Main Menu–Standard Software

Main Menu
Hach Programs
User Programs
Favorite Programs
Single Wavelength

System Checks	Recall Data	Instrument Setup

1.8   Using the DR/Check™ Absorbance Standards

Hach's DR/Check Absorbance standards are used in instrument performance verification on both the DR/2400 and DR/800 Series instruments. The set consists of three standards plus a blank. Each of the standards is certified to give a known absorbance value at a particular wavelength. The standards can be used to verify that the instrument is performing in a consistent manner on a routine basis.

1.8.1   How to Use the Standards

Note: Be sure to follow the cell alignment steps found on the product box.

The DR/Check Standards are used to verify instrument performance by measuring a specific absorbance at each of the following wavelengths:

- 420
- 520
- 560
- 610

1. From the Main Menu screen, touch **Single Wavelength.**

2. From the Single Wavelength screen, touch λ.

3. Key in 420 nm.

4. Insert the blank into the instrument so that it is properly aligned with the light source. Touch **Zero**.

Note: For best results, wipe all the cells with a clean tissue and silicone oil before use

5. Place Standard #1 in the instrument so that it is properly aligned. Read the absorbance.

6. Record the initial instrument reading in the blank table provided with the standards. The initial value should be within the tolerance limits of the certified absorbance specified on the Certificate of Analysis for the DR/Check Standards.

Note: If values are not within specified tolerance limits, contact Hach Technical Support. See Repair Service on page 63 for contact information.

7. Repeat *steps 2* through *6* for the other two standards, using the correct wavelength in *step 3*.

Note: To continuously monitor instrument performance, repeat all steps and compare readings to the recorded values.

1.9   Determining Photometric Accuracy

A verification of photometric accuracy can be performed on the DR/2400 using Hach DR/Check (Cat. No. 27639-00), NIST SRM 930 neutral density glass, or NIST SRM 2031 metal-on-quartz standard reference materials.

To verify the photometric performance of the DR/2400 with standards, the instrument zero should be performed on a "like" standard to obtain the maximum performance capability of the instrument. Using the DR/Check, a blank is performed on the blank provided with the DR/Check set and values of standards are read directly. When using NIST standards or equivalent glass standards, a blank is performed on the non-absorbing reference standard provided with the set. If the stated values for the standards include the reflection loss, then the stated value of the non-absorbing standard is subtracted from each of the absorbance standards to obtain an adjusted true value for the reference standards. It is these adjusted values that are used to compare the photometric accuracy of the DR/2400 when the instrument is blanked on material other than air. The following example provides a method for checking photometric accuracy using glass standards with the DR/2400 that most closely matches the performance obtained when a blank is used in Hach water analysis methods.

Example:

1. Turn the DR/2400 on and set the appropriate wavelength (see *How to Use the Standards* on page *18* for setting the wavelength). The wavelength should be set to the stated value of the reference standard being used.

2. Set the instrument to read in the same units as the reference standards (usually "Abs" units).

3. Insert the blank or non-absorbing reference standard into the DR/2400 and zero the instrument. The display should read **0.000 Abs**.

4. Remove the blank and insert a reference standard, such as the 0.250 Abs reference standard.

5. Touch **Read** to get the value for the reference standard. This is the "read" value for the reference standard. An average of ten readings should be used to obtain the "read" value.

6. Calculate an adjusted value for the 0.250 Abs standard by subtracting the stated value of the non-absorbing reference standard from the stated value of the 0.250 Abs standard. If the stated value for the non-absorbing standard is 0.0374 and the stated value for the 0.250 Abs standard is 0.2529, then the adjusted value for the 0.250 Abs standard is:

$$0.2529 - 0.0374 = 0.2155 \text{ Abs.}$$

7. Compare the "read" values to the adjusted values for the standard.

8. The standard deviation of the ten "read" values is the precision of the DR/2400.

9. Report the difference between the "read" value and "adjusted" value plus or minus the standard deviation.

10. Repeat steps 4 through 9 for reference standards of other values or wavelengths.

2.1   Selecting a Language

1. With the instrument off, press the **Power** key and hold it down until the language selection screen appears.

2. Select a language and touch **OK**. The menu screens will now appear in the chosen language.

2.2   Instrument Setup Menu
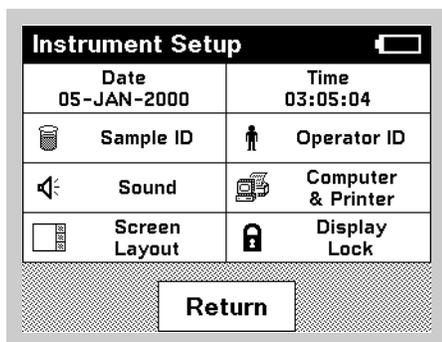
The Instrument Setup menu can be reached from the Main Menu by selecting **Instrument Setup**. From reading mode, select **Options** first.

2.2.1   Setting the Time and Date

1. Enter the Instrument Setup menu.

2. Touch the **Time** or **Date** menu option.

3. Set the time using a 24-hour clock (0:00 to 23:59, where 0:00 is midnight and 12:00 is noon) or a 12-hour clock (1:00-12:59 with a selection for AM or PM).

4. Set the date. The date is displayed in the following format: DD/MMM/YYYY. For example, 04-Feb-2001.

2.2.2   Setting Sound Preferences

To set sound preferences, enter the Instrument Setup menu. Touch **Sound**. Three options will appear.

- **Screen Touch** — The instrument default is set to make a short beep every time the screen is touched. To turn off the Screen Touch sound, uncheck the **Screen Touch** option.

- **Reading Done** — The instrument default is set to make a short beep every time a reading is complete. To turn off the Reading Done sound, uncheck the **Reading Done** option.

- **Timer** — To change the length of the timer sound touch **Short** or **Long**. Long beeps are better for noisy environments.

Touch **OK** to accept the settings and return to the Instrument Setup menu.

General Instrument Operation

2.3 Using the Alphanumeric Keypad

This screen is used to enter letters, numbers, and symbols as needed when programming the instrument. Unavailable options are grayed out.
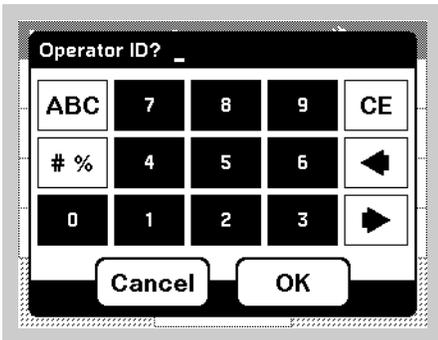
The icons to the left of the screen allow a choice of entry modes:

- Alphabetic—When entering alphabetic characters (ex. user-entered units), this key allows toggling between upper and lower case letters. It is inactive on some screens.
- Symbols—Punctuation, symbols, and numerical sub- and superscripts may be entered after touching this key.
- Numeric—For entering regular numbers.

The central keypad changes to reflect the chosen entry mode. Repeatedly touch a key until the desired character appears on the screen. A space can be entered by using the underscore on the **YZ_** key.

The icons to the right side of the screen are:

- Clear Entry
- Backspace
- Advance—This key can be used to advance to the next space in an entry when two adjacent characters occur on the same key.

2.3.1 Setting the Operator ID

Use this option to enter up to 10 sets of operator initials (up to three characters each) into the instrument. This feature helps record which operator measured each sample. (See *Section 2.3 Using the Alphanumeric Keypad* for more information.)
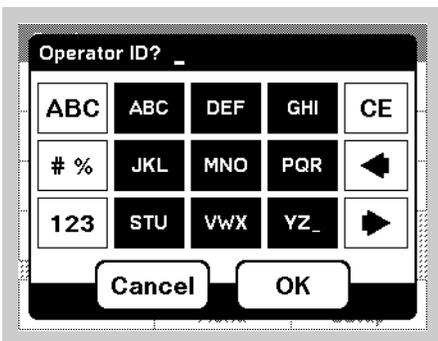
1. Enter the Instrument Setup Menu.
2. Touch **Operator ID**.
3. Enter the operator ID. Touch **OK**.

Note: Spaces are not available in this function. Use underscore symbols instead.

Alternatively, if an operator ID has been entered and Operator ID is active, touch the operator ID directly on the Hach Program screen. Use the alphanumeric keypad to change the operator ID.

2.3.2   Setting the Sample ID

Use this option to enter up to 25 sample identification tags (up to 10 characters each) into the instrument. Sample IDs can be used to identify the location where each sample was taken. (See *Section 2.3 Using the Alphanumeric Keypad* for more information.)
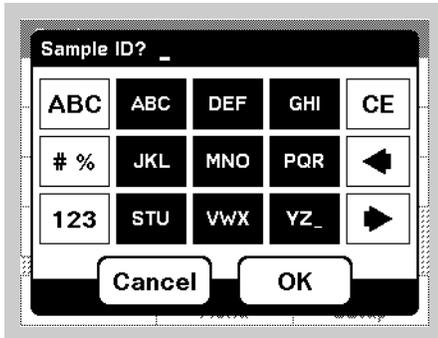
1. Enter the Instrument Setup menu.

2. Touch **Sample ID**.

3. Enter the sample ID. Touch **OK**.

Note: Spaces are not available in this function. Use underscore symbols instead.

Alternatively, if a sample ID has been entered and Sample ID is active, touch the sample ID directly on the Hach Program screen. Use the alphanumeric keypad to change the sample ID.

2.3.3   Right- or Left-Handed Screen Option

The screen layout is adaptable for use by either a right- or left-handed person.
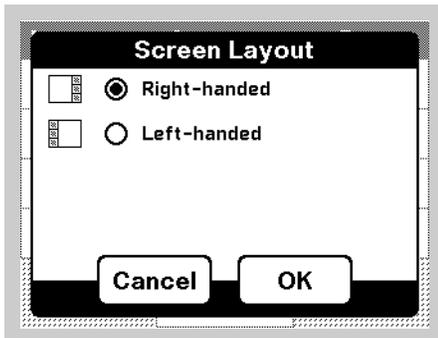
1. Enter the Instrument Setup menu.

2. Touch **Screen Layout**.

3. Touch **Right-handed** or **Left-handed**. Touch **OK**.

2.3.4 Communications with a Printer or Computer

2.3.4.1 Selecting the Destination for Sent Data
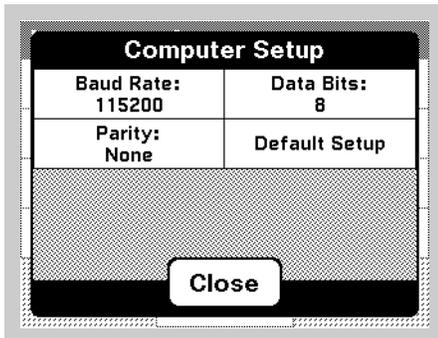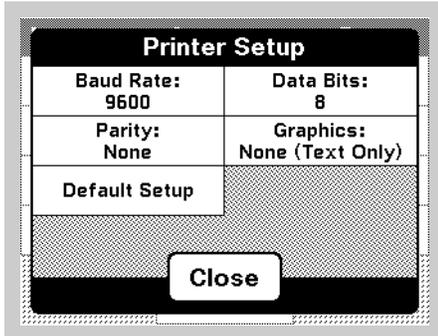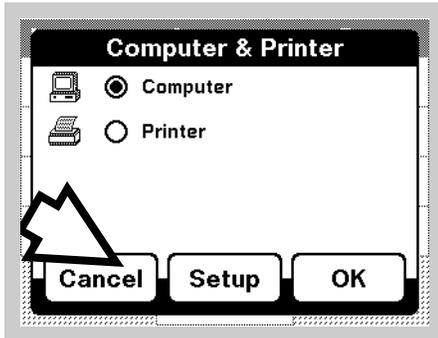
1. Connect the appropriate cable from the instrument to the printer or computer as described in *Section 1.3 Cable Connections*.

2. From the Main Menu, touch **Instrument Setup**. From a Hach Program window or other reading mode, touch **Options,** then **Instrument Setup**.

3. Touch the **Computer & Printer** menu item.

4. Touch **Computer** or **Printer**.

5. Touch **OK** to accept the destination for the sent data.

6. Touch **Setup** to bring up a menu of communication settings.

Please note:

- Data can be sent to only one destination at a time. The instrument saves the last computer and last printer setup, making it easy to switch between the two as necessary.

  Note: In the Computer Setup Menu, **Default Setup** *matches the defaults to those of* HachLink™.

- **Graphics** offers a choice between Hewlett-Packard Inkjet/Deskjet protocol and Epson Dot Matrix protocol, or no graphics (text only). Do not select the text only option for printing graphs.

7. After the settings are configured, touch **Close**.

8. Use the **Printer** or **Computer** icon to send data to the chosen device.

2.3.4.2 Changing the Destination of Sent Data

1. Follow steps *2* through *4* in section *2.3.4.1*, above.

2. Touch **OK**. Use the printer or computer icon whenever the data destination needs to be changed.

2.4 "Push-to-Read" Display Lock
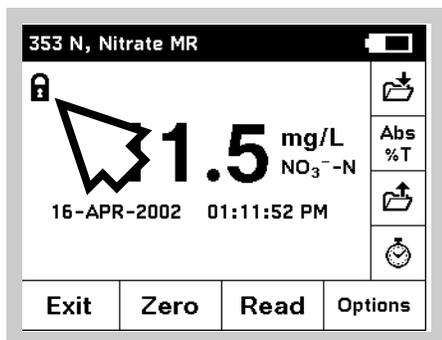
This feature allows the operator to select between "Push-to-Read" and continuous display modes. The default setting is "Push-to-Read" on. In this mode, the "Push-to-Read" **Display Lock** is on, and a padlock icon will appear on the screen.
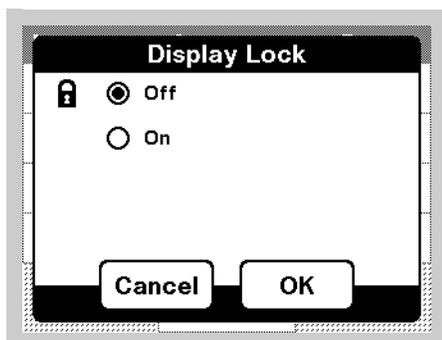
Note: To turn "Push-to-Read" Display Lock off from within a measurement screen, touch the display lock icon. Set the Display Lock setting as desired.

Note: In the off setting, the instrument provides constant power to both its display and its light sources. It is recommended that the "Push-to-Read" Display Lock be off only when the instrument is operating under external power. This will prolong battery life.
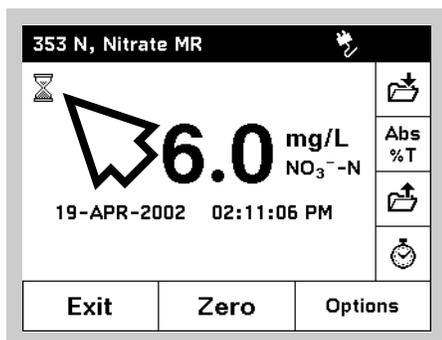
When the Display Lock is turned off and the instrument is in continuous read mode, an hourglass may appear in the upper left corner of the screen. This indicates that the instrument is still processing a reading. When the hourglass disappears, the measurement is complete and the results may be recorded.

2.5 Working with HachLink™

HachLink 2000 software, version 2.0 or higher, may be used with an DR/2400 Portable Spectrophotometer that is set up to communicate with a computer (see *Communications with a Printer or Computer*). Earlier versions of HachLink do not recognize the DR/2400.

To ensure accurate data transfer, make sure that the serial port settings on the DR/2400 match the settings in HachLink. Select **Instrument Setup**, **Computer & Printer**, **Computer** then **Setup**. Selecting **Default Setup** will match the DR/2400 defaults to those of HachLink.

2.6 ⚠ Sample Cell Adapters

CAUTION: Do not place vials that are hotter than 100 °C (212 °F) into any of the sample cell adapters.

ATENCIÓN: No colocar cubetas cuya temperatura sea superior a 100 °C (212 °F) sobre los soportes de muestra.

VORSICHT: Die Küvettentemperatur darf beim Einsetzen in die Küvettenhalter nicht mehr als 100°C (212 °F) betragen.

PRUDENCE: Ne placez pas de cuve de plus de 100°C (212°F) dans un des porte-cuves d'échantillon.

The DR/2400 Portable Spectrophotometer holds a 1 inch (25.4 mm) diameter round cell or an AccuVac® Ampul without an adapter. The 16-mm cell adapter (Cat. No. 59457-00) is used with Test 'N Tube™, Chemical Oxygen Demand, Total Organic Carbon, and UniCell procedures. Immunoassay tests and other procedures using the 1-cm square cell require the square cell adapter (Cat. No. 59459-00). See *Figure 9*. Tests requiring the multi-pathlength cell (Cat. No. 59405-00) or Pour-Thru Cell Kit (Cat. No. 59404-00) require the use of the multi-pathlength cell adapter (Cat. No. 59466-00).

2.6.1 ⚠ Installing Sample Cell Adapters

To place a cell adapter into the instrument, align the tabs on the adapter with the alignment recesses in the round-cell holder. Turn the adapter clockwise until the alignment marks on the adapter line up to the base alignment marks on the instrument. The adapter will snap into place. Place the sample cell into the cell adapter. For best results, use only the sample cells recommended in the Hach procedures.

Remove an adapter by turning it counter-clockwise until the tabs are aligned with the grooves and the adapter slides out easily.

Figure 9   Cell Adapters

TOC and UniCell Adapter (Cat. No. 59457-00)

1-cm Square Cell Adapter (Cat. No. 59459-00)
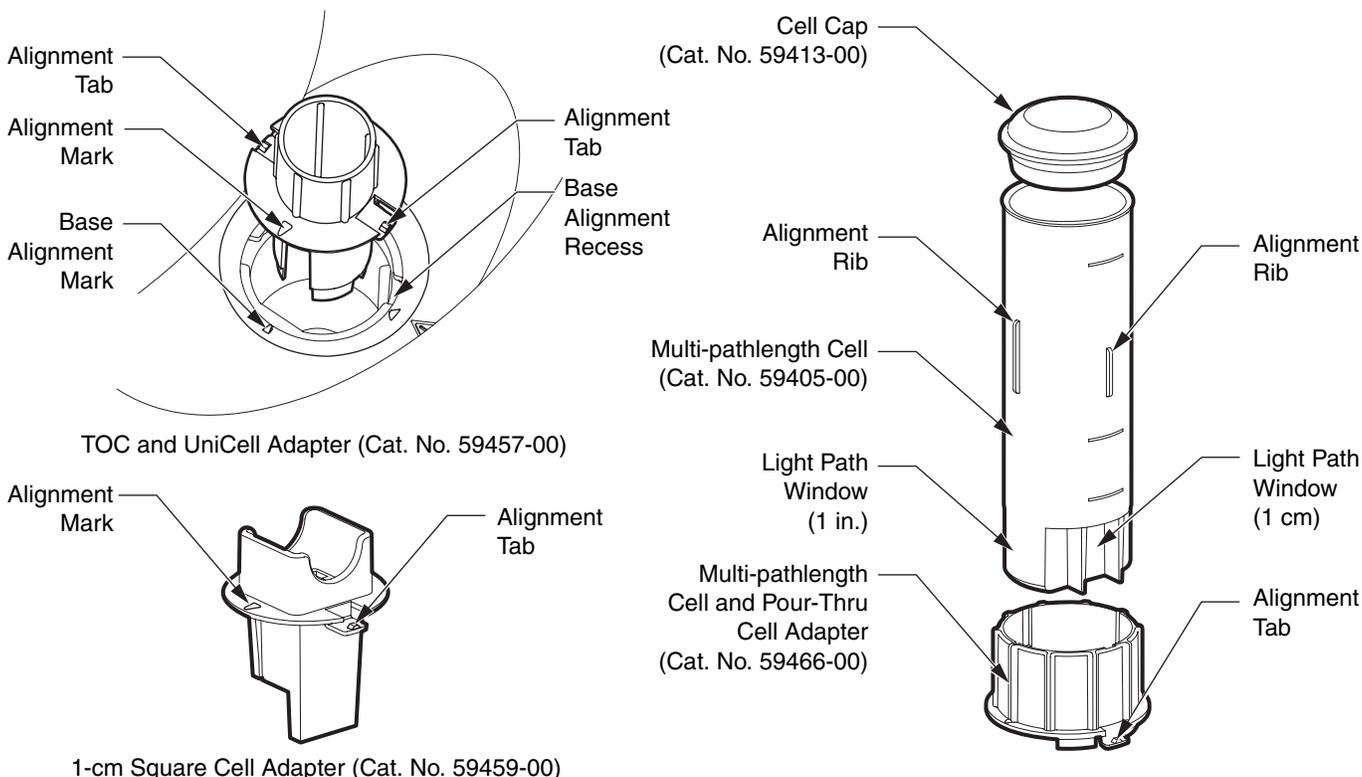
2.7 ⚠ Inserting and Removing Samples

DANGER
This instrument is not intended for use with flammable samples or those containing hydrocarbons, except as required for specific Hach Programs

DANGER
Cet instrument n'est pas conçu pour une utilisation avec des échantillons inflammables ou des échantillons contenant des hydrocarbures, sauf exigence contraire des programmes Hach.

PELIGRO
Este instrumento no está destinado para uso con muestras inflamables o que contengan hidrocarburos, con excepción de lo requerido para los Programas de Hach.

GEFAHR
Dieses Gerät darf nicht mit brennbaren oder kohlenwasserstoffhaltigen Proben verwendet werden, es sei denn, dies würde im Rahmen von HACH-Programmen ausdrücklich verlangt.

PERICOLO
Questo strumento non prevede l'utilizzo con campioni infiammabili o contenenti idrocarburi, ad eccezione di quanto richiesto dalle metodiche Hach.

When inserting and removing samples, place the cell into the cell adapter as described in the Hach procedure. For best results, wipe the samples to remove fingerprints or other marks before placing the samples into the cell adapter.

2.8 ⚠ Using the Optional Pour-Thru Cell

CAUTION
Do not use the Pour-Thru Cell in tests that call for the use of organic solvents such as toluene, chloroform, trichloroethane or cyclohexanone. These solvents may not be compatible with the plastic components of the Pour-Thru Cell creating the potential for equipment damage and chemical exposure for the analyst.

ATTENTION
Ne pas utiliser la cuve à circulation dans les techniques d'analyses qui utilisent des solvants organiques tels que le toluène, le chloroforme, le trichloroéthane ou la cyclohexanone. Les solvants organiques peuvent ne pas être compatibles avec les composants en plastique de la cuve à circulation et endommager l'équipement en créant un risque chimique pour l'opérateur.

ADVERTENCIA
No utilice la Célula de Flujo Continuo para pruebas que requieran el uso de solventes orgánicos tales como tolueno, cloroformo, tircloretano o ciclohexanona. Es posible que estos solventes sean incompatibles con los componenetes de material plástico de la Célula de Flujo Continuo y existe el riesgo de daños al equipo y exposición del analista a las substancias químicas.

WARNHINWEIS
Die "Pour-Thru-Zelle" darf nicht in Tests verwendet werden, die organische Lösungsmittel wie Toluol, Chloroform, Trichlorethan oder Cyclohexanon erfordern. Die Möglichkeit besteht, daß diese Lösungsmittel nicht mit den Kunstoffkomponenten der "Pour-Thru-Zelle" kompatibel sind und somit Geräteschaden verursachen und eine Chemikaliengefahr für den Untersuchungschemiker darstellen können.

CUIDADO
Não use a Cubeta de Fluxo em testes que exigem o uso de solventes orgânicos como tolueno, clorofórmio, tricloroetano ou ciclohexanona. Estes solventes podem não ser compatíveis com os componentes plásticos da Cubeta de Fluxo, havendo a possibilidade de danos ao equipamento e exposição do analista a substâncias químicas.

Use the optional Pour-Thru Cell (Cat. No. 59404-00) with the Multi-pathlength Cell Adapter (Cat. No. 59466-00) to save time when analyzing the same parameter in many samples. Because the same optical characteristics exist for both zeroing and measuring, or when comparing measurements of different samples, any error that would have resulted from optical differences between individual sample cells is eliminated. Rapid Liquid methods speed analysis and require use of the Pour-Thru Cell (see the *Procedure Manual* for these programs).

When using the Pour-thru Cell, keep the instrument lid open. The light cover on the cell will ensure accurate readings. See the instructions for the Pour-thru Cell for more information. Use at least 25 mL of sample to completely flush the cell.

2.9 Assembling the Pour-Thru Cell

The Pour-Thru Cell Assembly (Cat. No. 59404-00) must be assembled and installed before use. *Figure 10* illustrates the assembled unit.

Figure 10 Pour-Thru Cell Assembly
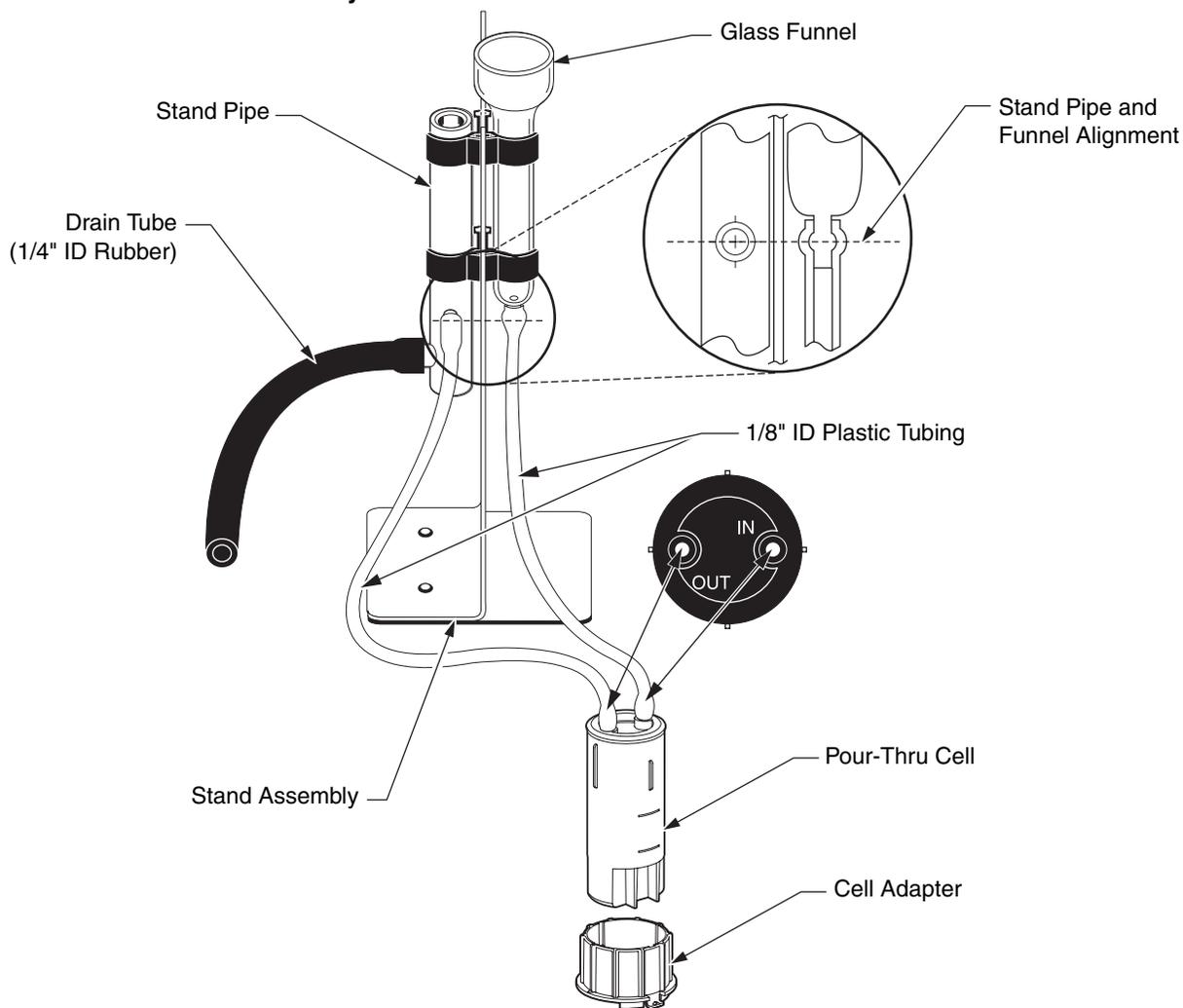
The kit includes:
- Pour-Thru Cell
- Cell Holder
- Stand Assembly
- Glass Funnel
- Stand Pipe
- 1/8" ID plastic tubing (6 ft.)
- 1/4" ID rubber tubing (12 ft.)
- Instruction Sheet

2.10 Installing the Pour-Thru Cell

Install the Pour-Thru cell in the spectrophotometer as follows:

1. Place the multi-pathlength cell adapter into the cell holder. See *Sample Cell Adapters* on page *26* for adapter installation instructions.

2. Examine the Pour-Thru Cell. Make sure the cell is clean and that there are no smudges or fingerprints on the cell faces.

3. Use 1/8″ tubing to attach the inlet port of the Pour-Thru Cell to the glass funnel. Attach the outlet port to the stand pipe.

4. Insert the Pour-Thru Cell into the adapter and seat it into the slots on the top of the adapter for the desired orientation. To select the 1-in./25.4-mm pathlength, orient the cell so that the 1-in./25.4-mm pathlength is parallel to the front of the instrument. The 1-cm pathlength is selected by placing the cell into the adapter with the 1-in./25.4-mm pathlength perpendicular to the front of the instrument. The outlet port of the cell must be at the back of the cell compartment for proper installation of the 1-cm pathlength.

    Note: The light of the optical system of the instrument passes right to left as viewed from the front of the instrument.

5. To ensure proper drainage for the funnel, adjust the relative heights of the stand pipe and funnel as shown in *Figure 10*. Adjust the stand pipe so that the inlet is 5 cm (2 inches) below the tip of the funnel, so that the funnel drains completely.

6. Pour 25 to 50 mL of deionized water into the funnel and allow the funnel to drain. If necessary, move the stand pipe up or down until the funnel drains smoothly and stops draining at the correct level.

The drain tube attached to the stand pipe must drain freely. It should always remain below the outlet of the stand pipe, and should run horizontally. Preferably, the entire tube should be as short as possible with the outlet end inserted into a drain (or suitable collecting vessel, if treatment is necessary before discharge).

The 10-mL procedures cannot be used with the Pour-Thru Cell because 10 mL is not enough to completely flush out the previous sample. Procedures with 10 mL as the final volume can be used with optional 25-mL reagents so that the Pour-Thru Cell can be used where procedures allow it.

2.11 Using the Pour-Thru Cell

Most of the DR/2400 Hach Programs specify the use of 25-mm round cells. The Pour-thru Cell and its 1-in./25-mm pathlength can be used as a replacement in most of these DR/2400 Hach Programs.

Note: For more information, see Correcting for a Diluted Sample, Running a Standard Adjust and Creating a User Program Based on a Hach Program in the DR/2400 Portable Spectrophotometer Instrument Manual.

The Pour-Thru cell can be used with Hach chemistries provided a 25 mL sample is analyzed. Exceptions are noted in *Table 1*.

Table 1 Hach chemistries that cannot be used with the Pour-Thru cell

Aluminum ECR	Arsenic	Barium	Boron, Carmine
Cyanuric Acid	Fluoride	Formaldehyde	Lead, LeadTrak
Mercury	Nickel, Heptoxime	Nitrite, HR	PCB
Phenols	Potassium	Selenium	Silver
Suspended Solids	Sulfate	TPH	Volatile Acids
Zinc	Surfactants, Anionic (Detergents)		

The Pour-Thru cell can be used with the following Hach chemistries, but special care must be taken to rinse the cell with deionized water between samples.

Table 2 Hach chemistries that need extra rinsing with the Pour-Thru cell

Aluminum, Aluminon	Chlorine Dioxide, LR	Cobalt, PAN
Copper, Porphyrin	Hardness, Calmagite	Manganese, LR, PAN
Nickel, PAN	Nitrate, MR	Nitrate, HR

The Pour-Thru cell can also be used to run Nitrogen, Ammonia, Nessler Method and TKN chemistries. Clean the cell by pouring a few sodium thiosulfate pentahydrate crystals into the cell. Rinse out the crystals with deionized water.

2.11.1 Cleaning the Pour-Thru Cell

Check the cell occasionally for an accumulation of film on the windows. If the windows appear dirty or hazy, or if bubbles form in the cell, pour 50 mL of a detergent solution into the cell. Let it soak for several minutes. Rinse thoroughly with deionized water. Use a soft cloth to clean the sample cell windows. Paper towels and other paper products may scratch the windows.

Note: *Do not use solvents (e.g. acetone) to clean the Pour-Thru Cell. A dilute acid solution can be used for cleaning. Rinse thoroughly with deionized water.*

2.12 Using the General-Purpose Timer
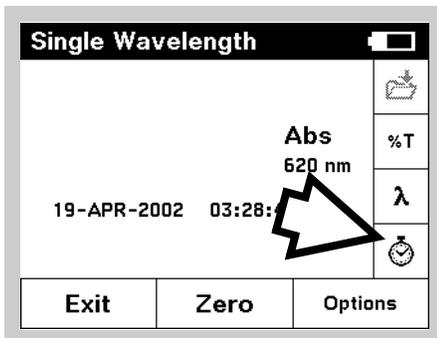
In addition to pre-programmed timers, many programs have a general purpose timer available. Touch the timer icon to access the timer system.
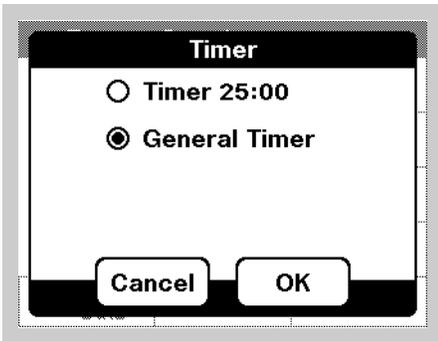
If the current procedure includes pre-programmed timers, select **General Timer** and touch **OK**. If no pre-programmed timers are available, the timer entry screen displays directly.
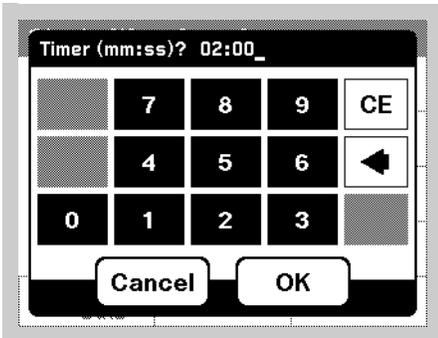
Enter the length of the timed interval in minutes and seconds. For more information, see *Using Program Timers* on page *33*.

The DR/2400 Portable Spectrophotometer contains more than 120 programmed procedures accessible through the Hach Programs menu.

3.1   Selecting a Hach Program

Hach Programs

Program	Limit
10 Aluminum, Alumin.	0.8 mg/L
9 Aluminum, ECR	0.25 mg/L
12 Aluminum, HCT 150	0.5 mg/L
802 Ammonium,HCT 100	1.5 mg/L
801 Ammonium,HCT 102	45 mg/L
20 Barium	100 mg/L

Cancel	Select by Number	Add to Favorites	Start

- To see an alphabetical list of Hach programs with program numbers, touch **Hach Programs** in the Main Menu.
- To select a specific program number, touch **Select by Number**. Enter the program number (listed in the procedures manual) and touch **OK**.
- To move quickly through the list, use the scroll bar to move up or down. When the selection is highlighted, touch **Start**.

3.2   Running a Hach Program

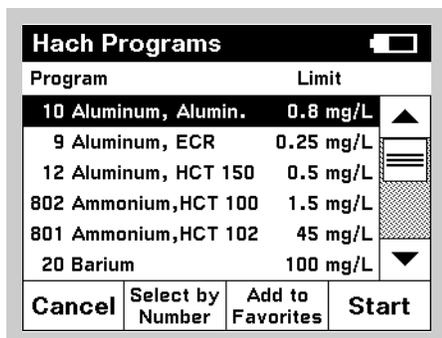After a program is selected, the screen for that parameter will appear. Wavelength selection is automatic.

Follow the chemical procedures described in the *DR/2400 Procedures Manual*.

3.3   Using Program Timers

Some Hach procedures do not require the use of timers. Other Hach procedures require several timers.

Timers

- ⦿ Invert 01:00
- ○ Shake 00:30
- ○ Timer 15:00
- ○ General timer

Cancel	Start

Touch the timer icon when prompted by the *Procedures Manual*. Choose the appropriate timer from the Timers screen and touch **Start**. The timer will count down on the screen. If necessary, cancel the timer midway through the countdown by touching **Cancel**.

By default, the timer displays large numbers as it counts down. Touch **Close** to view the Hach Program screen while the timer is running.

A general purpose timer is also available in many programs. Touch the timer icon and select **General Timer**, then enter the length of the timed interval.
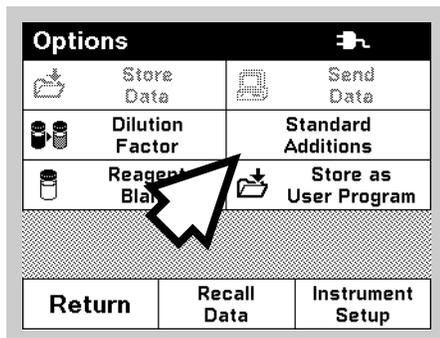
3.4   Taking a Reading

After preparing the samples according to the *Procedures Manual*, place the sample cell into the instrument. Touch **Read**.

- If the instrument is set so that Display Lock is off, the instrument will take readings continuously after the instrument is set to zero.
- If Display Lock is on, touch **Read** to obtain a sample reading.

3.5 Hach Program Options

3.5.1 Running a Reagent Blank

In some Hach Programs, the Reagent Blank option allows a reading or entry of a specific value that should be subtracted from subsequent measurements. Using a reagent blank shifts the entire calibration curve along the y-axis, without altering the shape or slope of the curve. The effect is equivalent to adding a y-intercept value to the calibration line. In other words:

Concentration = Concentration Factor x Abs – Reagent Blank

Use an actual reading to set the reagent blank, or enter a value manually.

3.5.1.1 Using an Actual Reading
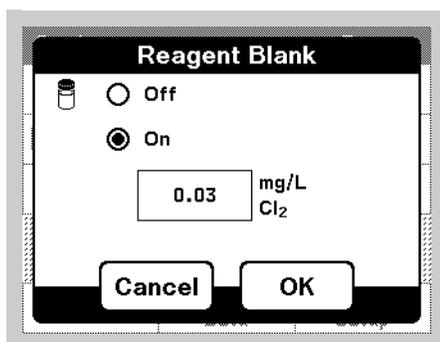
1. Follow the entire Hach procedure (as described in the *DR/2400 Procedures Manual*) substituting deionized water in place of the sample.

2. After reading the concentration, touch **Options**, then **Reagent Blank**.

3. If Reagent Blank is set to off, turn it on.

4. The concentration will appear in the box on the left of the screen.

5. Touch **Adjust** to enable the reagent blank.

3.5.1.2 Entering a Value Manually
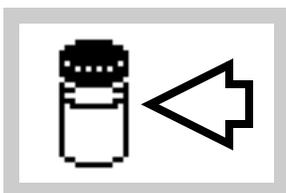
1. Touch **Options**, then **Reagent Blank**.

2. If Reagent Blank is set to off, turn it on.

3. Touch the button on the left that contains the last concentration read.

4. Enter a reagent blank value and touch **OK**.

5. Touch **Adjust** to enable the reagent blank. The **Reagent Blank** icon will appear.

Note: When the reagent blank option is in use, the Reagent Blank icon will appear on the reading screen.

Note: The adjustment must be within the limits specified for the program.

3.5.2 Creating a User Program Based on a Hach Program

To save the settings for Reagent Blank, Dilution Factor, Units & Form, and Standard Adjust from an existing Hach Program, create a User Program based on the Hach Program. These settings will then be available every time the User Program is opened. User Programs based on Hach Programs cannot be edited the same as original User Programs.

To save Hach Program settings as a User Program, touch **Options**, then **Save as User Program**. Follow the prompt to assign a number and a name to the program. Then the program will be listed in the list of User Programs until it is deleted or replaced.

3.5.3 Correcting for a Diluted Sample

A dilution factor is used to adjust for a variety of properties such as specific gravity and sample weight.
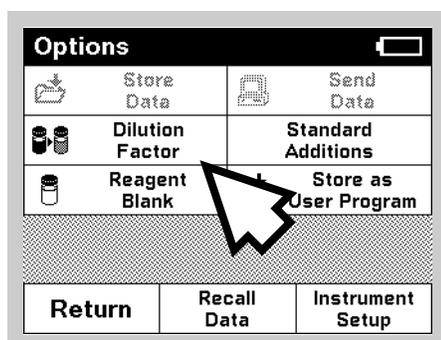
To enter a dilution factor, touch **Options** in the Hach Program screen. Touch **Dilution Factor**. The number entered at the dilution factor prompt will be multiplied by the result to compensate for the adjustment. For example, if the sample has been diluted by a factor of 2, enter 2. The default setting of the dilution factor is 1, corresponding to no dilution.

Note: When a dilution is in effect, the dilution icon will appear on the reading screen.
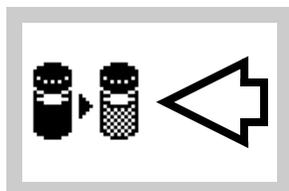
3.5.4 Changing the Chemical Form

Some Hach Programs allow a variety of chemical forms. When multiple options are available, units or chemical forms can be changed in two ways:
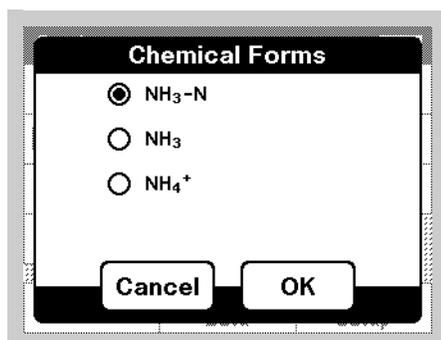
- Touch **Options** in the Hach Programs screen. Touch **Chemical Form**. Adjust the values as necessary.

3.5.5   Running a Standard Adjust

The *DR/2400 Procedures Manual* indicates which procedures can use the Standard Adjust and provides instructions for performing a Standard Adjust. The general procedure is explained here.

Read a standard before setting Standard Adjust to on.

1. Follow the entire Hach procedure (as described in the *DR/2400 Procedures Manual*), using a known standard for the sample.
2. After reading the concentration, touch **Options**, then **Standard Adjust**.
3. If Standard Adjust is set to off, turn it on.
4. The box will show the default standard value for the test, as mentioned in the procedure. To enter a different standard value, touch the box and enter the value. Touch **OK**.

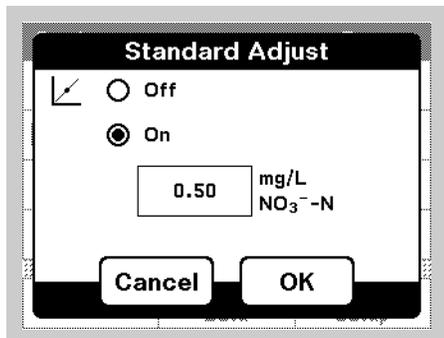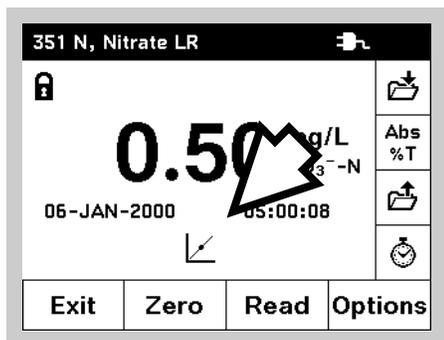The Standard Adjust icon will appear on the measurement screen when Standard Adjust is enabled.

> *Note: The adjustment must be within certain limits, which vary with each program.*

3.5.6   Performing Standard Additions

Running standard additions helps to confirm the accuracy of the measurements. The *DR/2400 Procedures Manual* and *Standard Additions* on page 43 describe in detail how to use this function.

3.6   Adding a Hach Program to the "Favorite Programs" List

It is possible to add a Hach program to the "Favorites" list that contains frequently used programs:

1. Touch **Hach Programs** in the Main Menu.
2. Scroll through the list of programs and highlight the program to be added, or touch **Select By Number** for a known program number.
3. Touch **Add to Favorites**.
4. Touch **OK**.
5. The program can now be selected from the list of **Favorite Programs** on the Main Menu.

4.1   The Datalog

This section describes how to work with data from the following reading modes: Hach Programs, Single-wavelength, and User Programs.

4.1.1   Storing Data to the Datalog

The DR/2400 datalog will store up to 1000 data points. A complete record of the analysis is stored, including the date, time, results, sample ID, and operator ID.
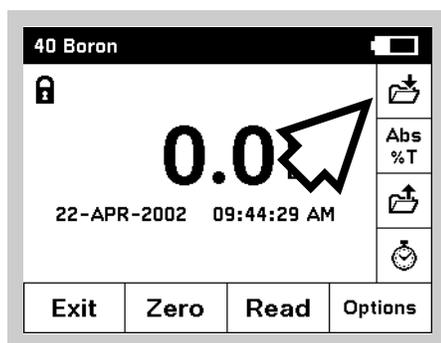
To store data, touch the **Store Data** icon on any reading screen, or from within any Options Menu.

4.1.2   Recalling, Sending, and Erasing Data from the Datalog

To recall data from the Datalog:
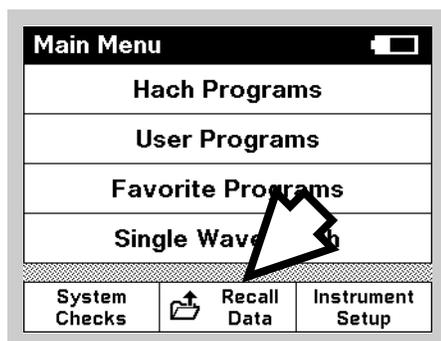
1. Touch the **Recall Data** icon.
2. If necessary, touch **Datalog**.
3. Touching any data point on the Datalog screen causes it to be highlighted.

Note: *Alternatively, touch **Options** from one of the modes listed in Section 4.1, and then **Recall Data**.*

Details

Touch **View Details** on the Recall Data screen to view all the information about the highlighted data point.

Filters

To select data by

- sample ID,
- operator ID,
- parameter,
- date,

or any combination of the four, touch **Filters** on the Recall Data screen.

Touch **On** to turn on the filters. Touch the checkbox next to each filter to be applied. Change the criteria for each type of filter by selecting it and entering the desired settings. Touch **OK**. Only the data that match the criteria will appear.

To see all the data again, return to this screen and turn filters **Off**.

Working with Data
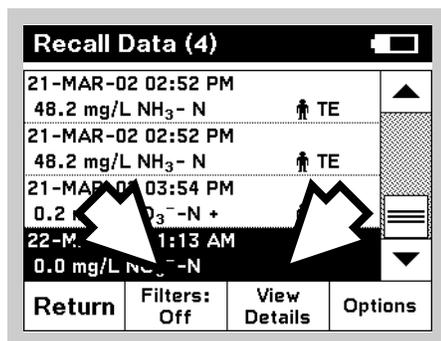
Options

Touch **Options** on the Recall Data screen to send or erase data from the datalog. A single data point, all data, or just filtered data (for applied filters) can be sent or erased.

Sending Graph Data

To send graph data, touch the **Send to Printer** icon or the **Send to Computer** icon, whichever is available. If the DR/2400 is configured to send data to a graphics-capable printer, select between sending data in graph form or table form. Touch **OK**.

User Programs allow the addition of custom analyses to the DR/2400. Once the calibration curve and other necessary information is entered, the DR/2400 will store the custom program for later use. User Programs are helpful when there is no Hach Program available, or for use of a different sample cell than the one specified in the Hach Procedures manual for a particular test.

5.1   Creating and Saving a New User Program

1. From the Main Menu, touch **User Programs**, then **Program Options**, then **New Program**.

2. Enter a new program number from 950 to 999. The lowest available number will appear on the screen automatically. To accept it, touch **OK**.

   *Note: If a number is selected that is already in use for another User program, the prompt **Replace existing program?** will appear. Touch **OK** to overwrite the existing program, or touch **Cancel** to return to the previous screen and select a different program number.*

3. The Edit User Program screen will appear. To edit an item shown on the screen, highlight it by scrolling, then touch **Edit**. Enter the following information about the custom program:

Highlighted User Programs Component	Edit Action
Name	Enter a program name. The name may be from 11 to 19 characters long, depending on the width of the characters.
Units	Select from a list of 21 types of units.
Chemical Form 1	Enter a description of the chemical form. Subscripts and superscripts are available for chemical notation.
Wavelength (Single Wavelength User Programs)	Enter a numeric value for the wavelength. The wavelength must be between 365 nm and 880 nm.
Calibration	Define a calibration curve by either: • Entering a calibration table with known values (See Section 5.1.1), or • Reading a series of standards and letting the DR/2400 create the curve (See Section 5.1.2) Make sure to select the correct units for the program before editing the Calibration.
Resolution	Select the maximum number of digits to display after the decimal point.
Upper limit	If desired, enter the maximum value that the program will read. To turn the limit off, touch **Edit**, then **CE**, then **OK**.
Lower limit	If desired, enter the minimum value that the program will read. The setting can be turned off again in the same way as the Upper limit.
Timer 1 Timer 2 Timer 3 Timer 4	If desired, assign labels and durations for up to four timers. Highlight one of the timers and touch **Edit** to begin. The check boxes on the left of the screen enable and disable the timers. The next column of fields allows selection from a list of 7 timer labels. The third column allows entry of the time duration for each active timer.
Chemical Form 2 Chemical Form 3 Chemical Form 4	If Chemical Form 1 is enabled, enter up to three alternate forms here. Highlight a form and touch **Edit**. For each alternate form, use the check box on the left to enable or disable the form. Then touch the field in the next column to enter a form. Finally, for the alternate forms, touch the third column to enter a Factor. The DR/2400 will multiply the results of Chemical Form 1 by the factor entered to arrive at a concentration for the alternate form.

4. After entering the Program Name, save the program by touching **Save Program**. Once the rest of the data in the table above is entered, touch **Save Program** again, then touch **Done**. The program is now in the list of User Programs.

5.1.1 Entering a Calibration Formula Directly

1. Scroll to Calibration and touch **Edit**.
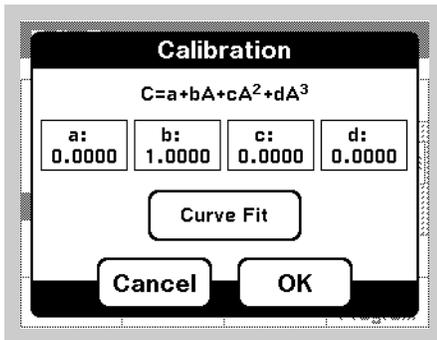
2. Touch and edit each of the coefficients to complete the formula. The coefficients determine the complexity of the formula. For example, a simple linear relationship would have coefficients of zero for *c* and *d*.

    The Calibration screen shows the formula that will be used to calculate concentration. This formula is shown at the top of the screen. "C" stands for the calculated concentration. The "A" corresponds to the absorbance reading, and the lowercase characters "a", "b", "c", and "d" correspond to the coefficients in the formula.

5.1.2 Creating a Calibration Table

The Curve Fit screen allows concentration values to be entered and the corresponding absorbance values to be read. After selecting the curve type, the instrument will calculate the coefficients of the formula, based on the points in the table.
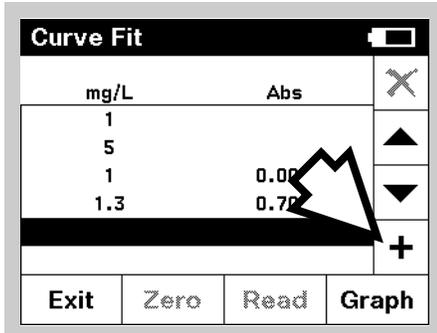
1. On the Edit User Program screen, highlight **Calibration** and touch **Edit**.
2. On the Calibration screen, touch **Curve Fit**.
3. Touch **+** to add a point.
4. Enter the first Standard Concentration value. Touch **OK**.
5. Insert a blank sample (not the first standard) and touch **Zero**.

6. When the first calibration standard is ready to read, insert it in the sample compartment. Touch **Read** to read the absorbance and capture the first point on the calibration curve.
7. Touch the **Add Point** icon again.
8. Enter the second calibration point concentration. Touch **OK**.
9. Insert the second calibration standard. Touch **Read** to read the absorbance.
10. Continue this process until all the standards are read (up to a maximum of 16 points).

Curve Fit

C=a+bA

0.837

0.706
Abs

0.706   r²=0.161

1   1.3 mg/L   5

| Done | Next Formula | Force 0: Off | Table |
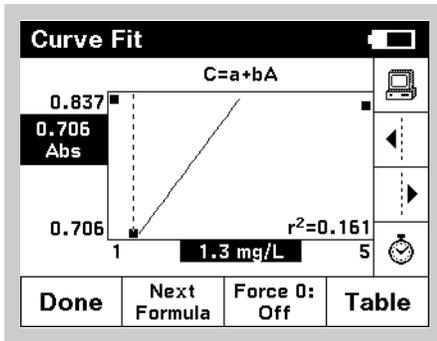
11. After entering all the points, touch **Graph**. The Curve Fit graph screen will appear.

12. Touch **Next Formula** to scroll through options for a type of curve to fit. To force the curve to go through (0, 0) touch **Force 0**.

13. To accept the curve, touch **Done**.

14. The Calibration screen will appear. Touch **OK** to accept the calibrations.

15. The Edit User Program screen will appear. Touch **Save Program** to save all the changes.

16. Once a calibration curve is saved, review the graph by following steps 1, 2, and 11 above.

5.2 Recalling a User Program

To see an alphabetical list of user programs with program numbers, touch **User Programs** in the Main Menu.

To recall a specific program by number, touch **Select by Number**. Enter the program number and touch **OK**. Then touch **Start Program** to run it.

To search the list, use the scroll bar on the right side of the screen to move up or down through the list. When the desired selection is highlighted, touch **Start Program**.

5.3 Editing an Existing User Program

1. To edit an existing user program, highlight the user program from the list.

   Note: If the user program was derived from a Hach Program, the **Edit Program** *function is disabled.*

2. Touch **Program Options**, then **Edit Program**.

3. Edit the program as necessary.

5.4 Erasing a User Program

1. Touch **User Programs** in the Main Menu. The User Programs list will appear.

2. To delete a user program, select the program by number or by scrolling through the list.

3. Touch **Program Options**.

4. Touch **Delete Program**.

User Programs—Customized Analysis

5.5 Adding User Programs to the "Favorite Programs" List

To add a User Program to the "Favorites" list that contains frequently used programs:

1. Touch **User Programs** in the Main Menu. The list of User Programs will appear.

2. Scroll through the list of programs and highlight the program to be added, or touch **Select by Number** to select the program using the numeric keypad.

3. Touch **Program Options**, then **Add to Favorites**.

4. The user program will now be available from the Favorite Programs option on the Main Menu.

Section 6   Standard Additions

6.1   Checking Results with Standard Additions

Both the accuracy (the nearness of a test result to the true value) and the precision (how closely repeated measurements agree with each other) of a procedure can be improved by using standard additions. Standard additions is a common technique for checking interferences, bad reagents, faulty instruments, and incorrect procedures. This technique is also referred to as "spiking" and "known additions."

Perform Standard Additions by adding a known amount of a standard solution to a sample and repeating the test. Use the same reagents, equipment, and technique. If results are not close to 100% recovery, an identifiable problem exists.

If the use of standard additions is appropriate for a test, a *Standard Additions Method* section will be in the procedure under *Accuracy Check*. Follow the detailed instructions given there.

If the results are about 100% recovery for each addition, they are likely correct. Results can be verified by running a standard solution through the test. Poor recovery indicates that a problem exists. For example, to test for interference in the sample, repeat the standard additions using deionized water as the sample to check the reagents, instrument, and technique. If recovery is now about 100% for each addition, interference is present in the sample. See *Section 6.3 Estimating Concentration Using Standard Additions*.

For poor recoveries with the deionized water, use the following checklist to find the problem:

1. Follow the procedure exactly:
    a. Are the reagents added in the correct order?
    b. Is enough time allowed for color development?
    c. Is the correct glassware in use?
    d. Is the glassware clean?
    e. Does the test need a specific sample temperature?
    f. Is the sample's pH in the correct range?

    Consult the written procedure in the *DR/2400 Procedure Manual* to answer these questions.

2. Follow the instructions in the *Section 10 Troubleshooting and FAQs* to check the performance of the instrument.

3. Check the reagents. Repeat the standard additions using fresh reagents. If the results are now good, the original reagents were bad.

4. If nothing else is wrong, the standard is almost certainly bad. Repeat the standard additions with a new standard.

5. If the problem persists, please call our Technical Support Group at 800-227-4224 (U.S.A.) or 970-669-3050 for assistance.

6.2   Using the Standard Additions Option

Standard additions involves adding small volumes of a known standard to a specific volume of sample. This "spiked" sample is then analyzed for the additional standard. The process includes three important items: (1) standard concentration; (2) standard additions volumes; and (3) sample volume.

The sample volume is not necessarily the volume analyzed in the procedure; it is the original volume of sample to which the standard is added. For example, in Hach Program 320, standard is added to 30 mL of sample, but only 10 mL of the solution is actually analyzed in the procedure. It is important to note that the volume of sample tested in the method does not change.

Not all Hach Programs include the Standard Additions option.

Hach Programs that have the Standard Additions option are usually pre-programmed for the three items listed above. These values are the same as those outlined in the *Accuracy Check* instructions at the back of the procedure. For alternative spiking schemes, the default values can be overridden. The values entered into the DR/2400, however, must be the same as those used to spike the samples.

Note: *Standard additions uses the units and chemical form currently in effect. Make certain that subsequent entries are made in the correct units.*

Select a measurement mode from the Main Menu. Modes with the Standard Additions option include most Hach programs and user programs that are derived from Hach programs.

Example: (using Hach Program 10)

1. From the Main Menu, touch **Hach Programs**. Touch **Select by Number** and enter **10**. Touch **OK**. Touch **Start Program**.

2. Analyze an unspiked sample per the instructions in the *Procedures Manual*. Leave the sample in the cell holder after taking a reading.
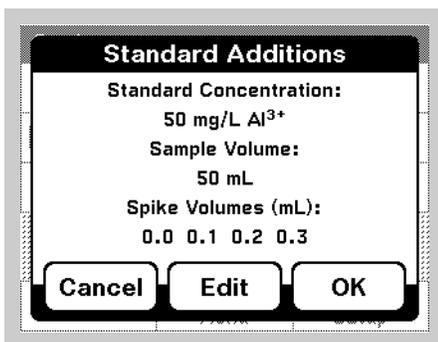
3. From the Hach Programs menu, touch **Options**, then **Standard Additions**. A summary of the standard additions procedure will appear.

4. Touch **OK** to accept the default values for standard concentration, sample volume, and spike volumes. Touch **Edit** to change these values. After values are accepted, the unspiked sample reading will appear in the top row.

5. Open a bottle of Aluminum Standard Solution, 50 mg/L Al^{3+}.

6. Prepare three sample spikes. Fill three mixing cylinders (Cat. No. 1896-40) with 50 mL of sample. Use the TenSette™ Pipet to add 0.1 mL, 0.2 mL, and 0.3 mL of standard, respectively, to each sample and mix thoroughly.

Note: Procedures using AccuVac® ampules require larger volumes. Refer to the instructions in the Procedure Manual.

7. Analyze each sample spike as described in the procedure, starting with the 0.1-mL sample spike. Accept each standard additions reading by touching **Read**. Each addition should reflect approximately 100% recovery.

8. After completing the sequence, touch **Graph** to view the best-fit line through the standard additions data points, accounting for matrix interferences. The r^2 value gives an indication of how well the data points line up. The closer to 1.000, the more the data points have a linear relationship.

9. To view the relationship between the sample spikes and the "Ideal Line" of 100% recovery, touch **View**, then select **Ideal Line** and **OK**.

6.3 Estimating Concentration Using Standard Additions

Even with a known interference, it may still be possible to estimate the concentration of the analyte in the sample. The following steps will help estimate the result:

1. Use the *Standard Additions Method* section under *Accuracy Check* in the procedure to analyze the sample.
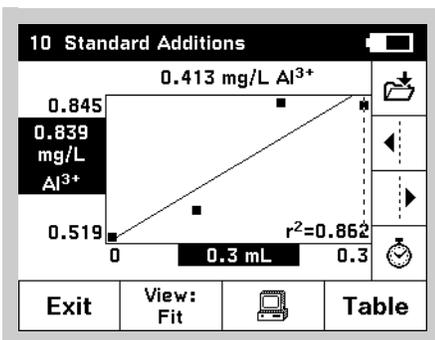
2. The display shows a plot of the data and a line that estimates the concentration curve.

3. The estimated concentration of the original unspiked sample is shown above the graph.

Below the plot is the calculated r^2 value. This is a measure of how well the data plots as a line. If $r^2 = 1.000$, it is likely that 100% of the variation in the data is due to the standard additions. If $r^2 = 0.900$, 90% of the variation in the data is due to the standard additions. The other 10% is due to factors other than the additional volume of standard.

Section 7   Single Wavelength Mode

The Single Wavelength Mode can be used in three ways. For a known parameter wavelength, set the instrument to measure the absorbance, % transmittance, or concentration of the analyte.

Percent (%) transmittance measures the percent of the original light that passes through the sample and reaches the detector.

Absorbance measures the amount of light absorbed by the sample, in units of Absorbance.

Turning on the concentration factor allows selection of a specific multiplier for converting absorbance readings to concentration. In a graph of concentration versus the absorbance, the concentration factor is the slope of the line.

7.1   Setting Up Single Wavelength Mode
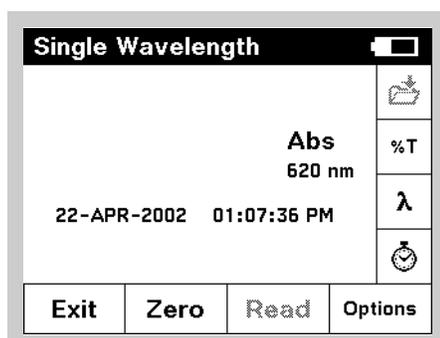
1. From the Main Menu, touch **Single Wavelength**.

2. Look at the second button from the top on the vertical menu bar. Touch **%T** to switch to % transmittance readings. Touch **Abs** to switch to absorbance readings. Touch **Conc** to switch to concentration, if it is enabled (see *step 5*).

3. Touch λ on the right menu bar to change the wavelength. Key in the desired wavelength and touch **OK.**

4. Touch **Options** to access store, send, or recall data, turn on the concentration mode, and set the desired resolution for concentration readings.

5. To convert absorbance readings to concentration, touch **Concentration Factor**. Touch **On** to turn on this feature. Touch **Factor** to enter the factor by which absorbance readings are to be multiplied. Touch **Units** to select the units for concentration measurements. Touch **OK**.

6. To change the number of decimal places shown in the Concentration reading, touch **Concentration Resolution** and make a selection.
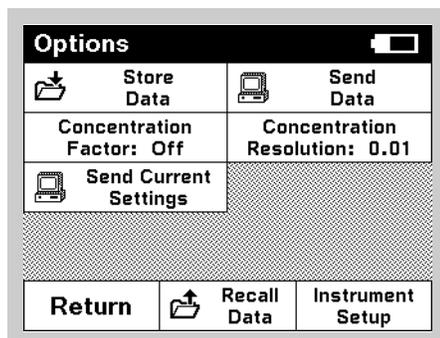
In Single Wavelength reading mode, the instrument will begin reporting a concentration value. Touch **Abs/%T** to toggle through the various reading modes.

7.2   Taking Single Wavelength Measurements

1. Prepare a blank.

2. Place the sample cell containing the blank in the cell holder. Touch **Zero**.

3. Remove the blank from the cell compartment. Place the sample cell in the cell holder. Read the results. (The reading will appear within 20 seconds.)

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Be Right™

Maintenance

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

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

Algunos de los capítulos del manual que presentamos contienen 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 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 Wartungsaufgaben dürfen nur von qualifiziertem Personal durchgeführt werden.

Alcune parti di questo manuale contengono informazioni sotto forma d'avvertimenti, di precauzioni e di osservazioni le quali richiedono una particolare attenzione. La preghiamo di leggere attentamente e di rispettare quelle istruzioni per evitare ogni ferita corporale e danneggiamento della macchina. Solo gli operatori qualificati per l'uso di questa macchina sono autorizzati ad effettuare le operazioni d'istallazione e di manutenzione descritte in questa parte del manuale.

Section 8   Maintenance

8.1   Caring for the Instrument

- Use the tip of a finger or fingernail, the non-writing end of a pen or pencil, or a stylus to prevent scratches on the touchscreen. Avoid using a pen point, pencil point, or other sharp object on the surface of the touchscreen.

- The touchscreen is water-resistant, but should not be exposed to direct rain or moisture. In general, treat the instrument with the same care as other electronic equipment.

- The touchscreen contains a glass element. Protect the touchscreen against strong impacts.

- Protect the instrument from temperature extremes, including heaters, direct sunlight, and other heat sources.

- Do not store or use the instrument in any location that is extremely dusty, damp, or wet.

8.2   Cleaning the Instrument

Use a soft, damp cotton cloth to wipe the instrument and the touchscreen. If the surface of the touchscreen becomes soiled, clean it with a soft cloth and diluted window cleaning solution. Do not use strong solvents.

8.3   Replacing the Lamp Module

The light sources in the DR/2400 were designed to provide years of reliable use. In the event that the Lamp Module becomes damaged or burned out, a replacement unit may be ordered (Cat. No. 59456-00). Installation instructions are included with the replacement module (Cat. No. 59456-88).

To determine whether the module needs replacing, or to get help replacing it, contact the Hach Service Department. In the United States, call 1-800-227-4224. Outside the United States, contact the Hach office or nearest dealer. See *Repair Service* on page *63* for more contact information.

8.4   Sample Cell Maintenance

Glass — Clean glass cells with detergent and water. Rinse the cells several times with tap water, and then rinse thoroughly with deionized water. Rinse sample cells containing organic solvents (chloroform, benzene, toluene, etc.) with acetone before the detergent wash, and again as a final rinse before drying.

Note: *Some cells may require acid washing or other special cleaning procedures.*

Polystyrene — Wash polystyrene sample cells with soap and water and rinse thoroughly with tap water. **Do not** use organic solvents to clean polystyrene sample cells.

8.5   Pour-thru Cell Maintenance

See *Cleaning the Pour-Thru Cell* on page *30*.

8.6   Alkaline Battery Replacement

The DR/2400 uses 3 D-cell alkaline batteries for field power. When the instrument indicates low batteries, see *Changing the Batteries on page 14* for instructions regarding battery replacement.

8.7   Rechargeable Battery Pack Replacement/Maintenance

The Rechargeable Battery Pack is replaced as a unit. See *Changing the Batteries on page 14* for instructions regarding replacement of the Rechargeable Battery Pack.

8.8   Recertification Interval

Hach recommends annual recertification of the instrument to maintain accuracy in measurement. Qualified Hach technicians will make sure that the instrument meets Hach specifications, and return it with a certificate of specification compliance.

Pack the instrument carefully, preferably in its original packaging material, to assure a safe shipment. Secure the sliding door in a closed position with strong tape before packing the instrument. Hach Company cannot be responsible for damage caused during shipment.

Contact Hach Service to arrange for recertification or other service. See *Repair Service* on page *63* for contact information.

Section 9   Upgrading the Instrument Software

The DR/2400 Software Upgrade Utility is a Microsoft Windows* application that allows use of a personal computer to load the latest version of instrument software into the DR/2400 Spectrophotometer. The upgrade utility will only upgrade instruments — it will not program instruments that are already up-to-date or that contain newer software.

Note: This software is copyrighted; however, it is not copy protected. This software may be used to upgrade all DR/2400 Spectrophotometers in the facility, and can be installed on more than one computer if necessary.

9.1   System Requirements

The following are the minimum requirements for successful installation and operation of the DR/2400 Software Upgrade Utility:

- PC with a 486/100 MHz or higher processor
- Windows 95, 98, 2000, or NT 4.0 operating systems
- 32 MB RAM
- Hard drive with 20 MB or more free space
- 3½ in. floppy disk drive or CD-ROM drive
- VGA graphics with 640 x 480 or higher resolution, 256 colors
- Mouse or other pointing device
- 9-pin serial port (or 25-pin serial port with 9-pin adapter) with a computer interface cable (Cat. No. 48129-00 or equivalent).

9.2   Installing the Upgrade Software on the PC

Use the following procedure to install the Software Upgrade Utility on the hard drive. Do not attempt to copy files directly from the setup disk to the hard drive because many of the files are compressed and will not function until properly installed.

9.2.1   Installing from Floppy Disk

1. Insert **Disk 1** into the floppy drive.
2. Click the **Start** button and select **Run** from the menu.
3. Type **a:\setup.exe** (where a:\ is the disk drive) in the Run dialog and click **OK**.
4. Follow the instructions as they appear on the screen.

9.2.2   Installing from CD-ROM

1. Insert the CD into the CD-ROM drive. The CD will automatically run.
2. Follow the instructions as they appear on the screen.

9.3   Connecting the Instrument to the Computer

1. Connect one end of the computer interface cable to the serial port connector on the back of the instrument.
2. Connect the other end of the cable to a serial port connector on the back of the computer. If there is more than one serial port on the computer, note the port number used (port 1 is usually labeled as COM-1 or 1010-1, port 2 as COM-2 or 1010-2, etc.).
3. Turn on the DR/2400 Spectrophotometer.

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* Microsoft and Windows are either registered trademarks or trademarks of Microsoft in the United States and/or other countries.

Upgrading the Instrument Software

9.4 Starting the Upgrade Utility

On the computer, click **Start**, **Programs**, **Hach Utilities**, **DR/2400 Software Upgrade Utility**.

The upgrade information window will appear. It displays information about the upgrade utility. Any last minute changes made to the utility that might not be included in this manual will be displayed here. Use the scroll bar to the right of the window to view additional information.

9.5 Setting the Communication Link

In order for the upgrade utility to program a DR/2400 Spectrophotometer, it must be able to establish a communication link with the instrument through one of the computer's serial ports. Using the serial port selection box in the DR/2400 DR/2400 Upgrade software, choose the serial port used to connect the computer to the instrument. Click on the down arrow to view a list of the available serial ports, then click on the appropriate port selection.

The DR/2400 Spectrophotometer must be set up as described in *Communications with a Printer or Computer* on page *24*.

9.6 Programming the Instrument

Once the instrument is connected to the computer and the communication settings are made, programming can begin. Click on the **Program** button to start the programming sequence.

1. When the upgrade utility completes its system checks, a confirmation prompt will appear. The estimated time to program the instrument is also displayed.

2. Click on **Yes** to upgrade the instrument, click on **No** or **Cancel** to cancel the programming sequence.

    After selecting **Yes**, the instrument switches to the programming mode and the upgrade begins. Do not disconnect or turn off the instrument or computer while programming. The status bar indicates the progress of the programming sequence.

3. A dialog box is displayed when programming is complete. Click on the **OK** button to return to the utility form.

4. At this time another instrument can be programmed, or click on the **Close** button to exit the upgrade utility.

9.7 Uninstalling the Upgrade Software

Future releases of the DR/2400 Spectrophotometer Upgrade Utility will automatically replace an older version on the hard drive, so uninstalling this version is not required. To remove the upgrade utility, use the following procedure.

From Windows Explorer, click on the DR/2400 Software Upgrade Utility icon to highlight it — do not double-click on it. Select the **File** menu and choose the **Delete** option. Choose **Yes** in the dialog box to confirm the deletion.

Section 10   Troubleshooting and FAQs

10.1 Troubleshooting (See http://www.hach.com for the latest information.)

10.1.1 Instrument Information

To see the serial number and software version number:

1. Touch **System Checks** on the Main Menu.

2. Touch **Instrument Information**. The serial number and software version number will appear.

10.1.2 Wavelength Check

To perform a wavelength check:

1. Touch **System Checks** on the main menu.

2. Touch **Wavelength Check**.

3. Touch **Read**.

The instrument will perform a wavelength check. The displayed wavelength should read 446 ±1 nm.

Note: If the displayed wavelength is outside of this range, turn the instrument off then on. Allow it to run through the automatic wavelength calibration. Repeat steps 1–3. If the displayed wavelength is still outside the expected range, contact Hach technical support. See Repair Service on page 63 for contact information.

10.2 Frequently Asked Questions

Does the DR/2400 Portable Spectrophotometer factor in sample dilutions?

Yes, this is available in the options menu. See *Section 3.5.3 Correcting for a Diluted Sample*.

I have large fingers. Can I still use the touchscreen? Yes, you can still use the touch screen very easily. You may want to use the tip of your fingernail, the non-writing end of a pen, or a stylus instead of your fingertip.

Is the Hach RS232 cable necessary for downloading information to a computer or can I purchase a generic 9-pin/9-pin cable from an electronics store? The Hach cable is specifically configured for the DR/2400 instrument. However, you may substitute a 9-pin/9-pin, null-modem cable with female connectors on both ends.

What does it mean when something is "highlighted"? When selecting an item from a list, whether it is a program, a data point, or a setup option, there is always one item that is shown in light text on a dark background. The current selection is the "highlighted" item. When you move the scroll bar or press the up and down arrow keys, the highlight moves. Also, in graph views, highlighted text corresponds to data at the cursor location.

What is meant by the term "reading modes"? The DR/2400 software includes the following types of measurements, which are all reading modes: Hach Programs, User Programs, and Single Wavelength analysis.

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

Replacement Parts

Description	Unit	Cat. No.
Alkaline Batteries, D-cell	3/pkg	59492-00
Cell Adapter, 16-mm round	each	59457-00
Cell Adapter, 1-cm square	each	59459-00
Cell Adapter, multi-pathlength	each	59466-00
Lamp Module, Replacement for Serial Numbers 030900002600 and higher	each	59648-00
Lamp Module, Replacement for Serial Numbers less than 030900002600	each	59456-00
Manual, Procedures	each	59400-22
Manual, Instrument	each	59400-18
Manual, CD-ROM, Instrument Manual and Procedure Manual	each	59400-45
Power Cord, UL listed	each	18010-00
Power Cord, VDE certified	each	46836-00
Power Supply, 115–230 Vac, 9 Vdc	each	59107-00
Sample Cells, 1-in. (25 x 90 mm), 10-20-25 mL	6/pkg	24019-06

Optional Parts

Description	Unit	Cat. No.
Cable, computer interface	each	48129-00
DR/Check Standards	1/pkg	27639-00
HachLink™ Data Retrieval and Analysis Software	each	49665-00
Instrument case, custom hard-side with inserts	each	47515-00
Pour-Thru Cell Kit	each	59404-00
Rechargeable Battery Pack, Hach	each	59495-00
Sample Cells, 1-in. (2.54 cm) round,	each	24276-06
Sample Cells, 1-in. (2.54 cm) round, polystyrene sample cells with caps	2/pkg	24102-00
Sample Cells, 1-cm, rectangular, matched pair	2/pkg	20951-00
Sample Cells, 1-cm polystyrene disposable	each	27434-01
Sample Cells, 1-cm plastic disposable	100/pkg	26295-00
Sample Cells, multi-pathlength, 25-mL	6/pkg	59405-00

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 DR/2400 Portable Spectrophotometer has been tested and is certified as indicated to the following instrumentation standards:

Product Safety

External Power Supply Only

95-240 V ac Supply, UL Listed, CSA Certified, & CE Marked per 73/23/EEC (TUV-GS Listed)

Immunity

Per **89/336/EEC** EMC: **EN 61326:1998** (Electrical Equipment for measurement, control and laboratory use- EMC requirements), Annex B (Controlled EM Environments). Supporting test records by Hach Company, certified compliance by Hach Company.

Standards include:

IEC 1000-4-2:1995 (EN 61000-4-2:1995) Electrostatic Discharge Immunity (Criteria B)

IEC 1000-4-3:1995 (EN 61000-4-3:1996) Radiated RF Electromagnetic Field Immunity (Criteria A)

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

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

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

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

Emissions

Per 89/336/EEC EMC: EN 61326:1998 (Electrical Equipment for measurement, control and laboratory use—EMC requirements) Class "B" emission limits. Supporting test records by records Hewlett Packard, Ft. Collins, CO Hardware Test Center (A2LA # 0905-01), certified compliance by Hach Company.

Standards include:

EN 61000-3-2 Harmonic Disturbances Caused by Electrical Equipment

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

Additional Emissions Standard/s include:

EN 55011 (CISPR 11), Class "B" emission limits

Canadian Interference-causing Equipment Regulation, IECS-003, Class A

Supporting test records by records Hewlett Packard, Ft. Collins, CO Hardware Test Center (A2LA # 0905-01), certified compliance by Hach Company.

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

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

FCC PART 15, Class "A" Limits

Supporting test records Hewlett Packard, Ft. Collins, CO Hardware Test Center (A2LA # 0905-01), certified compliance by Hach Company.

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

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

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

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

1. Disconnect the external power supply from the instrument to verify that the meter is or is not the source of the interference.

2. Move the instrument and its power supply away from the device receiving the interference.

3. Reposition the receiving antenna or the device receiving the interference.

4. Try combinations of the above.

By Telephone:

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

By Mail:

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

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

Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number

- Billing address
- Shipping address
- Catalog number
- Quantity

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

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

International Customers

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

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

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

Repair Service

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

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

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

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

Warranty

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

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

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

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

Limitations

This warranty does not cover:

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

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

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

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

Limitation of Remedies

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

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