



POCKET COLORIMETER™ II ANALYSIS SYSTEMS

INSTRUCTION MANUAL

Chromium, Hexavalent (Cr⁺⁶)

Cobalt (Co)

Copper (Cu)

Manganese (Mn)

Nickel (Ni)

Important Note

This manual is intended for use with the following Pocket Colorimeter™ II instruments:

| | |
|----------------|-------------------|
| Chromium (Cr) | Cat. No. 58700-17 |
| Cobalt (Co) | Cat. No. 58700-20 |
| Copper (Cu) | Cat. No. 58700-19 |
| Manganese (Mn) | Cat. No. 59530-18 |
| Nickel (Ni) | Cat. No. 58700-20 |

The Pocket Colorimeter™ II instruments listed above are **not** interchangeable.

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Safety Precautions

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

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

Laboratory Safety

As part of good laboratory practice, please familiarize yourself with the reagents used in these procedures. Read all product labels and the material safety data sheets (MSDS) before using them. It is always good practice to wear safety glasses when handling chemicals. Follow instructions carefully. Rinse thoroughly if contact occurs. If you have questions about reagents or procedures, please contact the manufacturer or distributor.

Use of Hazard Information

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

Safety Precautions, continued

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

Please pay particular attention to labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.



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

Specifications

Lamp: Light emitting diode (LED)

Detector: Silicon photodiode

Photometric Precision: ± 0.0015 Abs

Filter bandwidth: 15 nm

Wavelength: 550 nm

Absorbance range: 0–2.5 Abs

Dimensions: 3.2 x 6.1 x 15.2 cm (1.25 x 2.4 x 6 inches)

Weight: 0.2 kg (0.43 lb)

Sample cells: 25 mm (10 mL), AccuVac[®] Ampuls

Operating conditions: 0 to 50 °C (32 to 122 °F); 0 to 90% relative humidity (noncondensing)

Power supply: Four AAA alkaline batteries; approximate life is 2000 tests*

* Backlight usage will decrease battery life.

OPERATION

DANGER

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

DANGER

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

PELIGRO

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

GEFAHR

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

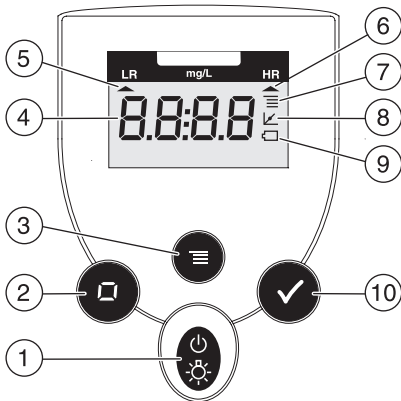
PERIGO

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

PERICOLO

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

Instrument Keys and Display



| Item | Description |
|------|--------------------------------|
| 1 | POWER/BACKLIGHT Key |
| 2 | ZERO/SCROLL Key |
| 3 | MENU Key |
| 4 | Numeric Display |
| 5 | Range Indicator |
| 6 | Range Indicator |
| 7 | Menu Indicator |
| 8 | Calibration Adjusted Indicator |
| 9 | Battery Low Indicator |
| 10 | READ/ENTER Key |

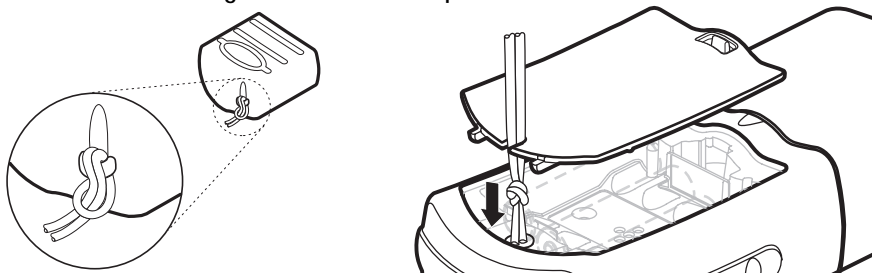
Instrument Cap Cord

The instrument cap for the Pocket Colorimeter™ II doubles as a light shield. Accurate measurements cannot be obtained unless the sample or blank is covered with the cap. Use the instrument cap cord to secure the cap to the body of the colorimeter and prevent loss of the cap. See [Figure 1 on page 1–13](#).

1. Loop the instrument cap cord through the ring on the cap.
2. Remove the battery compartment cover. Press the knotted end of the cord into the hole indicated by the arrow.
3. Slide the cord into the slot on the battery compartment cover. Snap the cover into place.

Instrument Cap Cord, continued

Figure 1 Attaching the Instrument Cap Cord



Chromium, Hexavalent (0.01 to 0.70 mg/L Cr⁶⁺)

Method 8023

For water and wastewater

1,5 Diphenylcarbohydrazide Method*

Measuring Hints

- Determine a reagent blank for each new lot of ChromaVer 3 reagent. Repeat steps 1–10 using deionized water as the sample. Subtract this value from each result obtained with the same lot of ChromaVer 3 reagent.
- The optional AccuVac Snapper simplifies testing by retaining the broken tip, minimizing exposure to the sample, and providing controlled conditions for filling the ampule.

Note: *The Pocket Colorimeter II™ is designed to measure solutions contained in sample cells. **DO NOT** dip the meter in the sample or pour the sample directly into the cell holder.*

* Adapted from *Standard Methods for the Examination of Water and Wastewater*.

Chromium, Hexavalent, continued

Using Powder Pillows



1. Fill a 10-mL cell to the 10-mL line with sample.



2. Add the contents of one ChromaVer 3 Powder Pillow to the cell (the prepared sample). Cap and swirl to mix.

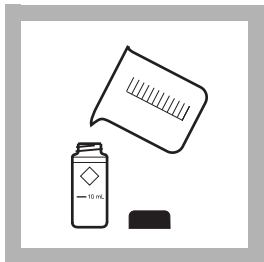
Note: *At high chromium levels a precipitate will form. Dilute the sample.*



3. Wait at least 5 minutes.

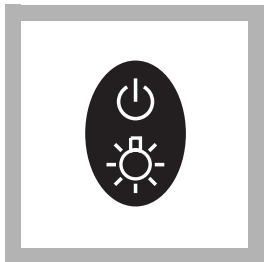
Note: *A purple color will form if hexavalent chromium is present.*

Chromium, Hexavalent, continued



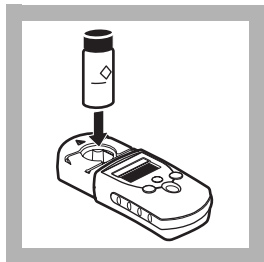
4. Fill a second sample cell with 10 mL of sample (the blank). Wipe off any liquid or fingerprints.

Note: For turbid samples, treat 25 mL of the blank with the contents of one acid reagent powder pillow. Any turbidity dissolved by acid in the sample will also be dissolved in the blank.



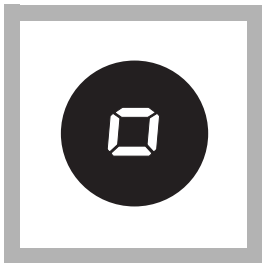
5. Press the **POWER** key to turn the meter on. The arrow should indicate mg/L Cr⁶⁺.

Note: See [page 2–4](#) for information on selecting the correct range channel.



6. Place the blank into the cell holder. Cover the sample cell with the instrument cap.

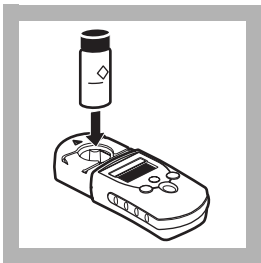
Chromium, Hexavalent, continued



7. Press **ZERO/SCROLL**.

The display will show “- - - -” then “0.00”.

Remove the blank from the cell holder.



8. Wipe off any liquid or fingerprints from the prepared sample and place it into the cell holder with the diamond mark facing the keypad.

Cover the sample cell with the instrument cap.



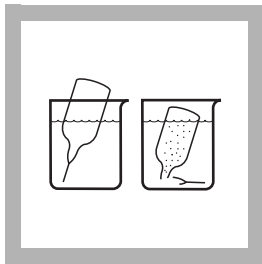
9. Press: **READ/ENTER**.

The meter will show “- - - -”, followed by the results in mg/L hexavalent chromium (as Cr^{6+}).

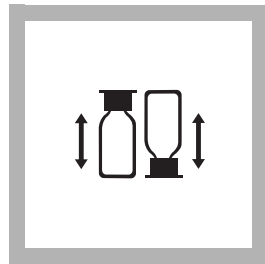
Using AccuVac® Ampuls



1. Fill a 10-mL sample cell to the 10-mL line with sample (the blank). Cap. Collect at least 40 mL of sample in a 50-mL beaker.



2. Fill a ChromaVer® 3 AccuVac® Ampul with sample.
Note: *Keep the tip of the ampule immersed until the ampule fills completely.*

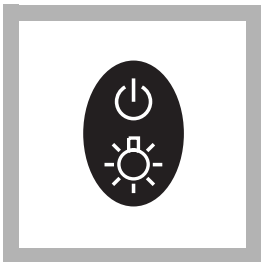


3. Invert the ampule several times.
Note: *Wipe liquid and finger prints from sample cells.*

Chromium, Hexavalent, continued



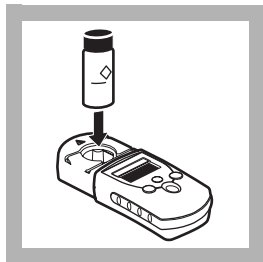
4. Wait at least 5 minutes for full color development before completing steps 5–8.



5. Press the **POWER** key to turn the meter on.

The arrow should indicate mg/L Cr⁶⁺.

Note: See [page 2–4](#) for information on selecting the correct range channel.

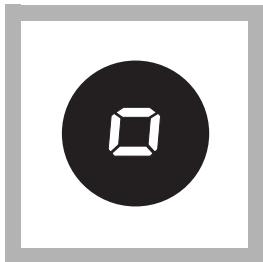


6. Place the blank into the cell holder.

Note: *Wipe off any liquid or fingerprints.*

Cover the sample cell with the meter cap.

Chromium, Hexavalent, continued

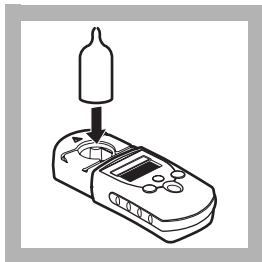


7. Press **ZERO/SCROLL**.

Note: *Wipe liquid off the AccuVac Ampul.*

The display will show
"- - - -" then "0.00".

Remove the blank from the
cell holder.



8. Place the ampule
containing the prepared
sample into the cell holder.
Cover the ampule with the
instrument cap.



9. Press **READ/ENTER**.

The instrument will show
"- - - -", followed by results
in mg/L Hexavalent
Chromium (Cr^{6+}).

Chromium, Hexavalent, continued

Sampling and Storage

Collect sample in a clean glass or plastic container. Adjust the pH to 2 or less with nitric acid (approximately 2 mL per liter). Preserved samples can be stored for at least six months at room temperature. Adjust the pH to 4 with 5.0 N sodium hydroxide standard solution before analysis. Correct the test result for volume additions.

Accuracy Check

Standard Additions Method

- Using the Ampule Breaker Kit, snap the neck off a chromium standard solution Voluette[®] ampule, 12.5 mg/L Cr⁶⁺.
- Use the TenSette[®] pipet to add 0.1 mL, 0.2 mL and 0.3 mL of standard, respectively, to three 25-mL samples. Mix each thoroughly.
- Analyze each sample as described above. The chromium concentration should increase 0.05 mg/L for each 0.1 mL of standard added.

Standard Solution Method

Prepare a 0.25 mg/L Cr⁶⁺ standard solution following steps 1-3 below. Analyze this solution following the procedure given.

1. Using the Ampule Breaker Kit, snap the neck off a chromium standard solution Voluette[®] ampule, 12.5 mg/L Cr⁶⁺.
2. Use a 50-mL volumetric pipet to transfer 5.00 mL of the standard solution to a 250 mL volumetric flask.
3. Dilute to volume with deionized water, stopper, and invert several times to mix.

Standard Calibration Adjust

To perform a standard calibration adjustment using the 0.25 mg/L chromium standard, or using an alternate concentration, see [Standard Calibration Adjust on page 2–13](#).

Method Performance

Typical Precision (95% Confidence Interval):

0.25 ± 0.01 mg/L Cr⁺⁶ (Powder Pillow and AccuVac Ampuls)

Estimated Detection Limit:

EDL = 0.01 mg/L Cr⁺⁶ (Powder Pillow and AccuVac Ampuls)

Chromium, Hexavalent, continued

Interferences

The following do not interfere in the test up to the following concentrations:

| | |
|-----------------------------|--------------------|
| Mercurous and mercuric ions | Interfere slightly |
| Iron | 1 mg/L |
| Vanadium | 1 mg/L |

Vanadium interference can be overcome by waiting ten minutes before reading. Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment.

Summary of Method

Hexavalent chromium is determined by the 1,5 diphenylcarbohydrazide method using a single dry powder formulation called ChromaVer 3 Chromium Reagent. This reagent contains a buffer combined with 1,5 diphenylcarbohydrazide, which reacts to give a purple color when hexavalent chromium is present.

Replacement Parts

Required Reagents and Apparatus

(Using Powder Pillows)

| Description | Unit | Cat. No. |
|---|--------------|----------|
| ChromaVer [®] 3 Chromium Reagent Powder Pillows, 5 or 10 mL sample..... | 100/pkg..... | 12710-99 |

(Using AccuVac[®] Ampuls)

| | | |
|---|-------------|----------|
| ChromaVer [®] 3 AccuVac [®] Ampuls..... | 25/pkg..... | 25050-25 |
| Beaker, 50 mL..... | each..... | 500-41H |

Optional Reagents

| | | |
|---|-----------------|----------|
| Acid Reagent Powder Pillows..... | 100/pkg..... | 2126-99 |
| Chromium, Hexavalent Standard Solution, Voluette [®] Ampule, 12.5 mg/L Cr ⁶⁺ | 16/pkg..... | 14256-10 |
| Nitric Acid, ACS..... | 500 mL..... | 152-49 |
| Sodium Hydroxide Standard Solution, 5.0 N..... | 50 mL SCDB..... | 2450-26 |
| Water, deionized..... | 4 L..... | 272-56 |

Chromium, Hexavalent, continued

Optional Apparatus

| Description | Unit | Cat. No. |
|--|-------------------|----------|
| AccuVac Snapper Kit | each | 24052-00 |
| Ampule Breaker Kit | each | 21968-00 |
| Flask, Volumetric, Class A, 100 mL..... | each | 14574-42 |
| pH Indicator Paper, 1 to 11 pH | 5 rolls/pkg | 391-33 |
| Pipet, Serological, 2 mL..... | each | 532-36 |
| Pipet, TenSette®, 0.1 to 1.0 mL..... | each | 19700-01 |
| Pipet Tips for 19700-01 TenSette® Pipet..... | 50/pkg | 21856-96 |
| Pipet, Volumetric, 5.0 mL..... | each | 14515-37 |
| Pipet Filler, Safety bulb | each | 14651-00 |

Replacement Parts

| | | |
|-----------------------------------|------------|----------|
| Batteries, alkaline, AAA | 4/pkg | 46743-00 |
| Instrument Cap/Light Shield | each | 59548-00 |
| Instruction Manual..... | each | 59573-88 |

Copper (0.04 to 5.00 mg/L Cu)

Method 8506 and 8026

For water, seawater, and wastewater*

Bicinchoninate Method (Powder Pillows or AccuVac® Ampuls)**
USEPA approved for wastewater (digestion required)***

Measuring Hints

- The chemistry is pH sensitive. Adjust the pH of acid-preserved samples to 4-6 with 8 N KOH before analysis.
- For proof of accuracy, use a 4.00 mg/L copper standard solution in place of the sample.
- After adding reagent, a purple color will form if copper is present.

* Pretreatment required; see *Interferences Using Powder Pillows* on [page 1–39](#).

** Adapted from Nakano, S., Yakugaku, Zasshi, 1962, 82: 486-491; *Chemical Abstracts* 58: 3390e (1963).

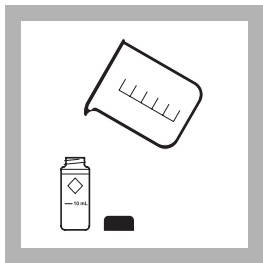
*** Powder Pillows only: *Federal Register*, 45 (105) 36166 (May 29, 1980). See the *Hach Water Analysis Handbook* for more information about digestion.

Copper, continued

- For more accurate results, determine a reagent blank for each lot of ampules. Repeat the test using deionized water as the sample. Subtract this value from each result obtained with this lot.
- The optional AccuVac Snapper simplifies testing by retaining the broken tip, minimizing exposure to the sample, and providing controlled conditions for filling the ampule.
- Accuracy is not affected by undissolved powder.

Note: *The Pocket Colorimeter II™ is designed to measure solutions contained in sample cells. **DO NOT** dip the meter in the sample or pour the sample directly into the cell holder.*

Copper, Method 8506 (using Powder Pillows, USEPA approved for reporting)



1. Fill a 10-mL sample cell to the 10-mL line with sample.



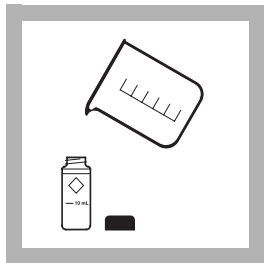
2. Add the contents of one CuVer[®] 1 Reagent Powder Pillow to the sample cell (the prepared sample). Cap the cell and invert several times to mix.

Note: Use a CuVer[®] 2 Reagent Powder Pillow for samples containing high levels of aluminum, iron, and hardness. See [page 1–38](#).

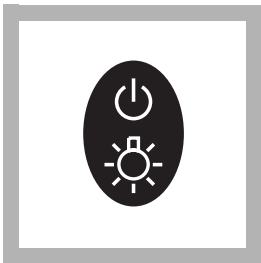


3. Wait 2 minutes. Continue with steps 4 through 8 while the timer is running.

Copper, continued

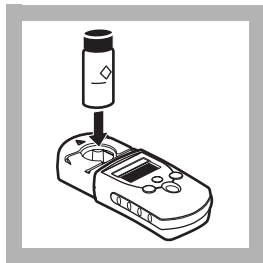


4. Fill a 10-mL cell to the 10-mL line with sample (the blank). Cap.
Wipe off any liquid or fingerprints from the cell.

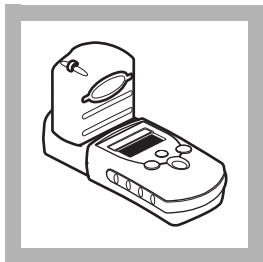


5. Press the **POWER** key to turn the meter on.
The arrow should indicate channel 1.

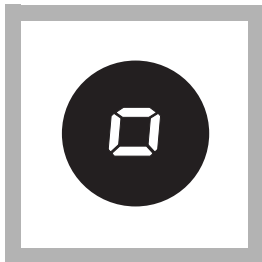
Note: See [page 2–4](#) for information on selecting the correct range channel.



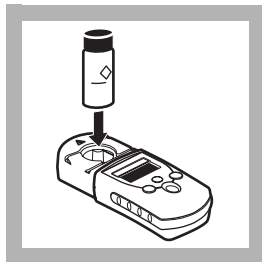
6. Place the blank in the cell holder.



7. Cover the blank with the instrument cap.

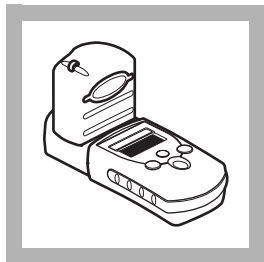


8. Press **ZERO/SCROLL**.
The display will show " - - - - " then "0.00".
Remove the blank from the cell holder.



9. Wipe off any liquid or fingerprints from the prepared sample. After the two-minute reaction period, place the prepared sample in the cell holder.

Copper, continued



10. Cover the sample cell with the instrument cap.

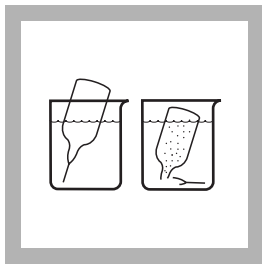


11. Press **READ/ENTER**.
The display will show "----", followed by results in mg/L copper (Cu).

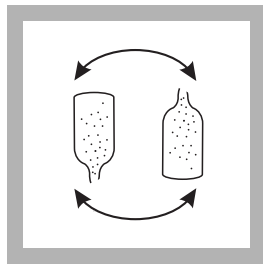
Copper, Method 8026 (using AccuVac[®] Ampuls)



1. Fill a 10-mL sample cell to the 10-mL line with sample (the blank). Cap. Collect at least 40 mL of sample in a 50-mL beaker.



2. Fill a CuVer[®] 2 AccuVac Ampul with sample. Keep the tip of the ampule immersed until the ampule fills completely.

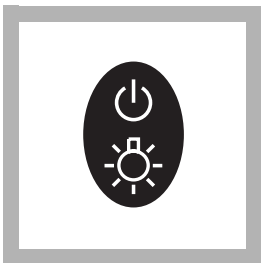


3. Invert the ampule several times to mix. Wipe off any liquid or fingerprints.

Copper, continued



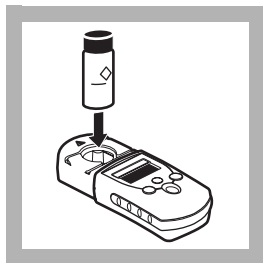
4. Wait 2 minutes.



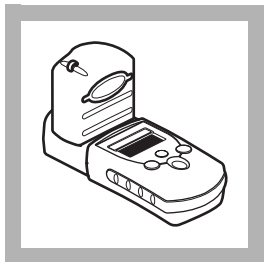
5. Press the **POWER** key to turn the meter on.

The arrow should indicate channel 2.

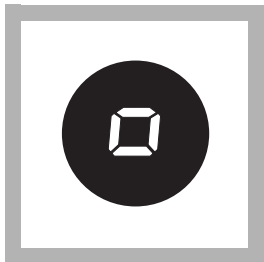
Note: See [page 2–4](#) for information on selecting the correct range channel.



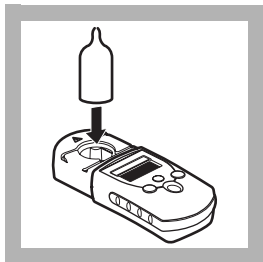
6. Place the blank in the cell holder.



7. Cover the blank with the instrument cap.

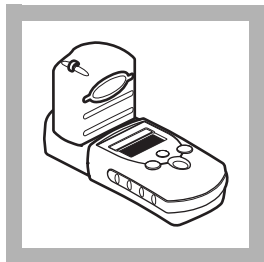


8. Press **ZERO/SCROLL**.
The display will show " - - - - " then "0.00".
Remove the blank from the cell holder.



9. After the two-minute reaction period, place the ampule in the cell holder.

Copper, continued



10. Cover the sample cell with the instrument cap.



11. Press **READ/ENTER**.
The display will show " - - - -", followed by results in mg/L copper (Cu).

Sampling and Storage

Collect samples in acid-washed plastic or glass bottles. To store, adjust the pH to 2 or less with nitric acid (about 2 mL per liter). Preserved samples can be stored for up to six months at room temperature. Adjust the pH to between 4 and 6 with 8.0 N potassium hydroxide before analysis. Do not exceed pH 6, as copper may

precipitate. Correct the test results for volume additions. If only dissolved copper is to be determined, filter the sample before acid addition using the lab ware listed under [Optional Apparatus on page 1–43](#).

Accuracy Check

Standard Additions Method

1. Using the Ampule Breaker Kit, snap the neck off a Copper Standard Solution Voluette™ Ampule, 75 mg/L.
2. Use a TenSette® pipet to add 0.1 mL, 0.2 mL, and 0.3 mL of standard, respectively, to three 25-mL samples. Mix each thoroughly (for AccuVac Ampuls use 50 mL beakers.)
3. Analyze each sample as described above. The copper concentration should increase 0.3 mg/L for each 0.1 mL of standard added.

Standard Solution Method

Prepare a 4.00-mg/L copper standard by diluting 4.00 mL of Copper Standard Solution, 100 mg/L as Cu, to 100 mL with deionized water. Prepare this solution daily.

Standard Calibration Adjust

To perform a standard calibration adjustment using the 4.00 mg/L copper standard or using an alternate concentration, see [Standard Calibration Adjust on page 2–13](#).

Multi-parameter standards that simulate the ranges of metals found in drinking water or in wastewater are available to confirm test results. See [Optional Reagents on page 1–42](#).

Method Performance

Typical Precision (95% Confidence Interval):

$$1.00 \pm 0.04 \text{ mg/L Cu}$$

Estimated Detection Limit:

$$\text{EDL} = 0.04 \text{ mg/L Cu}$$

Interferences

For a complete list of interferences, see the Hach *Water Analysis Handbook*.

Using Powder Pillows

If the sample is extremely acidic (pH 2 or less) a precipitate may form. Add 8.0 N Potassium Hydroxide Standard Solution drop-wise while swirling to dissolve the turbidity. Read the mg/L Cu.

If the turbidity remains and turns black, silver interference is likely. Eliminate silver interference by adding of 10 drops of Saturated Potassium Chloride Solution to 75 mL of sample, followed by filtering through a fine or highly retentive filter. Use this filtered sample in the procedure.

Cyanide interferences prevent sufficient color development but can be overcome by adding 0.2 mL of formaldehyde to the 10 mL sample. Wait four minutes before taking the reading. Multiply the test results by 1.02 to correct for sample dilution by the formaldehyde.

To test samples such as seawater containing high levels of hardness, iron, or aluminum, follow the powder pillow procedure above, but add a CuVer 2 Copper Reagent Powder Pillow to 25 mL of sample in a 25-mL mixing cylinder. After color development, transfer this solution to a 10-mL sample cell for copper measurements. Results obtained will include total dissolved copper (free and complexed).

Copper, continued

To differentiate free copper from that complexed to EDTA or other complexing agents, use a Free Copper Reagent Powder Pillow in place of the CuVer 1 Pillow in step 2 and add to 25 mL of sample in a 25-mL mixing cylinder. Transfer the solution to a 10-mL sample cell for measurements. The result will be free copper only. To determine total dissolved copper (free and complexed) return the 10-mL sample cell portion to the mixing cylinder and add a Hydrosulfite Reagent Powder Pillow. Stopper and invert to mix. Once again, transfer solution to a 10-mL sample cell for measurements.

Using AccuVac Ampuls

The CuVer 2 reagent contained in the AccuVac Ampuls is formulated to withstand high levels of calcium, iron, and aluminum without interference.

Unlike CuVer 1 reagent, CuVer 2 reagent reacts directly with copper which is complexed by chelants such as EDTA. If free copper is to be determined separately from complexed copper, see [page 1–39](#).

If the sample is very acidic, adjust to a pH greater than 4 before analysis. If a turbidity forms and turns black, silver interference is likely. This can be eliminated by adding 10 drops of Saturated Potassium Chloride Solution to 75 mL of sample,

followed by filtration through a fine filter using the lab ware listed under [Optional Apparatus on page 1–43](#). Use the filtered sample in the procedure.

Cyanide interferences prevent sufficient color development but can be overcome by adding 0.8 mL of formaldehyde to 40 mL of the sample. Wait four minutes before taking the reading. Multiply the test results by 1.02 to correct for sample dilution by the formaldehyde.

Summary of Method

Copper in the sample reacts with a salt of bichinonic acid contained in CuVer 1 or CuVer 2 Copper Reagent to form a purple-colored complex in proportion to the copper concentration. This method includes procedures using powder pillow and AccuVac reagents.

Copper, continued

Reagents and Apparatus

Required Reagents and Apparatus (Using Powder Pillows)

| Description | Units | Cat. No. |
|--|---------|---------------|
| CuVer [®] 1 Copper Reagent Powder Pillows | 100/pkg |21058-69 |

Required Reagents and Apparatus (Using AccuVac Ampuls)

| | | |
|--|--------|---------------|
| CuVer [®] 2 Copper Reagent AccuVac Ampuls | 25/pkg | 25040-25 |
| Beaker, 50-mL..... | each | 500-41H |

Optional Reagents

| | | |
|---|------------|----------------|
| Copper Standard Solution, 100-mg/L..... | 100 mL | 128-42 |
| Copper Standard Solution, Voluette [™] Ampules, 75-mg/L | 16/pkg | 14247-10 |
| CuVer [®] 2 Reagent Powder Pillows..... | 100/pkg | 21882-99 |
| Formaldehyde, 37% | 100-mL MDB | 2059-32 |
| Free Copper Reagent Powder Pillows | 100/pkg | 21186-69 |
| Hydrochloric Acid Solution, 6.0 N..... | 500 mL | 884-49 |
| Hydrosulfite Reagent Powder Pillows..... | 100/pkg | 21188-69 |

Optional Reagents, continued

| Description | Units | Cat. No. |
|--|------------------|----------|
| Mixed Parameter Quality Control Standards | | |
| metals, drinking water, low range | 500 mL..... | 28337-49 |
| Mixed Parameter Quality Control Standards | | |
| metals, drinking water, high range | 500 mL..... | 28336-49 |
| Nitric Acid, ACS | 500 mL..... | 152-49 |
| Nitric Acid Solution, 1:1 | 500 mL..... | 2540-49 |
| Potassium Chloride Solution, saturated | 100-mL SCDB..... | 765-42 |
| Potassium Hydroxide Standard Solution, 8.0 N | 100-mL MDB..... | 282-32H |
| Sodium Hydroxide Solution, 5.0 N..... | 100-mL MDB..... | 2450-32 |
| Water, deionized..... | 4 L..... | 272-56 |

Optional Apparatus

| | | |
|--|--------------|----------|
| AccuVac® Snapper Kit | each..... | 24052-00 |
| Ampule Breaker Kit | each..... | 21968-00 |
| Cylinder, graduated, polypropylene, 25-mL..... | each..... | 1081-40 |
| Cylinder, mixing, 25-mL, tall..... | each..... | 20886-40 |
| Cylinder, graduated, 100-mL..... | each..... | 508-42 |
| Filter Paper, folded, 12.5-cm | 100/pkg..... | 1894-57 |

Copper, continued

Optional Apparatus, continued

| Description | Units | Cat. No. |
|--|-------------------|----------|
| Flask, volumetric, 100-mL..... | each | 14574-42 |
| Funnel, polypropylene, 65-mm..... | each | 1083-67 |
| Hot Plate, 3½ inch diameter, 120 Vac..... | each | 12067-01 |
| Hot Plate, 3½ inch diameter, 240 Vac..... | each | 12067-02 |
| pH Indicator Paper, 1 to 11 pH..... | 5 rolls/pkg | 391-33 |
| Pipet Filler, safety bulb | each | 14651-00 |
| Pipet, TenSette®, 0.1 to 1.0-mL..... | each | 19700-01 |
| Pipet Tips, for 19700-01 TenSette® Pipet..... | 50/pkg | 21856-96 |
| Pipet, volumetric, 3.00-mL..... | each | 14515-03 |
| sension™1 Basic Portable pH Meter, with electrode..... | each | 51700-10 |

Replacement Parts

| | | |
|-----------------------------------|------------|----------|
| Batteries, AAA, alkaline | 4/pkg | 46743-00 |
| Instrument Cap/light shield..... | each | 59548-00 |
| Instruction Manual..... | each | 59573-88 |
| Sample Cell, 10-mL, with cap..... | 6/pkg | 24276-06 |

Manganese, Low Range (0.01 to 0.70 mg/L)

Method 8149

For water and wastewater

PAN Method* Digestion required for total manganese

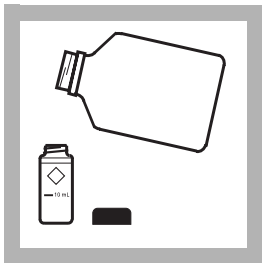
Measuring Hints

- Rinse all glassware with 1:1 Nitric Acid Solution. Rinse again with deionized water.
- Wipe the outside of each cell before inserting into the instrument cell holder.
- The Alkaline Cyanide Reagent Solution contains cyanide. Cyanide solutions should be collected for disposal as a reactive (D001) waste. Be sure cyanide solutions are stored in a caustic solution with a pH greater than 11 to prevent the release of hydrogen cyanide gas.

Note: *The Pocket Colorimeter™ II is designed to measure solutions contained in sample cells. **DO NOT** dip the meter in the sample or pour the sample directly into the cell holder.*

* Adapted from Goto, K. et al., *Talanta* 24:652-3 (1977).

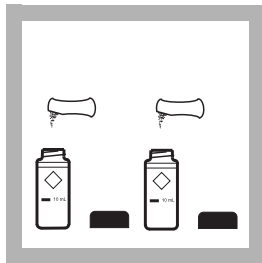
Manganese, Low Range, continued



1. Fill a 10-mL sample cell to the 10-mL mark with deionized water (this will become the blank).



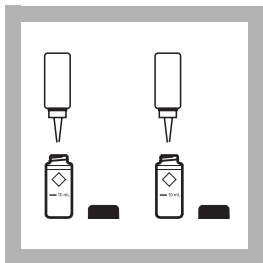
2. Fill a second 10-mL sample cell to the 10-mL mark with sample (this will become the prepared sample).



3. Add the contents of one Ascorbic Acid Powder Pillow to each cell. Cap and shake to mix.

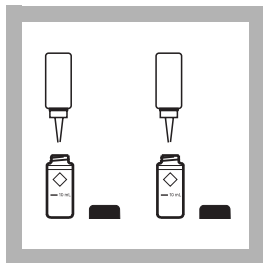
Note: *If samples contain hardness greater than 300 mg/L as CaCO_3 , add four drops of Rochelle Salt Solution to the sample after the Ascorbic Acid Powder Pillow.*

Manganese, Low Range, continued



4. Add 15 drops of Alkaline Cyanide Reagent Solution to each cell. Cap and gently invert several times to mix.

Note: A cloudy or turbid solution may form in some samples after addition of the reagent. The turbidity should dissipate.



5. Add 21 drops of PAN Indicator Solution, 0.1%, to each cell. Cap and gently invert several times to mix.

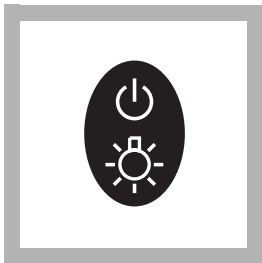
Note: The prepared sample will develop a darker orange color (compared to the blank) if manganese is present.



6. Wait two minutes for full color development.

Note: If the sample contains iron greater than 5 mg/L, allow ten minutes for complete color development.

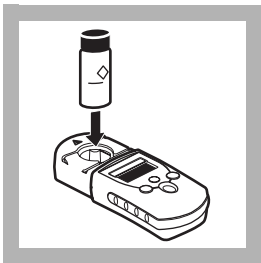
Manganese, Low Range, continued



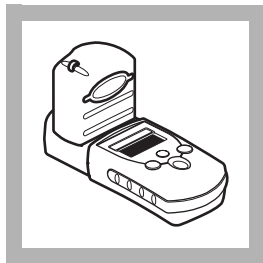
7. Press the **POWER** key to turn the meter on.

The arrow should indicate mg/L Mn.

Note: See [page 2–4](#) for information on selecting the correct range channel.

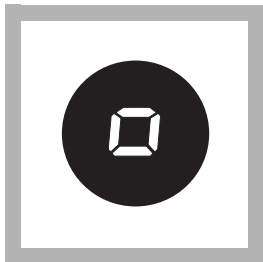


8. After the two-minute wait, wipe the blank to remove fingerprints and place the blank in the cell holder.

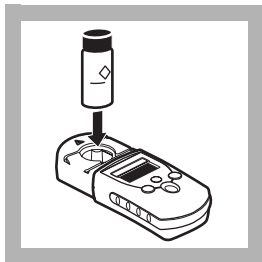


9. Cover the blank with the instrument cap.

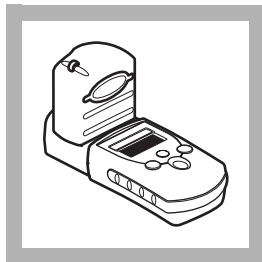
Manganese, Low Range, continued



- 10.** Press **ZERO/SCROLL**.
The display will show “- - - -” then “0.00”.
Remove the blank from the cell holder.



- 11.** Wipe the cell to remove liquid or fingerprints. Place the prepared sample in the cell holder.



- 12.** Cover the sample cell with the instrument cap.

Manganese, Low Range, continued



13. Press **READ/ENTER**.
The display will show
"- - - -", followed by results
in mg/L manganese (Mn).

Note: *To convert results to
other units, use the
conversion table (Table 1).*

Table 1

| To convert reading from | To | Multiply by |
|-------------------------|-----------------------|-------------|
| mg/L Mn | mg/L MnO_4^- | 2.16 |
| mg/L Mn | mg/L KMnO_4 | 2.88 |

Sampling and Storage

Collect samples in acid-washed plastic bottles. Manganese may be lost by absorption to glass container walls. Adjust the pH to 2 or less with nitric acid (about 2 mL per liter). Preserved samples may be stored up to six months at room

temperature. Adjust the pH to between 4 and 5 with 5.0 N sodium hydroxide before analysis. Do not exceed pH 5, as the manganese may be lost as a precipitate. Correct the test results for volume additions.

Accuracy Check

Standard Additions Method

1. Fill three 10-mL sample cells with 10 mL of sample.
2. Snap the neck off a Manganese PourRite™ Standard Ampule, 10 mg/L as Mn²⁺.
3. Use a TenSette® Pipet to add 0.1 mL, 0.2 mL, and 0.3 mL of standard, respectively, to the three sample cells. Cap each and mix thoroughly.
4. Analyze each standard addition sample as described in the procedure. The manganese concentration should increase approximately 0.10 mg/L Mn for each 0.1 mL of standard added.
5. Analyze each standard addition sample as described in the procedure. The iron concentration should increase 0.2 mg/L for each 0.1 mL of standard added.

Standard Solutions Method

Prepare a 0.50 mg/L Mn Standard Solution. Use the prepared standard solution in place of sample. Perform the procedure.

Manganese, Low Range, continued

1. Prepare the 0.50 mg/L manganese standard solution by pipetting 2.00 mL of Manganese Voluette Standard Solution, 25 mg/L Mn, in a 100-mL volumetric flask.
2. Dilute to the mark with deionized water, stopper, and mix thoroughly. Prepare this solution daily.

Multi-parameter standards that simulate typical drinking water concentrations without dilution are available to confirm test results. See [Optional Reagents on page 1–55](#).

Method Performance

Typical Precision (95% Confidence Interval):

$$0.50 \pm 0.02 \text{ mg/L Mn}$$

Estimated Detection Limit:

$$\text{EDL} = 0.02 \text{ mg/L Mn}$$

Standard Calibration Adjust Method

To perform a standard calibration adjustment using the 0.50 mg/L manganese standard, or to use an alternative concentration, see [Standard Calibration Adjust on page 2–13](#).

Interferences

The following do not interfere up to the indicated concentrations:

| Ion | Maximum Concentration without Interference |
|-----------|--|
| Aluminum | 20 mg/L |
| Cadmium | 10 mg/L |
| Calcium | 1000 mg/L as CaCO ₃ |
| Cobalt | 20 mg/L |
| Copper | 50 mg/L |
| Iron | 25 mg/L |
| Lead | 0.5 mg/L |
| Magnesium | 300 mg/L as CaCO ₃ |
| Nickel | 40 mg/L |
| Zinc | 15 mg/L |

Manganese, Low Range, continued

Summary of Method

The PAN method is a highly sensitive and rapid procedure for detecting low levels of manganese. An ascorbic acid reagent is used initially to reduce all oxidized forms of manganese to Mn^{2+} . An alkaline-cyanide reagent is added to mask any potential interferences. PAN Indicator is then added to combine with the Mn^{2+} to form an orange-colored complex.

Reagents and Apparatus

Required Reagents and Apparatus

| Description | Units | Cat. No. |
|---|-------|----------|
| Manganese Reagent Set, 10 mL (50 tests) | | 26517-00 |
| Includes: | | |
| Alkaline Cyanide Reagent Solution, 50 mL SCDB | | |
| Ascorbic Acid Powder Pillows (2 pillows), 100/pkg | | |
| PAN Indicator Solution, 0.1%, 50 mL SCDB | | |

Manganese, Low Range, continued

Optional Reagents

| Description | Units | Cat. No. |
|---|-----------------|----------|
| Manganese Standard, 10-mL Ampule, 25 mg/L as Mn (NIST)..... | 16/pkg..... | 21128-10 |
| Manganese Standard, 2-mL PourRite™ Ampule, 10 mg/L Mn (NIST)..... | 20/pkg..... | 26058-20 |
| Multi-parameter Quality Control Standard (Copper, 1.0 mg/L; Iron, 0.3 mg/L; Mn, 0.1 mg/L)..... | 500 mL..... | 28337-49 |
| Nitric Acid Solution, 1:1 | 500 mL..... | 2540-49 |
| Rochelle Salt Solution | 29 mL MDB..... | 1725-33 |
| Sodium Hydroxide Solution, 5.0 N..... | 50 mL SCDB..... | 2450-26 |
| Nitric Acid, ACS | 500 mL..... | 152-49 |
| Hydrochloric Acid Solution, 1:1 (6 N)..... | 500 mL..... | 884-49 |

Optional Apparatus

| | | |
|---|-----------|----------|
| Ampule Breaker Kit for Pour-Rite..... | each..... | 24846-00 |
| Cylinder, graduated mixing, 25 mL..... | each..... | 20886-40 |
| Flask, volumetric, 100 mL, Class A..... | each..... | 14574-42 |
| Pipet Filler, safety bulb | each..... | 14651-00 |
| Pipet, serological, 5 mL..... | each..... | 532-37 |

Manganese, Low Range, continued

Optional Apparatus, continued

| Description | Units | Cat. No. |
|---|---------------|----------|
| Pipet, TenSette [®] , 0.1 to 1.0 mL | each | 19700-01 |
| Pipet Tips, for 19700-01 TenSette [®] Pipet..... | 50/pkg | 21856-96 |
| Pipet Tips, for 19700-01 TenSette [®] Pipet..... | 1000/pkg | 21856-28 |
| Pipet, volumetric, 5.00 mL, Class A..... | each | 14515-37 |
| Timer, 3-channel | each | 23480-00 |

Replacement Parts

| | | |
|-----------------------------------|------------|----------|
| Batteries, AAA, alkaline | 4/pkg | 46743-00 |
| Instrument Cap/light shield..... | each | 59548-00 |
| Instruction Manual..... | each | 59573-88 |
| Sample Cell, 10-mL, with cap..... | 6/pkg | 24276-06 |

Nickel (0.01 to 1.00 mg/L)

Method 8150

For water and wastewater

1-(2 Pyridylazo)-2-Naphthol (PAN) Method*

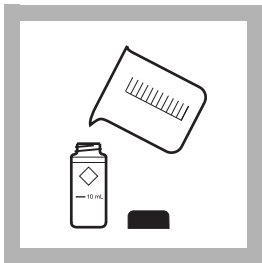
Measuring Hints

- If samples cannot be analyzed immediately, see [on page 1–68](#).
- If this sample is less than 10 °C (50 °F), warm to room temperature prior to analysis.
- This test will not differentiate between nickel and cobalt.

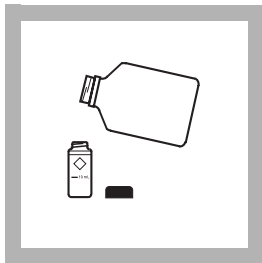
Note: *The Pocket Colorimeter™ II is designed to measure solutions contained in sample cells. **DO NOT** dip the meter in the sample or pour the sample directly into the cell holder.*

* Adapted from Watanabe, H., *Talanta*, 21: 295 (1974).

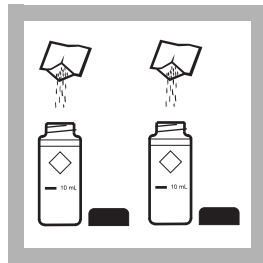
Nickel, continued



1. Fill a 10-mL sample cell to the 10-mL line with sample (the prepared sample).

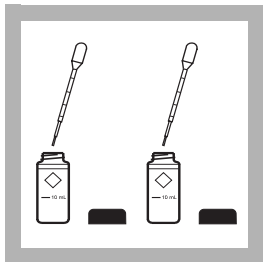


2. Fill a second 10-mL sample cell to the mark with deionized water (the blank).



3. Add the contents of one Phthalate-Phosphate Reagent Powder Pillow to each cell. Cap. Shake to dissolve.

Note: *If sample contains iron (Fe^{3+}), all powder must be dissolved before continuing with step 4.*



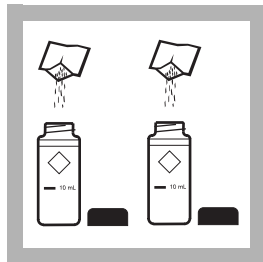
4. Add 0.5 mL of 0.3% PAN Indicator Solution to each cell. Cap. Invert several times to mix.

Note: Use the plastic dropper provided.



5. Wait 15 minutes before proceeding with step 6.

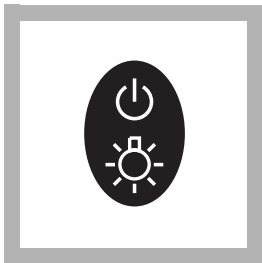
Note: During color development, the sample solution may vary from yellowish-orange to dark red, depending on the chemical make up of the sample. The blank should be yellow.



6. Add the contents of one EDTA Reagent Powder Pillow to each cell. Cap. Invert gently to dissolve. Allow bubbles to clear from the solution before measurement.

Note: Wipe any liquid or fingerprints off both cells.

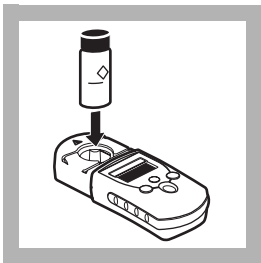
Nickel, continued



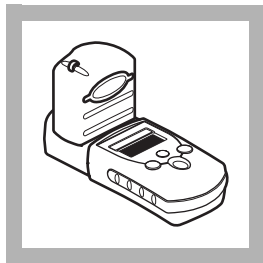
7. Press the **POWER** key to turn the meter on.

The arrow should indicate Ni.

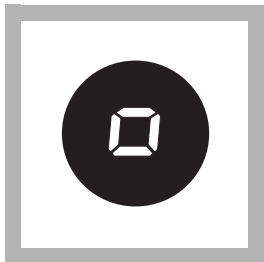
Note: See [page 2–4](#) for information on selecting the correct range channel.



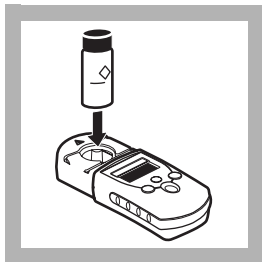
8. Place the blank in the cell holder.



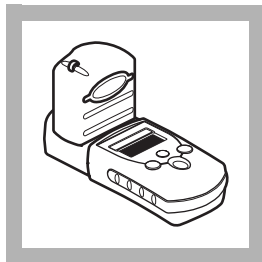
9. Cover the blank with the instrument cap.



- 10.** Press **ZERO/SCROLL**.
The display will show
"- - - -" then "0.00".
Remove the blank from the
cell holder.



- 11.** Place the prepared
sample in the cell holder.
Wipe off any liquid or
fingerprints.



- 12.** Cover the sample cell
with the instrument cap.

Nickel, continued



13. Press **READ/ENTER**.

The display will show
“- - - -”, followed by results
in mg/L nickel (Ni).

Cobalt (0.02 to 2.00 mg/L)

Method 8078

For water and wastewater

1-(2 Pyridylazo)-2-Naphthol (PAN) Method*

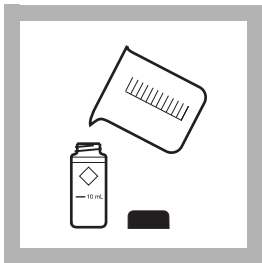
Measuring Hints

- If samples cannot be analyzed immediately, see [on page 1–68](#).
- If this sample is less than 10 °C (50 °F), warm to room temperature prior to analysis.
- This test will not differentiate between nickel and cobalt.

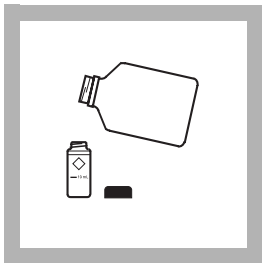
Note: *The Pocket Colorimeter™ II is designed to measure solutions contained in sample cells. **DO NOT** dip the meter in the sample or pour the sample directly into the cell holder.*

* Adapted from Watanabe, H., *Talanta*, 21: 295 (1974).

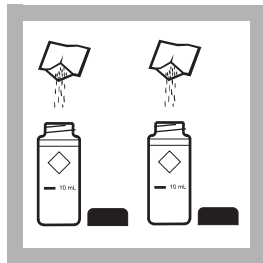
Cobalt, continued



1. Fill a 10-mL sample cell to the 10-mL line with sample (the prepared sample).

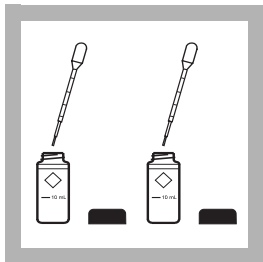


2. Fill a second 10-mL sample cell to the mark with deionized water (the blank).



3. Add the contents of one Phthalate-Phosphate Reagent Powder Pillow to each cell. Cap. Shake to dissolve.

Note: *If sample contains iron (Fe^{3+}), all powder must be dissolved before continuing with step 4.*



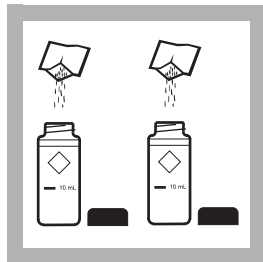
4. Add 0.5 mL of 0.3% PAN Indicator Solution to each cell. Cap. Invert several times to mix.

Note: Use the plastic dropper provided.



5. Wait 3 minutes before proceeding with step 6.

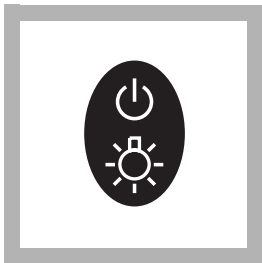
Note: During color development, the sample solution may vary from yellowish-orange to dark red, depending on the chemical make up of the sample. The blank should be yellow.



6. Add the contents of one EDTA Reagent Powder Pillow to each cell. Cap. Invert gently to dissolve. Allow bubbles to clear from the solution before measurement.

Note: Wipe any liquid or fingerprints off both cells.

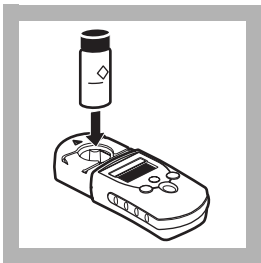
Cobalt, continued



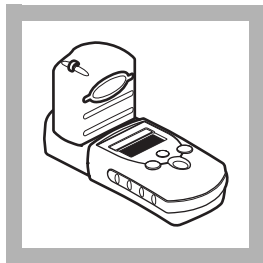
7. Press the **POWER** key to turn the meter on.

The arrow should indicate Co.

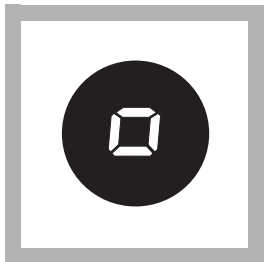
Note: See [page 2–4](#) for information on selecting the correct range channel.



8. Place the blank in the cell holder.



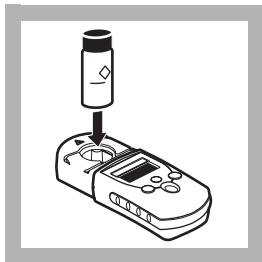
9. Cover the blank with the instrument cap.



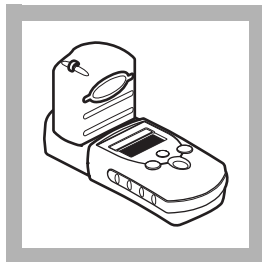
10. Press **ZERO/SCROLL**.

The display will show
"- - - -" then "0.00".

Remove the blank from the
cell holder.



11. Place the prepared
sample in the cell holder.



12. Cover the sample cell
with the instrument cap.

Cobalt, continued



13. Press **READ/ENTER**.

The display will show
"- - - -", followed by results
in mg/L cobalt (Co).

Sampling and Storage (Nickel and Cobalt)

Collect samples in acid-washed plastic bottles. For storage, adjust the pH to 2 or less with nitric acid (about 2 mL per liter). The preserved samples can be stored for up to six months at room temperature. Adjust the pH to between 3 and 8 with 5.0 N Sodium

Hydroxide before analysis. Do not exceed pH 8 as this may cause some loss of nickel or cobalt as a precipitate. Correct test for volume additions:

actual conc. (mg/L) =

displayed conc. (mg/L) $\times \frac{\text{sample vol. (mL)} + \text{addition vol. (mg/L)}}{\text{sample vol. (mL)}}$

A digestion is required for determining total nickel and cobalt when samples contain visible particulate matter. The Hach *Water Analysis Handbook* describes the various digestion options available.

Accuracy Check (Nickel and Cobalt)

Standard Solution Method for Nickel

Prepare a 50.0 mg/L nickel stock solution by pipetting 5.00 mL of Nickel Standard Solution, 1000 mg/L as Ni, into a 100-mL volumetric flask. Dilute to the mark with deionized water. Prepare this solution daily. Prepare a 0.5 mg/L Ni working solution by pipetting 5.0 mL of the 50.00 mg/L nickel stock solution into a 500-mL volumetric flask. Dilute to the mark with deionized water. Prepare this solution daily. Perform the nickel procedure as described on [page 1–57](#).

Cobalt, continued

Standard Solution Method for Cobalt

Prepare a 1.0 mg/L cobalt standard solution by diluting 10.0 mL of a 10-mg/L stock solution to 100 mL in a volumetric flask. Prepare the 10-mg/L working stock solution daily by diluting 10.00 mL of Cobalt Standard Solution, 1000 mg/L as Co, to 1000 mL with deionized water. Perform the nickel procedure as described on [page 1–63](#).

Standard Calibration Adjust

To perform a Standard Calibration Adjust, use a 0.5 mg/L Ni or a 1.0 mg/L Co standard or using alternate concentrations, see [Standard Calibration Adjust on page 2–13](#).

Method Performance

Typical Precision (95% Confidence Interval):

Nickel: 0.50 ± 0.02 mg/L Ni

Cobalt: 1.00 ± 0.03 mg/L Co

Estimated Detection Limit (EDL)

Nickel: EDL = 0.01 mg/L Ni

Cobalt: EDL = 0.02 mg/L Co

Interferences

The following may interfere when exceeding the levels listed. The test will not differentiate between nickel and cobalt on this instrument. Other multi-wavelength instruments will allow this differentiation. Cobalt interferes with nickel and vice versa.

| Element | Interference level | Element | Interference level |
|------------------|-----------------------------------|------------------|---|
| Al ³⁺ | 32 mg/L | Fe ²⁺ | Interferes directly. Must not be present. |
| Ca ²⁺ | 1000 mg/L as (CaCO ₃) | K ⁺ | 500 mg/L |
| Cd ²⁺ | 20 mg/L | Mg ²⁺ | 400 mg/L |
| Cl ⁻ | 8000 mg/L | Mn ²⁺ | 25 mg/L |
| Chelating agents | All levels ¹ | Mo ⁶⁺ | 60 mg/L |
| Cr ³⁺ | 20 mg/L | Na ⁺ | 5000 mg/L |
| Cr ⁶⁺ | 40 mg/L | Pb ²⁺ | 20 mg/L |

Cobalt, continued

| Element | Interference level | Element | Interference level |
|------------------|--------------------|-------------------|--|
| Cu^{2+} | 15 mg/L | Zn^{2+} | 30 mg/L |
| F^- | 20 mg/L | Extreme sample pH | May exceed the buffering capacity of the reagents and require sample pretreatment. |
| Fe^{3+} | 10 mg/L | | |

1. Use either the Digesdahl or vigorous digestion to eliminate this interference.

Summary of Method

After buffering the sample and masking any Fe^{3+} with pyrophosphate, the nickel and cobalt are reacted with 1-(2-Pyridylazo)-2-Naphthol indicator. The indicator forms complexes with most metals present. After color development, EDTA is added to destroy all metal-PAN complexes except those of nickel and cobalt.

Reagents and Apparatus

Required Reagents and Apparatus (Using Powder Pillows)

| Description | Units | Cat. No. |
|--|-------|----------|
| Nickel/Cobalt Reagent Set, 10 mL, (100 tests)..... | | 26516-00 |

Includes:

- (2) EDTA Reagent Powder Pillows, 50/pkg
- (2) Phthalate-Phosphate Reagent Powder Pillows, 100/pkg
- (2) PAN Indicator Solution, 0.3%, 100 mL

Optional Reagents

| | | |
|--|--------------|----------|
| Nickel Standard Solution, 1000-mg/L..... | 100 mL..... | 14176-42 |
| Cobalt Standard Solution, 1000-mg/L..... | 100 mL..... | 21503-42 |
| Nitric Acid, ACS..... | 500 mL..... | 152-49 |
| Nitric Acid Solution, 1:1..... | 500 mL..... | 2540-49 |
| Sodium Hydroxide Standard Solution, 5.0 N..... | 100 mL..... | 2450-32 |
| Sodium Hydroxide Standard Solution, 5.0 N..... | 1 liter..... | 2450-53 |

Cobalt, continued

Optional Apparatus

| Description | Units | Cat. No. |
|--|-------------------|----------|
| Flask, volumetric, Class A, 100-mL..... | each | 14574-42 |
| Flask, volumetric, Class A, 500-mL | each | 14574-49 |
| Flask, volumetric, Class A, 1000-mL | each | 14574-53 |
| pH Indicator Paper, 1 to 11 pH | 5 rolls/pkg | 391-33 |
| sension™1 Basic Portable pH Meter, with electrode..... | each | 51700-10 |
| Pipet, volumetric, Class A, 5.00-mL..... | each | 14515-37 |
| Pipet, volumetric, Class A, 10.00-mL..... | each | 14515-38 |
| Pipet Filler, safety bulb..... | each | 14651-00 |

Replacement Parts

| | | |
|-----------------------------------|------------|----------|
| Batteries, AAA, alkaline | 4/pkg | 46743-00 |
| Instrument Cap/light shield..... | each | 59548-00 |
| Instrument Manual..... | each | 59573-88 |
| Sample Cell, 10-mL, with cap..... | 6/pkg | 24276-06 |






Section 2


Instrument Manual

Instrument Operation

Key Functions

| Key | Description | Function |
|---|--------------------|---|
|  | POWER | On/Off/Backlight To turn on the backlight, turn on the instrument, then press and hold the power key until the backlight turns on. Press and hold again to turn off the backlight. This key functions the same in all instrument modes and ranges. |
|  | ZERO/SCROLL | In measurement mode, sets the instrument to zero. In menu mode, scrolls through menu options. Also scrolls numbers when entering or editing a value. |
|  | READ/ENTER | In measurement mode, initiates sample measurement. In menu mode, selects a menu option. When entering numbers, moves one space to the right and executes the function when the entry is complete. |

Instrument Operation, continued

| Key | Description | Function |
|--|-------------|---|
|  | MENU | Enter/Exit the menu mode Press and hold for approximately 5 seconds to enter user-entered method mode. |

Menu Selections

Press the **MENU** key to access the menu selections.

Switching Ranges

1. Press the **MENU** key. The display will show “SEL”. A flashing arrow indicates the current range.
2. Press the **READ/ENTER** key to toggle between ranges.
3. Press **MENU** again to accept and exit back to the measurement screen.

Setting the Time

1. Press the **MENU** key, then press the **ZERO/SCROLL** key until the display shows a time in the “00:00” format.

2. Press **READ/ENTER**. The digit to be edited will flash.
3. Use the **ZERO/SCROLL** key to change the entry, then press **READ/ENTER** to accept and advance to the next digit. The time is entered in 24-hour format.

Recalling Stored Measurements

1. Press the **MENU** key, then press the **ZERO/SCROLL** key until the display shows RCL. The instrument automatically stores the last 10 measurements.
2. In RCL, press **READ/ENTER** to recall the stored measurements, beginning with the most recent measurement taken. The meter stores the measurement number as 01 (most recent) through 10 (oldest), the time the measurement was taken, and the measurement value. The **ZERO/SCROLL** key allows for selection of a specific measurement by number. The **READ/ENTER** key scrolls through all stored data points.



Battery Installation

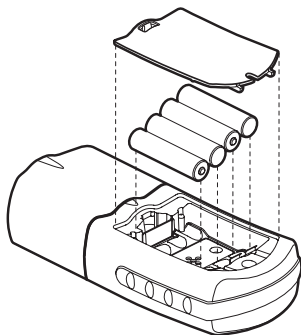
Figure 1 on page 2–7 provides an exploded view of battery installation.

1. Unhook the latch and remove the battery compartment cover. The polarities are shown on the battery holder.
2. Place the four batteries provided with the instrument in the holder as indicated and replace the battery compartment cover. The display will show the software version number (e.g., “P 1.6”) after correct battery installation.

When replacing discharged batteries, always replace the complete set of four alkaline batteries. **Rechargeable batteries are not recommended** and cannot be recharged in the instrument.

Note: *The Low Battery icon will appear on the display when the batteries have 10% battery life remaining. The battery icon will flash when the batteries are too low to complete measurements. See [Instrument Keys and Display on page 1–11](#).*

Figure 1 Battery Installation



Error Codes

When the instrument cannot perform the function initiated by the operator, an error message will appear in the display. Refer to the appropriate message information below to determine what the problem is and how it can be corrected. Resolve error messages in the order that they appear on the display. Service Centers are listed in [page 2–37](#).

Error Messages

1. E-0 No Zero (User mode)

Error occurs when trying to read a standard in the user calibration mode before setting the meter to zero.

- Zero the instrument on an appropriate blank.

2. E-1 Ambient Light Error

There is too much light present to take a valid measurement.

- Verify instrument cap is correctly seated.
- If the problem persists, contact a Service Center ([page 2–37](#)).

Error Codes, continued

3. E-2 LED Error

The LED (light source) is out of regulation.

- Replace batteries.
- Verify LED lights up (inside the cell holder) when the **READ/ENTER** or **ZERO/SCROLL** key is pressed.
- If the problem persists, contact a Service Center ([page 2–37](#)).

Note: When an E-1 or E-2 error occurs on a measurement, the display will show “_._.” (The decimal place is determined by the chemistry.) If the E-1 or E-2 error occurs while zeroing the meter, the meter will require the user to re-zero.

4. E-3 Standard Adjust Error

The value obtained on the prepared standard exceeds the adjustment limits allowed for the standard concentration, or the concentration of the standard is outside the concentration range allowed for standard calibration adjust.

- Prepare the standard and rerun according to the procedure.
- Prepare a standard at or near the recommended concentrations given in the procedure.
- Verify that the concentration of the standard has been entered correctly.

- If the problem persists, contact a Service Center ([page 2–37](#)).

5. E-6 Abs Error (User mode)

Indicates that the absorbance value is invalid, or indicates an attempt to make a curve with less than two points.

- Enter or measure the absorbance value again.
- If the problem persists, contact a Service Center ([page 2–37](#)).

6. E-7 Standard Value Error (User mode)

Standard concentration is equal to another standard concentration that is already entered.

- Enter the correct standard concentration.
- If the problem persists, contact a Service Center ([page 2–37](#)).

7. E-9 Flash Error

The meter is unable to save data.

- If the problem persists, contact a Service Center ([page 2–37](#)).

Error Codes, continued

8. Underrange—flashing number below stated test range

- Verify instrument cap is correctly seated.
- Check zero by measuring a blank. If error recurs, re-zero the instrument.
- If the problem persists, contact a Service Center ([page 2–37](#)).

Note: See [Maximum/Minimum Displayed Value on page 2–26](#) for more information.

9. Overrange—flashing number above stated test range

Note: Flashing value will be 10% over the upper test limit.

- Check for light blockage.
- Dilute and retest sample.

Note: See [Maximum/Minimum Displayed Value on page 2–26](#) for more information.

Standard Calibration Adjust

The Pocket Colorimeter™ II instrument is factory-calibrated and ready for use without user calibration. Use of the factory calibration is recommended unless the user is required to generate a calibration. The Standard Calibration Adjust can be used to meet regulatory requirements.

This feature allows the factory default calibration curve to be adjusted with a known standard. Use the standard described in the procedure.

1. Place a blank in the meter (in measurement mode). Press **ZERO/SCROLL**.
2. Place the reacted standard in the meter. Press **READ/ENTER**.
3. Press **MENU**, then press **ZERO/SCROLL** until the display shows “SCA”.
4. Press **READ/ENTER** to display the standard calibration adjust value.
5. Press **READ/ENTER** to adjust the curve to the displayed value. The meter will return to the measurement mode and the Calibration Adjusted icon will appear in the display window.

If an alternate concentration is used, or if a standard concentration is not given:

6. Repeat steps 1–4.

Standard Calibration Adjust, continued

7. Press **ZERO/SCROLL** to access the Edit function, then press **READ/ENTER** to begin editing. The digit to be edited will flash. Use the **ZERO/SCROLL** key to change the entry, then press **READ/ENTER** to accept and advance to the next digit.

When the last digit is entered, press **READ/ENTER** and the meter will adjust the curve to the value entered. The meter will return to measurement mode and the Calibration Adjusted icon will appear in the display window.

To turn off Standard Calibration Adjust (SCA):

1. Press **MENU**.
2. Press **ZERO/SCROLL** until “SCA” appears in the display.
3. Press **READ/ENTER**, then press **ZERO/SCROLL** until “Off” appears in the display.
4. Press **READ/ENTER** to turn off SCA.

Note: Perform another standard calibration adjust to turn SCA on again.

Note: For meters with factory-calibrated ranges or methods, Standard Calibration Adjust (SCA) will be disabled when a user-entered method is programmed into the meter. To turn SCA back on, restore the meter to factory default calibration. See Retrieving the Factory Calibration on page 2–25.

User-Entered Calibration

Overview

The Pocket Colorimeter™ II will accept a user-prepared calibration curve. The curve can extend from 0 to 2.5 absorbance. A user-prepared calibration curve may be entered into any channel that does not contain a factory-programmed curve. These channels are labeled “abs” on instruments having a single factory calibration or are labeled “1” and “2” on the uncalibrated single wavelength instruments. Any chemistry that can be run at the instrument wavelength may be user-entered in these channels.

Using prepared standard solutions that cover the range of interest, the meter generates a calibration curve by calculating the straight-line segments between each standard entered. A calibration curve may be entered using the keypad. Factory-entered calibration curves may also be recalculated or adjusted using the same procedure.

To enter the user-entered calibration mode, press the **MENU** key and hold it down until the display shows “USER” (about 5 seconds), followed by “CAL”. Press **ZERO/SCROLL** to scroll through the options.

User-Entered Calibration, continued

- CAL—Used to enter and edit standard values and measure absorbance values, or review the existing calibration.
- Edit—Used to enter and edit standard values and absorbance values with the keypad or review the existing calibration. Used to enter a predetermined calibration curve.
- dFL—Used to return the instrument back to the default factory calibration. User-entered calibrations are stored upon exit from the calibration or edit modes.

Note: To return to factory settings, following the instructions in [Retrieving the Factory Calibration on page 2–25](#).

If the instrument is shut off or loses power during data entry, all edits will be lost. Automatic shut-off in user-entered calibration entry mode is 60 minutes.

CAL and Edit Submenus

In CAL mode, standard values are entered and absorbance values are measured. In Edit mode, standard and absorbance values are entered.

- To select CAL from the User menu, press **READ/ENTER**.
- To select Edit from the User menu, press **ZERO/SCROLL** and **READ/ENTER**.

- Once in the CAL or Edit option, press the **READ/ENTER** key to navigate through each option.

*Note: Press **ZERO/SCROLL** to quickly scroll through each option.*

Calibration Procedure Using Prepared Standards

Note: *Deionized water or a reagent blank can be used to zero during the calibration procedure. Calibrations generated with deionized water as the zero will give less accurate results if the reagent blank is significantly more turbid or colored than deionized water. Use the deionized water or the reagent blank as the zero concentration point (S0) in the following calibration procedure.*

1. Turn on the instrument and select the range to be calibrated. An arrow at the top of the display will point to the selected range. To change ranges, press the **MENU** key, then use the **READ/ENTER** key to toggle between ranges 1 and 2. Press **MENU** again to return to measurement mode.
2. Follow the procedure for the chemical method to be calibrated. Prepare a reagent blank (if needed) and a standard solution. Allow the color to develop fully.

User-Entered Calibration, continued

3. Insert the reagent blank or deionized water into the meter and cover with the cap. Press the **ZERO/SCROLL** key. The meter will display “- - -”, followed by “0.000”. This initializes (zeroes) the meter.
4. Press the **MENU** key and hold it down until the display shows “USER”, followed by “CAL”. Press **READ/ENTER** to enter the calibration mode.
5. In factory-calibrated meters, S0 will appear in the display.

Note: When recalibrating a factory-calibrated meter or range, RES (resolution) cannot be changed.

6. In uncalibrated meters or meters with ranges labeled Abs, “RES” will appear. Press **ZERO/SCROLL** to review the current resolution (decimal placement). Press **ZERO/SCROLL** again to accept the current resolution. To change the resolution, press **READ/ENTER**, then **ZERO/SCROLL** to change the resolution. Press **READ/ENTER** to accept the new resolution. “S0” will appear on the display.
7. Press the **READ/ENTER** key again, then enter the blank value.

*Note: Press the **READ/ENTER** key to move from digit to digit. Use the **ZERO/SCROLL** key to change the number.*

8. After completing entry of the blank value, press the **READ/ENTER** key. The display will show “A0”.

User-Entered Calibration, continued

9. Insert the reagent blank or deionized water into the cell holder. Cover the blank with the instrument cap.
10. Press the **READ/ENTER** key. The meter will measure and display the absorbance value for “S0”.
11. Remove the sample blank. Press the **ZERO/SCROLL** key. “S1” will appear. Press the **READ/ENTER** key, then enter the first standard value.
*Note: Press the **READ/ENTER** key to move from digit to digit. Use the **ZERO/SCROLL** key to change the number.*
12. After completing entry of the first standard value, press the **READ/ENTER** key. The display will show “A1”.
13. Insert the first reacted standard solution into the cell holder. Cover the prepared standard with the instrument cap.
14. Press the **READ/ENTER** key. The meter will measure and display the absorbance value for S1.
15. The calibration is complete with two points. If additional standards are required, press **ZERO/SCROLL** until “Add” appears on the display. Repeat steps 11–14 to enter additional standards.

User-Entered Calibration, continued

16. Press the **MENU** key twice to exit and accept the changes. The instrument will use this calibration to determine the displayed concentration of future sample measurements.

Entering a Predetermined Calibration Curve

Note: Entering a predetermined calibration curve requires at least two data pairs. Each data pair requires a concentration value and the absorbance value for the given concentration. Up to 10 data pairs may be entered. This procedure uses the Edit mode.

1. Turn on the instrument and select the range to be calibrated. An arrow at the top of the display will point to the selected range. To change ranges, press the **MENU** key, then use the **READ/ENTER** key to toggle between ranges 1 and 2. Press **MENU** again to return to measurement mode.
2. Press the **MENU** key and hold it down until the display shows “USER”, followed by “CAL”. Press **ZERO/SCROLL** to scroll to EDIT. Press **READ/ENTER**.
3. In uncalibrated meters or in Abs range, “RES” will appear. Press **ZERO/SCROLL**. To change the resolution (decimal placement), press **READ/ENTER**. Press **ZERO/SCROLL** to select the new resolution, then press **READ/ENTER** to accept. “S0” will appear on the display.

User-Entered Calibration, continued

4. Enter the concentration value and absorbance value of the first data pair (S0, A0).
5. To enter the S0 value, press **READ/ENTER**. Use the **ZERO/SCROLL** key to select the numerical value, then press the **READ/ENTER** key to accept the entry and advance to the next decimal place. Repeat this sequence until the S0 concentration value is entered.
6. After editing the S0 value, press **READ/ENTER** to accept. "A0" will appear on the display.
7. To enter the absorbance value for S0, press the **READ/ENTER** key to go to entry mode. Use the **ZERO/SCROLL** key to select the numerical value, then press the **READ/ENTER** key to accept the entry and advance to the next decimal place. Repeat this sequence until the absorbance value for S0 is entered.
8. After entering A0, press **READ/ENTER** to accept. "S1" will appear on the display.
9. Repeat steps 5 through 8 for each standard value and absorbance value pair in the calibration curve

*Note: After A1 is entered, Add will appear in the display. If additional data pairs are to be entered, press **READ/ENTER** and continue with step 9.*

User-Entered Calibration, continued

10. When all the calibration data has been entered, press **MENU** twice to return to the measurement mode.

Editing a User-entered or Factory Calibration Curve

1. Press the **MENU** key and hold it down until the display shows “USER”, followed by “CAL”. Press **ZERO/SCROLL** until EDIT appears.
2. Press the **READ/ENTER** key to enter Edit mode. In factory-calibrated meters, “S0” will appear in the display.

Note: When editing a factory-calibrated meter or range, RES (resolution) cannot be changed.

*Note: When RES or S0 appears in the display, press **ZERO/SCROLL** to quickly scroll to the data to be edited.*

3. In uncalibrated meters or in Abs range, “RES” will appear. Press **ZERO/SCROLL** to review the current resolution. Press **ZERO/SCROLL** again to accept the displayed resolution. To change the resolution (decimal placement), press **READ/ENTER**. Press **ZERO/SCROLL** to select the new resolution, then press **READ/ENTER** to accept. “S0” will appear on the display.
4. Press **READ/ENTER**. The current concentration value for S0 will appear on the display.

User-Entered Calibration, continued

5. To edit the S_0 value, press **READ/ENTER**. Use the **ZERO/SCROLL** key to select the numerical value, then press the **READ/ENTER** key to accept the entry and advance to the next decimal place. Repeat this sequence until the S_0 concentration value is entered.
6. After editing the S_0 value, press **READ/ENTER** to accept. "A0" will appear on the display.
7. To edit the absorbance value for S_0 , press the **READ/ENTER** key to go to entry mode. Use the **ZERO/SCROLL** key to select the numerical value, then press the **READ/ENTER** key to accept the entry and advance to the next decimal place. Repeat this sequence until the absorbance value for S_0 is entered.
8. After editing A0, press **READ/ENTER** to accept. "S1" will appear on the display.
9. Repeat steps 4 through 8 for each standard value and absorbance value pair in the calibration curve.
10. When all calibration data has been reviewed or edited, "ADD" will appear in the display.
11. Press **READ/ENTER** to add more calibration points, or press **MENU** twice to return to the measurement mode.

User-Entered Calibration, continued

Note: When a factory calibration curve has been edited, the “calibration adjust” icon will appear in the display.

Exiting the Calibration Routine

Exit the calibration routine by pressing the **MENU** key to return to measurement mode. The instrument uses the last completed user-entered calibration or the factory calibration if no user-entered calibration has been completed.

Deleting Calibration Points

1. Select the range containing user-entered calibration points. See [Switching Ranges on page 2–4](#).
2. Press and hold the **MENU** key until “USER”, then “CAL” appears. Press **READ/ENTER**.
Note: Calibration points can also be deleted in Edit mode.
3. Press **ZERO/SCROLL** to select the point to delete (e.g., S0 or S1 or S2). Press **READ/ENTER**.
4. The left digit will flash. Press **ZERO/SCROLL** until “dEL” appears. (“dEL” will appear after the numeral 9.)

5. Press **READ/ENTER** to delete. Repeat for all points to be deleted.
Note: The minimum number of valid points is two. For example, if five points have been entered, three can be deleted using this feature.
6. Press **MENU** to return to the measurement mode.

Retrieving the Factory Calibration

1. Select the range to restore factory default calibration. See [Switching Ranges on page 2–4](#).
2. Press and hold the **MENU** key until “USER”, then “CAL” appears.
3. Press the **ZERO/SCROLL** key to find dFL.
4. Press the **READ/ENTER** key to select dFL and restore the instrument to the factory default calibration.

Note: For meters with factory-calibrated ranges or methods, Standard Calibration Adjust (SCA) will be disabled when a user-entered method is programmed into the meter. To turn SCA back on, restore the meter to factory default calibration.

User-Entered Calibration, continued

Maximum/Minimum Displayed Value

In meters with absorbance (Abs) ranges, the maximum displayed value and minimum displayed value is related to the value of the standards entered in a user calibration.

Measurements that exceed the minimum or maximum standards entered in the user calibration will return a flashing number indicating “underrange” or “overrange”. See *Error Codes* (page 2–12) for more information.

Example 1

For a calibration with the following standards:

S0=0.000

S1=1.000

| | |
|-------------------------|-------|
| Maximum Displayed Value | 1.000 |
| Minimum Displayed Value | 0.000 |

Example 2

For a calibration with the following standards:

S0=1.00

S1=2.00

S2=4.00

| | |
|-------------------------|------|
| Maximum Displayed Value | 4.00 |
| Minimum Displayed Value | 1.00 |

For Hach-calibrated programs, the maximum and minimum displayed values always equal the factory-calibrated values and cannot be changed.

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 Pocket Colorimeter™ II instrument has been tested and is certified as indicated to the following instrumentation standards:

EMC Immunity:

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

Standard(s) include:

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

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

Additional Immunity Standard(s) include:

ENV 50204: 1996 Radiated Electromagnetic Field from Digital Telephones

(Criteria A) Radio Frequency 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 from Hach EMC Test Facility, certified compliance by Hach Company.

Additional Radio Frequency Emissions Standard(s) include:

EN 55022 (CISPR 22), Class B emissions limits.

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

Supporting test records from Hach EMC Test Facility, 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 from Hach EMC Test Facility, certified compliance by Hach Company.

Certification, continued

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. Remove power from the Pocket Colorimeter instrument by removing one of its batteries to verify that it is or is not the source of the interference.
2. Move the Pocket Colorimeter instrument away from the device receiving the interference.
3. Reposition the receiving antenna for the device receiving the interference.
4. Try combinations of the above.



GENERAL INFORMATION

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

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

How to Order

By Telephone:

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

By FAX:

(970) 669-2932 (Hach Loveland)

By Mail:

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

For order information by E-mail:

orders@www.hach.com

Information Required:

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

How to Order, continued

Technical and Customer Service (USA only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use and to take your orders. 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 call (970) 669-3050.

In Canada

Hach Instrument Service Centre, Winnipeg, Manitoba, Canada

Telephone: (204) 632-5598; (800) 665-7635

FAX: (204) 694-5134

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 (USA only)
FAX: (515) 232-3835

Latin America, Caribbean, Africa,
Far East, Indian Subcontinent:
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.

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

Europe, the Middle East,
or Mediterranean Africa:
HACH Company, c/o
Dr. Bruno Lange GmbH & CO. KG
Willstätterstr. 11
40549 Düsseldorf, Germany
Telephone: +49/(0)211/52 88-0
FAX: +49/(0)211/52 88-134

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 **two years 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

Warranty, continued

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.