Manual of Operation and Instruction

Troxler RoadReader™

Model 3430 Surface Moisture-Density Gauge

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⚠ SAFETY ALERT SYMBOL ⚠

The Safety Alert Symbol shall appear within this manual. Wherever it appears in this manual or on safety signs affixed to the machine, this is to make all aware of the potential for personal injury and to be cautious when these images are present.

Always observe all WARNING, CAUTION, and NOTE recommendations listed within this manual before operating the machine.

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ABOUT THIS MANUAL

The Model 3430 *Manual of Operation and Instruction* provides detailed information about this gauge. The manual includes product safety information, as well as instructions for the proper installation and use of the Model 3430 gauge.

This manual is organized as follows:

Chapter 1, Introduction – Provides information on the safe use of the gauge; a brief overview of the unit and its features; a list of parts and accessories; and instructions for unpacking and inspection.

Chapter 2, Theory of Operation – Provides a brief description of how the gauge's operations work in relation to their sources.

Chapter 3, Using the Gauge – Describes the keypad and provides instructions for setting up, starting, and operating the gauge.

Chapter 4, Advanced Gauge Operation –Describes the options available from the gauge's Special menu.

Chapter 5, Special Functions – Describes the gauge's special functions, such as stat and drift tests and memory reset.

Appendix A, Maintenance & Troubleshooting – Provides maintenance and service information, as well as instructions for basic troubleshooting.

Appendix B, Specifications – Contains mechanical, electrical, and environmental performance specifications.

Appendix C, Transporting and Shipping – Provides information about shipping requirements for the United States and Canada.

Appendix D, Radiation Safety & Theory – Provides a radiation primer, regulatory requirements, and gauge safety precautions.

Appendix E, Standard Count Log – Use this form to record your standard count readings.

HOW TO USE THIS MANUAL

Congratulations on the purchase of the Troxler Model 3430 Surface Moisture-Density Gauge.

The Model 3430 *Manual of Operation and Instruction* contains information on how the Model 3430 operates, and provides directions on the use of this gauge. Site selection, basic parameter setup, moisture and density determination, data storage, and advanced operations are included, along with radiological information and system troubleshooting.

CONVENTIONS USED IN THIS MANUAL

Throughout this manual the following symbols and special formatting are used to reveal the purpose of the text.

⚠ WARNING

Warnings indicate conditions or procedures that, if not followed correctly, may cause personal injury.

⚠ CAUTION

Cautions indicate conditions or procedures that, if not followed correctly, may cause equipment damage.

NOTE

Notes indicate important information that must be read to ensure proper operation.

⟨**KEY**⟩ This style indicates a key or character to press on the ADU keypad.

DISPLAY–Typestyle and shading used to simulate the control panel display

1. Indicates a procedure with multiple steps.

♦ Indicates a list of things needed (such as equipment) or important points to know.

▶ Indicates that more than one option is available. Carefully select the option that applies.

CAUTIONS AND WARNINGS

Units intended for use in countries that are members of the European Community are shipped with an AC adapter, Troxler part number 108354.

Gauge cover is to be removed by trained service personnel only. There are no user-serviceable components inside. Note that components behind the cover can have voltage potentials in excess of 50 volts during normal operation of the gauge.

Appendix D, Radiation Theory and Safety should be read carefully and understood before using the gauge.

The source rod should automatically retract to the **SAFE** position when the gauge is lifted by the handle.

The Model 3430 gauges are not waterproof. Please do not use them in the rain. If the gauge gets wet make sure it is completely dry before sealing it in the case for storage. Even small amounts of moisture can get into the body of the gauge and cause damage. If you suspect that moisture may be inside the gauge open the keypad panel and run a fan or hairdryer (on low) in the gauge for an hour or more until dry.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ATTENTION MODEL 3430 GAUGE OWNER

This unit contains functions that require an Access Code to be entered. This allows some control over the access to these functions. If you would like management to retain this control, remove this page upon receipt of the gauge and file it somewhere safe.

THE ACCESS CODE IS FOR THIS GAUGE

IS: 4678

NOTES

Chapter 1: Introduction

This chapter covers the following topics and tasks:

- ✓ An introduction to your new Model 3430 gauge
- ✓ Inspecting and unpacking
- ✓ Included parts and accessories

Introduction

The Model 3430 Surface Moisture-Density Gauge can quickly and precisely determine the moisture and density of soils, soil bases, aggregate, concrete and asphaltic concrete without the use of core samples or other destructive methods.

Using direct transmission or backscattered gamma radiation, the Model 3430 gauge determines the density of materials by counting the number of photons emitted by a cesium-137 source. Geiger-Mueller (G-M) detectors located in the gauge base detect the gamma radiation and a microprocessor converts the counts into a density reading.

Using the principle of neutron thermalization, the Model 3430 determines the moisture content of soils and soil-like materials. Hydrogen (water) in the material slows neutrons emitted from an americium-241: beryllium source. Helium-3 detectors located in the gauge base detect the slowed neutrons.

The nuclear method of testing density and moisture has been approved by the American Society of Testing and Materials (ASTM). The Model 3430 meets or exceeds all applicable American Society of Testing and Materials (ASTM) standards (or corresponding equivalent), including:

- ASTM C–1040: Standard Test Methods for In-Place Density of Unhardened and Hardened Concrete, Including Roller Compacted Concrete, By Nuclear Methods
- ASTM D-2950: Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Method.
- ASTM D-6938: Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

Some information contained in this manual is used in training courses offered by Troxler Electronic Laboratories, Inc. and to assist purchasers in obtaining a Radioactive Materials License from the U.S. Nuclear Regulatory Commission or an Agreement State. Owners of this gauge must maintain a current radioactive materials license as long as they own the gauge, even if it is in storage and not actively being used.

Any licensing issues discussed in this manual are for the United States. To purchase a Model 3430 in Canada, owners must obtain a radioisotope license from the Canadian Nuclear Safety Commission (CNSC). The owner should obtain copies of the CNSC Regulations and the Transportation of Dangerous Goods Act and Regulations. This manual provides a guide to Canadian shipping requirements in Appendix D.

Owners are encouraged to require study of this manual by users before allowing any use of the instrument. To monitor exposure to radiation, personnel should wear a dosimeter while operating or cleaning the gauge. The sections of the manual covering radiation safety should be required reading for all operators and potential operators. **If these sections are not completely understood, users should seek assistance from Troxler, an appointed Troxler representative or others designated within the user organization.** Additional radiation safety information is available by attending a *Troxler Nuclear Gauge Training Course*.

As changes are made to local, state, and federal regulations on a continuing basis, the owner/user must maintain knowledge of these regulations**.** *The responsibility for compliance ultimately falls upon the owner***.** The owner may also wish to purchase and subscribe to Titles 10 and 49 of the *Code of Federal Regulations* in addition to applicable local/state regulations.

Gauge Parts and Accessories

Use Figure 1 and the list below to identify the gauge and parts as they are unpacked.

- The **Gauge** is the portable instrument containing all electronic modules, the rechargeable battery pack, detectors, and the radioactive sources.
- The **Reference Standard Block** provides a measurement standard for standard counts and is used during stat and drift tests.
- The **Drill Rod** is used to drill holes for direct transmission measurements. ***Do not use the source rod of the gauge to drill holes.***
- The **Scraper Plate / Drill Rod Guide** is used to prepare the test site and to guide the drill rod when preparing the site for direct transmission measurements.
- The **Extraction Tool** provides leverage to remove the drill rod from soil materials.
- The **AC Charger** and **DC Adapter** are used to charge the gauge batteries. The AC charger accepts 90 – 220 V AC, 50/60 Hz and supplies 12 V DC. The DC adapter allows recharging from an automobile accessory power outlet.
- The **Transport Case** provided with the gauge has been approved as a Type A package and should not be altered. Always use this transport case when transporting or shipping the gauge.
- The ***Manual of Operation and Instruction*** details how to use the gauge.

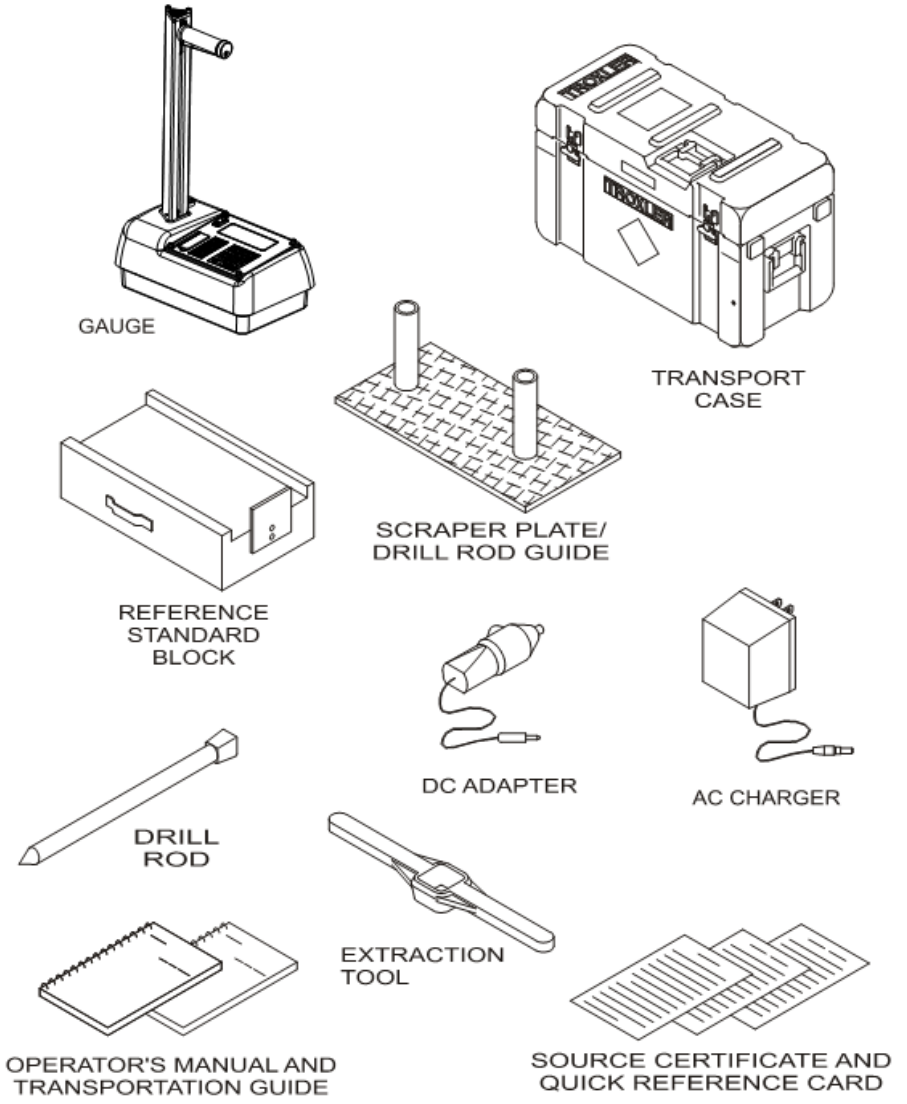


Figure 1. Model 3430 Gauge and Accessories

Unpacking and Inspection

Troxler recommends that all operators wear a dosimeter while working with the gauge. Upon receipt of the gauge from the factory, perform a complete inspection and inventory. If the shipping case and/or any other part or accessory appears damaged, notify the carrier and your Troxler Representative immediately.

Save the box and any packing material for shipping to another location or back to the factory

Check the shipping case for the following:

- Gauge
- Reference Standard Block
- Drill Rod
- Scraper Plate/Drill Rod Guide
- Extraction Tool
- AC Charger
- DC Adapter (for a vehicle cigarette lighter)
- *Manual of Operation and Instruction*
- Gauge Warranty
- Source Certificate
- *Transportation Guide* (This guide refers to U.S. standards. All other countries please refer to local regulations. In the absence of local regulations, please use this guide as a reference only.)

⚠ WARNING

The source rod should always be locked in the SAFE position when the gauge is not in use.

NOTE

Charge the batteries for three hours prior to initial use.

Complete the unpacking and inspection by following these steps:

1. Lift the gauge from the transport case and inspect the outside surface for damage.
2. Check the lock on the source rod handle and make sure the keys fit.
3. Remove the lock, release the trigger, and check the source rod operation. It should move up and down with minimal effort.
4. Replace the handle lock and return the gauge to the transport case.

NOTES

Chapter 2:
Theory of Operation

This chapter covers the following topics and tasks:

- ✓ Theory of operation and modes of transmission
- ✓ Overview of density and moisture measurements

Density

The Model 3430 gauge utilizes two modes of operation: *direct transmission mode* (source rod extended into the material) and *backscatter mode*. Figure 2 and Figure 3 9++6illustrate these two modes of operation.

In *direct transmission* mode, the rod containing the Cesium-137 (8 mCi/0.3 GBq) source is lowered to the desired depth. The detectors in the gauge base measure the radiation emitted by the source rod. Gamma photons reaching the detectors must first pass through the material, colliding with electrons present in the material. Generally, the lower the number of photons that reach the detectors, the more dense the material is.

In *backscatter* mode, the gamma photons that enter the material must be scattered (or reflected) to reach the detectors. With the rod locked in the first notch, the source and detectors are in the same plane, referred to as the backscatter position. Photons emitted from the source penetrate the material and the detectors measure the scattered photons.

While the direct transmission geometry measures the average density of the material from the source to the surface, the backscatter geometry yields an average heavily weighted by the density close to the surface.

Figure 4 shows two normalized *top layer effect curves*, illustrating the percentages of photons at the detectors for various depths. The two curves can be used to compute the gauge response to layered material of different densities. For example, the density of the top inch of a surface layer accounts for about 52% of the backscatter density measurement.

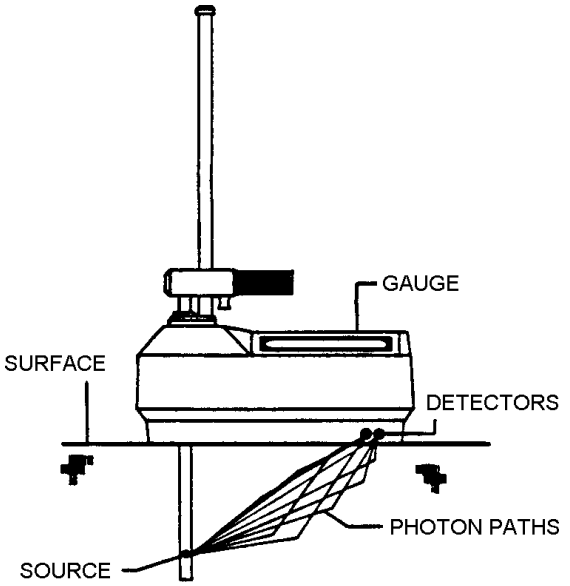


Figure 2. Direct Transmission Geometry

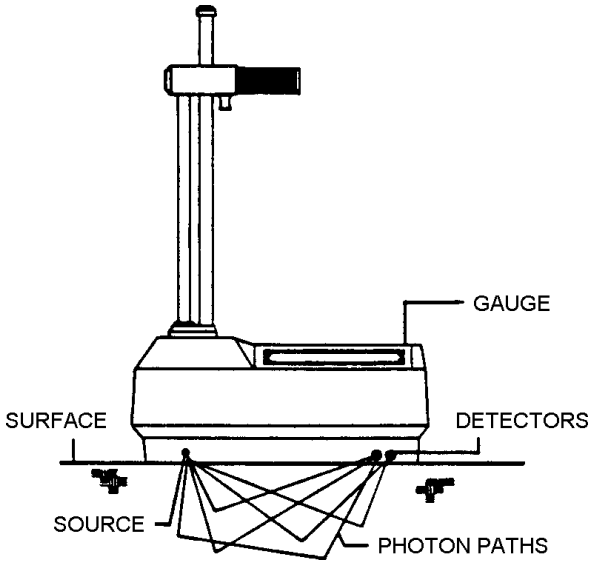
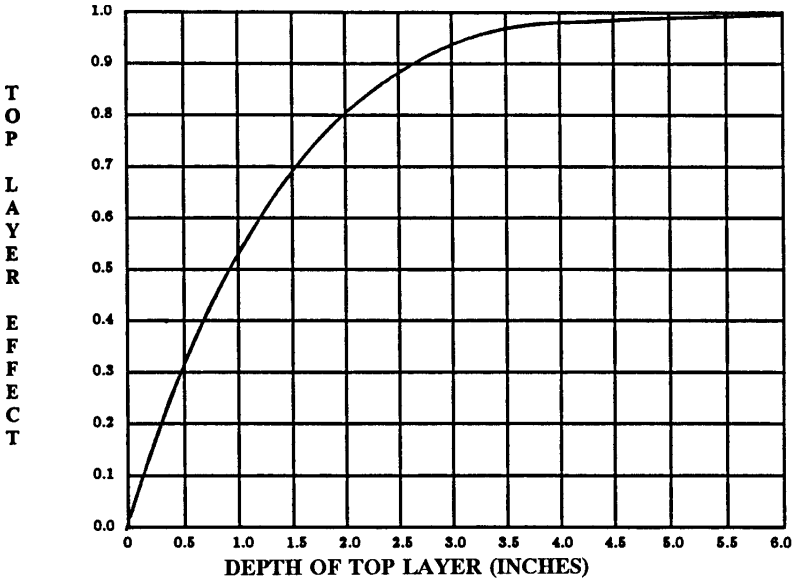


Figure 3. Backscatter Geometry



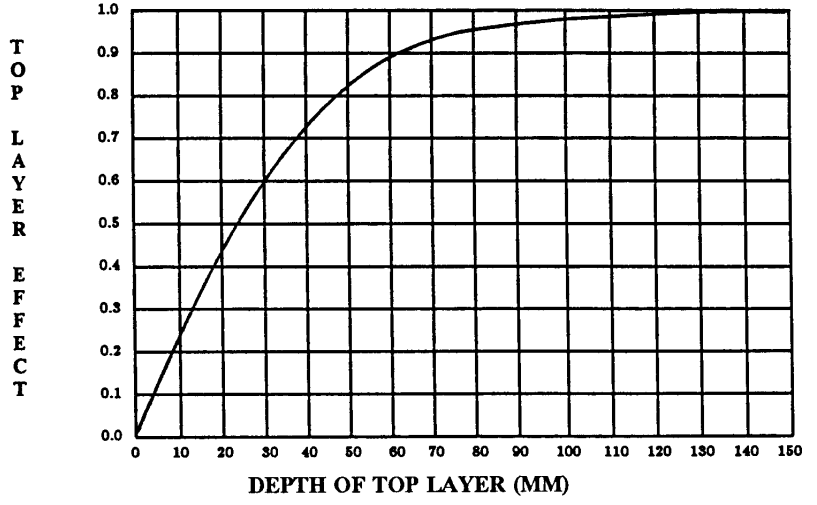


Figure 4. Backscatter Surface Density Effects

(Top Layer Effect Curves)

Moisture

The Model 3430 gauge uses a 40 mCi (1.48 GBq) Americium-241:Beryllium neutron source to measure the hydrogen content (consequently the water content) of the material.

Neutrons emitted by the Am-241:Be source penetrate the material and are *thermalized* (or slowed). *Thermalization* is the process where neutrons are slowed to the point where further collisions with hydrogen or other materials will not continue to slow the neutron.

The Model 3430 gauge contains a helium-3 neutron detector that is sensitive to thermalized neutrons. This detector is insensitive to non-thermalized or "fast" neutrons and, as a result, the counts obtained are directly proportional to the amount of hydrogen/moisture present in the material.

The depth of measurement, or depth at which 98% of the counted neutrons pass before reaching the detector, is a function of moisture content:

$$\textit{Depth (in.)} = 11 - (0.17 \times M), \textit{ where: } M = \textit{moisture in pcf}$$

or

$$\textit{Depth (mm)} = 280 - (0.27 \times M), \textit{ where: } M = \textit{moisture in kg/m}^3$$

Therefore, the higher the moisture content in the material being measured, the smaller the depth of measurement. The normalized curve set shown in Figure 5 on the next page illustrates the effect of moisture content on the depth of measurement.

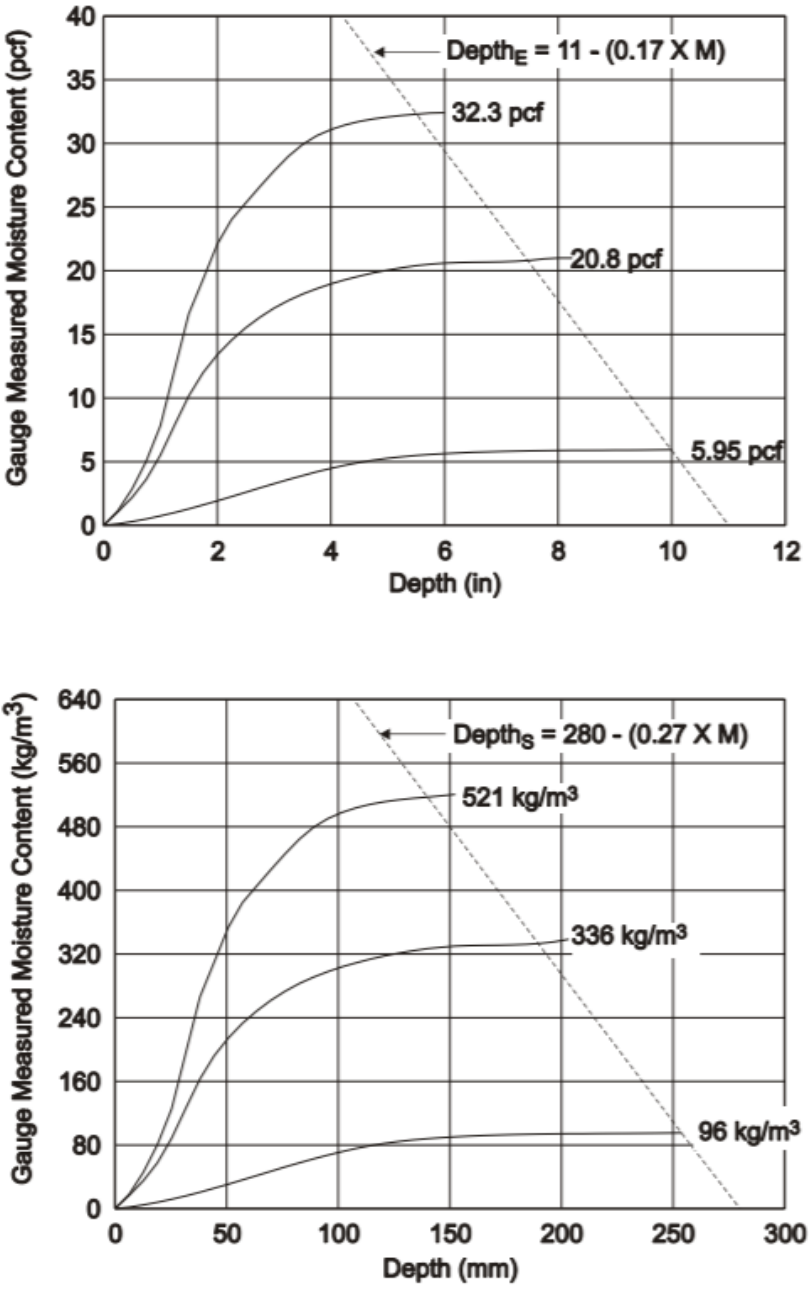


Figure 5. Effect of Moisture on Depth of Measurement

Chapter 3:
Using the Gauge

This chapter covers the following topics and tasks:

- ✓ Basic operation of the Model 3430
- ✓ Initial setup
- ✓ Preparing the test site
- ✓ Taking measurements

The Keypad

The keypad of the Model 3430 Surface Moisture-Density Gauge consists of eleven keys—an eight-function keypad plus the ⟨**YES**⟩, ⟨**NO/ESC**⟩, and ⟨**LIGHT**⟩ keys.

The gauge is equipped with an internal beeper to verify keystrokes. If a *beep* is not heard when a key is pressed, the keystroke was not recognized and should be repeated.

The ⟨**YES**⟩ and ⟨**NO/ESC**⟩ keys are used for responses to specific questions displayed on the screen. The ⟨**LIGHT**⟩ key is used to turn the LCD backlight on and off.

The up and down arrows allow the operator to scroll through various function lists displayed by the gauge.

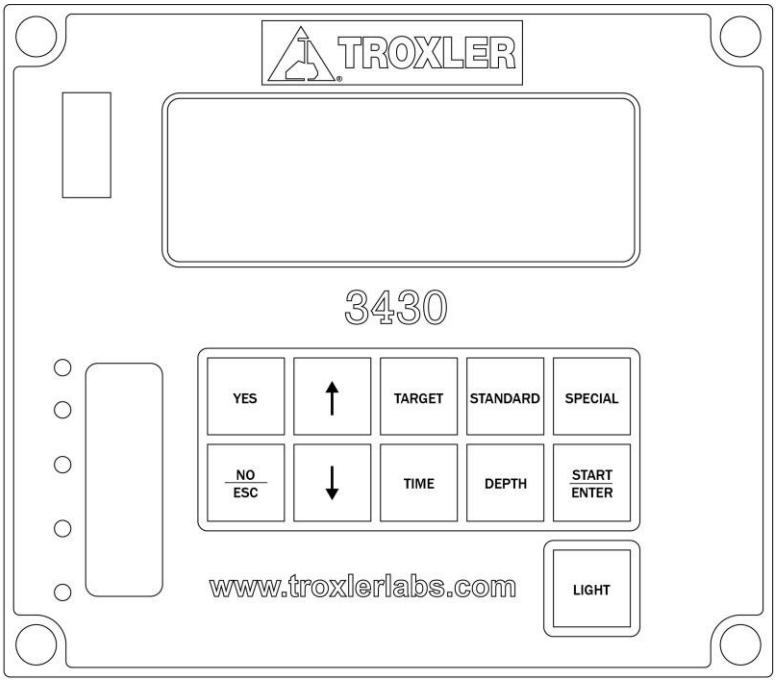


Figure 6. Model 3430 Keypad

Table 1 provides a detailed description of the individual keys.

Table 1. Model 3430 Keypad Functions

KEYS	DESCRIPTION
YES	Answers *Yes* to prompts.
NO **ESC**	Answers *No* to prompts and exits menus without saving changes.
↑	Scrolls the display up.
↓	Scrolls the display down.
TARGET	Allows entering or enabling of a Proctor or Gmb value.
TIME	Allows the operator to change the count time.
STANDARD	Use to access the *Standard Count* mode.
DEPTH	Allows entry of the source rod depth.
SPECIAL	Provides access to the *Special* functions.
START **ENTER**	Starts a measurement or completes answer entry.
LIGHT	Turns on and off the LCD display backlight.

NOTE

The gauge will automatically turn off after five hours if no keys are pressed.

Source Rod Positions

As shown in Figure 7, the source rod can be placed in the **SAFE**, backscatter, or direct transmission positions. When not taking measurements, keep the source rod in the **SAFE** position. When measuring thin layer or other materials through which you cannot drill a hole, use the backscatter position. In the direct transmission positions, the source rod extends into a pre-drilled hole.

Figure 7 shows the available positions of the source rod.

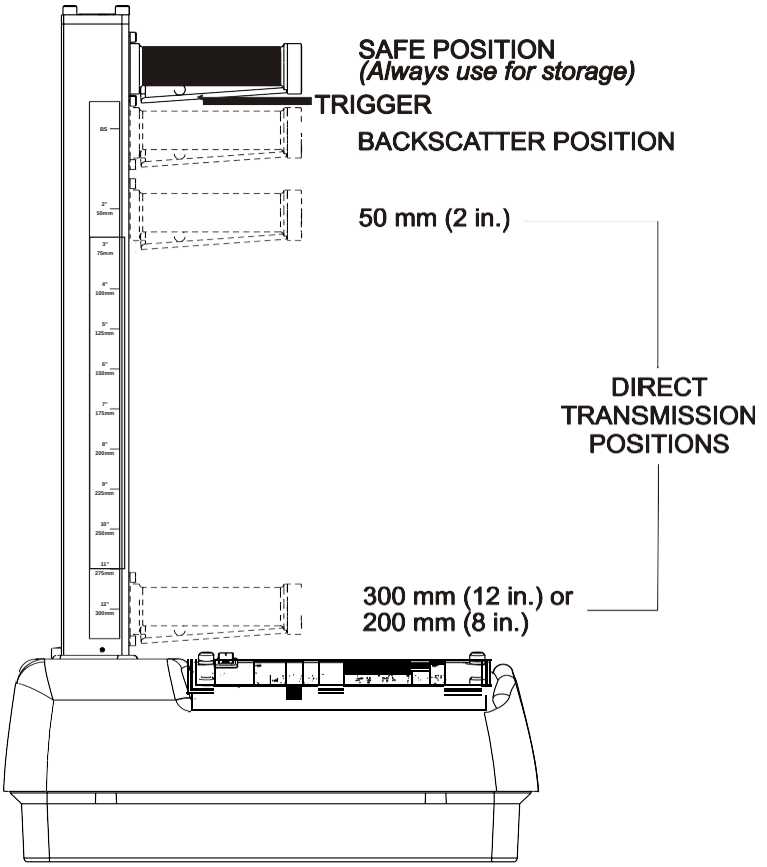


Figure 7. Source Rod Positions

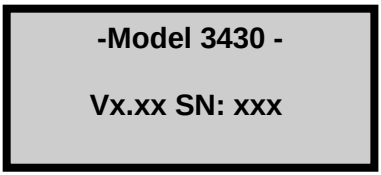
Daily Inspection

The gauge should be inspected daily before use to ensure proper operation of all safety features. Refer to Appendix D for the inspection procedure.

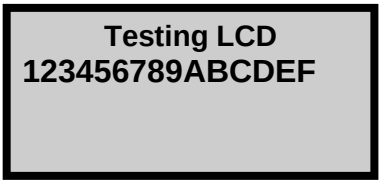
Turning the Gauge On

The gauge uses rechargeable NiMH batteries (included) as a power source. When first turned on, the control panel displays test characters before proceeding to the self-test.

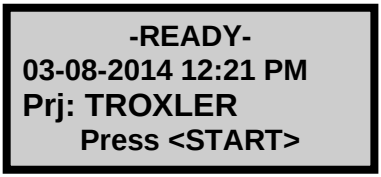
To turn the gauge on, toggle the on/off switch located to the left of the gauge's display. Upon turning the gauge on, the gauge displays:



The gauge then performs a test of its LCD (liquid crystal display):



After the gauge performs a 300-second self-test, the gauge enters the *Ready* mode. In this state any of the gauge functions may be accessed. The *Ready* mode display is:



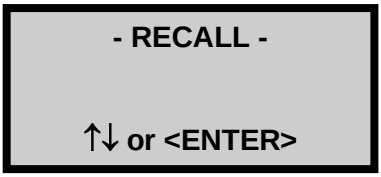
The first line of the display indicates the current *count time*. The second line of the display indicates the selected source rod depth.

Gauge Setup

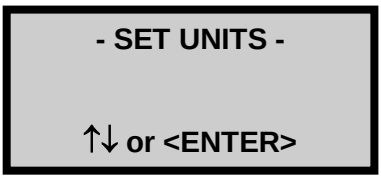
After unpacking the gauge and turning it on, several parameters can be initialized, such as measurement units and count time. These parameters do not usually change once they are set.

Setting Measurement Units

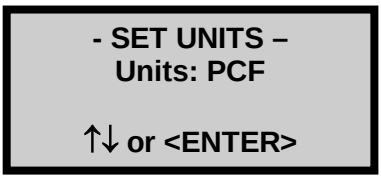
The Model 3430 gauge allows measurement results to be displayed in either metric or US units. To set the measurement units, first access the *Special* function menu by pressing ⟨**SPECIAL**⟩. The gauge displays:



Press the down arrow seven times to display:



To select *Set Units* press ⟨**START/ENTER**⟩.



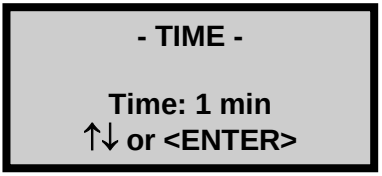
Use the up and down arrows to scroll through the available units. When the desired units are displayed press ⟨**START/ENTER**⟩.

Setting the Count Time

The *count time* defines how long the gauge measures. Longer count times produce better measurement precision. Troxler

recommends a count time of one minute for most sample measurements.

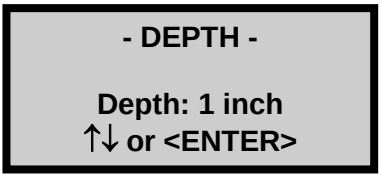
To change the count time, press ⟨**TIME**⟩ to display:



Use the up and down arrows to scroll through the available count times. When the desired count time is displayed press ⟨**START/ENTER**⟩.

Setting the Depth

To change the depth of measurement, press ⟨**DEPTH**⟩.



Use the up and down arrows to scroll through the available measurement depths. When the desired depth is displayed press ⟨**START/ENTER**⟩ to select the displayed depth and return to the *Ready* mode.

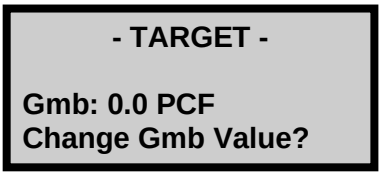
Selecting the Mode (Gmb/Proctor)

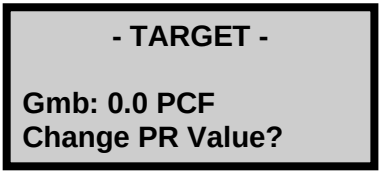
The gauge may be used on construction materials (soils, asphalt, concrete, and so on). To select the *Soil* mode, enter or activate a Proctor value. To select the *Asphalt* mode, enter or activate a Gmb value. Only one Gmb and one Proctor can be stored in the gauge at one time.

NOTE

To measure concrete, use either the Asphalt or Soil mode. For moisture results select the Soil mode. For density measurement only, use the Asphalt mode.

To enter or activate a Gmb or Proctor value, press ⟨**TARGET**⟩. The display will be one of the following:





To switch from a Gmb value to a Proctor value, or vice versa, use the arrow keys.

- To activate the displayed value, press ⟨**NO/ESC**⟩.
- To change the displayed value, press ⟨**YES**⟩. The first digit of the value will flash. Use the arrow keys to scroll through the possible entries (0 – 9) and when the correct value for the current digit is displayed, press ⟨**START/ENTER**⟩. The gauge will proceed to the next digit to the right.

When the value entry is complete, the gauge activates the value and returns to the *Ready* mode.

Taking the Standard Count

The Model 3430 gauge uses a Cesium-137 and an Americium-241:Beryllium source for taking measurements. These radioactive sources undergo a natural decay process, resulting in a gradual loss in the intensity of their radiation. The time required for the source strength to diminish by 50% is referred to as the *half-life*.

To compensate for the source decay and to check proper operation of the gauge, a daily reference *standard count* should be performed. To ensure the highest accuracy possible with the gauge, it is important to take a daily standard count.

The gauge is equipped with a reference standard block for taking the standard count. Place the reference standard block on a dry, flat surface at least 3 m (10 ft.) from any large vertical surface and at least 10 m (33 ft.) from any other radioactive source. The surface should be asphalt, concrete or soil at least 10 cm (4 in.) thick and with a density of at least 1600 kg/m^3 (100 pcf). The right side of the gauge, farthest from the handle, should be against the metal butt plate (see Figure 8).

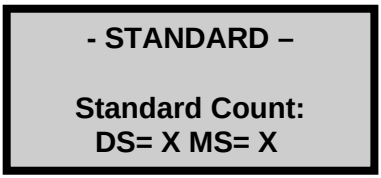
To begin the standard count procedure, press ⟨**STANDARD**⟩.

```
- STANDARD –

DS= 1870 MS= 468
New Std Cnt?
```

To take a new standard count, press ⟨**YES**⟩**.**

```
- STANDARD –

Press START for
Standard Count
```

Ensure that the gauge is positioned as shown in Figure 8. To initiate the standard count press ⟨**START/ENTER**⟩. After the count is complete, the display is:



Troxler recommends that the operator keep a daily log of the moisture and density standard counts (see Appendix E for a sample log you can use). To verify gauge stability, compare the daily standard count to a reliable reference as follows:

- During the first four days of operation of a new or recalibrated gauge, compare the daily standard count to the factory calibrated values.
- After the first four days of operation (or after taking four standard counts), compare the daily standard count to the average of the last four counts. Acceptable standard count limits are:

±1% each day for DS (density standard) and

±2% each day for MS (moisture standard).

After recording the standard counts, press ⟨**YES**⟩ to return to the *Ready* mode.

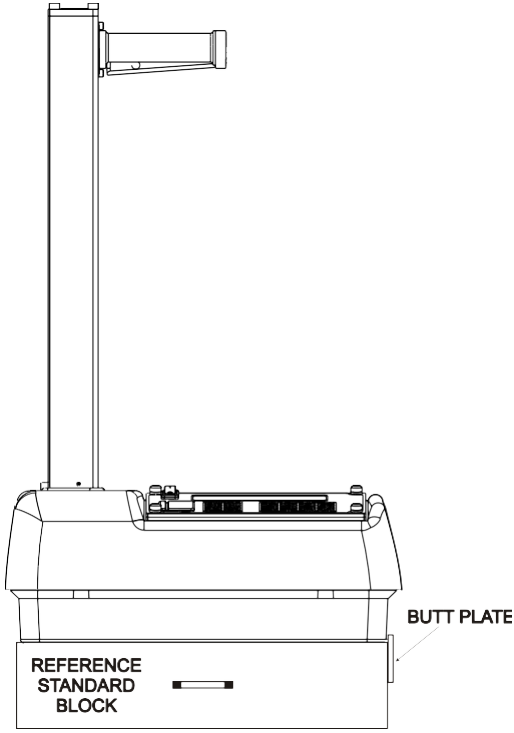


Figure 8. Standard Count Position

Site Preparation

Preparation of the test site surface is critical to gauge performance. This section provides site preparation procedures for both soils and base courses and asphalt surfaces. To ensure the most accurate gauge readings, the appropriate preparation procedure should be followed.

Soil and Base Course Preparation

1. Locate a level site free from any large holes, cracks, or debris (soil surface conditions are critical to accurate measurements).
2. Smooth the surface by moving the scraper plate in a back and forth motion. Filler such as fine sand may be used to fill in the surface voids.

NOTE

Use only enough filler to fill the voids. Too much filler will cause an error in the measurement.

3. For direct transmission measurements, put the drill rod through the extraction tool and then through one of the guides on the plate (see Figure 9).
4. **Wearing a radiation badge and safety glasses (or other locally approved safety devices),** step on the plate and hammer the drill rod at least 50 mm (2 in.) deeper than the desired test depth. The drill rod increments include the additional depth.
5. Remove the drill rod by pulling straight up and twisting the extraction tool. **Do not loosen the drill rod by tapping from side to side with a hammer.** This will distort the hole or cause loose material to fall into the hole.
6. To ensure accurate placement of the gauge, before removing the scraper plate mark the test area using the drill rod as shown in Figure 10.

7. Carefully pick up the scraper plate and place the gauge on the surface prepared by the plate. Insert the source rod into the hole made by the drill rod. **Use care when inserting the source rod; do not to disturb the soil around the hole.**
8. Lower the source rod into the hole. Release the trigger and lock the source rod into the correct position. A *click* should be heard when the source rod is locked into position.
9. Gently slide the gauge toward the keypad so the source rod makes contact with the wall of the hole.

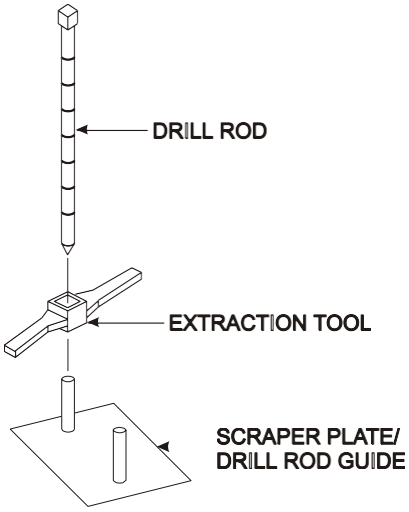


Figure 9. Drill Rod Positioning

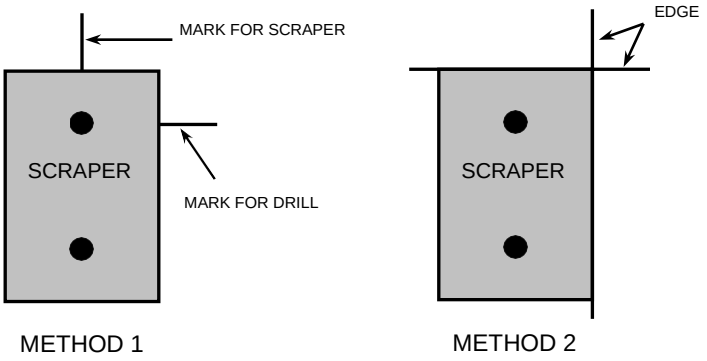


Figure 10. Marking the Test Area

Asphalt Surface Preparation

It is possible, but usually not necessary, to take direct transmission readings on asphalt. Drilling a hole in asphalt can be difficult, and may require the use of a drill (rather than the drill rod) if the asphalt has cooled and hardened.

Under normal conditions, a backscatter reading provides an accurate measurement of asphalt density.

1. Find a smooth location on the asphalt. The operator may want to fill the voids on open mixes with sand or cement. Take care to leave the asphalt exposed. **The gauge base must rest on the asphalt, not the fill material!**
2. Ensure that the gauge does not "rock." It must remain steady. If rocking occurs, find a more suitable test site. If taking a measurement around a core, the gauge may be moved up to a few inches to any side of the hole.

Taking a Measurement – Soil Mode

The *Soil* mode is automatically selected when a Proctor value is enabled (see page 3–8).

⚠ CAUTION

When not taking measurements, always keep the source rod in the **SAFE** position. For added operator safety, the source rod on the gauge automatically retracts to the **SAFE** position when the gauge is lifted by the handle.

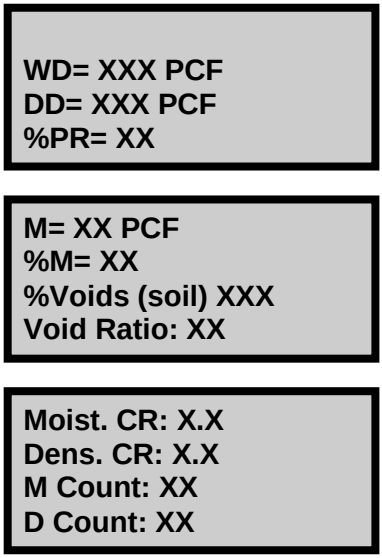
⚠ Warning

Do not store or transport the gauge unless the sliding block is completely closed. Increased radiation levels may violate transportation regulations and cause excessive personnel exposure.

Place the gauge on the test site. Release the gauge handle and push it down until it is in the correct position. Ensure that the handle stops in the notch designated for the proper measurement depth.

Press ⟨**START/ENTER**⟩**.**

After the count time has elapsed, the gauge displays the measurement results in a series of three screens, as follows. Use the up and down arrows to scroll through the various screens.



where:

WD = Wet density in kg/m^3 or pcf

DD = Dry density in kg/m^3 or pcf

%PR = Percent Proctor (This value is valid only if an appropriate target has been entered for the material being tested.)

MOIST = Moisture value in kg/m^3 or pcf

% MOIST = Percent moisture

Void Ratio = See description below

Moist. CR = Moisture count ratio

Dens. CR = Density count ratio

M Count = Moisture counts as read by the gauge

D Count = Density counts as read by the gauge

Press ⟨**START/ENTER**⟩ to return to the *Ready* mode.

Figure 11 illustrates the terms *void ratio* and *% air voids*. The *void ratio* is the ratio of the volume occupied by air and water in the soil to the volume occupied by solid particles. The term *% air voids* refers to the volume of air voids only as a percentage of the total volume.

The following formulas are used to calculate the *% air voids* and *void ratio* values.

% AIR VOIDS = 100 (1 – (Vs/Vt) – (Vw/Vt))

where:

Vs = Volume of Soil

Vt = Total Volume

Vw = Volume of Water

or,

% AIR VOIDS = 100 (1 – (DD / SG(Dw)) – (M / (Dw)))

where:

Dw = Density of Water

SG = Specific Gravity of Soil Particles

DD = Dry Density

M = Moisture

***VOID RATIO* = Volume of Voids / Volume of Soil**

= *(SG(Dw) – DD) / DD*

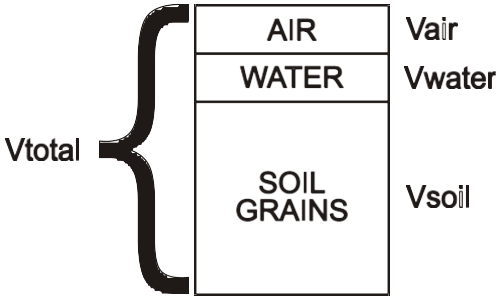


Figure 11. Voids Illustration

Taking a Measurement – Asphalt Mode

The *Asphalt* mode is automatically selected when a Gmb value is enabled (see page 3–8).

⚠ Warning

Do not store or transport the gauge unless the sliding block is completely closed. Increased radiation levels may violate transportation regulations and cause excessive personnel exposure.

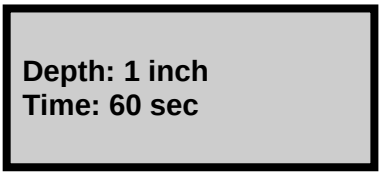
⚠ CAUTION

When not taking measurements, always keep the source rod in the **SAFE** position. For added operator safety, the source rod on the gauge automatically retracts to the **SAFE** position when the gauge is picked up by the handle.

⚠ CAUTION

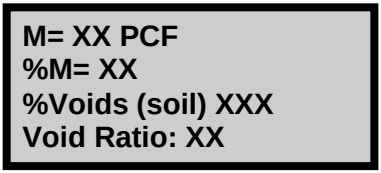
The Model 3430 gauge is not waterproof. Please do not use it in the rain. If the gauge gets wet, make sure it is completely dry before sealing it in the case for storage. See page A-2 for an explanation.

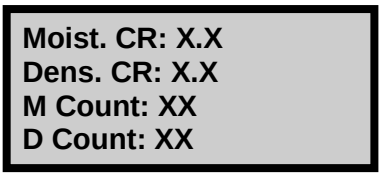
1. Place the gauge on the test site.
2. Release the gauge handle and push it into the backscatter position. Ensure that the handle is securely seated by gently tapping the handle down. Do not pass the notch.
3. Set the depth to *Backscatter* (1 inch) using the arrows on the keypad.
4. Press ⟨**START/ENTER**⟩.



After the count time has elapsed, the gauge displays the measurement results in a series of three screens, as follows.

5. Use the up and down arrows to scroll through the various screens.





where:

WD = Wet density in kg/m^3 or pcf

DD = Dry density in kg/m^3 or pcf

%Gmb = Bulk specific gravity

MOIST = Moisture value in kg/m^3 or pcf

% MOIST = Percent moisture

% VOIDS = 100 (1 – WD/VOIDLESS (Gmm))

VOIDS RATIO = Value given by subtracting the percent Gmb value from 100. Applies to soil mode only.

Moist. CR = Moisture count ratio

Dens. CR = Density count ratio

M Count = Moisture counts as read by the gauge

D Count = Density counts as read by the gauge

6. Press ⟨**YES**⟩ to return to the *Ready* mode.

NOTES

Chapter 4: Advanced Gauge Operation

This chapter covers the following topics and tasks:

- ✓ Enabling offsets
- ✓ Taking thin layer measurements

Offsets

The Model 3430 is factory-calibrated for soils, asphalt, and concrete with an approximate density range of 1100 to 2700 kg/m^3 (70 to 170 pcf). With an *offset*, the operator can adjust the gauge readings to correlate to traditional laboratory methods, such as core samples. The Model 3430 gauge provides three offsets: *density*, *moisture*, and *trench*.

NOTE

When an offset has been enabled, all future readings will automatically be adjusted with the offset factor regardless of the test site. It is very important that the operator disable the offset function prior to taking readings on materials that do not require an offset. Offsets are disabled if the gauge is turned off for more than 10 seconds.

Density offsets are common when the material being measured is outside the range of 70 to 170 pcf (1121 to 2723 kg/m^3) or if the material composition varies from average soil/asphalt on which the factory calibration is based.

Moisture offsets are required for accurate measurements if the material to be measured contains elements that can cause the gauge to yield erroneous results. A *negative* offset is required if the material to be measured is high in hydrogenous components such as cement, gypsum, coal, or lime. A *positive* offset is required if the material is high in neutron-absorbing material such as boron or cadmium.

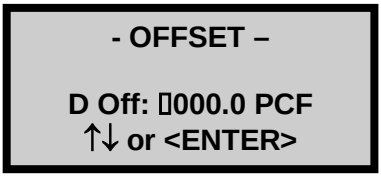
The Model 3430 gauge requires an offset if measurements are to be taken inside a trench or close to vertical structures. Vertical structures can scatter neutrons and gamma photons back to the gauge, increasing the possibility of moisture or density errors due to high counts.

Density Offset

1. To access the *Special* functions, press ⟨**SPECIAL**⟩.
2. Press the down arrow key once to access the *Offset* function. Press ⟨**START/ENTER**⟩ to display:

3. Press ⟨**START/ENTER**⟩.

4. To enable the *Density Offset* function, press ⟨**YES**⟩.



5. Input the difference between the gauge and alternative density readings. To input a minus sign (for a negative offset), press the down arrow first. To scroll through the numerals, press up and down arrows.
6. To select the next digit and/or exit, press ⟨**START/ENTER**⟩. The display will be:

Moisture Offset

Some soils contain hydrogen sources other than water or may contain neutron absorbers. The gauge measures moisture by determining the hydrogen content of the material and relating this to the water content. Because of this, both types of material could cause gauge readings that differ from the true moisture. If measuring such materials, use the moisture offset to adjust the readings.

The offset factor (k) is determined by comparing the moisture content of a laboratory sample with the moisture content determined by a gauge reading.

To determine the offset factor:

1. Take a gauge reading at the site. Record the reading ($\%M_{GAUGE}$).
2. Remove one or more samples from the site and seal the container until it can be dried by lab methods. Calculate the average moisture of the dried laboratory samples and the average of the gauge measurements. These averages should be used for the offset factor calculation.
3. Calculate the offset factor (k).

$$k = \frac{\%M_{LAB} - \%M_{GAUGE}}{100 + \%M_{GAUGE}} \times 1000$$

NOTE

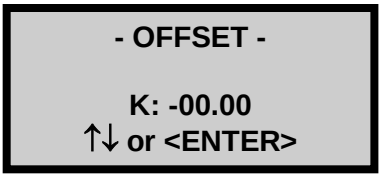
If the k value is negative, enter a minus sign (–) by pressing the down arrow before entering the first digit.

To enter the offset factor in the gauge:

1. Access the *Special* functions by pressing ⟨**SPECIAL**⟩.
2. Press the down arrow key once to access the *Offset* function. Press ⟨**START/ENTER**⟩ to display:

3. To enter a moisture offset, press the down arrow once and press ⟨**START/ENTER**⟩.

4. To enable the *Moisture Offset* function, press ⟨**YES**⟩.



The first digit will flash. To input a minus (–) sign (for a negative offset), press the down arrow <u>first</u>.

5. Press the down arrow key to scroll through the possible values for each digit. Select the next digit by pressing ⟨**START/ENTER**⟩. When all digits are entered, the gauge will enable the offset. The display will be:

Trench Offsets

If the gauge is to be used for moisture or density measurements in a trench or within 2 ft. (0.6 m) of a large vertical structure, a trench offset may be required. If used, the trench offset adjusts all moisture measurements but only the density measurements from backscatter through 4 in. (10 cm). Measurements deeper than 10 cm (4 in) do not require the offset.

To perform a trench offset:

1. Take the daily standard count (outside the trench) and record the density standard (*DS*) and moisture standard (*MS*) values.
2. Place the gauge on the reference standard block in the trench the same distance from the wall as the anticipated readings. **Do not take another standard count.**
3. Set the count time to four minutes.
4. With the source rod in the **SAFE** (standard count) position, take a four-minute count. To start the count, press the ⟨**START/ENTER**⟩ key.
5. Record the trench density count (DC_{Trench}) and moisture count (MC_{Trench}.) by scrolling to the third data screen.
6. Subtract the daily standard count values from the trench count values:

   Dens Cnst = (DC_{Trench}) – DS

   Mois Cnst = (MC_{Trench}) – MS

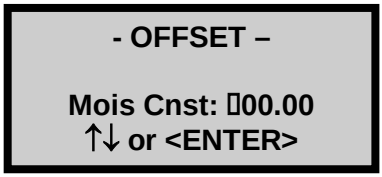
The Dens Cnst and Moist Cnst will be entered as the Trench Offset values.

To enable a trench offset:

1. Press ⟨**SPECIAL**⟩ to access the *Special* functions, then press the down arrow key once to access the *Offset* function. Press ⟨**START/ENTER**⟩ to display:

To enter a trench offset, press the down arrow twice and press ⟨**START/ENTER**⟩.

To enable the *Trench Offset* function, press ⟨**YES**⟩.



The gauge requests the *Mois Cnst* and *Dens Cnst* values determined earlier. The procedure for entering the values is the same as for moisture and density offsets, **ignoring the ± sign on the display.**

When the values are complete, the gauge enables the offset and displays:

Thin Layer Measurements

Conventional backscatter gauges measure density to depths of approximately 4 in. To perform readings on layers of asphalt with thickness of 3.33 in. or less, use the following method (formula):

$$DT = \frac{WD - DB \times K}{1 - K}$$

where:

DT = Overlay wet density

WD = Density read by gauge

DB = Bottom layer wet density

K = Effect of top layer thickness on the gauge- see Table 4-1

To use the above method of overlay measurement, follow the procedure below:

1. Determine the wet density of the bottom layer (underlying material) (*DB*).
2. Apply the thin lift overlay.
3. Determine the thickness of the overlay and select the corresponding (*k*) value from Table 2 on page 4–10.
4. Measure the thin lift overlay density with the gauge in backscatter position (*WD*).
5. Enter all values into the above equation and calculate the overlay density (*DT*).

Example

Given the following values:

Bottom Layer Wet Density (DB) = 135 pcf (2162 kg/m3)

Overlay Thickness = 1.2 in. (30 mm)

K (from Table 4-1) = 0.38235

Density read by gauge (WD) = 142.0 pcf (2275 kg/m3)

$$DT = \frac{142.0 - (135 \times 0.38235)}{1 - 0.38235}$$

$$DT = 146.3 \text{ pcf}$$

or,

$$DT = \frac{2275 - (2162 \times 0.38235)}{1 - 0.38235}$$

$$DT = 2345 \text{ kg/m}^3$$

NOTE

The majority of the backscattered gamma rays reaching the detectors are the result of interactions in the top 3.3 in. (84 mm) of the overlay. In applications where the overlay thickness is greater than 3.3 in. (84 mm), use (0) for the k value or use the actual gauge readings (WD).

Table 2. K Values for Thin Lift Overlays

Thickness (inches)	Thickness (mm)	K
1.0	25	0.46159
	26	0.44787
	27	0.43414
1.1	28	0.42042
	29	0.40138
1.2	30	0.38235
	31	0.36475
	32	0.35889
1.3	33	0.34716
	34	0.33631
	35	0.32547
1.4	36	0.31462
	37	0.29958
1.5	38	0.28454
	39	0.27527
	40	0.26600
1.6	41	0.25673
	42	0.24387
1.7	43	0.23102
	44	0.22310
	45	0.21517
1.8	46	0.20725
	47	0.19626
1.9	48	0.18527
	49	0.17850
	50	0.17172
2.0	51	0.16495
	52	0.15556
2.1	53	0.14617
	54	0.14038

Thickness (inches)	Thickness (mm)	K
	55	0.13459
2.2	56	0.12880
	57	0.12078
2.3	58	0.11275
	59	0.10781
	60	0.10285
2.4	61	0.09790
	62	0.09104
2.5	63	0.08418
	64	0.07995
	65	0.07572
2.6	66	0.07149
	67	0.06562
2.7	68	0.05976
	69	0.05615
	70	0.05253
2.8	71	0.04892
	72	0.04390
2.9	73	0.03889
	74	0.03580
	75	0.03271
3.0	76	0.02962
	77	0.02676
	78	0.02391
3.1	79	0.02105
	80	0.01709
3.2	81	0.01313
	82	0.01069
	83	0.00825
3.3	84	0.00581

Chapter 5: Optional Features & Special Functions

This chapter covers the following topics and tasks:

- ✓ Overview of optional features and special functions
- ✓ Recalling data
- ✓ Performing stat and drift tests
- ✓ Resetting the memory
- ✓ Understanding specific gravity and voidless density
- ✓ Setting the units and calibration constants

Data Storage

The optional data storage feature automatically stores the most recent 100 data records. These data records can be viewed on the screen or transferred to a computer or printer via the serial port or transferred to a storage device or printer via the optional USB port (if installed on the gauge).

To access the stored data, press **<SPECIAL>**, then use the arrow keys to scroll to "DATA OUTPUT" then press **<ENTER>**. There are four menu options under DATA OUPUT. Scroll to select the appropriate option to manage stored data:

- Output Records
- View Data, Erase Data
- Set Output Destination

We recommend that you erase stored data after it is output and saved. This will keep the output files size smaller when downloading data in the future.

Before printing or downloading stored data set the Output Destination:

- Serial Port,
- USB Printer
- Thumb Drive.

USB Port

The optional USB port can be used to transfer data to a mass storage device (thumbdrive) or to a USB printer. To access the menu for the USB port, press <SPECIAL>, then use the arrow keys to scroll to "DATA OUTPUT" and press <ENTER>. Scroll to select Set Output Destination, and then select Thumb Drive for any mass storage device or USB printer for printing the data. Press ENTER. Connect your device to the USB port, then select Output Records and press ENTER.

Remote Start Keypad

If the optional remote start keypad is installed, there will be ⟨**START**⟩ and ⟨**ESC**⟩ keys near the handle (at the top of the triangular extrusion). These keys are used the same way as those on the gauge keypad. ⟨**START**⟩ will begin a reading and ⟨**ESC**⟩ will clear the display and return to the *Ready* screen.

Alkaline Battery for Backup Use

The optional alkaline battery pack can be used when the rechargeable battery is depleted and the gauge cannot be charged. These batteries allow the gauge to run for approximately 50 hours. Note that extra features such as USB port and external beeper will shorten battery life.

To use the back-up battery, open the front panel assembly by loosening the four captive screws on the corners. Lift the front panel and find the switch labeled **Alkaline/Rechargeable**. Toggle the switch to the **Alkaline** position.

When charging the alkaline battery, be sure to toggle the switch back to the **Rechargeable** position or the batteries will not charge.

Languages

The Model 3430 is available in English, French, and Spanish. This option is typically chosen at the time of purchase and enabled at the factory. If you are interested in the Spanish or French software, keypad, and operator's manual, please contact your Troxler representative.

Recall

The *Recall* function displays only the last measurement data. The Model 3430 gauge does not store multiple readings (unless this is purchased as an optional feature). Therefore, this function displays only the most recent measurement data.

To access the *Special* functions press ⟨**SPECIAL**⟩.

To access the *Recall* feature press ⟨**START/ENTER**⟩.

The gauge displays the data from the last measurement. Scroll through the screens using the up and down arrow keys.

Offset

For information on offsetting gauge readings, refer to page 4–2.

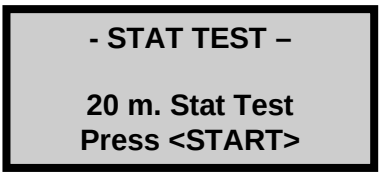
Stat Test

The *statistical stability test*, or *stat test*, may be performed to validate the normal operation of the gauge. Erratic readings or readings that seem to fluctuate may indicate a problem with the gauge. In the event the readings are suspect, a stat test may be executed.

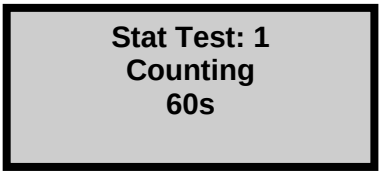
A *stat test* consists of 20 one-minute counts. After the 20 counts, the gauge calculates the standard deviation. This standard deviation is compared to a theoretical standard deviation value. Ideally this ratio should be one. However, the Model 3430 gauge pre-scales (or divides) the counts by 16, resulting in an ideal ratio of 0.25. The acceptable limits for the ratio are from 0.17 to 0.33. The gauge is considered unstable if the ratio is outside these limits.

To perform a stat test:

1. Place the gauge on the reference standard block in the standard count position (see page 3–10).
2. To access the *Special* functions press ⟨**SPECIAL**⟩.
3. To access the *Stat Test* feature press the down arrow twice and then press ⟨**START/ENTER**⟩.

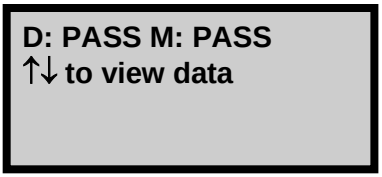


4. To begin the twenty counts, press ⟨**START/ENTER**⟩. Do not disturb the gauge or allow other nuclear sources within 30 ft. (10 m) during the twenty counts.
5. The gauge will display the stat test count progress as shown below.

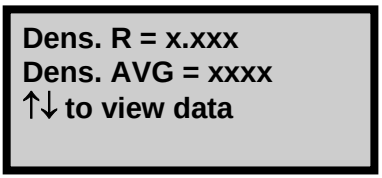


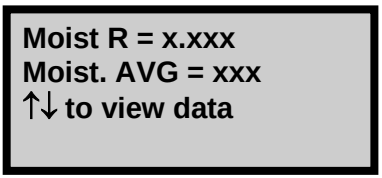
6. Upon completion of the stat test, the gauge displays the pass/fail status. If the stat test fails, repeat the test twice more. If two out of three stat tests fail, contact Troxler Technical Support.

   If the stat test passes, the display is:



To view the stat test data, use the up and down arrow keys.





(Use ↑ & ↓ keys)

Drift Test

If the stat test has already been performed, and passed, but gauge readings seem to drift between tests, the *drift test* can check the long-term drift of the gauge.

A drift test consists of five 4-minute counts taken approximately three to eight hours after completion of a stat test ***with no movement of the gauge between tests***. Pass/fail limits are set using the percent difference between the average of the stat and drift test results. If the percent difference exceeds 0.5% for density or 1% for moisture, the drift test fails.

NOTE

The gauge should not be turned off between the stat test and drift test. The stat test must be current.

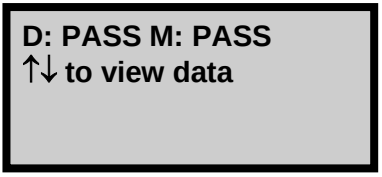
In addition, the gauge must not be moved between the stat and drift tests to eliminate possible failure due to positioning changes.

To perform a drift test:

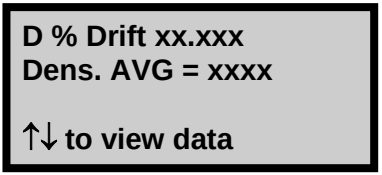
1. With the gauge still in the standard count position (on the reference standard block), press ⟨**SPECIAL**⟩.
2. From the *Special* functions display, select the *Drift Test* feature by pressing the down arrow three times and then press ⟨**START/ENTER**⟩.

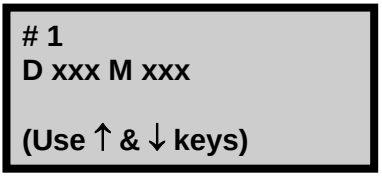
3. To begin the five counts press ⟨**START/ENTER**⟩.
4. The gauge will display the drift test count progress as shown below.

5. As with the stat test, the gauge indicates the count progress during the drift test.
6. After the five counts have been completed, the display is:



7. To view the drift test data, use the up and down arrow keys.



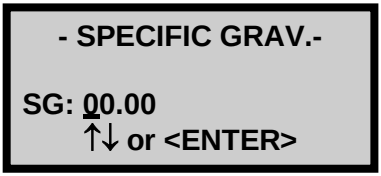


Specific Gravity

The specific gravity of a solid is defined as the density of the material divided by the density of water. The *Specific Gravity* function allows the operator to input the specific gravity of a material into the gauge. This value (*SG*) is used in the calculation of *% Air Voids* and *Void Ratio* (see page **Error! Bookmark not defined.**).

To view or change the specific gravity value:

1. Access the *Special* functions, by pressing ⟨**SPECIAL**⟩.
2. To access the *Specific Gravity* feature, press the down arrow five times and press ⟨**START/ENTER**⟩.



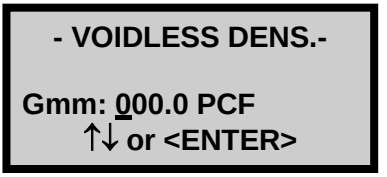
3. To change the value of the flashing digit, use the up and down arrows. To accept the flashing value and select the next digit, press ⟨**START/ENTER**⟩.
4. If a value is not entered, the default value is 2.70, the "typical" specific gravity for soil, but will not apply to all soil types

Voidless Density

The *Voidless Density* function allows the input of the *theoretical* voidless density value of the asphalt material being measured. This value is used in the % Voids calculation.

To view or change the voidless density value:

1. Access the *Special* functions, by pressing ⟨**SPECIAL**⟩.
2. To access the *Voidless Density* feature, press the down arrow six times and press ⟨**START/ENTER**⟩.



To change the value of the flashing digit, use the up and down arrows. To accept the flashing value and select the next digit, press ⟨**START/ENTER**⟩.

Set Units

For information on the *Set Units* feature, see page 3–7.

Memory Reset

This function is protected by a special access code and should only be used with proper authorization from Troxler.

NOTE

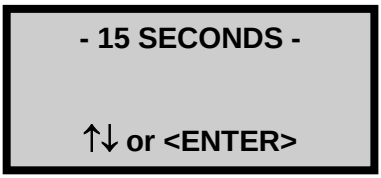
This function is for authorized personnel only!

> ⚠ **CAUTION**
>
> The *Memory Reset* function resets settings to the default values (except calibration constants).

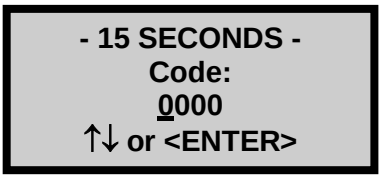
15- Second Inhibit

The *15-Second Inhibit* function enables the gauge owner or operator to disable the 15-second count option. When this function is enabled, the gauge can only conduct one- or four-minute counts.

To disable the 15-second count option, first access the *Special* functions by pressing ⟨**SPECIAL**⟩. Use the up or down arrows to display:

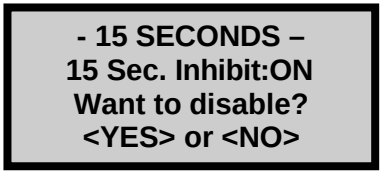


To access the *15-Second Inhibit* function, press ⟨**START/ENTER**⟩.



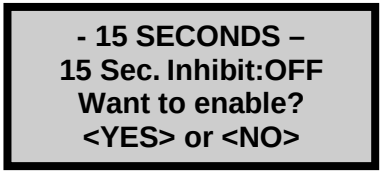
This feature requires the input of the access code found in the front of this manual. Using the up and down arrow keys to select the correct number for the flashing digit, enter the access code. To accept the flashing value and select the next digit, press ⟨**START/ENTER**⟩.

If the 15-second count option is currently enabled, the gauge displays:



Press ⟨**YES**⟩ to disable the 15-second count option. The gauge returns to the *Ready* mode.

If the 15-second count option is currently disabled, the gauge displays:



Press ⟨**YES**⟩ to enable the 15-second count option. The gauge returns to the *Ready* mode.

Battery Status

The *Battery Status* feature shows the voltage left on the rechargeable batteries. When the batteries are fully charged, the battery voltage should be between 6.8 and 7.2 V dc. Charge batteries as described on page A-7.

View Constants

The *View Constants* feature displays the moisture and density constants for the depths for which is the gauge is calibrated.

CLI Status

NOTE

This function is for factory-authorized personnel only.

Appendix A: Maintenance & Troubleshooting

This appendix covers the following topics and tasks:

- ✓ Troubleshooting
- ✓ Maintaining and servicing your gauge
- ✓ Charging the battery
- ✓ Replacement parts list
- ✓ Returning the gauge for service

Troubleshooting

Gauge Fails Standard Counts

Ensure that the source rod opening on the gauge bottom is completely closed or covered by the tungsten sliding block. If any opening is visible, the sliding block should be cleaned by the Radiation Safety Officer as described in Appendix D. If the sliding block still does not close completely, contact the nearest Troxler Service Center.

Ensure that the guidelines for performing the standard count listed on page 3-9 are followed.

Perform the standard count again. If it still fails, contact your nearest Troxler service center or representative.

No Density Readings

The most likely reason for no density readings is an electronic problem, such as a failure of the detector preamplifier.

Also, the gauge may have gotten wet. The Model 3430 and 3440 gauges are not waterproof and should not be used in the rain. If the gauge gets wet make sure it is completely dry before sealing it in the case for storage. If you suspect that moisture may be inside the gauge open the keypad panel and run a fan or hairdryer (on low) in the gauge for 15 minutes to an hour in a clean environment. .

As a precaution, ensure that the tip of the source rod is intact and undamaged. Use a radiation survey meter to check the radiation levels at the surface of the gauge base where the source rod exits (without extending the source rod). A maximum reading of 10-20 mrem/hr is normal, and indicates the source is presentIf the maximum reading is less than 1 mrem/hr or if a survey meter is not available, **perform a visual inspectio**n of the source rod tip as follows to confirm its integrity.

Extend the source rod just far enough to see the source rod tip. The tip should appear flat to slightly rounded and smooth.

Complete the inspection as quickly as possible and stay at least 1 meter from the rod tip to minimize exposure (the dose rate at 1 meter from the unshielded source is about 2.7 mrem/hr).

If the visual inspection indicates that the source rod tip is broken off (source is missing):

1. Immediately contact your Radiation Safety Officer (RSO).
2. Initiate a search for the source starting at the location where the gauge was last used.
3. Report lost or missing radioactive sources to your state or federal radiation control agency in accordance with applicable regulatory requirements.
4. Contact the Troxler Radiation Safety Department for further advice.

Gauge Readings Appear Erratic

1. Ensure that the source rod is properly positioned in the desired measurement position. For backscatter readings, do not allow the source rod to contact the material.
2. Erratic density readings may be caused by a dirty sliding block. Clean the sliding block as instructed in Appendix D and then take readings again.
3. Check the inside of the gauge for moisture. To dry the gauge interior, remove the keypad. If necessary, use a hair dryer (on low heat) to circulate warm air for 15 minutes to 1 hour.
4. Remove any foreign objects from inside the gauge.
5. Ensure the hardware mounting screws are tight and in place.
6. Check count time – a four-minute count will give the highest precision with a repeatability of ±1 pcf.
7. Perform a statistical stability (stat) test.
   - ▶ If test passes, proceed with job.
   - ▶ If test fails, repeat two more times. If test fails two out of three times, contact the nearest Troxler Service Center.

NOTE

To aid in verifying gauge readings, after a gauge has been calibrated, mark a test area on a concrete floor, sidewalk, or equivalent and measure the density (WD). This measurement can then be used as a reference to verify later gauge readings.

Unreadable, XXXX or ++++ is Displayed

1. Check the standard counts in memory. If the standard counts are suspect, perform new standard counts. If counts equal zero for both systems, replace high voltage board. Contact the nearest Troxler Service.
2. Ensure that the measurement depth (depth of the source rod handle) is the same as the depth displayed on the display before starting a measurement.
3. Check gauge for water damage. If the gauge is wet, dry the gauge interior with hairdryer (on low heat) for 15 minutes to 1 hour..
4. Check that the calibration constants are valid.
5. If necessary, perform a statistical stability (stat) test, record the results and contact the nearest Troxler Service Center.

Gauge Turns off after it is Turned On

1. The gauge automatically turns off after five hours if no keys are pressed. Try to turn the gauge on again.
2. The gauge may be wet. Do not turn the gauge on until moisture is removed from gauge interior! Component damage may result.
3. If the battery is below 5.5 volts, recharge or replace the batteries.
4. The front panel assembly may be defective. To test, replace the suspect front panel assembly with a good front panel assembly.

Short Battery Life after Recharging

1. Check that you are using the correct charger.
2. Ensure the charging indicator light (red LED) is illuminated when the gauge is plugged in.
3. NiMH batteries may be charged up to 500 full charge-discharge cycles. The batteries may be reaching end of life cycle - replace. Note that all information stored in the gauge except the calibration constants and the chosen language is lost when the batteries are disconnected.
4. Remove any loose screws or foreign objects from the gauge interior that may cause an electrical short to ground.
5. The AC charger may be defective. Check voltage output of charge with a voltmeter, or use the dc charger to charge the batteries.

Satisfactory Counts, but Results are in Error

- Ensure that the handle is seated in bottom of notch.
- Ensure the measurement depth on the display screen corresponds to the actual source rod handle depth.
- Check to see if an offset (density, moisture, trench or special) is enabled.
- Ensure that the standard counts are correct.
- Check calibration constants.

Possible Malfunction Indicators

Symptom	Possible Malfunction
Batteries discharge prematurely	HV Board
Batteries do not charge	CPU Board, Preamp Board
Battery low indicator does not function correctly	CPU Board
Beeper stops (or is erratic)	CPU Board
Display malfunctions	CPU Board
Display test Fails	CPU Board
Fails stability or drift tests	Preamp board
Gauge does not turn on when charger is connecte	CPU Board
Gauge doesn't turn off	CPU Board
Gauge fails stat or drift tests	HV Board
Gauge fails tube test	Preamp board
Moisture or density counts are unstable	HV Board
No keypad response	CPU Board
No moisture or density counts	Preamp Board, HV Board

Error Messages

The following error messages are not user-serviceable. Contact Troxler Customer Service for more information.

- KEY PAD TEST ERROR!
- GM TUBE TEST ERROR!
- HELIUM TUBE TEST ERROR!
- DISPLAY TEST ERROR!

Battery Charging

With fully charged batteries, the Model 3430 gauge will remain operational for approximately eight weeks under normal (8-hour day) conditions.

If the batteries become discharged, the following message will be displayed on the gauge:

When this display appears, there are a few hours remaining before the battery must be recharged. In an emergency, a 30-minute recharge with the dc or ac charger gives several hours of use. If possible, run the batteries down before recharging.

NOTE

Batteries should not be recharged unless the Battery Low! **indication is displayed!**

Installing and Using Alkaline Batteries

If your Model 3430 gauge is installed with the optional alkaline battery backup (see page 5–3), you can power the gauge using five AA alkaline batteries. To install the batteries:

1. Turn the gauge off.
2. Loosen the four captive screws on the control unit.
3. Carefully lift the control unit from the gauge.
4. Unplug the ribbon cable from the control unit by pushing the levers on either side of the ribbon down.
5. Install five standard AA alkaline batteries into the battery holder.
6. Set the battery select switch to the **ALKALINE** position.
7. Plug the ribbon cable into the control unit.
8. Attach the control unit to the gauge with the four captive screws.

Mechanical Maintenance

The following procedures should be performed to keep the Model 3430 gauge in good working order. If a serious problem with the gauge arises, contact the nearest Troxler Service Center or representative for instructions. For a list of Troxler and authorized Troxler service centers, refer to the front of this manual or visit the Troxler website at www.troxlerlabs.com

⚠ CAUTION

Personnel should wear a dosimeter to monitor radiation exposure while performing maintenance on the gauge if it is required by their radioactive materials license or local regulations.

Cleaning

If the Model 3430 gauge is to provide precise and accurate measurements over a long period of time the gauge should be kept as clean as possible. Monitor the outside surfaces of the instrument for accumulations of dirt, oil, asphalt, or any other foreign matter. If a build-up of material is visible on the gauge base or topshell, use the following procedures for cleaning:

To clean the gauge base, use a putty knife to scrape away any built-up accumulations of soil or asphalt. **Be careful not to damage the gauge base!** After removing any large accumulations, wipe the gauge base with a cloth soaked in BindOff, WD-40 or similar non-corrosive cleaner to remove the remaining debris.

CAUTION

Cleaners and lubricants can damage the keypad. Do not allow these chemicals to make contact with the keypad!

Currently, the Model 3430 gauge topshell is manufactured from an engineering thermoplastic designed specifically to provide

high impact strength and to offer excellent compatibility with many industrial solvents and petrochemicals. The topshell may be cleaned with mild (low alkaline) soap and water. Other approved cleaning substances include methyl, isopropyl, or isobutyl alcohols.

⚠ CAUTION

The use of any unapproved cleaning agents such as methyl-ethyl-ketones, amines, and methylene chloride will damage the topshell and void the warranty.

Source Rod Lubrication

If the source rod does not slide up and down freely, the source rod bearing may require cleaning and lubrication.

- Remove the control panel assembly from the gauge by loosening the four captive screws that secure it to the topshell. Lift the control unit and disconnect the ribbon cable. Set control unit aside.
- Locate the grease fitting at the base of the source rod tower.

NOTE

The vent valve was not installed on earlier gauges. Instead, an Allen-head screw was located beneath the grease fitting. On the gauges, remove the Allen-head screw before applying lubricant to allow the old grease to be ejected. Failure to remove the Allen screw may result in severe mechanical damage to the base assembly.

- Using a standard 16-ounce grease gun loaded with a Magnalube-G cartridge, apply five shots of lubricant or enough to eject all dirty grease until clean grease is visible.
- Re-assemble the gauge. Do not apply more than 6 in-lb torque to the topshell screws.

Gasket Replacement

Four gaskets seal the gauge from moisture, dirt, and debris. Condensation may form inside the gauge if the gauge has been out in extremely wet weather or in high humidity, or if it is used in the heat and stored in an air conditioned building. In this case, remove the topshell and allow the gauge to dry. If necessary, use a hairdryer (on low heat) to remove any built-up moisture. If moisture continues to be a problem or debris is present inside the gauge base, the gaskets may need replacing.

To replace the control panel gasket (P/N 110841), loosen the four screws in the corners of the panel, and remove the panel from the gauge topshell. Use care in removing the panel and disconnecting the ribbon cable. Gently peel the old gasket from the panel and replace with a new gasket. Reconnect the ribbon cable and replace the control panel.

To replace the two post gaskets and the topshell gasket, remove the screws that hold the topshell to the gauge base. Remove the screws from the metal triangle around the base of the triangle extrusion and raise this piece. Then lift the topshell from the base. Gently peel the gaskets away from the topshell and gauge base and replace. Tighten topshell screws to 6 in-lb.

If replacing the post gaskets, slide up and over the source rod handle. A light coating of talcum powder on the inside of the new post gasket will aid in reassembly.

Replacement Parts

This section provides a list for replacing the major parts of the gauge and purchasing accessories. Many parts can be ordered from our e-commerce site at www.troxlerlabs.com.

PART NO.	DESCRIPTION
110899	3430 Gauge Topshell O-ring/Gasket
110013	3430 Bottomplate
110016	3430 Battery Assembly (with case)
110821	3430 Topshell
110848.0040	3430 Nameplate
007158	O-ring for Triangle Tower

Maintenance Supplies

PART NO.	DESCRIPTION
012784	Lubricant, Magnalube-G paste 1.5 oz tube
012786	Lubricant, Magnalube-G paste 1 lb can
012789	Lubricant, Magnalube-G 14.5 oz
100761	Source rod pig
018141	BindOff (1 gallon)

Accessories

PART NO.	DESCRIPTION
110017	3430P/3440 Shipping Case
100421	Drill Rod
102111	Scraper Plate
103680.1000	Extraction Tool
110403	AC Adapter
104156	DC Charger
110990	3430 Operator's Manual
113128	RS-232 Cable
102876.0005	Leak Test Kit (4 units)
109661	TroxAlert Survey Meter
104661.4000	Printer Package

Returning the Gauge for Service

All shipments within the United States to the factory must be accompanied by an RGA (Returned Goods Authorization) number, and a description of the instrument and its problem. Send a completed RGA form, found on the Downloads page at www.troxlerlabs.com, with each item returned for service. This information is used by Troxler shipping and service personnel to expedite the repair work.

To obtain an RGA number, please call or fax the factory or branch office with your request. Please have the following information available when contacting Troxler for an RGA number:

- Is the gauge still under warranty?
- Model and Serial number
- Will estimate be required before performing any work on the gauge?
- Problem or difficulty you are having with the instrument.
- Shipment method to Troxler and for return shipment.
- Shipping and billing address (not P.O. Box): street address and zip code.
- Telephone number and contact (for questions from Troxler).
- Payment method: credit card, account number, or purchase order number. All U.S. government agencies (city, county, state and federal) must send purchase orders.

Appendix B: Specifications

This appendix provides the measurement specifications for Model 3430 gauges.

Measurement Specifications

Density at 2000 kg/m3

Direct Transmission (150 mm)

	.25 min	1 min	4 min
Precision (kg/m^3)	±6.8	±3.40	±1.70
Composition error (kg/m^3)	±20.0	±20.0	±20.0
Surface error (kg/m^3) (100% Void)	–17.0	–17.0	–17.0

Backscatter (98%, 100 mm)

	.25 min	1 min	4 min
Precision (kg/m^3)	±16.0	±8.00	±4.00
Composition error (kg/m^3)	±40.0	±40.0	±40.0
Surface error (kg/m^3) (100% Void)	–75.0	–75.0	–75.0

Moisture at 240 kg/m^3

	.25 min	1 min	4 min
Precision (kg/m^3)	±10.3	±5.1	±2.6
Surface error (kg/m^3) (1.25 mm, 100% void, kg/m^3)	–18.0	–18.0	–18.0

Precision is defined as ±one (1) standard deviation in density readings. This number is calculated by the ratio of the standard deviation in the counting rate and the slope of the calibration curve at a given density.

U.S. Customary Units

Density at 125 PCF

Direct Transmission (6 inches)

	.25 min	1 min	4 min
Precision (pcf)	±0.42	±0.21	±0.11
Composition error (pcf)	±1.25	±1.25	±1.25
Surface error (pcf) (100% Void)	–1.06	–1.06	–1.06

Backscatter (98%, 4 inches)

	.25 min	1 min	4 min
Precision (pcf)	±1.00	±0.50	±0.25
Composition error (pcf)	±2.50	±2.50	±2.50
Surface error (pcf) (100% Void)	–4.68	–4.68	–4.68

Moisture at 15 PCF

	.25 min	1 min	4 min
Precision (pcf)	±0.64	±0.32	±0.16
Surface error (pcf) (0.05 in., 100% void, pcf)	–1.12	–1.12	–1.12

Radiological Specifications

Gamma Source	0.30 GBq (8 mCi) ± 10% Cs-137
Neutron Source	1.48 GBq (40 mCi) ± 10% Am-241:Be
Source Type	Sealed Source – Special Form
Source Housing	Stainless Steel, Encapsulated
Shielding	Lead, Tungsten
Surface Dose Rate	See Radiation Profile on page D-18
Shipping Case	Type A, Yellow II, TI = 0.3

Electrical Specifications

Stored Power	4 ampere hours

Average Current Consumption

Normal	35 mA
With backlight on	140 mA
With GPS on	105 mA
With backlight and GPS on	210 mA

Time Before Automatic Shutdown	5 hours of complete inactivity
Power Source(s):	
Main	5 C NiMH (Rechargeable Pack) batteries

Backup (optional)	5 AA alkaline batteries
Charge Source	12 V dc, 2A
Battery Recharge Time	3 hours maximum, automatic cutoff (may be charged incrementally without damaging the batteries)
Liquid Crystal Display	Alphanumeric, 4 line × 20 character, backlit
Keypad	10-key sealed membrane
Serial Data Format	9600 baud 1 stop bit No parity 8 data bits Xon-Xoff flow control

Gauge-to-PC Computer Cable
(Null Modem Serial Cable, Part Number 113128)

9 pin FEMALE	9 pin FEMALE
Rx (pin 2)	Tx (pin 3)
Tx (pin 3)	Rx (pin 2)
Gnd (pin 5)	Gnd (pin 5)

USB Port (optional)	A list of compatible USB devices is available at the Documents page of Troxler's website (www.troxlerlabs.com)

Mechanical Specifications

Gauge Size (w/ handle)

12-Inch Rod	597 H × 368 L × 229 W mm (23.5 H × 14.5 L × 9 W in.)
8-Inch Rod	495 H × 368 L × 229 W mm (19.5 H × 14.5 L × 9 W in.)
Shipping Case Size	745 H × 419 L × 353 W mm (29.35 H × 16.5 L × 13.88 W in.)
Weight	13.8 kg (30.5 lb.)
Shipping Weight	37.6 kg (83.0 lb.)
Operating Temperature	0 to 70 °C 32 to 158 °F
Max Test Material Surface	175 °C (347 °F) for 15 minutes
Storage Temperature	–55 to 85 °C –67 to 185 °F
Humidity	98% RH, non-condensing

⚠ CAUTION

This instrument contains sensitive electronic and nuclear components. This instrument *must not* be subjected to stress, abuse, or use other than in accordance with the standard operating procedures listed in this manual.

Appendix C: Transporting & Shipping

Devices containing radioactive materials must be transported in accordance with the rules of the U.S. Department of Transportation (DOT) and the International Atomic Energy Agency (IAEA).

The IAEA recommendations have been codified in the International Air Transport Association (IATA) Dangerous Goods Regulations. International customers should consult their local government or licensing authority for applicable regulations.

U.S. Shipping Requirements

The U.S. DOT hazmat regulations (49 CFR, Parts 100–185) apply any time a nuclear device is transported by motor vehicle on a public highway or by other means of transport (rail, air, ship).

The major requirements for transporting a nuclear gauge in the United States are listed below. For more detailed information about these requirements, please refer to the *Troxler Transportation Guide*.

- A copy of the current IAEA Certificate of Competent Authority for each source in the gauge (Special Form Certificate) must be kept on file. Current versions can be downloaded from the Troxler website, www.troxlerlabs.com.
- A copy of the results of the Type A package testing must be kept on file.
- Hazmat employee training records must be kept on file.
- An *Emergency Response Information* document must be in the vehicle and immediately accessible to the driver.
- A properly completed bill of lading must be in the vehicle and immediately accessible to the driver. The shipping papers must include a 24-hr emergency response phone number.
- If shipping by air, a *Shipper's Declaration for Dangerous Goods* must accompany the air waybill.
- The package must be properly marked and labeled in accordance with hazmat regulations.
- The package must have a tamper-evident seal.
- The package must be inspected prior to each shipment.
- The package must be securely blocked and braced in the vehicle to prevent shifting during transport.

Accident Notification Requirements

In the event of a reportable incident involving radioactive material, notify the licensing agency as soon as practical. The operator is also required to notify, at the earliest practical moment, the U.S. DOT at 1-800-424-8802 of an accident that occurs during the course of transportation (including loading, unloading, and temporary storage) in which fire, breakage, spillage, or suspected contamination occurs involving shipment of radioactive materials.

Hazmat Training

The U.S. DOT regulations require every hazmat employer to train, test, certify, and maintain records for each hazmat employee. Hazmat training applies to anyone who transports or prepares for transport radioactive materials. Refresher training is required every three years for shipment / transport by roadway in the US. Shipment by air requires training every 2 years under IATA Dangerous Goods regulations.

Canadian Shipping Requirements

The *Transportation of Dangerous Goods Act and Regulations* (TDG) and *Transport Packaging of Radioactive Materials Regulations* (TPRM) apply any time a nuclear device used in commerce is transported by any means in Canada.

For training and accident notification requirements, consult the *Transportation of Dangerous Goods Regulations*. For further information on transporting a nuclear device, contact the transportation section of the Canadian Nuclear Safety Commission (CNSC).

Appendix D: Radiation Theory & Safety

This appendix is required reading for anyone who will operate the Model 3430 Surface Moisture- Density Gauges.

This appendix covers topics related to radiation theory and the safe operation of the gauge. A brief overview of the regulatory requirements related to the ownership and use of the gauge, as well as a listing of radiation safety-related warnings and cautions, is included.

Radiation Theory

A more detailed discussion of radiological theory can be found in the *Troxler Nuclear Gauge Safety Training Program* manual, provided at the Troxler Safety Class.

Atomic Structure

All matter is made up of atoms. For example, water has two atoms of hydrogen (H) and one atom of oxygen (O), which in chemical notation is written H_2O.

An atom is made up of a dense nucleus, consisting of positively charged protons and uncharged neutrons, surrounded by a cloud of negatively charged electrons. Under normal circumstances, the number of electrons in an atom equals the number of protons. The number of protons in the atom is called the *atomic number* (Z). A chemical element consists of all atoms having the same atomic number.

The number of protons plus neutrons in the nucleus is called the *atomic mass* (A). Atoms of a given chemical element can exist in slightly different variants called *isotopes* that have different atomic masses. For example, carbon-12 (C-12) is non-radioactive and carbon-14 (C-14) is radioactive. Isotopes that are radioactive are termed radioisotopes or radionuclides.

Figure 12 depicts a helium atom consisting of two protons and two neutrons in the nucleus and two orbiting electrons.

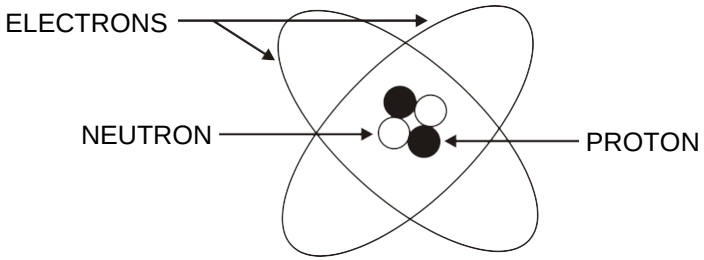


Figure 12. Diagram of an Atom

Radioactivity

Radioactivity is the spontaneous transformation (or disintegration) of an unstable nucleus into a more stable configuration accompanied by the emission of radiation.

The quantity of a radioactive material is measured in terms of the average number of nuclear disintegrations per unit time. The traditional unit of measure for radioactivity (or *activity*) is the *curie* (Ci), which is defined as 3.7×10^{10} disintegrations per second. The activities of the radioactive sources in nuclear gauges are so small that they are typically measured in *millicuries* (mCi), which is one-thousandth of a curie, or *microcuries* (μCi), which is one-millionth of a curie.

In the Standard International (SI) (or *metric*) system, the unit of activity is the *becquerel* (Bq), which equals one disintegration per second. Because the becquerel is such an extremely small unit, the activity of sources in nuclear gauges is normally expressed in *megabecquerel* (MBq), which is one million becquerels, or *gigabecquerel* (GBq), which is one billion Bq.

The radioactivity of a source is not constant, but decreases with time as the source decays. The time it takes for one-half of the original atoms to disintegrate is called the *half-life*. In successive half-lives, the activity decreases to 1/2, 1/4, 1/8 and so on of the initial value. After seven half-lives, less than 1% of the original radioactive atoms remain. Each radioisotope has a characteristic half-life, which can range from seconds to billions of years. The half-lives for the typical radioisotopes used in nuclear gauges are:

Radioisotope	Half-life
Cs-137	30 years
Am-241	432 years

Types of Radiation

The radioactive sources in the gauge produce four types of radiation:

Alpha particles

Beta particles

Gamma rays (photons)

Neutrons

The alpha and beta particles are stopped by the source capsule. Therefore, they present no external hazard to personnel. Only the gamma and neutron radiation from sealed sources contribute to any occupational radiation exposure.

Gamma rays (photons) are a type of electromagnetic radiation, like X rays, radio waves, and visible light. Photons have no mass or electrical charge, and travel at the speed of light. Gamma rays are energetic and penetrating. Dense materials (such as lead, tungsten, and so on) provide the best shielding against gamma radiation.

Neutrons are a form of particulate radiation but, unlike alpha and beta particles, they have no electrical charge. This makes neutron radiation very penetrating. Fast neutrons lose energy primarily by so-called “billiard ball” elastic collisions with the nuclei of low atomic number atoms, especially hydrogen. The best shielding materials for fast neutrons are those with a high hydrogen content, such as water, concrete, and polyethylene.

Radiation Safety

This section discusses the principles of general radiation safety. This information includes specific procedures for operating, inspecting, cleaning, and leak testing the gauge to ensure safe operation.

Radiation Dose

Radiation cannot be detected by any of the human senses (sight, touch, hearing, smell). However, using appropriate instruments and devices, radiation can be detected and measured at levels far below those that significantly affect health.

For purposes of radiation protection, the basic unit of radiation dose is the *rem*. The SI unit is the *sievert* (Sv), where 1 Sv = 100 rem. The rem is a relatively large unit, so often radiation dose is expressed in smaller units called millirem (mrem), where 1 rem = 1000 mrem.

The risk of injury from radiation is generally related to the total radiation dose received over a period of time. It is also related to the dose rate, which is the amount of dose received per unit time. The same amount of radiation received over a long period (months to years) is much less hazardous than if received over a very short period (hours). This has to do with the body's ability to repair cell damage caused by the radiation.

The U.S. Nuclear Regulatory Commission (NRC) has established the following limits on the amount of whole body radiation exposure that individuals may safely receive from licensed radioactive materials.

Type of Individual	Dose Limit
Adult worker	5000 mrem per year
Minor (under 18 years old)	500 mrem per year
Member of the public	100 mrem per year

Limiting Exposure

Under average conditions, an individual working with the gauge will receive less than 200 mrem per year.

A basic principle of radiation protection is that radiation exposure should be kept as far below the limits as is reasonably achievable. This is known as the *ALARA* (as low as reasonable achievable) principle. The three methods for limiting exposure are:

- Time
- Distance
- Shielding

Time

The simplest way to reduce exposure is to minimize the time spent around a radioactive source. If the time spent near a source is cut in half, then the exposure is halved, all other factors remaining constant.

Distance

Distance is another effective means to reduce radiation exposure. A formula known as the *inverse square law* relates the radiation exposure rate to distance (see Figure 13). Doubling the distance from a radiation source reduces the exposure to one-fourth its original value. If the distance is tripled, then the exposure is reduced by a factor of nine, and so on.

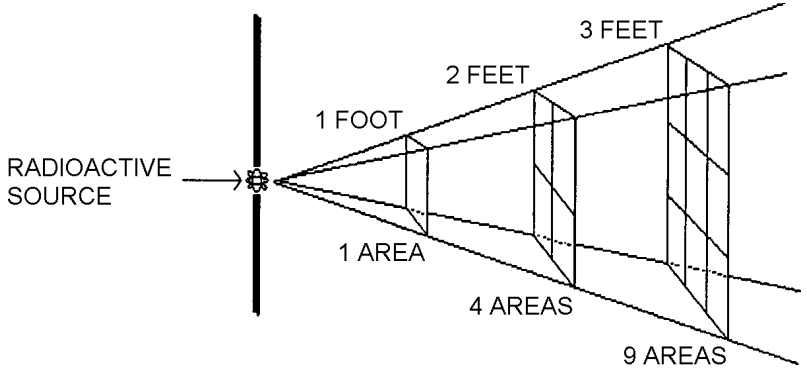


Figure 13. Effect of Distance on Exposure

Shielding

Shielding is any material used to reduce the radiation exposure rate from a radioactive source. The gauge has some built-in shielding, which reduces the exposure rate. When gauges are in storage, additional shielding may be necessary to keep exposure to personnel in adjacent areas below the dose limits for members of the public.

The thickness of any material that reduces the incident radiation intensity by one-half is known as the *half-value layer (HVL)*. The HVL of a material varies with the type and energy of radiation. The HVL values of certain common shielding materials are shown below for gamma and fast neutron radiation.

Material	Cs-137 Gamma Half-Value Layer	Am-241:Be Neutrons Half-Value Layer
Concrete	1.9 in.	4.3 in.
Lead	0.3 in.	*

* Lead does not provide any effective shielding of fast neutrons.

Personnel Monitoring

In the United States, anyone working with or near radioactive materials is subject to occupational dose limits. Individual monitoring of each authorized user is recommended in order to demonstrate compliance with these dose limits.

The most common types of individual monitoring devices used by licensees are film badges and thermoluminescent dosimeter (TLD) badges. Film badges are typically exchanged and processed monthly due to concerns about film fading. TLD badges are usually exchanged quarterly. Troxler offers NVLAP-certified personnel monitoring services using TLD badges.

In Canada, nuclear gauge users are not normally classified as Atomic Radiation Workers. In such cases, the general public dose limit of 500 mrem/year applies. Users may not be required to wear a dosimeter. To establish the personnel monitoring requirements for your application, consult the conditions of your radioisotope license and the CNSC regulatory document *R91: Monitoring and Dose Recording for the Individual*.

Source Encapsulation

The neutron (americium-241:beryllium in the Model 3430 and photon (cesium-137) source materials are welded inside stainless steel capsules. These sealed sources meet U.S. and international regulatory requirements for classification as "Special Form" radioactive material for purposes of transportation. The sealed sources are designed to prevent leakage of radioactive material under severe accident conditions. They are also designed to comply with applicable ANSI classification requirements for sealed sources used in portable gauges.

Source Rod Inspection

To ensure the integrity of the source rod, Troxler recommends that a qualified Troxler service person inspect the gauge and the source rod at least once every five years. This inspection includes checking for excessive wear, corrosion, or damage that could affect the safety of gauge operation.

However, as a precaution if the gauge is ever damaged or dropped, ensure that the tip of the source rod is intact and undamaged (that is, ensure that the source is not missing) as described on page A-2 – A-3.

Contact the Troxler Radiation Safety Department for further advice.

Daily Inspection

The gauge should be inspected daily before use to ensure proper operation of all safety features as follows:

- The source rod opening in the bottom of the gauge is equipped with a spring-loaded tungsten sliding block that shuts when the source rod is in the **SAFE** (shielded) position. To check the operation of the sliding block, push the source rod down into the backscatter position (see Figure on page 3–4), and then raise it back to the **SAFE** position. You should hear a *click* as the sliding block snaps shut. Turn the gauge over and verify that the sliding block is completely shut. If any portion of the opening is uncovered, the sliding block should be cleaned before using, transporting, or storing the gauge. Refer to page D–10 for instructions on cleaning the tungsten sliding block.

⚠ WARNING

Do not store or transport the gauge unless the sliding block is closed. Increased radiation levels may cause excessive personnel radiation exposure and may violate transportation regulations.

If a radiation survey instrument is available, verify that the radioactive gamma source is in place by measuring the exposure rate at the surface of the gauge. The exposure rate should be approximately 10 – 20 mrem per hour. A reading of about 1 mrem or less indicates either that the survey instrument is not working properly or that the cesium-137 source may be missing. Refer to the *Troubleshooting* section of Appendix A for further instructions.

Cleaning the Tungsten Sliding Block

If the tungsten sliding block is not kept clean, it may stick partially or completely open when the source rod is raised to the **SAFE** (shielded) position. This will result in high radiation levels near or in line with the source rod opening on the bottom of the gauge. After cleaning and reassembling the gauge as described below, check the operation of the sliding block by pushing the source rod into the backscatter position, then returning it to the **SAFE** position. You should hear a *click* as the sliding block snaps shut. Inspect the opening on the base of the gauge to confirm that the sliding block is closed. If not, check that the sliding block spring was properly installed after cleaning. If the sliding block still does not close properly, immediately contact the nearest Troxler Service Center. For a list of Troxler and authorized Troxler service centers, refer to the front of this manual or visit the Troxler website at www.troxlerlabs.com/services.

⚠ WARNING

Do not store or transport the gauge unless the sliding block is closed. Increased radiation levels may violate transportation regulations and may cause excessive personnel radiation exposure.

The tungsten sliding block may require cleaning if the source rod becomes difficult to lower into the “measure” position, or if a *click* is not heard when the source rod is raised to the **SAFE** (shielded) position. An improperly operating sliding block may

also result in erratic or incorrect density readings and increased radiation levels.

> **⚠ WARNING**
>
> **Removal of the sliding block results in dose rates of up to one rem per hour in the path of the beam. Stand clear of the gauge bottom while performing this procedure and proceed as quickly as possible while working in the cavity to minimize exposure to your extremities.**

9. With the source rod in the **SAFE** (shielded) position, place the gauge on its side.
10. Clean the heads of the four corner screws that hold the bottom plate to the gauge base (see Figure 14). Using a Phillips screwdriver, remove the four screws in the corner of the plate and remove the plate.
11. To reduce radiological exposure, stand to one side of the gauge. Paying close attention to the position of the sliding block, remove the block.
12. Using a stiff brush or rag soaked in alcohol, clean the sliding block and the cavity.
13. Re-install the sliding block with the angled side up. Apply a light coating of Magnalube-G paste to the **top angled** surface of the sliding block.
14. Re-install the bottom plate. Do not over-tighten screws! Ensure that the source rod moves up and down freely.

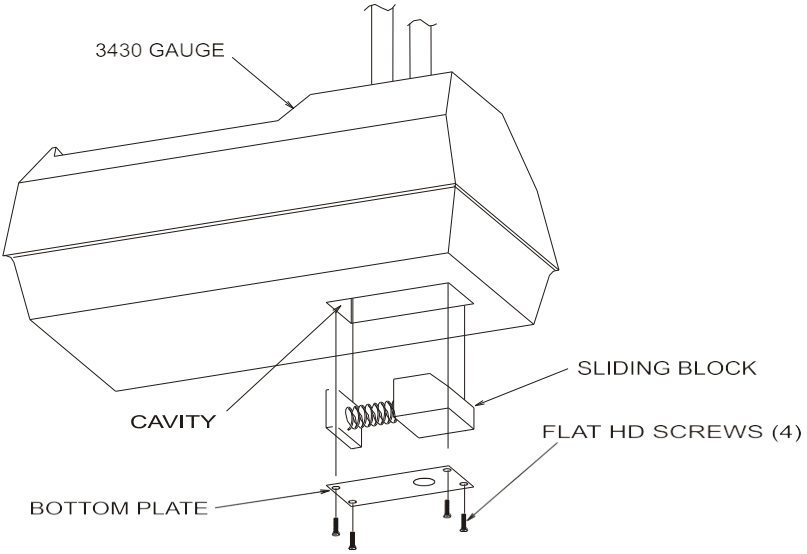


Figure 14. Cleaning the Tungsten Sliding Block

Leak Testing

Unless specified otherwise by your license or state regulations, the gauge must be leak tested at intervals not exceeding 12 months to ensure the integrity of the radioactive source encapsulation. Sample analysis must be performed by a licensed laboratory only.

Using the Troxler Model 3880 Leak Test Kit (PN 102868) and accompanying instructions, perform the following procedure:

⚠WARNING

Ensure that the source rod is in the SAFE position (see Figure 7 on page 3–4).

1. Write the date, gauge model number, and serial number on the sample form and label.

2. Remove the control panel from the gauge topshell. Locate the yellow radiation label on the top surface of the base.
3. Holding the wipe disk with the tongs, wipe the radiation label.
4. Turn the gauge on its side and locate the opening where the source rod extends through the gauge base.
5. Holding the wipe disk with tongs, wipe the area around and inside the opening where the source rod extends from the gauge base.
6. Pack the disk, as instructed, in the envelope and mail to Troxler Electronic Laboratories, Inc. for analysis.
7. Secure the gauge properly.

Regulatory Requirements

This section summarizes the licensing and training requirements that pertain to ownership or operation of a nuclear gauge. This section also provides information on the proper disposal of the gauge, as well as emergency procedures to follow if the gauge is lost, stolen, or damaged.

Licensing

In the United States, possession and use of the radioactive materials in a nuclear gauge require a license issued by the U.S. Nuclear Regulatory Commission (NRC) or an Agreement State licensing agency. Detailed information on obtaining a license is contained in the *Troxler Licensing Guide*. Copies of this guide are available from Troxler, or can be downloaded from the Troxler website, www.troxlerlabs.com.

To purchase a nuclear gauge in Canada, an owner must obtain a radioisotope license from the Canadian Nuclear Safety Commission (CNSC). The owner should obtain copies of the CNSC Regulations and the Transportation of Dangerous Goods Act and Regulations. For other countries, please consult your local regulatory agency.

Training

In the United States, anyone working with or near radioactive materials must complete a radiation safety training course to be designated an *authorized user*. Authorized users must be trained in the precautions and procedures to minimize radiation exposure; applicable regulatory requirements; and the operating, emergency, maintenance, and transportation procedures for the gauge. Troxler offers training classes designed to meet regulatory agency training requirements for nuclear gauge users.

Disposal

A nuclear gauge contains licensed radioactive material. At the end of a gauge's service life, it must not be discarded as ordinary trash, recycled as scrap material, or abandoned. Instead, a nuclear gauge must be transferred to an authorized recipient licensed by the NRC or an Agreement State. For further information on gauge disposal, contact Troxler.

Emergency Procedures

If the nuclear gauge is lost or stolen, then immediately notify the gauge owner's Radiation Safety Officer (RSO).

The gauge owner should complete the emergency contact information on the lines furnished below. (Note that company refers to the gauge owner's company, not Troxler Electronic Laboratories.) This information should be readily available to the gauge operator at all times.

The company RSO is _____

Call the RSO at _____

The regulatory agency is _____

Call the agency at _____

If a gauge is damaged, then follow the steps below:

1. Locate the gauge and/or sources.
2. Do not touch or move the gauge.
3. Immediately rope off an area around the nuclear gauge and/or sources. A radius of 15 ft. (5 m) is sufficient. Do not leave the area unattended.
4. Keep all unauthorized personnel from the nuclear gauge.
5. If a vehicle is involved, it must be stopped until the extent of contamination, if any, can be established.

6. The gauge user should perform a visual inspection of the nuclear gauge to determine if the source housing or shielding has been damaged.
7. Use a survey meter (such as the TroxAlert Survey Meter) to measure the dose rate at a distance of 1 m (3 ft.) from the gauge.
8. Contact the company RSO (name and number given at the beginning of this section). Provide the RSO with the following:
    a. The date, time, and location of the accident
    b. The gauge model and serial number
    c. The nature of the accident
    d. The location and condition of the gauge and/or source
    e. The dose rate at 1 m (3 ft.) from the gauge
9. If you are unable to reach the RSO, then call your regulatory agency (name and number given at the beginning of this section).
10. Follow the instructions of the RSO. The RSO may need to report the incident to the regulatory agency. The RSO may also be required to notify the USDOT of accidents during transport.
11. Before shipping a damaged gauge to Troxler, obtain an RGA (Returned Goods Authorization) number from the Troxler Customer Service Department, as described in the *Returning the Gauge for Service* section on page C–14.

Gauge Use Precautions

The following precautions should be observed when transporting, storing, maintaining, or operating the gauge.

- Never touch the unshielded tip of the source rod with your bare hands. The dose rates on contact with the source rod tip can result in exposures exceeding the annual dose limits to the skin of the extremities within a short time period (about 1 hour).
- When not taking readings, always keep the source rod in the **SAFE** (shielded) position. For added user safety, the source rod automatically retracts to the **SAFE** position when the gauge is lifted by the handle.
- If you do not hear a *click* when the gauge is raised to the **SAFE** position, look at the bottom of the gauge to verify that the tungsten sliding block is completely closed. If the gauge base opening is not completely closed by the sliding block, the sliding block may require cleaning. Refer to page A–10 for cleaning instructions.
- Do not store or transport the gauge unless the sliding block is completely closed. Increased radiation levels may cause excessive personnel radiation exposure and may violate transportation regulations.
- When preparing a test site, use the drill rod assembly to drill the test hole. Under no circumstances should the source rod of the gauge be used to drill holes.
- Do not tamper with or modify the gauge. Also, do not remove the sealed source from the gauge. Tampering with or modifying the gauge or removing the sealed source can be dangerous. Such actions are illegal unless authorized by your radioactive materials license.

Radiation Profile

Table 3 shows the radiation profile for the Model 3430 gauge. Each table lists the radiation dose equivalent rates (in mrem/hour) for each side of the gauge and transport case shown in Figure 15.

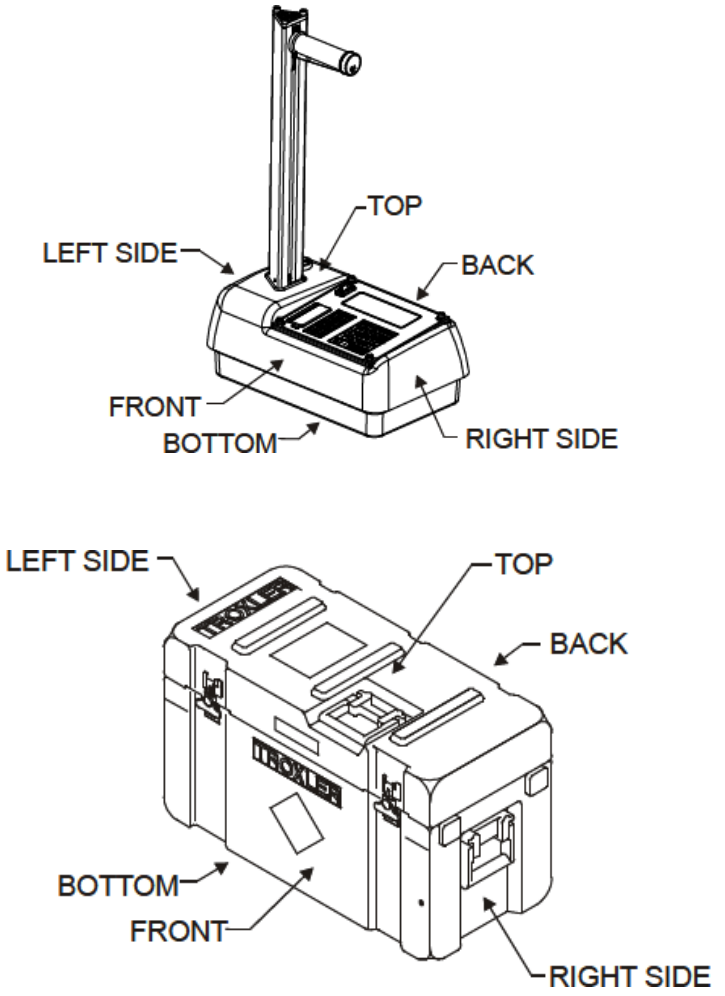


Figure 15. Model 3430 Gauge and Transport Case

Table 3. Radiation Profile for Model 3430 Gauge

(Exposure rate in mrem/hour)

	Surface		5 cm		30 cm		100 cm	
	Gamma	Neutron	Gamma	Neutron	Gamma	Neutron	Gamma	Neutron
GAUGE								
Top	30.0	1.0	20.0	1.0	2.0	0.2	§	§
Bottom	19.0	3.0	9.0	2.0	0.6	0.6	§	§
Left Side	25.0	0.6	10.0	0.4	1.2	0.2	0.2	§
Right Side	8.0	1.2	3.0	0.4	1.0	0.2	0.2	§
Front	16.0	1.0	9.0	0.6	1.7	0.2	0.3	§
Back	25.0	1.0	13.0	0.8	2.0	0.3	0.4	§
GAUGE IN TRANSPORT CASE								
Top	17.0	0.2	8.0	0.2	1.2	§	0.2	§
Bottom	6.0	0.2	4.0	0.2	1.0	0.2	0.4	§
Left Side	1.0	§	0.8	§	0.3	§	§	§
Right Side	9.0	2.0	4.0	1.6	0.5	1.0	§	§
Front	9.0	0.4	6.5	0.2	2.0	§	0.2	§
Back	7.0	0.2	5.0	0.2	2.0	§	0.2	§

NOTES:

1. Radiation measurements were of a gauge containing a nominal 8 milli Curies Cesium-137 gamma source and a nominal 40 milli Curies Americium-241: Beryllium neutron source.
2. Gamma measurements were taken with a Bicron Micro Rem survey meter, Serial Number B464Y calibrated in January 2011.
3. Neutron measurements were taken with a Ludlum Model 12-4 survey meter, Serial Number 140077 calibrated in September 2011.
4. The symbol § denotes a radiation measurement of less than 0.2 milli rem per hour.
5. Measurement position nomenclature for the gauge and transport case is shown in Figures 1 and 2.
6. Orientation of the gauge in the transport case is as follows:
   a. Back of the gauge to the front of the case
   b. Bottom of the gauge to the right side of the case, and
   c. Top of the gauge to the left side of the case.

Appendix E: Standard Count Log

Use the form in this appendix as a guide when recording the daily standard counts. To verify gauge stability, compare the daily standard count to the average of the last four recorded standard counts.

STANDARD COUNT LOG

Gauge Serial Number _____

Date	MS	DS

Date	MS	DS

INDEX

TROXLER ELECTRONIC LABORATORIES, INC.

LIMITED WARRANTY

TROXLER ELECTRONIC LABORATORIES, INC., and subsidiary, TROXLER INTERNATIONAL, LTD., hereinafter referred to as "TROXLER," warrants this instrument, Model_____, Serial Number_____, against defects in material and workmanship for a period of twelve (12) months from date of shipment. For products sold through authorized TROXLER representatives, the date of shipment will be as of the transfer from representative to purchaser. During the applicable warranty period, TROXLER's obligation under this warranty shall be limited exclusively to the repair at a TROXLER facility at no charge, except for shipping to and from TROXLER'S plant, of any instrument which may prove defective under normal use and which TROXLER's examination shall disclose to its satisfaction to be thus defective. Normal use is defined for the purpose of this warranty as operation under normal load, usage, and conditions with proper care and maintenance and competent supervision. In no event shall TROXLER be held liable for damages, delays, or losses consequential, incidental, or otherwise attributable to the failure of this instrument. TROXLER's liability being specifically limited to repair as stated hereinabove. This warranty is automatically initiated except where modified by contractual or other written and signed agreement.

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TROXLER ELECTRONIC LABORATORIES, INC.
3008 E. Cornwallis Road
Post Office Box 12057
Research Triangle Park, NC 27709 USA

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Any disclaimer or limitation on the remedies expressed above shall not be effective to the extent prohibited by state or federal law.

NOTE: THIS WARRANTY EXCLUDES DAMAGE INCURRED IN SHIPMENT. IF THIS INSTRUMENT IS RECEIVED IN DAMAGED CONDITION, THE CARRIER SHOULD BE CONTACTED IMMEDIATELY. ALL CLAIMS FOR DAMAGE IN TRANSIT SHOULD BE FILED WITH THE CARRIER. IF REQUESTED, TROXLER WILL AID IN FILING OF CLAIMS AND/OR LOCATING PRODUCTS LOST IN TRANSIT.