

# **Manual of Operation and Instruction**

## **Model 4640-B**

# **Thin Layer Density Gauge**



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## **SAFETY ALERT SYMBOL**

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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.



# **TROXLER SERVICE CENTERS**

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## **NOTE**

**To locate an independent, Troxler-authorized service center near you, call 1.877.TROXLER (1.877.876.9537).**

## HOW TO USE THIS MANUAL

Congratulations on the purchase of the **Troxler Model 4640-B Thin Layer Density Gauge**. Take a few minutes to read this short overview before using the gauge to obtain a better idea of where to find gauge information quickly.

This manual is organized into six chapters and six appendices. The chapters describe the theory of operation and all the operations of the gauge. The appendices include information on radiation theory and safety, gauge specifications, troubleshooting and maintenance, shipping, unit conversion, and printing (uploading) data to a computer.

The *Model 4640-B Maintenance and Service Information* manual (PN 105280) is available for those users who will perform service and calibration functions on the Model 4640-B gauge.

# CONVENTIONS USED IN THIS MANUAL

Throughout this manual, symbols and special formatting are used to reveal the purpose of the text as follows:

## WARNING

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

## CAUTION

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

## NOTE

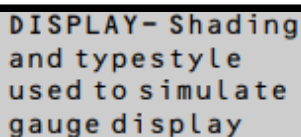
Indicates important information that must be read to ensure proper operation.

### <KEY>

Angle brackets and a different typestyle indicate a key or character (number or letter) to press on the gauge keypad. For example, “Press <YES>” means to press the key labeled *YES*.

### DISPLAY

A different typestyle is used in text to indicate information or messages displayed on the gauge.



DISPLAY- Shading  
and typestyle  
used to simulate  
gauge display

- ◆ Diamonds indicate a list of things needed (such as equipment) or things to know.
- ✓ Check marks indicate the performance of an action. With lists of check marks, follow the instructions in the order of the check marks.
- Triangles indicate that more than one option is available. Carefully select the option that applies.

# EU DECLARATION OF CONFORMITY

Application of Council EMC Directive 89/336/EEC and Low Voltage Directive 72/23/EEC

## Standards to which Conformity is Declared:

EN 61010-1  
EN 55011 Group 1, Class A  
EN 50082-2

An **EMC Technical Report/Certificate** has been issued in accordance with Part IV (Reg 50) of the UK Regulations (SI 1992 No. 2372) by a UK-appointed Competent Body, namely:

Interference Technology International Limited  
41-42 Shrivenham Hundred Business Park  
Shrivenham, Swindon, Wiltshire SN6 8TZ

Certificate Number: C283TRO.1ABS    Dated: 16th January 1997  
Troxler Document Number: 108205

**Manufacturer:**                      Troxler Electronic Laboratories, Inc.  
P.O. Box 12057, 3008 Cornwallis Road  
Research Triangle Park, North Carolina  
27709 U.S.A.

**Apparatus:**                            Model 4640-B Thin Layer Density Gauge

**Year of Declaration:**            1997 (Original)  
2006 (Corrected)

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## **ATTENTION GAUGE OWNER**

*This gauge contains functions that require an ACCESS CODE. This code must be entered before these functions may be used.*

*For more information on using the access code, see Chapter 6.*

**The ACCESS CODE for this gauge is:**

**5888**

*This page should be removed if the access code is not to be distributed to other parties or users of this gauge.*

# NOTES

<b>CHAPTER 1</b>
<b>GENERAL INFORMATION</b>

This chapter provides the user with a brief overview of the Model 4640-B Thin Layer Density Gauge’s many features and capabilities. The user can also find information on storage site selection in this chapter.

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# INTRODUCTION

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The Model 4640-B Thin Layer Density Gauge can quickly and precisely determine the density of thin lift asphaltic concrete overlays. The 4640-B determines the density of thin lift asphalt overlays using backscatter gamma radiation technology. A patented system with G-M detectors in the gauge base detects the gamma radiation. A microprocessor converts the counts into a thin layer density reading.

The gauge may be specially calibrated to accommodate many different hot mix asphalt (HMA) mixes with variations in aggregate size and type. The operator-selected depth of measurement assures that the measurement is not influenced by underlying material. Measurements may be obtained in as little as 60 seconds, and up to 750 readings may be stored for later use.

The nuclear method of testing asphalt density has been approved by the American Society of Testing and Materials (ASTM) and the Model 4640-B meets or exceeds all the requirements of *ASTM D-2950-91: Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Method*.

Some information contained in this manual is used in training courses offered by Troxler Electronic Laboratories, Inc., to assist purchasers in obtaining a Radioactive Materials License from the U.S. Nuclear Regulatory Commission (NRC) 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. 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* (TDG). This manual provides a guide to Canadian shipping requirements on page D-4. For other countries, please consult your local regulatory agency.

Owners are encouraged to require study of this manual before allowing anyone to use the gauge. To monitor exposure to radiation, any user of the gauge should wear a dosimeter while operating or cleaning. While no radiation hazard is imposed on operator(s) during normal use, *a potential hazard does exist if improperly used*. The sections of the manual covering radiological 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's organization.** Additional nuclear 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/operator must maintain awareness of current regulations. *The responsibility for compliance ultimately falls on the owner*. An owner in the United States may also wish to purchase and subscribe to Titles 10 and 49 of the *Code of Federal Regulations* (CFR) in addition to applicable local/state regulations.

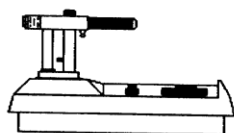


## GAUGE PARTS AND ACCESSORIES

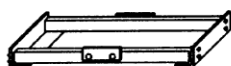
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Figure 1–1 shows the Model 4640-B gauge and its accessories. Use this figure and the list below to identify the gauge and parts as they are unpacked.

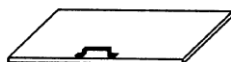
1. The **Gauge** is the portable instrument containing all electronic modules, rechargeable battery packs, detectors, and the radioactive source.
2. The **Air Gap Spacer** is used whenever a reference standard count is taken. The spacer ensures that underlying material does not influence the reference standard count.
3. The **(Magnesium) Reference Block** provides a uniform reference material for gauge adjustment due to such factors as source decay.
4. The **Charger/Adapter** provides a means to recharge the gauge batteries. The charger/adapter for domestic use operates on 120 V ac/60 Hz; the charger/adapter available for use outside the U.S. operates on 120/230 V ac (50/60 Hz). Also included is a 12 V dc charger.
5. The **Transport Case** is a DOT-approved shipping container that may be used for shipping the gauge and accessories.
6. The optional **Serial Printer** connects to the gauge for printing data.
7. The optional **Serial Interface Cable** (not shown) may be used to connect the gauge to a printer or computer.



4640-B  
Thin Layer Density Gauge



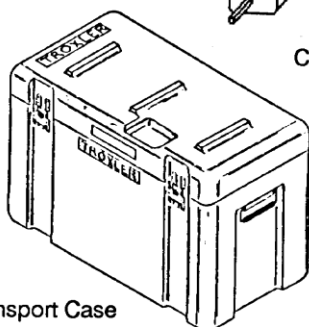
Air Gap Spacer



Reference Block



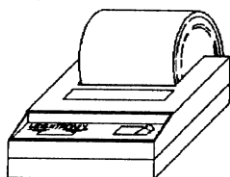
Charger/Adapter



Transport Case



Operator's Manual



Optional Printer

*Figure 1-1. Model 4640-B Parts and Accessories*

# KEYPAD

The 4640-B keypad consists of 22 keys, the 20 keys shown in Figure 1–2 and the **<ON>** and **<OFF>** keys. The gauge is equipped with a “beeper” to verify keystrokes were received by the gauge. If a “beep” is not heard, the keystroke did not register and should be repeated. The **<YES>** and **<NO/CE>** keys are used for responses to specific questions displayed on the screen.

When the gauge provides several options, select the desired option by pressing the corresponding numerical key or highlighting the option using **<YES>** then pressing **<START/ENTER>**.

The **<SHIFT>** key provides access to the functions located above the numeric keys.

Table 1–1 provides a more detailed description of the individual keys and the location in the manual where the functions are described.

<b>YES</b> EXIT	<b>NO/CE</b> C/CE	<b>STATUS</b> <b>7</b>	<b>AVERAGE</b> <b>8</b>	<b>SPECIAL</b> <b>9</b>
<b>STORE</b> MS	<b>THICK</b> MR	<b>PROJECT</b> <b>4</b>	<b>PRINT</b> <b>5</b>	<b>ERASE</b> <b>6</b>
<b>MA/ VOIDLESS</b> +	<b>TIME</b> –	<b>SP. CAL.</b> <b>1</b>	<b>OFFSET</b> <b>2</b>	<b>CALC.</b> <b>3</b>
<b>SHIFT</b> ×	<b>STD</b> +	<b>RECALL</b> <b>0</b>	<b>.</b>	<b>START/ ENTER</b>

Figure 1–2. Model 4640-B Keypad

Table 1–1. Model 4640-B Keypad Functions

KEYS	DESCRIPTION	PAGE
YES Exit	Answers display prompts Exit calculator mode	1–6
NO/CE CE/C	Answer or clear entry Clears calculator entry	1–6
STATUS 7	Displays gauge status	5–2
AVERAGE 8	Average readings	5–3
SPECIAL 9	Special functions	6–1
STORE MS	Store data in memory Calculator memory store	4–3
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PROJECT 4	Enter/view/erase project	4–2
PRINT 5	Print data	4–4
ERASE 6	Erase data	4–6
MA/ VOIDLESS +	Marshall or voidless  Calculator function	3–15
TIME –	Count time interval Calculator function	3–5
SP. CAL. 1	Special calibration	5–5
OFFSET 2	Offset correction	5–8
CALC. 3	Calculator mode	5–9
SHIFT ×	SHIFT function modes Calculator function	5–1
STD ÷	Reference standard count Calculator function	3–9
RECALL 0	Recall data for viewing	5–10
START/ ENTER =	See manual text  Calculator function	

## UNPACKING AND INSPECTION

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Upon receipt of the gauge from the factory, a complete inspection and inventory should be performed. If the shipping case, any other part of the container, and/or the gauge appears to be damaged, notify the carrier and your Troxler Representative **immediately**.

For shipping to another location or back to the factory, save the box and any packing material. For shipping instructions and regulations, please see Appendix D.

Check to see if the following literature and components have been included:

- ◆ Manual of Operation and Instruction
- ◆ Quick Reference Card
- ◆ Gauge Warranty
- ◆ Gauge Certificate
- ◆ Calibration Data Sheet
- ◆ Troxler Regulatory Update (contains required shipping documents)
- ◆ Magnesium Reference Block
- ◆ Air Gap Spacer
- ◆ Charger/Adapter
- ◆ Power Adapter (for cigarette lighter)
- ◆ Keys for Handle Lock

Lift the gauge from the case and inspect the outside surface for damage. Check the lock on the source rod handle and make sure the keys fit. Remove the lock and check the source rod operation. It should move up and down with little effort. Return the gauge to the transport case. Remember to wear a dosimeter while working with the gauge.

## STORAGE SITE SELECTION

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When deciding where to store the gauge, take into consideration the rules governing the storage of low-level radioactive devices that are set forth by your regulatory agency and the conditions of your gauge license.

- ◆ The gauge should be locked in the **SAFE** position (page 3–8) and the gauge stored in its transport case.
- ◆ It is recommended that the gauge and transport case should be stored at least 15 ft (5 m) from full-time work areas, preferably in a locked closet/storage area in a dry location (indoors).
- ◆ The storage area should be marked with a radiation sign that reads “CAUTION RADIOACTIVE MATERIALS” (can be obtained from Troxler).
- ◆ The storage of a nuclear gauge in a motor vehicle is not recommended.

## NOTES

## CHAPTER 2

## THEORY OF OPERATION

This chapter contains a brief description of the 4640-B theory of operation based on backscatter of gamma radiation.

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## THEORY OF OPERATION

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The 4640-B Thin Layer Density Gauge obtains density measurements using backscattered gamma radiation (photons). The photons from an 8 mCi cesium-137 source located in the base of the gauge penetrate the asphalt overlay (see Figure 2–1). The photons collide with the electrons in the material and are either scattered or absorbed. As the density increases, the number of photons scattered back to the detectors decreases.

The 4640-B uses two sets (referred to as *System 1* and *System 2*) of Geiger-Mueller (G-M) tubes for photon detection. When the source rod is in the “measure” position, the source and detectors are in the same horizontal plane. Ideally, no photons should reach the detectors in a direct path from the source. In the “backscatter” mode, the photons must be scattered at least once before reaching the detectors.

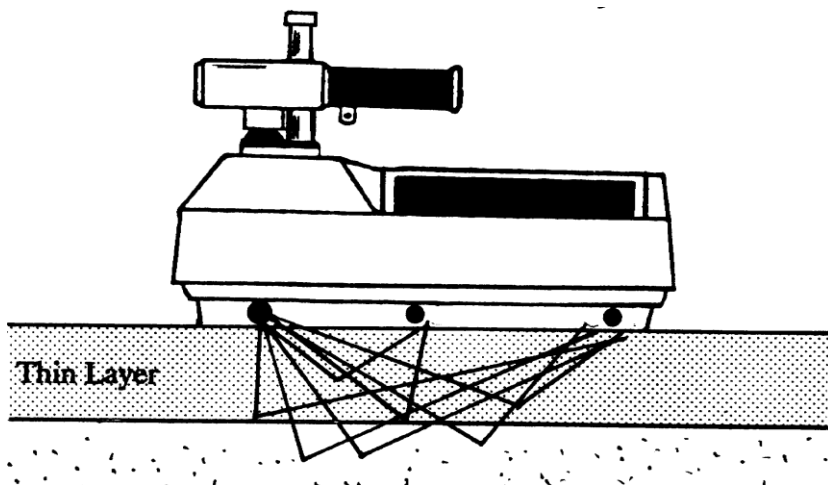


Figure 2–1. Gauge in Measurement Position  
on Thin Layer Material

Photons reaching the G-M detectors in the 4640-B are counted for selected intervals of time (*the number of photons counted is directly related to the density of the material*). The gauge program uses the counts to determine the density of the material top layer and the results are automatically displayed on the screen.

The gauge is calibrated using a set of metallic blocks of different densities and thicknesses. Readings are taken on these blocks and the counts obtained are used during the density calibration. The calibration range is 100 to 170 pcf (1602 to 2723 kg/m<sup>3</sup>). The thickness range is 1.0 to 4.0 in. (2.5 to 10 cm) with over 95% of the influence from the top 2.5 in. (6.4 cm).

### NOTE

**The source rod of a 4640-B gauge has two positions: SAFE and measurement. With the source rod all the way up, the gauge is referred to as being in the SAFE position (page 3–8). In this configuration, the source is surrounded by shielding. This position is used for transporting and storing the gauge. In the measurement position, the source rod is pushed down against the stop pin (page 3–8). This removes the shielding under the source, allowing the photons to penetrate the material directly under the gauge. The shielding around the source rod remains in place at all times.**

# NOTES

## CHAPTER 3

# OPERATING THE GAUGE

This chapter explains the basic operation of the Model 4640-B Thin Layer Density Gauge. Instructions for gauge parameter set-up, taking the daily standard count, and taking density measurements are included.

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## DAILY INSPECTION

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

- ✓ Push the source rod down into the measurement position, and then raise it back to the safe (shielded) position. 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 position. Turn the gauge over and verify that the sliding block is completely shut. If any portion of the opening is uncovered, the tungsten sliding block and fixed tungsten block should be cleaned as described in Appendix C, page C-11 before using, transporting, or storing the gauge.



### CAUTION

**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 radiation exposure.**

- ✓ 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 C for further instructions.

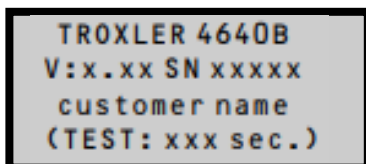
## TURNING THE GAUGE ON

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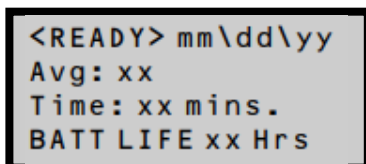
The gauge uses rechargeable NiMH batteries (*included*) as a power source.

To turn the gauge on, press **<ON>**.

When first turned on, the gauge executes an LCD test. After the screen fills with test characters, the gauge proceeds to the self-test.



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



The first line of the display alternates between the current time and date. The second line of the display indicates any gauge options that are enabled such as *Average Mode*. The third line indicates the enabled count time. The last line indicates the current battery voltage.

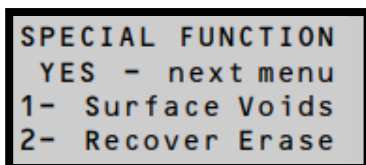
## GAUGE PARAMETER SETUP

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After unpacking and turning the gauge on, several parameters can be initialized. These parameters do not usually require changing and may include the measurement units, count time, company name, and time/date.

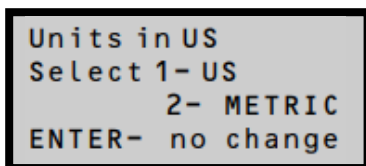
### SELECTING UNITS

The 4640-B allows measurement results to be displayed in either metric or U.S. units. To select the unit type, press **⟨SHIFT⟩** and **⟨SPECIAL⟩**. The display will be:



SPECIAL FUNCTION  
YES - next menu  
1- Surface Voids  
2- Recover Erase

Press **⟨YES⟩** twice then **⟨START/ENTER⟩**, or press **⟨7⟩** for the display:



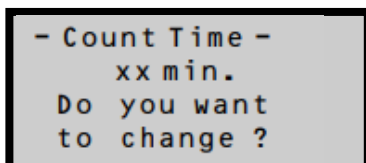
Units in US  
Select 1- US  
2- METRIC  
ENTER- no change

To select the required units, press either **⟨1⟩** or **⟨2⟩**.

## SETTING THE COUNT TIME

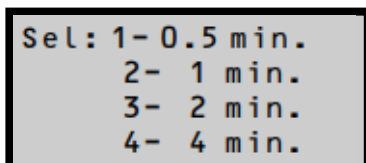
Typically, the count time may be selected once and will not require changing except for special measurements. Increasing the count time improves the measurement precision.

Press **<TIME>** for the display:



- Count Time -  
xx min.  
Do you want  
to change ?

Press **<YES>** for the display:

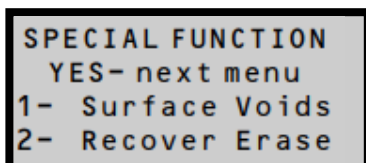


Sel: 1- 0.5 min.  
2- 1 min.  
3- 2 min.  
4- 4 min.

Press **<1>**, **<2>**, **<3>**, or **<4>** to select the desired count time. The display will return to *Ready* mode.

## SETTING THE TIME AND DATE

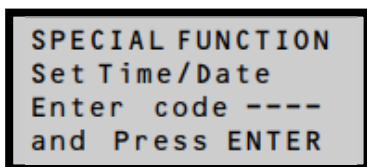
Press **<SHIFT>** and **<SPECIAL>**. The display will be:



SPECIAL FUNCTION  
YES- next menu  
1- Surface Voids  
2- Recover Erase



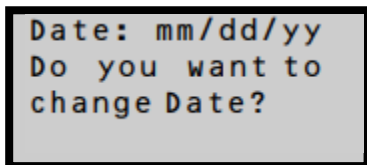
Press either **<YES>** three times then **<START/ENTER>**, or press **<10>** for the display:



SPECIAL FUNCTION  
Set Time/Date  
Enter code ---  
and Press ENTER

The *Time/Date* function is a *restricted function* and requires an access code for operation. This is to ensure that unauthorized personnel do not change the time and date.

Input the access code (see page xi) and press **<START/ENTER>**.  
The display will be:



Date: mm/dd/yy  
Do you want to  
change Date?

Press **<YES>**. Select the format to be used: *dd/mm/yy* or *mm/dd/yy*.

Input the new date and press **<START/ENTER>**.

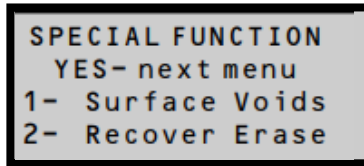
Repeat the above procedure to change the time.

## **CHANGE CUSTOMER NAME**

The gauge may be programmed to display your name or any other message (not to exceed 16 characters) during the powerup/self-test stage.

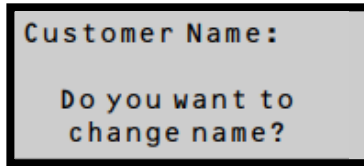
Press **<SHIFT>** and **<SPECIAL>**.

The display will be:



```
SPECIAL FUNCTION
YES- next menu
1- Surface Voids
2- Recover Erase
```

Either press **⟨YES⟩** three times then **⟨START/ENTER⟩**, or press **⟨9⟩** for the display:

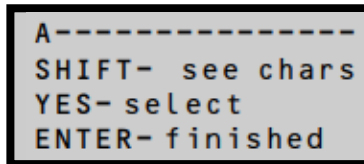


```
Customer Name:

Do you want to
change name?
```

The *Customer Name* function is a *restricted function* and requires an access code for operation. This is to ensure that unauthorized personnel do not change the name/message.

Press **⟨YES⟩**. Input the access code (see page xi) and press **⟨START/ENTER⟩**. The display is:



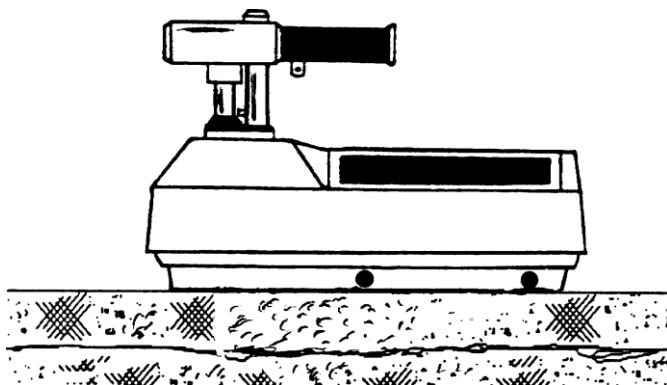
```
A-----
SHIFT- see chars
YES- select
ENTER- finished
```

Scroll through the alphabet by pressing **⟨SHIFT⟩**. To select the letter and move to the next position, press **⟨YES⟩**. To complete the operation, press **⟨START/ENTER⟩**.

## SOURCE ROD POSITIONS

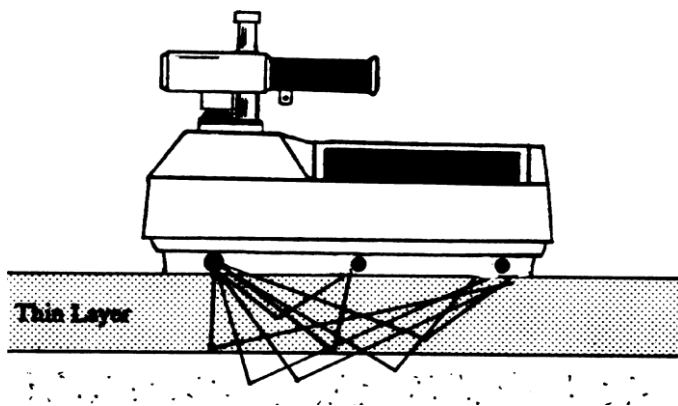
---

To position source rod in the **SAFE** position, pull the source rod handle to the upper position and ensure that the plunger is engaged in the index notch (see Figure 3-1).



*Figure 3-1. Source Rod in SAFE Position*

The gauge is in the measurement position when the source rod handle is all the way down (see Figure 3-2). The handle must rest on the stop pin.



*Figure 3-2. Source Rod in Measurement Position*

## STANDARD COUNT

---

The 4640-B uses a cesium-137 gamma source for taking density measurements. This low-level radioactive source undergoes a natural decay process that results in a gradual loss of strength. The time required for the source strength to diminish by 50% is referred to as the *half-life*. The half-life of cesium-137 is approximately 30 years.

To compensate for the source decay a daily reference *standard count* is performed. It is very important to take a standard count on a daily basis to ensure the highest accuracy and precision possible with the gauge.

The 4640-B is equipped with two methods of testing the reference standard count. The first method compares the new standard count with the average of the last four standard counts. This method is the *Multi-Standard Mode*. The second method compares the new standard count to the decay corrected factory calibration reference standard count. The factory standard count is corrected for the decay over the elapsed time. The new count is compared to the decay corrected calibration count and is referred to as the *Single-Standard Mode*. Refer to Chapter 6, page 6–12 for information on selecting Single-Standard or Multi-Standard Mode.

## TAKING THE STANDARD COUNT

The gauge comes with a magnesium (Mg) reference block and an air gap spacer for taking the standard count. Place the reference block on a dry, flat surface at least 10 ft (3 m) from any large vertical surface (for example, a concrete block wall) and at least 33 ft (10 m) from any other radioactive source. The surface should be asphalt or concrete at least 4 in. (10 cm) thick.

Place the spacer on the Mg reference block and then place the gauge on top of the spacer. The gauge must be in the **SAFE** position. The handle end of the gauge should rest over the two posts on the spacer.

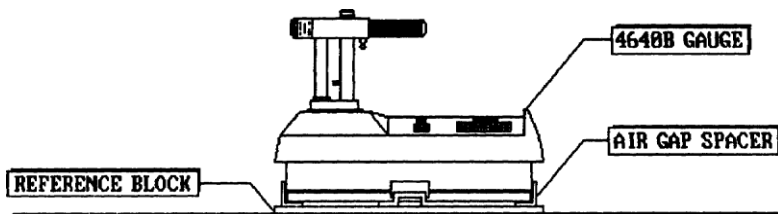


Figure 3-3. Standard Count Position

Press **<STD>** for the display:

```
-Standard Count-  
  xxx      xxx  
  Take a new  
  Standard Count?
```

Press **<YES>**.

```
  Place Gauge on  
  Spacer & both on  
  Block,Put Rod in  
  SAFE,Press ENTER
```

Check the gauge position. Press **<START/ENTER>** to start the count.

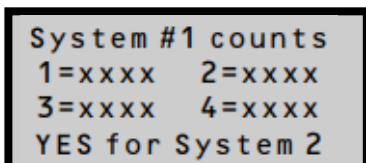
```
  Taking  
  Standard Count.  
  xxx seconds  
  remaining.
```

After the count is completed, accept the new count by pressing **<YES>**. The pass/fail tolerance is based on a 1% maximum allowed variation for System 1 reference standard counts and a 1.2% maximum allowed variation for System 2 standard counts.

## **VIEWING STANDARD COUNTS**

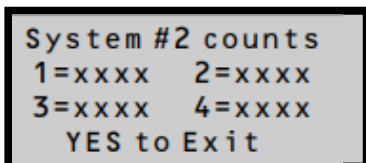
The last four standard counts stored in gauge memory may be viewed.

Press **<SHIFT>** and **<SPECIAL>**. Either press either **<YES>** four times then **<START/ENTER>**, or press **<12>** for the display:



System #1 counts  
1=xxxx 2=xxxx  
3=xxxx 4=xxxx  
YES for System 2

To view the counts for System #2, press **<YES>**.



System #2 counts  
1=xxxx 2=xxxx  
3=xxxx 4=xxxx  
YES to Exit

## **SITE PREPARATION/GAUGE POSITIONING**

The 4640-B Thin Layer Density Gauge is designed for use on asphalt surfaces and does not require a great deal of site preparation.

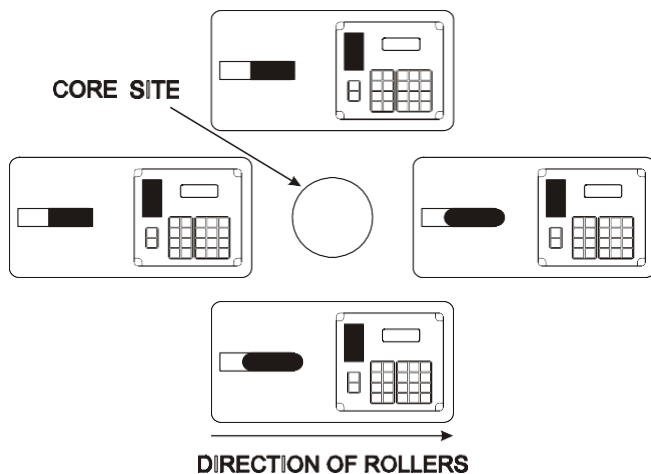
### **NOTE**

**Keep the gauge turned parallel to the direction of the paver and rollers (see Figure 3–4).**

- ◆ Remove any loose material (sand, aggregate, and so on) from the test site.
- ◆ Ensure that the gauge does not “rock;” it must remain level and steady. If rocking occurs, find a more suitable test site. To take a measurement around a core, the operator may move the gauge a few inches away from the core to level the gauge.

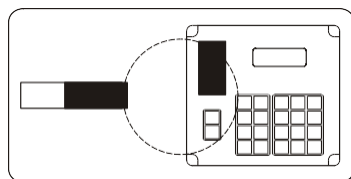
Figure 3–4 shows the gauge positioned *around* a core site. This type of measurement is taken *after* the core has been cut. When taking this type of measurement, Troxler recommends averaging four 1-minute counts taken around the core site.

Figure 3–5 shows the gauge positioned *over* a core site. This type of measurement is taken *before* the core is removed.



**Keep gauge turned in the direction of the paver!**

*Figure 3–4. Gauge Positioned Around a Core Site  
(After Core Has Been Removed)*



*Figure 3–5. Gauge Positioned Over a Core Site  
(Before Removing Core)*



## **TAKING A MEASUREMENT**

### **NOTE**

**When not taking readings, always keep the source rod in the SAFE position. For added operator safety, the source rod on the 4640-B gauge 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 Appendix C, page C-11 for cleaning instructions.



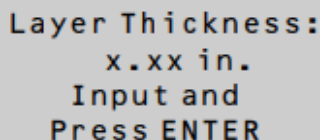
### **CAUTION**

**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 radiation exposure.**

## **OVERLAY THICKNESS SELECTION**

To ensure underlying material does not influence the readings, input the overlay thickness prior to taking a measurement with the 4640-B.

Press **⟨THICK⟩** for the display:

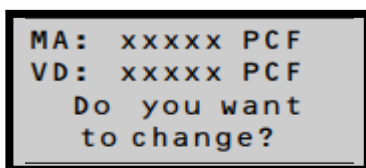


Layer Thickness:  
x.xx in.  
Input and  
Press ENTER

It is recommended that unless the overlay thickness is known, the user should enter a value slightly less than the target thickness. This ensures that the gauge reads only the new overlay. Input the thickness of the overlay and press **⟨START/ENTER⟩**.

## **MARSHALL/VOIDLESS DENSITY PARAMETERS**

Input the target density prior to taking a measurement. Press **<MA/VOIDLESS>** for the display:



```

MA:  xxxxx PCF
VD:  xxxxx PCF
Do you want
to change?
  
```

Press **<YES>** and input any target Marshall and voidless density values.

### **NOTE**

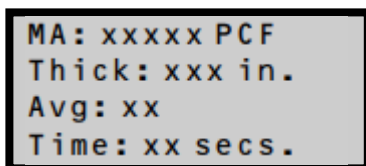
The “voidless” density is the maximum theoretical density obtained in laboratory tests.

## **TAKING A READING**

For added user safety, the source rod on the 4640B gauge retracts to the **SAFE** position when the gauge is picked up by the handle.

Place the gauge over the test site. Release the gauge handle and push it down until the handle is resting on top of the stop pin.

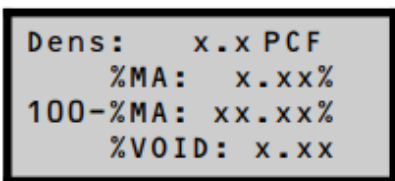
Press **<START/ENTER>**:



```

MA:  xxxxx PCF
Thick: xxx in.
Avg:  xx
Time: xx secs.
  
```

After the count time has elapsed, the display will be:



```
Dens:  x.x PCF
      %MA:  x.xx%
100-%MA: xx.xx%
      %VOID: x.xx
```

### NOTE

If *Surface Voids* mode has been enabled, the surface voids density value will be displayed. Refer to Chapter 6, page 6–2 for more information.

## VIEWING THE COUNTS

To view the actual counts for detector systems 1 and 2, press **<SHIFT>** and **<RECALL>**.

## CHAPTER 4

### STORING PROJECT DATA

This chapter explains the procedures for assigning project numbers, storing gauge measurements, printing project data, and erasing old projects from memory.

#### CONTENTS

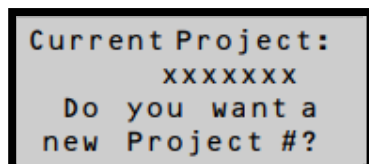
Creating a Project.....	4-2
Create a New Project.....	4-2
View/Erase Project.....	4-2
Storing a Measurement .....	4-3
Printing Measurement Data .....	4-4
Erasing a Project .....	4-6

## CREATING A PROJECT

---

The *Project* function allows the user to create, retrieve, view, and/or erase projects. Data is stored in the 4640-B under a *project number*. If the user presses the **<STORE>** key after a reading is taken (see page 4–3), the reading will be stored in the gauge memory under the *active* project number.

Press **<SHIFT>** and **<PROJECT>** for the display:



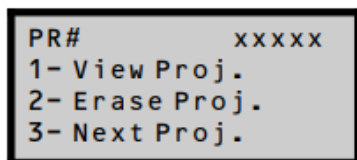
```
Current Project:
      xxxxxxx
Do you want a
new Project #?
```

From this screen projects can be created (press **<YES>**) or viewed and/or erased (press **<NO/CE>**).

## CREATE A NEW PROJECT

Input the number of a new project. The project will be active until a new project number is entered. All gauge readings that are stored will be stored under the new project.

## VIEW/ERASE PROJECT



```
PR#          xxxxx
1- View Proj.
2- Erase Proj.
3- Next Proj.
```

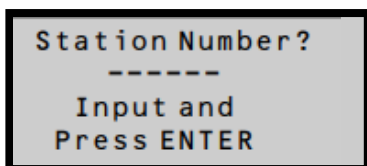
Scroll through the project numbers by pressing **<3>**. When the desired project number is displayed, the user may either view the project data (press **<1>**) or erase the project from the gauge memory (press **<2>**). After making the selection to either view or erase, follow all instructions on the gauge display.

## STORING A MEASUREMENT

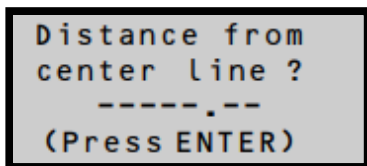
---

After reviewing the data, the reading may be stored under the *active project number*, allowing the data to be recalled and printed at a later time.

When the measurement has been completed press **<STORE>**. The display will request a station number.



Input a station number or reading number (up to six characters) and press **<START/ENTER>**.



Input the distance from the centerline (if applicable) and press **<START/ENTER>**. The gauge will request if the measurement was to the *left* (press **<1>**) or *right* (press **<2>**) of the centerline.

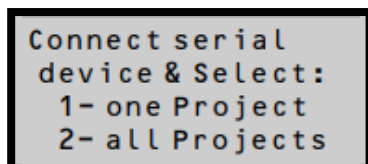
Additional information such as grid coordinates, mix type, or any other numeric information may be stored (up to twelve characters per line). To store additional information, press **<YES>**. To exit, press **<NO/CE>**.

## PRINTING MEASUREMENT DATA

---

The measurement data from *one* project or from *all* projects may be printed (uploaded) to a computer file if the gauge control unit is connected to the serial port. Appendix F provides instructions on using the HyperTerminal program in Microsoft® Windows 95® and later operating systems to print (upload) data to a computer.

Press **<SHIFT>** and **<PRINT>**. The display will be:



Connect the printer to the RS-232 serial port located on the front of the gauge (see Figure 4-1). See page 6-10 for information on the serial port parameters.

To print a single project, press **<1>**. To print all projects, press **<2>**.

If printing all files the gauge will return to the *Ready* mode upon completion.

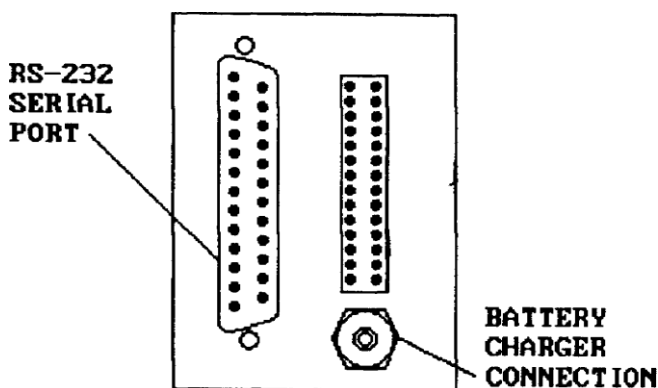
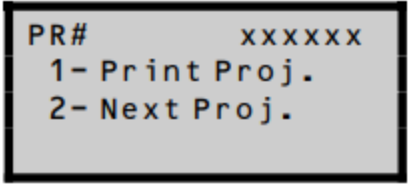


Figure 4-1. Gauge Connections

If printing a single file, the gauge will display the first project number in memory.



Scroll through the project numbers with **<2>**. When the project for printing is displayed, press **<1>**.

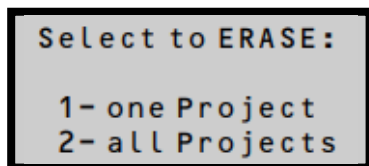


## ERASING A PROJECT

---

The *Erase* function allows project data to be erased or removed from gauge memory.

Press **⟨SHIFT⟩** and **⟨ERASE⟩**. The display will be:



To erase a single project, press **⟨1⟩**.

To erase all projects stored in the gauge, press **⟨2⟩**.

### NOTE

**In the event that project data is inadvertently erased, the *Recover Erase* feature may recover lost data. See page 6–4 for information on using the *Recover Erasure* feature.**

## CHAPTER 5

### THE SHIFT FUNCTIONS

This chapter gives brief explanations of the *Shift* functions available on the Model 4640-B Thin Layer Density Gauge. These functions are accessed by pressing **<SHIFT>** and the corresponding function key.

#### CONTENTS

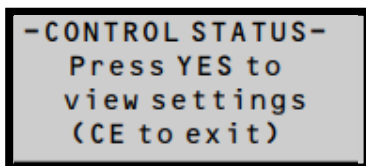
Status.....	5-2
Average.....	5-3
Project.....	5-4
Print.....	5-4
Erase .....	5-4
Special Calibration (SP. CAL.).....	5-5
New Calibration .....	5-6
Offset .....	5-8
Calculator (CALC.) .....	5-9
Recall .....	5-10

## STATUS

---

The *Status* function allows the user to view each gauge setting without accessing the individual function.

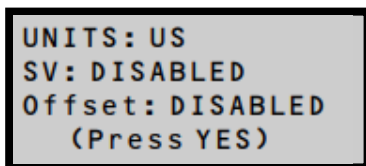
Press **<SHIFT>** and **<STATUS>** for the display:



A screenshot of a monochrome LCD display showing the STATUS menu. The text is arranged in four lines: '-CONTROL STATUS-', 'Press YES to', 'view settings', and '(CE to exit)'. The display is enclosed in a black rectangular border.

```
-CONTROL STATUS-  
Press YES to  
view settings  
(CE to exit)
```

To view the settings, press **<YES>**.



A screenshot of a monochrome LCD display showing gauge settings. The text is arranged in four lines: 'UNITS: US', 'SV: DISABLED', 'Offset: DISABLED', and '(Press YES)'. The display is enclosed in a black rectangular border.

```
UNITS: US  
SV: DISABLED  
Offset: DISABLED  
(Press YES)
```

To continue viewing gauge settings, press **<YES>**.

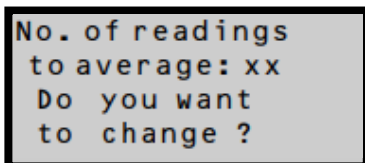
To exit, press **<NO/CE>**.

## AVERAGE

The *Average* function provides a method of averaging from two to twelve readings. This technique is especially useful if taking measurements around a core or core site.

When the gauge is in the *average mode*, the display will automatically prompt the user to take the required measurements.

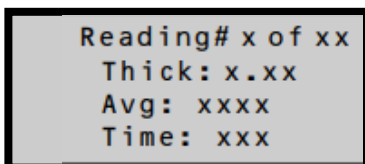
Press **(SHIFT)** and **(AVERAGE)** for the display:



No. of readings  
to average: xx  
Do you want  
to change ?

Press **(YES)** and input the number of readings to be averaged.

When the next measurement is taken, the display will reflect that the current reading is one of a total number of readings to be averaged.



Reading# x of xx  
Thick: x.xx  
Avg: xxxx  
Time: xxx

To continue taking readings, press **(START/ENTER)**.

When all the readings are complete, the average result will be displayed.

## PROJECT

---

Refer to page 4–2 for information on setting up or viewing project files.

## PRINT

---

The *Print* function allows project data to be printed or downloaded to a computer. For more information on the use of this function, see page 4–4.

## ERASE

---

See page 4–6 for information on erasing projects. In case of accidental erasure, see page 6–4.

## SPECIAL CALIBRATION (SP. CAL.)



### CAUTION

**Do not use Special Calibration #12; it is not operational!**

The 4640-B Thin Layer Density Gauge is factory calibrated for a density range of 100 to 170 pcf (1602 to 2723 kg/m<sup>3</sup>). However, in some instances the asphalt mix may contain materials such as iron slag, glass, large aggregate, rubber, and so on that will result in a different asphalt composition and texture for which the gauge is not calibrated.

The *Special Calibration* function allows the user to re-calibrate the gauge for use on materials that are not covered by the factory calibration. Once the special calibration is enabled, it remains active until the gauge is turned off or the factory calibration is enabled again.

*Special Calibration* uses the average of 5 to 25 measurements. This average and the density obtained by another method (such as core samples) are used to re-calculate the gauge constants.

Up to eleven calibrations can be stored in the gauge. These calibrations will be referenced by the calibration number.

Press <SHIFT> and <SP. CAL.>.

SPEC. CALIB: OFF  
Press: 1- enable  
2- disable  
3- New calib.

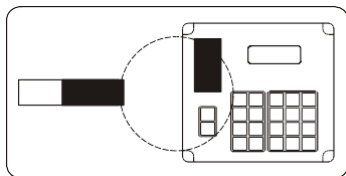
## **NEW CALIBRATION**

To perform a special calibration, press **⟨3⟩**. Input the calibration number and the number of readings to be averaged.

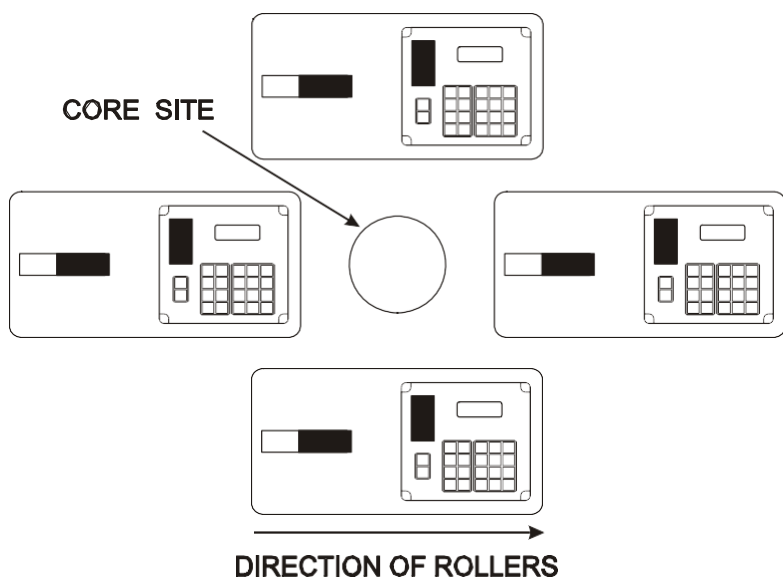
The *core value* is the density obtained using an alternative method of measurement. If the core has not yet been removed, position the gauge over the alternative test site as shown in Figure 5–1. If the core has been removed, position the gauge around the alternative test site as shown in Figure 5–2. Take the readings and enter the core value.

To enable the calibration, press **⟨START/ENTER⟩**. Disable the calibration by pressing **⟨2⟩**.

A special calibration may be erased by performing a new calibration and using the number of the existing calibration.



*Figure 5–1. Gauge Positioned Over Alternative Test Site*



*Figure 5–2. Gauge Positioned Around Alternative Test Site*



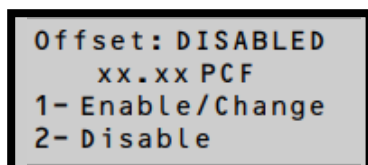
## OFFSET

---

The *Offset* function, like a special calibration, allows the gauge to be adjusted for asphalt mixes not covered by the factory calibration. This function is quicker than performing a special calibration but less accurate. The *offset* should be used only to temporarily adjust the gauge readings.

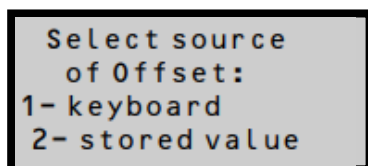
An offset may be a positive or negative value. If the offset is positive, the value will be added to the gauge density readings. If the offset is negative, the value will be subtracted from the density readings. Offset values may be stored in memory for later recall or input from the keypad.

Press **<SHIFT>** and **<OFFSET>**.



Offset: DISABLED  
xx.xx PCF  
1- Enable/Change  
2- Disable

To enable a stored offset or enter a new offset, press **<1>**. To change the value, press **<YES>**.



Select source  
of Offset:  
1- keyboard  
2- stored value

For a keypad entry, press **<1>** and choose whether the number is positive or negative. Input the offset. To enable the new value, press **<START/ENTER>**.

To recall a previously stored offset, press **<2>**.

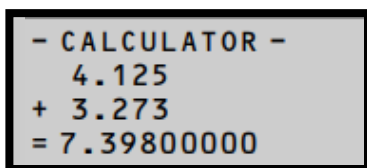
## CALCULATOR (CALC.)

The 4640-B Thin Layer Density Gauge is equipped with a four-function calculator. The function keys are located on the two left rows of the keypad. When the calculator function is active, these keys are enabled.

Press **<SHIFT>** and **<CALC.>**.

To perform the calculator functions, use the **<+>**, **<->**, **<×>**, and **<÷>** keys located in the lower left corner of the keypad. The **<=>** key is located on the **<START/ENTER>** key.

An example of a calculator entry display is as follows.



Results may be stored in memory by pressing **<MS>**.

Results may be retrieved from memory by pressing **<MR>**.

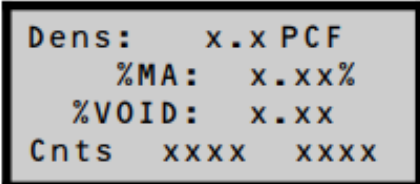
Exit the calculator mode by pressing **<EXIT>** (located on the **<YES>** key).

## RECALL

---

The *Recall* function allows the last reading taken with the 4640-B Thin Layer Density Gauge to be recalled for review.

Press **⟨SHIFT⟩** and **⟨RECALL⟩** for the display:



```
Dens:  x.x PCF
      %MA:  x.xx%
      %VOID: x.xx
Cnts  xxxx  xxxx
```

To return to the *Ready* mode, press **⟨NO/CE⟩**.

## CHAPTER 6

## SPECIAL FUNCTIONS

This chapter gives brief explanations of the *Special* functions available on the Model 4640-B Thin Layer Density Gauge. These functions are accessed by pressing <SHIFT> and <SPECIAL>, then the corresponding function key.

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## SURFACE VOIDS

---

In cases where thin layer measurements must be taken on asphalt mixes containing large aggregate (open mixes), the *surface voids* mode may be enabled to obtain a more accurate reading. Refer to Figure 6–1 on the following page to aid the decision of *surface voids* mode usage.

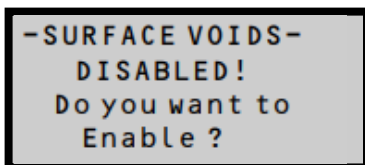
When measuring a thin layer containing large aggregate, the gauge bottom will not make uniform contact with the asphalt surface. The resulting “air voids” may shift or bias the density readings. In *surface voids* mode, the 1-inch magnesium reference block is placed under the gauge to remove the air voids between the gauge and the road surface (see Figure 6–2). The readings calculated will reflect the bulk density of the top 3 in. (8 cm) of the material under the block and will be unaffected by the thickness setting of the gauge.

### NOTE

**In most cases, a *special calibration* will provide satisfactory readings on large aggregate mixes. If the user suspects that the gauge readings are skewed, perform a special calibration. Refer to page 5–5 for more information.**

To enable the *surface voids* mode press **⟨SHIFT⟩** and **⟨SPECIAL⟩**.

Press **⟨1⟩**.



The display returns to the *Ready* mode.

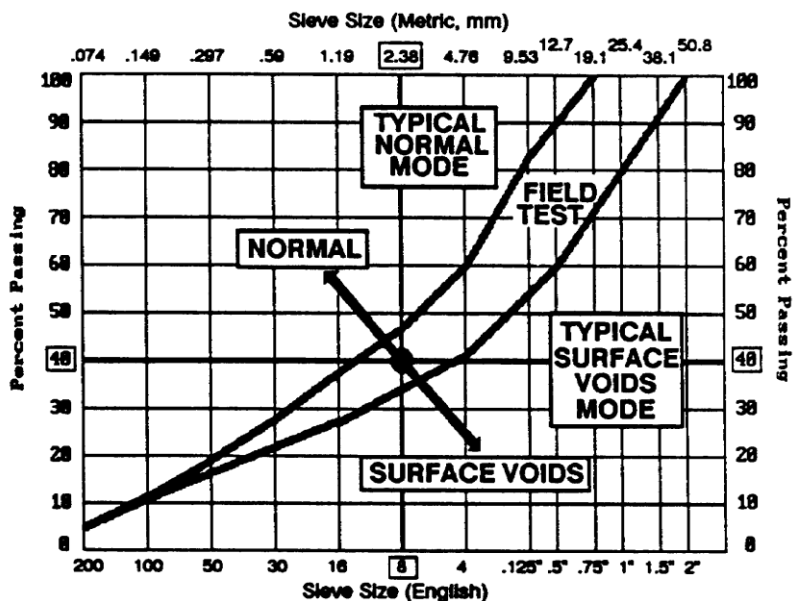


Figure 6-1. Normal Versus Surface Voids Mode Selection

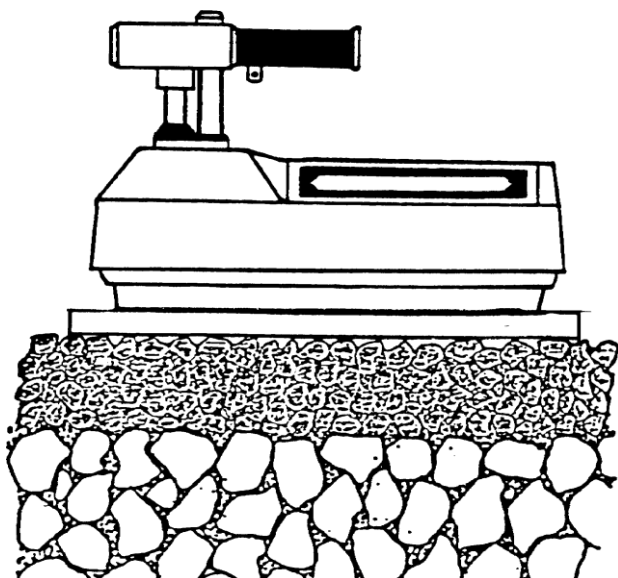


Figure 6-2. Gauge/Reference Block Position

## RECOVER ERASE

---

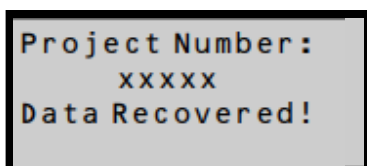
If project data is inadvertently erased, the *Recover Erase* function may recover the lost information.

### NOTE

**There is no guarantee that the *Recover Erase* function will successfully recover the lost data. If any data has been stored after the accidental erasure, a successful recovery is impossible.**

To use the *Recover Erase* function, press <SHIFT> and <SPECIAL>.

Press <2>. If the recovery is successful, the display will be:



If the recovery is not successful, the display is:



## STAT TEST

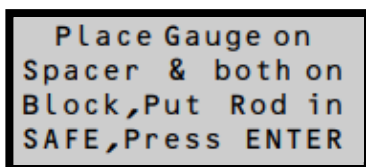
---

Erratic readings or readings that seem to fluctuate may indicate a problem with the gauge. If the readings are suspect, the *stat test* or *statistical stability test* may be performed by an operator to validate the normal operation of the gauge.

A stat test consists of twenty 1-minute counts. From the twenty counts, the standard deviation is calculated. This standard deviation is compared to a theoretical standard deviation value. Ideally, this ratio should be one. However, the 4640-B pre-scales (or divides) the counts by 8, resulting in an ideal ratio of (0.35). The acceptable limits for the ratios are from (0.25) to (0.45). The gauge is considered unstable if the ratios are outside these limits for two out of three stat tests.

To execute a stat test, press **<SHIFT>** and **<SPECIAL>**.

Either press **<YES>** once then **<START/ENTER>**, or press **<3>** for the display:



Place Gauge on  
Spacer & both on  
Block, Put Rod in  
SAFE, Press ENTER

Place the gauge on the air gap spacer with the handle end resting over the two posts (on the bottom of the fixture). Place the gauge and spacer on the 1-inch magnesium reference block. Place the source rod in the **SAFE** position. To start taking the twenty counts press **<START/ENTER>**.

After the twenty counts have been completed, the gauge will display the average counts and indicate if the test passed or failed. The individual count data may be viewed or printed at this time. Figure 6-3 shows a sample printout of the stat test data.



```

*****
* TROXLER 4640 Stability Test *
*****
    5/31/89      8:10 AM
Serial #:      590
READING :      COUNTS
-----
    1      6948      2080
    2      6900      2056
    3      6894      2055
    4      6880      2081
    5      6886      2075
    6      6857      2088
    7      6884      2086
    8      6893      2074
    9      6913      2086
   10      6926      2084
   11      6930      2080
   12      6908      2077
   13      6909      2057
   14      6913      2097
   15      6920      2097
   16      6874      2066
   17      6897      2078
   18      6923      2065
   19      6921      2061
   20      6849      2082

```

*Figure 6–3. Sample Stat Test Printout*

## DRIFT TEST

If the stat test has already been performed (and passed), but gauge readings seem to drift between tests, a *drift test* can be performed to check the long-term drift of the 4640-B.

A drift test consists of five 4-minute counts that are begun approximately 3 to 8 hours after completion of a stat test *with no movement of the gauge between tests*.

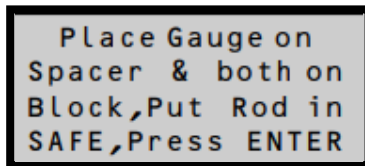
### NOTE

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.

With the gauge still on the air gap spacer and reference block, and the source rod in the **SAFE** position, press **<SHIFT>** and **<SPECIAL>**.

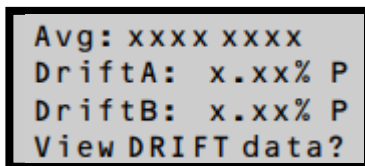
Either press **<YES>** once then **<START/ENTER>**, or press **<4>** for the display:



Place Gauge on  
Spacer & both on  
Block, Put Rod in  
SAFE, Press ENTER

To start taking the five counts, press **<START/ENTER>**.

After the five counts have been completed, the gauge will display the average counts and indicate if the test passed or failed.



Avg: xxxx xxxx  
DriftA: x.xx% P  
DriftB: x.xx% P  
View DRIFT data?

The pass/fail tolerance for System 1 is 0.50%; the tolerance for System 2 is 0.80%.

The individual count data may be viewed or printed at this time. Figure 6–4 shows a sample printout of the drift test data.

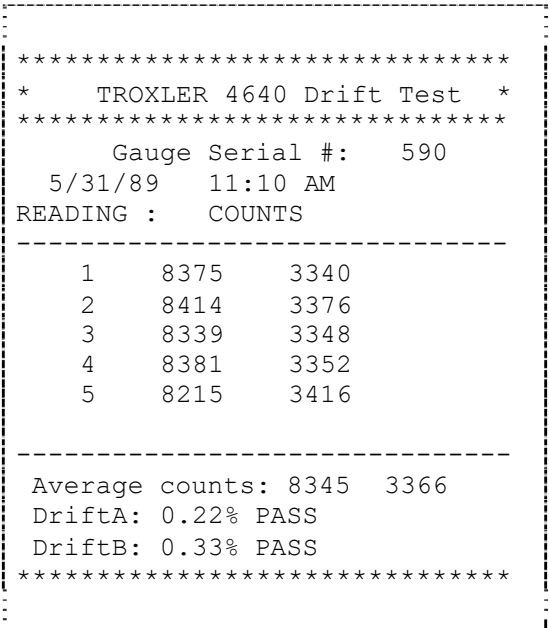


Figure 6–4. Sample Drift Test Printout

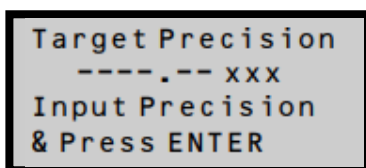
## TARGET PRECISION

---

If better than normal precision is required, the 4640-B may be programmed to automatically increase the count time to reach the desired precision.

The 4640-B count time will be adjusted (up to a maximum of 60 min) to obtain the specified precision. The required precision time is rounded to the nearest 15-second interval.

Press **<SHIFT>** and **<SPECIAL>**. Either press **<YES>** once then **<START/ENTER>**, or **<5>** for:

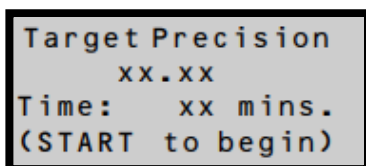
A rectangular screen with a black border. The text is displayed in a monospaced font. The first line is "Target Precision". The second line is "----. -- xxx". The third line is "Input Precision". The fourth line is "& Press ENTER".

```
Target Precision
----. -- xxx
Input Precision
& Press ENTER
```

Input the desired precision and press **<START/ENTER>**.

The gauge will request the thickness of the overlay for measurement. Input the thickness and press **<START/ENTER>**.

Place the gauge on the asphalt and start the 1-minute baseline count.

A rectangular screen with a black border. The text is displayed in a monospaced font. The first line is "Target Precision". The second line is "xx.xx". The third line is "Time: xx mins.". The fourth line is "(START to begin)".

```
Target Precision
xx.xx
Time: xx mins.
(START to begin)
```

When the baseline count is complete, start the *target precision* count.

### NOTE

Refer to page B-2 for precision specifications.

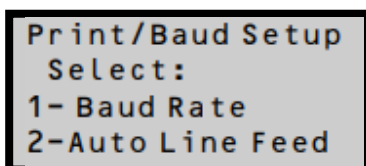
## PRINT/BAUD SETUP

---

The *Print/Baud Setup* function allows the user to configure the gauge for communication with an RS-232 serial device such as a printer or computer.

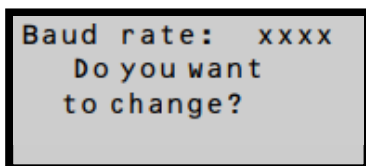
The baud rate or communication speed should be set to match the peripheral device. Refer to the device owner's manual for the proper settings. The *Print/Baud Setup* function also provides a *line feed* option to automatically transmit a line feed with each carriage return.

Press **<SHIFT>** and **<SPECIAL>**. Either press **<YES>** two times then **<START/ENTER>**, or press **<6>** for the display:



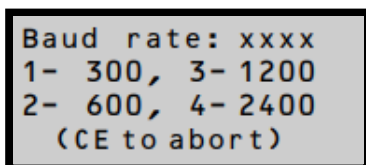
Print/Baud Setup  
Select:  
1- Baud Rate  
2-Auto Line Feed

To access the baud rate selection menu, press **<1>**. To activate the automatic line feed feature, press **<2>**.



Baud rate: xxxx  
Do you want  
to change?

To change the baud rate, press **<YES>**.



Baud rate: xxxx  
1- 300, 3- 1200  
2- 600, 4- 2400  
(CE to abort)

Choose the appropriate baud rate with the numeric keys. The gauge returns to the *Ready* mode.

## UNITS

---

Refer to page 3–4 for information on the *Units* function.

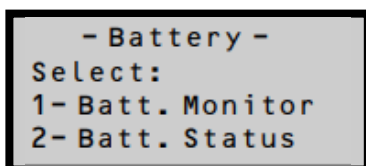
## BATTERY

---

The *Battery Monitor* function provides the user with multiple methods for displaying the battery status. The recommended display method is actual battery voltage. However, the other choices may be useful. The following choices are available:

- ◆ Display the actual battery voltage
- ◆ Display the estimated battery life
- ◆ Display the elapsed time from the last charge

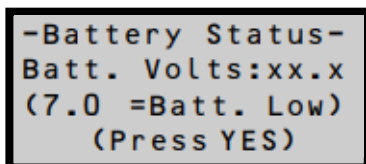
Press **<SHIFT>** and **<SPECIAL>**. Either press **<YES>** twice then **<START/ENTER>**, or press **<8>** for the display:



A screenshot of a monochrome LCD display showing a menu. The text is as follows:  
- Battery -  
Select:  
1- Batt. Monitor  
2- Batt. Status

To change the battery status display, press **<1>** and follow the instructions on the gauge display.

To review the current battery status (voltage, charge date, time used, and so on), press **<2>**.



A screenshot of a monochrome LCD display showing battery status information. The text is as follows:  
-Battery Status-  
Batt. Volts:xx.x  
(7.0 =Batt. Low)  
(Press YES)

To view the date of the last charge and elapsed time, press **<YES>**.

## CUSTOMER NAME

---

Refer to page 3–6 for information on entering the customer name.

## TIME/DATE

---

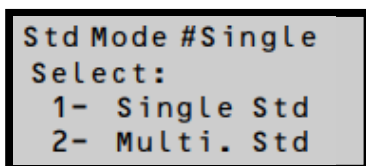
The *Time/Date* function is discussed on page 3–5.

## STANDARD MODE

---

Refer to page 3–9 for detailed information on when to use this function.

Press **<SHIFT>** and **<SPECIAL>**. Either press **<YES>** three times then **<START/ENTER>**, or press **<11>** for the display:



```
Std Mode #Single  
Select:  
1- Single Std  
2- Multi. Std
```

With the numerical keys, choose the method best suited for your applications.

## STANDARD DATA

---

The last four standard counts stored in gauge memory may be viewed. Refer to page 3–11 for more information.

## SOURCE DECAY

---

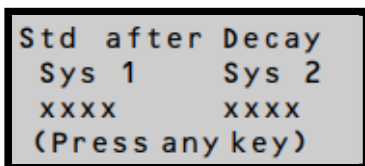
Refer to page 3–9 for more information on the use of this feature.

The *Source Decay* function instructs the gauge to calculate a theoretical set of standard counts. The factory standard counts are “adjusted” mathematically to compensate for the 2.3% per year source decay. These counts can be compared to the current standard count. The correction formula uses daily increments to compensate the effects source decay on the standard counts.

The adjusted counts may be compared to the existing daily standard counts to determine if the gauge is operating properly.

Press **<SHIFT>** and **<SPECIAL>**.

Either press **<YES>** four times then **<START/ENTER>**, or press **<13>** for the display:



```
Std after Decay
Sys 1      Sys 2
xxxx      xxxx
(Press any key)
```

To exit, press any key.



## ERASE STANDARD COUNTS

---

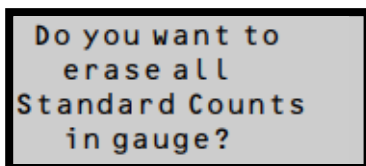
The *Erase Standard Counts* function allows the user or technician to erase all four standard counts from gauge memory. This may be desirable if the gauge has been repaired or mechanical changes have been made. These factors may affect the standard counts and comparing the new one to the average of the last four may cause the gauge to fail the standard count test when nothing is wrong with the gauge.

### NOTE

**This function will erase all the standard counts from memory!**

Press **⟨SHIFT⟩** and **⟨SPECIAL⟩**.

Either press **⟨YES⟩** four times then **⟨START/ENTER⟩**, or press **⟨14⟩** for the display:



Do you want to  
erase all  
Standard Counts  
in gauge?

To erase the standard counts, press **⟨YES⟩**.

# APPENDIX A

## RADIATION THEORY AND SAFETY

This appendix is required reading for anyone who will operate the 4640-B nuclear system. This appendix covers radiation theory along with a brief explanation of radiation statistics and radiation terminology.

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Radiation Terminology .....	A-3
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# 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 materials consist of chemical elements that cannot decompose by ordinary chemical methods. Some examples are:

- (H) Hydrogen
- (C) Carbon
- (O) Oxygen
- (U) Uranium
- (Cf) Californium
- (Co) Cobalt

Each element contains an atom with a unique structure (see Figure A-1). The atom consists of smaller particles such as protons, neutrons, and electrons. The protons and neutrons are grouped together in the nucleus. The electrons orbit the nucleus. Under normal circumstances, an atom is electrically neutral because the positive protons cancel out the negative electrons.

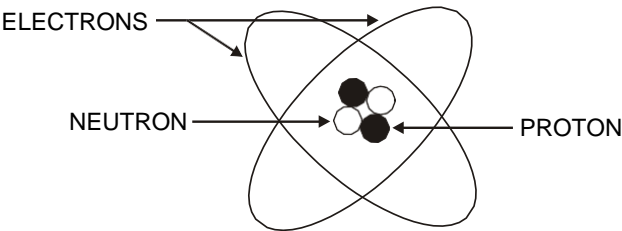


Figure A-1. Diagram of an Atom

Protons carry a positive charge, and are described as having a mass of one. Neutrons have no charge and have a mass of one. Electrons carry a negative charge and essentially have no mass.

MASS (ATOMIC WEIGHT SCALE)		CHARGE
Protons	1.0073	+1
Neutrons	1.0087	0
Electrons	0.0006	1

Since protons and neutrons are clustered together in the nucleus, the mass of an atom is concentrated in the nucleus. The atom in Figure A-1 has two protons and two neutrons; therefore, it is a helium atom. The atomic weight of an atom is the sum of the protons and neutrons.

## **RADIATION THEORY**

Radioactivity is the spontaneous breakdown of unstable nuclei (radioisotopes) with the resulting emission of radiation. The basic unit of radiation used in the U.S. is the *curie (Ci)*. The curie is defined as  $3.7 \times 10^{10}$  disintegrations of nuclei per second. In the “Special Form” encapsulated sealed sources used in the 4640-B, the unit of measure is the *millicurie* (1/1,000 of a curie). The SI unit of radiation is the *becquerel (Bq)*. A becquerel equals one disintegration per second. Therefore, one curie equals  $3.7 \times 10^{10}$  becquerels.

The strength of radioactive material is measured by its activity, or rate of decay. This activity decreases with time. The length of time it takes a given amount of radioactive material to decay to half of its original strength is referred to as the *half-life*. The half-life of the cesium-137 (Cs-137) source is 30 years.

## **RADIATION TERMINOLOGY**

The *rad* or *radiation absorbed dose*, is the unit of absorbed dose equal to 0.01 joules/kg in any medium. To account for the effect of various types of radiation on biological tissue, the *roentgen equivalent man (rem)*, or more appropriate for Troxler users, the *millirem* (mrem), is used when measuring radiation dose. The rem is derived from scaling the radiation absorbed dose (rad) by a quality factor (QF). One *rad* is equal to the exposure of one *rem* of gamma radiation.

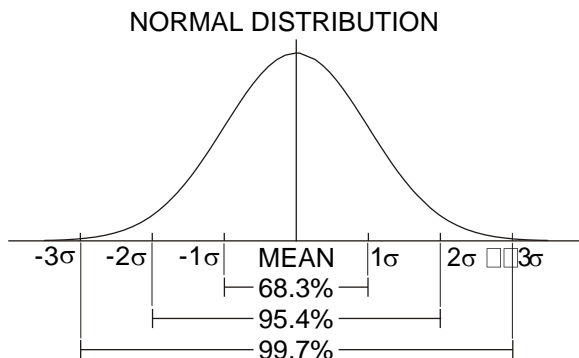
For example, the quality factor (QF) for the cesium-137 gamma source in the 4640-B is one. Therefore, one rad of absorbed dose produces a dose equivalent (absorbed dose  $\times$  QF) of 1 rem. Note that other types of radiation may have quality factors greater than 1.

## **RADIATION STATISTICS**

Radioactive emission is a random process. The number of emissions in a given time period is not constant but varies statistically about an average value. The variation about the true mean value is a Poisson distribution. In this distribution, the standard deviation ( $\sigma$ ) about the mean ( $n$ ) is defined as:

$$\sigma = \sqrt{n}$$

When the mean is greater than 100, the Poisson distribution can be closely approximated by the normal distribution (Figure A-2). The normal distribution predicts the probability that any given count rate will fall within a selected region about the mean.



*Figure A-2. Variation of Radioactive Emission*

Using the mean of a larger number of counts to approximate the true mean, the distribution shows that 68.3% of the time the count rate obtained will be within  $\pm 1$  standard deviation of the mean. Figure A-2 shows the chance of counts falling within three standard deviations of the mean. The user may perform a statistical stability test (stat test) to compare the experimental standard deviation to the theoretical standard deviation (see page 6-5).

# **RADIATION SAFETY**

This section provides a brief discussion of general radiation safety. The exposure profile for the Model 4640-B gauge is also included, along with a discussion of the source encapsulation.

## **TYPES OF RADIATION**

The radioactive source in the Model 4640-B produces two types of radiation:

Beta particles  
Photons (gamma rays)

The beta particles are stopped by the source capsule. Only the gamma radiation contributes to any occupational radiation exposure.

Gamma radiation is electromagnetic radiation, as are x-rays, radio waves, and visible light. Visible light and gamma rays have no mass, a zero electrical charge, and travel at the speed of light. Gamma rays are energetic and penetrating. Dense materials (such as lead, cadmium, and so on) provide the best shielding against gamma radiation.

## **LIMITING EXPOSURE**



### **WARNING**

**Do not tamper with or modify the Model 4640-B gauge. Also, do not remove the sealed source from the gauge. Tampering with or modifying the gauge or removal of the sealed source can be dangerous. Such actions are illegal unless authorized by your radioactive materials license.**

Government agencies set occupational exposure limits. The current limit in the United States and many other countries is 5,000 mrem per year. Under average conditions, a full-time employee working with the 4640-B will receive less than 200 mrem per year.

Taking advantage of all available means to limit radiation exposure is always recommended. The three methods of limiting exposure are:

TIME  
DISTANCE  
SHIELDING

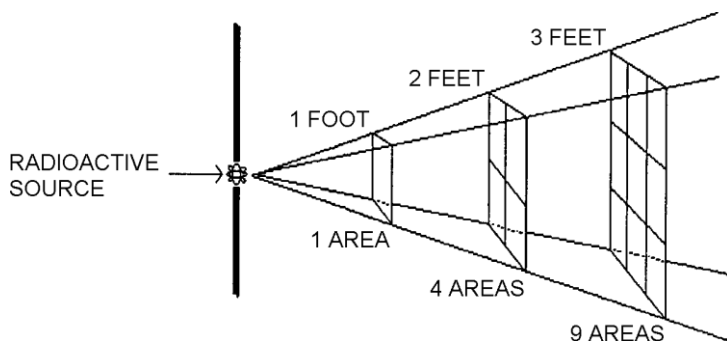
These methods are a part of an *ALARA* (As Low As Reasonably Achievable) program.

## **Time**

The simplest way to reduce exposure is to keep the time spent around a radioactive source to a minimum. If time is cut in half, so is the exposure, with 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 (Figure A-3). Doubling the distance from a radiation source reduces the exposure to one-fourth its original value. If the distance is tripled, the exposure is reduced by a factor of nine, and so on



*Figure A-3. Effect of Distance on Exposure*

## **Shielding**

Shielding is any material used to reduce the radiation reaching the user from a radioactive source. While some types of radiation such as alpha particles may be stopped by a single sheet of paper, other particles such as gamma rays require much more shielding. Dense materials, such as lead, shield gamma rays. The Model 4640-B has shielding built into the system that reduces the exposure.

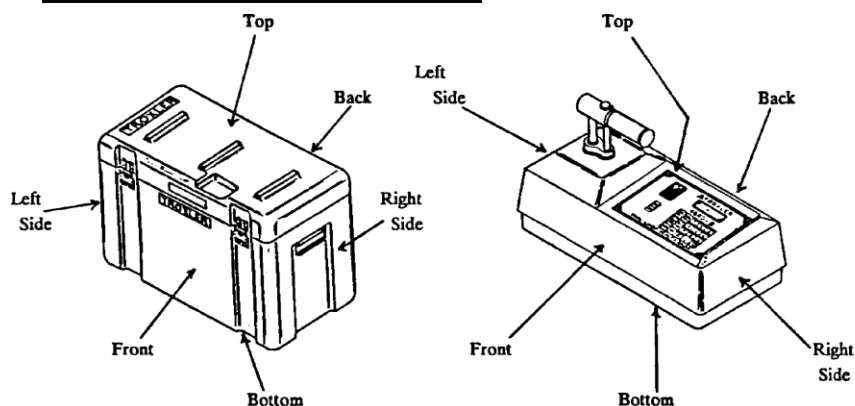
## **MONITORING RADIATION**

In the United States, anyone working with or near radioactive materials is subject to the limits on occupational exposure and must complete a radiation safety training course to be designated an authorized user. As an authorized user, an individual so designated must work in a “controlled” environment to the extent that their exposure to radiation must be monitored. Several means of personnel monitoring or *dosimetry* exist; the most common methods are film badges and thermoluminescent dosimeter (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*.



## 4640-B RADIATION PROFILE



Radiation Profile for 4640 Gauge

Location	Surface	10 cm	30 cm	1 meter
	$\gamma$	$\gamma$	$\gamma$	$\gamma$
Top	2.5	1.1	0.35	0.1
Bottom	3.0	1.2	0.4	0.1
Left	3.0	1.5	0.4	0.1
Right	5.0	3.6	1.4	0.25
Front	20.0	7.0	0.8	0.1
Back	7.0	1.0	0.3	0.1

Radiation Profile for 4640 Gauge in Plastic Transport Case

Location	Surface	10 cm	30 cm	1 meter
	$\gamma$	$\gamma$	$\gamma$	$\gamma$
Top	2.5	0.9	0.3	0.1
Bottom	1.0	0.5	0.25	0.1
Left	3.0	1.6	0.7	0.2
Right	3.5	1.5	0.4	0.1
Front	1.5	0.6	0.3	0.1
Back	7.0	0.7	0.4	0.1

### Notes:

1. Gamma ( $\gamma$ ) measurements were obtained with a Victoreen Model 2035 survey meter.
2. All reading in mrem/hr.

Figure A-4. Radiation Profile

## **SOURCE ENCAPSULATION**

The source in the Model 4640-B gauge meets regulatory requirements of U.S. and international authorities as “Special Form” or “Sealed” source material. With the exception of the direct radiation hazard, these sources are considered extremely safe.

Sealed sources are encapsulated to prevent leakage of the radioactive material and to meet radiation safety requirements.

The photon, or gamma source (cesium-137) in the 4640-B is in a capsule.

Proper use of this gauge (following the instructions in this manual) and the shielding design of the gauge will keep the exposure levels at a minimum under normal conditions. It is, however, required that 4640-B users wear personnel dosimetry when using the gauge.

## **EMERGENCY PROCEDURES**

If the nuclear gauge is lost or stolen, then immediately notify the 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:

- ✓ Locate the gauge and/or source.
- ✓ Do not touch or move the gauge.
- ✓ Immediately cordon off an area around the nuclear gauge and/or source. A radius of 15 ft (5 m) will be sufficient. Do not leave the area unattended.
- ✓ Keep all unauthorized personnel from the nuclear gauge.
- ✓ If a vehicle is involved, it must be stopped until the extent of contamination, if any, can be established.
- ✓ The gauge user should perform a visual inspection of the nuclear gauge to determine if the source housing and/or shielding has been damaged.
- ✓ Use a survey meter to measure the dose rate at a distance of 3 ft (1 m) from the gauge.
- ✓ Contact the company RSO (name and number given at the beginning of this section). Provide the RSO with the following:
  - ◆ The date, time, and location of the accident
  - ◆ The gauge model and serial number
  - ◆ The nature of the accident
  - ◆ The location and condition of the gauge and/or source
  - ◆ The dose rate at 3 ft (1 m) from the gauge

- ✓ If you are unable to reach the RSO, then call your regulatory agency (name and number given at the beginning of this section).
- ✓ Follow the instructions of the RSO. The RSO should report the incident to the regulatory agency. The RSO may also be required to notify the U.S. DOT of accidents during transport.
- ✓ Before shipping a damaged gauge to Troxler, obtain an RGA (Returned Goods Authorization) number from the Troxler RSO.

# NOTES

**APPENDIX B**

**4640-B SPECIFICATIONS**

This appendix contains gauge and measurement specifications for the Model 4640-B Thin Layer Density Gauge.

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Measurement Specifications .....B-2

    Gauge Precision at 140 PCF (2240 kg/m<sup>3</sup>).....B-2

Radiological Specifications .....B-3

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Mechanical Specifications .....B-6

## MEASUREMENT SPECIFICATIONS

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### GAUGE PRECISION AT 140 PCF (2240 KG/M<sup>3</sup>)

<u>Time (min)</u>	<u>Thickness</u>	<u>PCF</u>	<u>kg/m<sup>3</sup></u>
0.5	1.0" (2.5cm)	± 1.4	± 22
	2.0" (5.0cm)	± 0.85	± 14
	2.5" (6.3cm)	± 0.69	± 11
	4.0" (10.0cm)	± 0.69	± 11
1.0	1.0" (2.5cm)	± 1.0	± 16
	2.0" (5.0cm)	± 0.60	± 10
	2.5" (6.3cm)	± 0.50	± 8
	4.0" (10.0cm)	± 0.5	± 8
2.0	1.0" (2.5cm)	± 0.71	± 11
	2.0" (5.0cm)	± 0.42	± 7
	2.5" (6.3cm)	± 0.37	± 6
	4.0" (10.0cm)	± 0.37	± 6
4.0	1.0" (2.5cm)	± 0.50	± 8
	2.0" (5.0cm)	± 0.30	± 5
	2.5" (6.3cm)	± 0.25	± 4
	4.0" (10.0cm)	± 0.25	± 4

Precision is defined as  $\pm$ one 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.

## **RADIOLOGICAL SPECIFICATIONS**

---

Gamma source	0.30 GBq (8 mCi) $\pm$ 10% cesium-137
Source type	Sealed Source – Special Form
Source housing	Stainless steel, encapsulated
Shielding	Tungsten, lead, and cadmium
Surface dose rate	See radiation profile on page A–8.
Source rod material	Stainless steel
Shipping case	DOT 7A, Type A, Yellow II, TI. 0.2



# ELECTRICAL SPECIFICATIONS

---

Time accuracy and stability	$\pm 0.005\%$ $\pm 0.0002\%$ / °C
Power supply stability	$\pm 0.01\%$ / °C
Stored power	30 watt-hours
Battery recharge time	16 hours, automatic cutoff
Charge source	110/220 V ac, 50/60 Hz/12 V dc
Liquid crystal display	4-line x 16-character alphanumeric
Keypad	22-key sealed membrane
Power consumption	0.16 watts average
RAM	32 kilobytes non-volatile
ROM	64 kilobytes
Serial data format:	8 Data Bits 2 Stop Bits No Parity

Gauge to PC Compatible Computer Cable (PN 104334.1000):

Rx (pin 3).....	Tx (pin 2)
Tx (pin 2) .....	Rx (pin 3)
DTR (pin 20).....	DSR (pin 6)
DSR (pin 6).....	DTR (pin 20)
Gnd (pin 7).....	Gnd (pin 7)

Gauge to WEIGH-TRONIX<sup>7</sup> Printer Cable (PN 104324.1000):

Tx (pin 2).....Rx (pin 2)  
CTS (pin 5).....DSR (pin 6)  
DSR (pin 6) .....CTS (pin 5)  
Gnd (pin 7) .....Gnd (pin 7)

4640-B Gauge Serial Pin Description

1	GND	Signal Ground
2	TXD	Transmit Data
3	RXD	Receive Data
4	RTS	Request To Send
5	CTS	Clear To Send
6		Not used
7	GND	Signal Ground
8		Not used
9		Not used
10		Not used
11		Not used
12		Not used
13	CGND	Charger Ground (Reserved)
14		Not used
15		Not used
16		Not used
17		Not used
18		Not used
19		Not used
20	DTR	Data Terminal Ready
21		Not used
22	-5	-5 Volts (Reserved)
23	CHG	Gauge Charger (Reserved)
24	CHG	Gauge Charger (Reserved)
25	CGND	Charger Ground (Reserved)

## MECHANICAL SPECIFICATIONS

---

Base	Cast aluminum
Gauge size (w/o handle)	18.6 x 9.1 x 6.2 in. 472 x 231 x 157 mm
Gauge height (w/ handle)	11.1 in. 282 mm
Weight	29.7 lb 13.5 kg
Shipping weight	77.5 lb 35.2 kg
Operating temperature	
Ambient:	14 to 158 °F −10 to 70 °C
Surface:	350 °F 177 °C
Storage temperature	−70 to 185 °F −57 to 85 °C
Vibration test	0.1 in. (2.54 mm) at 12.5 Hz
Drop test	11.8 in. (300 mm) onto 0.98 in. (25 mm) steel ball

## APPENDIX C

### PERIODIC MAINTENANCE AND SERVICE

This appendix contains important information for maintaining and servicing the Model 4640-B Thin Layer Density Gauge. The following procedures should be performed to keep the 4640-B in good working order. In the event that a serious problem with the gauge arises, contact your nearest Troxler Service Center or representative for instructions. Troxler Service Center addresses and telephone numbers are included in this appendix.

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# TROUBLESHOOTING

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## BATTERY LIFE HOURS INCORRECT

- ✓ Charge the gauge overnight (16 hours).
- ✓ Check battery voltage (refer to page 6–11).
  - ▶ If battery voltage is equal or greater than 7.0 volts, manually enter the correct hour value. With a new gauge after a full 16-hour charge, enter a battery life of 200. With age the battery life will decrease, so enter 200 hours and monitor the gauge until battery low is displayed. After the next recharge, enter the new battery life (200 – battery low life). The user may leave the gauge in *voltage mode* for future reference.
  - ▶ If battery voltage is less than 7.0 volts, change the mode to *the elapsed time* since last charge. Monitor gauge until **BATTERY LOW!** is displayed. If the time is too low (less than 16 hours), replace the batteries.

## GAUGE FAILS STANDARD COUNTS

- ✓ Check for 10 ft (3 m) clearance around gauge.
- ✓ Check that any sources are at least 33 ft (10 m) away.
- ✓ Check that the source rod handle is fully notched in the safe position (see page 3–8).
- ✓ Check for correct gauge position on the magnesium reference block (see page 3–9).
- ✓ If the gauge is in *Multi Standard Mode*, make sure the last standard count was taken within the last three months. If the count was taken over three months ago, erase the standard counts and take a new count.
- ✓ If the gauge is in *Single Standard Mode*, check the calibration date and standard count. If both values are correct, take a new standard count and accept the new value. Measure the magnesium reference block. If the density is within 108-112 pcf (1730-1794 kg/m<sup>3</sup>), continue the job.

- ✓ 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. Refer to page C-11 for instructions. If the sliding block still does not close completely, contact the nearest Troxler Service Center (see page iii).

## ASPHALT READINGS ARE HIGH/LOW

- ✓ Take magnesium (Mg) reference block readings. When taking Mg block reference readings, place the 1-inch Mg reference block on top of a uniform 4 in. (10 cm) thick asphalt or concrete layer. Place the gauge on top of the Mg reference block. Set the count time to 4 minutes and the layer thickness to 1 in. (2.5 cm). Place the source rod in the measurement position. Take a count. If the readings are high or low, proceed to the next step.
- ✓ Check the thickness and count time parameters.
- ✓ Incorrect special calibration and/or incorrect offset should be disabled.
- ✓ Check calibration constants against the factory calibration sheet.
- ✓ If all of the above parameters are correct, use the *special calibration* to calibrate the gauge for the job.

## GAUGE READS REFERENCE BLOCK HIGH/LOW (Perform a Mg Reference Block reading as described above)

- ✓ Check thickness parameter.
- ✓ Check standard counts.
- ✓ Check source rod measurement position (see page 3-8).
- ✓ Special calibration disabled?
- ✓ Offsets disabled?
- ✓ Surface under the reference block should have at least 4 in. (10 cm) of homogenous material such as asphalt or concrete.
- ✓ Surface under the reference block must be smooth, flat and dry.
- ✓ The gauge may need to be sent back for re-calibration.

## **GAUGE READINGS APPEAR ERRATIC**

- ✓ Check the count time – A 4-minute count will give highest precision with a repeatability of  $\pm 1$  pcf ( $\pm 16$  kg/m<sup>3</sup>).
- ✓ Perform 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 your nearest Troxler Service Center (see page iii).

## **GAUGE WILL NOT COMMUNICATE WITH PRINTER OR COMPUTER**

- ✓ Check the cable for continuity.
- ✓ Ensure that the correct cable is in use.
- ✓ Make sure the gauge and printer/computer baud rates are the same (see page 6–10).
- ✓ Make sure all other parameters match:
  - ◆ Data bits = 8
  - ◆ Stop bits = 2
  - ◆ Parity = none
  - ◆ Protocol = DSR/DTR

## **GARBAGE OR XXXXXX IS DISPLAYED**

- ✓ Check the standard counts in memory.
- ✓ Check gauge for water damage – dry gauge interior with hair dryer on low heat) for 3 hours.
- ✓ Perform new standard counts. If counts = 0 for both systems, replace high voltage module (contact your nearest Troxler Service Center, see page iii).
- ✓ Check calibration constants against the factory calibration sheet.

## GAUGE IN MEASUREMENT POSITION BUT DISPLAY INDICATES SAFE POSITION

- ✓ Switch is defective.
  - ✓ Press **⟨START/ENTER⟩** again.
  - ✓ Call your nearest Troxler Service Center (page iii) for replacement part (page C-13).

## NO DENSITY READINGS

- ✓ The most likely reason for no density readings is an electronic problem, such as a failure of the detector preamplifier. However, as a precaution, ensure that the tip of the source rod is intact and undamaged (that is, ensure that the source is not missing). Use a radiation survey meter to check the radiation levels at the gauge base surface (without extending the source rod). A maximum reading of 10-20 mrem/hr is normal, and indicates the source is present. However, if the maximum reading is less than 1 mrem/hr or if a survey meter is not available, perform a visual inspection of the source rod tip as follows to confirm its integrity:
  1. Extend the source rod just far enough to see the source rod tip. The tip should appear flat to slightly rounded and smooth.
  2. Stay at least 3 ft (1 m) away from the tip of the unshielded source rod and complete the inspection as quickly as possible to minimize exposure (the dose rate at 3 ft 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 the state or federal radiation control agency in accordance with applicable regulatory requirements.
4. Contact the Troxler Radiation Safety Department for further advice.

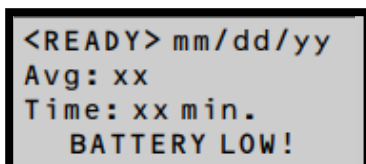


## BATTERY CHARGING

---

The 4640-B with fully charged batteries will remain operational for approximately 8 weeks under normal 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. For emergency use, a 30-minute recharge with the dc or ac charger provides several hours of use.

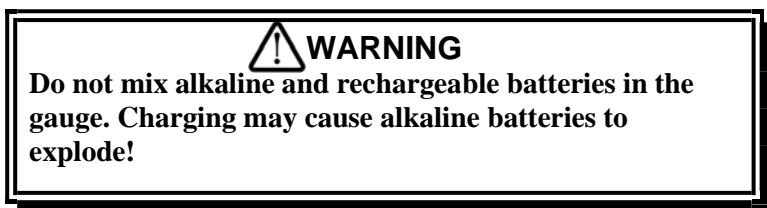
Although batteries cannot be “overcharged,” rechargeable batteries have a “memory” and repeated needless recharging will shorten the battery life. If possible, run the batteries down before recharging.

### NOTE

**Batteries should not be recharged unless the BATTERY LOW! indicator is visible!**

## ALKALINE BATTERY USE

If recharging is not an option, alkaline batteries may be installed **temporarily**. Separate battery cases (PN 104148) can be purchased as an option.



To exchange the rechargeable battery packs with optional alkaline battery packs use the following procedure:

- ✓ Remove the four screws holding the display panel. Lift off the panel.
- ✓ Remove the ribbon cable on the back of the panel.
- ✓ Remove the protective box covering the baseboard.
- ✓ Locate the two battery packs. The battery leads are red and black with white plugs.
- ✓ Unplug the leads from the baseboard. Remove the screw holding the battery pack to the gauge base. Slide the battery pack forward and lift out (see note).

#### NOTE

**If necessary, loosen the plastic top shell to exchange the batteries. After the top shell has been removed, proceed.**

- ✓ Insert D-size alkaline batteries in the optional battery packs. Install the packs in the gauge in accordance with the polarity indicated on the labels.
- ✓ **REMEMBER** to reconnect the battery packs and the control panel ribbon cable. Reverse the above removal procedure for installation.

## LEAK TESTING

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*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 3–1 on page 3–8).**

- ✓ Write the gauge model number and serial number on the wipe disk.
- ✓ Locate the area directly to the left of where the handle mechanism enters the top shell (body) of the gauge.
- ✓ Using the wipe disk, wipe the area around and to the left of the location where the handle mechanism enters the gauge body.
- ✓ Pack the disk, as instructed, in the envelope and mail to Troxler Electronic Laboratories, Inc. for analysis.
- ✓ Secure the gauge properly.

## **MECHANICAL MAINTENANCE**

The 4640-B will not need much maintenance, but the gauge should be inspected periodically to ensure precise operation. When performing maintenance on the gauge, monitor radiation by wearing a dosimeter.

### **INSPECTING THE SOURCE ROD**

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

### **CLEANING THE BASE AND TOP SHELL**

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 WD-40® (see note below). The WD-40 should remove the remaining debris.



#### **CAUTION**

**WD-40 can damage the keypad. Do not allow WD-40 to come in contact with the keypad! The keypad may be cleaned using a mild soap (such as 409™ or Fantastic™), followed by clean water.**

The 4640-B gauge top shell is manufactured from an engineering thermoplastic designed specifically to provide high impact strength and offer excellent compatibility with many industrial solvents and petrochemicals. The top shell may be cleaned with mild (low alkaline) soap and water. Other approved cleaning substances include methyl, isopropyl or isobutyl alcohols. A cloth dampened with kerosene or diesel fuel may be used to remove heavy soils. **Avoid prolonged exposure and do not soak.**



## **CAUTION**

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

## **LUBRICATING THE SOURCE ROD**

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

- ✓ Carefully remove the gauge top shell and slide it up, out of the way. To keep it out of the way, tie the top shell to the handle.
- ✓ To catch any grease, place a rag or cloth under the vent valve located below the grease fitting on the source rod tower.
- ✓ Using a standard 16-oz grease gun loaded with a Magnalube® cartridge, apply 5 shots of lubricant or until all dirty grease is ejected from the vent valve and clean grease is visible.

## **NOTE**

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

- ✓ Re-assemble the gauge.

## **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 measurement 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 completely 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.



### **CAUTION**

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

If the source rod becomes difficult to lower into the measurement position or a *click* is not heard when the source rod is raised to the **SAFE** position, the sliding block may require cleaning. An improperly operating sliding block may also result in erratic density readings.

- ✓ With the source rod in the **SAFE** position, place the gauge on its side.
- ✓ Clean the heads of the four screws that hold the bottom plate to the gauge base. Using a screwdriver, remove the four screws and the plate. Replace the plate if excessive wear is evident on the inside surface of the plate.
- ✓ Remove the sliding block. Pay close attention to the position of the block as it is removed. Clean the block and the cavity with a stiff brush or rag soaked in alcohol.

- ✓ Re-install the sliding block with the angled side up. Apply a light coating of Magnalube to the **top angled** surface of the block **only**.
- ✓ Re-install the bottom plate. **Do not overtighten screws!** Ensure that the source rod moves up and down freely.

## **GASKET REPLACEMENT**

Four gaskets seal the gauge from moisture, dirt, and debris. However, if the gauge has been out in extremely wet weather, high humidity or if the gauge was used in the cold and stored in a warm building, condensation may form inside the gauge. If this happens, remove the top shell, and allow the gauge to dry. Use a hair dryer (on low heat) if necessary, 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, remove the four screws and take the panel off the gauge top shell. Use care in removing the panel and ribbon cable. Gently peel the old gasket from the panel and top shell and replace with new gaskets. Replace the connectors and the control panel.

To replace the top shell gaskets, remove the screws that hold the top shell to the gauge base. Gently peel the gaskets away from the top shell and gauge base and replace. Tighten top shell screws to 6 in-lb.

If replacing the post gasket slide it up over the source rod. A light coating of talcum powder on the inside of the new post gasket will aid in re-assembly.

## REPLACEMENT PARTS

<b><u>PART NUMBER</u></b>	<b><u>DESCRIPTION</u></b>
104983	Front Panel Assembly
103948	20 Pin Ribbon Cable assembly (front panel to base)
104184	Cover Plate Assembly
100528.3000	Captive screw (Front panel)
104767	4640B Overlay (keypad)
104520	4640-B Top shell
012200	Spring (trigger)
104553	Plunger 3400 (indexer)
105108	Trigger
104305	Handle sleeve
101603.1010	Roll Pin, 3/32 D x 5/8 L (index rod)
012176	Lock with 2 keys
012176.1000	Key P812 (handle lock)
012804	Seal (bearing)
012752	Seal Wiper
013200	Fitting 3/16 Grease w/ serrated shank.
104190	Wiper Cap, 4640
102096	3400 Cap screw
102103	Cap Screw Bumper
104634	Source Rod Bearing (2 required)
100761	Source Rod Pig
100996	3400, Sliding Block
100999.0001	Bottom Plate
102399	Shield Spring, 3400
104035	4640 Tungsten Shield
104171	Post Gasket, 4640
104982	Front panel gasket (2 required)
103928.1000	Top gasket, foam
100156	GM tube (3 required)
105062	3/4-in. tube (2 required)



**PART NUMBER****DESCRIPTION**

104149	Battery set (w/ case) (rechargeable)
104113.1000	Battery Holder Part A (rechargeable-bottom)
104113.2000	Battery Holder Part B (rechargeable-top)
1016230	Fuse 1/2 A 3AG
104639	HV power supply module assembly
104761	4640-B Baseboard Assembly
104764	4640-B CPU board Assembly
106785	4640B 2 Tube Inter BD Assembly (Interface Board)
106363	PCB Assembly 4640B 3 Tube (Interface Board)
105396	Cover Box (4640B)

**ACCESSORIES****PART NUMBER****DESCRIPTION**

021140	Radiation Sign Kit
105005	4640B Instruction manual
102868	3880 Leak Test Kit w/ 4 Packets
102876.0005	Leak Test Packet (4 unit)
102873	1 oz solution
109661	Survey Meter
105026	Air Gap Fixture Assembly 4640B
104148	Battery Case Assembly (non-rechargeable)
110403	AC Adapter, 12 V CE
104156	DC Charger
104340	Printer
104324.1000	Cable, Printer-to-Gauge (Male/Male)
104334.1000	Cable, PC-to-Gauge (Female/Male)

**MAINTENANCE SUPPLIES**

**PART NUMBER**

**DESCRIPTION**

012784	Lubricant Magnalube 1.5 oz Tube
012786	Lubricant Magnalube 1 lb Can
012787	Lubricant Magnalube 5 lb Can
012789	Lubricant Magnalube 14.5 oz

## **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. 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:

- ◆ Gauge model and serial number.
- ◆ Part number/serial number (if applicable).
- ◆ Is the gauge still under warranty?
- ◆ 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).
- ◆ Will estimate be required before performing any work on the gauge?
- ◆ Payment method: credit card, account number, or purchase order number. All U.S. government agencies (city, county, state and federal) must send purchase order numbers.

### **NOTE**

**To prevent order duplication, if an order has been placed by telephone, please write “Confirming Order” on any follow-up written requests.**

### **NOTE**

**When returning a 4640-B gauge, follow the required special handling and shipping procedures detailed in Appendix D. Please contact a Troxler Sales Support or Service Representative with any questions.**

## APPENDIX D

### TRANSPORTATION AND 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.

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## U.S. SHIPPING REQUIREMENTS

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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](http://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.

## **CANADIAN SHIPPING REQUIREMENTS**

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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 E

## UNIT CONVERSION

The 4640-B gauge can display measurement results in either SI (metric) units or English units. Also, HM-181 of 49 CFR changes the standard units of radioactivity in the United States from the English unit of *curies (Ci)* to the SI unit of *becquerel (Bq)*. This requires the shipper to convert the activity on the Bill of Lading from curies to becquerels (GBq). Until everyone is accustomed to the SI units, it is permitted to follow the SI units with the English units in parentheses to clarify the description [for example: 1.48 GBq (40 mCi)].

To help our users convert from English units to SI units, the table in this appendix provides SI conversions factors for common English units relevant to the 4640-B gauge.

### CONTENTS

Measurement Units .....	E-2
Radiological Units .....	E-2



# MEASUREMENT UNITS

---

1 in. = 25.4 mm  
1 in. = 2.54 cm

1 ft = 30.48 cm  
1 ft = 0.30 m

1 pcf = 16.02 kg/m<sup>3</sup>  
1 pcf = 1.6 x 10<sup>-2</sup> g/cm<sup>3</sup>

# RADIOLOGICAL UNITS

---

1 rem = 0.1 Sv

1 Ci = 37 GBq  
1 mCi = 37 MBq

The following table is provided to assist the user in converting from microcuries (μCi) and millicuries (mCi) to gigabequerels (GBq):

<u>μCi</u>	to	<u>MBq</u>
60.....		2.22
100.....		3.70

<u>mCi</u>	to	<u>GBq</u>
5.0.....		0.19
7.2, 7.3, 7.4.....		0.27
7.5, 7.6.....		0.28
7.7, 7.8, 7.9.....		0.29
8.0, 8.1, 8.2.....		0.30
8.3, 8.4, 8.5.....		0.31
8.6, 8.7.....		0.32
8.8, 8.9.....		0.33
10.....		0.37
40.....		1.48
100.....		3.70
300.....		11.10

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# APPENDIX F

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## PRINTING (UPLOADING) PROJECT DATA

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Current versions of Microsoft® Windows® (Windows 95 and later) include a *HyperTerminal* communications program that can be used to transfer project data from the Model 4640-B Thin Layer Density Gauge. This appendix provides instructions on using the *HyperTerminal* program to print (upload) data from the gauge.

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HyperTerminal Setup .....	F-2
Equipment Connection .....	F-3
Printing (Uploading) Project Data.....	F-3
Viewing Project Data.....	F-5

# WINDOWS HYPERTERMINAL

---

To print (upload) data from the gauge to a computer equipped with a Microsoft Windows operating system, use the *HyperTerminal* program as described in the following sections.

## HYPERTERMINAL SETUP

To configure the Windows *HyperTerminal* program and set up a dedicated icon to transfer data from the gauge, perform the following steps:

1. Click on the **Start** button, select the **Programs** menu, and then the **Accessories** folder.
  - ▶ In Windows 95, select the **HyperTerminal** icon.
  - ▶ In Windows 98 and later versions, select the **Communications** subfolder, and then select the **HyperTerminal** icon.
2. From the **HyperTerminal** window, double-click on the **Hypertrm** icon. The **Connection Description** window is displayed. This window is used to set up a new connection.
3. In the **Name** box, enter a name (for example, *Troxler Data*) for the new connection. Select an icon to use for the connection, then click **OK**. The **Connect To** window is displayed.
4. In the **Connect To** window, *do not* enter a telephone number. Instead, select **Direct to Com1**, **Direct to Com2**, **Direct to Com3**, or **Direct to Com4**, depending upon the computer. The **COM# Properties** window is displayed, where # is the number of the selected COM port.
5. Configure the **Port Settings** as follows:

<b>Bits per second</b>	<b>2400</b>
<b>Data bits</b>	<b>8</b>
<b>Parity</b>	<b>None</b>
<b>Stop bits</b>	<b>1</b>
<b>Flow control</b>	<b>Hardware</b>

6. Click **OK**. The **Troxler Data – HyperTerminal** window is displayed, where *Troxler Data* is the icon name entered in step 3.
7. From the toolbar, click on **F**ile and select **S**ave from the dropdown menu.
8. Close the **Troxler Data – HyperTerminal** window by selecting **E**xit from the **F**ile menu.

## **EQUIPMENT CONNECTION**

Connect the gauge to the computer using the appropriate serial cable (see the list of *Accessories* on page C-14). Connect the gauge's serial port (see Figure 4-1 on page 4-4) to the computer COM port selected in step 4 of the *HyperTerminal Setup* section on the previous page.

## **PRINTING (UPLOADING) PROJECT DATA**

To print (upload) project data from the gauge to the computer:

1. On the computer, click on the **S**tart button, then select the **P**rograms menu and the **A**ccessories folder.
  - ▶ In Windows 95, select the **H**yperTerminal icon.
  - ▶ In Windows 98 and later versions, select the **C**ommunications subfolder, then select the **H**yperTerminal icon.
2. From the **H**yperTerminal window, double-click on the **Troxler Data – HyperTerminal** icon (where *Troxler Data* is the icon name entered in the *HyperTerminal Setup* section on the previous page). The **Troxler Data – HyperTerminal** window is displayed.

3. From the toolbar, click **T**ransfer, then select **C**apture **T**ext from the dropdown menu. The **Capture Text** window is displayed, showing a default folder and filename to be used to store the data. Troxler recommends using the default settings when first using the program. After selecting a filename, click **S**tart to enable data capture.
4. On the gauge, select the project data to be printed (uploaded) to the computer, and follow the instructions in Chapter 4 to print the data to the computer. The project data will be displayed in the **Troxler Data – HyperTerminal** window as it is uploaded.
5. When the data transmission is complete, select **T**ransfer from the toolbar. Then select **C**apture **T**ext and **S**top from the dropdown submenu.
6. Exit the *HyperTerminal* program.

## VIEWING PROJECT DATA

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After project data has been printed (uploaded) to the computer, the *.txt* file can be viewed using Microsoft Notepad or a word processing program, such as Microsoft Word®.

The data can also be imported into an Excel spreadsheet, which can then be used to manipulate and manage the data. To import the data into an Excel spreadsheet:

1. Open the Excel program.
2. From the Excel toolbar, click **Data**, then select **Get External Data** and **Import Text File**. The **Import Text File** window is displayed.
3. Select the file that was saved when data was downloaded using the *Hyperterminal* program, then click **Import**. The **Text Import Wizard** is displayed.
4. In step 1 of the **Text Import Wizard**, check the **Delimited** radio button, then click **Next**. In step 2 of the wizard, select only the **Comma** checkbox, then click **Next**. In step 3, select the **General** radio button, then click **Finish**. The **Import Data** window is displayed.
5. Check the **Existing worksheet** radio button, then click **OK** to import the data.

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## NOTES

WARRANTY

# **TROXLER ELECTRONIC LABORATORIES, INC.**

## **LIMITED WARRANTY**

TROXLER ELECTRONIC LABORATORIES, INC., and subsidiary, TROXLER INTERNATIONAL, LTD., hereinafter referred to as "TROXLER," warrants this instrument, Model 4640-B, Serial Number \_\_\_\_\_, against defects in material and workmanship for a period of twelve (12) months from date of shipment. For gauges 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 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.**

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