

Manual of Operation and Instruction

EGauge™ **Model 4590** **Soil Density Gauge**



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SAFETY ALERT SYMBOL



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

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



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NOTE

To locate an independent, Troxler-authorized service partner near you,
call 1-877-TROXLER.

ABOUT THIS MANUAL

The Model 4590 *Manual of Operation and Instruction* provides detailed information about this gauge. The manual includes product safety information, as well as instructions for the proper installation and use of the Model 4590 gauge.

This manual is organized as follows:

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

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

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

Chapter 4, Using the Gauge – Describes taking a standard count, preparing the test site, and taking measurements.

Chapter 5, Setup Menu – Describes the options available from the Setup menu.

Chapter 6, Target Menu – Describes the options available from the Target menu.

Chapter 7, Calibration Offsets – Provides procedures for taking density, moisture, and trench offsets.

Chapter 8, Project Data – Describes the options available from the Project menu.

Chapter 9, Extended Menu – Describes the options available from the Extended menu.

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

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

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

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

Appendix E, Unit Conversion – Provides conversions for measurement and radiological units.

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

Appendix G, Global Positioning System (GPS) – Describes the accuracy of the optional GPS feature.

HOW TO USE THIS MANUAL

Congratulations on the purchase of the Troxler Model 4590 Surface Density Gauge.

The Model 4590 *Manual of Operation and Instruction* contains information on how the Model 4590 operates and provides directions on the use of this gauge. Site selection, basic parameter setup, moisture and density determination, data storage, and advanced operations are included, along with radiological information and system troubleshooting.

CONVENTIONS USED IN THIS MANUAL

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



WARNING

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



CAUTION

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

NOTE

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

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

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

1. Indicates a procedure with multiple steps.

- ◆ Indicates a list of things needed (such as equipment) or important points to know.
- ◆ Indicates that more than one option is available. Carefully select the option that applies.

CAUTIONS AND WARNINGS



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



Do not store or transport the gauge unless the handle is raised to the safe position and locked. Increased radiation levels may violate transportation regulations and cause excessive personnel exposure.



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



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



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



The Model 4590 gauges are not waterproof. Do not use them in the rain. If the gauge gets wet, make sure it is completely dry before sealing it in the case for storage. Even small amounts of moisture can get into the body of the gauge and cause damage. See *Troubleshooting* on page-A-2 for more information.

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WARRANTY

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ATTENTION MODEL 4590 GAUGE OWNER

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

THE ACCESS CODE IS FOR THIS GAUGE IS:

5838

NOTES

Chapter 1:

Introduction

This chapter covers the following topics and tasks:

- ✓ An introduction to your new Model 4590 gauge
- ✓ Inspecting and unpacking
- ✓ Included parts and accessories

Introduction

The Model 4590 Surface Density Gauge uses the latest engineering, design, and manufacturing techniques. This gauge uses a gamma-ray transmission method of measuring the specific gravity and density of soil and soil aggregate bases. When the moisture content of the material is known, the gauge can determine the dry density.

The density measurement method used in the Model 4590 is based on the scattering and absorption properties of gamma rays with matter. This gauge uses a 3.3 MBq (90- μ Ci) cesium-137 (Cs-137) gamma-ray source and a sodium iodide (NaI) scintillation gamma ray detector. The gamma ray source is securely placed at one end of the source rod. The detector is located inside the gauge housing.

The gamma-ray method also known as the nuclear method of measuring density of soil and soil-aggregate bases has been approved by the American Society of Testing and Materials (ASTM). The Model 4590 gauge complies with ASTM D8167, Standard Test Method for In-Place Bulk Density of Soil and Soil-Aggregate by a Low-Activity Nuclear Method (Shallow Depth).

NOTE

This gauge does not have a backscatter mode; therefore, it cannot be used on asphalt pavements.

Using the Model 4590 gauge, you can precisely measure the moisture content and density of construction materials. The gauge features:

- ◆ Over **30 functions** to facilitate all phases of testing compaction on construction materials.
- ◆ A **backlit LCD screen** to help you read the display during night construction.
- ◆ Easy-to-use **keypad** and user-friendly menus to reduce training time to increase productivity.
- ◆ A **remote keypad**, including a **⟨START⟩** and **⟨ESC⟩** key, at the top of its source rod housing. These keys perform the same function as the keys on the control panel.

- ◆ An internally mounted **beeper**, which emits a short tone in response to a valid keystroke on the keypad. The beeper sounds a longer tone if you press an invalid key, if the gauge displays an error message, or to signal the conclusion of a measurement.
- ◆ A **USB port** that can be used to output data to a USB printer or storage device (flash drive or external hard drive).
- ◆ A **serial port** used to connect the gauge to a computer or printer for data transfer and printing.
- ◆ **Calibration offsets** (density and trench) to expand measurement possibilities, and to enhance gauge readings on materials that may fall outside the range of factory calibration.

Regulations and Licensing

The receipt, possession, use, and transfer of the Troxler Model 4590 are exempt from licensing by the U.S. Nuclear Regulatory Commission (US NRC) or Agreement States.

NOTE

International communities should follow local regulations regarding products utilizing radioactive materials. Hazmat training is required for shipping hazardous material, for more information visit www.troxlerlabs.com/safety.

Owners are encouraged to require study of this manual before allowing anyone to use the gauge. A potential hazard does exist if improperly used. Appendix D, which covers radiological safety and transportation requirements, should be required reading for all users and potential users. If these appendices are not completely understood, users should seek assistance from Troxler, an appointed Troxler representative, or others designated within the user's organization.

Additional radiation safety information is available by attending a Troxler Nuclear Gauge Safety Training Course. For pricing and availability of these courses, call 1-877-TROXLER (1-877-876-9537).

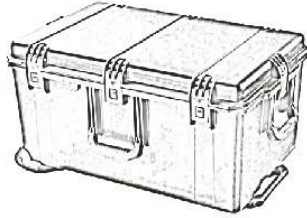
Gauge Parts and Accessories

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

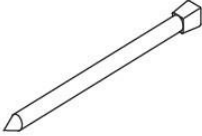
- ◆ The **Model 4590** is the portable surface density gauge containing a radioactive source, electronics, and rechargeable battery packs. The gauge serial number appears on the gauge handle, as well as on the calibration, gauge, and warranty certificates (found on the back page of this manual).
- ◆ The **Scraper Plate/Drill Rod Guide** is used to prepare the test site. It is used to guide the drill rod in preparing a hole for the source rod for direct transmission measurements.
- ◆ The **Drill Rod** is used to drill a hole for direct transmission measurements. ***Under no circumstances should the source rod be used to drill holes.***
- ◆ The **Drill Rod Extraction Tool** provides leverage to remove the drill rod from clays and other soil materials.
- ◆ The **Moisture Probe** allows you to take soil moisture measurements without a nuclear source. Refer to the Quick Reference card for more information.
- ◆ The **AC Charger** and **DC Adapter** are used to charge the gauge batteries. The AC charger accepts 90 – 220 V AC, 50/60 Hz and supplies 12 V DC. The DC adapter allows recharging from an automobile cigarette lighter.
- ◆ The **Transport Case** is specially fitted for safe transport of the 4590 and associated parts. The case is water-resistant but is not watertight. In case of inclement weather, the case should be protected with some type of covering to prevent intrusion of rain, etc. Always use this transport case when transporting or shipping the gauge.
- ◆ *Manual of Operation and Instruction*
- ◆ Calibration Documents
- ◆ Gauge Certificate.



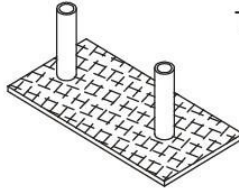
MODEL 4590 GAUGE



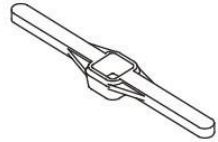
TRANSPORT CASE



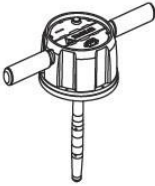
DRILL ROD



SCRAPER PLATE/
DRILL ROD GUIDE



DRILL ROD
EXTRACTION TOOL



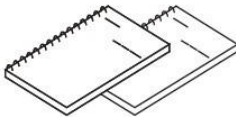
MOISTURE PROBE



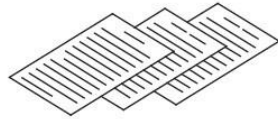
AC CHARGER



DC ADAPTER



MANUAL OF OPERATION AND INSTRUCTION
AND QUICK REFERENCE GUIDE



GAUGE CERTIFICATE
AND WARRANTY

Figure 1. 4590 Gauge and Standard Accessories

Unpacking and Inspection

Upon receipt of the gauge from the factory, perform a complete inspection and inventory. If the shipping case and/or any other part or accessory appears damaged, immediately notify the carrier and your Troxler representative 1-877-TROXLER (1-877-876-9537).

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

Inspection

Upon receiving the Model 4590 from the factory, perform a complete inspection and inventory as described below.

- ◆ Gauge
- ◆ Drill Rod
- ◆ Scraper Plate/Drill Rod Guide
- ◆ Extraction Tool
- ◆ AC Charger
- ◆ DC Adapter
- ◆ *Manual of Operation and Instruction*
- ◆ Gauge Certificate
- ◆ Transportation Guide

Lift the gauge from the transport case and inspect the outside surfaces for damage. Check the lock on the source rod handle and make sure the keys fit. Remove the lock, release the trigger, and check the source rod operation. It should move up and down with little effort. Return to the safe position, replace the handle lock and return the gauge to the transport case.

Chapter 2:

Theory of Operation

This chapter covers the following topics and tasks:

- ✓ Mode of operation
- ✓ Direct transmission
- ✓ Overview of density and moisture measurements
- ✓ Offsets

Mode of Operation

The Troxler Model 4590 Surface Density Gauge uses *direct transmission mode*. Source rod positions are described in Figure 4 on page 3–5.

In the direct transmission mode, the source rod extends through the base of the gauge into a pre-drilled hole to a desired depth.

Photons from the cesium-137 (Cs-137) source in the source rod pass through the test material, the photons collide with electrons and lose their energy. A high material density increases the probability of these photon collisions. This decreases the number of photons that reach the highly efficient gamma ray detector in the base of the gauge.

Thus, the number of photons reaching the detectors is inversely related to the density of the material; the higher the density of the material, the fewer the photons that reach the detectors. Using the gauge calibration, the gauge software converts the detector counts to a density value.

Moisture Measurements

The Troxler Model 6760 Moisture Probe, supplied with the Model 4590 EGauge, uses dielectric measurement technology to indicate the moisture content of the soil being measured. If a moisture value is known by the gauge the moisture content, percent moisture and Dry Density value can be reported and the % Proctor can also be calculated. The EGauge also allows the moisture value (%M) to be entered using the keypad if another moisture measurement method is specified.

The probe is approx. 5.5 inches (14 cm) in length and the moisture measurement occurs from 3.5 inches (8.9 cm) to the bottom (tip) of the probe. The probe is inserted in the same predrilled hole that the EGauge uses for the density measurements. It is important that the probe be inserted in the predrilled hole carefully as it requires a tight fit in order to achieve a reliable reading. For this reason, it may be best to perform the density measurement first because the probe could damage the hole.

The EGauge is preprogrammed with 3 generic soil profiles: General, Clay and Cr. Aggregate. General is best used when measuring granular and non-clay type materials, Clay is used on materials classified as clay and the Crushed Aggregate profile is for aggregate subbase material. It is also recommended that the user adjust the probe readings to the particular material being measured using either the Moisture Probe Calibration or the Moisture Probe Offset. This will ensure the most accurate results.

The Moisture Offset is a simple procedure and generally works well to adjust the probe to measure moisture of most typical fill materials. The Moisture Probe Calibration is another option that requires a bit more work and can be used in situations where the material may have a wide range of moisture values.

The Probe uses electromagnetic technology for measuring moisture content. For a given material, the dielectric property can be correlated with its moisture content. With a suitable calibration the probe can be used for measuring moisture content of a soil material. Figure 1.1 demonstrates how the probe should fit into the predrilled hole to obtain a reliable result.

The moisture probe must be charged periodically. The probe will operate approximately 35 hours per charge. The red LED (3rd light from left) illuminates when low, indicating approximately 4 hours of use remaining. Charge the probe with the charger supplied with the Troxler EGauge. The yellow LED illuminates during charging. The probe fully charges in approximately 4hours (max).

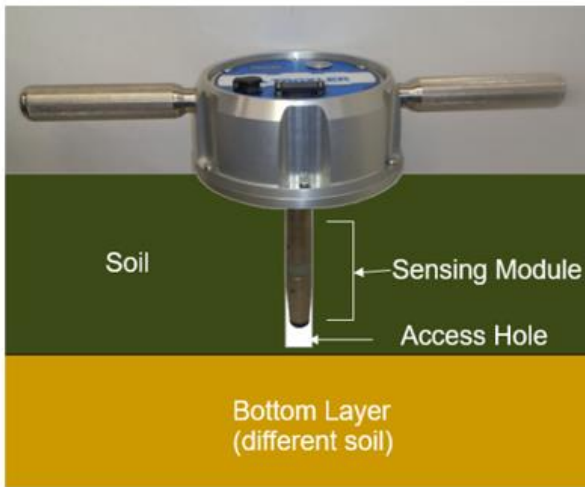


Figure 1.1: Probe in Measurement Mode

Calibration

Troxler calibrates the gauge at the factory and recommends that it is always calibrated by an authorized Troxler service center. A list of Troxler and authorized Troxler service centers are provided at the front of this manual or at:

www.troxlerlabs.com/services.

The calibration range of the gauge's density measurements is from 1750 to 2700 kg/m³ (approximately 110 to 170 pcf).

NOTE

Moisture content of the measured material can be determined with an external device, such as the Troxler Moisture Probe Model 6760 (included). Other manual methods, such as an oven dry, may also be used. If the Model 6760 is used, it is strongly recommended that the results are compared to an alternative moisture measurement and an offset applied if needed (see p. 7-7) or a calibration profile generated (see p. 5-15)

Offsets

The factory calibration provides accurate results for the majority of materials encountered in construction. If the gauge is to be used to test materials not covered by the factory calibration, the readings can be adjusted using an *offset*.

Perform a *density offset* if the test material is outside the density range for average soil or if the material composition varies from average soil.

Vertical structures may scatter gamma photons back to the gauge. This could result in inaccurate density readings. To take readings in a trench or within 0.6 m (2 ft.) of a large vertical structure, perform a *trench offset*.

A *moisture offset* is commonly used with the EGauge. When the provided probe is used for moisture readings due to the fact that the factory calibration profiled do not provide accurate results for all soils that are used for fill. This offset should also be used when the moisture content of a laboratory sample differs from the reading provided by the Troxler Moisture Probe Model 6760 (included).

Chapter 3:

Preparing for Use

This chapter covers the following topics and tasks:

- ✓ Overview of the control panel
- ✓ Source rod positions
- ✓ Daily inspection
- ✓ Turning the gauge on
- ✓ Setting up the gauge for the first time

Gauge Illustration

The following figure shows the various components of the gauge that are referred to throughout this manual.

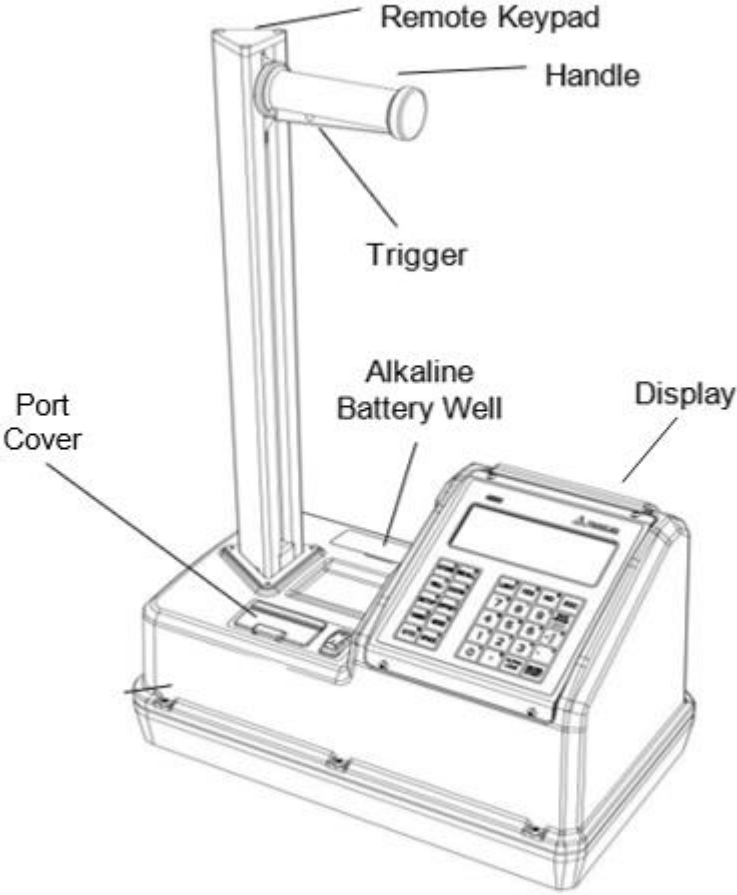


Figure 2. Model 4590 Gauge Components

Control Panel

The gauge control panel shown below contains the LED screen and keypad.

The keypad allows you to access the gauge software. Troxler has designed the keypad for ease of use with larger keys and anti-glare coating. Pressing a menu key activates that menu only when the *Ready* screen is displayed. Table 1 explains the functions of each key on the keypad.

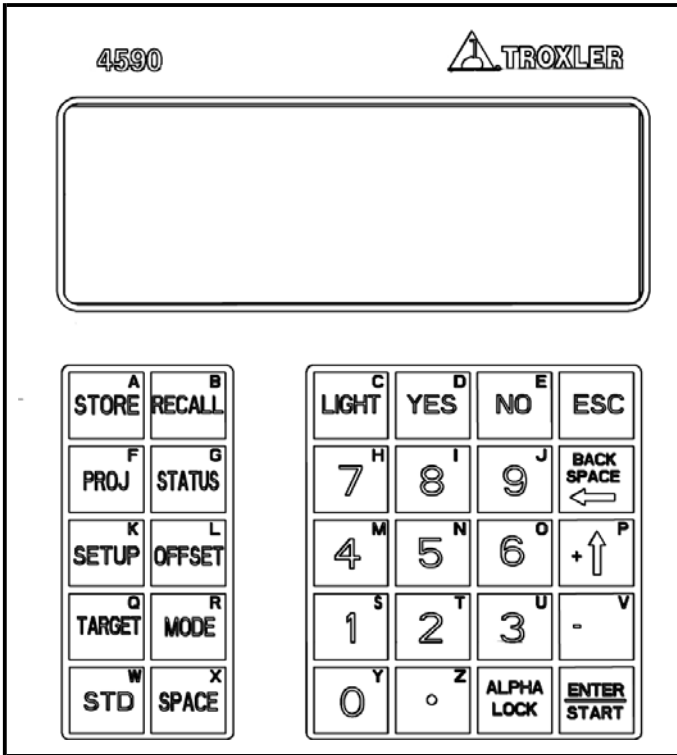


Figure 3. Model 4590 Control Panel

Table 1. Model 4590 Keypad Functions

KEY	MENU
⟨STORE⟩	Store most recent data in the current project.
⟨RECALL⟩	Display the most recent data.
⟨PROJ⟩	Select or create a project file and view, output, or erase project data file.
⟨STATUS⟩	Displays gauge status information.
⟨SETUP⟩	Displays the gauge Setup menu.
⟨OFFSET⟩	Enable, disable, or change an offset.
⟨TARGET⟩	Select, enter, or disable a Proctor.
⟨MODE⟩	Take a background count.
⟨STD⟩	Take a standard count.
⟨SPACE⟩	Enter a space.
⟨LIGHT⟩	Manually toggle the LCD backlight on or off.
⟨YES⟩	Respond <i>yes</i> to <i>yes/no</i> questions.
⟨NO⟩	Respond <i>no</i> to <i>yes/no</i> questions.
⟨ESC⟩	Return the display to the <i>Ready</i> screen without storing or updating the data.
⟨0⟩ .. ⟨9⟩	Enter numbers and access menu options.
⟨.⟩	Enter a decimal point.
⟨ALPHA LOCK⟩	Access the letters.
⟨BACK SPACE⟩	Moves cursor back one space.
⟨↑⟩, ⟨↓⟩	Scroll through menu options or view screens.
⟨ENTER/START⟩	Accept data entry or begin a measurement.

Source Rod Positions

As shown below, the source rod can be placed in the **SAFE** position, background (BGD) position, or the direct transmission position. When not taking measurements, keep the source rod in the **SAFE** position at all times.

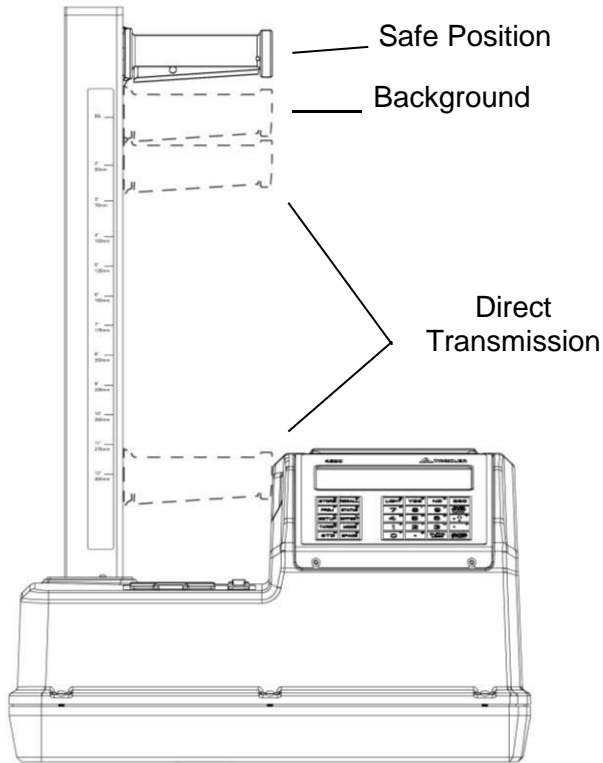



Figure 4. Source Rod Positions

In the background and direct transmission positions, the source rod extends into a pre-drilled hole described in the next chapter.

Charging the Gauge

The gauge is equipped with a rechargeable nickel-metal hydride (NiMH) battery pack containing five C batteries. Before turning on the gauge, charge the battery for about 3 hours.

To charge the NiMH batteries:

1. Plug the AC charger or DC adapter into the charger connector under the gauge's Port Cover (see Figure 3 on page 3-3). The battery charge indicator icon () appears on the top-right of the display.

If using the AC charger, plug the other end of the charger into a standard 100–240 V AC outlet.

If using the DC adapter, connect the other end to any 12-14 V DC source (such as a vehicle's power receptacle).

2. After the gauge is fully charged (approximately 3 hours), unplug the AC charger or DC adapter and store for later use.

For more information about batteries, see the *Batteries* section on page A-9.

Turning the Gauge On

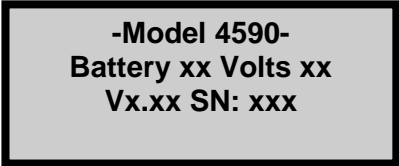
NOTE

Charge the batteries for three to four hours prior to initial use.

The gauge uses rechargeable NiMH batteries as a power source. Press the power switch to turn the gauge to the on position. When powered on the display screen fills with test characters before proceeding to the two-second self-test phase.

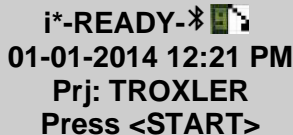
Afterwards, the gauge enters a 300-second warm-up period. During the warm-up period, the gauge displays the gauge model number, software version, serial number, company name (if programmed), and progress (in seconds) of the warm-up.


After the self-test, press any key to enter the *Ready* mode.




**-Model 4590-
Battery xx Volts xx
Vx.xx SN: xxx**


The gauge returns to the *Ready* mode when the gauge is ready to proceed to another menu. The screen displays:





i*-READY-* 
01-01-2014 12:21 PM
Prj: TROXLER
Press <START>

NOTE

The symbol  in the upper right of the display indicates that the Bluetooth is enabled and connected to the Moisture probe or other Bluetooth device.

The symbol  in the upper right of the display indicates that the GPS is enabled.

The symbol  in the upper right-hand corner indicates that the AC charger or DC adapter are connected to the charger connector under the gauge's Port Cover.

The symbol  in the upper left of the display indicates that the gauge will need to initialize before the next reading.

After five hours of no activity, the gauge automatically performs a total power shutdown.

Daily Inspection

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

Ensure that the handle is in the Safe position and a lock is in place to prevent unauthorized use and exposure of the source.

For more information regarding radiation does refer to page D-2.

Selecting Measurement Options

After turning the gauge on, you can set several parameters, including:

- Measurement Count Time
- Background Count Time
- Measurement Units
- Automatic or Manual Depth Modes
- Moisture Input Method
- Measurement Order
- Date and Time
- User ID
- Initialization frequency

These parameters may need to be changed from time to time depending on the intended use of the gauge.

Additionally, the gauge offers a *Status* function that enables you to view selected information about the current gauge status and setup. To access this function, press the **<STATUS>** key.

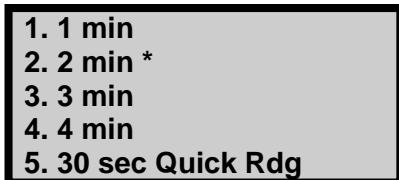
The gauge displays two screens of information, including the measurement units, count time, measurement mode, battery status, Gmb (Marshall) value, Proctor value, Gmm (Voidless density) value, and measurement depth. Use the arrow keys to scroll between the two screens.

To begin, press the **<SETUP>** key. For information on all of the functions available from the *Setup* menu, see Chapter 5: Setup Menu.

Setting the Count Time

The *count time* defines how long the gauge measures. Longer count times produce better measurement precision. Troxler recommends a count time of two minutes for most sample measurements.

To change the count time, press **<1>** at the *Setup* menu. The gauge displays:

- 
1. 1 min
 2. 2 min *
 3. 3 min
 4. 4 min
 5. 30 sec Quick Rdg

Select the desired count time using the corresponding number key. The gauge sets the new count time and returns to the *Setup* menu.

NOTE:

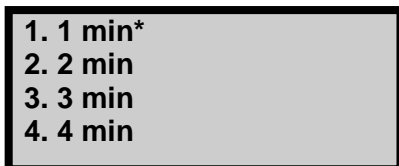
The active selection is noted by the asterisk

All count times may be used for depth 2 through 8 inches. For depths 9,10,11, and 12, 3- and 4-minute count times may be used. Due to the low source activity these count times must be used to achieve reliable results. The gauge sets the new count time and returns to the *Setup* menu

Setting the Background Count Time

The background count time defines how long the gauge measures the background radiation. There are four options provided for background time. Background radiation affects readings; a new background count is necessary when background environment or testing material changes.

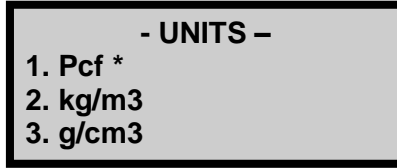
To change the background count time, Press **<2>** at the *Setup* menu. The gauge displays:

- 
1. 1 min*
 2. 2 min
 3. 3 min
 4. 4 min

A one-minute background count is the default setting and the recommended setting.

Setting Measurement Units

The gauge can display measurement results in either U.S. units pounds per cubic foot (pcf) or metric (SI) units (kg/m^3 or g/cm^3). To select the units, press **(3)** at the *Options* menu. The gauge displays:



Select the new units using the corresponding number key. The gauge sets the new units and returns to the *Setup* menu.

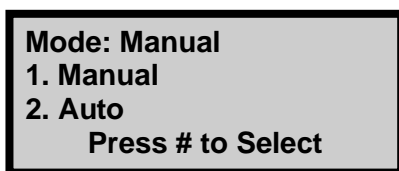
NOTE:

The active selection is noted by the asterisk

Setting the Automatic or Manual Depth Mode

The Model 4590 gauge offers two depth modes: *Automatic* and *Manual*. In the *Automatic* mode, the gauge software determines the source rod depth automatically. In the *Manual* mode, the operator must enter the source rod depth at a gauge prompt whenever taking a measurement.

The *Depth Mode* function allows you to set the depth mode. To access this function, press **(4)** at the *Options* menu, the gauge displays:

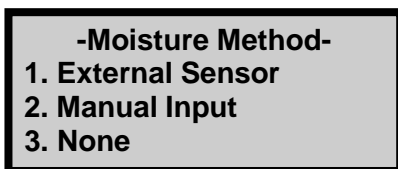


Mode: Manual
1. Manual
2. Auto
Press # to Select

Select the desired depth mode using the corresponding number key. After the depth mode is selected, the gauge sets the mode and returns to the *Setup* menu.

Setting the Moisture Input Method

To select how you want to input moisture values, press **<4>** from the *Setup* menu shown on the previous page. The gauge displays:



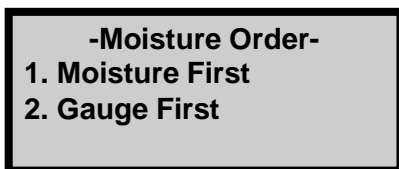
- ▶ Press **<1>** to use an external sensor. Choose this option to use the provided moisture probe. The gauge displays a confirmation message and returns to the *Moisture Input* menu.
- ▶ Press **<2>** to input the value manually. Choose this option to input your percent moisture with each measurement result. An alternative method will be needed to determine the soil moisture value. The gauge displays a

confirmation message and returns to the *Moisture Input* menu.

- ▶ Press **<3>** to disable the moisture input feature. Results provide wet density only. The gauge displays a confirmation message and returns to the *Moisture Input* menu.

Setting the Measurement Order

To select what order the measurements are taken, press **<2>** from the *Options* menu. The gauge displays:



- ▶ Press **<1>** to take moisture measurements with the included probe first. The gauge displays a confirmation message and returns to the *Measurement Order* menu.
- ▶ Press **<2>** to take density measurement readings first. The gauge displays a confirmation message and returns to the *Measurement Order* menu.

In most cases, it is recommended that the density measurement be performed first because the probe fits tightly and may cause distortion or damage to the hole.

Setting the Date and Time

The *Clock/Calendar* function allows you to change the date and time, and to select the display format for each. This function is described on page 9-3.

Setting the User ID

The gauge can store a three-character *user ID* with each measurement. To enter or change the user ID, refer to page 9-5.

Chapter 4:

Using the Gauge

This chapter covers the following topics and tasks:

- ✓ Preparing a test site
- ✓ Taking a standard count
- ✓ Taking measurements
- ✓ Using the Recall function

Site Preparation

Preparation of the test site surface is critical to gauge performance. This section provides site preparation procedures for soil and base course sites. To ensure the most accurate gauge readings, the appropriate preparation procedure should be followed.

Soil and Base Course Preparation

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



CAUTION

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

3. For direct transmission measurements, put the drill rod through the extraction tool and then through one of the guides on the plate (see Figure 5).



WARNING

Under no circumstances should you use the source rod of the gauge to drill holes. This could result in breaking or damaging the source rod or providing inaccurate readings.

4. Wearing safety glasses (or other locally approved safety devices), step on the plate and hammer the drill rod at least 50 mm (2 in.) deeper than the desired test depth. (The drill rod increments include the additional depth.)

NOTE:

It is very important to drill the hole at least 2 inches (5 cm) deeper than the measurement depth. The EGauge source rod is approx. 2 inches longer than the measurement depth, (the rod extends below the source). If the hole isn't deep enough the source rod cannot be lowered properly into the hole resulting in erroneous readings.

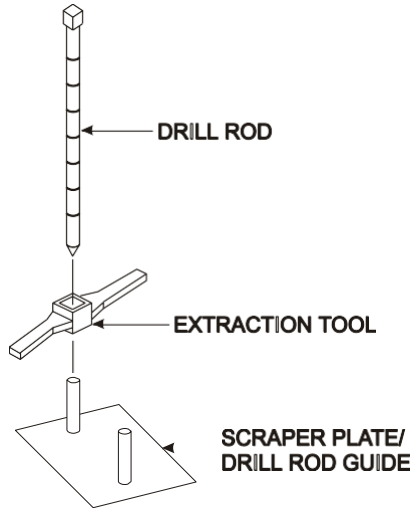


Figure 5. Drill Rod Positioning

5. Remove the drill rod by pulling straight up and twisting the extraction tool. **Do not loosen the drill rod by tapping from side to side with a hammer.** This will distort the hole or cause loose material to fall into the hole.
6. Ensure accurate placement of the gauge. Before removing the scraper plate, mark the test area using the drill rod as shown in Figure 6. Mark lines in the dirt along two perpendicular sides of the scraper plate.

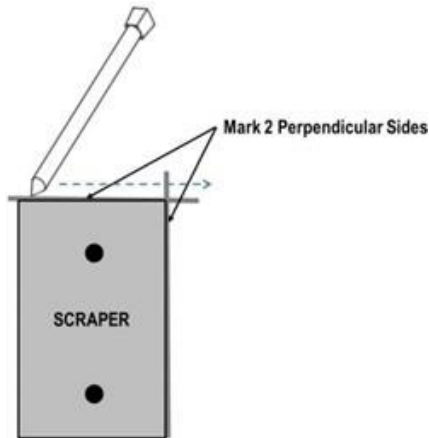


Figure 6. Marking the Test Area

7. Carefully pick up the scraper plate. Be careful not to disturb the soil around the hole.
8. Position the Gauge on the prepared area inside the markings.
9. To ensure correct positioning of the Gauge, lower the source rod into the prepared hole. **Use care when inserting the source rod; do not to disturb the soil around the hole.**
10. Raise the source rod back to the SAFE position.
11. You are now ready to perform your measurement

NOTE:

Perform the standard count at least once a day.

The best practice is to perform the standard count at the jobsite on the first test site of the day.

Taking the Standard Count

NOTE:

Before you start any measurements, ensure that no other gauges are nearby. 30 feet minimum distance is required.

A daily standard count should be performed to adjust for source decay, environmental conditions and to check for proper functioning of the gauge. A four-minute standard count and a background count help to ensure the highest measurement accuracy.

The gauge should be turned on 10 minutes before the standard count is performed to allow all systems to warm up and stabilize. When practical, turn on the gauge before loading it in the vehicle so it can warm up during transport to the jobsite and be ready upon arrival.

Site Requirements

Troxler recommends that the standard count be performed at the test site on the same soil where readings will be performed in order to account for background influences.

The test site should meet the following criteria:

- ◆ A smooth, dry surface such that the EGauge does not rock.
- ◆ At least 3 meters (10 ft.) from any large vertical surface.
- ◆ At least 10 meters (33 ft.) from any other radioactive source such as other nuclear gauges.
- ◆ On concrete or compacted soil at least 10 centimeters (4 in.) thick and with a wet density of at least 1600 kg/m³ (100 pcf).

The Model 4590 gauge is placed directly on the soil when performing the standard count.

NOTE

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

Instructions for Taking a Standard Count

The standard count consists of 2 separate 2-minute counts. The first count occurs with the handle in **SAFE** position.

- ◆ To ensure that the handle is seated in the Safe position properly, lightly press down on it (without engaging the trigger) just before starting the standard count.

During the second part the handle is in background position and the source rod end protrudes about 1 ½ inches into the prepared hole. This is also different than other nuclear density gauges.

1. Prepare the test site as instructed on page 4-2.
2. Take a standard count by pressing the **<STD>** key.

Standard Count
DS= xxxx BGD= xxxx
Take New Count?
<YES> or <NO>

3. Press **<YES>** to start the standard count:

Place Gauge on
Test Site & Source
Rod in SAFE Pos.
Press <START>

4. Make sure the gauge is on the material to be measured and ensure that the source rod in the **SAFE** position.

NOTE

If not in correct position this warning displays:

Source Rod
NOT in Safe
Position
Press <ENTER>

If you see this message, place the source rod in the **SAFE** position and press **<ENTER>**.

5. Press **<START>** to begin taking the 2-minute standard count.

**Taking
Standard Ct. Step 1
xxx s
Remaining**

NOTE

The standard and background standard must each be within 1% of the average of the last 4 counts performed and stored. If the standard count average is greater than 1%, the standard count fails, and an error code displays as shown below:

**Error Code#:11
Please Refer
to Users Manual
Press <ENTER>**

6. When count is finished and passed, the first step results displays:

**Step 1 Ct.= xxxx
<ENTER> to continue**

7. Press **<ENTER>** to continue:

**With Gauge on
Test Site & Source
Rod in Background Pos.
Press <START>**

8. Lower the handle to the background position (first notch below SAFE). The gauge automatically checks whether the

source rod is in the background position and starts the second step of the background count.

If the source rod is not in the background position, and if automatic depth mode is enabled (default setting), it displays:

**Place the source rod to
BGD position and press
ENTER key.**

9. When count is complete, raise handle to **SAFE** position.
10. The gauge checks whether the new standard count meets the required trend and displays:

Message 1:

**New standard count
accepted**

Message 2:

**New standard count x %
different than the
expected count.**

**Do you want to accept
the new count?
Yes/No**

11. If count is acceptable, the gauge performs the following:
 - ◆ Use the Destiny Standard -Background (**DS-BGD**) count as the Active Standard Count.
 - ◆ Assign filenames and archives the acquired data.
 - ◆ Display filenames of this data.
 - ◆ Use the **BGD** count as the Active Background.

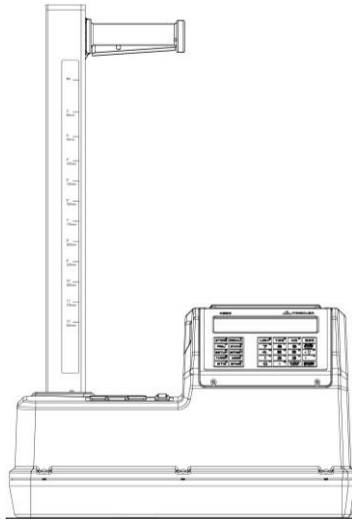


Figure 7. Gauge Position on Soil

12. If the first attempt fails, check items listed below and retake standard count. Press **(STD)** for the display:

Standard Count
DS= xxxx BGD= xxxx
Take New Count?
<YES> or <NO>

NOTE

Manual mode or auto depth sensor detects correct position. After count completion, the display is:

DS= xxxx xx.x% (P/F)
BGD= xxx
Do You Want to
Use the New Std.?

13. The **P** indicated to the right of the percentage figures indicates that the new counts are within the 1% of the acceptance limits. If the percentages are not within these limits, an **F** displays. If you do get an **F**, or **fail**, display check for the following conditions:
- ◆ Is the source rod in the proper position?
 - ◆ Are any other gauges nearby?
 - ◆ Is the gauge seated correctly on the soil?
 - ◆ Is the base of the gauge and the top of the soil both smooth and free of debris?
14. If all other conditions are normal, do not accept the standard count just taken. Press **<NO>** and take *another* standard count.

NOTE

If the second count also fails, the old standard count sets should be erased as described in Chapter 7. Successive standard count failures are usually the result of a prolonged period between the last standard count and the new one. This causes the tolerance to be exceeded because of source decay. After the old standard counts are erased, four new standard counts should be taken. Compare the new standard counts to those shown in the recent calibration report. The DS should fall into the range shown by month on pg. 2 of the report. The standard background count should be within 1% of that shown on the top of each page of the report.

15. Press **<YES>** to accept the new standard count and enter it into memory. If **<NO>** is pressed, the new count is not accepted, and the display returns to show the old values.

NOTE

Compare the new standard counts to those shown in the recent calibration report. The DS should fall into the range shown by month on pg. 2 of the report. The standard background count should be within 1% of that shown on the top of each page of the report.

Viewing the Last Four Standard Counts

1. To view the last four standard counts, press **<STD>**. The gauge displays:

Standard Count
DS= xxxx BGD= xxx
Take New Count?
<YES> or <NO>

2. Press **<NO>** for this display:

Standard Count
Want to View
Last Four counts?
<YES> or <NO>

3. Press **<NO>** to return to the *Ready* screen.
4. Press **<YES>** to view the last four standard counts.

Density Std. Counts
1:xxxx 2:xxxx
3:xxxx 4:xxxx
<YES> for Background

5. Press **<YES>** to view the background standard counts.

Background Std. Counts
1:xxxx 2:xxxx
3:xxxx 4:xxxx
<ENTER> to Continue

6. Press **<ENTER>** to return to the *Ready* screen.

Recording the Standard Count

Troxler recommends keeping a daily log of the density and background counts (see Appendix F for a sample log).

To verify gauge stability, compare the daily standard count to a reliable reference as follows:

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

$\pm 1\%$ each day for DS and

$\pm 1\%$ each day for Bkg

After recording the standard counts, press **(YES)** to return to the *Ready* mode.

NOTE

The factory standard count values should be used as a reference if the daily standard counts are ever in question. Be sure to refer to the most recent calibration report for the gauge in question.

Taking Measurements

The Model 4590 uses a low-level gamma-ray source and a highly efficient gamma-ray detector. Ensure that there are no other nuclear gauges within 30 feet (10 meters) of this equipment while in use. An excess of background radiation from a nearby gauge may affect the accuracy of the reading.



CAUTION

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

The *Status* function (see page 3–9) allows you to view selected information concerning the current gauge status and setup. To access the *Status* function, press the **(STATUS)** key. Check the gauge's current status before taking measurements.

Remember to take a standard count at least once each day the gauge is to be used (see page 4–2). A background count performed after the density count, should be done at the first test site each day and any time the material being measured or the environment changes.

The gauge can store measurement results in files (memory locations) called *projects*. For information on creating and activating project files, refer to Chapter 8. Upon completion of a measurement, the results can be stored either automatically by enabling the *Auto-Store* function (see page 8–12) or manually by using the *Store* function (see page 8–14).

NOTE

The Model 4590 reports either dry density or wet density measurements. For dry density results, a moisture measurement is required and can be keypad entered or measured using the provided probe. Additionally, the moisture measurement can be performed either before or after the density measurement (default). For wet density results only, the moisture measurement is typically disabled. See Sections titled, Moisture Input on page 5–8 and Measurement Order on page 5–9.

1. Prepare the test site and position the gauge as described on page 4-2.
2. With the source rod in the **SAFE** position, press **<START>**.
3. After initialization, follow the instructions on the display.
4. If the *Measurement Order* Option is set to *Default Setting* the gauge leads you through the procedure described in the section Taking Density Measurement on page 4-16 and then leads you through the procedure described in section Taking a Moisture Measurement on page 4-18.
5. If the *Measurement Order* Option is set to *Moisture First*, the gauge leads you through the procedure described in section Taking a Moisture Measurement on page 4-18 and then leads you through the procedure describe in section Taking Density Measurement on page 4-16.
6. If the *Moisture Input* option is set to *None*, the gauge only performs the procedure describe in section *Taking Density Measurement* on page 4-16.
7. When the density measurement is complete and a moisture reading is accepted from the supplied probe or entered using the keypad, the gauge displays the results:

<pre> %PR= xxx.x DD= xxx.x WD= xxx.x M= xxx.x %M=xxx.x </pre>	↑↓
---	----

<pre> DC= xxx BC= xxxx Diff= xxxx kHz </pre>	↑↓
--	----

<pre> Lat: + x x x.x Lng: + x x x.x </pre>	↑↓
--	----

where:

%PR = Percent Proctor – Displays only if the Target function is enabled. See Chapter 6: Target Menu on page 6-1.

DD = Dry Density – density value with the moisture content removed. If a moisture measurement is not used, the value displayed will match the wet density value.

Formula: $(DD/Proctor\ Target) \times 100$

WD = Wet Density – density value without the moisture content removed.

Formula: $(WD - M)$

M = Moisture Value

%M = Percent Moisture

Formula: $(M/DD) \times 100$

If % Voids (soil) is enabled, the gauge displays:

%Voids (soil) xx.x ↑ ↓
Voids Ratio: x.xx

DC = Density count

BC = Background count for this reading.

Diff = Moisture Probe raw data.

Lat = Latitude coordinates of this reading.

Long = Longitude coordinates of this reading.

NOTE

Lat and *Long* are displayed if the GPS is enabled and receiving signals from the GPS satellites. For accuracy of the GPS system see Appendix G.

8. Lift the gauge from the test site by the source rod handle. This returns the source rod to the **SAFE** position, where it should stay when not taking readings.

Taking Density Measurement

1. The gauge display prompts you to lower the source rod to the desired measurement depth and press **<ENTER/START>**.

**Move rod to desired
Measurement depth.**

Press <ENTER>

2. Move the rod to the desired depth position between 2 and 12 inches. Be sure the rod is seated properly in the position notch.
3. Gently slide the gauge to the right until the source rod is in contact with the side of the hole.
4. Press ENTER to start the measurement. The gauge displays:

**Depth: x in
PR:
xxx.x pcf
Time: xxx s**

NOTE

If the depth sensor detects an invalid depth the following displays.

Invalid Depth

Press <ENTER>

Reposition the rod at the correct depth. If the error continues, use the gauge in Manual Depth mode (see Setting the Automatic or Manual Depth on page 3–12) until it can be serviced by a Troxler authorized service center. In the Manual Depth mode, you will be prompted to enter the depth.

5. After the measurement completes, raise the handle to the

SAFE position and follow the instructions on the display.

BGD= xxxx
Is this background
Count current
Press <YES> or <NO>

- ▶ Press **<YES>** if conditions have not changed since performing the most recent background count. Follow the prompts on the display to complete the measurement.

NOTE

A background count should be performed after the density measurement on a new material and or at a new jobsite. Do this at the first test site daily as a minimum.

- ▶ If conditions have changed you should perform a new background count, Answer **<NO>** to the question and the following message displays:

With Gauge on
Test Site & Source
Rod in Background Pos.
Press <START>

- a. If you have opted to take a background count, lower the handle to the first position and press **<ENTER>**. The gauge takes a count and displays the following:

Getting background
Count Please wait
15s

When the background count is finished, the display shows:

BGD = xxxx
Press <ENTER>

- b. Press **<ENTER>** to continue.

Taking a Moisture Measurement with the Moisture Probe

In order to use the Moisture Probe, the Moisture Input must be set to External Sensor (default setting). See page 5-8.

1. Turn on the probe. The green light illuminates. The blue light on the probe remains solid when it has connected to the Bluetooth in the gauge.
2. Insert the moisture probe into the prepared hole. The hole must be at least 6 inches deep. The probe baseplate must have contact with the soil surface. The probe must fit tightly in the hole and have contact with the soil material on all sides. You should feel some resistance when placing it in the hole.
3. If the Moisture Input is set to External Sensor (default setting). The gauge prompts for this measurement.

Prepare Moisture Measurement?

Press <ENTER> to take a reading.

4. Once the probe moisture measurement (M) is displayed on the EGauge screen and has settled on value (3-4 seconds), press Enter to accept the reading and see the final result for the test.

Diff: xxxx.xx kHz
M: xx.xx pcf
Profile: General
<ENTER> to Accept.

Entering a Moisture Value from Another Method

1. If the Moisture Input is set to Manual Input, the gauge displays:

**Do you know the
Moisture content of
the soil?
Press <YES> or <NO>**

2. Press **<YES>** to input the moisture percentage:

**%Moisture Input
0.00
Press <ENTER>**

3. Enter the moisture percentage using the keypad and press **<ENTER/START>**.

Storing Measurement Data

After completing a measurement and before taking another measurement, data can be stored to an active project. Refer to Chapter 7: for instructions on creating and selecting the active project.

If a project is active and the *Auto-Store* function (see page 8–12) is enabled, press **⟨ESC⟩** or **⟨ENTER/START⟩** to continue. For each measurement, the gauge can store a location description of up to 12 characters, as well as a note of up to 15 characters. Follow the prompts to enter location information and/or a note.

If a project is active but the *Auto-Store* function is **not** enabled:

- ▶ Press **⟨STORE⟩** to store the results. Follow the prompts to enter location information and/or notes. For more information on storing results manually, see page 8–14.
- ▶ Press **⟨ESC⟩** to return to the *Ready* screen without storing the results. Note that, until another measurement has been taken, the results can be recalled (as described below) and stored later.

Recall

To view the results of the most recent measurement, press the **<RECALL>** key from the *Ready* screen. The *Recall* function can also be used to view the gauge counts from the most recent measurement.

To return to the *Ready* screen, press the **<ENTER/START>** key.

NOTE

The **<RECALL>** key is active only when the Ready screen is displayed.

Chapter 5:

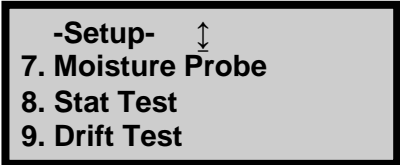
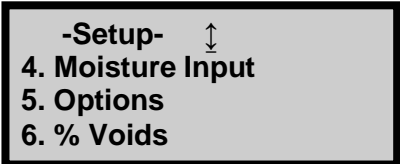
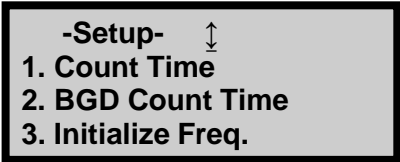
Setup Menu

This chapter covers the following topics and tasks:

- ✓ Overview of the Setup menu
- ✓ Setting count time and units
- ✓ Setting the depth mode
- ✓ Taking a stat test
- ✓ Taking a drift test
- ✓ Overview of optional features

Setup Menu

The gauge software groups most of the setup features into one menu. To access the *Setup* menu, press the **(SETUP)** key. The gauge displays:



NOTE

The **(SETUP)** key is active only when the Ready screen is displayed.

Use the arrows keys to scroll through the menu screens. To select a menu option, use the number key that corresponds to that option. The remainder of this section provides details on the functions available from the *Setup* menu.

Count Time

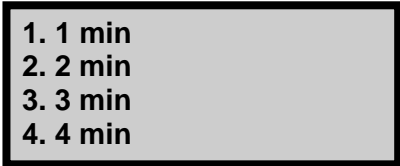
The gauge provides three different count times for taking measurements. To change the count time, see page 3–10.

A two-minute count time is recommended for the density measurement on most materials.

For the EGauges that offer the 9-12-inch depth positions, a minimum 3-minute count is required for the depths below 8 inches.

BGD Count Time

There are four options provided for background count time. Background radiation affects readings; a new background count is necessary when background environment or the material measured changes.

- 
- 1. 1 min
 - 2. 2 min
 - 3. 3 min
 - 4. 4 min

A one-minute background count is recommended for measurements depths two inches through eight inches.

For EGauges that offer depths of 9-12 inches, the background count is required for these depths. A minimum one- minute BGD count will be required by default. These deeper measurements are more sensitive to changes in background radiation.

Initialize Frequency

The *Initialize Frequency* function determines how often the gauge performs an initialization, or “warm-up,” before the measurement. Troxler recommends the default option of every 10 minutes.

To access this menu, press **<3>** from the *Setup* menu. The gauge displays:

- 1. Always *
- 2. 5 min
- 3. 10 min
- 4. 15 min

NOTE:

The active selection is noted by the asterisk

Select the desired count time using the corresponding number key. The gauge displays a brief confirmation menu and returns to the *Setup* menu.

Moisture Input

To select how you want to input moisture values, press **<4>** from the *Setup* menu shown on the previous page. The gauge displays:



- ▶ Press **<1>** to use an external sensor. Choose this option to use the provided moisture probe. The gauge displays a confirmation message and returns to the *Moisture Input* menu.
- ▶ Press **<2>** to input the value manually. Choose this option to input your percent moisture with each measurement result. An alternative method will be needed to determine the soil moisture content. The gauge displays a confirmation message and returns to the *Moisture Input* menu.
- ▶ Press **<3>** to disable the moisture input feature. Results provide wet density only. The gauge displays a confirmation message and returns to the *Moisture Input* menu.

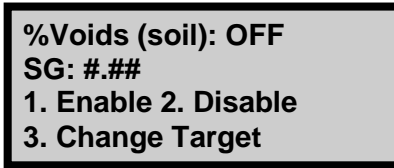
Options

To access this menu, press **<5>** and refer to page 5-17.

% Air Voids

The gauge uses the specific gravity function to calculate percent air voids and void ratio in *Soil* mode only. The % Voids function allows the operator to enter the specific gravity of a material and disable or enable the percent air voids display.

To access the % Voids function, press **<6>** at the *Setup* menu. The gauge displays:

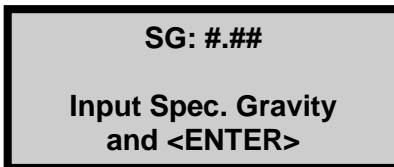


%Voids (soil): OFF
SG: #.##
1. Enable 2. Disable
3. Change Target

The current specific gravity (default 2.70) is shown on the second line of the display. For optimum results, use a specific gravity value that is appropriate for the material being measured.

- ▶ To enable the current specific gravity value, press **<1>**. The gauge enables the value, displays a brief confirmation message, and returns to the *Setup* menu.
- ▶ To disable the current specific gravity, press **<2>**. The gauge disables the value, displays a brief confirmation message, and then returns to the *Setup* menu.
- ▶ To enter a new specific gravity value, press **<3>**. The gauge prompts you for a new specific gravity. If the displayed specific gravity is acceptable, press **<ENTER/START>**.

To change the value, use the numeric keys to do so, and then press **<ENTER/START>**.

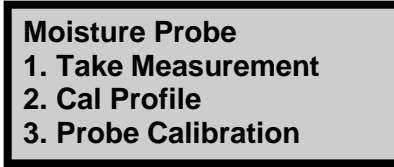


SG: #.##
Input Spec. Gravity
and <ENTER>

In either case, the gauge enables the value, displays a brief confirmation message, and then returns to the *Setup* menu.

Moisture Probe

The following options are available in the Moisture Probe Menu:

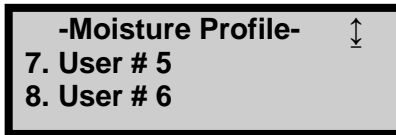
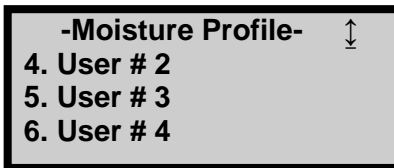
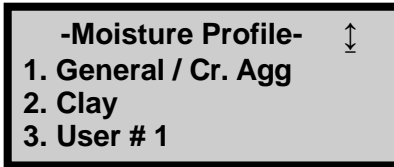


1. Performs a measurement with the probe.

To perform a moisture measurement with the external moisture probe without pairing with a density measurement, choose option 7. Moisture Probe from the Setup menu, then select option 1. Take measurement.

To Select a Probe Calibration Profile

Press 2. Cal Profile for the following menu to select Probe Calibration Profile.



2. Cal Profile allows the selection / enabling of the stored moisture probe calibrations.

General/ Cr. Agg and Clay are the calibration profiles available in the gauge by default (factory calibrations). These can be used to get a general moisture measurement; however, the user should create soil specific calibrations to accurately measure the moisture of the particular soil. Scroll down to access memory positions 1 – 6 where soil specific calibrations may be stored.

To Perform a Moisture Probe Calibration

To calibrate the probe to a specific soil in the field- create a soil specific Cal Profile. Carefully read and follow the steps below and use the worksheet in Appendix F for Moisture Cal Profile development to ensure that all the data needed is obtained.

1. Choose 3 to 25 sites to perform probe measurements and collect a sample to analyze in the lab (to determine true %M). More sites will create a better calibration, at least 5 sites are recommended. It is recommended the moisture content of these selected sites vary by 5% to achieve the best calibration curve.
2. At each site, perform the density reading and the moisture probe reading. As this is done, write down the WD and Diff values for each site (see worksheet on page. F-5 in back of manual). If you want the gauge to store these values as a partial calibration, choose “Gauge Derived” as the “Method of Data Entry” *before* performing the measurements.
3. Determine the True % moisture of the samples using your preferred method. Typically, this is done in a lab (oven dry) or onsite using a cook stove or Speedy moisture tester. These values will be entered during keypad entry of the data points or as the last step of the probe calibration if using the gauge derived method.

Follow these keypresses to perform the material specific probe calibration as described above:

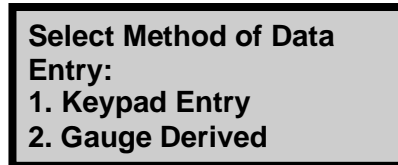
Select 3. Probe Calibration, under the Moisture Probe menu, to begin the new calibration for a specific soil.

Next determine if you want to 1. Create a new calibration or 2. Enter calculated constants (use option 2 if you have derived your own constants outside of the gauge software).

A screenshot of a menu titled "Probe Calibration" with two options: "1. Create New Cal" and "2. Enter Constants".

Probe Calibration
1. Create New Cal
2. Enter Constants

If choosing 1, the following screen will display:

A screenshot of a menu titled "Select Method of Data Entry:" with two options: "1. Keypad Entry" and "2. Gauge Derived".

Select Method of Data Entry:
1. Keypad Entry
2. Gauge Derived

Select 1. Keypad Entry to enter the data by hand after accumulating all information in the field (at the measurement sites) and the true % moisture (usually determined in the lab for the samples collected at these measurement sites).

Select 2. Gauge Derived to perform the density and moisture readings on the particular soil and store a partial calibration to be completed after the true %moisture has been determined (usually in the lab).

After Selecting 1. Keypad Entry or 2. Gauge Derived select the number of data points that have been or will be sampled (measurements performed, and sample collected for drying). This must be between 3 and 25 measurements in order to have a valid calibration.

If using keypad entry, the gauge will prompt for the data from each measurement site, the WD, Diff value and the True

%Moisture are all needed.

If using the Gauge derived, the gauge will then prompt you to perform reading #1 to be stored as a partial calibration. Perform the readings as usual.

Enabling a Stored Partial Calibration

At the Moisture Probe menu, choose Option 2, Cal Profile. Then scroll to select the stored partial profile which will be indicated by an asterisk symbol.

Stat Test

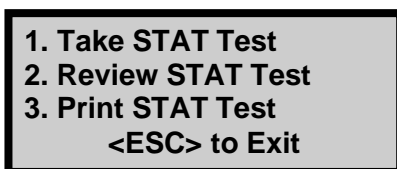
Erratic readings, or readings that seem to fluctuate, may indicate a problem with the gauge. If the readings are suspect, perform a *stat test*, or statistical stability test, to validate the normal operation of the gauge.

A stat test consists of twenty 1-minute counts. From the twenty counts, the gauge calculates the standard deviation. This standard deviation is compared to a theoretical standard deviation value. Ideally, this ratio should be 0.44, with acceptable limits from 0.18 to 0.70.

The gauge is considered unstable if the ratio is outside these limits and the stat test will fail. If the stat test fails, ensure that the gauge setup and testing was conducted correctly, and take an additional test. If the second test fails, contact the nearest Troxler service center for assistance.

For a list of Troxler and authorized Troxler service centers, refer to page *iii* of this manual or visit the Troxler website at: www.troxlerlabs.com/services.

To access the *Stat Test* function, press **<8>** at the *Setup* menu. The gauge displays the *Stat Test* menu:

- 
- 1. Take STAT Test**
 - 2. Review STAT Test**
 - 3. Print STAT Test**
 - <ESC> to Exit**

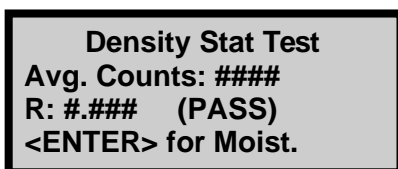
To select a menu option, press the corresponding numeric key or press **<ESC>** to return to the *Setup* menu.

Taking a Stat Test

Choose an area free of other nuclear gauges or radioactive sources. Place the gauge on a level surface and ensure the source rod is in the **SAFE** position.

To take a new stat test, press **<1>** at the *Stat Test* menu shown on the previous page, and then press **<ENTER/START>**.

The gauge displays the progress of the stat test (twenty 1-minute counts). Upon completion of the counts, the gauge displays the results of the density stat test, including an indication of whether the test passed or failed:



Density Stat Test
Avg. Counts: #####
R: #.### (PASS)
<ENTER> for Moist.

Press **<ENTER/START>** to view the results of the moisture stat test. Follow the prompts to scroll through the results.

Reviewing the Stat Test

To review the results of the last stat test, press **<2>** at the *Stat Test* menu shown on page 5-7. The gauge displays the results of the density stat test as shown above.

Printing the Stat Test

To print the results of the last stat test to a serial printer or computer via the gauge's 9-pin serial port, press **<3>** at the *Stat Test* menu shown on page 5-7. The gauge prompts the operator to connect the printer to the gauge.

Connect the serial cable to the printer or computer serial port. Press **<ENTER/START>**. The gauge prints or uploads the stat test data and returns to the *Stat Test* menu.

NOTE

Gauge Serial Communications Cable is Part Number 113128.

Drift Test

If the gauge passes the stat test, but shows long-term drift between measurements, perform a *drift test* to check the long-term drift of the gauge. A drift test consists of five counts taken three to eight hours after a stat test ***with no movement of the gauge between tests.***

The gauge sets the pass/fail limits based on the percent difference between the average of the stat test and drift test results. If the percent difference exceeds 0.5 percent for density counts, the drift test fails.

If the drift test fails, ensure that the gauge setup and testing were conducted correctly, and take an additional test. If the second test fails, contact the nearest Troxler service center for assistance.

For a list of Troxler and authorized Troxler service centers, refer to page *iii* of this manual or visit the Troxler website at: www.troxlerlabs.com/services.

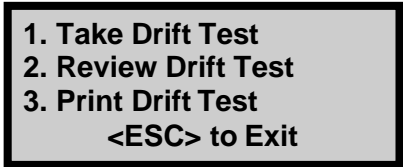
NOTE

The drift test consists of five 4-minute counts, whereas the stat test consists of twenty 1-minute counts. Therefore, each test takes approximately 20 minutes to conduct.

DO NOT turn the gauge off between a stat test and a drift test.

DO NOT move the gauge between the stat and drift tests to eliminate possible failure due to positioning changes.

To access the *Drift Test* function, press **<9>** at the *Setup* menu. The gauge displays the *Drift Test* menu:

- 
1. Take Drift Test
 2. Review Drift Test
 3. Print Drift Test
- <ESC> to Exit**

To select a menu option, press the corresponding numeric key or press **<ESC>** to return to the *Setup* menu.

Taking a Drift Test

To take a new drift test, press **<1>** at the *Drift Test* menu. Place the gauge on a level surface with the source rod in the **SAFE** (shielded) position, and then press **<ENTER/START>**.

NOTE

If it has been less than three hours or more than eight hours since the last stat test, the gauge displays an error message. Press **<ENTER/START>** to return to the Setup menu.

The gauge displays the progress of the drift test (five 4-minute counts). Upon completion of the counts, the gauge displays the results of the density drift test, including an indication of whether the test passed or failed:

Density Drift Test
Avg. Counts: ####
R: #.### (Pass)
<ENTER> for Moist.

Press **<ENTER/START>** to view the results of the moisture drift test. Follow the prompts to scroll through the results.

Reviewing the Drift Test

To review the results of the drift stat test, press **<2>** at the *Drift Test* menu. The gauge displays the results of the density drift test.

Printing the Drift Test

To print the results of the last drift test to a serial printer or computer via the gauge's 9-pin serial port, press **<3>** at the *Drift Test* menu. The gauge prompts the operator to connect the printer to the gauge.

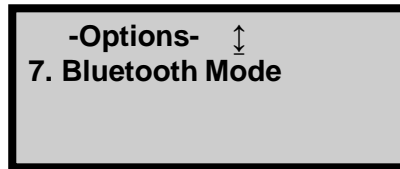
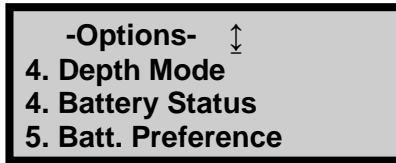
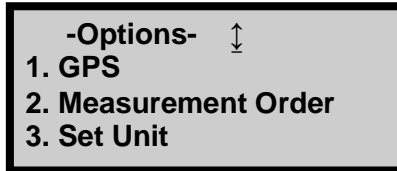
Connect the serial cable to the printer or computer serial port. Press **<ENTER/START>**. The gauge prints or uploads the drift test data and returns to the *Drift Test* menu.

NOTE

Gauge Serial Communications Cable is Part Number 113128.

Options

The Model 4590 gauge offers the following optional features that may be added to the gauge. These features can be toggled on and off from the *Options* menu, accessed by pressing **(5)** from the *Setup* menu.



GPS Option

The Model 4590 gauge can be equipped with an optional global positioning system (GPS) receiver. The GPS receiver enables the gauge to store precise GPS coordinates (latitude and longitude) for each measurement when satellite communication is available.

To toggle the *GPS* function on or off, press **(1)** on the *Options* menu shown above.

NOTE

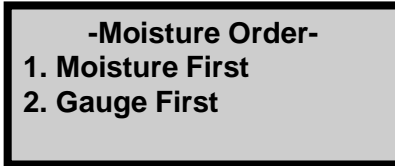
When the GPS option is installed and enabled, the symbol **g** appears in the upper right of the Ready screen when the gauge is receiving GPS satellite signals.

NOTE

If a Model 4590 equipped with the GPS option is moved a long distance between uses, the GPS system must be allowed to initialize. In some instances, initialization may take as long as 30 to 45 minutes from the time the gauge is powered on with the GPS enabled. Note also that the gauge must be positioned such that the GPS receiver can receive signals from the GPS satellites (see Appendix G for more information). If the GPS does not initialize within 45 minutes, contact your Troxler representative.

Measurement Order

To select what order the measurements are taken, press **<2>** from the *Options* menu. The gauge displays:



- ▶ Press **<1>** to take moisture measurements with the included probe first. The gauge displays a confirmation message and returns to the *Measurement Order* menu.
- ▶ Press **<2>** to take density measurement readings first. The gauge displays a confirmation message and returns to the *Measurement Order* menu.

Set Units

The gauge can display measurement results in either U.S. units (pcf) or metric (SI) units (kg/m³ or g/cm³). To change the units, see page 3-11.

Depth Mode

The Model 4590 gauge offers two depth modes: *Automatic* and *Manual*. The *Depth Mode* function allows the operator to select the depth mode, as described on page 3-12.

Battery Status

The *Battery Status* function displays the active battery and the voltage of both the NiMH (Rch) and alkaline batteries. To access this function, press **<5>** at the *Options* menu. The gauge displays:

Batt. Active: RCH
Rch: 7.00 V
Alk: 6.00 V
Press <ENTER>

If the NiMH (Rch) battery voltage is 6.0 volts or less, recharge the batteries as described on page A-9. Press **<ENTER/START>** to return to the *Setup* menu.

Battery Preference

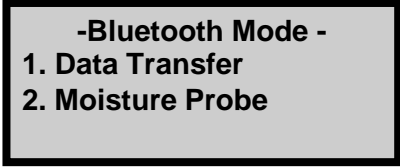
To switch from NiMH battery power to the Alkaline battery backup, press **<6>** from the *Options* menu. The gauge displays:

-Battery Preference-
1. Rechargeable NiMH
2. Alkaline

- ▶ Press **<1>** to select the rechargeable NiMH batteries. The gauge displays a confirmation message and returns to the *Battery Preference* menu.
- ▶ Press **<2>** to select the Alkaline battery backup. For instructions on installing these batteries, see page A-11. The gauge displays a confirmation message and returns to the *Battery Preference* menu.

Bluetooth Mode

Select Bluetooth Mode accessed by pressing (7) from the Options menu.



NOTE:

By default, the Bluetooth Mode is set to "2. Moisture Probe." This setting automatically changes to "1. Data Transfer" once Output Data is selected and changes back to "2. Moisture Probe" once the data transfer completes.

Data Transfer (Option 1)

Used when pairing the EGauge with another Bluetooth enabled device for transferring stored data from the gauge.

Moisture Probe (Option 2)

Use this option if the EGauge and Moisture probe are failing to connect. The EGauge will automatically reset to the Moisture Probe once any data transfer is complete.

Chapter 6:

Target Menu

This chapter covers the following topics and tasks:

- ✓ Overview of the Target menu
- ✓ Enabling and disabling the target value
- ✓ Storing a new target value

Target Menu

The gauge provides the ability to store up to four different Proctor values (PR) for later use. These values are used to calculate percent compactions of soil. The percent compaction calculations for *Soil* mode is as follows:

$$\text{Soil mode} = (\text{DD} \div \text{PR}) \times 100 = \% \text{PR}$$

The *Target* function enables you to enter and store a new target value, as well as enable or disable a target value stored in memory.

NOTE

Proctor values entered must be between 80 and 170 pcf (1280-2700 kg/m³). If value is outside these parameters an error displays the Proctor Target Exceeds Limits.

To access the *Target* menu, press the **<TARGET>** key. The gauge displays:

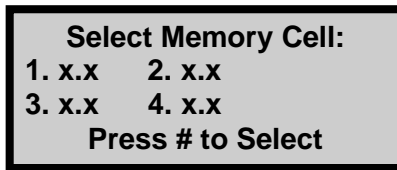
PR: ##	pcf
1. 0.0	2. 0.0
3. 0.0	4. 0.0
5. New	6. Disable

NOTE

The **<TARGET>** key is active only when the Ready screen is displayed.

- ▶ To set a new Proctor target value, press **<5>**. Enter the new target and press **<ENTER>**. After entering the value, the gauge prompts you to store the value for later use. Select **<YES>** or **<NO>**
- ▶ To disable and have no Proctor, press **<6>**.

- ▶ To use a Proctor value stored in the memory, press the number key. The gauge displays:



Select the desired memory cell by selecting the corresponding number key. The gauge displays a brief confirmation message and returns to the *Ready* screen.

Chapter 7:

Calibration Offsets

This chapter covers the following topics and tasks:

- ✓ Overview of the offset menu
- ✓ Enabling density, moisture, and trench offsets

About Offsets

The Troxler Model 4590 is factory-calibrated for typical soil materials. Gauge readings can be adjusted based on alternative density tests, such as sand cone or drive cylinder tests. This adjustment, or shift, is known as an *offset*.

NOTE

When an offset has been enabled, all future readings will automatically be adjusted until the offset is disabled or the gauge is turned off. Be sure to disable offsets and prior to taking readings on materials that do not require an offset. Offsets will be disabled if the gauge is turned off for more than 10 seconds.

The gauge provides *density*, *trench* and *moisture probe* offset options.

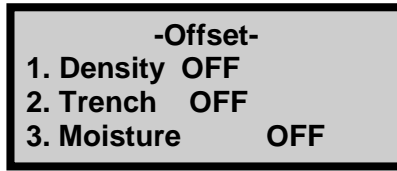
The *density* offset is often needed if the material has a density that is outside the range of 70 to 170 pcf (1100 to 2700 kg/m³). Also, if material has a high concentration of elements with atomic numbers greater than 20 (such as concrete, some coals, or ferrous soils).

A *trench* offset should be used if measurements are to be taken inside a trench or close to a solid structure such as a wall, barrier, or construction equipment. The Trench offset is not needed if all density measurements are to be performed at 6" (150 mm) or deeper in the trench situation.

A *moisture probe* offset is often needed to achieve accurate moisture results in the field on regional soils. The factory Cal Profiles are not representative of all soil types. This offset should be used when the moisture content of a laboratory sample differs from the reading provided by the Troxler Moisture Probe Model 6760 (included).

The moisture offset function is a simple procedure to adjust the moisture readings up or down. A new Cal Profile (p. 5-2) can also be created for regional soils if needed. This is generally used on soils with large moisture ranges. Otherwise, a moisture offset to one of the factory profiles works well.

To access the *Offset* menu, press **<OFFSET>**. The gauge displays:



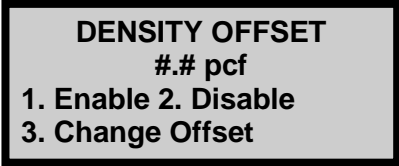
NOTE

The **<OFFSET>** key is active only when the Ready screen is displayed.

To select a menu option, press the corresponding number key. The remainder of this chapter details the functions available from the *Offset* menu.

Density Offset

To access the *Density Offset* functions, press **<1>** at the *Offset* menu.



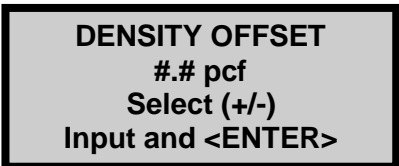
The gauge displays the current density offset on the second line.

- ▶ To enable the displayed density offset, press **<1>**. The gauge enables the offset, displays a brief confirmation message, and returns to the *Ready* screen.
- ▶ To disable the density offset, press **<2>**. The gauge disables the offset, displays a brief confirmation message, and returns to the *Ready* screen.

NOTE

The density offset is also disabled when the gauge is turned off for more than 10 seconds.

- ▶ To enter a new density offset, press **<3>**. The gauge prompts for the density offset as shown:



The density offset value is determined by calculating the difference between the gauge wet density result and an alternative wet density measurement (Ex. Sand cone or drive cylinder) performed on the particular soil being measured.

To change the offset, select the sign (positive or negative) using the up and down arrows, enter the density offset value (in lb/ft³ or kg/m³), and press **<ENTER/START>**. The gauge enables the new density offset and returns to the *Ready* screen.

Trench Offset

Vertical structures such as the walls of a building, trench, or ditch often “echo” gamma photons back to the gauge, which may adversely affect density measurements. *Trench offsets* compensate for the influence of vertical structures on measurements.

Use a trench offset if taking a measurement inside a trench or within 18 inches (45 cm) of a large vertical structure. The walls of the trench or structure may scatter the gamma photons back to the gauge, resulting in inaccurate density readings. When used, the trench offset adjusts only the density measurements from 2 in. (5 cm) to 4 in. (10 cm). If your density measurements are 5 inches or greater in depth, a trench offset is not necessary.

1. To access the *Trench Offset* menu, press **(2)** at the Offset menu. The gauge displays:



2. When enabled the gauge corrects for the influence of the trench at depth 2 inches through 4 inches (50 mm through 100 mm). This correction is predetermined, and no further steps are to be performed by the operator.

NOTE

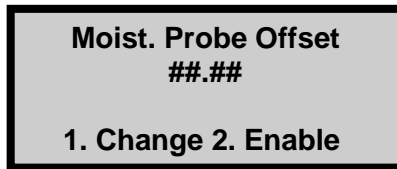
If all density measurements in the trench situation are to be performed at depths greater than 4 inches (100 mm) in depth the trench offset is not needed.

Moisture Probe Offset

The moisture offset adjusts the moisture probe (Model 6760) readings to match an alternative moisture measurement (ex: oven dry). This is often necessary because the factory moisture Cal Profiles do not represent all soil types. An alternative moisture measurement method must be used to find the %M needed for the offset determination.

Carefully read and follow the instructions below before beginning the Moisture offset process.

To access the *Moisture Offset* menu, press **<3>** at the *Offset* menu shown on page 7-2. The gauge displays:



The *Moisture Offset* menu shows the moisture offset values stored in memory (if any) and the Change and Enable/Disable options.

NOTE

If a value is already enabled, the display shows the Enable option instead.

To change the displayed value, or create a new offset, press **<1>**.

- ▶ To enable the displayed value, press **<2>**. The gauge enables the moisture offset value and returns to the *Ready* screen.

To change the *Moisture Offset* value press 1 at the menu above.

The gauge then asks for the Probe Moisture value (M) in lb/ft³ or kg/m³. Press Enter after entering the M value from the probe reading.

NOTE

A moisture offset simply adds or subtracts a set value to the moisture probe reading using the enabled calibration (usually a factory calibration). The Moisture Probe Calibration (page 5–15) recalibrates the probe for that particular soil allowing a material specific profile to be created.

**Input Probe
Moisture**
M= 0.00 pcf
<ENTER> to Accept

Then enter the Wet Density value from the initial measurement site. Press Enter to accept.

Input Wet Density
WD= 0.0 pcf
<ENTER> to Accept

Last enter the True Moisture percent (%M) resulting from the lab moisture analysis (oven dry or Speedy for example) of the soil taken from the initial site.

Input True Moisture
%M= 0.00 %Wt
<ENTER> to Accept

The gauge then displays the new moisture offset value and returns to the Offset menu.

Chapter 8:

Project Data

This chapter covers the following topics and tasks:

- ✓ Overview of the Project menu
- ✓ Selecting and viewing projects
- ✓ Creating new projects
- ✓ Erasing projects
- ✓ Outputting and printing projects
- ✓ Deactivating projects
- ✓ Using the Auto-Store feature
- ✓ Using the Manual Store feature

Project Menu

The gauge can store up to 1000 readings. The *Project* and *Store* functions allow handling of measurement data. Measurement results are stored in files (memory locations) called *projects*, which are named by the operator.

Projects are managed using the *Projects* menu. From this menu, the operator can select a project (make an existing project active so that additional data may be added to it), view project data, create a new project, erase projects, output project data to the selected destination (via the serial or USB port), deactivate a project, and enable the *Auto-Store* function.

To access the *Projects* menu, press **<PROJ>**. The gauge displays:



NOTE

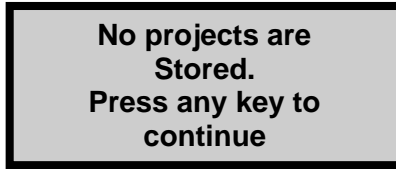
The **<PROJ>** key is active only when the Ready screen is displayed.

Use the arrow keys to scroll through the menu options. Use the numeric keys to select a menu option. Press **<ESC>** to return to the *Ready* screen.

Select a Project

To select an existing project, press **<1>** at the *Projects* menu shown on page 8-2.

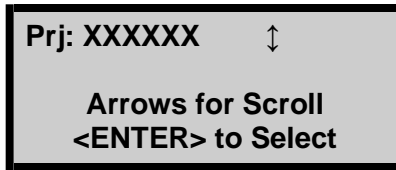
- ▶ If no projects have been created, the gauge displays the error message:



**No projects are
Stored.
Press any key to
continue**

Press any key to return to the *Projects* menu, and create a project as described on page 8-5.

- ▶ If a project has been created, the gauge displays:



Prj: XXXXXX ↕

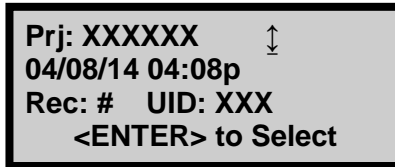
**Arrows for Scroll
<ENTER> to Select**

Use the arrow keys to scroll through the names of the existing projects. When the desired project is displayed, press **<ENTER/START>** to select it as active. The gauge sets the selected project as active, briefly displays a confirmation message, and returns to the *Projects* menu.

View Project Data

The gauge offers two methods of viewing data. You can either view the last measurement results using the *Recall* function (see page 4–20), or any measurement results, including project notes, stored in a project file using the *View* function available from the *Projects* menu.

To view data stored in a project file, press **<2>** from the *Projects* menu. The gauge displays:



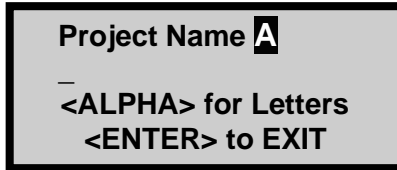
Use the arrow keys to scroll through the project names. Press **<ENTER/START>** when the gauge displays the desired project name. If any measurement data has been stored in the selected project file, the gauge displays the data for the first measurement.

Six screens of information are displayed for each measurement. Use the up and down arrows to scroll through the project data.

Press the **<ESC>** key to return to the project selection screen shown above.

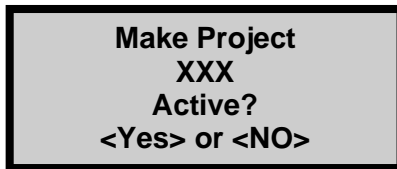
Create a Project

To create a new project, press **<3>** at the *Projects* menu. The gauge displays:



Press the **<ALPHA LOCK>** key to enable the alphabetic keys on the gauge. When the alphabetic keys are enabled, the symbol **A** appears in the upper right of the display, as shown above.

Enter the project name (up to twelve alphanumeric characters) and press the **<ENTER/START>** key. The gauge displays:



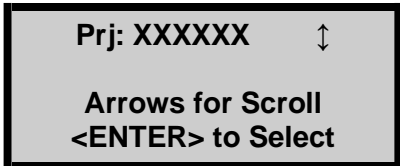
- ▶ To save the new project name without activating it, press **<NO>**. The gauge saves the new project, briefly displays the name of the active project (if any) and returns to the *Projects* menu.
- ▶ To save the new project name *and* activate the project, press **<YES>**. The gauge enables the new project, displays a brief confirmation message, and returns to the *Projects* menu.

Erase Projects

To erase either a selected project file or all project files, press **<4>** at the *Projects* menu. The gauge displays the *Erase* menu:



- ▶ To erase a single project, press **<1>**. If more than one project has been created, the gauge displays:



Use the arrow keys to scroll through the project names displayed on the first line. When the gauge displays the desired project, press **<ENTER/START>**. At the **Are you sure?** prompt, press the **<YES>** key. The gauge erases the project and returns to the *Projects* menu.

- ▶ To erase all projects, press **<2>** at the *Erase* menu. At the **Are You Sure?** prompt, press the **<YES>** key. The gauge erases all the projects and returns to the *Projects* menu.

Output Project

The *Output Project* function within the *Projects* menu allows the operator to print or upload project data stored in the gauge to a computer or serial printer connected to the serial port, to a USB printer or storage device connected to the USB port, or to a Bluetooth enabled device. To select the output destination, see page 8–9.

Uploading or Printing Project Data

Uploading Data Using the Serial Port

You can upload project data to a computer via the serial port using Troxler’s Gauge Download Program, available at: www.troxlerlabs.com/downloads/software/gaugedownload.zip

You can also upload the data using Windows® HyperTerminal or Terra Term. See the “Downloading Data” procedure at www.troxlerlabs.com/documents for HyperTerminal instructions.

To output project data via the 9-pin serial port, connect a serial cable to the port. An optional serial cable, P/N 113128, is available from Troxler. Connect the serial cable to the computer’s COM port (or a printer’s serial port).

Uploading or Printing Data Using the USB Port

To output project data to a USB printer via the USB port, connect a USB cable to the USB port and connect the cable to the USB printer. To output project data to a USB storage device, connect the storage device directly to the USB port.

NOTE

The opening for the USB port accepts a device with maximum dimensions of 10 mm (0.40 in.) high by 29 mm (0.79 in.) wide.

Uploading Data to Bluetooth Devices

Gauge Reader App is a useful tool for uploading project data and is available on Google Play.

Spreadsheet Column Definitions

Table 2. Spreadsheet Column Definitions

A	Record Number	U	Center Line Distance
B	Time and Date	V	Gmb Target
C	Project Name	W	Gmm Target
D	User	X	Proctor Target
E	Mode:	Y	Specific Gravity
F	Units	Z	Bottom Layer Density
G	Location	AA	Top Layer Thickness
H	Notes	AB	Density Offset
I	Wet Density	AC	Moisture Offset
J	Dry Density	AD	Trench Density Offset
K	Moisture	AE	Trench Moisture Offset
L	% Moisture	AF	Model Number:
M	%Gmb	AG	Serial Number
N	%Voids	AH	Depth
O	%Proctor	AI	Time (Count Time)
P	%Voids – Soil	AJ	Density Standard Count
Q	Voids Ratio	AK	Moisture Standard Count
R	Latitude	AL	Density Count
S	Longitude	AM	Moisture Count
T	Center Line Side		

Set Output Destination

To select the output destination, press **<6>** at the Projects menu.
The gauge displays:



Option 1 – Serial Port

Selecting Option 1 Serial Port allows the data to output to either a computer or serial printer connected to the serial port.

Option 2 – USB Printer

Selecting Option 2 USB Printer allows the data to output to a printer connected to the USB Port.

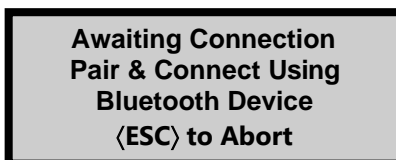
Option 3 – USB Storage

Selecting Option 2 USB Storage allows the data to output to a storage device connected to the USB Port

Option 4 - Bluetooth

Selecting option 4 Bluetooth allows the data to output to a Bluetooth enabled device for future uploading of projects.

Upon choosing Option 5 “Output Project” from the project menu, the following screen appears.



Complete Pairing on the Bluetooth enabled device.

A Confirmation screen displays once pairing is successful.

Deactivate a Project

To deactivate the current project without selecting a different one as active, press **(7)** at the *Projects* menu. The gauge deactivates the current project, displays a brief confirmation message, and returns to the *Projects* menu. Press **(ESC)** to return to the *Ready* screen.

Auto-Store

The *Auto-Store* function automatically stores sample data upon completion of a measurement. The data is stored under the active project, using a sequential sample ID number. When a new project is created, the sample ID number for the *Auto-Store* function starts at 1 and is incremented each time a new measurement is stored automatically or manually.

To access the *Auto-Store* function, press **<8>** at the *Projects* menu shown on page 8-2. The gauge requests an access code (see the front of this manual). After entering the code, the gauge displays:

Auto-Storage: OFF
1. ON
2. OFF
Press # to Select

- ▶ To return to the *Projects* menu without changing the *Auto-Store* status, press **<ESC>**.
- ▶ To turn the *Auto-Store* function on, press **<1>**.
- ▶ To turn the *Auto-Store* function off, press **<2>**. The gauge updates the *Auto-Store* status, displays a brief confirmation message, and returns to the *Projects* menu.

Active Project Selected

If you attempt to enable the *Auto-Store* function and a project has been selected as active, the gauge enables the *Auto-Store* function, briefly displays the confirmation message shown below, and then returns to the *Projects* menu.

Auto-Storage
Is Now ON
Prj: XXX
Next Sample # X

No Project Data

If you attempt to enable the *Auto-Store* function but no project has been created, the gauge displays:

**No Project Data
Do You Want To
Enable Auto-Store by
Creating a Project?**

- ▶ To return to the *Projects* menu without enabling the *Auto-Store* function, press **<NO>**.
- ▶ To create a project and enable the *Auto-Store* function, press **<YES>**. The gauge displays the screens required to create a project as described on page 8–5. When the project name is complete, the gauge sets the project as active, displays the confirmation message shown on page 8–12, and returns to the *Projects* menu.

No Project Selected

If the operator attempts to enable the *Auto-Store* function and one or more projects have been created, but no project has been selected as active, the gauge displays:

**Auto-Store Requires
An Active Project:
1. Select Project
2. Create Project**

To select an existing project, press **<1>**. The gauge displays the screens required to select a project as described on page 8–3. After the project is selected, the gauge sets the project as active, briefly displays the confirmation shown on page 8–12 and returns to the *Projects* menu.

To create a new project, press **<2>**. The gauge displays the screens required to create a. After the project is created, the gauge sets the project as active, briefly displays a confirmation message, and returns to the *Projects* menu.

Manual Store

After completing a measurement and before taking another one, sample data can be stored manually under the active project. Refer to pages 8-3 through 8-5 for instructions on creating and selecting the active project.

To manually store measurement data, press the **⟨STORE⟩** key while data is being displayed. If no project is active when the **⟨STORE⟩** key is pressed, the gauge displays the error message **No active project!** then returns to the *Ready* screen.

NOTE

The **⟨STORE⟩** key is active only when measurement data is displayed. Measurement data is displayed at the end of a reading, or the most recent test results can be displayed using the **⟨RECALL⟩** key (see page 4-20).

For each measurement, the gauge can store a location description of up to 12 characters, as well as a note of up to 15 characters.

Chapter 9:

Extended Menu

This chapter covers the following topics and tasks:

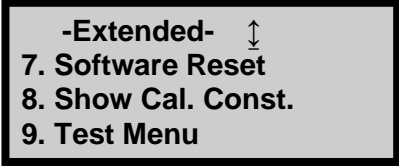
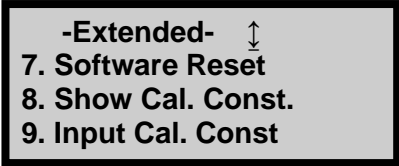
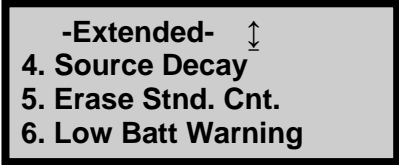
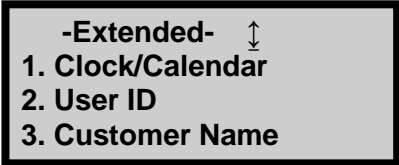
- ✓ Setting the date and time
- ✓ Setting a user ID and customer name
- ✓ Viewing source decay information
- ✓ Erasing standard counts
- ✓ Setting the Low Battery Warning display options
- ✓ Resetting the software

Extended Menu

To access the *Extended* menu, press **<SETUP>** to display the *Setup* menu, then press **<.>** **(9)**. The gauge requests an access code:



Enter the access code shown on page xv and press the **<ENTER/START>** key. The gauge displays the *Extended* menu:

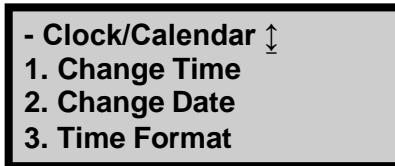


Use the up and down arrows to scroll between the menu options. To select a menu option, press the corresponding numeric key. To return to the *Setup* menu, press the **<ESC>** key.

Clock/Calendar

The *Clock/Calendar* function allows the operator to change the date and time, and to select the display format for each. To access the *Clock/Calendar* menu, press **<1>** at the *Extended* menu.

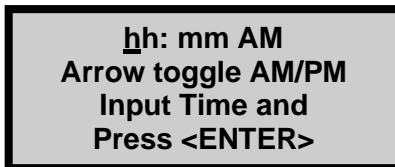
The gauge displays:



Use the up and down arrows to scroll between the menu options. To select a menu option, press the corresponding numeric key. To return to the *Extended* menu, press the **<ESC>** key.

CHANGE TIME

To change the time, press **<1>** at the *Clock/Calendar* menu. The gauge displays:



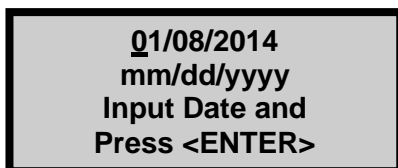
(Note that in this example, the time is displayed in *AM/PM* format. To change the format, see the *Time Format* section on the following page.)

To accept the displayed time, press **<ENTER/START>**. To change the time, use the numeric keys to enter the new time, and the arrow keys to toggle between *AM* and *PM*. Press

<ENTER/START>. The gauge sets the time and returns to the *Clock/Calendar* menu.

CHANGE DATE

To change the date, press **<2>** at the *Clock/Calendar* menu. The gauge displays:



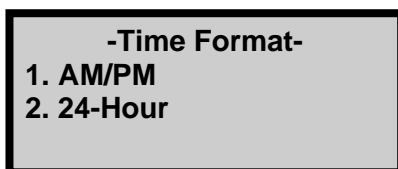
01/08/2014
mm/dd/yyyy
Input Date and
Press <ENTER>

(Note that in this example, the time is displayed in *mm/dd/yyyy* format. To change the date format, refer to the *Date Format* section below.)

To accept the displayed date, press **<ENTER/START>**. To change the date, use the numeric keys to enter the new date. When finished, press **<ENTER/START>**. The gauge sets the date and returns to the *Clock/Calendar* menu.

TIME FORMAT

The gauge can display the time in either *AM/PM* or *24-hour* format. To select the desired time format, press **<3>** at the *Clock/Calendar* menu. The gauge displays:



-Time Format-
1. AM/PM
2. 24-Hour

Use the numeric keys to select the desired time format. The gauge sets the time format and returns to the *Clock/Calendar* menu.

DATE FORMAT

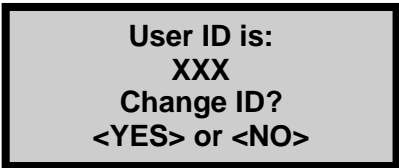
The gauge can display the date in either *mm/dd/yyyy* or *dd/mm/yyyy* format, where *mm* is the month, *dd* is the day, and *yyyy* is the year. To change the date format, press **<4>** at the *Clock/Calendar* menu. The gauge displays:



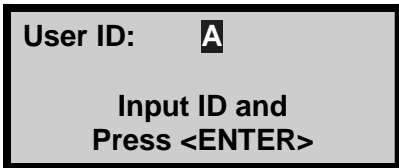
Use the numeric keys to select the desired format. The gauge sets the date format and returns to the *Clock/Calendar* menu.

User ID

The gauge can store a three-character alphanumeric *user ID* with each measurement. To enter or change the user ID, press **<2>** at the *Extended* menu. The gauge displays:



To change the user ID, press **<YES>**. The gauge displays:



Press the **<ALPHA LOCK>** key to enable the alphabetic keys on the gauge. When the alphabetic keys are enabled, the symbol **A** appears in the upper right of the display, as shown above.

Enter the new user ID and press **<ENTER/START>**. The gauge stores the new user ID and returns to the *Extended* menu.

Customer Name

The gauge can store a customer name of up to 12 alphanumeric characters. To enter a customer name, press **<3>** at the *Extended* menu. The gauge displays the current customer name on the second line.


A rectangular box with a black border representing a gauge display. The text inside is centered and reads: "Customer Name is: CUSTOMER Change Name? <YES> or <NO>".

Customer Name is:
CUSTOMER
Change Name?
<YES> or <NO>

To change the customer name, press **<YES>**. The gauge displays:

A rectangular box with a black border representing a gauge display. The text inside is centered and reads: "Customer Name: A Input Name and Press <ENTER>".

Customer Name: A
Input Name and
Press <ENTER>

Press the **<ALPHA LOCK>** key to enable the alphabetic keys on the gauge. When the alphabetic keys are enabled, the symbol  appears in the upper right of the display, as shown above.

Enter the new name and press the **<ENTER/START>** key. The gauge stores the new customer name, then returns to the *Extended* menu.

Press **<ESC>** twice to return to the *Ready* screen.

Source Decay

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 Cs-137 source is 30 years.

The *Source Decay* function allows the operator to view how the decrease in the radiation intensity of the source affects gauge density measurements. It displays the actual density standard count, the predicted standard count, and the percent difference between the two sets of counts. The gauge calculates the predicted standard count based upon the density standard count at the time the gauge was calibrated and the number of days that have elapsed since calibration.

To access the *Source Decay* function, press **<4>** at the *Extended* menu. The gauge displays:

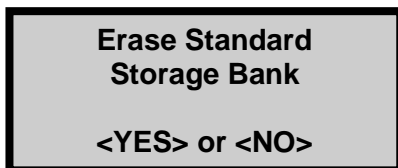
Standard After Decay Current: ### Predicted: ### %Diff: ###
--

To return to the *Extended* menu, press the **<ENTER/START>** or **<ESC>** key.

Erase Standard Counts

The *Erase Standard Counts* function allows the operator or service technician to remove all (four) standard counts from gauge memory.

To execute the *Erase Standard Counts* function, press **<5>** at the *Extended* menu. The gauge displays:



- ▶ To return to the *Extended* menu without erasing the standard counts stored in memory, press **<NO>**.
- ▶ To erase all the standard counts, press **<YES>**. The gauge erases the standard counts stored in memory and returns to the *Extended* menu.

Low Battery Warning

The *Battery Status* function (see page 5–12) displays the status of the battery voltage. If the battery voltage falls below a pre-determined threshold, the gauge displays a low-battery warning symbol (☐) in the upper-right corner of the *Ready* screen.

By default (*Normal* setting), the low-battery warning is displayed when the battery voltage falls below 6.2 V dc. At that point, the gauge has approximately three hours of battery operating life left, or less if the backlight is used. If the gauge is equipped with a GPS unit, the remaining battery operating life is approximately one hour.

The *Low Battery Warning* function enables the operator to select how early or late the low-battery warning is displayed. An early setting provides more time between when the warning is displayed and when the gauge shuts down. A later setting provides less warning time.

To access this function, press <6> at the *Extended* menu. The gauge displays:



Use the up and down arrows to scroll between the menu options. To select the desired low battery warning option, press the corresponding numeric key. The gauge displays the battery voltage threshold associated with the selected option, and then returns to the *Extended* menu.

Software Reset

The *Software Reset* function sets selected user setup values (count time, measurement units, depth mode, user ID, customer name, etc.) to their factory default values.

NOTE

The Software Reset function does not affect the calibration constants, gauge serial number, clock and calendar settings, or projects stored in the gauge memory.

To access this function, press **<7>** at the *Extended* menu. The gauge displays:

**System Reset Sets
System Variables to
Defaults! Continue?
<YES> or <NO>**

- ▶ To return to the *Extended* menu without resetting system variables, press **<NO>**.
- ▶ To reset system variables to default values, press **<YES>**. The gauge resets the system variables and returns to the *Extended* menu.

Show Calibration Constants

The *Show Calibration Constants* menu displays current calibration constants programmed in the gauge memory. To access this function, press **<9>** at the *Extended* menu. The gauge displays:

```
A/1: #.#####  
B/1: #.#####  
C/1: #.#####  
<ENTER> to Continue
```

To return to the *Extended* menu, press **<ESC>**.

Test Menu

NOTE

The functions available from the Test Menu are to be used by qualified service personnel only!

Appendix A:

Maintenance & Troubleshooting

This appendix covers the following topics and tasks:

- ✓ Troubleshooting and error messages
- ✓ Maintaining and servicing your gauge
- ✓ Cleaning the gauge
- ✓ Battery information
- ✓ Replacement parts list
- ✓ Returning the gauge for service

Troubleshooting

Gauge Fails Standard Counts

1. Ensure that the guidelines for performing the standard count listed on page 4–5 are followed.
2. Perform the standard count again. If it still fails, contact your nearest Troxler service center or representative.

No Density Readings

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



CAUTION

Also, the gauge may have gotten wet. The Model 4590 gauges are not waterproof and should not be used in the rain. If the gauge gets wet, make sure it is completely dry before sealing it in the case for storage.

As a precaution, ensure that the tip of the source rod is intact and undamaged. Use a radiation survey meter to check the radiation levels at the surface of the gauge base where the source rod exits (without extending the source rod). A maximum reading of .2 mrem/hr is normal, and indicates the source is present. If the maximum reading is less than 0.1 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.

Extend the source rod just far enough to see the source rod tip. The tip should appear flat to slightly rounded and smooth. Complete the inspection as quickly as possible and stay at least 1 meter from the rod tip to minimize exposure.

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

1. Initiate a search for the source starting at the location where the gauge was last used.

2. Report lost or missing radioactive sources to your state or federal radiation control agency in accordance with applicable regulatory requirements.
3. Contact the Troxler Radiation Safety Department for further advice.


Gauge Readings Appear Erratic

1. Ensure that the source rod is properly positioned in the desired measurement position.
2. Ensure that the gauge is not wet.
3. Check count time – a four-minute count gives the highest precision.
4. Perform a statistical stability (stat) test.
 - ▶ If test passes, proceed with job.
 - ▶ If test fails, repeat two more times. If test fails two out of three times, contact the nearest Troxler Service Center.

Gauge Turns off after it is Turned On

1. The gauge automatically turns off after five hours if no keys are pressed. Try to turn the gauge on again.
2. The gauge may be wet. Do not turn the gauge on until the gauge is completely dry, as component damage may result.
3. If the battery is below 5.5 volts, recharge or replace the batteries.

Short Battery Life after Recharging

1. Check that you are using the correct charger.
2. Ensure the charging icon () displays on the top-right of the display.
3. NiMH batteries may be charged up to 500 full charge-discharge cycles. The batteries may be reaching end of life cycle and may need to be replaced.



CAUTION

All information stored in the gauge except the calibration constants is lost when the batteries are disconnected.

4. The AC charger may be defective. Check voltage output of charge with a voltmeter or use the DC charger to charge the batteries.

Satisfactory Counts, but Results are in Error

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

Possible Malfunction Indicators

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

Error Messages

The following table displays a list of the gauge error messages, as well as the possible causes and recommended solutions for each message.

Table 3. Error Messages

Error Message	Possible Causes	Solution
Bad Checksum! Default Settings Restored	Gauge settings and/or project data stored in memory have been corrupted and default (factory) settings have been restored.	Set up user preferences (such as measurement mode, count time, and so on) as described in Chapter 3.
Cannot Close File after Writing.	An error occurred when attempting to store data to a USB storage device.	Try to store the data again. If error recurs, try a different USB storage device.
Cannot Initialize Media	An error occurred when trying to access the USB storage device.	Check that the USB storage device is installed properly. If error recurs, try a different USB storage device.
Cannot Open Printer	An error occurred when trying to communicate with a USB printer.	Check that the printer is powered on and is properly connected to the USB port. Ensure that the printer is compatible with the gauge.
Cannot Write to the File	An error occurred when attempting to store data to a USB storage device.	Try to store the data again. If error recurs, try a different USB storage device.
Cannot Write to the Printer	An error occurred when trying to communicate with a USB printer.	Check that the printer is powered on and is properly connected to the USB port. Ensure that the printer is compatible with the gauge.

Error Message	Possible Causes	Solution
Depth Sensor Error. Enable Manual Mode	A hardware problem has occurred with the depth strip.	<i>Enable Manual</i> depth mode. Contact 877-TROXLER and press "2" and TroxTechSupport@troxlerlabs.com
Initialization Error	System is unable to initialize. Another gauge or nuclear source nearby. Vertical surface too close. Must be at least 6 feet away. Insufficient warm-up time.	This occurs if the source rod is not in the SAFE position during initialization. If the error continues to show in the SAFE position, contact the Troxler Service Center.
Error Writing to the File	An error occurred when attempting to store data to a USB storage device.	Try to store the data again. If error recurs, try a different USB storage device.
Error! Stat Test Not Valid	Operator has tried to run a drift test without having a valid stat test.	Perform a stat test, and then run a drift test.
Gauge Requires Re-calibration! Contact Tech Support	The calibration constants stored in the gauge have become corrupted.	Contact the Troxler Service Center.
Invalid Access Code	Operator entered an invalid access code.	Enter the correct access code (see the front of this manual).
Invalid Depth	The source rod is not at a valid depth when starting a measurement.	Ensure the source rod position is at a valid depth when starting a measurement. Contact the Troxler Service Center.

Error Message	Possible Causes	Solution
Moisture Offset Exceeds Limits!	The moisture offset is outside the accepted range.	Enter a new moisture offset.
-nan	Gauge cannot calculate results.	Take new standard and background counts. Ensure the source rod position matches what is shown on the screen. If problem continues, contact the Troxler Service Center.
No active project!	Operator tried to store measurement data, but no project is active.	Select an existing project or create a new project and select as active.
Proctor Target Exceeds Limits!	The target value must be between 80 and 170 pcf. The operator has entered a value outside this range.	Enter a target value between 80 and 170 pcf.
Project has No Data!	Operator attempted to view a project with no data.	Select the correct project when attempting to view.
Warning!! Time to Reach Precision too high	When using the <i>Precision</i> function, the time required to reach the selected precision value exceeds 60 minutes.	Enter a different precision value or disable the Precision function.
Error 13	System is unable to initialize.	Issue with Gamma Detector. Contact Troxler Service Center
Error 64	System is unable to initialize.	Issue with Gamma Detector. Contact Troxler Service Center
Remote Keypad Failure	If remote START button is active for more than 20 sec "Remote START button failure! Displays.	Press YES to ignore and continue. The same changes apply to remote ESC button.

Batteries

The gauge is equipped with a rechargeable nickel-metal hydride (NiMH) battery pack containing five C batteries. When the rechargeable battery is fully charged it will indicate 7.0 V. When the NiMH batteries drop below 5.5 V, the gauge shuts off. Troxler recommends recharging the NiMH batteries. The NiMH batteries can be fully recharged in only three hours.

Backup gauge power can also be supplied using the AA alkaline batteries supplied with the gauge as described.

Table 4 shows the typical operating life of a new, fully charged NiMH battery pack and a set of new AA alkaline batteries. As shown in the table, the typical battery operating life is impacted by the use of the backlight and whether or not the gauge is equipped with a GPS unit.

Table 4. Typical Battery Operating Life

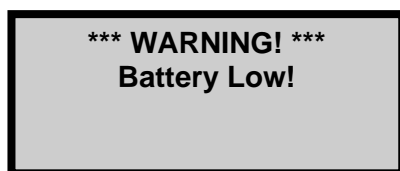
Backlight	GPS Installed?	Typical Life, NiMH Battery Pack*	Typical Life, AA Batteries*
Off	No	40 hours	12 hours
Off	Yes	13 hours	6 hours
On	Yes	8 hours	5 hours
On	No	14 hours	8 hours

* From full charge
Model 4590

Battery Charging


With fully charged batteries, the Model 4590 gauge remains operational for approximately one week under normal (8-hour day) conditions.

If the batteries become discharged, the following message displays on the gauge:



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

To charge the NiMH batteries:

1. Plug the AC charger or DC adapter into the charger connector in the gauge's control panel (see Figure 3. Model 4590 Control Panel on page 3-3).
2. If using the AC charger, plug the other end of the charger into a standard 100-240 V AC outlet. If using the DC adapter, connect the other end to any 12-14 V DC source (such as a vehicle's power receptacle). The charging icon () shows at the top-right of the screen.
3. After recharging the batteries, unplug the AC charger or DC adapter and store for later use.

Installing and Using Alkaline Batteries

The Model 4590 gauge includes alkaline battery for backup use. To install the batteries:

1. Turn the gauge off.
2. Remove the two thumb screws on the battery cover.
3. Remove the black battery holder from the battery well and remove the old batteries.
4. Install five standard AA alkaline batteries into the battery holder, alternating positive and negative.
5. Replace the battery holder into the battery well and replace the cover and screws.

NOTE

To power the gauge using the alkaline batteries, refer to the Battery Preference section on page 5–9.

Mechanical Maintenance

The following procedures should be performed to keep the Model 4590 gauge in good working order. If a serious problem with the gauge arises, contact the nearest Troxler Service Center or representative for instructions.

For a list of Troxler and authorized Troxler service centers, refer to the front of this manual or visit the Troxler website at www.troxlerlabs.com.

Cleaning the Base and Topshell

If the Model 4590 gauge is to provide precise and accurate measurements over a long period of time the gauge should be kept as clean as possible. Monitor the outside surfaces of the instrument for accumulations of dirt, oil, or any other foreign matter. If a build-up of material is visible on the gauge base or topshell, use the following procedures for cleaning:

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



CAUTION

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

The topshell may be cleaned with mild (low alkaline) soap and water. Other approved cleaning substances include methyl, isopropyl, or isobutyl alcohols.



CAUTION

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

Replacement Parts

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

PART NO.	DESCRIPTION
012754	4590 Scraper Ring
012753	4590 Snap Ring
110016	4590 Battery Assembly (with case)
128432	4590 Plastic Topshell
128146	4590 Nameplate
007158	O-ring for Triangle
110016.0001	Tower Battery Pack (rechargeable)

Maintenance Supplies

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

Accessories

PART NO.	DESCRIPTION
110017	Shipping Case
100421	Drill Rod
128022	Scraper Plate
103680.1000	Extraction Tool
110403	AC Adapter
104156	DC Charger
118990	4590 Operator's Manual
113128	RS-232 Cable
107480	Concrete Adapter
Model 6760	Moisture Probe

Returning the Gauge for Service

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

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

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

Appendix B:

Specifications

This appendix provides the measurement, mechanical and electrical specifications for Model 4590 gauges.

Measurement Specifications

Precision

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

Parameters at 6-inch depth

Direct Transmission Mode

150 mm (6 inch)

Measurement time is **2 min**; Background Time is **1 min**

	kg/m³	lb/ft³
Density	2150	135
Precision	± 4	± 0.25
Composition error	± 0	± 0

Parameters at 12-inch depth

Direct Transmission Mode

300 mm (12 inch)

Measurement time is **3 min**; Background Time is **1 min**

	kg/m³	lb/ft³
Density	2150	135
Precision	± 10	± 0.6
Composition error	± 0	± 0

Radiological Specifications

Gamma Source	3.3 MBq (90 μ Ci) \pm 40% Cs-137
Source Type	Sealed Source – Special Form
Source Housing	Stainless Steel, Encapsulated
Shielding	Lead
Max. Surface Dose Rate	0.2 mrem/hr at 5 cm
Shipping Case	Excepted Package

Electrical Specifications

Power Source(s):

Main 5 C NiMH (Rechargeable Pack) batteries

Backup 5 AA alkaline batteries

Charge Source 12 V DC, 2A

Battery Recharge Time 3 hours maximum, automatic cutoff (may be charged incrementally without damaging the batteries)

Time Before Automatic Shutdown 5 hours of complete inactivity

Mechanical Specifications

Gauge Size (w/ handle)	603 H × 438 L × 345 W mm (23.75 H × 16.5 L × 13.88 W in.)
Shipping Case Size	795 H × 518 L × 393 W mm (31.3 H × 20.4 L × 15.5 W in.)
Weight	13.8 kg (30.5 lb.)
Shipping Weight	37.6 kg (83.0 lb.)
Operating Temperature	0 ° to 50 °C (32 to 122 °F)
Storage Temperature	-17° to 60 °C (0 ° to 140 °F)
Humidity	98% RH, non-condensing
USB Port	Accepts devices up to 10 H x 29 W mm (0.40 H x .79 W in.)



CAUTION

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

Appendix C:

Transporting & Shipping

This appendix contains the following topics:

- ✓ U.S. Shipping Requirements
- ✓ Accident Notification Requirements

U.S. Shipping Requirements

Although the Model 4590 gauge is exempt from radioactive material licensing requirements, it is still subject to the U.S. DOT HAZMAT regulations. Since the Model 4590 contains a small quantity of radioactive material in the form of a sealed source, it must be prepared for shipment in accordance with applicable rules and regulations governing hazardous materials.

These include:

- ◆ IATA's *Dangerous Goods Regulations*
- ◆ U.S. DOT's Hazardous Material Regulations (49 CFR Parts 100 to 185)

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.

Because the amounts of radioactivity and the radiation levels are very low, the Model 4590 meets the criteria for transport as an *excepted package* under all of the above regulations. Excepted packages must meet the following requirements.

Packaging

The Model 4590 must be transported in a package (transport case) that meets general packaging requirements and must be capable of withstanding the conditions likely to be encountered during routine transport without any deterioration in the integrity of the package as a whole. No special design, testing, or certification of the package is required. The transport case provided with the gauge meets this requirement.

Markings

The package must be marked as follows:

- ◆ UN ID number – UN 2911
- ◆ Full name and address of shipper and consignee
- ◆ Permissible gross weight of package if this exceeds 50 kg (110 lb.) (not applicable to the Model 4590)
- ◆ If the package is being transported by air, then the package must be marked with a Handling Label - **Radioactive Materials – Excepted Package** (*IATA 10.7.8*)

Waybill

When shipping this gauge by common carrier (trucking company or FedEx) the waybill must state “Radioactive material, excepted package, instruments, UN 2911” in the Nature and Quantity of Goods box. A Dangerous Goods Declaration is not required for air transport. No Bill of Lading is required for a Private Carrier (owner of the gauge) shipment, this includes the day to day transport to jobsites.

Accident Notification Requirements

If there is a reportable incident during transportation of the gauge, the operator is required to notify, at the earliest practical moment, the U.S. DOT at **1-800-424-8802**. A reportable incident is 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 the radioactive materials.

As this is an exempt device, there is no requirement to notify any Radioactive Materials regulatory or licensing authority.

Appendix D: Radiation Theory & Safety

This appendix covers the following topics and tasks:

- ✓ Radiological Information
- ✓ Leak Testing
- ✓ Training
- ✓ Disposal
- ✓ Emergency Procedures
- ✓ Gauge Use Precautions

Radiological Information

The Model 4590 contains 3.3 MBq (90 μ Ci) of Cesium-137 (Cs-137) in the form of a sealed source. The source is located in an extendable source rod. The source rod provides protection against release of radioactivity under normal use and likely accident conditions, including fire.

 WARNING!
Do not attempt to disassemble or remove the radioactive source from this device.

The radiation levels near the Model 4590 are very low. Therefore, no special radiological precautions are necessary for operation of the device:

- ◆ Radiation safety training is not required to operate the gauge.
- ◆ Personnel radiation monitoring is not required.
- ◆ Sealed source leak testing is not required.
- ◆ Radiation area posting is not required.

The maximum radiation levels in or near the Model 4590 are shown in the table below:

Location	Dose Rate	
	mrem/h	μ Sv/h
External surface (5 cm)	0.22	2.2
Distance of 30 cm	0.03	0.3
Distance of 100 cm	<0.01	<0.1

NOTE

The receipt, possession, use, and transfer of the Model 4590 are exempt from licensing by the U.S. Nuclear Regulatory Commission (NRC) or Agreement States.

Leak Testing

Routine leak testing of the Model 4590 is not required in the USA due to the low activity of the source. However, if you desire to perform a leak test of the Model 4590, please perform the following using the Troxler Model 3880 Leak Test Kit (P/N 102868) and accompanying instructions.

1. Write the date, gauge model number, and serial number on the sample form and label.
2. Ensure that the source rod is in the SAFE position.
3. Turn the gauge on its side and locate the opening where the source rod extends through the gauge base.
4. Holding the wipe disk with tongs, wipe the area around and inside the opening where the source rod extends from the gauge base.
5. Pack the disk, as instructed, in the envelope and mail to Troxler Electronic Laboratories, Inc. for analysis.
6. Secure the gauge properly.

NOTE

Sample analysis must be performed by a licensed laboratory only.



WARNING!

Ensure that the source rod is in the SAFE position.

Training

Because the Model 4590 is a device exempt from regulations in the USA, there is no requirement for radiological safety training to use the gauge. However, training is required to transport the gauge (DOT HAZMAT) and operate the gauge. Troxler offers training classes that meet regulatory agency training requirements for nuclear gauge users and for DOT HAZMAT.

Disposal

The Model 4590 contains a small radioactive source. It is recommended that users return the device to Troxler at the end of its useful life for removal and disposal of the radioactive sources in the most environmentally responsible manner. Please contact Troxler for further information.

Emergency Procedures

If the nuclear gauge is lost or stolen, then immediately notify the gauge owner. The gauge owner should complete the emergency contact information on the lines furnished below. This information should be readily available to the gauge operator at all times.

Gauge Owners Name _____

Gauge Owners Phone _____

Additional Contact _____

Additional Contact _____

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

1. Locate the gauge and/or sources.
2. Do not touch or move the gauge.
3. Immediately rope off an area around the nuclear gauge and/or sources. A radius of 6 ft. (2 m) is sufficient. Do not leave the area unattended.
4. Keep all unauthorized personnel from the nuclear gauge.
5. The gauge user should perform a visual inspection of the nuclear gauge to determine if the source housing or shielding has been damaged.
6. Contact the gauge owner (name and number given at the beginning of this section). Provide the gauge owner with the following:
 - a. The date, time, and location of the accident
 - b. The gauge model and serial number
 - c. The nature of the accident
 - d. The location and condition of the gauge and/or source

NOTE

The dose rate at 1 meter (3 feet) from the gauge is less than 0.01 mrem/hr.

7. If you are unable to reach the Gauge Owner, then call the Other Contact (name and number given at the beginning of this section).
8. Follow the instructions of the Gauge Owner. The Gauge Owner may need to report the incident.

Gauge Use Precautions

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

- ◆ Never touch the unshielded tip of the source rod with your bare hands.
- ◆ When not taking readings, always keep the source rod in the **SAFE** (shielded) position. For added user safety, the source rod automatically retracts to the **SAFE** position when the gauge is lifted by the handle.
- ◆ Do not store or transport the gauge unless the source is in the **SAFE** position.
- ◆ The package should be inspected prior to each shipment.
- ◆ The package should be securely blocked and braced in the vehicle to prevent shifting during transport.
- ◆ When preparing a test site, use the drill rod assembly to drill the test hole. ***Under no circumstances should the source rod of the gauge be used to drill holes.***
- ◆ Do not tamper with or modify the gauge. Also, do not remove the sealed source from the gauge. Tampering with or modifying the gauge or removing the sealed source can be dangerous.
- ◆ Before shipping a gauge to Troxler for service or repair, obtain an RGA (Returned Goods Authorization) number from the Troxler Customer Service Department, as described in Appendix A.

Appendix E:

Unit Conversion

This chapter contains the following topics and tasks:

- ✓ Measurement units
- ✓ Radiological units

The Model 4590 gauges 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 convert from English units to SI units, the following provides SI conversion factors for common English units relevant to the gauge.

Measurement Units

1 in. = 25.4 mm

1 in. = 2.54 cm

1 ft. = 30.48 cm

1 ft. = 0.3048 m

1 pcf = 16.02 kg/m³

1 pcf = 1.6×10^{-2} g/cm³ Radiological Units

1 rem = 0.01 Sv

1 Ci = 37 GBq

1 mCi = 37 MBq

1 μ Ci = 37 kBq

The following table is provided to assist in converting from millicuries to gigabequerels:

mCi to GBq	
8.0	0.30
40	1.48
0.09	.00333

Appendix F:

Standard Count Log

This chapter contains the following Work Sheets:

- ✓ Standard Count Log
- ✓ Moisture Probe Calibration Worksheet

Standard Count Log

Use the form in this appendix as a guide when recording the daily standard counts. To verify gauge stability, compare the daily standard count to the average of the last four recorded standard counts. It may be useful to copy or scan this page for future use.

Moisture Probe Cal Profile Worksheet

This worksheet is intended to assist the user in collecting the moisture probe data in the field when performing the Moisture Probe Cal Profile (see page 5–15). It may be useful to copy or scan this page for future use.

Moisture Probe Cal Profile Generation Worksheet

I

	<u>Date</u>		<u>Soil</u>		<u>Jobsite</u>	
	Test site 1	Test Site 2	Test site 3	Test Site 4	Test site 5	Test Site 6
WD						
Diff						
True %M						

	Test site 7	Test Site 8	Test site 9	Test Site 10	Test site 11	Test Site 12
WD						
Diff						
True %M						

II

	<u>Date</u>		<u>Soil</u>		<u>Jobsite</u>	
	Test site 1	Test Site 2	Test site 3	Test Site 4	Test site 5	Test Site 6
WD						
Diff						
True %M						

	Test site 7	Test Site 8	Test site 9	Test Site 10	Test site 11	Test Site 12
WD						
Diff						
True %M						

III

	<u>Date</u>		<u>Soil</u>		<u>Jobsite</u>	
	Test site 1	Test Site 2	Test site 3	Test Site 4	Test site 5	Test Site 6
WD						
Diff						
True %M						

	Test site 7	Test Site 8	Test site 9	Test Site 10	Test site 11	Test Site 12
WD						
Diff						
True %M						

Appendix G: Global Positioning System (GPS)

This appendix covers the following topics:

- ✓ GPS Accuracy

The Model 4590 Surface Density Gauge can be equipped with an optional GPS (Global Positioning System) receiver that provides accurate information on the location (latitude and longitude) of the gauge.

GPS Accuracy

As described earlier, the Model 4590 gauge can be equipped with an optional GPS receiver that determines the location (latitude and longitude) of the gauge. This information is stored with each gauge measurement. The GPS receiver used in the Model 4590 has *Wide Area Augmentation System (WAAS)* capabilities, which provides accuracy to within 3 m (10 ft.). However, the accuracy is dependent upon the user's location and other factors as described below.

The global positioning system is a satellite-based navigation system that consists of 24 satellites and a network of ground stations that monitor and control those satellites. The satellites orbit the earth at an altitude of approximately 11,000 miles and constantly transmit signal information back to earth. A GPS receiver uses this information to determine its location.

To determine its latitude and longitude, a GPS receiver must receive the signals from at least three satellites.

On average, the receiver used in the gauge is accurate to within 15 m (approximately 50 ft.) when receiving GPS data alone. However, the WAAS capabilities can increase the accuracy to within 3 m (10 ft.), as shown in Table 5.

The accuracy of GPS information can be affected by a number of atmospheric forces and other conditions. The Wide Area Augmentation System (WAAS) corrects for these factors by placing GPS receivers at 25 known, precisely surveyed locations, called *reference stations*, across the United States. The reference stations determined a *measured* distance to each satellite using the signals received from the satellites. For each satellite, the stations compare the *measured* distance to the *actual* range (as calculated from its known position) to determine a *differential correction* for each satellite

Two *master stations*, located on either coast, collect data from the reference stations to create a *GPS correction message*. This message is then broadcast through two geostationary satellites that are in a fixed position over the equator. The GPS receiver applies the correction factors contained in the correction message to increase the accuracy of its measurements.

Note that the signals from the WAAS satellites may not be available to gauge users in locations where trees, mountains, and other large objects obstruct the view of the horizon. On other occasions, the GPS receiver may not be able to access the signals from the three satellites required to determine a position. As noted earlier, the gauge stores location information with the results of each measurement. The measurement display also denotes the quality of the location fix as follows:

- ▶ If WAAS information is available during a gauge measurement, the latitude and longitude displays to the nearest hundredth (1/100) of a second.
- ▶ If a GPS location is determined, but the WAAS information is unavailable, the latitude and longitude be displays to the nearest tenth (1/10) of a second.
- ▶ If the GPS receiver cannot determine a location, the latitude and longitude is denoted as θ .

NOTE

The Wide Area Augmentation System (WAAS) is currently functional only in the United States.

NOTE

If a Model 4590 equipped with the GPS option is moved a long distance between uses, the GPS system must be allowed to initialize. Initialization may take as long as 30 to 45 minutes after the gauge is powered and GPS enabled. The gauge must be positioned such that the GPS receiver can receive signals from the GPS satellites. If the GPS does not initialize within 45 minutes, contact your Troxler representative.

Table 5. GPS Position Accuracy

Quality of GPS Data	Accuracy	Fix Quality
GPS reading with WAAS	Within 3 m (10 ft.)	Latitude and longitude displayed to nearest 1/100 second
GPS reading without WAAS	Within 15 m (50 ft.)	Latitude and longitude displayed to nearest 1/10 second
No GPS reading	N/A	Latitude and longitude displayed as 0.

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