

Manual of Operation and Instruction

Model 3451 Enhanced RoadReader™ Plus

Surface Moisture-Density Gauge

NOTE

The Model 3451 Enhanced RoadReader Plus is equipped with a global positioning system (GPS) receiver. If the gauge 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 page 1–5 for more information). If the GPS does not initialize within 45 minutes, contact your Troxler representative.



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PN 110399

July 2009

Edition 3.1



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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HOW TO USE THIS MANUAL

Congratulations on the purchase of the **Troxler Model 3451 Enhanced RoadReader™ Plus**. Troxler continues the proven technology of its 3400 Series surface moisture-density gauges with the Troxler Model 3451 Enhanced RoadReader Plus.

The *Model 3451 Manual of Operation and Instruction* contains information on safely using this gauge. Also included in this manual are safety warnings, gauge setup, troubleshooting, and general maintenance.

CONVENTIONS USED IN THIS MANUAL

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

WARNING

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

CAUTION

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

NOTE

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

<Button> Angle brackets and a different typestyle indicate a button or character (number or letter) to press on the handheld personal digital assistant (PDA) or on the keyboard of a personal computer (PC) when using the Data Manager software provided with the gauge. For example, “Press **<Start>**” means to press the button labeled *Start*.

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

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

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ATTENTION 3451 GAUGE OWNER

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

The ACCESS CODE for this gauge is:

4012

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

NOTES

CHAPTER 1

INTRODUCTION TO THE MODEL 3451

This chapter provides a brief overview of the Troxler Model 3451 Enhanced RoadReader™ Plus, as well as an explanation of the global positioning system (GPS). This chapter also includes a list of the gauge parts and accessories, and instructions for unpacking and inspecting the gauge.

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INTRODUCTION

Troxler's Model 3451 Enhanced RoadReader Plus combines the impressive features of the Model 3450 RoadReader Plus with advanced global positioning system (GPS) and wireless technologies to provide unparalleled performance, flexibility, ease of use, and operator safety.

Like the 3450 gauge, the Model 3451 incorporates the proven capabilities of Troxler's 3400 (moisture/density) and 4640 (thin-layer density) gauges in a single unit that can perform thin-layer, backscatter, direct transmission, and moisture measurements. In addition to the features found in the 3450 gauge:

- ◆ The Model 3451 is controlled using a handheld *personal digital assistant (PDA)*, which allows the operator to stand away from the gauge while operating it via Bluetooth® wireless communications.
- ◆ An onboard *GPS receiver* enables the Model 3451 to store precise GPS coordinates, along with the standard date and time stamp, for each measurement.
- ◆ The *Data Manager PDA to PC Model 3451 for Windows XP®* software included with the gauge enables the operator to collect project data from the PDA or gauge on a personal computer (PC), print project configuration information, and recover data from the gauge in case of an emergency (such as the loss of the PDA).

With the Model 3451, the operator can quickly and precisely measure the moisture content and density of construction materials. The gauge's features include:

- ◆ Three measurement modes (*soil, asphalt, and thin layer*) for precise compaction control readings in most construction materials:

Soil Mode: For moisture/density determinations in soil, soil-stone materials in layers of 4 inches or greater.

Asphalt Mode: For density determinations in asphalt or hardened concrete layers of 4 inches or greater.

Thin Layer Mode: For density determinations in asphalt layers of less than 4 inches.

- ◆ Calibration offsets (*wet density, moisture, and trench*) and special calibrations (*soil and thin layer*) to expand measurement possibilities, and to enhance gauge readings on materials that may fall outside the range of factory calibration.
- ◆ Over 30 functions to facilitate all phases of testing compaction on construction materials.
- ◆ To preserve battery life, the gauge shuts down automatically after five hours of inactivity.

The Model 3451 meets or exceeds all applicable American Society of Testing and Materials (ASTM) standards (or corresponding equivalent), including:

- ◆ ASTM D-2950: *Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Method.*
- ◆ ASTM D-6938: *Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*

NOTE

As of November 2006, ASTM D-6938 replaced *ASTM D-2922: Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)* and *ASTM D-3017: Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)*.

Any licensing issues discussed in this manual are for the United States. To purchase a Model 3451 in Canada, owners must obtain a radioisotope license from the Canadian Nuclear Safety Commission (CNSC). The owner should obtain copies of the AECB Regulations and the *Transportation of Dangerous Goods Act and Regulations* (TDG). For other countries, please consult your local regulatory agency.

Owners are encouraged to require study of this manual before allowing anyone to use the gauge. *A potential hazard does exist if improperly used.* Appendices A and D, which cover radiological safety, 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 Training Course.

Before operating the Model 3451 gauge, users in European countries must refer to **Appendix G** for special considerations, additional safety warnings, and the Declaration of Conformity.

Since changes are made to local, state, and federal regulations on a continuing basis, the owner/operator must maintain awareness of current requirements. *The responsibility for compliance ultimately falls on the owner.* An owner in the United States may also wish to purchase and subscribe to Titles 10 and 49 of the *Code of Federal Regulations* (CFR) in addition to applicable local/state regulations.

GLOBAL POSITIONING SYSTEM ACCURACY

As described earlier, the Model 3451 is equipped with a *global positioning system (GPS) receiver* that provides accurate information on the location (latitude and longitude) of the gauge. This information is stored with each gauge measurement. The GPS receiver used in the Model 3451 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 (GPS) 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 Model 3451 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 1-1.

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 *fix quality* for that measurement will be denoted as *DGPS fix*.
- ▶ If a GPS location is determined, but the WAAS information is unavailable, the fix quality will be denoted as *GPS fix*.
- ▶ If the GPS receiver cannot determine a location, the latitude and longitude will be denoted as *0*.

NOTE

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

NOTE

If the gauge 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 as described above. If the GPS does not initialize within 45 minutes, contact your Troxler representative.

Table 1–1. GPS Position Accuracy

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

GAUGE PARTS AND ACCESSORIES

Figure 1–1 shows the gauge and its accessories.

1. The **Gauge** is the portable instrument containing electronic modules, a cordless serial adapter with Bluetooth wireless technology, a rechargeable battery pack, detectors, and the radioactive sources.
2. The **Intermec® 700 Series Color Mobile Computer**, or **PDA**, provides the operator interface with the gauge. Included with the PDA are a *stylus*, a rechargeable *battery pack*, a *serial cable*, a *dc adapter* used to charge the PDA from an automobile cigarette lighter, a universal *ac adapter* and *ac power cord* used to charge the PDA from an ac outlet, a *Quick Start Guide*, and a *Pocket PC Companion CD* containing Microsoft ActiveSync® software.
3. The **Transport Case** for the Model 3451 is a Type A package. Always use a Type A package to ship the Model 3451.
4. The **Reference Standard Block** provides a measurement standard for standard counts. It is also used during stability and drift tests.
5. The **Scraper Plate/Drill Rod Guide** is used to prepare the test site and to guide the drill rod when preparing the source rod hole for direct transmission measurements.
6. The **Drill Rod** is used to drill holes for direct transmission measurements. **Do not use the gauge source rod to drill holes.**
7. The **Extraction Tool** provides leverage to remove the drill rod from soil materials.
8. The **Model 3451 Manual of Operation and Instruction** details how to use the gauge. Both the manual and the **Transportation Guide** discuss radiation safety and gauge shipping concerns.
9. The **AC Charger** and **DC Adapter** are used to charge the gauge batteries. The ac charger accepts 110 (220 and European optional) V ac, 50/60 Hz and supplies 12 V dc. The dc adapter allows recharging from an automobile cigarette lighter.
10. The **Data Manager PDA to PC Model 3451 for Windows XP** software includes tools for retrieving and managing project data from the PDA or gauge. This software is provided on CD-ROM (not shown).



MODEL 3451 GAUGE



REFERENCE STANDARD BLOCK
PN 107830



DRILL ROD
PN 100421



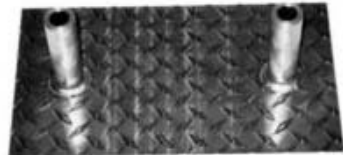
TRANSPORT CASE
PN 110422.3451



EXTRACTION TOOL
PN 103680.1000



SERIAL CABLE,
PN 110708
(GAUGE TO PC)



SCRAPER PLATE/
DRILL ROD GUIDE
PN 107795

Note: Images not to scale.

Figure 1–1. Model 3451 Parts and Accessories



AC CHARGER
PN 110403
(FOR GAUGE)



DC (AUTO) ADAPTER
PN 104156
(FOR GAUGE)



INTERMEC® 700 SERIES
MOBILE COMPUTER (PDA)
PN 110687



UNIVERSAL AC ADAPTER
PN 110691
&
AC POWER CORD
PN 110690
(FOR PDA)



DC (AUTO) ADAPTER
PN 110692
(FOR PDA)



SERIAL CABLE ASSEMBLY
PN 110693
(PDA to PC)

Note: Images not to scale.

Figure 1–1. Model 3451 Parts and Accessories (Continued)

UNPACKING AND INSPECTION

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

Check the shipping cases for the items listed on page 1–8. In addition, the shipping cases should contain the *Gauge Warranty* and a *Source Certificate*.

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

NOTE

Charge the 3451 batteries for 2.5 hours prior to initial use. Install the PDA battery pack and charge the PDA as directed in the *Quick Start Guide* provided with the unit.

NOTE

If the PDA battery pack is completely discharged when the gauge and accessories are unpacked, charge the PDA for 4 hours before use. Refer to the *Quick Start Guide* provided with the unit for instructions on installing and charging the battery pack.

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

NOTES

CHAPTER 2

THEORY OF OPERATION

This chapter provides a brief description of the theory of operation of the Troxler Model 3451 Enhanced RoadReader Plus. The *direct transmission* and *backscatter* modes of operation are illustrated, along with an explanation of the cesium-137 source, americium-241:beryllium source, and detector geometry.

2. THEORY OF OPERATION

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DENSITY

The Troxler Model 3451 Enhanced RoadReader Plus uses two modes of operation: *direct transmission mode* (with the source rod extended into the material to be measured) and *backscatter mode* (with the source rod in the backscatter position). Source rod positions are described in **Chapter 3**.

Direct transmission mode is used on materials with layers four inches thick or more. This mode is most commonly used on soils, but can also be used to measure asphalt and concrete. In the direct transmission position, 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. While passing through the test material, the photons collide with electrons and lose energy. A high material density increases the probability of these photon collisions. This decreases the number of photons that reach the Geiger-Mueller (G-M) detectors 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 G-M detector counts to a density value.

Backscatter mode is used on concrete, asphalt, and soil layers approximately four inches thick. In the backscatter position, the source rod is lowered to the first notch below the **SAFE** (shielded) position. This places the source and the detectors in the same plane. Shielding between the source and detectors greatly reduces the number of photons reaching the detectors in a direct path from the source. Thus, the photons from the Cs-137 source must travel into the test material and scatter (or reflect) at least once to reach the G-M detectors. The detectors in the gauge base count these scattered photons. For *thin layer* readings, the gauge uses two sets of G-M detectors. Refer to the **Thin Layer** section on page 2-5.

MOISTURE

The Model 3451 uses the principle of neutron *thermalization* to monitor the moisture content of a material. The gauge includes an americium-241:beryllium (Am-241:Be) source that is fixed in the gauge's base. Fast neutrons emitted by the Am-241:Be source pass into the test material. Multiple collisions between the fast neutrons and a similarly sized mass (such as the nuclei of hydrogen atoms) cause the neutrons to slow to the point where further collisions with hydrogen or other materials will not continue to reduce the neutron energy further. These neutrons are said to have been *thermalized*.

The 3451 gauge contains a helium-3 detector that is sensitive only to thermalized, or "slow," neutrons. As a result, the moisture counts relate directly to the amount of hydrogen in the material. Using the gauge calibration, the gauge software converts the helium-3 detector counts to a moisture content. (Note that the helium-3 detector is in the same plane as the Am-241:Be source. Therefore, moisture measurement is similar to a density measurement taken in backscatter mode, as described earlier in this chapter.)

The *depth of measurement* is defined in terms of a maximum depth beneath the surface of the material being measured. Of the neutrons counted by the gauge, 98 percent will penetrate no deeper than the depth of measurement. The depth of measurement is a function of moisture content. The following equations can be used to determine the approximate depth of measurement.

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

or

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

The normalized curve set shown in Figure 2–1 illustrates the effects of moisture content on the depth of measurement.

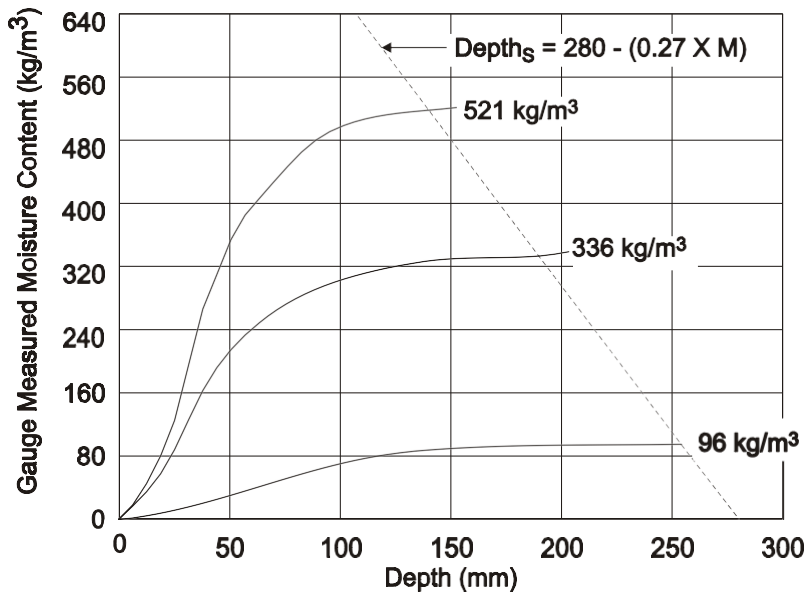
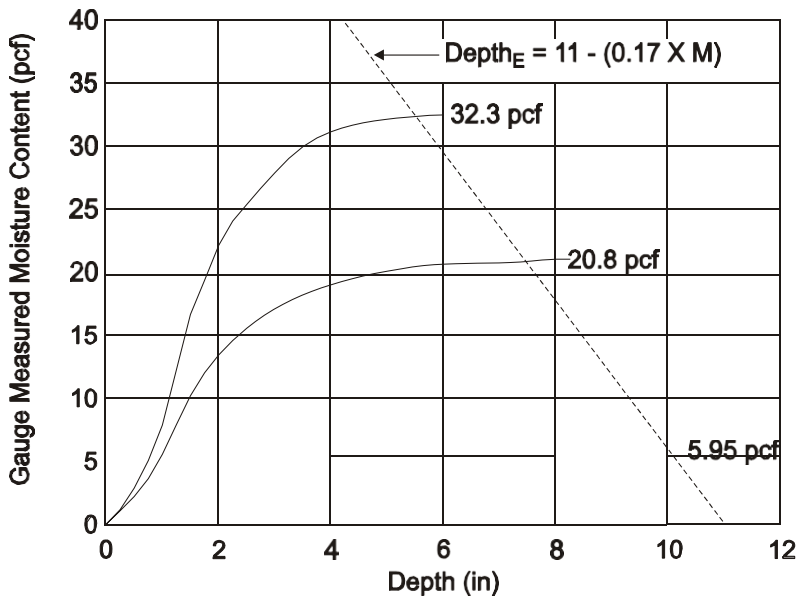


Figure 2-1. Effect of Moisture on Depth of Measurement

THIN LAYER

The Model 3451 contains two sets of G-M tubes for photon detection. The set closest to the source rod is referred to as *System 1*, while the set farthest from the source rod is *System 2*. When the source rod is in the backscatter position, the source and the detectors are on approximately the same plane.

Both System 1 and System 2 tube sets will primarily detect photons that have been scattered by the material as described in the *Density* theory of operation (see page 2–2). However, due to its greater distance from the source, System 2 is more likely to detect scattered photons from deeper in the material than is System 1. The density measured by each system, the factory calibration, and mathematical modeling allow the 3451 gauge to determine the density of the top layer of material.

CALIBRATION

Troxler calibrates the 3451 gauge at the factory. The calibration standards used represent “average” soil, covering a density range of 1100 to 2700 kg/m³ (70 to 170 pcf).

Troxler also calibrates the Model 3451 for thin layer measurements. The thin layer factory calibration covers a thickness range of 2.5 to 10 cm (1.0 to 4.0 in.).

OFFSETS

The factory calibration provides accurate results for the majority of materials found in the field. If the gauge is to be used to test materials not covered by the factory calibration, the readings can be adjusted using either an *offset* as described below or a *special calibration* as described in **Chapter 6**.

Perform a *wet density offset* if the test material is outside the density range for average soil or if the material composition varies from average soil/asphalt. Perform a *moisture offset* if the test material contains hydrogenous materials other than water or materials that absorb neutrons. Materials such as cement, gypsum, coal, mica, and lime are all hydrogenous. Material such as boron and cadmium are neutron absorbers.

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

If the composition of the test material differs greatly from average soil and an offset does not provide adequate measurement accuracy, then the gauge may need to be calibrated *specifically for that material*. A *special calibration* allows the operator to calculate new calibration constants. For more information on the *Special Calibration* feature, see **Chapter 6**.

CHAPTER 3

GETTING STARTED

This chapter provides details on getting started with the Troxler Model 3451 Enhanced RoadReader Plus. It provides instructions for turning the gauge and PDA on, and explains how to set up and manage *project files* and how to check the gauge status.

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MODEL 3451 ILLUSTRATIONS

Figure 3–1 illustrates various components of the Model 3451 Enhanced RoadReader Plus referred to throughout this chapter and the remainder of the manual. Figure 3–2 is a detailed view of the gauge back panel.

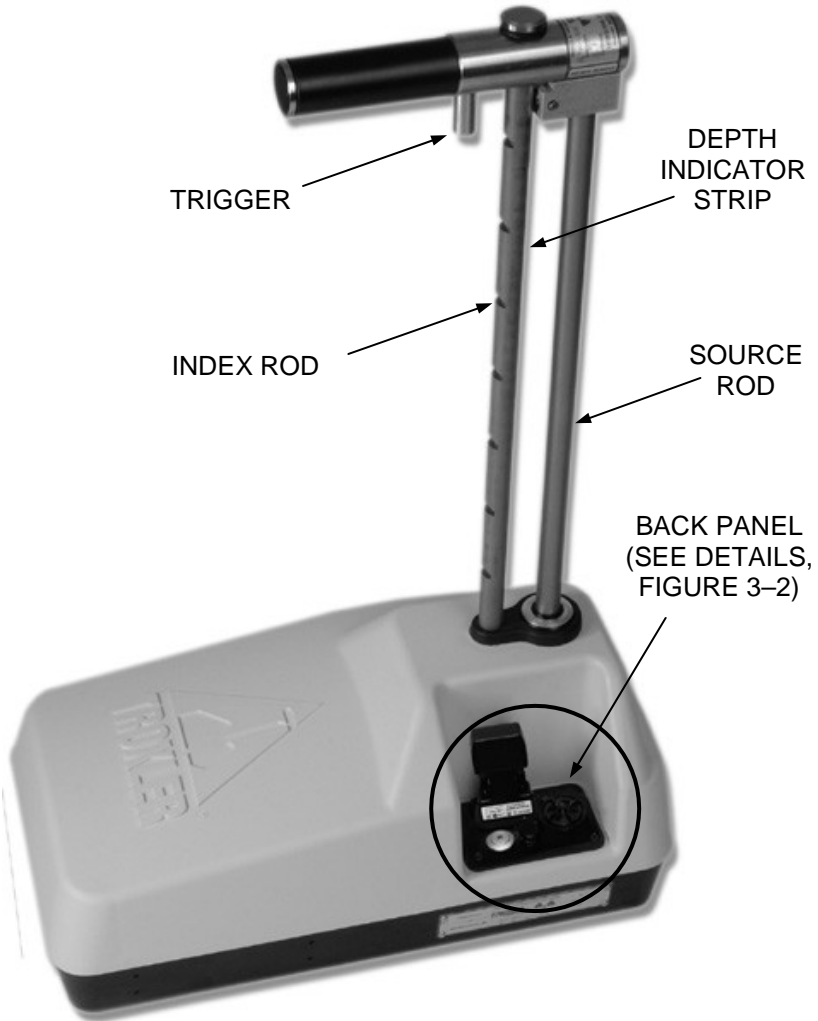


Figure 3–1. Model 3451 Illustration

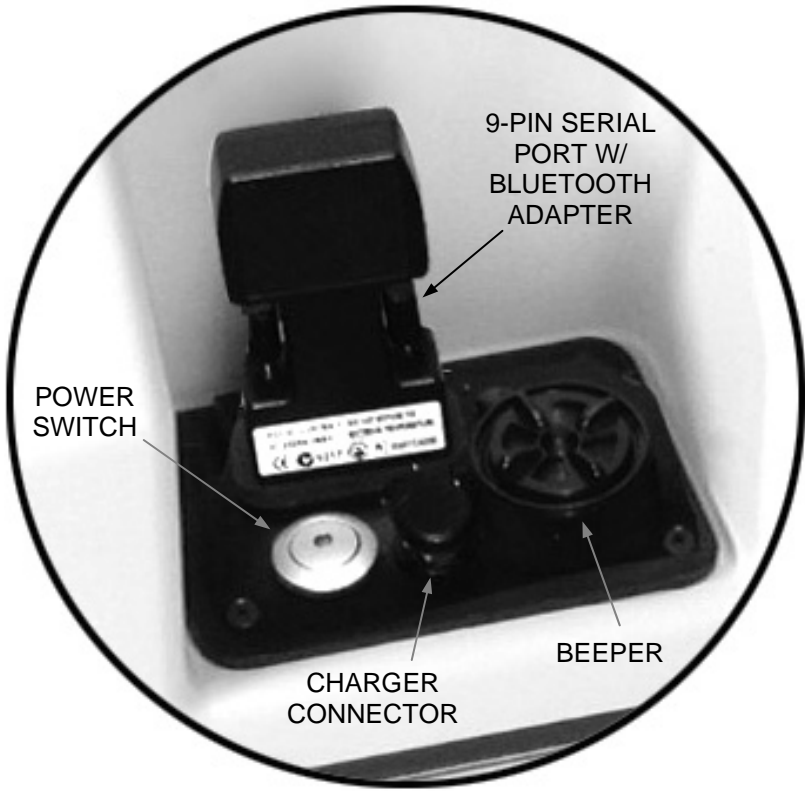


Figure 3–2. Back Panel Details

NOTE

To adjust the volume of the gauge beeper, open or close the beeper’s built-in shutters.

SOURCE ROD POSITIONS

As shown in Figure 3–3, the source rod can be placed in the *SAFE*, *backscatter*, or *direct transmission* positions. When not taking measurements, keep the source rod in the **SAFE** position. When measuring thin layer or other materials through which you cannot drill a hole, use the backscatter position. In the direct transmission positions, the source rod extends into a pre-drilled hole.



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

NOTE

As shown below, the Model 3451 is available with maximum source depths of 200 mm (8 in.) and 300 mm (12 in.). The index rod can be incremented at either 25-mm (1-in.) or 50-mm (2-in.) intervals.

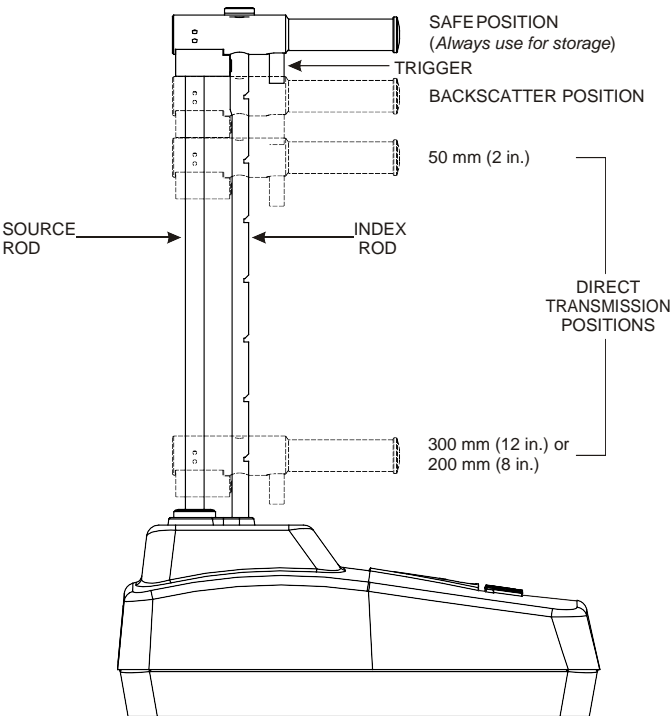


Figure 3–3. Source Rod Positions

BEFORE USING THE GAUGE AND PDA

Before using the gauge and PDA for the first time:

- ✓ Review the *Quick Start Guide* provided with the PDA, and become familiar with the use and operation of the unit.

- ✓ Install the PDA battery pack as described in the *Quick Start Guide* provided with the unit.

NOTE

If the PDA battery pack is completely discharged, charge the PDA for 4 hours before use.

NOTE

Because of the advanced features installed in the PDA, its battery life is approximately 6 hours. Troxler recommends charging the PDA battery pack when the unit is not in use. As listed below, additional PDA battery packs and a battery pack charger kit are available from Troxler, and are recommended:

<u>Part #</u>	<u>Description</u>
110705	PDA Battery Pack, Lithium Ion, Spare
110709	PDA Battery Pack Charger Kit

Refer to the *Quick Start Guide* provided with the PDA for more information on charging and/or changing the battery pack.

CAUTION

DO NOT change the Regional Settings in the PDA. If these settings are changed, the RoadReader Plus software in the PDA will be unable to calculate test results.

- ✓ If desired, follow the instructions in the *Quick Start Guide* provided with the PDA to install the Microsoft ActiveSync software included on the *Pocket PC Companion CD* provided with the unit. The ActiveSync software enables the user to link the PDA to the computer when using applications other than the Troxler Data Manager software.

NOTE

Before installing the Troxler Data Manager PDA to PC Model 3451 for Windows XP software, ensure that the computer meets the system requirements listed on page 7-4.

- ✓ Install the Troxler Data Manager PDA to PC Model 3451 for Windows XP software as follows. Refer to **Chapter 7** for information on managing project data using the Data Manager software.
 - ✓ Insert the Data Manager CD-ROM into the computer's CD-ROM drive.
 - ✓ From the Windows XP desktop, click on the **Start** button in the taskbar.
 - ✓ Select **Run**.
 - ✓ In the displayed dialog box, type **d:setup** (where *d*: is the letter designation of the CD-ROM drive) and press the **(Enter)** key or click on the **OK** button. Follow the instructions on the screen to complete the installation.
 - ✓ The installation program adds a **DataManager** group to the **Programs** menu, with one program item: **DataManager**.

TURNING THE GAUGE AND PDA ON

NOTE

The gauge should be inspected each day before use to ensure proper operation of all safety features. Refer to page A-10 for the daily inspection procedure.

NOTE

Charge the 3451 batteries for 2.5 hours prior to initial use. Charge the PDA as directed in the documentation provided with the unit.

NOTE

When controlling the gauge with the PDA, the PDA should be within 4.6 m (15 ft) of the gauge. The operating range may be as much as 15.2 m (50 ft) depending upon various conditions.

CAUTION

DO NOT change the Regional Settings in the PDA. If these settings are changed, the RoadReader Plus software in the PDA will be unable to calculate test results.

To turn on the gauge, press the power switch located on the rear panel of the gauge (see Figure 3-2). The internal beeper will sound to signify that the gauge is ready for use.

Press the power switch (labeled **I/O**) located in the upper left corner of the PDA keypad. The PDA powers up, then displays the **Troxler** menu shown in Figure 3-4.

NOTE

If the PDA has been completely discharged, the first time it is powered up after recharging, it will go through a series of reboots, during which it reloads the RoadReader Plus software and other applications. Please be patient, as this process may take several minutes. Do not attempt to use the PDA until it displays the menu shown in Figure 3-4.

NOTE

If the gauge 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 page 1–5 for more information). If the GPS does not initialize within 45 minutes, contact your Troxler representative.

TROXLER MENU

Figure 3–4 shows the **Troxler** menu that is displayed when the PDA is powered up. From this menu, the user can start the RoadReader Plus software, launch the Windows *Notes* or *Calculator* function, or display the Windows desktop. A description of the RoadReader Plus software begins on page 3–16.

NOTES

To launch the *Notes* function, press the **<Notes>** button. The PDA displays a **Notes** screen similar to that shown in Figure 3–5. This function allows the user to capture information as written or typed notes, or as audio recordings. For more information on using the *Notes* function, press the **<Notes>** button in the upper left corner of the screen and select **Help** from the dropdown menu.

NOTE

The *Notes* function described here is not related to the *project notes* that can be stored with measurement data (see Figure 4–7 on page 4–12).

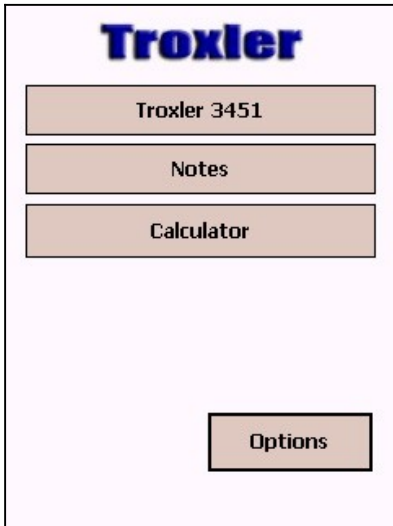


Figure 3–4. Troxler Menu

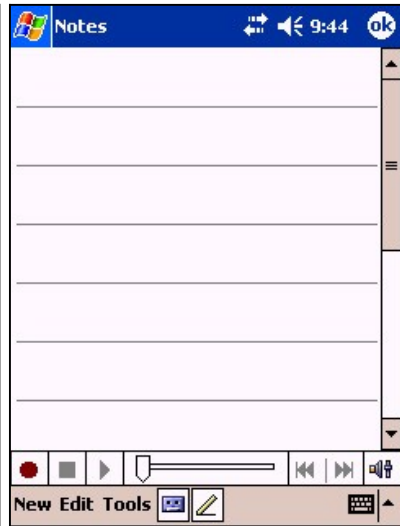


Figure 3–5. Notes Screen

CALCULATOR

To launch the *Calculator* function, press the **<Calculator>** button. The PDA displays the **Calculator** shown in Figure 3–6. For more information on using the *Calculator*, press the **<Calculator>** button in the upper left corner and select **Help** from the dropdown menu.

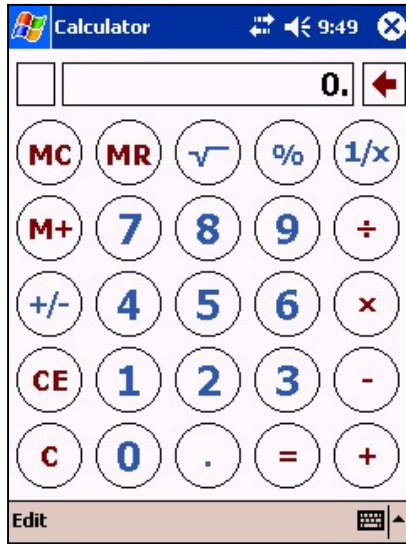


Figure 3–6. Calculator

SYSTEM

To display the Windows desktop, press the **Options** button in the lower right of the **Troxler** menu. The PDA displays the **Intermec Launcher** screen shown in Figure 3-7. This screen shows the status of the PDA battery pack. To return to the Troxler menu, press the **Back** button.

To continue to the Windows desktop, press **System**. When prompted for a password, leave the password field blank and press **OK**. The PDA displays the Windows desktop, as shown in Figure 3-8.

To return to the **Troxler** menu, press the **Start** button in the upper left and select **Intermec Launcher** from the dropdown menu, as shown in Figure 3-9.

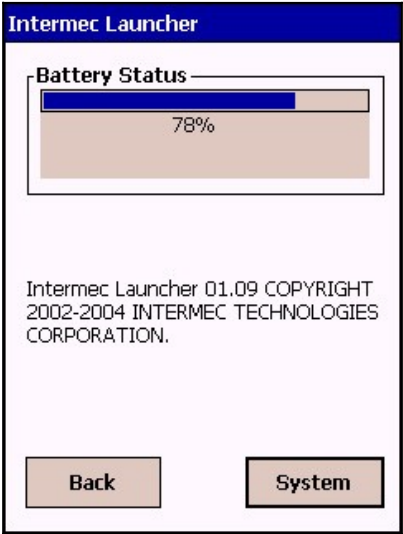


Figure 3-7. Intermec Launcher Display



Figure 3-8. Windows Desktop



Figure 3–9. Return to Troxler Menu

PDA ACTIVESYNC CONFIGURATION

The Microsoft ActiveSync software provided on the *Pocket PC Companion CD* allows the user create a partnership between the PDA and a desktop computer using the serial cable provided with the PDA. ActiveSync must be properly configured in order to use the Data Manager software included with the gauge.

If the PDA becomes completely discharged, verify the ActiveSync configuration after the unit is recharged.

To check the PDA's ActiveSync settings:

- ✓ Follow the directions on page 3–12 to display the Windows desktop.
- ✓ Press the **<Start>** button in the upper left corner of the desktop and select **ActiveSync** from the dropdown menu.

- ✓ Press the **⟨Tools⟩** button in the lower left corner of the **ActiveSync** display and select **Options...** from the menu. The **ActiveSync PC Synchronization** screen is displayed.
- ✓ Press the **⟨Options...⟩** button. The **ActiveSync PC Synchronization Options** screen is displayed.
- ✓ Ensure that the **Enable PC sync using this connection** checkbox is checked, and that **115200 Default** is selected from the dropdown menu. Also ensure that the **Maintain connection** radio button is selected.
- ✓ Press the **⟨ok⟩** button to return to the **ActiveSync PC Synchronization** screen.
- ✓ Press the **⟨ok⟩** button to the **ActiveSync** display.
- ✓ Press the **⟨X⟩** button to return to the Windows desktop.
- ✓ Follow the directions on page 3–12 to return to the **Troxler** menu.

BLUETOOTH COMMUNICATION CONFIGURATION

The PDA is configured at the factory to enable Bluetooth communications with the gauge. If communications between the PDA and gauge cannot be established, check the Bluetooth configuration as follows:

- ✓ Follow the directions on page 3–12 to display the Windows desktop.
- ✓ Press the **⟨Start⟩** button in the upper left corner of the desktop and select **Settings** from the dropdown menu.
- ✓ Select the **Connections** tab at the bottom of the **Settings** display.
- ✓ Press the **Bluetooth** icon. A **Bluetooth Settings** window is displayed with the **Mode** tab selected.

- ✓ Ensure that the **On** radio button is selected.
- ✓ Select the **File Transfer** tab at the bottom of the display.
- ✓ Ensure that the **Enable** radio button is selected.
- ✓ Select the **Wireless Printing** tab at the bottom of the display.
- ✓ Ensure that a gauge (**3451-XXXX**) is displayed in the lower **Connected** box. If not:
 - ✓ Ensure that the gauge is turned on as described on page 3–8.
 - ✓ Press the **Device Discovery** button on the PDA. The PDA will attempt to establish communications with (or *discover*) the gauge. Upon discovery, the gauge will be listed in the upper **Devices** box.
 - ✓ Highlight the **3451-XXXX** listing in the **Devices** box and press the **Connect** button. The **3451-XXXX** listing should move to the **Connected** box.
- ✓ Highlight **3451-XXXX** listing in the **Connected** box and press the **Properties** button.
- ✓ In the **Choose COM Port** box, ensure that the **Com 6** radio button is selected.
- ✓ Ensure that the **Enable Wireless Printing** box is checked.
- ✓ Press the **<ok>** button to return to the **Bluetooth Settings** display.
- ✓ Press the **<ok>** button to return to the **Settings** display.
- ✓ Press **<X>** to return to the Windows desktop.
- ✓ Follow the directions on page 3–12 to return to the **Troxler** menu.

ROADREADER PLUS MAIN MENU

NOTE

To ensure proper communications between the PDA and gauge, always power the gauge on before starting the RoadReader Plus software.

To start the RoadReader Plus software, press the **<Troxler 3451>** button on the **Troxler** menu (see Figure 3–4 on page 3–10). The software displays a splash screen that includes the software version and gauge serial number. The software then establishes Bluetooth wireless communications between the PDA and gauge.

When communications have been established, the software checks the leak test interval and the date of the last leak test stored in the PDA memory (see page 5–11). If the leak test interval has been exceeded, the software displays **Warning! Leak test is due.** If this warning appears, perform a leak test (see page A–13 and update the leak test date (see page 5–13). Press the **<ok>** button to continue.

The software then checks the date of the last gauge calibration. If the gauge is due for calibration, the software displays **Warning! Calibration is due.** If this warning appears, Troxler recommends returning the gauge and PDA to the nearest service center (refer to page C–**Error! Bookmark not defined.**) for calibration. Press the **<ok>** button to continue.

The software then communicates with the gauge to check the status of the gauge battery. If the PDA cannot establish communications with the gauge, the PDA displays **Error! Checking Battery Voltage.** If this error message is displayed:

- ✓ Check that the gauge is powered on.
- ✓ Ensure that the gauge was powered on before the RoadReader Plus software was started.
- ✓ Ensure that the PDA is within 4.6 m (15 ft) of the gauge.
- ✓ Verify the PDA's Bluetooth communications configuration as described on page 3–14.
- ✓ Verify the PDA's ActiveSync configuration as described on page 3–13.

Once the PDA establishes communications with the gauge, the software displays the status of the gauge's nickel-metal hydride (NiMH) batteries, as shown in Figure 3–10. This display includes the charger status (*ON* or *OFF*), the actual battery voltage, and the battery status (*OK* or *LOW*). Press the **⟨Done⟩** button to continue.

NOTE

If the battery voltage falls below 5.5 V, the gauge shuts off. Recharge the NiMH batteries as described on page C–24.

The gauge then enters a five-minute warmup period, which allows the baseboard electronics to warm up, and the gauge to acquire GPS data.

NOTE

If the operator presses ⟨Abort⟩ to bypass the gauge warmup, Troxler does not guarantee the accuracy of the GPS location data.

NOTE

To preserve battery life, the gauge shuts down automatically after five hours of inactivity.

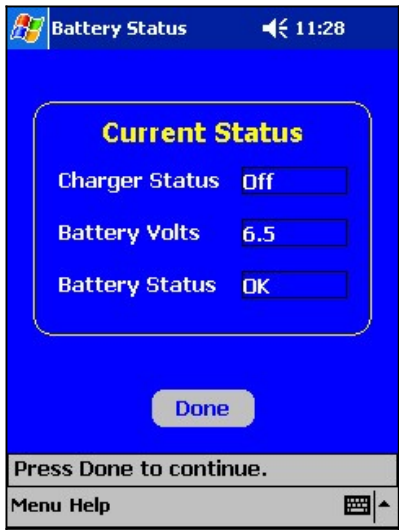


Figure 3–10. Battery Status Display

When all of the checks performed at power on are complete, the RoadReader Plus software displays the main menu shown in Figure 3–11). From this menu, the operator can take a reading or standard count, change the gauge settings, or access a set of gauge tools.

The main menu also displays the measurement mode (*Soil, Asphalt, or Thin Layer*), count time (*15 seconds, 1 minute, or 4 minutes*), and the selected project name (if any).

Before taking measurements, read this manual carefully. If you do not completely understand the sections that cover radiation safety, contact your company radiation safety officer (RSO) or the nearest Troxler representative.

NOTE

Pressing the <Exit> button on the main menu shuts down the RoadReader Plus software and commands the gauge to power off.

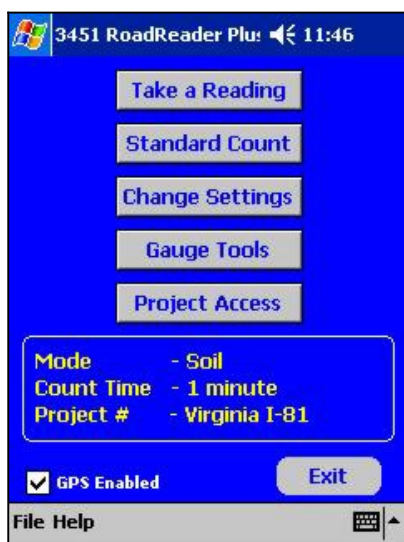


Figure 3–11. RoadReader Plus Software Main Menu

PROJECT FILES

The Model 3451 stores measurement results in files called *projects*, which are named by the operator. The *Project* function allows the operator to create a new project, view project data, erase projects, enable a project (make an existing project active so that additional data may be added to it), or disable the active project.

NOTE

The gauge will not take a reading unless a project has been created and is active.

To access the *Project* function, press **(Project Access)** on the main menu (see Figure 3–11). The PDA displays the **Project Menu** shown in Figure 3–12.

When checked, the **Disable Storage to Gauge** check box prevents the PDA from storage measurement data to the gauge for storage following a reading. The **Disable Project Notes** check box disables the **Would you like to add project notes?** prompt that otherwise is displayed following a measurement.

The following sections describe the other functions available from the **Project Menu**.

NOTE

The *Project* function cannot be used to enter target values, offsets, or special calibrations. For information on entering target values, see page 5–14. For information on using offsets and special calibrations, refer to Chapter 6.

NEW PROJECT

To create a new project, press the **(New)** button on the **Project Menu** shown in Figure 3–12. The PDA displays the first page of the setup **Wizard** for a new project, as shown in Figure 3–13.

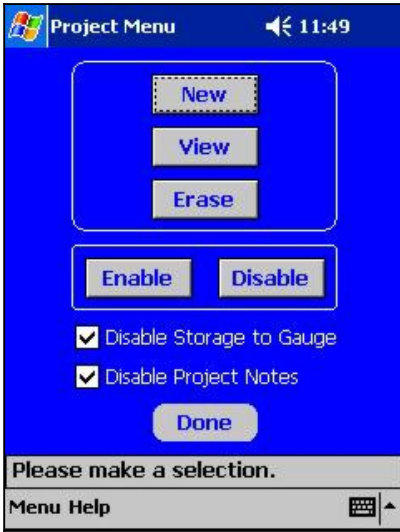


Figure 3–12. Project Menu



Figure 3–13. New Project Setup Wizard, Page 1

The **Wizard** is a series of screens that provides step-by-step instructions for setting up a new project. Using the wizard, the operator is prompted to:

- ✓ Select the measurement mode (*Soil, Asphalt, or Thin Layer*). For more information, refer to page 5–5.
- ✓ Select the desired measurement units. For more information on measurement units, refer to page 5–4.
- ✓ Set the count time. For more information, see page 5–6.
- ✓ For thin layer mode, enter the thickness of the top layer.
- ✓ Enable any previously entered target values. For more information on target values, see page 5–14.

The **Wizard** displays the operator selections for review. To change a setting, press the **<Back>** button to return to the page for that function or press the **<Cancel>** button to start over. When all settings are correct, press the **<Next>** button to continue.

The **Wizard** displays an information screen, then requests a project name. Enter a descriptive name for the project using the PDA's *Block Recognizer*, *Keyboard*, *Letter Recognizer*, or *Transcriber* functions. For more information on these functions, refer to the documentation provided with the PDA.

Press the **<Ok>** button when finished. The PDA displays the confirmation message **Gauge configuration has been set according to your specifications**. Press **<ok>** to continue.

VIEW PROJECT

The Model 3451 allows the operator to view measurement data stored in any of the defined project files. To view project data, press the **<View>** button on the **Project Menu** (see Figure 3–12). The PDA displays the Project File Selector screen shown in Figure 3–14.

To select a project, press the project file name twice. The PDA displays the measurement data stored in the project, as shown in Figure 3–15. The data is stored sequentially, with the earliest measurement listed first. To scroll through the data, press the scroll bar using the stylus. If the selected project contains no measurement data, the display will be blank. Press the **<Done>** button to return to the **Project Menu**.

NOTE

The *View Project* function is intended to view measurement data. To view *setup* information for the active project, use the *View Status* function described on page 3–25 and the *View Setup* function described on page 5–3.

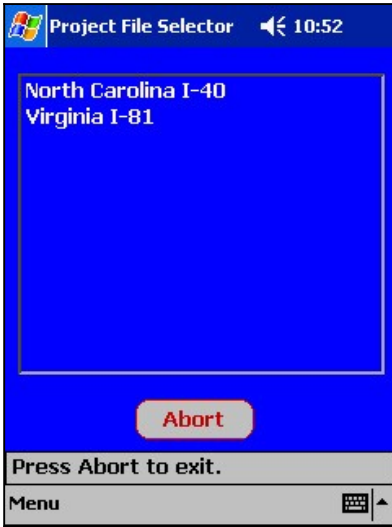


Figure 3–14. Project File Selector

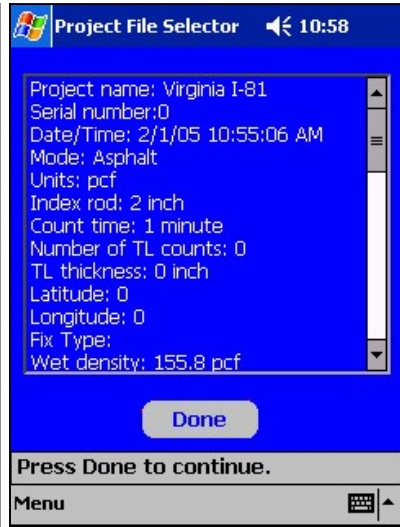


Figure 3–15. Project Data Display

ERASE PROJECT

The *Erase* function enables the operator to delete a project file and any data stored in it. To erase a project file, press the **<Erase>** button on the **Project Menu** (see Figure 3–12). The PDA displays the **Project File Selector**, as shown in Figure 3–14.

To select a project file, press the project file name twice. The PDA displays the prompt shown in Figure 3–16.

- ▶ Press **<OK>** to erase the project file. The PDA displays **Project file XXX has been erased**. Press **<ok>** to continue.
 - ▶ If the erased project was not previous active, the PDA returns to the **Project Menu**.
 - ▶ If the erased project was previously active, the PDA displays **Project XXX disabled!** Press **<ok>** to return to the **Project Menu**.
- ▶ Press **<Cancel>** to exit without erasing the project file. The PDA displays **The project file named XXX will not be erased!** Press **<ok>** to return to the **Project Menu**.

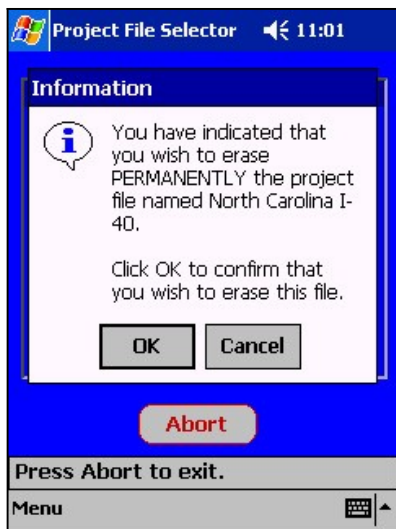


Figure 3–16. Project Erase Prompt

ENABLE PROJECT

To enable a project file, press the **<Enable>** button on the **Project Menu** (see Figure 3–12). The PDA displays the **Project File Selector**, as shown in Figure 3–14.

To select a project file, press the project file name twice. The PDA displays **The project XXX has been enabled**. Press **<ok>** to return to the **Project Menu**.

DISABLE PROJECT

To disable the currently active project file, press the **<Disable>** button on the **Project Menu** (see Figure 3–12). The PDA displays **Do you wish to disable the currently active project, XXX?**

- ▶ Press **<Yes>** to disable the project. The PDA displays **Project XXX disabled!** Press **<ok>** to return to the **Project Menu**.
- ▶ Press **<No>** to return to the **Project Menu** without disabling the project.

STATUS

The RoadReader Plus software enables the operator to view information concerning the current gauge status, calibration constants, temperature, battery status, and source decay. To access these functions, press the **<Gauge Tools>** button on the main menu (see Figure 3–11). The software displays the **Gauge Tools** menu shown in Figure 3–17.

Press the **<Gauge Status>** button on the **Gauge Tools** menu to access the **Gauge Status Menu** (see Figure 3–18).

NOTE

The PDA queries the gauge during the *Gauge Temperature* and *Battery Status* functions. Therefore, these functions can also be used to verify that the PDA and gauge can communicate properly.

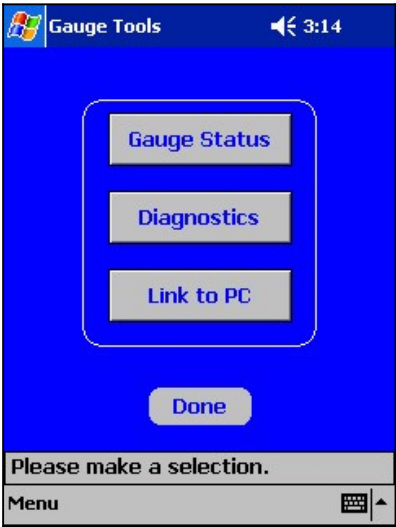


Figure 3–17. Gauge Tools Menu

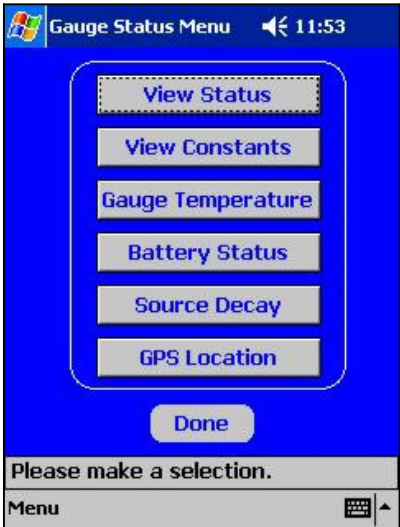


Figure 3–18. Gauge Status Menu

VIEW STATUS

The *gauge status* information includes the software version; measurement units; count time; measurement mode; Marshall, Proctor, and voidless density values; measurement mode status; percent air voids status; specific gravity; and offset status and values. To view this information, press the **<View Status>** button on the **Gauge Status Menu**. The PDA displays a **View Status** screen similar to the one shown in Figure 3–19. To scroll through the various gauge values, press the scroll bar using the stylus. Press the **<Done>** button to return to the **Gauge Status Menu**.

VIEW CONSTANTS

The *constants* include the calibration constants, as well as the date of the most recent calibration. To view this information, press the **<View Constants>** button on the **Gauge Status Menu**. The PDA displays the **View Constants** screen shown in Figure 3–20. To scroll through the calibration constant values, press the scroll bar using the stylus. Press the **<Done>** button to return to the **Gauge Status Menu**.

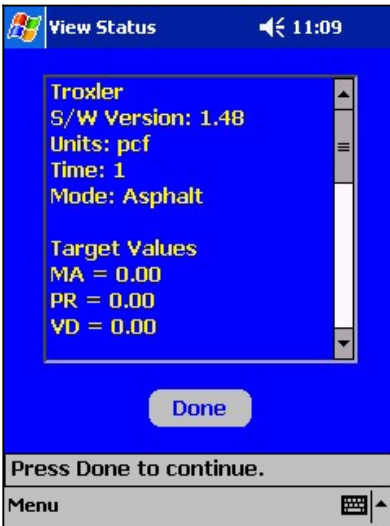


Figure 3–19. View Status Display

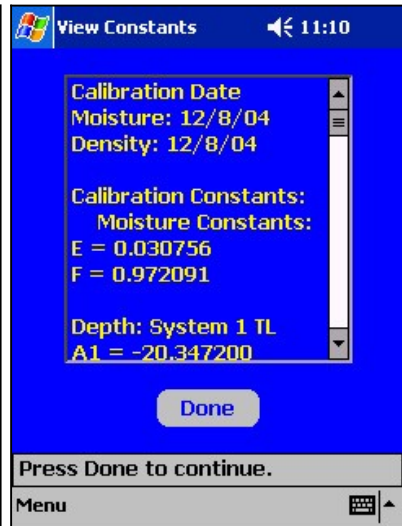


Figure 3–20. View Constants Display

GAUGE TEMPERATURE

To view the gauge temperature, press the **⟨Gauge Temperature⟩** button on the **Gauge Status Menu** (see Figure 3–18). The PDA displays the gauge temperature both in degrees Fahrenheit and in degrees Celsius. Press the **⟨Done⟩** button to return to the **Gauge Status Menu**.

BATTERY STATUS

To view the current status of the gauge's NiMH batteries, press the **⟨Battery Status⟩** button on the **Gauge Status Menu** (see Figure 3–18). The software displays the status of the batteries, as shown in Figure 3–10 on page 3–17. This display includes the charger status (*ON* or *OFF*), the actual battery voltage, and the battery status (*OK* or *LOW*). Press the **⟨Done⟩** button to return to the **Gauge Status Menu**.

NOTE

If the battery voltage falls below 5.5 V, the gauge shuts off. Recharge the NiMH batteries as described on page C–24.

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 Am-241:Be source is 432 years. The half-life of the Cs-137 source is 30 years.

The **Source Decay Menu** (see Figure 3–21) allows the operator to view how the decrease in the radiation intensity of the source affects standard counts. It displays the actual standard count, the predicted standard count, and the difference between the two counts. The gauge calculates the predicted standard count by adjusting the calibration standard count for source decay.

To access the **Source Decay Menu**, press the **<Source Decay>** button on the **Gauge Status Menu** (see Figure 3–18). Press the **<Done>** button to return to the **Gauge Status Menu**.



Figure 3–21. Source Decay Menu

GPS LOCATION

To view the gauge’s current GPS location, press the **⟨GPS Location⟩** button on the **Gauge Status Menu** (see Figure 3–18). The PDA queries the gauge to take a GPS reading, and displays the message **Collecting GPS Data**. Upon completion, the PDA displays the gauge’s GPS location as shown in Figure 3–22. Press **⟨OK⟩** to return to the **Gauge Status Menu**.



Figure 3–22. GPS Location Display

CHAPTER 4

USING THE GAUGE

This chapter explains the basic use of the Troxler Model 3451 Enhanced RoadReader Plus. Basic use includes taking the daily standard count, preparing measurement sites, setting the measurement mode, and taking measurements.

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TAKING A STANDARD COUNT

To adjust readings for source decay (see **Appendix A**) and natural background radiation, take a daily *standard count*. A four-minute daily standard count helps ensure the highest measurement accuracy.

Locate the reference standard block shipped with the gauge. Always take standard counts using the reference standard block.

Choose a standard count site. The standard count site should be:

- ◆ Dry and flat
- ◆ At least 3 meters (10 ft) from any large vertical surface
- ◆ At least 10 meters (33 ft) from any other radioactive source
- ◆ On asphalt, concrete, or compacted soil at least 10 centimeters (4 in.) thick

Turn the gauge and PDA on as described on page 3–8. At the RoadReader Plus main menu (see Figure 3–11 on page 3–18), press the **<Standard Count>** button. The PDA displays the **Standard Menu** (see Figure 4–1), which shows the last standard counts for moisture (*MS*) and density (*DS1* and *DS2*).

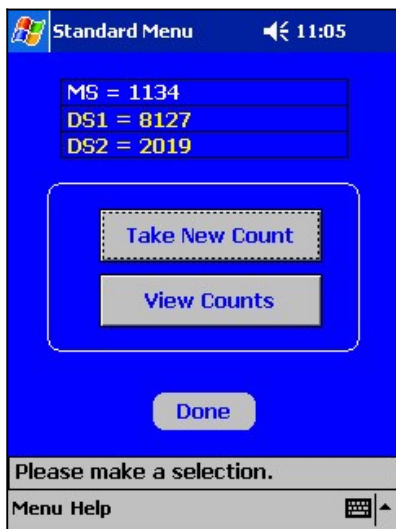


Figure 4–1. Standard Menu

TAKE A NEW STANDARD COUNT

To take a new standard count, press the **(Take New Count)** button. The PDA displays the prompt **Place the gauge on the standard block with the source rod in the STD position and click OK.**

Place the reference standard block on the standard count site. As shown in Figure 4-2, place the gauge on the reference standard block, with the right side (Troxler logo side) of the gauge against the metal butt plate. Ensure that the source rod is in the standard (**SAFE**) position and is firmly seated.

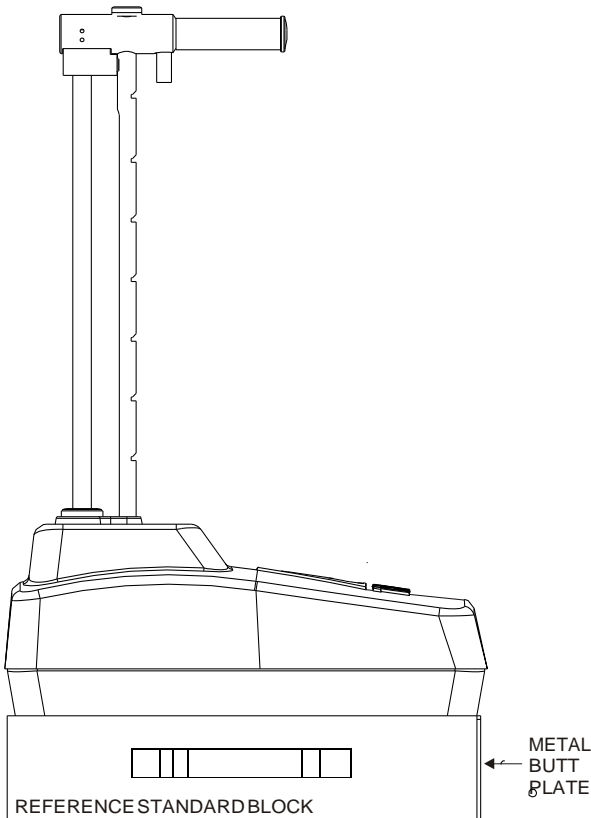


Figure 4-2. Standard Count Position

Press the **<OK>** button to begin the standard count. After taking the standard count, the gauge software displays the results, as shown in Figure 4–3.

Troxler recommends that the operator keep a daily log of the standard counts (see **Appendix E**). To verify gauge stability, compare the daily standard count to a reliable reference as follows:

- ◆ During the first four days of operation of a new or recalibrated gauge, compare the daily standard count to the factory-calibrated values.
- ◆ After the first four days of operation (or after taking four standard counts), compare the daily standard count to the average of the last four counts. Acceptable standard count limits are:
 - ±1% each day for DS1 (density standard),
 - ±1.3% each day for DS2 (density standard), and
 - ±2% each day for MS (moisture standard).

If the standard count *passes*, record the standard counts, then press the **<Yes>** button. The PDA displays the prompt **Do you wish to erase the last four standard counts?** Press **<No>**. The PDA displays **Standard counts have been stored.** Press the **<ok>** button to return to the **Standard Menu**.

- ▶ If the standard count *fails by less than 10%* and it has been *more than a month* since the last standard count, then accept the standard count by pressing the **<Yes>** button. At the **Do you wish to erase the last four standard counts?** prompt, press the **<Yes>** button. The PDA displays **Standard counts have been stored. Previous four standard counts were erased from memory.**

Press the **<ok>** button to return to the **Standard Menu**. Take four additional standard counts. The last of these counts will be compared to the previous four, and the standard counts should pass. If not, repeat the procedure. If it still fails, perform a stat test (see page C–2) and a drift test (see page C–5), then contact your Troxler representative.

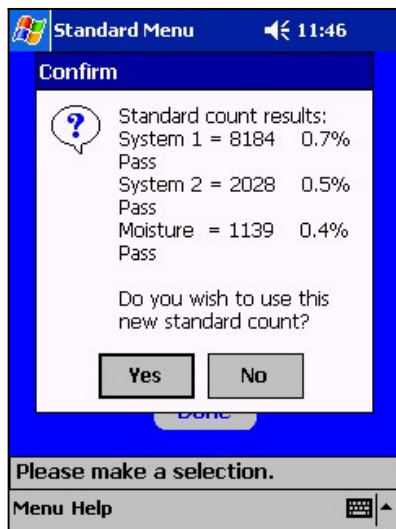


Figure 4–3. Standard Count Results

- ▶ If the standard count *fails* and it has been *less than a month* since the last standard count, but the count was performed correctly and the *failure is less than 5%*, press the **<Yes>** button. If the *failure is more than 5%*, press the **<No>** button. Ensure that the gauge is properly positioned on the reference standard block (Figure 4–2). Verify that the standard count site meets the criteria listed on page 4–2. Take another standard count and accept it if it fails by less than 5%. If the standard count fails four times, perform a stat test (see page C–2) and a drift test (see page C–5), and then contact your Troxler representative.

After the standard count passes, the operator can take measurements with the gauge. When not taking readings, always keep the source rod in the **SAFE** position. For added operator safety, the source rod automatically retracts to the **SAFE** position when the gauge is lifted using the handle.

VIEW STANDARD COUNTS

To view the last four standard counts, press the **<View Counts>** button on the **Standard Menu** (see Figure 4-1). The PDA displays the **View Standard** screen shown in Figure 4-4. Press the **<Done>** button to return to the **Standard Menu**.

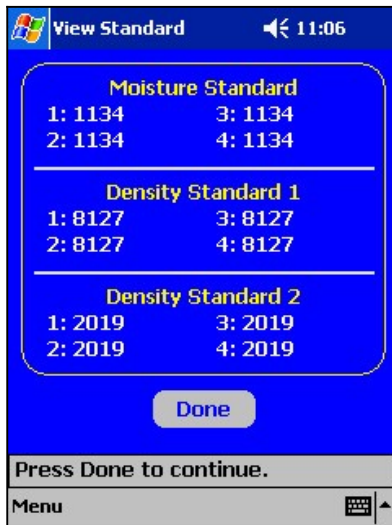


Figure 4-4. View Standard Screen

PREPARING A TEST SITE

To ensure measurement accuracy, properly prepare the test site before taking gauge measurements. This section describes how to prepare test sites properly for *direct transmission* and *backscatter* measurement modes. For a description of these measurement modes, refer to page 2–2.

DIRECT TRANSMISSION MODE

Direct transmission mode is used on materials with layers four inches thick or more. This mode is most commonly used on soils, but can also be used to measure asphalt and concrete.

- ✓ Locate a smooth site on the test material free from any large holes, cracks, or debris.
- ✓ If necessary, smooth the surface by moving the scraper plate in a back and forth motion.
- ✓ Fill any voids or depressions with fine sand. Strike off any excess fill.
- ✓ Place the scraper plate back on the surface and press down slightly to level the surface.
- ✓ Drill a hole in the test material as follows:
 - ✓ Put the drill rod through the extraction tool and then through one of the guides on the scraper plate (Figure 4–5).
 - ✓ Wear safety glasses and a radiation dosimeter.
 - ✓ Place the drill rod assembly on the test site.
 - ✓ Step on the scraper plate.
 - ✓ Hammer the drill rod at least fifty millimeters (2 in.) deeper than the desired test depth. The drill rod increments include the additional depth.

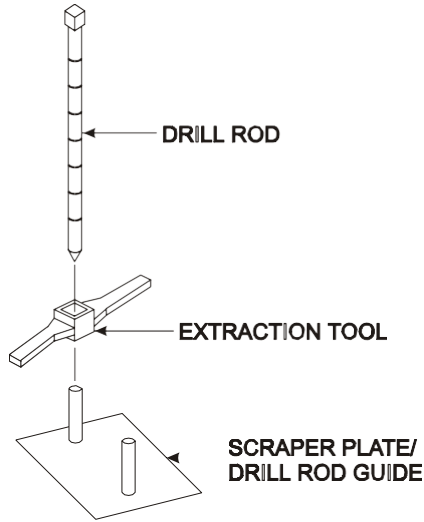


Figure 4-5. Drill Rod Assembly

- ✓ Mark the test area before removing the scraper plate to ensure the gauge is placed over the same area as the scraper plate (Figure 4-6).

CAUTION

Under no circumstances should the source rod of the gauge be used to drill holes.

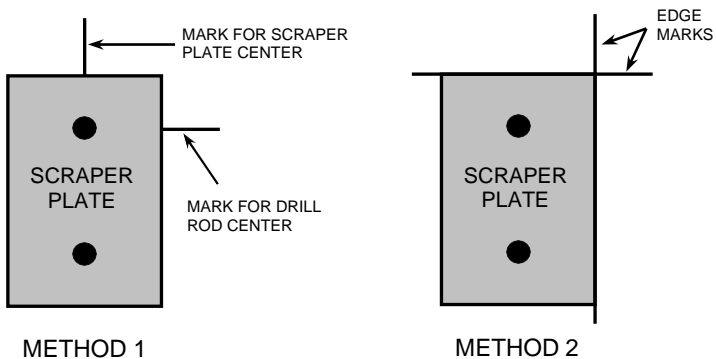


Figure 4-6. Marking the Test Area

- ✓ 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.* Also, do not rock the extraction tool from side to side. This will distort the hole or cause loose material to fall into the hole.
- ✓ Carefully pick up the scraper plate.

BACKSCATTER MODE

Backscatter mode is used on concrete, asphalt, and soil layers approximately four inches thick.

- ✓ Locate a smooth site on the test material.
- ✓ Fill the voids on open mixes with sand or cement.

NOTE

The gauge base must rest on the test material, not the fill material.

- ✓ Ensure that the gauge does not rock. To ensure accurate readings, the gauge base must be completely in contact with the test material. If the gauge rocks, then find a more suitable test site. If taking a measurement around a core, the gauge may be moved a few inches away from the core to level it.

TAKING MEASUREMENTS



NOTE

When not taking readings, always keep the source rod in the SAFE (shielded) position. For added operator safety, the source rod automatically retracts to the SAFE position when the gauge is lifted by the handle.

If you do not hear a *click* when the gauge is raised to the **SAFE** position, look at the bottom of the gauge to verify that the tungsten sliding block is completely closed. If the gauge base opening is not completely closed by the sliding block, the sliding block and fixed tungsten block may require cleaning. Refer to page A-11 for cleaning instructions.



WARNING

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

The **Gauge Status Menu** (see page 3-24) allows the operator to view the current gauge status. This feature provides a quick overview of all enabled functions (mode of operation, enabled offsets, displayed units, etc.). Check the gauge's current status before taking measurements. To change any of the gauge parameters, refer to **Chapter 5**.

NOTE

Always take a standard count each day the gauge is to be used (see page 4-2).

NOTE

A project must be enabled before taking a measurement. Refer to page 3-19 for instructions on creating and enabling projects.

NOTE

During a measurement, if communications between the PDA and gauge are interrupted, the PDA displays the warning **Please move closer to the gauge**. Move the PDA to within 1.5 m (5 ft) of the gauge and press **<ok>**.

SOIL MODE

To measure the moisture and density of soil, soil-stone aggregate, and similar materials, follow the steps below:

- ✓ Prepare the test site as described on page 4–7.
- ✓ Place the gauge on the test area.
- ✓ Insert the source rod into the hole made by the drill rod or source rod adapter. *Use care when inserting the source rod. Try not to disturb the soil around the hole.*
- ✓ Lower the source rod to the measurement depth. Release the trigger. Gently push down on the handle over the source rod to lock the source rod into position. You should hear a *click* when the source rod locks into position.
- ✓ Gently slide the gauge to the right (towards the Troxler logo) so the source rod makes contact with the wall of the hole.
- ✓ Press the **<Take a Reading>** button on the RoadReader Plus main menu (see Figure 3–11).
 - ▶ In the *Manual* depth mode (see page 5–10), the PDA prompts for the source rod depth. Enter the source rod depth and press the **<Ok>** button.
 - ▶ In the *Automatic* depth mode, the gauge software reads the source rod depth strip to determine the source rod depth.
 - ▶ Note that the Proctor value is based on soil particles 3/8 inches or less in diameter (or those passing a #4 sieve). If an unusual reading is obtained and oversize particles are suspected, rotate the gauge 90°. Use the same drill hole to take a second reading.

- ✓ While the gauge is taking a measurement, the PDA displays the time remaining.
- ✓ After the count time, the gauge collects the count information and GPS data, and then transmits this data to the PDA.
- ✓ The PDA displays the prompt **Would you like to add project notes?** This enables the operator to enter project notes to be stored with the measurement results.
 - ▶ To continue without entering project notes, press **<No>**.
 - ▶ To add project notes, press **<Yes>**. The PDA displays the **Project Notes** screen shown in Figure 4–7. Enter the desired notes and press **<Ok>**. Troxler recommends that the information entered as project notes does not exceed 40 characters.
- ✓ The PDA displays the measurement results as shown in Figure 4–8. Note that the **Fix Quality** is displayed as **GPS fix**. This indicates that the gauge’s GPS receiver was able to determine a GPS location, but the Wide Area Augmentation System (WAAS) was not available. For more information on GPS accuracy, refer to page 1–5. Press the **<ok>** button to continue.



Figure 4–7. Entering Project Notes

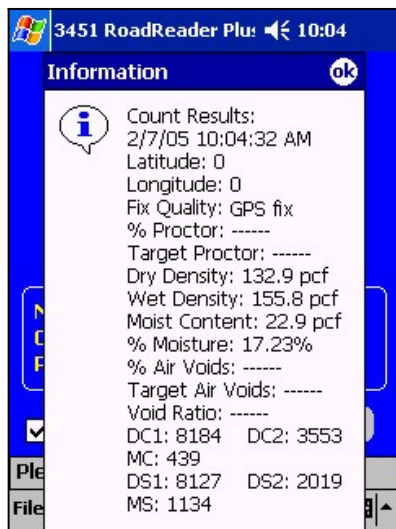


Figure 4–8. Count Results, Soil Mode

- ✓ The PDA stores the measurement results in the active project, then displays the confirmation message **Soil results stored in project: XXX**, where XXX is the active project name. Press the **<ok>** button to continue.
- ✓ The PDA then stores the project data in the gauge. Upon completion, the PDA displays **Project storage to gauge complete**. Press the **<ok>** button to return to the main menu.

NOTE

If the gauge is unable to obtain GPS data after taking a count, it will still send the count results to the PDA and the results will be stored in the active project.

- ✓ Lift the gauge from the test site by the source rod handle. This returns the source rod to the **SAFE** (shielded) position. When not taking readings, always keep the source rod in the **SAFE** position. If you do not hear a *click* when the gauge is raised to the **SAFE** position, look at the bottom of the gauge to verify that the tungsten sliding block is completely closed. If the gauge base opening is not completely closed by the sliding block, the sliding block may require cleaning. Refer to page A–11 for cleaning instructions.



WARNING

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

NOTE

To preserve battery life, the gauge shuts down automatically after five hours of inactivity.

ASPHALT MODE

To measure the density of asphalt, or hardened concrete of 4 inches or more, follow the steps below:

- ✓ Prepare the test site as described on page 4–9.
- ✓ Place the gauge on the test area.
- ✓ Lower the source rod to the backscatter position. Release the trigger. Gently tap on the handle over the source rod to lock the source rod into position. You should hear a *click* when the source rod locks into position.
- ✓ Press the **⟨Take a Reading⟩** button on the RoadReader Plus main menu (see Figure 3–11).
 - ▶ In the *Manual* depth mode (see page 5–10), the PDA prompts for the source rod depth. Enter the source rod depth and press the **⟨Ok⟩** button.
 - ▶ In the *Automatic* depth mode, the gauge software reads the depth strip on the source rod to determine the source rod depth.
- ✓ While the gauge is taking a measurement, the PDA displays the time remaining.
- ✓ After the count time, the gauge collects the count information and GPS data, and then transmits this data to the PDA.
- ✓ The PDA displays the prompt **Would you like to add project notes?** This enables the operator to enter project notes to be stored with the measurement results.
 - ▶ To continue without entering project notes, press **⟨No⟩**.
 - ▶ To add project notes, press **⟨Yes⟩**. The PDA displays a **Project Notes** screen similar to the one shown in Figure 4–7 on page 4–12. Enter the desired notes and press **⟨Ok⟩**. Troxler recommends that the information entered as project notes does not exceed 40 characters.

- ✓ The PDA displays the measurement results as shown in Figure 4–9. Note that:

$$\% \text{Voids} = 1 - \left(\frac{\text{WetDensity}}{\text{Voidless}} \right) \times 100$$

- ✓ Note also that the **Fix Quality** is displayed as **GPS fix**. This indicates that the gauge’s GPS receiver was able to determine a GPS location, but the Wide Area Augmentation System (WAAS) was not available. For more information on GPS accuracy, refer to page 1–5. Press the **<ok>** button to continue.
- ✓ The PDA stores the measurement results in the active project, then displays the confirmation message **Asphalt results stored in project: XXX**, where **XXX** is the active project name. Press the **<ok>** button to continue.
- ✓ The PDA then stores the project data in the gauge. Upon completion, the PDA displays **Project storage to gauge complete**. Press the **<ok>** button to return to the main menu.

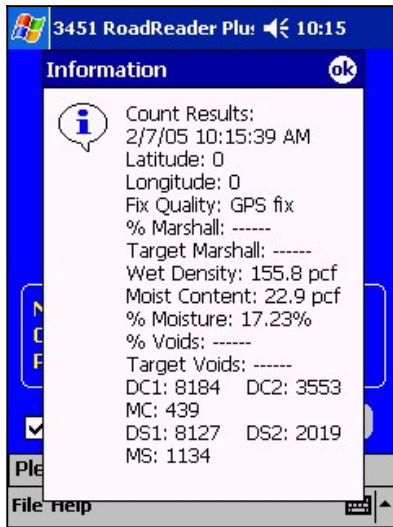


Figure 4–9. Count Results, Asphalt Mode

NOTE

If the gauge is unable to obtain GPS data after taking a count, it will still send the count results to the PDA and the results will be stored in the active project.

- ✓ Lift the gauge from the test site by the source rod handle. This returns the source rod to the **SAFE** (shielded) position. When not taking readings, always keep the source rod in the **SAFE** position. If you do not hear a *click* when the gauge is raised to the **SAFE** position, look at the bottom of the gauge to verify that the tungsten sliding block is completely closed. If the gauge base opening is not completely closed by the sliding block, the sliding block may require cleaning. Refer to page A-11 for cleaning instructions.



WARNING

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

NOTE

To preserve battery life, the gauge shuts down automatically after five hours of inactivity.

THIN LAYER MODE

To measure the density of a top layer of asphalt, follow the steps below. When taking counts after a core has been removed, Troxler recommends averaging four one-minute readings taken around the core site, as shown in Figure 4–10. If no core has been removed, place the gauge over the test site, as shown in Figure 4–11.

- ✓ Prepare the test site as described on page 4–9 for a backscatter measurement.
- ✓ Press the **<Take a Reading>** button on the RoadReader Plus main menu (see Figure 3–11).
- ✓ The PDA displays **Position the gauge for count 1 out of X and click OK**, where *X* is the selected number of readings per site.

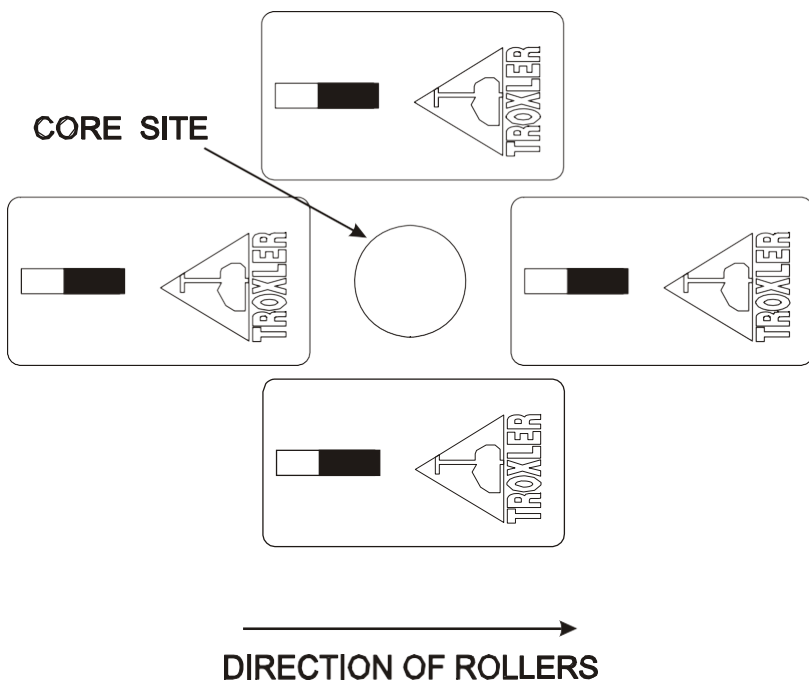


Figure 4–10. Gauge Positioned Around a Core Site
(If Core Has Been Removed)

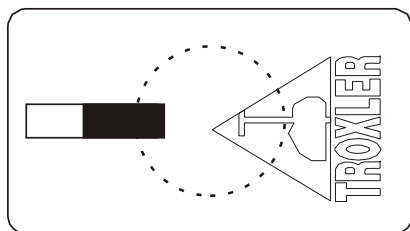


Figure 4–11. Gauge Positioned Over Designated Test Site

- ✓ Place the gauge on the test area and lower the source rod to the backscatter position. Release the trigger. Gently tap down on the handle over the source rod to lock the source into position. You should hear a *click* when the source rod locks into position.
- ✓ When the gauge is in position, press the **<OK>** button on the PDA. While the gauge is taking a measurement, the PDA displays the time remaining.
- ✓ After the count time, the gauge collects the count information and GPS data, and then transmits this data to the PDA.
- ✓ The PDA displays the prompt **Would you like to add project notes?** This enables the operator to enter project notes to be stored with the measurement results.
 - ▶ To continue without entering project notes, press **<No>**.
 - ▶ To add project notes, press **<Yes>**. The PDA displays the **Project Notes** screen shown in Figure 4–7 on page 4–12. Enter the desired notes and press **<Ok>**. Troxler recommends that the information entered as project notes does not exceed 40 characters.
- ✓ The PDA displays the results of the count (see Figure 4–12). Note that the **Fix Quality** is displayed as **GPS fix**. This indicates that the gauge’s GPS receiver was able to determine a GPS location, but the Wide Area Augmentation System (WAAS) was not available. For more information on GPS accuracy, refer to page 1–5. Press the **<ok>** button to continue.

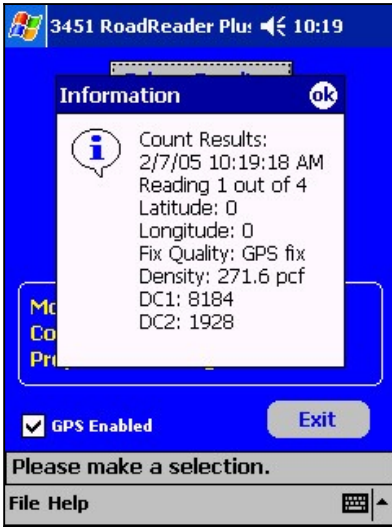


Figure 4–12. Individual Count Results, Thin Layer Mode

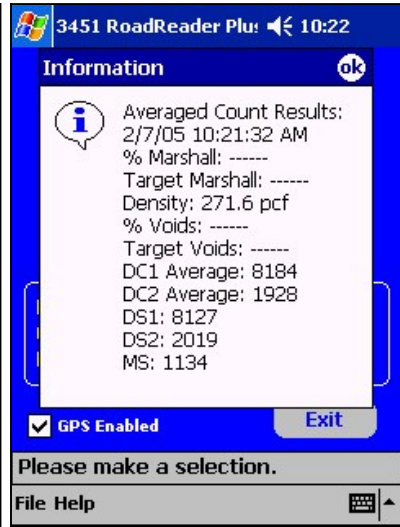


Figure 4–13. Averaged Count Results, Thin Layer Mode

- ✓ Reposition the gauge as prompted by the PDA and repeat the above procedure at each position.
- ✓ After the final count is completed, the gauge collects the count information and GPS data, and then transmits this data to the PDA.
- ✓ The PDA displays the averaged measurement results as shown in Figure 4–13. Press the **(ok)** button to continue.

NOTE

If the gauge is unable to obtain GPS data after taking a count, it will still send the count results to the PDA and the results will be stored in the active project.

- ✓ The PDA stores the measurement results in the active project, then displays the confirmation message **Thin lift results stored in project: XXX**, where *XXX* is the active project name. Press the **<ok>** button to continue.
- ✓ The PDA then stores the project data in the gauge. Upon completion, the PDA displays **Project storage to gauge complete**. Press the **<ok>** button to return to the main menu.
- ✓ Lift the gauge from the test site by the source rod handle. This returns the source rod to the **SAFE** (shielded) position. When not taking readings, always keep the source rod in the **SAFE** position. If you do not hear a *click* when the gauge is raised to the **SAFE** position, look at the bottom of the gauge to verify that the tungsten sliding block is completely closed. If the gauge base opening is not completely closed by the sliding block, the sliding block may require cleaning. Refer to page A-11 for cleaning instructions.



WARNING

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

NOTE

To preserve battery life, the gauge shuts down automatically after five hours of inactivity.

NOTES

CHAPTER 5

SETUP AND TARGET MENUS

The RoadReader Plus software includes a **Gauge Setup** menu, which allows the operator to manually set or change operating parameters usually configured when setting up a project file. This chapter describes these parameters, as well as the use of *target values*.

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GAUGE SETUP MENU

The Model 3451 software groups all the setup features in the **Gauge Setup** menu. To access the **Gauge Setup** menu, press the **<Gauge Settings>** button on the main menu (see Figure 3–11 on page 3–18). The PDA displays the **Change Settings** menu shown in Figure 5–1. Press the **<Gauge Setup>** button to display the **Gauge Setup** menu shown in Figure 5–2.

To select a menu option, press the button that corresponds to the option. Press the **<Done>** button to return to the main menu. The following sections describe the setup options.

NOTE

Most of the setup options described in the following sections are configured by the setup wizard during the creation of a new *project* (see page 3–19). If the operator later changes any of the gauge settings using the **Gauge Setup** menu, those changes will be saved in the active project file.



Figure 5–1. Change Settings Menu

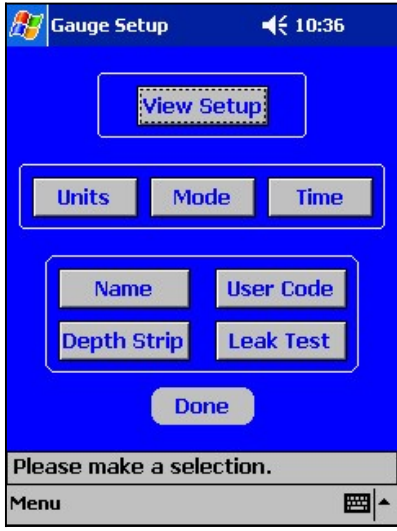


Figure 5–2. Gauge Setup Menu

VIEW SETUP

To view the current gauge setup, press the **(View Setup)** button. The PDA displays the **View Setup** screen (see Figure 5–3), which shows the software version, gauge serial number, source rod type, charger and battery status, count time, measurement units, measurement mode, and depth mode. To scroll through the display, press the scroll bar using the stylus. Press the **(Done)** button to return to the **Gauge Setup** menu.

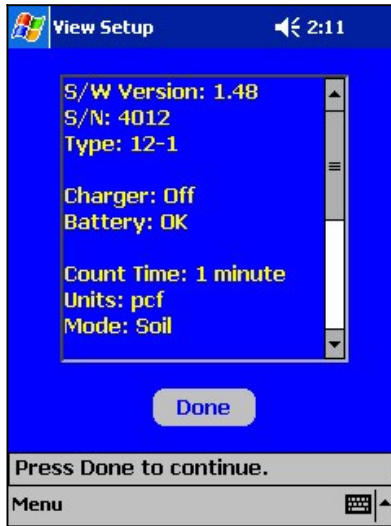


Figure 5–3. View Setup Display

UNITS

The Model 3451 can display measurement results in either metric (SI) or U.S. units. To set the units, press the **(Units)** button on the **Gauge Setup** menu shown on page 5-2. The PDA displays the **Set Units Menu** shown in Figure 5-4.

The current units selection is shown at the top of the menu. To select new measurement units, press the corresponding button. The PDA sets the new units and displays a confirmation message. Press the **(ok)** button to return to the **Set Units Menu**.

Press the **(Done)** button to return to the **Gauge Setup** menu.

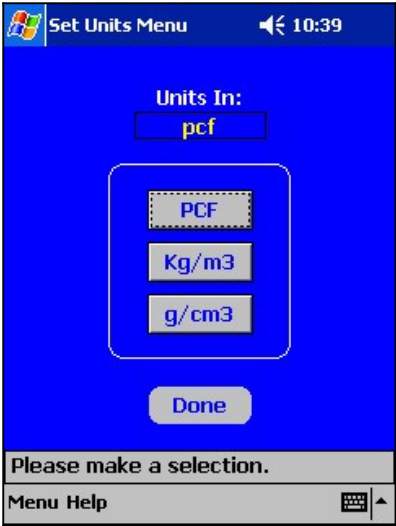


Figure 5-4. Set Units Menu

MODE

The Model 3451 provides three measurement modes (*Soil*, *Asphalt*, and *Thin Layer*) for precise readings on base and thin layer asphalt, concrete, soil, soil-stone aggregate, and similar materials.

- ▶ Use the *Soil* mode when measuring soil or a soil-stone aggregate.
- ▶ Use *Asphalt* mode when measuring concrete or asphalt layers of 4 inches or greater.
- ▶ Select the *Thin Layer* mode when measuring thin-layer asphalt of less than 4 inches. In thin layer mode, the gauge can average up to 20 readings from a single test location. When using this function, the PDA automatically prompts for repositioning of the gauge from a test location and begins another measurement. After all measurements have been completed, the gauge calculates the average density of the test material. When taking counts on thin layer asphalt, Troxler recommends averaging four one-minute readings.

NOTE

The Model 3451 gauge can store measurements performed using different modes under a single project name. For example, the operator may select the *Soil* mode when setting up the project (see page 3–19), but can also save *Asphalt* mode measurements under the same project.

To change the measurement mode for the current project, press the **<Mode>** button on the **Gauge Setup** menu shown on page 5–2. The PDA displays the message shown in Figure 5–5.

- ▶ To maintain the current measurement mode, press **<Cancel>**.
- ▶ To change measurement modes, press **<OK>**. The PDA displays the setup **Wizard** (see page 3–20). Follow the prompts in the wizard to select the mode, measurement units, count time, and so on. Upon completion, the wizard requests a project name while displaying the currently named project file. To change the project name, enter a new one, or press **<ok>** to accept the current name.



Figure 5–5. Mode Change Display

COUNT TIME

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

To change the count time, press the **<Time>** button on the **Gauge Setup** menu (see page 5–2). The PDA displays the **Count Time Menu** shown in Figure 5–6. The current count time is displayed at the top of the menu.

To select the desired count time, press the corresponding button. The PDA sets the count time and displays a confirmation message. Press the **<ok>** button to return to the **Count Time Menu**.

Press the **<Done>** button to return to the **Gauge Setup** menu



Figure 5–6. Count Time Menu

CUSTOMER NAME

The Model 3451 can store a customer name or other messages up to 20 characters. To enter a customer name, press the **(Name)** button on the **Gauge Setup** menu (see page 5–2).

As shown in Figure 5–7, the *Customer Name* option requires an access code. The initial access code is shown on page xv. For instructions on changing the user code, see page 5–9.

To enter the access code, use the PDA's *Block Recognizer*, *Keyboard*, *Letter Recognizer*, or *Transcriber* functions. For more information on these functions, refer to the documentation provided with the PDA.

After the correct access code is entered, press the **(Done)** button. The PDA displays the question **Do you want to change name?** Press the **(OK)** button to continue to the **Enter Customer Name Menu** shown in Figure 5–8.

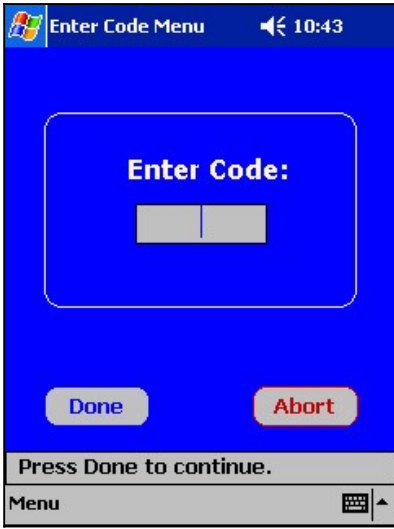


Figure 5–7. Enter Code Menu

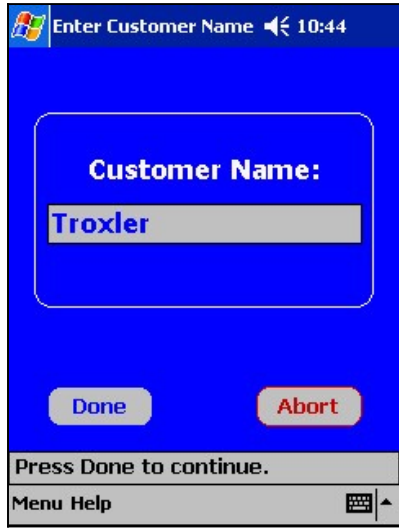


Figure 5–8. Enter Customer Name Menu

The customer name currently stored in the gauge memory is displayed. To change the name, use the PDA’s *Block Recognizer*, *Keyboard*, *Letter Recognizer*, or *Transcriber* functions. For more information on these functions, refer to the documentation provided with the PDA.

Enter the new name and press the **Done** button. The PDA stores the new customer name and returns to the **Gauge Setup** menu.

USER CODE

The *User Code* function enables the operator to change the code used to access certain gauge functions. The code can be any numeric value from 1 to 9999. When shipped, the access (user) code is set to the value shown on page xv.

To change the code, press the **<User Code>** button on the **Gauge Setup** menu. The PDA requests the current user code, as shown in Figure 5–7 on page 5–8. Enter the access code using the PDA's *Block Recognizer*, *Keyboard*, *Letter Recognizer*, or *Transcriber* functions, and press the **<Done>** button. (For more information on these functions, refer to the documentation provided with the PDA.)

The PDA displays the **Change User Code Menu** shown in Figure 5–8. Enter the new code and press the **<Done>** button. The PDA displays a confirmation message showing the entered code and the question **Is this correct?** Press the **<OK>** button to accept the new code and return to the **Gauge Setup** menu, or the **<Cancel>** button to return to the **Change User Code Menu**.

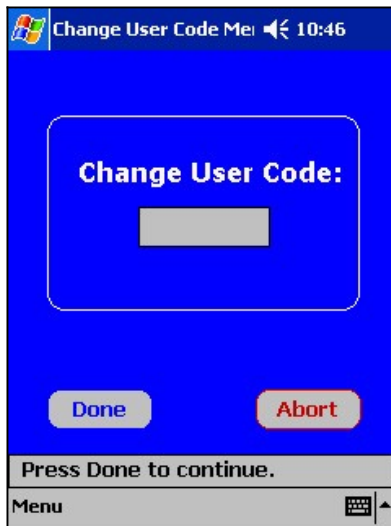


Figure 5–9. Change User Code Menu

DEPTH STRIP

The *Depth Strip* feature allows the operator to set the depth mode. The depth mode determines how the gauge will receive data about the source rod depth. The Model 3451 offers two depth modes: *Automatic* and *Manual*. In the *Automatic* mode, the gauge software reads a depth strip on the index rod to determine the source rod depth. In the *Manual* mode, the operator enters the source rod depth at a gauge prompt whenever taking a measurement.

NOTE

In the *Manual* mode, the gauge uses the source rod depth entered by the operator. If the operator enters an incorrect depth, the measurement results will be invalid.

To access the **Depth Indicator Menu** (see Figure 5–10), press the **<Depth Strip>** button on the **Gauge Setup** menu (see page 5–2).

To select a depth mode, press either the **<Automatic>** or **<Manual>** button. The PDA sets the mode and displays a confirmation message. Press **<ok>** to return to the **Depth Indicator Menu**.

Press the **<Done>** button to return to the **Gauge Setup** menu.

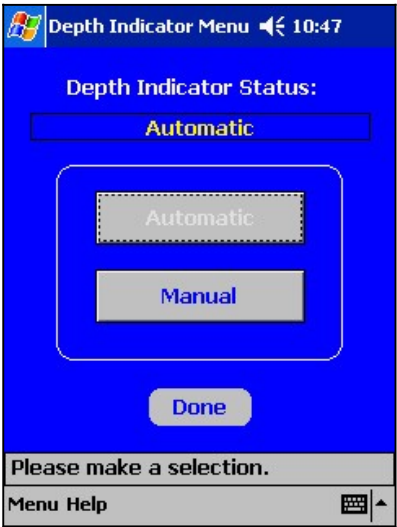


Figure 5–10. Depth Indicator Menu

LEAK TEST

To ensure the integrity of the radioactive source encapsulation, the Model 3451 must be periodically leak tested. For instructions on performing the leak test, see page A-13.

The gauge uses the *leak test interval* and *leak test date* values to determine when a leak test is due. To change these values, press the <Leak Test> button on the **Gauge Setup** menu (see page 5-2). The PDA displays the **Leak Test Menu** shown in Figure 5-11.

NOTE

The *Leak Test* function does not replace the leak test analysis records that must be maintained for review by your licensing agency.

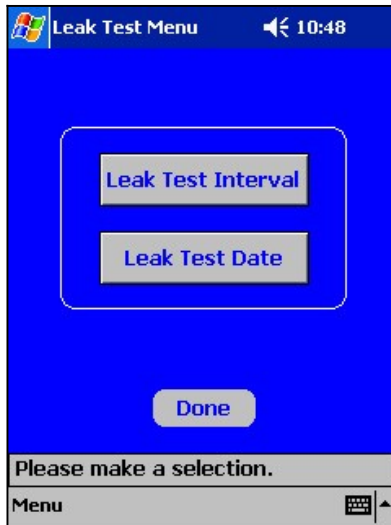


Figure 5-11. Leak Test Menu

Leak Test Interval

By default, the leak test interval is set to six months (183 days). In countries outside of the United States, the time required between leak tests may vary from six months to three years. Check local regulations, and then refer to the following instructions on setting the leak test interval.

To change the leak test interval, press the **<Leak Test Interval>** button. The PDA displays the **Leak Test Interval Menu** shown in Figure 5–12.

The current leak test interval is displayed at the top of the menu. Press the **<Abort>** button to return to the **Leak Test Menu** without changing the value. To change the leak test interval, enter the desired number of days using the PDA's *Block Recognizer*, *Keyboard*, *Letter Recognizer*, or *Transcriber* functions. (For more information on these functions, refer to the documentation provided with the PDA.) Press the **<Done>** button. The PDA sets the new value and returns to the **Leak Test Menu**.

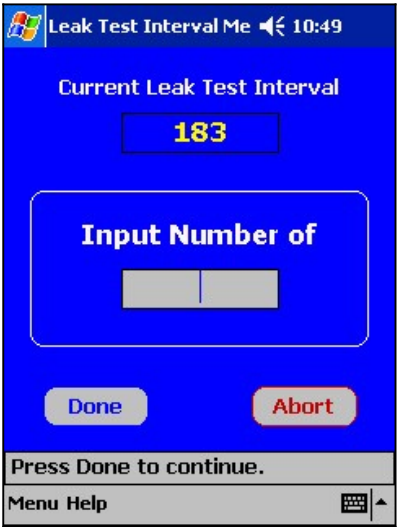


Figure 5–12. Leak Test Interval Menu

Leak Test Date

The *Leak Test Date* function allows the operator to view or change the date of the last leak test. The gauge alerts the operator if the *leak test interval* has been exceeded. To view or change the leak test date, press the **<Leak Test Date>** button. The PDA displays the **Leak Test Date Menu** shown in Figure 5–13.

The current leak test date is displayed at the top of the menu. Press the **<Abort>** button to return to the **Leak Test Menu** without changing the value. To change the leak test date, enter the desired date using the PDA's *Block Recognizer*, *Keyboard*, *Letter Recognizer*, or *Transcriber* functions. (For more information on these functions, refer to the documentation provided with the PDA.) Press the **<Done>** button. The PDA sets the new value and returns to the **Leak Test Menu**.

NOTE

The month and day must each be entered as two-digit numerals, with leading zeroes as required. The year must be entered as a four-digit numeral. For example, to set the leak test date to *April 8, 2005*, enter *04/08/2005*.



Figure 5–13. Leak Test Date Menu

TARGET

Target values include Proctor, percent air voids, Marshall, and voidless density values.

The gauge uses the Proctor value to calculate the compaction level when taking counts in the *Soil* mode. The gauge uses the specific gravity of the material to calculate percent air voids and void ratio. The gauge uses a default value of 2.7, which may not be appropriate for all soil types. If the true percent air voids is desired, a specific gravity for the soil being measured must be entered.

The gauge uses the Marshall and/or voidless density values to calculate the compaction level in the *Asphalt* and *Thin Layer* modes. The *voidless density* is the maximum theoretical density for the test material as obtained in laboratory tests.

The gauge uses the target values to determine the percent compaction after it has determined the density of the test material.

The *Target* function enables the operator to enter and store a new target value, as well as to view, erase, enable, or disable a stored value. To access this function, press the **(Target)** button on the main menu (see Figure 3–11). Depending on the current measurement mode (*Soil*, *Asphalt*, or *Thin Layer*), the PDA displays one of the two menus shown in Figure 5–14.

In *Soil* mode, the **Target Menu** is used to enter, view, erase, enable, or disable Proctor and percent air void values. In the *Asphalt* and *Thin Layer* modes, the **Target Menu** is used to manage the Marshall and voidless density values. To manage a target value, press the corresponding button on the **Target Menu**. The PDA displays a menu similar to the one shown in Figure 5–15.

NOTE

Because the menus for managing the Proctor, percent air voids, Marshall, and voidless density values are essentially the same, the following sections describe only the Proctor Value Menu.

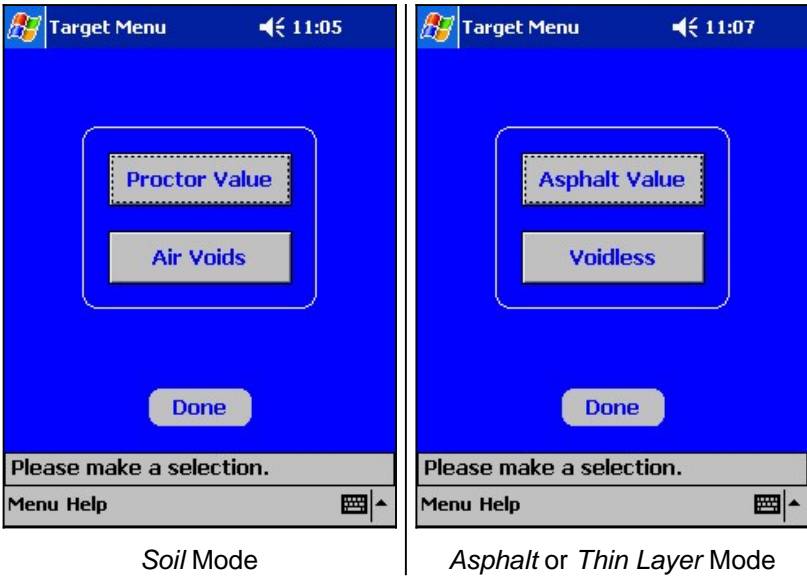


Figure 5–14. Target Menus

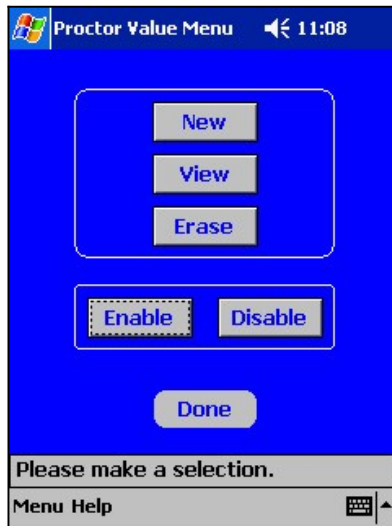


Figure 5–15. Proctor Value Menu

ENTER A TARGET VALUE

To enter a new target value, press the **<New>** button on the **Proctor Value Menu** (see Figure 5–15). As shown in Figure 5–16, the PDA displays its onscreen keyboard and requests the new value. Enter the target value using the selected measurement units (see page 5–4), then press the **<Ok>** button.

The PDA then requests a descriptive name for the target value. Enter an alphanumeric name (up to 20 characters) for the target value and press the **<Ok>** button. The name should be as descriptive as possible, to ensure that the target value can be easily identified. The PDA stores the new value and asks if the new value is to be activated. To activate the new value, press the **<Yes>** button. Pressing the **<No>** button allows the operator to store the value for later use. The PDA returns to the **Proctor Value Menu**.

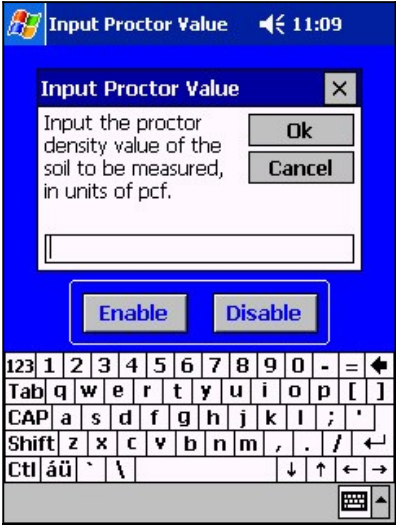


Figure 5–16. Input Proctor Value Display

VIEW A TARGET VALUE

To view a target value stored in memory, press the **<View>** button on the **Proctor Value Menu** (see Figure 5–15). The PDA displays a target value selector menu, as shown in Figure 5–17. To view a value, press the file name twice. The PDA displays a popup window showing the current value. Press the **<ok>** button to return to the **Proctor Value Menu**.

ERASE A TARGET VALUE

To erase a target value stored in memory, press the **<Erase>** button on the **Proctor Value Menu** (see Figure 5–15). The PDA displays a target value selector menu, as shown in Figure 5–17. To erase a value, press the file name twice. The PDA requests confirmation that the target value is to be erased. Press the **<OK>** button to erase the target value, or the **<Cancel>** button to maintain the value in memory. The PDA displays a confirmation message. Press the **<ok>** button to return to the **Target Menu**.

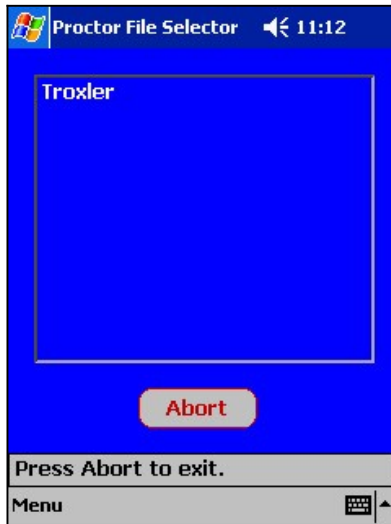


Figure 5–17. Proctor File Selector

ENABLE A TARGET VALUE

To enable a target value stored in memory, press the **⟨Enable⟩** button on the **Target Menu** (see Figure 5–15). The PDA displays the target value selector menu, as shown in Figure 5–17. To enable a target value, press the file name twice. The PDA displays a confirmation message. Press the **⟨ok⟩** button to return to the **Proctor Value Menu**.

DISABLE THE TARGET VALUE

To disable the target value, press the **⟨Disable⟩** button on the **Proctor Value Menu** (see Figure 5–15). The PDA requests confirmation that the target value is to be disabled. Press the **⟨No⟩** button to return to the **Proctor Value Menu** without disabling the target value.

Press the **⟨Yes⟩** button to disable the target value. The PDA disables the target value and displays a confirmation message. Press the **⟨ok⟩** button to return to the **Proctor Value Menu**.

NOTE

The 3451 gauge can be used with the target value disabled. In this case, however, no percent compaction value will be displayed.

CHAPTER 6

ADJUSTING MEASUREMENTS

This chapter explains how to adjust gauge readings using *offsets*, and how to create a special calibration.

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CALIBRATION OFFSET

Troxler calibrates the Model 3451 Enhanced RoadReader Plus at the factory for use on soils, asphalt, and concrete. This factory calibration covers an approximate density range of 1100 to 2700 kg/m³ (70 to 170 pcf). If the gauge is to be used on materials not covered by the original calibration, the operator can adjust the gauge using an offset. The 3451 gauge provides three offsets: *wet density*, *moisture*, and *trench*.

Perform a *wet density offset* if the test material is outside the range of material composition and/or texture used during factory calibration.

Perform a *moisture offset* if the test material contains hydrogen in forms other than water, or is high in neutron absorbers. Examples of materials rich in hydrogen are Portland cement concrete, gypsum, coal, or lime. The moisture offset for soils containing these materials is a *negative* value. If the material is high in neutron-absorbing material, such as boron, cadmium, or chlorine, then the offset must be a *positive* value.

Perform a *trench offset* before taking measurements inside a trench or close vertical structures. Vertical structures scatter neutrons and gamma photons back to the gauge. This scattering could result in inaccurate moisture and density readings.

To enable an offset, press the **<Change Settings>** button on the RoadReader Plus main menu (see Figure 3–11 on page 3–18). The PDA displays the **Change Settings** menu shown in Figure 5–1 on page 5–2.

Press the **<Gauge Offsets>** button. The PDA displays the **Offset Menu** shown in Figure 6–1.



Figure 6–1. Offset Menu

WET DENSITY OFFSET

The *wet density offset* is the actual wet density of the material minus the wet density determined by the gauge. To access the wet density offset functions, press the **Wet Density** button on the **Offset Menu** (see Figure 6–1).

The PDA displays the **Wet Density Offset Select** screen shown in Figure 6–2. The current wet density offset is displayed in the box.

To enable the offset, press **Enable**. To disable the offset, press **Disable**. The PDA displays a confirmation message. Press the **ok** button to return to the **Wet Density Offset Select** screen.

To enter a new wet density offset, press **Change**. The PDA displays the input screen shown in Figure 6–3. Enter the new wet density offset and press **Ok**. The PDA enables the new offset and displays **Wet density offset is enabled**. Press the **ok** button to return to the **Wet Density Offset Select** screen.



Figure 6–2. Wet Density Offset Select

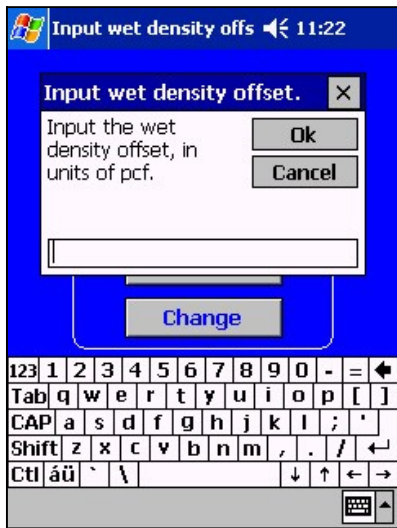


Figure 6–3. Input Wet Density Offset

MOISTURE OFFSET

The moisture offset (k) is determined by comparing the *true moisture* of a laboratory sample with the gauge moisture reading. The Model 3451 can derive the moisture offset either by taking a moisture measurement and comparing the reading to the true moisture entered by the operator, or by comparing measured and true values entered by the operator. To access the moisture offset functions, press the **(Moisture)** button on the **Offset Menu** (see Figure 6–1). The PDA displays the **Moisture Offset Select** screen shown in Figure 6–4.

New Moisture Offset from Gauge Reading

To derive the moisture offset by first taking a moisture reading, the operator must take a reading with the gauge and enter the true moisture derived by an oven dry or similar method. The gauge can store one *partial offset*, which allows the operator to take a reading and enter the true moisture at different times.

NOTE

When using destructive methods such as drilling cores or sample removal for true moisture measurement, take gauge readings before removing samples.

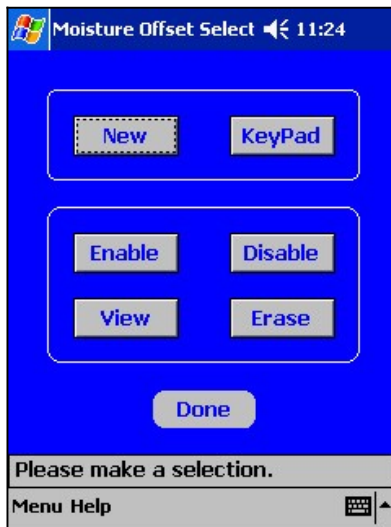


Figure 6–4. Moisture Offset Select

MEASURING THE MOISTURE. To access this function, press the **<New>** button on the **Moisture Offset Select** screen. If no partial offset exists, the PDA displays the prompt **Place the gauge on the surface to be tested and click OK for a four-minute count.**

Prepare the test site as described on page 4–7. Place the gauge on the test site and position the source rod in the measurement position. Press the **<OK>** button to take a four-minute reading.

The PDA displays **Moisture Count in Progress**, as well as the time remaining (in seconds). Upon completion, the PDA collects the counts, stores the partial moisture offset, then displays **Partial moisture offset saved. Press ‘New’ again to enter true moisture value.** Press **<ok>** to return to the **Moisture Offset Select** screen.

ENTERING TRUE MOISTURE. To enter the true moisture after a partial offset has been stored, press the **<New>** button on the **Moisture Offset Select** screen. The PDA displays **A partial moisture offset exists. Do you wish to enter the true percent moisture?**

- ▶ To enter the true moisture, press **<Yes>**. The PDA requests the true percent moisture (see Figure 6–5). Enter the true moisture and press **<OK>**. The PDA requests a file name for the moisture offset (see Figure 6–6). Enter a file name (up to 20 characters) and press **<OK>**. The name should be as descriptive as possible, to ensure that the offset value can be easily identified. The PDA displays **Moisture offset saved. Do you wish to activate this offset?** Press **<Yes>** to activate the offset, or **<No>** to continue. The PDA returns to the **Moisture Offset Select** screen.
- ▶ To erase the existing partial offset and start a new one, press **<No>**. The PDA asks **Do you wish to erase the current partial moisture offset?** Press **<Yes>** to erase the stored partial moisture offset and begin a new moisture measurement as described above, or **<No>** to return to the **Moisture Offset Select** screen.

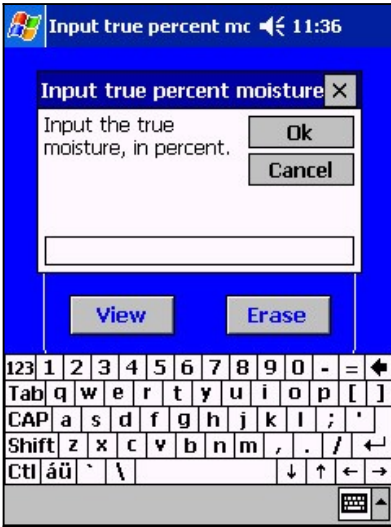


Figure 6–5. Input True Percent Moisture



Figure 6–6. Enter Moisture Offset File Name

Moisture Offset from Keypad Entry

As described earlier in this chapter, the Model 3451 can derive the moisture offset (k) by comparing measured and true values entered by the operator. Before accessing this function:

- ✓ Take a gauge reading at a site and record the reading. Repeat at several test sites.
- ✓ Remove a soil sample from each test site at a depth of at least 8 in. (or the appropriate *depth of measurement* determined using the formulas on page 2–3).
- ✓ Use standard laboratory methods (for example, oven or microwave drying) to determine the *true moisture content* of each soil sample.
- ✓ Calculate the average *gauge-measured moisture* and the average *laboratory-derived moisture*. Use these average values to calculate the offset factor.

To determine the moisture offset, press **<KeyPad>** on the **Moisture Offset Select** screen (see Figure 6–4). The PDA prompts for the percent moisture value, as measured by the gauge (see Figure 6–7). Enter the average moisture value determined above and press **<Ok>**.

The PDA then prompts for the true percent moisture value. Enter the true (laboratory) moisture determined above and press **<Ok>**.

The PDA determines the offset (k) value. If the k value is larger than that which is typical, the PDA displays a warning message. If the derived value is within parameters, the PDA requests a file name for the offset as shown in Figure 6–6 on page 6–7. Enter a descriptive name (up to 20 characters), and press **<Ok>**. The name should be as descriptive as possible, to ensure that the offset value can be easily identified. The PDA displays **Moisture offset saved. Do you wish to activate this offset?**

Press **<Yes>** to activate the offset, or **<No>** to exit without activating the offset. The PDA returns to the **Moisture Offset Select** screen.

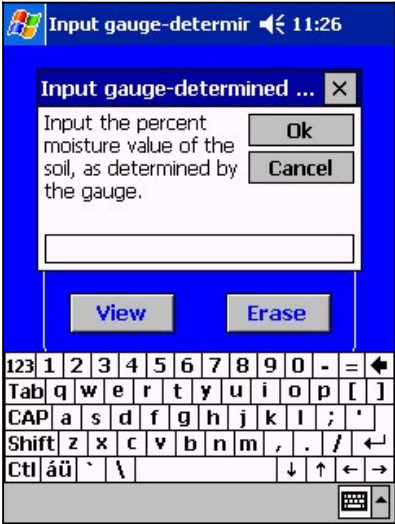


Figure 6–7. Input Moisture Value from Gauge

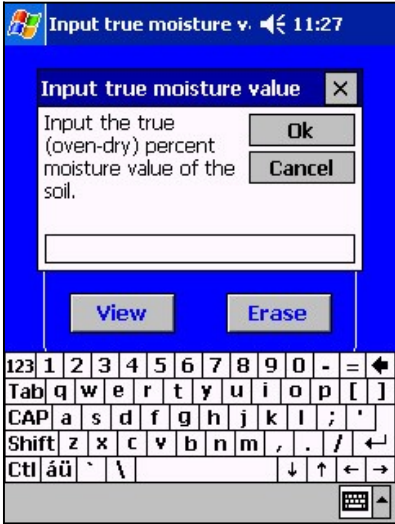


Figure 6–8. Input True Moisture

Enable a Stored Moisture Offset

To enable a moisture offset already stored in the gauge, press the **<Enable>** button on the **Moisture Offset Select** screen (see Figure 6-4). The PDA displays the **Offset File Selector** screen, as shown in Figure 6-9.

To select and enable an offset file, press the offset file name twice. The PDA displays **Moisture offset enabled**. Press **<ok>** to return to the **Moisture Offset Select** screen.

Disable Moisture Offset

To disable the moisture offset, press the **<Disable>** button on the **Moisture Offset Select** screen (see Figure 6-4). The PDA displays **The moisture offset named XXX has been disabled**. Press **<ok>** to return to the **Moisture Offset Select** screen.

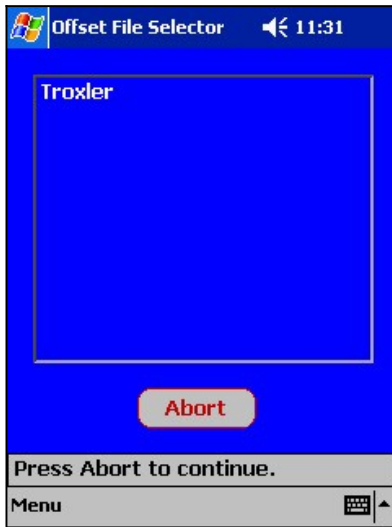


Figure 6-9. Offset File Selector

View a Stored Moisture Offset

To view the value of a moisture offset already stored in the gauge, press the **<View>** button on the **Moisture Offset Select** screen (see Figure 6–4). The PDA displays the **Offset File Selector** screen, as shown in Figure 6–9.

To view an offset value, press the offset file name twice. The PDA displays an information block showing the file name and moisture offset (*K*) value. Press **<ok>** to return to the **Moisture Offset Select** screen.

Erase a Stored Moisture Offset

To erase a moisture offset, press the **<Erase>** button on the **Moisture Offset Select** screen (see Figure 6–4). The PDA displays the **Offset File Selector** screen shown in Figure 6–9.

To erase an offset value, press the offset file name twice. The PDA displays the prompt shown in Figure 6–10.

- ▶ Press **<OK>** to erase the project file. The PDA displays **Moisture offset XXX has been erased**. Press **<ok>** to continue.
 - ▶ If the erased project was not previously active, the PDA returns to the **Moisture Offset Select** screen.
 - ▶ If the erased project was previously active, the PDA displays **The moisture offset named XXX has been disabled!** Press **<ok>** to return to the **Moisture Offset Select** screen.
- ▶ Press **<Cancel>** to exit without erasing the project file. The PDA displays **The moisture offset named XXX will not be erased**. Press **<ok>** to return to the **Moisture Offset Select** screen.

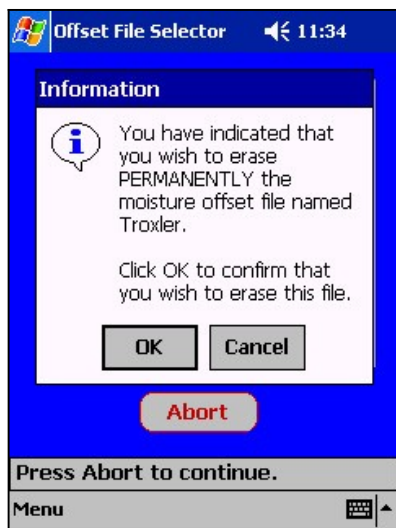


Figure 6–10. Moisture Offset Erase Prompt

TRENCH OFFSET

To use the Model 3451 in a trench or within 0.6 m (2 ft) of a large vertical surface, first perform a *trench offset*. When a trench offset is enabled, the gauge automatically applies a *trench density offset* to readings of 4 in. or less, and a *trench moisture offset* to all readings. For direct transmission measurements over 4 inches deep, only the trench moisture offset is used. In the displays shown in this section, *TMO* refers to *trench moisture offset*; *TDO* refers to *trench density offset* values (one for each set of detectors).

To access the trench offset function, press the **<Trench>** button on the **Offset Menu** shown in Figure 6–1 on page 6–3. The PDA displays the **Trench Offset Select** screen shown in Figure 6–11. The current trench offset values are displayed in the box.

To enable the offset, press **<Enable>**. To disable the offset, press **<Disable>**. The PDA displays a confirmation message. Press the **<ok>** button to return to the **Trench Offset Select** screen.



Figure 6–11. Trench Offset Select

To determine a new trench offset, press **<Change>**. The PDA displays the prompt **Set rod to STD Pos. Press OK for 1 minute STD count in trench.**

Select a position inside the trench and the same distance from the wall as the test measurements. Place the gauge on the standard block in this position. Press the **<OK>** button on the PDA.

The PDA displays the progress of the standard count operation. After the standard count is complete, the PDA displays the results as shown in Figure 6–12.

- ▶ To enable the new trench offset, press the **<Yes>** button. The PDA displays **Trench offset enabled.** Press the **<ok>** button to return to the **Trench Offset Select** screen.
- ▶ To reject the new trench offset, press the **<No>** button. The PDA displays **Trench offset measurement rejected!** Press the **<ok>** button to return to the **Trench Offset Select** screen.



Figure 6–12. New Trench Offset Confirmation

SPECIAL CALIBRATION

The *Special Calibration* features allow the operator to recalibrate Model 3451 soil and thin layer readings. Special calibrations are specific for the test material and measurement depth. To access these features, press the **<Change Settings>** button on the RoadReader Plus main menu (see Figure 3–11 on page 3–18). The PDA displays the **Change Settings** menu shown in Figure 5–1 on page 5–2.

In *Soil* mode, the PDA can activate a special calibration for each source rod depth.

NOTE

A soil special calibration is active only at the source rod depth at which it was created. For proper operation, create a soil special calibration for each required measurement depth.

Before performing a special calibration, prepare the sample area for testing as described in **Chapter 4**.

SOIL SPECIAL CALIBRATION

The factory calibration provides accurate results for the majority of materials encountered in the field. However, there are situations when varying material compositions and/or texture could affect the gauge accuracy.

The *Soil Special Calibration* function is used to recalibrate the Model 3451 gauge for material characteristics not covered by the factory calibration. The “true density” can be determined by carefully measuring samples of a known material using an alternate method in a laboratory or in the field. This function is activated only in *Soil* mode.

To access the *Soil Special Calibration* function, press the **<Special Calibration>** button on the **Change Settings** menu (see Figure 5–1). The PDA displays the **Special Calibration Menu** shown in Figure 6–13. The following sections provide details on the *Special Calibration* function.

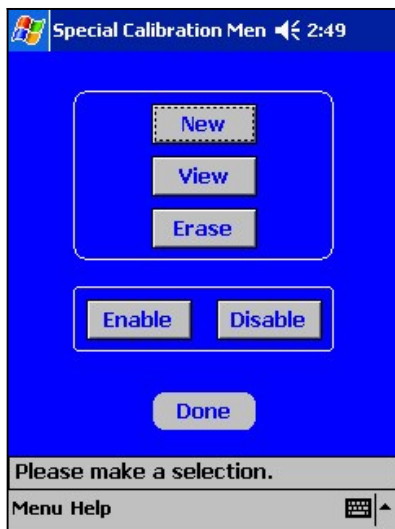


Figure 6–13. Soil Special Calibration Menu

New Special Calibration

To create a new special calibration, the operator must take readings with the gauge and enter the true density. The Model 3451 can store one partial calibration. A partial calibration allows the operator to enter the true density or take readings at different times.

MEASURING THE DENSITY. To create a new special calibration, press **<New>** at the **Special Calibration Menu**. If no partial calibration exists, the PDA displays **Place the gauge on the measurement site, lower the gauge to the proper depth, and click OK.**

Place the gauge on the test site and position the source rod in the desired measurement position.

NOTE

When using destructive methods (such as drilling cores or sample removal) for true density measurement, take gauge readings before removing samples. Position the gauge over the designated test site as in Figure 6–14.

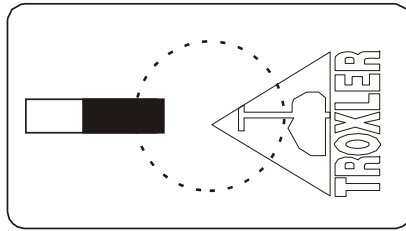


Figure 6–14. Gauge Positioned Over Designated Test Site

Press **<OK>** to begin the measurement. The PDA displays **Special Count in Progress** as well as the time remaining (in seconds). Upon completion of the count, the PDA collects the counts, stores the partial calibration, and displays **Partial calibration saved**. Press **'New'** again to enter true density value. Press **<ok>** to return to the **Special Calibration Menu**.

ENTERING TRUE DENSITY. To enter the true density after a partial offset has been stored, press the **<New>** button on the **Special Calibration Menu**. The PDA displays **A partial special calibration exists. Do you wish to enter the true density value?**

- ▶ To enter the true density, press **<Yes>**. The PDA requests the true density (see Figure 6–15). Enter the true density and press **<Ok>**. The PDA requests a file name for the special calibration (see Figure 6–16). Enter a file name (up to 20 characters) and press **<Ok>**. The name should be as descriptive as possible, to ensure that the special calibration value can be easily identified. The PDA displays **Special calibration saved. Do you wish to activate this special calibration?** Press **<Yes>** to activate the special calibration, or **<No>** to continue. The PDA returns to the **Special Calibration Menu**.
- ▶ To erase the existing partial calibration and start a new one, press **<No>**. The PDA asks **Do you want to erase the current partial calibration?** Press **<Yes>** to erase the stored partial calibration and begin a new density measurement as described above, or **<No>** to return to the **Special Calibration Menu**.

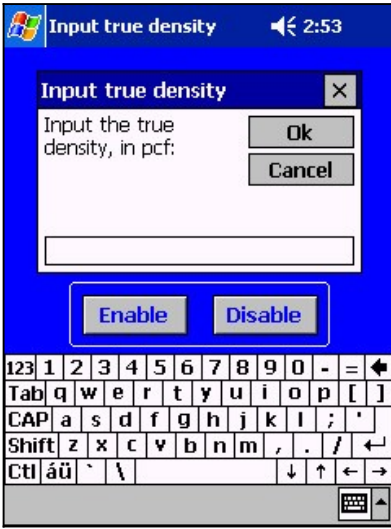


Figure 6–15. Input True Density



Figure 6–16. Enter File Name

View a Special Calibration

To view the value of a special calibration stored in memory, press **<View>** on the **Special Calibration Menu**. The PDA displays the **Special File Selector** screen shown in Figure 6–17.

To view a special calibration, press the calibration file name twice. The PDA displays an information block showing the file name, index rod depth, and $B*1000$ value. Press **<ok>** to return to the **Special Calibration Menu**.

Erase a Special Calibration

To erase a special calibration, press the **<Erase>** button on the **Special Calibration Menu** (see Figure 6–13). The PDA displays the **Special File Selector** screen shown in Figure 6–17.

To erase a special calibration, press the file name twice. The PDA displays the prompt shown in Figure 6–18.

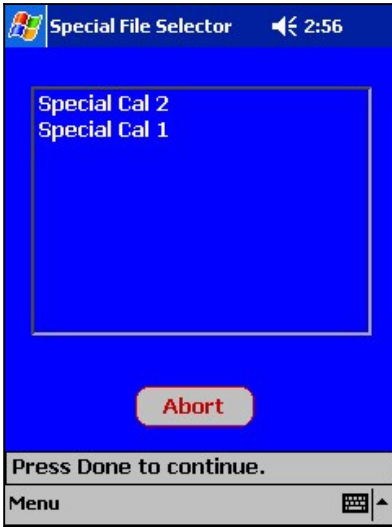


Figure 6–17. Special File Selector



Figure 6–18. Special Calibration Erase Prompt

- ▶ Press **<OK>** to erase the special calibration file. The PDA displays **Special calibration XXX has been erased.** Press **<ok>** to continue.
 - ▶ If the erased project was not previously active, the PDA returns to the **Special Calibration Menu.**
 - ▶ If the erased project was previously active, the PDA displays **The special calibration named XXX at index rod position X has been erased.** Press **<ok>** to return to the **Special Calibration Menu.**
- ▶ Press **<Cancel>** to exit without erasing the special calibration file. The PDA displays **The special calibration named XXX will not be erased!** Press **<ok>** to return to the **Special Calibration Menu.**

Enable a Special Calibration

To enable a special calibration already stored in the gauge, press the **<Enable>** button on the **Special Calibration Menu** (see Figure 6–13). The PDA displays the **Special File Selector** screen, as shown in Figure 6–17.

To select and enable a special calibration, press the file name twice. The PDA displays **The special calibration XXX has been activated at X position**. Press **<ok>** to return to the **Special Calibration Menu**

Disable a Special Calibration

To disable the special calibration, press the **<Disable>** button on the **Special Calibration Menu** (see Figure 6–13). The PDA asks for the source rod position, as shown in Figure 6–19.

Enter the source rod position and press **<OK>**. The PDA displays **The special calibration named XXX at index rod position X has been disabled**. Press **<ok>** to return to the **Special Calibration Menu**



Figure 6–19. Enter Rod Position

THIN LAYER SPECIAL CALIBRATION

The *Thin Lift Special Calibration* function allows the operator to re-calibrate the gauge for materials not covered by the factory calibration.

The thin layer special calibration uses the average of 3 to 20 measurements. Troxler recommends averaging one-minute readings taken on a test site (see Figure 6–14 on page 6–16) or around a core site (as shown in Figure 6–20). This average and the density obtained by another method (such as core samples) are used to re-calculate the gauge constants.

To access the *Thin Lift Special Calibration* function, press the **<Special Calibration>** button on the **Change Settings** menu (see Figure 5–1). The PDA displays the **Thin Lift Special Calibration** menu shown in Figure 6–21. The following sections provide details on the *Thin Lift Special Calibration* function.

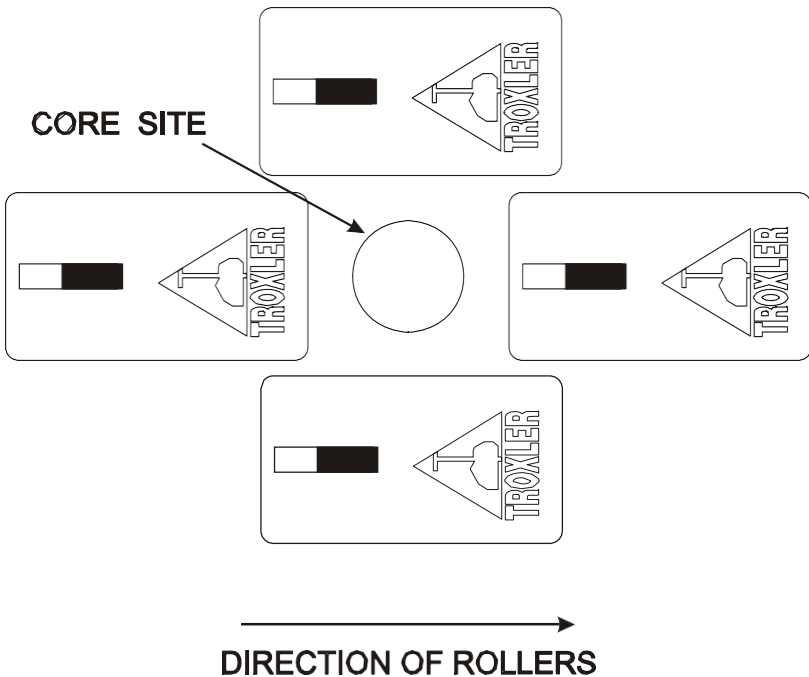


Figure 6–20. Taking Measurements Around a Core Site

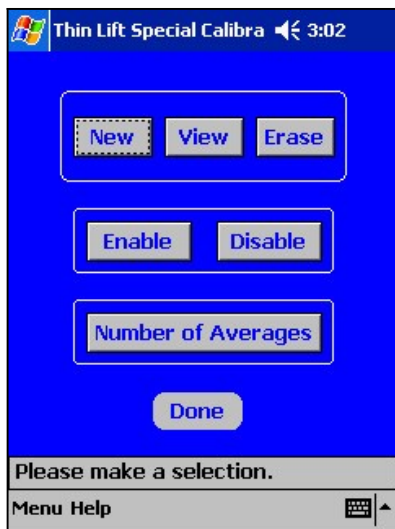


Figure 6–21. Thin Lift Special Calibration Menu

Create a New Thin Layer Special Calibration

To create a thin layer special calibration, the operator must take readings with the gauge and enter the true densities for each reading. The gauge uses these values to calculate the thin layer special calibration constants. The Model 3451 can store one partial calibration. A partial calibration allows the operator to enter the asphalt parameters and take readings at different times.

MEASURING THE DENSITY. To create a thin layer special calibration, press the **<New>** button on the **Thin Lift Special Calibration** menu. The PDA asks **How many thin layer measurements do you wish to make (3-20)?** Enter the desired number of measurements and press **<Ok>**.

NOTE

When taking counts on thin layer asphalt, Troxler recommends averaging large numbers of readings over the same material to ensure results that are more accurate. Use at least ten (10) gauge readings before cutting cores.

The PDA displays **The current top layer thickness setting in the gauge is X inches. Do you wish to use this value for the upcoming readings?**

- ▶ To accept the displayed top layer thickness, press **<Yes>**.
- ▶ To enter a different value for the top layer thickness, press **<No>**. The PDA requests the new top layer thickness value as shown in Figure 6–22. Enter the top layer thickness and press **<Ok>**.

The PDA displays **Place the gauge on measurement site, 1, place the source rod in BS position, and click OK.** Prepare the test site as described on page 4–9. Place the gauge on the test site. Lower the source rod to the backscatter position. Release the trigger and lock the source rod into position. You should hear a *click* when the source rod locks into position.

Press **<OK>** to begin the measurement. When the measurement is complete, the PDA prompts the operator to move the gauge to the next measurement site for the next reading.

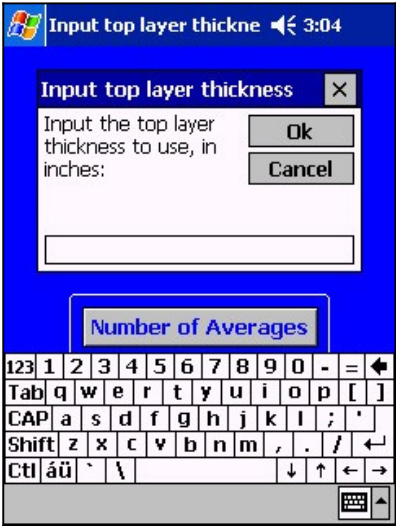


Figure 6–22. Input Top Layer Thickness

Reposition the gauge and repeat the above procedure for each count (see Figure 6–20). After taking all the readings, the PDA displays **Partial calibration saved. Press ‘New’ again to enter true density value.** Press **⟨OK⟩** to return to the **Thin Lift Special Calibration** menu.

ENTERING THE TRUE DENSITIES. To enter the true densities after a partial offset has been stored, press the **⟨New⟩** button on the **Thin Lift Special Calibration** menu. The PDA displays **A partial thin layer calibration exists. Do you wish to enter the true density value?**

- ▶ To enter the true density values, press **⟨Yes⟩**. The PDA requests the true density for each reading, as shown in Figure 6–23. Enter each value and press **⟨Ok⟩**. The PDA displays the thin layer special calibration values, as shown in Figure 6–24. Press **⟨ok⟩** to continue.

The PDA requests a file name for the special calibration (see Figure 6–25). Enter a file name (up to 20 characters) and press **⟨Ok⟩**. The name should be as descriptive as possible, to ensure that the special calibration value can be easily identified. The PDA displays **Thin layer calibration saved. Do you wish to activate this thin layer calibration?** Press **⟨Yes⟩** to activate the special calibration, or **⟨No⟩** to continue. The PDA returns to the **Thin Lift Special Calibration** menu.

- ▶ To erase the existing partial calibration and start a new one, press **⟨No⟩**. The PDA asks **Do you wish to erase the current partial thin lift calibration?** Press **⟨Yes⟩** to erase the stored partial calibration and begins a new density measurement as described previously, or **⟨No⟩** to return to the **Thin Lift Special Calibration** menu.

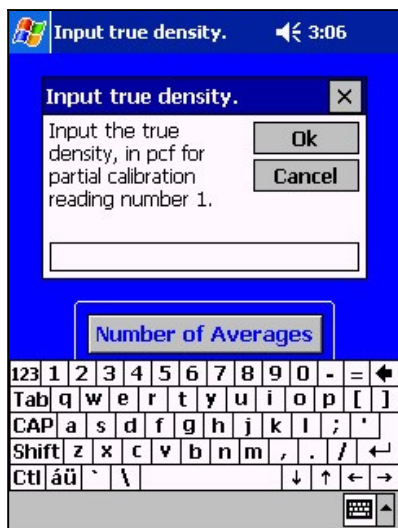


Figure 6–23. Input True Density

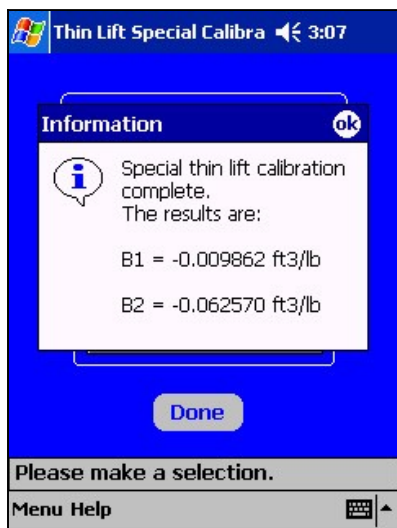


Figure 6–24. Thin Layer Special Calibration Results



Figure 6–25. Enter File Name

View a Thin Layer Special Calibration

To view the value of a thin layer special calibration stored in memory, press **(View)** on the **Thin Lift Special Calibration** menu (see Figure 6–21). The PDA displays the **Thin Lift File Selector** screen shown in Figure 6–26.

To view a thin layer special calibration, press the file name twice. The PDA displays an information block showing the file name and calibration values. Press **(ok)** to return to the **Thin Lift Special Calibration** menu.

Erase a Thin Layer Special Calibration

To erase a thin layer special calibration, press the **(Erase)** button on the **Thin Lift Special Calibration** menu (see Figure 6–21). The PDA displays the **Thin Lift File Selector** screen shown in Figure 6–26.

To erase a special calibration, press the file name twice. The PDA displays the prompt shown in Figure 6–27.

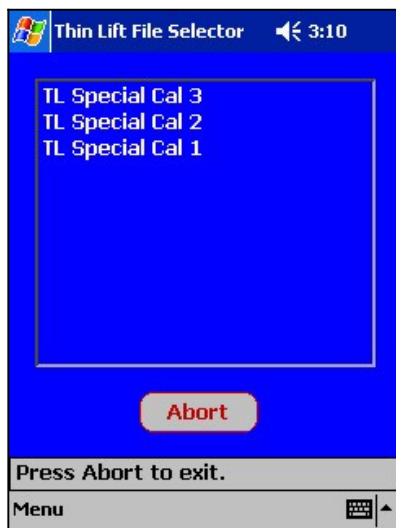


Figure 6–26. Thin Lift File Selector



Figure 6–27. Thin Lift Special Calibration Erase Prompt

- ▶ Press **<OK>** to erase the thin layer special calibration file. The PDA displays **Thin layer calibration XXX has been erased**. Press **<ok>** to continue.
 - ▶ If the erased project was not previously active, the PDA returns to the **Thin Lift Special Calibration** menu.
 - ▶ If the erased project was previously active, the PDA displays **The thin layer calibration XXX has been deactivated!** Press **<ok>** to return to the **Thin Lift Special Calibration** menu.
- ▶ Press **<Cancel>** to exit without erasing the special calibration file. The PDA displays **The thin layer calibration named XXX will not be erased!** Press **<ok>** to return to the **Thin Lift Special Calibration** menu.

Enable a Thin Layer Special Calibration

To enable a thin layer special calibration already stored in the gauge, press the **<Enable>** button on the **Thin Lift Special Calibration** menu (see Figure 6–21). The PDA displays the **Thin Lift File Selector** screen shown in Figure 6–26.

To select and enable a thin layer special calibration, press the file name twice. The PDA displays **The thin layer calibration XXX has been activated**.

Press **<ok>** to return to the **Thin Lift Special Calibration** menu.

Disable a Thin Layer Special Calibration

To disable the active thin layer special calibration, press the **<Disable>** button on the **Thin Lift Special Calibration** menu (see Figure 6–21). The PDA displays **The special thin layer calibration XXX has been deactivated!**

Press **<ok>** to return to the **Thin Lift Special Calibration** menu.

Number of Averages

The *Number of Averages* function allows averaging of up to 20 readings from a single test location when testing thin layer asphalt. This function is used only when the gauge is measuring in thin layer mode. When the gauge is using this function, the PDA automatically prompts for repositioning of the gauge from a test location and begins another measurement. After all measurements have been completed, the gauge calculates the average density of the test material. When taking counts on thin layer asphalt, Troxler recommends averaging four one-minute readings (see the *Thin Layer Mode* section on page 4–18).

To access this function, press the **(Number of Averages)** button on the **Thin Lift Special Calibration** menu (see Figure 6–21). The PDA requests the number of thin layer averages, as shown in Figure 6–28. Enter the desired number of readings (1 through 20) for the gauge to average.

Press **(ok)** to return to the **Thin Lift Special Calibration** menu.

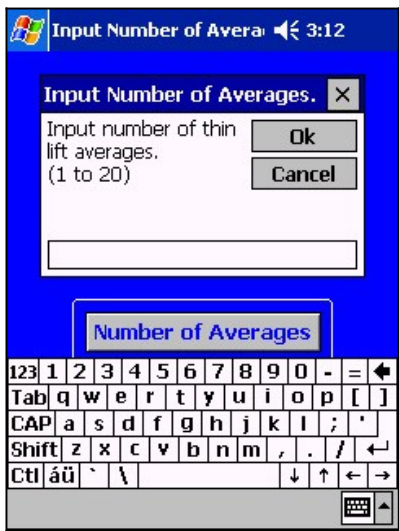


Figure 6–28. *Input Number of Averages*

NOTES

CHAPTER 7

USING DATA MANAGER

This chapter describes the Data Manager PDA to PC Model 3451 for Windows XP software provided with the gauge. This software provides tools for retrieving and managing project data from the PDA or gauge.

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INTRODUCTION

The Data Manager PDA to PC Model 3451 for Windows XP is the software companion to the Model 3451 Enhanced RoadReader Plus. This software includes tools for collecting project data from the PDA or gauge on a personal computer (PC), printing project configuration information, and recovering data from the gauge in case of an emergency (such as the loss of the PDA).

NOTE

The Data Manager software is intended to be used with Windows XP operating systems only.

SYSTEM REQUIREMENTS

The following sections list the hardware and software requirements for using Data Manager software.

MINIMUM HARDWARE

- ◆ Personal computer with a Pentium® 300 MHz processor or better
- ◆ 64 MB RAM
- ◆ Hard disk with 10 MB of free disk space
- ◆ CD-ROM drive
- ◆ VGA graphics adapter and monitor (default) with 256 colors or better
- ◆ Mouse
- ◆ Keyboard

RECOMMENDED HARDWARE

- ◆ Pentium 1 GHz processor
- ◆ 128 MB RAM

SOFTWARE

- ◆ Microsoft Windows XP
- ◆ Microsoft Excel 7.0 or higher, or Excel for Office 97/2000/XP

STARTING THE DATA MANAGER PROGRAM

To start the Data Manager program, click on the Windows **(Start)** button, then select the **P**rograms menu and the **D**ataManager folder. Select the **D**ataManager menu item.

The application loads, then displays a copyright screen. *Click anywhere on the screen to continue.* The software displays the **Main Menu**, as shown in Figure 7-1.

The Data Manager program includes tools to download and manage project (measurement) data stored on the PDA, to download and view the active project configuration, and to recover project data directly from the gauge in case of an emergency (such as the loss or failure of the PDA). These tools are described in the following sections.

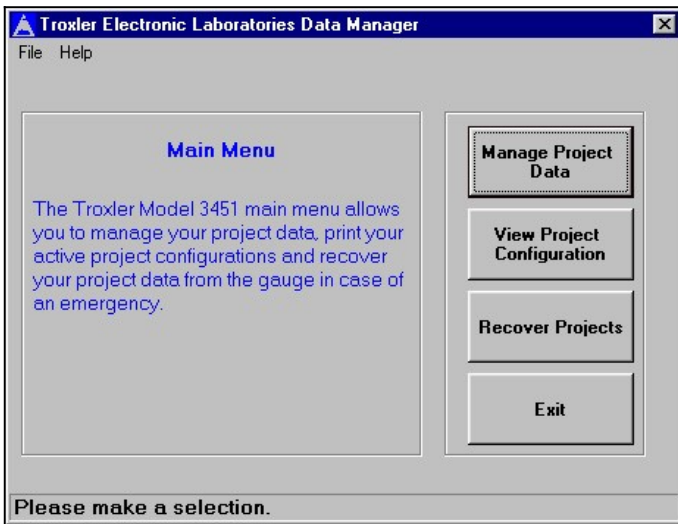


Figure 7-1. Data Manager Main Menu

MANAGE PROJECT DATA

As noted earlier, the Data Manager software includes tools for downloading and managing project (measurement) data from the PDA. To access these tools, click **Manage Project Data** on the **Main Menu** (see Figure 7-1). From the resulting menu (see Figure 7-2), the operator can:

- ◆ Download all projects from the PDA
- ◆ Select and view a downloaded project
- ◆ Print project data
- ◆ Delete all projects from the computer
- ◆ Send a selected project or all projects to a Microsoft Excel spreadsheet

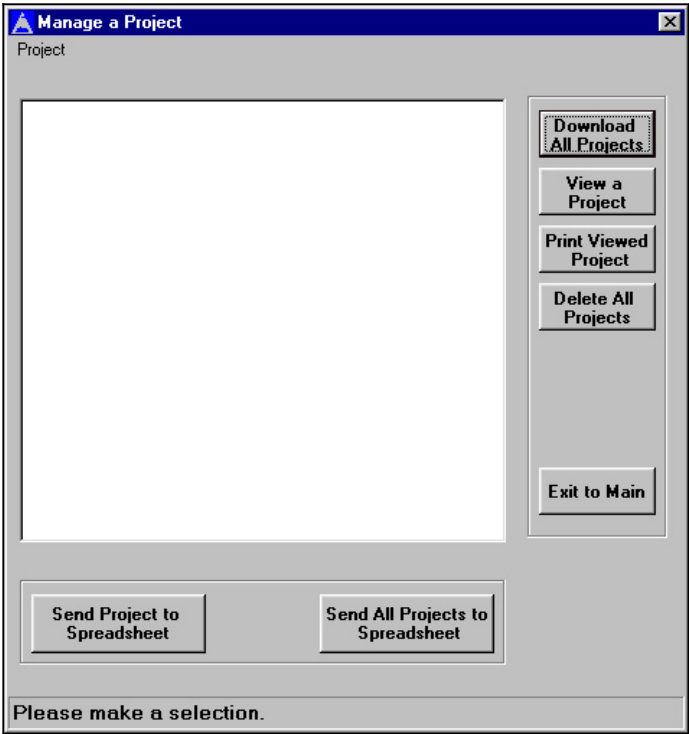


Figure 7-2. Manage a Project Menu

DOWNLOAD ALL PROJECTS

NOTE

To download data from the PDA to the computer, the PDA must be powered on with the RoadReader Plus application started as described on page 3–8.

NOTE

After project data is downloaded to the computer, it is deleted from the PDA.

To download project data from the PDA to the computer, press the **<Download Projects>** button on the **Manage a Project** menu (see Figure 7–2). The Data Manager software displays the prompt shown in Figure 7–3 on the following page. As directed:

- ✓ Using the serial cable (PN 110693) provided with the PDA, connect the PDA to the computer's serial port.
- ✓ On the PDA, press the **<Gauge Tools>** button to display the **Gauge Tools** menu (see Figure 3–17 on page 3–24). Press the **<Link to PC>** button. The PDA displays **Waiting for command**.
- ✓ On the computer, press the **<OK>** button to download the project data from the PDA. During the download, the PDA displays **Transmitting Data** while the computer displays **Receiving Project X of XX**.
- ✓ Upon completion of the download:
 - ✓ The computer displays **Project collection complete**. Press **<OK>** to return to the **Manage a Project** menu.
 - ✓ The PDA displays **Project data has been sent to the PC and should be removed from the PDA. Remove this project data?** Press **<Yes>** to delete the project data and continue. If you press **<No>**, the data will remain in the PDA, and will be duplicated the next time project data is downloaded to the Data Manager program.

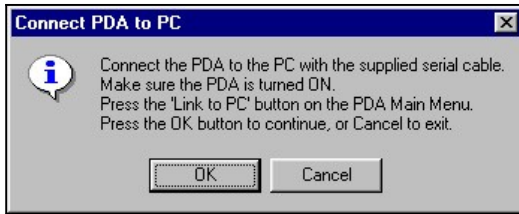


Figure 7–3. Connect PDA to PC Prompt

VIEW A PROJECT

To view all of the measurement data for a project, press the **<View a Project>** button on the **Manage a Project** menu. The software displays a list of the projects currently stored on the computer. To select a project, double-click its name on the list. The software displays the data stored in the project (see Figure 7–4).

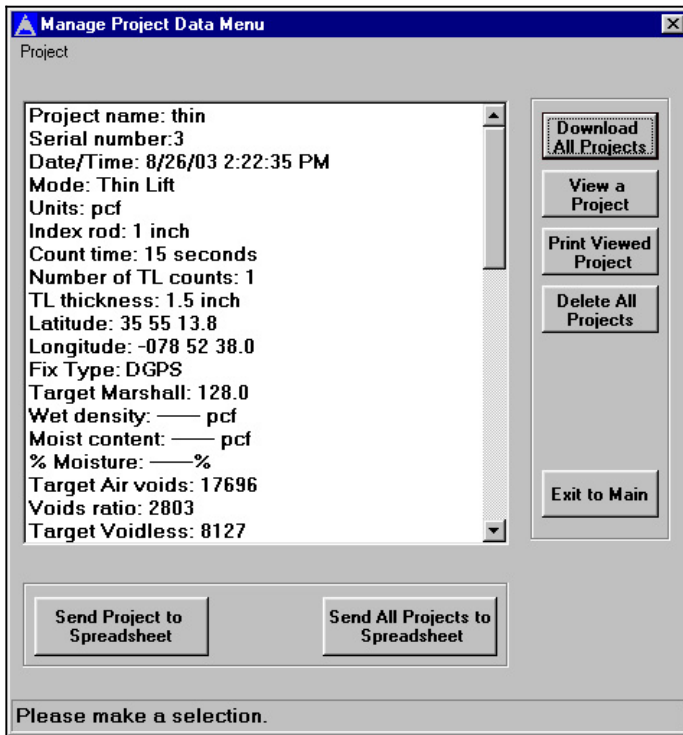


Figure 7–4. View a Project Display

PRINT VIEWED PROJECT

To print the project data that is currently displayed, press the **<Print Viewed Project>** button on the **Manage a Project** menu. The software sends the project data to the default printer.

DELETE ALL PROJECTS

To delete all projects currently stored on the computer, press the **<Delete All Projects>** button on the **Manage a Project** menu. The software displays the prompt **You have indicated that you wish to permanently erase all the projects. Click 'OK' to delete all the projects.** Press **<OK>** to delete the projects or **<Cancel>** to return to the **Manage a Project** menu without deleting.

SEND PROJECT TO SPREADSHEET

The Data Manager software can send data from a selected project or all projects to a Microsoft Excel spreadsheet. Note that this function requires that Microsoft Excel has been installed on the computer running the Data Manager software.

- ▶ To send data from a single project, press the **<Send Project to Spreadsheet>** button on the **Manage a Project** menu. The software displays a list of the projects currently stored on the computer. To select a project, double-click its name on the list.
- ▶ To send the data from all the projects, press the **<Send All Projects to Spreadsheet>** button.

The software launches the Microsoft Excel program, then enters the project data into the spreadsheet as shown in Figure 7-5. Upon completion, the computer displays **New workbook is now ready.**

The screenshot shows a Microsoft Excel window titled "Microsoft Excel - project.xls". The spreadsheet contains the following data:

	A	B	C	D	E	F	G
1	Project	SN	Date/Time	Mode	Units	Depth	Count Time
2	soil	0	8/26/2003 14:18	Soil	pcf	BS	15
3	soil	0	8/26/2003 14:19	Soil	pcf	BS	15
4	soil	0	8/26/2003 14:19	Soil	pcf	BS	15
5	1961	3	8/26/2003 14:21	Asphalt	pcf	BS	15
6	thin	3	8/26/2003 14:22	Thin Layer	pcf	BS	15
7	thin	3	8/26/2003 14:23	Thin Layer	pcf	BS	15
8							
9							
10							
11							
12							
13							
14							
15							
16							

The status bar at the bottom shows "Ready" and "NUM".

Figure 7-5. Project Data Spreadsheet

VIEW PROJECT CONFIGURATION

The Data Manager software also includes tools for downloading, viewing, printing, and storing the configuration of the active project. To access these tools, click the **<View Project Configuration>** button on the **Main Menu** (see Figure 7-1). From the resulting menu (see Figure 7-6), the operator can:

- ◆ Download the active project from the PDA
- ◆ View the gauge calibration constants, project setup and status, standard counts, source decay, and results of stat and drift tests
- ◆ Print project configuration data
- ◆ Save the configuration data as a text (.txt) file

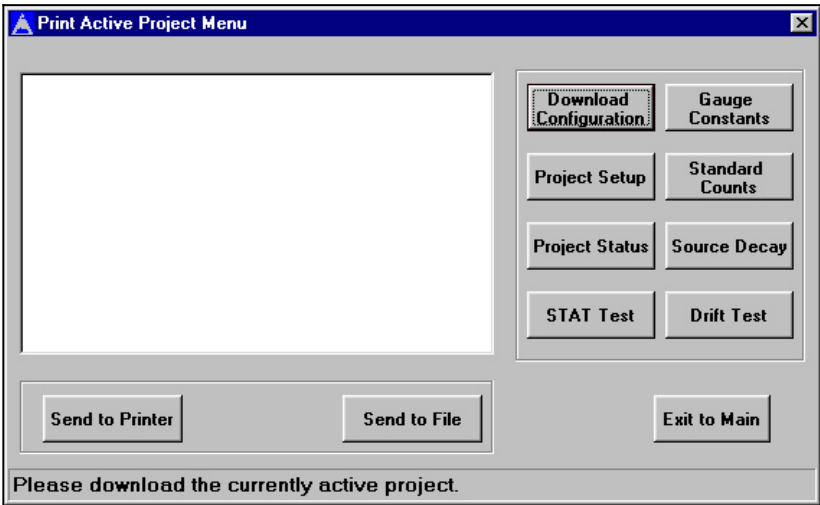


Figure 7-6. Print Active Project Menu

DOWNLOAD CONFIGURATION

NOTE

To download data from the PDA to the computer, the PDA must be powered on with the RoadReader Plus application started as described on page 3–8.

To download the configuration data for the active project, press the **⟨Download Configuration⟩** button on the **Print Active Project Menu**. The Data Manager software displays the prompt shown in Figure 7–3. As directed:

- ✓ Using the serial cable (PN 110693) provided with the PDA, connect the PDA to the computer's serial port.
- ✓ On the PDA, press the **⟨Gauge Tools⟩** button on the RoadReader Plus main menu (see Figure 3–11). The software displays the **Gauge Tools** menu shown in Figure 3–17. Press the **⟨Link to PC⟩** button. The PDA displays **Waiting for command**.
- ✓ On the computer, press the **⟨OK⟩** button to download the project data from the PDA. During the download, the PDA displays **Transmitting Data** while the computer displays **Downloading Project Info**.
- ✓ Upon completion of the download:
 - ✓ The computer displays **Project print complete!** Press the **⟨OK⟩** button to return to the **Print Active Project Menu**.
 - ✓ The PDA automatically returns to the RoadReader Plus main menu.

GAUGE CONSTANTS

To view the gauge calibration constants, press the **⟨Gauge Constants⟩** button on the **Print Active Project Menu**. The Data Manager software displays the constants, as shown in Figure 7–7.

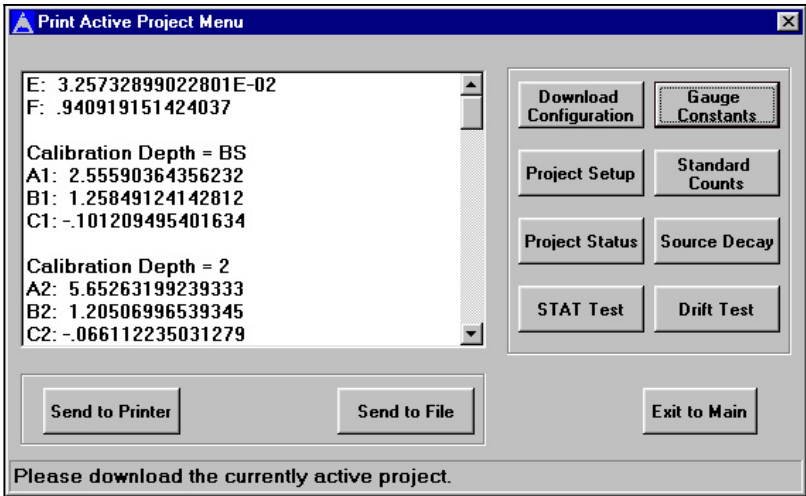


Figure 7–7. Gauge Constants Display

PROJECT SETUP

The Data Manager enables the operator to view the configuration (setup) of the active project, including the software version, measurement units, count time, measurement mode, target values, and offset values. To view the project configuration, press the **<Project Setup>** button on the **Print Active Project Menu**. The Data Manager software displays the active setup, as shown in Figure 7–8.

STANDARD COUNTS

To view the results of the most recent count, press the **<Standard Counts>** button on the **Print Active Project Menu**. The Data Manager software displays the standard counts, as shown in Figure 7–9. For more information on standard counts, refer to page 4–2.

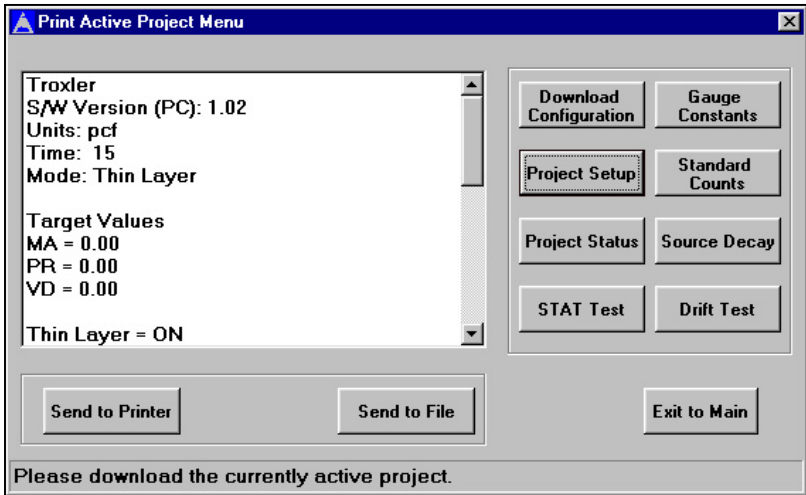


Figure 7–8. Project Setup Display

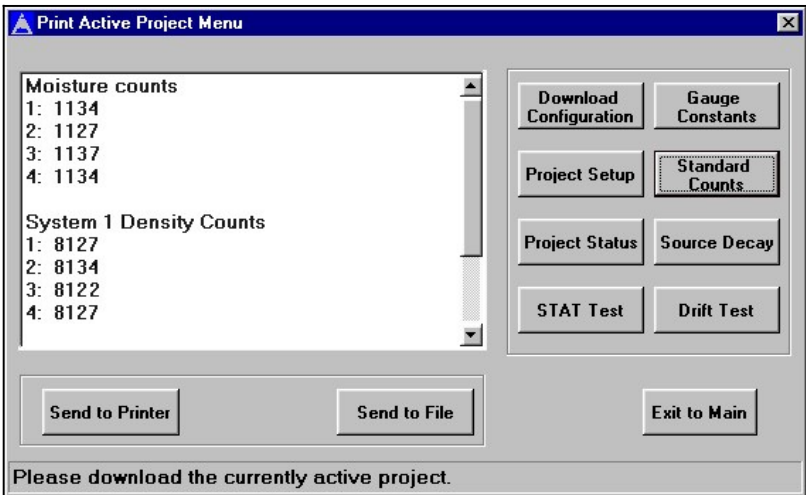


Figure 7–9. Standard Counts Display

PROJECT STATUS

The Data Manager provides a quick view of information on the gauge, including the software version, serial number, type (length of source rod and depth increments), count time, measurement units, measurement mode, and depth mode. To view the gauge information, press the **⟨Project Status⟩** button on the **Print Active Project Menu**. The Data Manager software displays the active setup, as shown in Figure 7–10.

SOURCE DECAY

As described earlier, the strength of radioactive material is measured by its activity, or rate of decay. This activity decreases with time. The Data Manager allows the operator to view how the decrease in the radiation intensity of the source affects gauge measurements.

To view source decay information, press the **⟨Source Decay⟩** button on the **Print Active Project Menu**. The Data Manager software displays the actual standard count, the predicted standard count, and the difference between the counts (see Figure 7–11). The gauge calculates the predicted standard count by correcting the calibration standard count for source decay. For more information on source decay, refer to page 3–27.

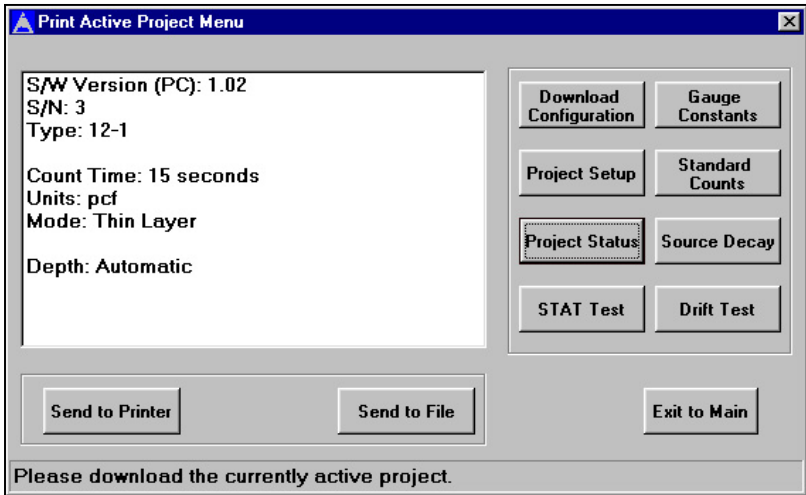


Figure 7–10. Project Status Display

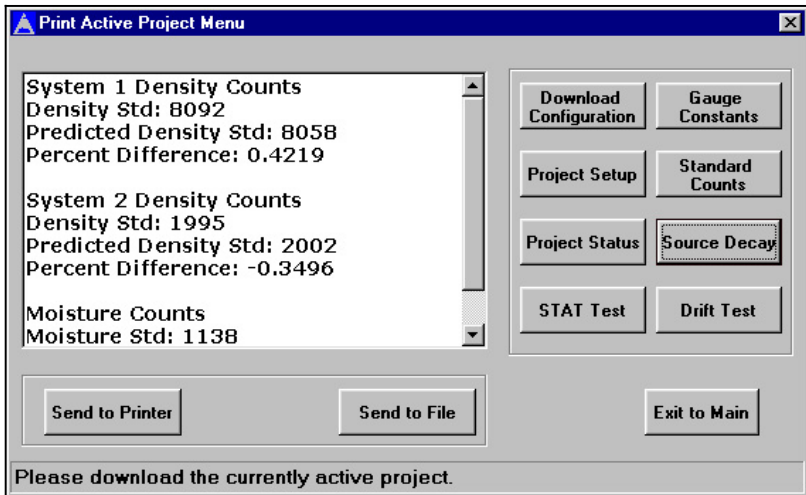


Figure 7–11. Source Decay Display

STAT TEST

As described on page C-2, erratic readings, or readings that seem to fluctuate, may indicate a problem with the gauge. If the readings are suspect, the operator can perform a *stat test*, or statistical stability test, to validate the normal operation of the gauge.

To view the results of the most recent stat test, press the **<STAT Test>** button on the **Print Active Project Menu**. As shown in Figure 7-12, the Data Manager software displays the stat test results.

DRIFT TEST

As described on page C-5, if the gauge passes the stat test, but shows long-term drift between measurements, the operator can perform a *drift test* to check the long-term drift.

To view the results of the most recent drift test, press the **<Drift Test>** button on the **Print Active Project Menu**. As shown in Figure 7-13, the Data Manager software displays the drift test results.

SEND TO PRINTER

To print the configuration of the active project, press the **<Send to Printer>** button on the **Print Active Project Menu**. The software prompts the operator to ensure that a printer is connected to the computer and that the printer is powered on. After doing so, press **<OK>**. The software sends the project configuration to the default printer.

SEND TO FILE

To save the configuration of the active project as a comma-delimited text (*.txt*) file, press the **<Send to File>** button on the **Print Active Project Menu**. In the resulting display, enter a file name and press **<Open>** to save the file.

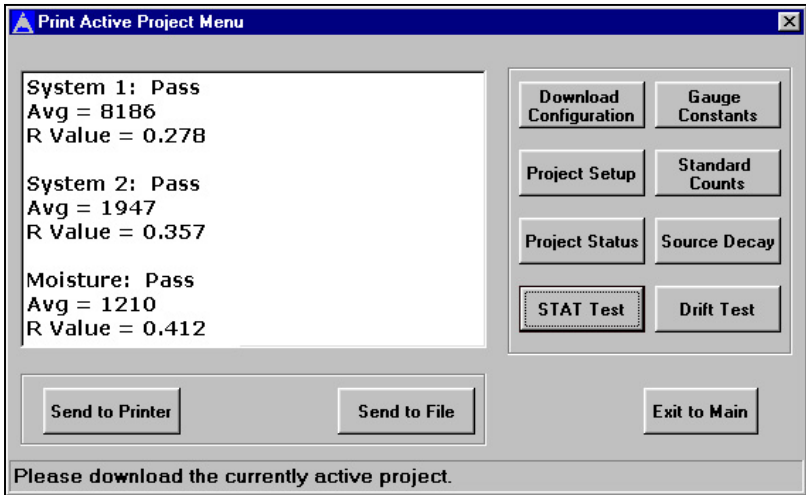


Figure 7–12. Stat Test Display

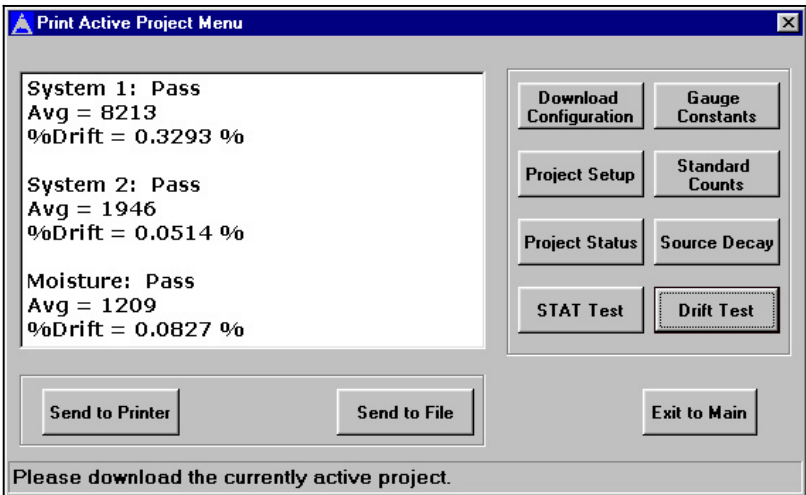


Figure 7–13. Drift Test Display

RECOVER PROJECTS

The Data Manager program includes tools to recover and manage project data directly from the gauge in case of an emergency (such as the loss or failure of the PDA).

To access these tools, press the **⟨Recover Projects⟩** button on the **Main Menu** (see Figure 7–1). The software displays the **Recover Project Menu** shown in Figure 7–14. From this menu, the operator can download project data from the gauge to the computer, print the project data, and send the data to a Microsoft Excel spreadsheet.

RECOVER PROJECTS

NOTE

The *Recover Projects* function does not delete project data from the gauge.

To recover (download) project data from the gauge into Data Manager, press the **⟨Recover Projects⟩** button on the **Recover Project Menu**. The Data Manager software displays the prompt shown in Figure 7–15.

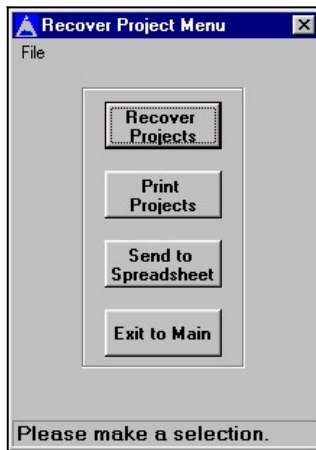


Figure 7–14. Recover Project Menu

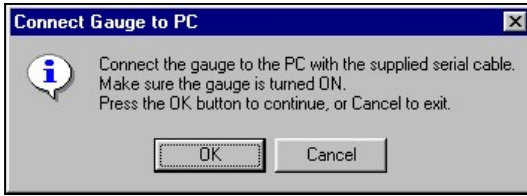


Figure 7–15. Connect Gauge to PC Prompt

As directed:

- ✓ Remove the Bluetooth adapter from the gauge's serial port (see Figure 3–2 on page 3–4).
- ✓ Using the serial cable (PN 110708) provided with the gauge, connect the gauge to the computer's serial port.
- ✓ Ensure that gauge is powered on.
- ✓ On the computer, press the **<OK>** button to recover the project data from the gauge. During the download, the computer displays **Project X of XX**.
- ✓ Upon completion, the computer displays **Project collection complete**. Press **<OK>** to return to the **Recover Project Menu**.

PRINT PROJECTS

To print the project data recovered from the gauge, press the **<Print Projects>** button on the **Recover Project Menu**. The software prompts the operator to ensure that a printer is connected to the computer and that the printer is powered on. After doing so, press **<OK>**. The Data Manager software sends the project data in spreadsheet format to the default printer.

SEND TO SPREADSHEET

The Data Manager software can send the project data collected from the gauge to a Microsoft Excel spreadsheet. To send the data, press the **<Send to Spreadsheet>** button. The software launches the Microsoft Excel program, then enters the project data into the spreadsheet as shown in Figure 7-5 on page 7-10. Upon completion, the computer displays **New workbook is now ready.**

NOTES

APPENDIX A

RADIATION THEORY AND SAFETY

This appendix is required reading for anyone who will use the Troxler Model 3451 RoadReader Plus. This appendix covers topics related to radiation theory and the safe operation of the gauge. A brief overview of the regulatory requirements related to the ownership and use of the gauge, as well as a listing of radiation safety-related warnings and cautions, is included.

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RADIATION THEORY

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

ATOMIC STRUCTURE

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

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

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

Figure A-1 depicts a helium atom consisting of two protons and two neutrons in the nucleus and two orbiting electrons.

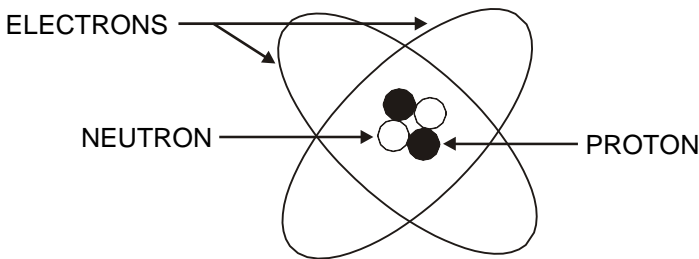


Figure A-1. Diagram of an Atom

RADIOACTIVITY

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

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

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

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

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

TYPES OF RADIATION

The radioactive sources in the Model 3451 produce four types of radiation:

- Alpha particles
- Beta particles
- Gamma rays (photons)
- Neutrons

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

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

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

RADIATION SAFETY

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

RADIATION DOSE

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

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

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

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

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

LIMITING EXPOSURE

Under average conditions, an individual working with the 3451 gauge will receive less than 200 millirem per year.

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

Time

Distance

Shielding

Time

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

Distance

Distance is another effective means to reduce radiation exposure. A formula known as the *inverse square law* relates the radiation exposure rate to distance (Figure A-2). Doubling the distance from a radiation source reduces the exposure to one-fourth its original value. If the distance is tripled, then the exposure is reduced by a factor of nine, and so on.

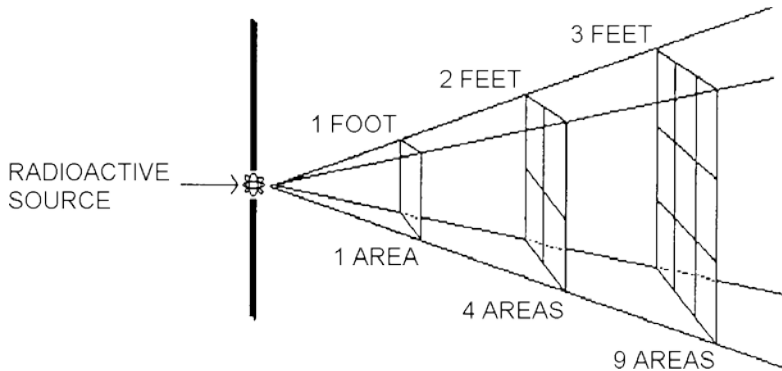


Figure A-2. Effect of Distance on Exposure

Shielding

Shielding is any material used to reduce the radiation exposure rate from a radioactive source. The 3451 gauge has some built-in shielding, which reduces the exposure rate. When gauges are in storage, additional shielding may be necessary to keep exposure to personnel in adjacent areas below the dose limits for members of the public.

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

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

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

PERSONNEL MONITORING

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

The most common types of individual monitoring devices used by licensees are thermoluminescent dosimeter (TLD) badges. TLD badges are usually exchanged monthly or quarterly. Troxler offers NVLAP-certified personnel monitoring services using TLD badges.

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

SOURCE ENCAPSULATION

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

SOURCE ROD INSPECTION

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

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

1. Extend the source rod just far enough to see the source rod tip. The tip should appear flat to slightly rounded and smooth.
2. Stay at least three feet away from the tip of the unshielded source rod and complete the inspection as quickly as possible to minimize exposure (the dose rate at three feet from the unshielded source is about 2.7 mrem/hr).

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

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

Contact the Troxler Radiation Safety Department for further advice.

DAILY INSPECTION

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

- ✓ The source rod opening in the bottom of the gauge is equipped with a spring-loaded tungsten sliding block that shuts when the source rod is in the **SAFE** (shielded) position. To check the operation of the sliding block, push the source rod down into the backscatter position (see Figure 3–3 on page 3–5), and then raise it back to the **SAFE** position. You should hear a *click* as the sliding block snaps shut. Turn the gauge over and verify that the sliding block is shut. If any portion of the opening is uncovered, the tungsten sliding block and fixed tungsten block should be cleaned before using, transporting, or storing the gauge. Refer to page A–11 for instructions on cleaning the sliding and fixed blocks.

NOTE

The bottom edge of the tungsten sliding block is beveled, as shown in Figure A–3 on page A–12. As a result, there may appear to be a slight opening when the sliding block is closed. However, you should hear a *click* as the sliding block snaps shut when the source rod is raised to the **SAFE position.**



WARNING

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

- ✓ If a radiation survey instrument is available, verify that the radioactive gamma source is in place by measuring the exposure rate at the surface of the gauge. The exposure rate should be approximately 10–20 mrem per hour. A reading of about 1 mrem or less indicates either that the survey instrument is not working properly or that the cesium-137 source may be missing. Refer to the **Troubleshooting** section on page C–9 for further instructions.

CLEANING THE TUNGSTEN BLOCKS

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



WARNING

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

The tungsten sliding block and the fixed tungsten block may require cleaning if the source rod becomes difficult to lower into the “measure” position, or if a *click* is not heard when the source rod is raised to the **SAFE** (shielded) position. An improperly operating sliding block may also result in erratic or incorrect density readings and increased radiation levels.



WARNING

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

- ✓ With the source rod in the **SAFE** (shielded) position, place the gauge on its side.
- ✓ Clean the heads of the four corner screws that hold the bottom plate to the gauge base (Figure A-3). Using a 1/8-inch Allen wrench, remove the four screws in the corners of the plate and remove the plate. **Do not remove** the two screws located near the center of the plate that secure the fixed block to the plate.
- ✓ To reduce radiological exposure, stand to one side of the gauge. Paying close attention to the position of the sliding block, remove the block.
- ✓ Using a stiff brush or rag soaked in alcohol, clean the sliding block, the fixed block mounted on the bottom plate, and the cavity.
- ✓ Re-install the sliding block with the angled side up. Apply a light coating of Magnalube-G paste to the **top angled** surface of the sliding block and to the top surface of the fixed block.
- ✓ Re-install the bottom plate. **Do not over-tighten screws!** Ensure that the source rod moves up and down freely.

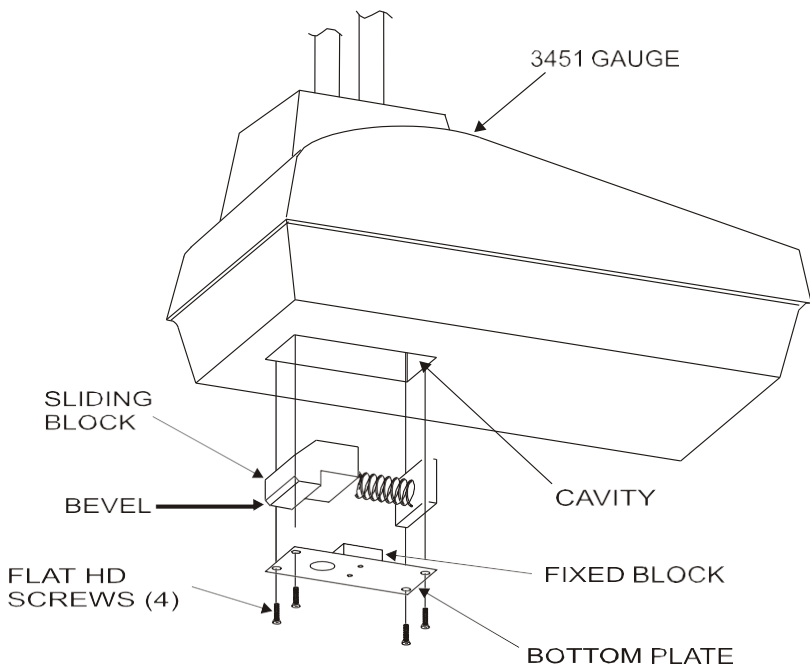


Figure A–3. Cleaning the Sliding and Fixed Blocks

LEAK TESTING

The 3451 gauge contains two radioactive sources that must be periodically leak tested. The purpose of leak testing is to verify the integrity of the source encapsulation. Because the source capsules are not directly accessible to users, the leak test is performed indirectly by testing gauge components near the capsules for contamination. Unless specified otherwise by your radioactive material license, the gauge must be leak tested at intervals not exceeding 12 months to verify the integrity of the radioactive sources contained in the gauge. In the United States, leak tests may only be performed by an organization licensed to provide leak test kits to licensees and to analyze leak test samples.

To perform a leak test, use the Troxler Model 3880 Leak Test Kit (PN 102868) and accompanying instructions to perform the following procedure:

- ✓ Write the gauge model and serial number on the wipe disk.
- ✓ Ensure that the source rod is latched in the **SAFE** (shielded) position.
- ✓ Wipe the area where the plastic top shell joins the metal base on both sides of the gauge. This is the location nearest the Am-241:Be source.
- ✓ Turn the gauge on its side and locate the opening on the bottom of the gauge through which the source rod would protrude.
- ✓ Holding the wipe disk with the tongs, wipe around and in this opening. This is the area nearest the Cs-137 source.
- ✓ Pack the disk in the envelope as instructed in the leak test kit, and mail to Troxler Electronic Laboratories, Inc. for analysis.
- ✓ Secure the gauge properly.

REGULATORY REQUIREMENTS

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

LICENSING

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

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

TRAINING

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

DISPOSAL

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

EMERGENCY PROCEDURES

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

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

The company RSO is _____

Call the RSO at _____

The regulatory agency is _____

Call the agency at _____

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

1. Locate the gauge and/or sources.
2. Do not touch or move the gauge.
3. Immediately rope off an area around the nuclear gauge and/or sources. A radius of 15 ft (5 m) is sufficient. Do not leave the area unattended.
4. Keep all unauthorized personnel from the nuclear gauge.

5. If a vehicle is involved, it must be stopped until the extent of contamination, if any, can be established.
6. The gauge user should perform a visual inspection of the nuclear gauge to determine if the source housing or shielding has been damaged.
7. Use a survey meter (such as the TroxAlert Survey Meter) to measure the dose rate at a distance of one meter (3 ft) from the gauge.
8. Contact the company RSO (name and number given at the beginning of this section). Provide the RSO with the following:
 - a. The date, time, and location of the accident
 - b. The gauge model and serial number
 - c. The nature of the accident
 - d. The location and condition of the gauge and/or source
 - e. The dose rate at 3 ft (1 m) from the gauge
9. If you are unable to reach the RSO, then call your regulatory agency (name and number given at the beginning of this section).
10. Follow the instructions of the RSO. The RSO may need to report the incident to the regulatory agency. The RSO may also be required to notify the U.S. DOT of accidents during transport.
11. Before shipping a damaged gauge to Troxler, obtain an RGA (Returned Goods Authorization) number from the Troxler Customer Service Department, as described in the *Returning the Gauge for Service* section on page C-32.

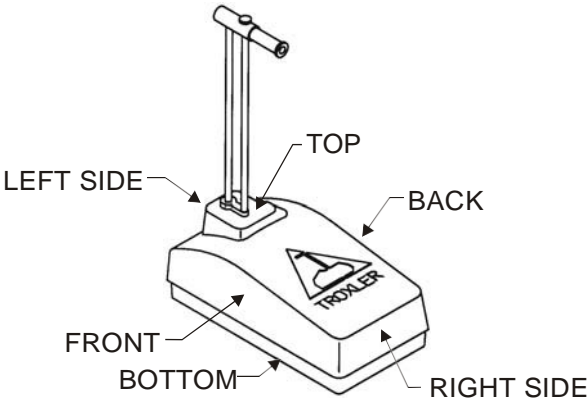
GAUGE USE PRECAUTIONS

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

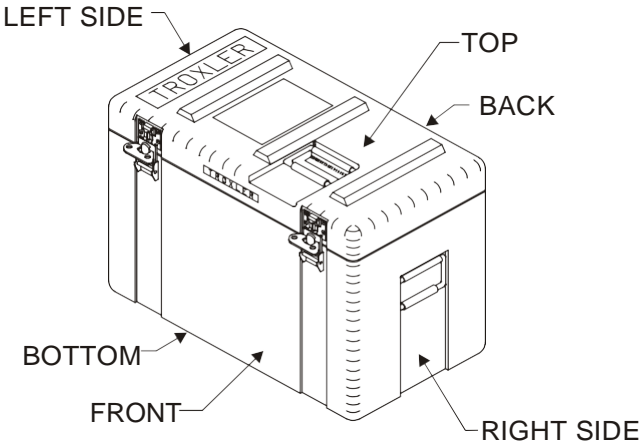
- ◆ Never touch the unshielded tip of the source rod with your bare hands. The dose rates on contact with the source rod tip can result in exposures exceeding the annual dose limits to the skin of the extremities within a short time period (about 1 hour).
- ◆ When not taking readings, always keep the source rod in the **SAFE** (shielded) position. For added user safety, the source rod automatically retracts to the **SAFE** position when the gauge is lifted by the handle.
- ◆ If you do not hear a *click* when the gauge is raised to the **SAFE** position, look at the bottom of the gauge to verify that the tungsten sliding block is completely closed. If the gauge base opening is not completely closed by the sliding block, the sliding block and fixed tungsten block may require cleaning. Refer to **Appendix C** for cleaning instructions.
- ◆ Do not store or transport the gauge unless the sliding block is completely closed. Increased radiation levels may cause excessive personnel radiation exposure and may violate transportation regulations.
- ◆ When preparing a test site, use the drill rod assembly to drill the test hole. **Under no circumstances should the source rod of the gauge be used to drill holes.**
- ◆ Do not tamper with or modify the 3451 gauge. Also, do not remove the sealed source from the gauge. Tampering with or modifying the gauge or removing the sealed source can be dangerous. Such actions are illegal unless authorized by your radioactive materials license.

3451 RADIATION PROFILE

Table A-1 shows the radiation profile for the Model 3451 gauge. The table lists the radiation dose equivalent rates (in mrem/hour) for each side of the gauge and transport case shown in Figure A-4.



GAUGE



TRANSPORT CASE

Figure A-4. Model 3451 Gauge and Transport Case

Table A–1. Radiation Profile for Model 3451 Gauge
(Dose Rate in Millirem per Hour)

	5 cm		30 cm		100 cm	
	Gamma	Neutron	Gamma	Neutron	Gamma	Neutron
GAUGE						
Front	5.0	N/A	1.9	0.3	0.3	<0.1
Back	5.0	N/A	1.7	0.4	0.2	<0.1
Left Side	7.0	N/A	1.0	0.1	0.1	<0.1
Right Side	0.7	N/A	0.3	<0.1	0.1	<0.1
Top	4.0	N/A	0.9	0.5	0.1	<0.1
Bottom	1.4	N/A	0.5	0.5	0.1	<0.1
GAUGE IN TRANSPORT CASE						
Front	4.5	N/A	0.8	0.1	0.2	<0.1
Back	5.5	N/A	0.9	0.2	0.2	<0.1
Left Side	0.3	N/A	0.1	0.1	<0.1	<0.1
Right Side	3.5	N/A	0.3	0.5	0.1	<0.1
Top	2.0	N/A	0.9	0.1	0.1	<0.1
Bottom	1.1	N/A	0.4	0.4	0.1	<0.1

NOTES:

1. All tabulated values are in units of mrem/hr.
2. Gamma measurements performed using a Bicron Micro Rem survey meter, serial #B464Y, calibrated March 28, 2003.
3. Neutron measurements performed using a Nuclear Research Corporation NP-2 survey meter, serial #NP183404, calibrated February 11, 2003.
4. Dose equivalent rates for 8 mCi Cs-137 and 40 mCi Am-241:Be.
5. "Surface" means surface of the gauge or surface of the transport case.

NOTES

APPENDIX B

3451 SPECIFICATIONS

This appendix contains gauge and measurement specifications for the Troxler Model 3451 Enhanced RoadReader Plus.

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MEASUREMENT SPECIFICATIONS

SOIL AND ASPHALT MODES

SI Units

Density at 2000 kg/m³

Direct Transmission (150 mm)

	15 sec	1 min	4 min
Precision (kg/m ³)	5.2	2.6	1.3
Composition error (kg/m ³)	8.0	8.0	8.0
Surface error (1.25 mm, 100% Void) (kg/m ³)	-18.0	-18.0	-18.0

Backscatter

	15 sec	1 min	4 min
Precision (kg/m ³)	16.0	8.0	4.0
Composition error (kg/m ³)	14.0	14.0	14.0
Surface error (1.25 mm, 100% Void) (kg/m ³)	-80.0	-80.0	-80.0

Moisture at 240 kg/m³

	15 sec	1 min	4 min
Precision (kg/m ³)	11.0	5.5	2.8
Surface error (1.25 mm, 100% Void) (kg/m ³)	-19.0	-19.0	-19.0

U.S. Customary Units

Density at 125 pcf

Direct Transmission (6 in.)

	15 sec	1 min	4 min
Precision (pcf)	0.32	0.156	0.08
Composition error (pcf)	0.50	0.50	0.50
Surface error (0.05 in., 100% Void) (pcf)	-1.1	-1.1	-1.1

Backscatter

	15 sec	1 min	4 min
Precision (pcf)	1.0	0.50	0.25
Composition error (pcf)	0.87	0.87	0.87
Surface error (0.05 in., 100% Void) (pcf)	-5.0	-5.0	-5.0

Moisture at 15 pcf

	15 sec	1 min	4 min
Precision (pcf)	0.69	0.34	0.17
Surface error (0.05 in., 100% Void) (pcf)	-1.2	-1.2	-1.2

THIN LAYER MODE

Precision at 2240 kg/m³ (140 pcf)

<u>Time (min)</u>	<u>Thickness</u>	<u>kg/m³</u>	<u>pcf</u>
1.0	2.5 cm (1.0 in.)	±16	±1.0
	5.0 cm (2.0 in.)	±10	±0.60
	6.3 cm (2.5 in.)	±8	±0.50
	10.0 cm (4.0 in.)	±8	±0.5
4.0	2.5 cm (1.0 in.)	±8	±0.50
	5.0 cm (2.0 in.)	±5	±0.30
	6.3 cm (2.5 in.)	±4	±0.25
	10.0 cm (4.0 in.)	±4	±0.25

Precision is defined as ±one standard deviation in readings.

RADIOLOGICAL SPECIFICATIONS

Gamma Source	0.30 GBq (8 mCi) \pm 10% Cs-137
Neutron Source	1.48 GBq (40 mCi) \pm 10% Am-241:Be
Source Type	Sealed Source – Special Form
Source Housing	Stainless Steel, Encapsulated
Shielding	Lead, Tungsten
Surface Dose Rate	See Radiation Profile on page A-19
Shipping Case	Type A, Yellow II, TI = 0.3
Certificates of Competent Authority	Cs-137 – USA/0614/S or USA/0356/S Am-241:Be – USA/0632/S or CZ/1009/S-85

ELECTRICAL SPECIFICATIONS

Stored Power	32.5 watt-hours
Average Current Consumption	
Ready mode	40 mA
Measurement mode	140 mA
Off	2 mA
Time Before Automatic Shutdown	5 hours of complete inactivity
Power Source(s):	
Base	5 C NiMH (Rechargeable Pack) batteries
Charge Source	12 V dc \pm 5%, 1.8 A minimum
Battery Recharge Time	2.5 hours maximum, automatic cutoff (may be charged incrementally without damaging the batteries)

MECHANICAL SPECIFICATIONS

Gauge Size (w/ handle)	12-inch rod: 604 H × 411 L × 229 W mm (23.8 H × 16.2 L × 9.0 W in.)
	8-inch rod: 503 H × 411 L × 229 W mm (19.8 H × 16.2 L × 9.0 W in.)
Shipping Case Size	782 H × 353 L × 455 W mm (30.8 H × 13.9 L × 17.9 W in.)
Weight	16 kg (35.3 lb)
Shipping Weight	42.5 kg (94.0 lb)
Operating Temperature (Ambient)	0 to 70 °C (32 to 158 °F)
Max Test Material Surface Temperature	175 °C (347 °F) for 15 minutes
Storage Temperature	-55 to 85 °C (-67 to 185 °F)
Humidity	98%, noncondensing

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.

NOTES

APPENDIX C

TROUBLESHOOTING AND SERVICE

This appendix provides details for troubleshooting and servicing the Troxler Model 3451 Enhanced RoadReader Plus. For further details, call the nearest Troxler Service Center or representative.

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DIAGNOSTICS MENU

The RoadReader Plus software includes a **Diagnostics Menu** (see Figure C-1) that enables the operator to perform a stat test and a drift test, as well as to calibrate the source rod depth strip. To access these functions, press the **<Gauge Tools>** button on the RoadReader Plus main menu (see Figure 3-11). The software displays the **Gauge Tools** menu shown in Figure 3-17. Press **<Diagnostics>** to display the **Diagnostics Menu**.

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 20 one-minute counts. From the 20 counts, the gauge calculates the standard deviation, which is compared to a theoretical standard deviation value. Ideally, this ratio should be 0.354, with acceptable limits from 0.225 to 0.465. 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.

To access the *Stat Test* function, press **<STAT Test>** on the Diagnostics Menu. The PDA displays the **STAT Test Menu** (see Figure C-2).

Taking a Stat Test

Choose an area free of other nuclear gauges or radioactive sources. Place the gauge on the reference standard block as shown in Figure 4-2 on page 4-3.

To perform a stat test, press **<Take STAT Test>**. The PDA displays **To take a STAT test, place the gauge on the standard block with the source rod in the STD position and click OK**. Ensure that the gauge is properly positioned and press **<OK>**.

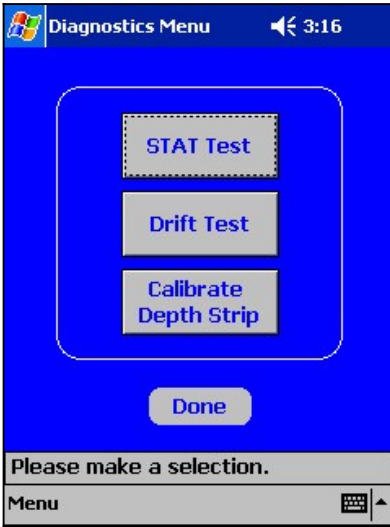


Figure C-1. Diagnostics Menu

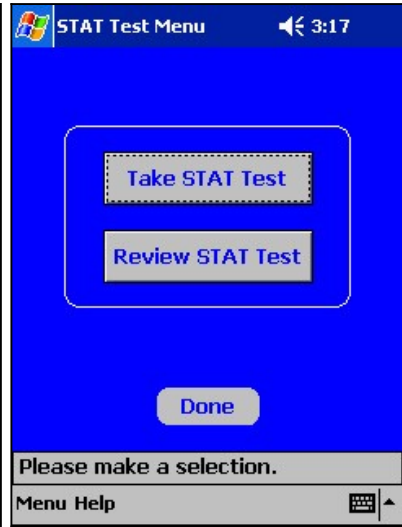


Figure C-2. Stat Test Menu

As noted earlier, the gauge takes 20 one-minute counts. Upon completion, the PDA displays the raw counts (see Figure C-3). To scroll through the data, press the scroll bar using the stylus. When finished, press **<Continue>**. The PDA displays the average counts for each system and indicates if the test passed or failed, as shown in Figure C-4. Press **<Yes>** to accept the stat test results, or **<No>** to reject them. The PDA displays a confirmation message. Press **<ok>** to return to the **STAT Test Menu**.

If the stat test *fails*, see page C-2.

Reviewing the Stat Test

To review the results of the most recent stat test, press the **<Review STAT Test>** button on the **STAT Test Menu**. The PDA displays the results of the last stat test as shown in Figure C-5. To scroll through the data, press the scroll bar using the stylus. Press **<Done>** to return to the **STAT Test Menu**.



Figure C-3. View Stat Counts

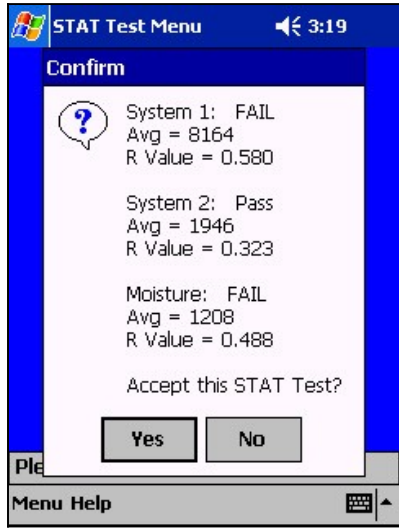


Figure C-4. Stat Test Results

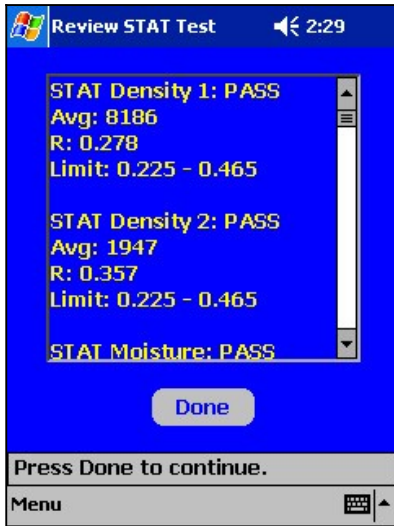


Figure C-5. Review Stat Test

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. A drift test consists of five counts taken 3–8 hours after a stat test. 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 or 1 percent for moisture 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, call the nearest Troxler service center for assistance.

NOTE

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

DO NOT turn the gauge off between a stat test and a drift test. The stat test must be current. The gauge must not be moved between the stat and drift tests to eliminate possible failure due to positioning changes.

To access the *Drift Test* functions, press the **(Drift Test)** button on the **Diagnostics Menu** (see Figure C–1). The PDA displays the **Drift Test Menu** shown in Figure C–6.

Taking a Drift Test

With the gauge still in an area free of other nuclear gauges or radioactive sources and on the reference standard block, press **(Take Drift Test)**. The PDA displays the date and time of the last stat test and asks whether to continue with the drift test.

NOTE

If it has been less than four hours or more than eight hours since the last stat test, then the gauge allows the operator to exit the drift test. To exit and take another stat test, press **(No) at the prompt. To continue with the drift test, press **(Yes)** at the prompt.**



Figure C–6. Drift Test Menu

The PDA displays **To perform a Drift test, place the gauge on the standard block with the source rod in the STD position and click OK.** Ensure that the gauge is positioned properly and press **<OK>**.

As noted earlier, the gauge takes five 4-minute counts. Upon completion, the PDA displays the raw counts (see Figure C–7). When finished reviewing the counts, press **<Continue>**. The PDA displays the average counts for each system and indicates if the test passed or failed, as shown in Figure C–8. Press **<Yes>** to accept the drift test results, or **<No>** to reject them. The PDA displays a confirmation message. Press **<ok>** to return to the **Drift Test Menu**.

Reviewing the Drift Test

To review the results of the most recent drift test, press the **<Review Drift Test>** button on the **Drift Test Menu**. The PDA displays the results of the last drift test as shown in Figure C–9. To scroll through the data, press the scroll bar using the stylus. Press **<Done>** to return to the **Drift Test Menu**.

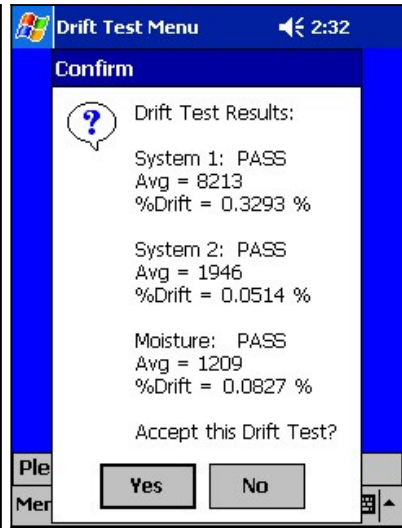
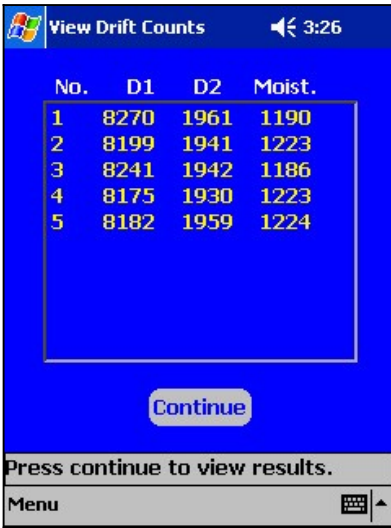


Figure C-7. View Drift Counts Figure C-8. Drift Test Results

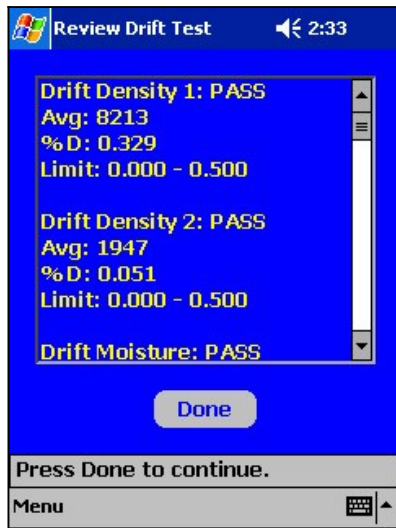


Figure C-9. Review Drift Test

CALIBRATE DEPTH STRIP

To calibrate the depth strip, press the **<Calibrate Depth Strip >** button on the **Diagnostics Menu** (see Figure C-1). The PDA displays the message **Depth Verification. Set rod to BS and press OK**. Set the source rod to the backscatter position and press the **<OK>** button on the PDA to calibrate the depth strip. Upon completion, the PDA displays **Depth strip validation passed**. Press **<ok>** to return to the **Diagnostics Menu**.

PDA SOFTWARE IS LOCKED UP

- ✓ If the PDA software is locking up, it may be due to a lack of free memory space. This is most likely caused by other programs running in the background. To close unnecessary programs that may be running:
 - ✓ Press **Start** and select **Settings** from the dropdown menu.
 - ✓ Press the **<System>** button at the bottom of the display.
 - ✓ Press the **Memory** icon.
 - ✓ Press the **<Running Programs>** button at the bottom of the display.
 - ✓ Press the **<Stop All>** button to halt all programs currently running in the PDA memory.

NOTE

PDA devices run programs in the background, even when these programs are “closed.” Therefore, the above procedure may need to be repeated regularly. Refer to the PDA user manual for more information.

- ✓ If the PDA memory has been completely depleted, the PDA may remain in a locked up state. In this case:
 - ✓ Remove the PDA battery pack.
 - ✓ Press the Reset button located beneath the battery pack.
 - ✓ Reinstall the battery pack.
 - ✓ The PDA will reboot several times (this may take a few minutes).
 - ✓ Wait until the PDA displays the **Troxler** menu (see Figure 3-4 on page 3-10).
 - ✓ Turn the gauge on.
 - ✓ Press the **<Troxler 3451>** button to initiate communications between the PDA and gauge.

PDA CANNOT COMMUNICATE WITH THE GAUGE

- ✓ Gauge is not turned on.
- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.
- ✓ Check that the PDA is the one shipped with the gauge. Before leaving the Troxler factory, the transceivers on the gauge and PDA are programmed with a unique, matching address. The PDA can only communicate with the matching gauge.
- ✓ Verify the PDA's Bluetooth communications configuration as described on page 3–14.
- ✓ Verify the PDA's ActiveSync configuration as described on page 3–13.

NO DENSITY READINGS

- ✓ The most likely reason for no density readings is an electronic problem, such as a failure of the detector preamplifier. However, there is a remote possibility that the radioactive source could have become dislodged or lost. Refer to the *Source Rod Inspection* section on page A–9 for instructions on inspecting the source rod.

GAUGE FAILS STANDARD COUNTS

- ✓ Ensure the source rod opening on the bottom of the gauge is completely closed or covered by the tungsten sliding block. If any opening is visible, the sliding block should be cleaned. Refer to page A–11 for instructions. If the sliding block still does not close completely, contact the nearest Troxler Service Center.
- ✓ Ensure that the standard count site is asphalt, concrete, or compacted soil at least 4 in. (10 cm) thick.
- ✓ Check for 10 ft (3 m) clearance around gauge.
- ✓ Check that any sources are at least 33 ft (10 m) away.

- ✓ Ensure the source rod handle is fully latched in the **SAFE** (shielded) position.
- ✓ Check that the gauge is positioned correctly on the reference standard block (see Figure 4–2 on page 4–3).
- ✓ Perform the standard count again. If the standard count still fails, contact the nearest Troxler Service Center.

GAUGE READINGS APPEAR ERRATIC

- ✓ If taking readings in the backscatter position, ensure the source rod is properly locked in the notch and not resting on the test material.
- ✓ Check the inside of the gauge for moisture. If necessary, use a hair dryer (on low heat) to circulate warm air for one to three hours.
- ✓ Remove any foreign objects from inside the gauge.
- ✓ Ensure the hardware mounting screws are tight and in place.
- ✓ Check count time – a four-minute count will give the highest precision, with a repeatability of ± 1 pcf on repeated tests performed without moving the gauge.
- ✓ Erratic density readings may be caused by a dirty tungsten sliding block. Clean the sliding block (see page A–11).
- ✓ Perform a 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

- ✓ If the rechargeable battery is below 5.5 volts, recharge or replace the batteries (see page C–24).

SATISFACTORY COUNTS BUT RESULTS ARE IN ERROR

- ✓ Check that the calibration constants are valid.
- ✓ Check to see if an offset (density, moisture, trench or special) is enabled.
- ✓ Ensure the standard counts are correct.

SHORT BATTERY LIFE AFTER RECHARGING

- ✓ NiMH batteries may be charged up to 500 or more full charge/discharge cycles, and typically have a 4-year life. The batteries may be reaching the end of their life cycle, and should be replaced.
- ✓ Charger/adaptor may not be supplying full charge – check the ac outlet and the dc output (12 V dc) using a voltmeter on the proper setting.
- ✓ Check that you are using the correct charger.
- ✓ The ac charger may be defective. To check, use the dc adapter to charge the batteries.

ERROR MESSAGES

4 inch (98 mm) top layer thickness maximum value allowed!

This error can occur if the operator enters a thin layer thickness greater than 4 inches (98 mm) while performing a thin layer special calibration.

Checksum Error!

After every command that is transmitted/received the gauge sends a checksum to the PDA to confirm that the data transmitted/received is valid.

Possible causes:

- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.

Critical error number XX has occurred!

This error message can occur when illegal or invalid data has been entered by the operator.

Depth strip validation failed!

This error can occur when trying to recalibrate the depth strip from a process.

Possible causes:

- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.
- ✓ Source rod not in the proper position.

Error! Checking Battery Voltage.

This error can occur when checking the battery voltage, charger status, or battery status.

Possible causes:

- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.
- ✓ Check that the PDA is the one shipped with the gauge. Before leaving the Troxler factory, the transceivers on the gauge and PDA are programmed with a unique, matching address. The PDA can only communicate with the matching gauge.

Error! Communicating with gauge.

This error can occur when the PDA cannot communicate with the gauge.

Possible causes:

- ✓ Gauge not turned on.
- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.
- ✓ Check that the PDA is the one shipped with the gauge. Before leaving the Troxler factory, the transceivers on the gauge and PDA are programmed with a unique, matching address. The PDA can only communicate with the matching gauge.
- ✓ Verify the PDA's Bluetooth communications configuration as described on page 3–14.
- ✓ Verify the PDA's ActiveSync configuration as described on page 3–13.

Error: File copy!

This error can occur when the PDA is storing information to its hard drive.

Possible causes:

- ✓ Hard drive full.
- ✓ The directory/subdirectory does not exist.

Error: File Erase!

This error will occur when trying to delete a file and the PDA will not allow the file to be erased. This may indicate that another program has control of the file.

Error: File init.txt does not exist!

This error can occur if the PDA attempts to store information to its hard drive but the directory/subdirectory does not exist.

Error! Gauge communication will NOT be possible!

This error can occur if the gauge and the PDA cannot communicate.

Possible causes:

- ✓ Gauge not turned on.
- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.
- ✓ Check that the PDA is the one shipped with the gauge. Before leaving the Troxler factory, the transceivers on the gauge and PDA are programmed with a unique, matching address. The PDA can only communicate with the matching gauge.
- ✓ Verify the PDA's Bluetooth communications configuration as described on page 3–14.
- ✓ Verify the PDA's ActiveSync configuration as described on page 3–13.

ERROR! Invalid ABORT Characters.

This error can occur when trying to abort from a process.

Possible causes:

- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.

Error! Invalid data received.

This error can occur if a command or data transmitted to the gauge or received by the PDA is not legal.

Possible causes:

- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.

ERROR! Invalid Depth Characters.

This error can occur when trying to recalibrate the depth strip from a process.

Possible causes:

- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.

ERROR! Invalid Warmup Characters.

This error can occur when warming up the gauge.

Possible causes:

- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.

Error: Math error encountered!

Retake the measurement.

This error can occur after taking a reading (count) or a partial calibration.

Possible causes:

- ✓ Counts received are not valid.
- ✓ Depth strip was in an improper position (Manual mode).

Error: No marshall directory exists!

This error can occur if the PDA directory/subdirectory structure has been altered.

Possible causes:

- ✓ The Marshall directory has been deleted.
- ✓ PDA has an internal problem.

Error: No proctor directory exists!

This error can occur if the PDA directory/subdirectory structure has been altered.

Possible causes:

- ✓ The proctor directory has been deleted.
- ✓ PDA has an internal problem.

Error: No project directory exists!

This error can occur if the PDA directory/subdirectory structure has been altered.

Possible causes:

- ✓ The project directory has been deleted.
- ✓ PDA has an internal problem.

Error: No special directory exists!

This error can occur if the PDA directory/subdirectory structure has been altered.

Possible causes:

- ✓ The special calibration directory has been deleted.
- ✓ PDA has an internal problem.

Error: No specific gravity directory exists!

This error can occur if the PDA directory/subdirectory structure has been altered.

Possible causes:

- ✓ The specific gravity directory has been deleted.
- ✓ PDA has an internal problem.

Error: No thin lift directory exists!

This error can occur if the PDA directory/subdirectory structure has been altered.

Possible causes:

- ✓ The thin layer special calibration directory has been deleted.
- ✓ PDA has an internal problem.

Error: No voidless density directory exists!

This error can occur if the PDA directory/subdirectory structure has been altered.

Possible causes:

- ✓ The voidless density directory has been deleted.
- ✓ PDA has an internal problem.

Error! Powering-up GPS.

This error can occur when turning on the GPS.

Possible causes:

- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.

Error! Turning off GPS.

This error can occur when turning off the GPS.

Possible causes:

- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.

Invalid Code Entered

This error will occur if an illegal or invalid code is entered while trying to change the operator code.

Invalid density value. Try again!

This error can occur if the operator enters an invalid density value while performing a special calibration. The value must be greater than 0.

Invalid percent moisture value entered!

This error can occur if the operator enters an invalid moisture offset from the keypad menu selection. The value must be between 1 and 99.

Invalid thickness entered!

This error can occur if the operator enters an invalid thin layer thickness while performing a thin layer special calibration.

Legitimate rod depth not entered!

This error can occur if, while performing a special calibration, the operator enters an invalid source rod depth to store this calibration position.

Math error encountered in thin lift calibration! Calibration aborted.

This error can occur after taking a reading (count) in the thin layer calibration mode.

Possible causes:

- ✓ Counts received are not valid.
- ✓ Depth strip was in an improper position (*Manual* mode).

Moisture offset name must be 20 chars or less!

This error can occur when the operator is prompted for the moisture offset name while performing a moisture offset.

Possible causes:

- ✓ Name was greater than 20 characters long.
- ✓ No name was entered.

No marshall value exists!

This error can occur if the operator attempts to activate a Marshall value but there is not one available.

Possible causes:

- ✓ The Marshall value has been deleted.
- ✓ No Marshall values were created.

No marshall value selected!

This error can occur if the operator attempts to enable, disable, view or erase a Marshall value but does not select one.

No proctor values exist!

This error can occur if the operator attempts to activate a proctor value but there is not one available.

Possible causes:

- ✓ The proctor value has been deleted.
- ✓ No proctor values were created.

No proctor value selected!

This error can occur if the operator attempts to enable, disable, view or erase a proctor value but does not select one.

No project exists!

This error can occur if the operator attempts to activate a project but there is not one available.

Possible causes:

- ✓ The project has been deleted.
- ✓ No projects were created.

No project selected!

This error can occur if the operator attempts to enable, disable, view or erase a project but does not select one.

No special calibration exists!

This error can occur if the operator attempts to activate a special calibration but there is not one available.

Possible causes:

- ✓ The special calibration has been deleted.
- ✓ No special calibration was created.

No special calibration selected!

This error can occur if the operator attempts to enable, disable, view or erase a special calibration but does not select one.

No specific gravity value exists!

This error can occur if the operator attempts to activate a specific gravity value but there is not one available.

Possible causes:

- ✓ The specific gravity value has been deleted.
- ✓ No specific gravity values were created.

No specific gravity value selected!

This error can occur if the operator attempts to enable, disable, view or erase a specific gravity value but does not select one.

No thin lift calibration exists!

This error can occur if the operator attempts to activate a thin layer special calibration but there is not one available.

Possible causes:

- ✓ The special calibration has been deleted.
- ✓ No special calibration was created.

No thin lift calibration selected!

This error can occur if the operator attempts to enable, disable, view or erase a thin layer special calibration but does not select one.

No True Density values entered!

This error can occur if the true density value was entered incorrectly while trying to calculate a thin layer special calibration.

No voidless density value exists!

This error can occur if the operator attempts to activate a voidless density value but there is not one available.

Possible causes:

- ✓ The voidless density value has been deleted.
- ✓ No voidless density values were created.

No voidless density value selected!

This error can occur if the operator attempts to enable, disable, view, or erase a voidless density value but does not select one.

Serial Port is not accessible!**Please close any programs that are using the serial port.**

When the RoadReader Plus software is first turned on, it checks the serial port to see if another program has control of it. If another program has control, this error will occur. Exit the RoadReader Plus software and perform the following to close out all other running programs:

- ✓ Press **Start** and select **Settings** from the dropdown menu.
- ✓ Press the **<System>** button at the bottom of the display.
- ✓ Press the **Memory** icon.
- ✓ Press the **<Running Programs>** button at the bottom of the display.
- ✓ Press the **<Stop All>** button to halt all programs currently running in the PDA memory.

Special calibration name must be 20 chars or less!

This error can occur when performing a special calibration after the operator is prompted for the special calibration name.

Possible causes:

- ✓ Name was greater than 20 characters long
- ✓ No name was entered

The gauge is not in Safe position! To take a standard count, with the on the standard block with the source rod in STD position and click OK.

This error can occur when performing a standard count and *Automatic* depth strip mode is selected.

Possible causes:

- ✓ PDA is not within 4.6 m (15 ft) of the gauge.
- ✓ Object in the way of the transmitter/receiver.
- ✓ Source rod not in the **SAFE** position.
- ✓ Gauge has lost its depth strip calibration.
- ✓ Gauge has turned itself off.

The index rod cannot be in safe position to take this measurement!

This error can occur when taking a reading or other special features.

Possible causes:

- ✓ Source rod is in the **SAFE** position
- ✓ Depth strip is not being read correctly
- ✓ Gauge has lost its depth strip calibration
- ✓ Gauge is turned off

The index rod must be in Backscatter position to take this measurement!

This error can occur when taking a thin layer reading.

Possible causes:

- ✓ Source rod is **NOT** in the Backscatter position
- ✓ Depth strip is not being read correctly
- ✓ Gauge has lost its depth strip calibration
- ✓ Gauge is turned off

There is currently not a moisture offset enabled!

This error can occur if the operator attempts to disable a moisture offset, but no offset is enabled.

There is currently no special thin lift calibration enabled!

This error can occur if the operator attempts to disable a special calibration but no special calibration is enabled at the specified depth.

Thin lift calibration name must be 20 chars or less!

This error can occur when the operator is prompted for a thin layer special calibration name while performing a thin layer special calibration.

Possible causes:

- ✓ Name was greater than 20 characters long
- ✓ No name was entered

Value must be 1 to 20!

This error can occur if the operator enters a value less than 1 or greater than 20 while manually entering the number of thin layer averages to take.

Warning!

Calibration is due.

Last calibration: 3-1-2003

Calibration due warning message

Warning!

Leak test is due.

Last leak test: 3-1-2003

Leak test warning message

BATTERIES

The Model 3451 is equipped with one set of rechargeable nickel-metal hydride (NiMH) batteries (pack of five C batteries). Under standard conditions, fully charged NiMH batteries can power the gauge for approximately 24 hours of actual use.

When the NiMH batteries drop below 5.5 V, the gauge shuts off. Troxler recommends that the operator recharge the NiMH batteries. The NiMH batteries can be fully recharged in only 2.5 hours.

CHARGING

To charge the NiMH batteries, plug the charger into the round jack on the back of the gauge. Plug the other end of the ac charger into a standard 100–240 V ac outlet.

The dc adapter may be connected to any 12-14 V dc source (such as a vehicle's cigarette lighter). To ensure a full charge, charge the batteries for four hours.

After recharging the batteries, unplug the charger from both the wall outlet and the gauge. Store the charger for later use.

REPLACING THE BATTERIES

To replace the NiMH battery pack (PN 110374):

- ✓ Turn the gauge off.
- ✓ Using a 9/64-inch Allen wrench, remove the six screws that hold the top shell to the gauge base.
- ✓ Clean the screws and set them aside.
- ✓ Carefully remove the gauge top shell and slide it up, out of the way. To keep it out of the way, tie the top shell to the handle.

- ✓ Unplug the battery cable from the battery connection on the top circuit board (see Figure C-10). Gently squeeze the connector to disconnect.
- ✓ Remove the two battery cover screws and set them aside.
- ✓ Open the battery cover and remove the old NiMH battery pack.
- ✓ Slide a new NiMH battery pack into the gauge.
- ✓ Close the battery cover and replace the two screws.
- ✓ Plug the battery cable into the battery connection on the top circuit board.
- ✓ Re-assemble the gauge top shell.

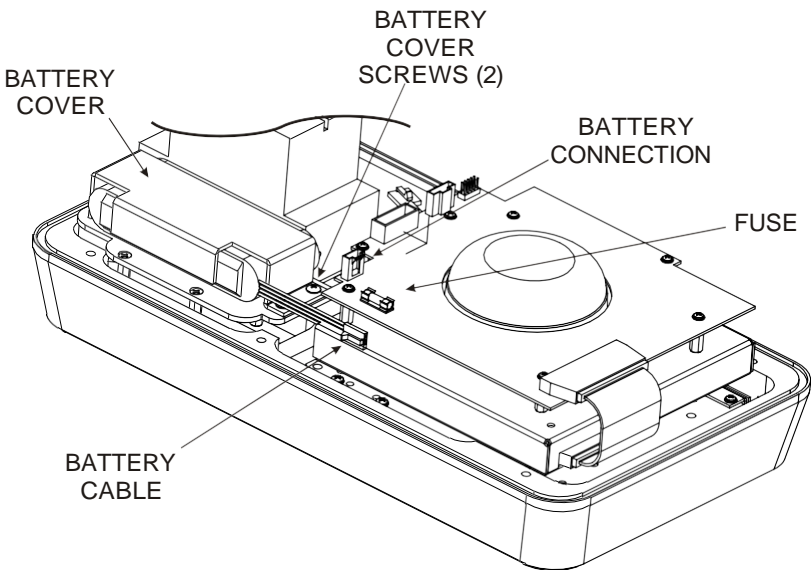


Figure C-10. Replacing NiMH Battery Pack or Fuse

REPLACING FUSE

The Model 3451 contains an internal 3/4 A, 2AG, slow-blow fuse (PN 016233). If the gauge will not power up, this fuse may be blown. To replace the fuse:

- ✓ Turn the gauge off.
- ✓ Using a 9/64-inch Allen wrench, remove the six screws that hold the top shell to the gauge base.
- ✓ Clean the screws and set them aside.
- ✓ Carefully remove the gauge top shell and slide it up, out of the way. To keep it out of the way, tie the top shell to the handle.
- ✓ Locate the fuse, which is located on the top circuit board (see Figure C-10).
- ✓ Remove the old fuse, and replace it with a new one.
- ✓ Re-assemble the gauge top shell.

MECHANICAL MAINTENANCE

CLEANING THE BASE AND TOP SHELL

To clean the gauge base, use a putty knife to scrape away any built-up accumulations of soil or asphalt. **Be careful not to damage the gauge base!** After removing any large accumulations, wipe the gauge base with a cloth soaked in WD-40® (see note below). The WD-40 should remove the remaining debris.

The 3451 gauge top shell is manufactured from an engineering thermoplastic designed specifically to provide high impact strength and to offer excellent compatibility with many industrial solvents and petro-chemicals. The top shell may be cleaned with mild (low alkaline) soap and water. Other approved cleaning substances include: methyl, isopropyl, or isobutyl alcohols. A cloth dampened with kerosene or diesel fuel may be used to remove heavy soils. **Avoid prolonged exposure and do not soak.**



CAUTION

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

LUBRICATING THE SOURCE ROD

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

- ✓ Using a 9/64-inch Allen wrench, remove the six screws that hold the top shell to the gauge base.
- ✓ Clean the screws and set them aside.
- ✓ Carefully remove the gauge top shell and slide it up, out of the way. To keep it out of the way, tie the top shell to the handle.
- ✓ To catch any grease, place a rag or cloth under the vent valve located below the grease fitting on the source rod tower.
- ✓ Using a standard 16-oz grease gun loaded with a Magalube®-G cartridge, apply five shots of lubricant or until all dirty grease is ejected from the vent valve and clean grease is visible.
- ✓ Re-assemble the gauge.

REPLACING GASKETS

The Model 3451 employs two o-rings to protect its electronics from moisture, dirt, and debris. However, if the gauge has been exposed to extremely wet weather or high humidity, or if the gauge was used in the cold and stored in a warm building, condensation may form inside the gauge. If this happens the top shell should be removed and the gauge allowed to dry. Use a hair dryer (on low heat) if necessary to remove any built-up moisture. If moisture continues to be a problem or debris is present inside the gauge base, the gaskets or O-ring may need replacing.

To replace the top shell/base O-ring, remove the screws that hold the top shell to the gauge base. Lift the top shell from the gauge base. Remove the O-ring from the gauge base. Coat the replacement O-ring with vacuum grease. Install the new O-ring in the groove on the base. Replace the top shell and tighten the top shell screws.

REPLACEMENT PARTS

<u>PART #</u>	<u>DESCRIPTION</u>
107849	O-Ring, Gauge Base
007145	O-Ring, Auxiliary Panel
107846	Gasket, Beeper
107233	Grommet, Tower Index Rod
110361	3451 Topshell
110362	Assembly, I/O Baseboard Cable
107847	Base Plate Assembly
107276	3451 Bottom Plate
012754	Ring Scraper (for Bottom Plate)
012753	Ring Retaining (for Scraper Ring)
013200	Fitting, 3/16 Grease w/ Serrated Shank
107493	3451 Sliding Block
107494	Fixed Tungsten Block
102069.1000	2400/3400 Wiper Cap
012752	Seal, Wiper
012759	Seal, Oil 5/8-inch ID
102399	Shield Spring 3400
108866	Source Rod Bearing
012176	Lock w/ 2 Keys (Handle)
107835	Handle Assembly
104305	Handle Sleeve
108865	Trigger
012225	Spring (For Trigger)
102096	3400 Cap Screw
102103	Cap Screw Bumper
104553	Plunger 3400
101603.1010	Roll Pin, 3/32 D × 5/8 L (Index Rod Top)
110374	Assembly, 3451 NiMH Battery
100156	5/8-inch Tube GM (Detector)
105062	3/4-inch GM Tube (Detector)
104094.0001	900 V dc Moisture Tube Assembly
108863	Bioshield w/ Bearing
016233	Fuse, 3/4 A, 2AG, Slow Blow
015203	Beeper
004360	Switch, Pushbutton
110384	Antenna Gasket
110687	Intermec 700 Series Mobile Computer (PDA)
110689	Kit, PDA Stylus with Tether
110688	Secure Digital Card, 32 MB
110694	Cordless Serial Adapter with Bluetooth Wireless Technology

ACCESSORIES

<u>PART #</u>	<u>DESCRIPTION</u>
110422.3451	3451 Shipping Case/Carton Assembly
100421	Forged Drill Rod
107795	Scraper Plate Weldment
103680.1000	Extraction Tool
107830	Reference Standard Block Assembly
110403	AC Charger, 12 V CE (for gauge only)
104156	DC Charger (for gauge only)
110399	3451 User Manual
110423	Data Manager Software on CD-ROM
110708	Cable, 9-Pin D-Sub M/F (Used to connect gauge to computer)
110692	Cable, Auto Adapter (for PDA only)
110693	Cable Assembly, Serial, 4 ft (Used to connect PDA to computer)
110691	Universal AC Adapter (for PDA only) – Requires PN 110690 AC Power Cord
110690	AC Power Cord
110390.2000	PDA Software Package

GAUGE OPTIONS

<u>PART #</u>	<u>DESCRIPTION</u>
107480	3451 Concrete Adapter
021140	Radiation Sign Kit
102868	3880 Leak Test Kit w/4 Packets
102873	1-oz Solution Detergent
102876.0005	Leak Test Packet (4 units)
109661	Survey Meter
105817	Kit, Emergency Response

PDA OPTIONS

<u>PART #</u>	<u>DESCRIPTION</u>
110707	PDA Dock Station, including:
110695	Single Dock, USB/Ethernet
110696	AC Adapter for Dock Station – Requires PN 110690
	AC Power Cord
110690	AC Power Cord
110697	USB Communications Cable
<hr/>	
110709	PDA Battery Pack Charger Kit
110705	PDA Battery Pack, Lithium Ion, Spare
110706	Holster, with Belt for 700 Series Mobile Computer

MAINTENANCE SUPPLIES

<u>PART #</u>	<u>DESCRIPTION</u>
012784	Lubricant Magnalube-G Paste 1.5 oz
012786	Lubricant Magnalube-G Paste 1 lb Can
012789	Lubricant Magnalube-G 14.5 oz
100761	Source Rod Pig

RETURNING THE GAUGE FOR SERVICE

All shipments within the United States to the factory must be accompanied by an RGA (Returned Goods Authorization) number, and a description of the instrument and its problem. This information is used by Troxler shipping and service personnel to expedite the repair work.

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

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

NOTE

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

NOTE

When returning a 3451 gauge, follow the required special handling and shipping procedures detailed in Appendix D. Please contact a Troxler Sales Support or Service Representative with any questions.

APPENDIX D

TRANSPORTATION AND SHIPPING

Devices containing radioactive materials must be transported in accordance with the rules of the U.S. Department of Transportation (DOT) and the International Atomic Energy Agency (IAEA). The IAEA recommendations have been codified in the International Air Transport Association (IATA) Dangerous Goods Regulations. International customers should consult their local government or licensing authority for applicable regulations.

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Accident Notification Requirements.....	D-3
Hazmat Training.....	D-3
Canadian Shipping Requirements.....	D-5

U.S. SHIPPING REQUIREMENTS

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

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

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

ACCIDENT NOTIFICATION REQUIREMENTS

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

HAZMAT TRAINING

The U.S. DOT regulations require every hazmat employer to train, test, certify, and maintain records for each hazmat employee. Hazmat training applies to anyone who transports or prepares for transport radioactive materials. Refresher training is required every three years.

Type A Package Testing Results for Model 3451

Water Spray Test: Subject the package to a water spray simulating rainfall of approximately 2 inches per hour for 1 continuous hour.

Results: Engineering evaluation – Water exposure of the magnitude required by the regulations would not affect the shielding or containment integrity of the package.

Vibration Test: The package was vibrated with a displacement of 0.1" at approximately 12 Hz for a period of 24 continuous hours.

Results: No physical damage to the package was observed.

Free Drop Test: The package was dropped from a height of 4 feet onto a non-yielding surface from a position to cause maximum damage to the package.

Results: The case was scratched due to the abrasiveness of the concrete, but no other physical damage to the package was observed.

Penetration: The package was placed on a non-yielding surface. A 1-1/4-inch diameter, 13-pound steel cylinder with a hemispherical end was dropped in the vertical position from a height of 40 inches onto the package to a point to cause maximum damage to the package.

Results: No physical damage to the package was observed.

Compression: Package was placed on a non-yielding surface and subjected to a compressive load of at least 13 kilopascals multiplied by the vertically projected area of the package, in square feet, for 24 continuous hours.

Results: No physical damage to the package was observed.

Weight of package as tested: 96 pounds

Date test completed: July 1996

Figure D–1. Type A Package Testing Results

CANADIAN SHIPPING REQUIREMENTS

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

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

NOTES

APPENDIX E
STANDARD COUNT LOG

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

STANDARD COUNT LOG

Gauge Serial Number _____

Date	Moisture (MS)	Density (DS1)	Density (DS2)

STANDARD COUNT LOG

Gauge Serial Number _____

Date	Moisture (MS)	Density (DS1)	Density (DS2)

E STANDARD COUNT LOG

STANDARD COUNT LOG

Gauge Serial Number _____

Date	Moisture (MS)	Density (DS1)	Density (DS2)

STANDARD COUNT LOG

Gauge Serial Number _____

Date	Moisture (MS)	Density (DS1)	Density (DS2)

E STANDARD COUNT LOG

STANDARD COUNT LOG

Gauge Serial Number _____

Date	Moisture (MS)	Density (DS1)	Density (DS2)

STANDARD COUNT LOG

Gauge Serial Number _____

Date	Moisture (MS)	Density (DS1)	Density (DS2)

E STANDARD COUNT LOG

STANDARD COUNT LOG

Gauge Serial Number _____

Date	Moisture (MS)	Density (DS1)	Density (DS2)

APPENDIX F

UNIT CONVERSION

The Troxler Model 3451 Enhanced RoadReader Plus can display measurement results in either SI (metric) units or English units. Also, HM-181 of 49 CFR changes the standard units of radioactivity in the United States from the English unit of *curies (Ci)* to the SI unit of *becquerel (Bq)*. This requires the shipper to convert the activity on the Bill of Lading from curies to becquerels (GBq). Until everyone is accustomed to the SI units, it is permitted to follow the SI units with the English units in parentheses to clarify the description [for example: 1.48 GBq (40 mCi)].

To help our users convert from English units to SI units, the table in this appendix provides SI conversion factors for common English units relevant to the 3451 gauge.

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Measurement Units F-2

Radiological Units F-2

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 μCi = 37 kBq

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

<u>mCi</u>	to	<u>GBq</u>
8.0.....		0.30
40.....		1.48

APPENDIX G

SPECIAL EUROPEAN CONSIDERATIONS

This section applies only to those Troxler Model 3451 Enhanced RoadReader Plus gauges with the CE mark that are to be used in European countries.

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Safety Warnings.....	G-3

DECLARATION OF CONFORMITY

Application of Council EMC Directive 89/336/EEC.

NOTE

The Low Voltage Directive 73/23/EEC does not apply to the Model 3451 Enhanced RoadReader Plus Surface Moisture-Density Gauge because there are no voltages greater than 75 V dc that are accessible by the operator.

Standards to which Conformity is Declared:

Guidance Documents:

Emissions: EN 61326-2:1997 + A1:1998 + A2:2001

Immunity: EN 61326-2:1997 + A1:1998 + A2:2001

Test Methods:

Emissions: EN 55011:1998, EN 61000-3-2:1995,
EN 91000-3-3:1995

Immunity: EN 61000-4-2:1995, EN 61000-4-3:1995,
EN 61000-4-4:1995, EN 61000-4-5:1995,
EN 61000-4-6:1995, EN 61000-4-11:1995

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

Apparatus: Model 3451 Enhanced RoadReader Plus
Surface Moisture-Density Gauge

Year of Manufacture: 2004

Responsible Person: Ulrich J. Lux
Technician
Troxler Electronics GmbH
Wholly Owned Subsidiary
Gilchinger Strasse 33
D-82239 Alling nr. Munich
Germany
Telephone: 011 49 81 41 71063
FAX: 011 49 81 41 80731



SAFETY WARNINGS

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

The following list of safety warnings applies to gauges with the CE mark and that are to be used in European countries. In addition to these safety warnings, all other safety warnings and cautions throughout this manual apply to gauges with the CE mark.

- ◆ There are no user-serviceable parts — only qualified service personnel should remove shields or covers to attempt repairs.
- ◆ Do not remove any shields or covers. A high-voltage hazard is located under the baseboard cover.
- ◆ The dc adapter shall be used on properly fused vehicle cigarette lighters only.
- ◆ European countries shall use a proper IEC input cord to the European charger (specified by local laws and practices).
- ◆ Do not throw batteries into fires. There is a risk of explosion.
- ◆ Use caution when lifting, moving, and/or carrying the gauge — it is heavy.
- ◆ See Appendix A for radiation safety instructions.

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