Manual of Operation and Instruction

Model 4300

Depth Moisture Gauge

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HOW TO USE THIS MANUAL

Congratulations on purchasing the **Troxler Model 4300 Depth Moisture Gauge**. This product's design allows measurement of moisture through an access tube.

The Model 4300 *Manual of Operation and Instruction* contains information on how the Model 4300 operates and provides directions on the use of the control unit and probes. Site selection, basic parameter set up, moisture measurement, reading storage and advanced operations are included, along with radiological information and system troubleshooting.

CONVENTIONS USED IN THIS MANUAL

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

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

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

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

⟨KEY⟩ Angle brackets and a different typestyle indicate a key or character (number or letter) to press on the gauge keypad. For example, "Press **⟨ON/YES⟩**" means to press the key labeled *ON/YES*.

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

```
DISPLAY - Typestyle
and shading used to
simulate the gauge
display
```

♦ Diamonds indicate a list of things needed (such as equipment) or things to know.

✓ Check marks indicate the performance of an action. With lists of check marks, follow the instructions in the order of the check marks.

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

NOTES

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

NOTES

ATTENTION GAUGE OWNER

This gauge contains functions that require an ACCESS CODE. This code must be entered before these functions may be used. For more information on using the access code, refer to Chapter 5.

The ACCESS CODE for this gauge is:

5548

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

GENERAL INFORMATION

This chapter will acquaint the reader with the Model 4300 Depth Moisture Gauge's many features and capabilities.

CONTENTS

INTRODUCTION

With the Model 4300 Depth Moisture Gauge (see Figure 1–1), the user can quickly and precisely determine the moisture content of soils, aggregates and similar materials.

Utilizing the principle of neutron thermalization, the Model 4300 determines the moisture content of a soils and soil-like material. Hydrogen (found in water) in the material slows neutrons emitted from an americium-241:beryllium (Am-241:Be)source. A helium-3 detector located in the probe detects the slowed neutrons. Both the source and the detector are located in the probe.

The gauge should be calibrated for each soil or soil-like material type. The *Calibration Transfer* feature allows transfer of these material dependent calibrations to two or more gauges. Calibration transfer decreases gauge downtime, reduces labor and helps ensure more precise, uniform measurements among gauges.

Moisture units are user selectable. The gauge may be configured to display moisture in pcf, percent by volume, count ratio, inches per foot, kg/m^3, g/cm^3, m^3/m^3, mm/m and cm/m.

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

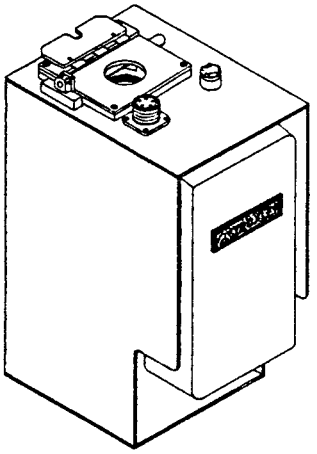
Any licensing issues discussed in this manual are for the United States. To purchase a Model 4300 in Canada, owners must obtain a radioisotope license from the Canadian Nuclear Safety Commission (CNSC). The owner should obtain copies of the CNSC Regulations and the Transportation of Dangerous Goods Act and Regulations (TDG). This manual provides a guide to Canadian shipping requirements on page G–4.

Figure 1–1. Model 4300 Depth Moisture Gauge

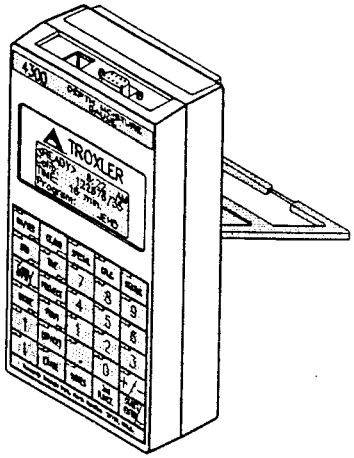
Owners are encouraged to require study of this manual by operator(s) before allowing any use of the instrument. While no radiation hazard is imposed on operator(s) during normal use, a potential hazard does exist if improperly used. The sections of the manual covering radiation safety should be required reading for all operators and potential operators. If these sections are not completely understood, users should seek assistance from Troxler, an appointed Troxler representative or others designated within the user organization. Additional radiation safety information is available by attending a Troxler Nuclear Gauge Training Course.

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

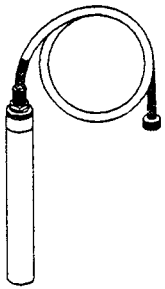
GAUGE PARTS AND ACCESSORIES



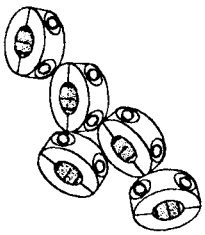
The Shield



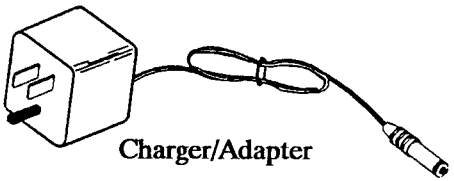
Control Unit



The Probe and Cable



Cable Stops



Charger/Adapter

Figure 1–2. Gauge Parts and Accessories

1. The **Control Unit**, a portable hand-held device, contains the control electronics, display, keypad, microprocessor and system memory.

2. The **Shield** contains the reference standard, probe shielding and acts as a carrier for the probe and control unit.

3. The **Probe** contains the source and helium-3 detector.

4. The **Power Adapter** connects the gauge to a 115 VAC, 60 Hz power source (or 230 VAC, 50 Hz for international use).

5. The **Optional Serial Interface Cable** (not shown) is used to connect the control unit to a printer or computer.

6. **Optional Serial Printer** (not shown) connects to the control unit for printing gauge data.

7. The **Transport Case** (not shown) is a DOT-approved shipping container used for shipping the gauge.

8. **Cable Stops** (6) are provided for the positioning the probe at set depths in the access tube.

NOTE

Part numbers for the optional gauge accessories are listed on page E–9.

UNPACKING AND INSPECTION

Upon receipt of the gauge, a complete inspection and inventory should be performed. If the shipping case or any other part of the container is damaged, contact the shipper immediately.

When removing the transport case from the cardboard box, check to see if the following literature and accessories have been included:

- Manual of Operation and Instruction
- Gauge Warranty (warranty not included with leased equipment)
- Source Certificate
- Calibration Data Sheet

- 4300 Shield
- 4300 Control Unit
- 4300 Probe
- AC Power Adapter
- DC Power Adapter (for cigarette lighter)
- Gauge to Control Unit Interface Cable
- (6) Cable Stops

Lift the gauge from the case and inspect the outside surface for damage. Check the lock and make sure the keys fit the lock. Return the gauge to the transport case.

NOTE

If the gauge appears to be damaged, notify the carrier and your Troxler Representative immediately.

Save the box and any packing material in case you need to ship the gauge to another location or back to the factory.

STORAGE SITE SELECTION

When deciding where to store the gauge, take into consideration the rules governing the storage of low-level radioactive devices that are set forth by the Code of Federal Regulations (CFR 49) and your gauge license.

- The gauge should be locked and stored in its transport case.
- The gauge and transport case should be stored at least 15 feet from normal work areas, preferably in a locked closet/storage area in a dry location (indoors).
- The storage area should be marked with a radiation sign.
- The storage of a nuclear gauge in a motor vehicle is not recommended.
- If a gauge is not in storage, do not leave it unattended!
- When on a job site, do not leave the gauge in the path of vehicles and equipment.

CHAPTER 2

OPERATING THE GAUGE

This chapter explains the basic operation of the Model 4300 Depth Moisture Gauge. Instructions for taking the daily standard count, parameter set-up, and taking moisture measurements are included.

CONTENTS

THE KEYPAD

The user interface (keypad) requires similar keystrokes in similar situations. For this reason, it will be helpful in increasing proficiency with the depth moisture gauge to become acquainted with these keys. Pressing a function key will only activate the function if the gauge is at the *Ready* screen. Following are the keys that will have universal functions:

⟨**ON/YES**⟩	To turn the control unit on, press ⟨**ON/YES**⟩. This key will also be used as a response to yes/no questions.
⟨**2nd FUNCT.**⟩	The second function key allows access to the yellow keys (i.e., the off key and the alphabetic keys).
⟨**2nd FUNCT**⟩**.** ⟨**OFF**⟩	Turn the control unit off with the combination of these keys.
⟨**CE/NO**⟩	Use this key in response to yes/no questions. As a clear entry key, it completely erases any information being entered by the user. If the screen displays menu options, this key takes the user to the Ready mode.
⟨**1**⟩ **–** ⟨**9**⟩	Use the numeric keypad to enter data, make menu selections, and perform calculator operations.
⟨↑⟩**,** ⟨↓⟩	These keys allow for scrolling through and highlighting menu choices or for viewing screens.
⟨**.**⟩	This key enters a decimal point.
⟨**START/ENTER**⟩	Use ⟨**START/ENTER**⟩ to select a highlighted menu option, after the completion of data or file name entry, and to begin a reading.

TURNING THE GAUGE "ON"

Make sure the control unit is connected to the shield and the probe is in the **SAFE** (shielded) position. The probe is in the **SAFE** position when locked in the indexer as shown in Figure 1–1 on page 1–3.

NOTE

Do not pull on the probe cable. Pulling on the probe cable may damage the probe.

Turn the gauge on by pressing the ⟨**ON/YES**⟩ key. The display will be:

```
Testing LCD...
0123456789ABCDEF
GHIJKLMNOPQRST
UVWXYZ@#$%&*()^-=
```

After the LCD test, the gauge will enter the 15-second self-test. In this mode the software version number, serial number and customer name is displayed. The display will be:

```
 - TROXLER 4300 -
 V:2.13   snXXXXX

 (Test  15  sec.)
```

After the 15-second self-test, press ⟨**START/ENTER**⟩ to place the gauge in the *Ready* mode. The control unit alternately displays the time and date in the upper right corner of the display. The current calibration and count time will also be displayed.

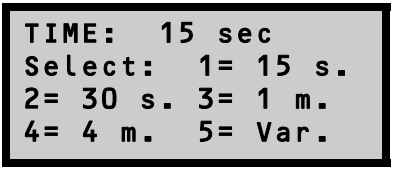
```
<READY>  mm/dd/yy
Calib: FACTORY
TIME: 30 sec.
```

GAUGE PARAMETER SETUP

After unpacking and turning the 4300 “On,” several parameters can be initialized. These parameters do not usually require changing and may include the time\date, company name, count time, etc.

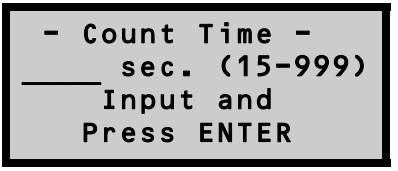
SETTING THE COUNT TIME

In most cases, a desired count time may be selected and will not require changing. Keep in mind that the longer the count time, the better the measurement precision. Press ⟨**TIME**⟩ for the display:



Select the required count time with the number keys.

If a different count time is required (other than what is displayed) press ⟨**5**⟩ for variable time. The display will be:



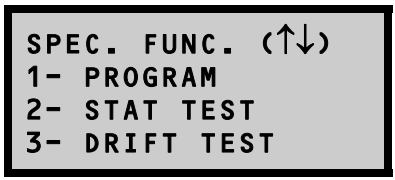
Input the required time (in 15 second intervals) and press ⟨**START/ENTER**⟩. The display will return to *Ready* mode.

NOTE

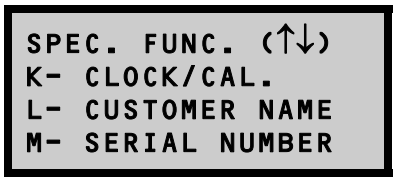
The count time is rounded down to the nearest 15-second interval. For example, 29 seconds is rounded down to 15 seconds.

SETTING THE TIME/DATE

Press ⟨**SPECIAL**⟩. The display will be:

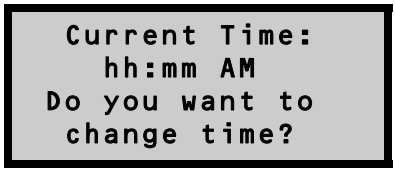


Press the down arrow four times for the display:



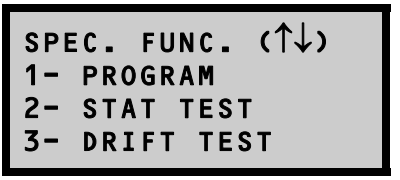
Press ⟨**2nd FUNCT.**⟩ and then press ⟨**K**⟩. The display is:

Press ⟨**ON/YES**⟩. Input the date. Press ⟨**START/ENTER**⟩. Repeat the above procedure to change the time.

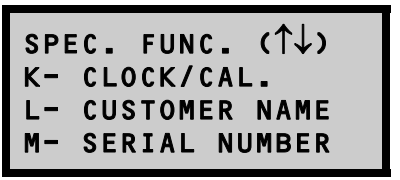


CHANGING CUSTOMER NAME

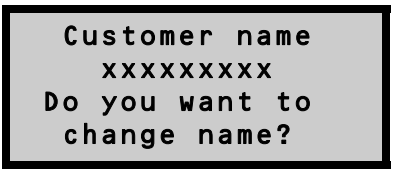
The gauge may be programmed to display your name or any other message (not to exceed 16 characters) during the power-up stage. Press ⟨**SPECIAL**⟩. The display will be:



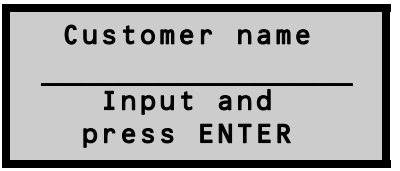
Press the down arrow four times for the display:



Press ⟨**2nd FUNCT.**⟩ and then press ⟨**L**⟩. The display is:



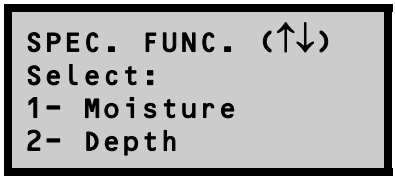
Press ⟨**ON/YES**⟩. Use alphabetic keys to enter name. Press ⟨**START/ENTER**⟩.



SETTING MEASUREMENT UNITS

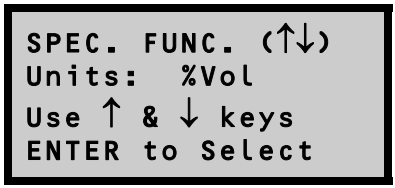
Moisture measurements can be displayed in one of the following units: **%Vol, g/cm3, kg/m3, PCF, m3/m3, mm/m, cm/m,** or **in/ft.**

Press ⟨**SPECIAL**⟩. The user may scroll through the menu options, pressing ⟨**4**⟩ to select.



Moisture Units

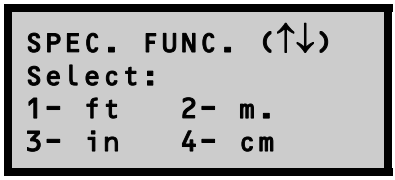
Press ⟨**1**⟩ to select the "moisture units."



Use the up and down keys to scroll the list of measurement units. Press ⟨**START/ENTER**⟩ to select. The control unit will return to the *Ready* mode.

Depth Units

To change the depth units, press ⟨**2**⟩ at the display at the top of this page.



The depth display can be configured for metric or U.S. units. To select the depth measurement units press the appropriate numerical key. The control unit returns to the *Ready* mode.

TAKING THE STANDARD COUNT

Prior to performing any tests or calibrations, the standard count should be taken. The standard count will verify gauge operation. The neutron source used in the 4300 is americium-241:beryllium and has a half-life of 432 years (or will undergo a natural decay of 0.15% per year). The gauge automatically compares the new standard count with the average of the last four standard counts. If the new count is within 2% of the average of the last four counts, the gauge will indicate "PASS."

Place the gauge (probe and shield) a minimum of 24 inches (61 cm) above the surface of the ground. The United States Department of Agriculture recommends placing the shield 32–36 inches above the surface. Best results can be obtained by installing a tube at the correct height and placing the gauge on the tube (see Appendix D).

NOTE

Keep all tubes, including the one for standard counts, at the same height above the ground.

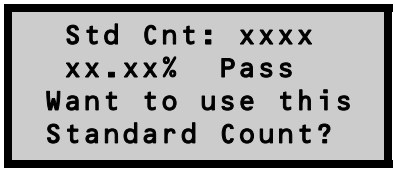
The probe should remain in the shield except during measurements.

The Access Tube Must Be Kept Dry (Appendix D)!

Press ⟨**STD**⟩ for the display:

Press ⟨**ON/YES**⟩.

Lock the probe in the retracted (**SAFE**) position. Press ⟨**START/ENTER**⟩.



After the count is complete, if the count is acceptable (count passes), press ⟨**ON/YES**⟩.

Press ⟨**CE/NO**⟩ if the count is not acceptable. Retake the count.

TAKING A MEASUREMENT

Taking a moisture measurement with the Model 4300 gauge is a simple process. However, several preliminary steps must be taken to ensure precise readings at the correct depth.

INSTALLING CABLE STOPS

Determine the desired measurement depth. Place a cable stop as determined below. Figure 2–1 shows the orientation and spacing of the probe and cable in the measurement position. The position of the cable stop is determined as follows:

Cable Stop Position (from top of probe) =*
D + A + 3.4 – 2.313 – 13.75 + 13 inches

where: *D* = depth of measurement (below surface)
A = height of access tube (above soil surface)

Therefore:

Cable Stop Position = D + A + 0.337 inches

* *Note that the top of the probe is the point at which the cable and strain relief begin.*

Example:

Depth of Measurement = 24 inches
Height of Access Tube = 32 inches

Cable Stop Position = 24 + 32+ 0.337 = 56.337 inches

For the above example, place the *bottom* of the cable stop 56.337 inches from the top of the probe.

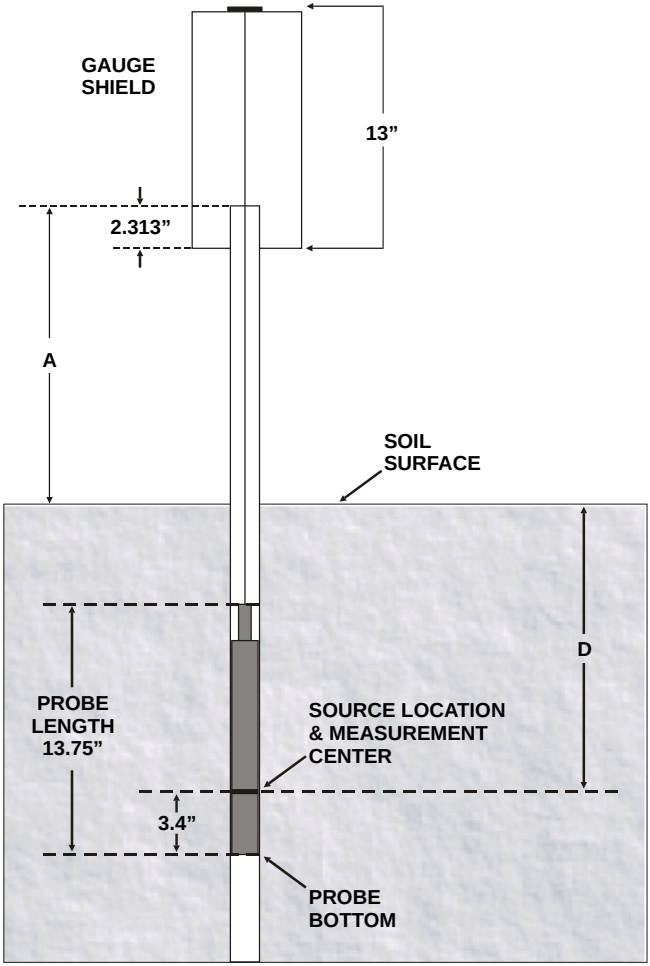


Figure 2–1. Probe and Cable Orientation at Measurement Position

INSTALLING THE PROBE

NOTE

It is recommended that a “dummy probe,” available from Troxler, be lowered into the access tube prior to installing the gauge. The dummy probe will ensure that the 4300 probe will freely enter and exit the access tube and will not become stuck or damaged.

Ensure that the access tube is dry. Water will damage the probe electronics. Place the gauge shield over the access tube. A receptacle for the access tube is located on the bottom of the shield.

TAKING A READING

Release the probe and lower the probe to the correct depth as shown in Figure 2–2.

With the probe in the correct position, verify the gauge parameters, such as count time, correct calibration, etc.

Press ⟨**START/ENTER**⟩. If the user activated a program, then the gauge displays:

```
Project Name:
XXXX    _ _ _ _
Input Name and
 Press ENTER
```

The control unit displays the active program name and four blank lines for the project extension on the second line. The gauge will store data under the project name, which is the program name followed by the project extension. Enter the project extension (four alphanumeric characters) and press ⟨**START/ENTER**⟩.

The gauge displays the count progress. After the count time has elapsed, the display will be:

```
Calib:  xxx.xx
Count:    xxxx
  xx.x %Vol
Want to store?
```

Refer to Chapter 3 for storing and printing readings.

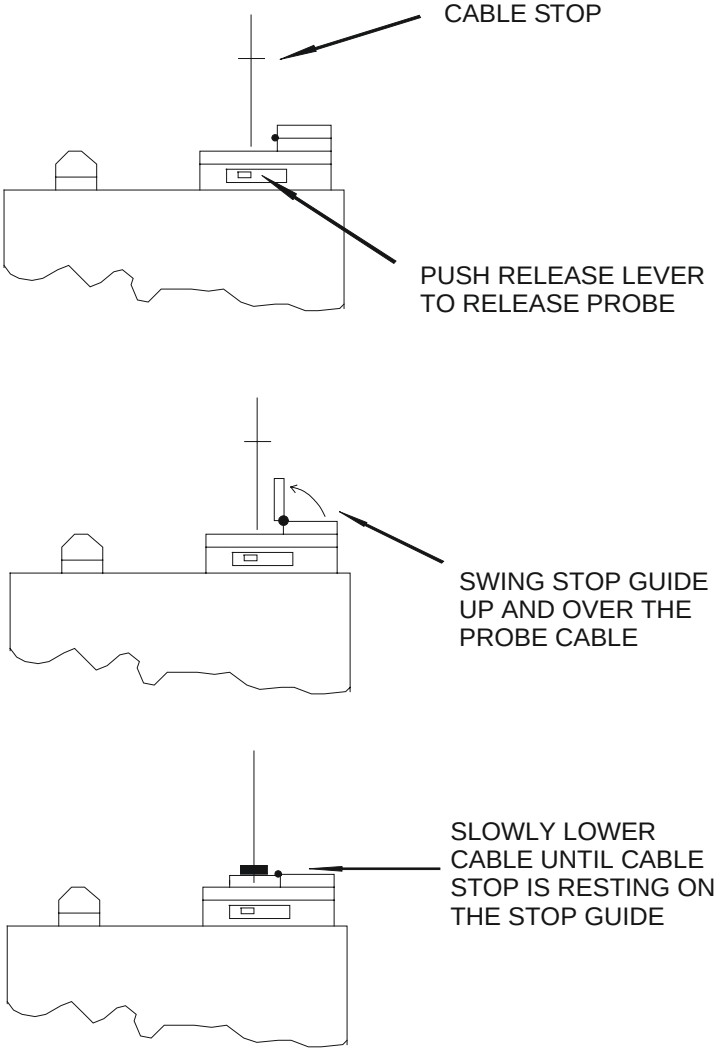


Figure 2–2. Lowering the Probe

NOTES

CHAPTER 3

STORING PROJECT DATA

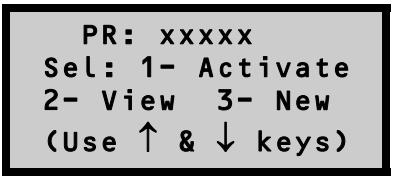
This chapter covers the procedures for storing gauge measurements, assigning project numbers, printing project data and erasing old projects from memory.

CONTENTS

CREATING A PROJECT

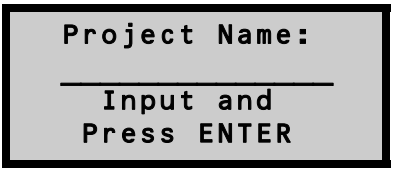
Data is stored in the Model 4300 Depth Moisture Gauge under a *project name/number*. When a project is active, all readings will be stored in memory using this name. The user can then retrieve, view, and print (or download to a computer) data. After the user completes a project, Troxler recommends printing or downloading the data and erasing the project. This maximizes data storage space.

Press ⟨**PROJECT**⟩ for:



CREATE A NEW PROJECT

Press ⟨**3**⟩ and input the project name. A project name may contain up to twelve alphanumeric characters. The alphabetic keys will be activated. To input numeric digits, press the ⟨**2nd FUNCT.**⟩ key.

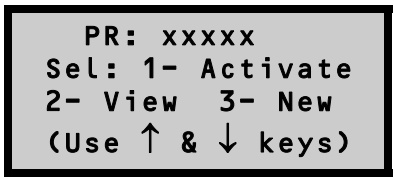


Input a project name and press ⟨**START/ENTER**⟩.

The project will be activated. The gauge returns to *Ready* mode.

VIEW AN EXISTING PROJECT

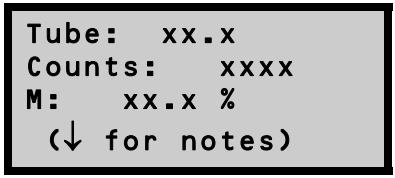
Press ⟨**PROJECT**⟩ for:



Use the up and down arrows to select the project to view.

Press ⟨**2**⟩ for the display:

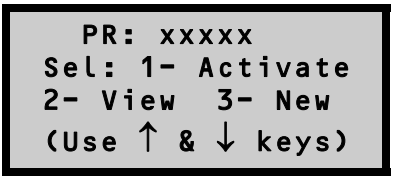
Press the down arrow to view the data.



Press the down arrow again to view any “notes” stored with the reading.

ACTIVATE AN EXISTING PROJECT

If data is to be stored under an existing project name, press ⟨**PROJECT**⟩ for:



Use the up and down arrows to select the project to activate.

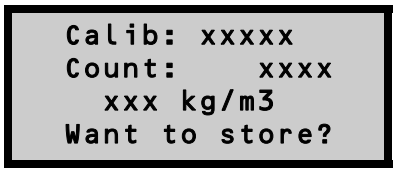
Press ⟨**1**⟩ for the display:

The gauge will return to the *Ready* mode.

STORING A MEASUREMENT

After reviewing the measurement data, the reading may be stored under a *Project*. This function allows the data to be recalled and printed later.

When the measurement is complete, the display will request storage:

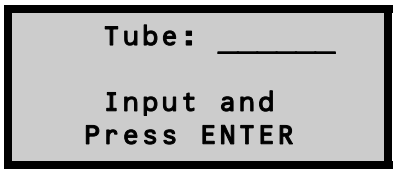


Press ⟨**ON/YES**⟩.

NOTE

If the reading is not satisfactory after reviewing, press ⟨CE/NO⟩, take another reading and press ⟨ON/YES⟩.

The display will request an access tube number:



Input a tube number and press ⟨**START/ENTER**⟩. The gauge will request the depth of the reading:

Input the depth of the reading and press ⟨**START/ENTER**⟩.

After the depth is input, enter any additional information as notes. The alphabetic keys will be activated (indicated by a large flashing cursor). Press the ⟨**2nd FUNCT.**⟩ key to enter numeric data. Press ⟨**START/ENTER**⟩ after each line. Press ⟨**START/ENTER**⟩ one more time to exit the storage routine. The display will be:

PRINTING MEASUREMENT DATA

Measurement data may be printed at any time after the readings have been taken and stored under a project. When using the printer with Troxler units, critical printer setup options are the data bits, the stop bits, and the handshake (*hshake*) type. The printer is set to the Troxler default printer settings. See page F–4 for the Troxler default printer settings. See the printer manual for details on setting up the printer.

Press ⟨**PRINT**⟩. The display will be:

```
Select to print:
1- Project data
2- Notes
3- Calib. data
```

Press ⟨**1**⟩ to print *Project Data*. The display will be:

```
Connect serial
device & Select:
1- one Project
2- all Projects
```

Connect the printer to the serial port located on the control unit (refer to page 5–7 for information on setting the baud rate).

Press ⟨**1**⟩ to select a single project. Press ⟨**2**⟩ to print all projects.

If ⟨**1**⟩ is selected, the user can scroll through the project list.

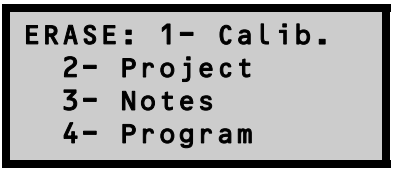
```
    PR: #####
(use ↑ & ↓ keys)
  Press ENTER
   to select
```

Press the up and down keys to view the projects. Press ⟨**START/ENTER**⟩ to select.

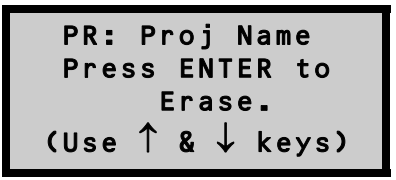
ERASING A PROJECT

The *Erase* function allows project data (or a calibration, notes, or program) to be erased or removed from gauge memory. This frees memory for future storage. After the user completes a project, Troxler recommends printing or downloading the data and erasing the project.

For example, if a project is to be erased, press ⟨**ERASE**⟩.



Press ⟨**2**⟩.



Press the up and down arrows to select a project for erasure.

Press ⟨**START/ENTER**⟩ to erase the project. The gauge will request verification. Press ⟨**ON/YES**⟩ to erase.

ACCIDENTAL ERASURE

If data is accidentally erased, press ⟨**SPECIAL**⟩. Press the down arrow three (3) times and/or press ⟨**2nd FUNCT.**⟩ and ⟨**R**⟩ to select *Recover* Erase.

Use the arrow keys to select the erased data. Press ⟨**START/ENTER**⟩ to recover.

CHAPTER 4

ADVANCED GAUGE OPERATION

This chapter explains the advanced functions available on the Model 4300 Depth Moisture Gauge. These functions are used for taking readings automatically, automatic message display, and storing additional alphanumeric information.

CONTENTS

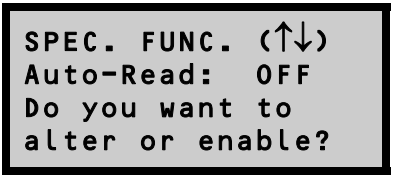
AUTO-READ

The Model 4300 Depth Moisture Gauge is equipped with a function that allows automatic moisture data collection. The *Auto-Read* function programs the gauge to take a finite number of readings at specific intervals.

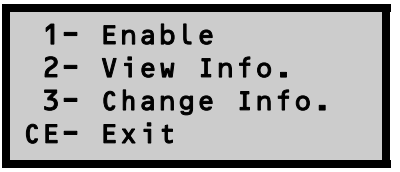
The default settings are:

12 readings
1-hour intervals
Auto-Store disabled
Auto-Print disabled

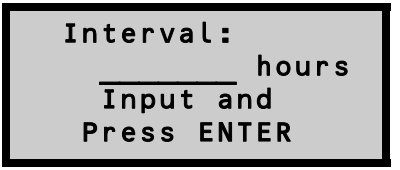
Press ⟨**SPECIAL**⟩. The user may scroll through the menu options, pressing ⟨**7**⟩ to select.



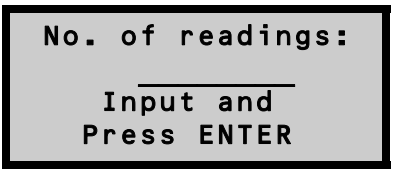
Press ⟨**ON/YES**⟩ to change the parameters or to enable the function.



To change the current *Auto-read* settings press ⟨**3**⟩.



Input the interval (or delay between readings). Valid intervals are from 0.1 to 25 hours, in 0.10-hour increments. Press ⟨**START/ENTER**⟩.

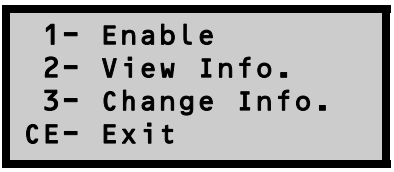


Input the number of readings (max = 255).

NOTE

If "0" is entered, readings will be taken continuously until the gauge is out of memory.

The display returns to the *Auto-Read* menu.

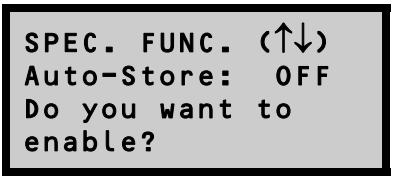


Press ⟨**1**⟩ to enable the function.

AUTO-STORE

The *Auto-Store* function provides a method where individual measurements are automatically stored under a project name after the reading is completed.

Press ⟨**SPECIAL**⟩. The user may scroll through the menu options, pressing ⟨**8**⟩ to select.

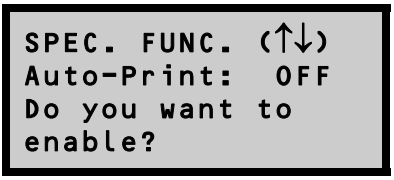


Press ⟨**ON/YES**⟩ to enable the *Auto-Store* function.

AUTO-PRINT

When the *Auto-Print* function is enabled, readings will be automatically printed or uploaded to a computer after the measurement is complete.

Press ⟨**SPECIAL**⟩. The user may scroll through the menu options, pressing ⟨**9**⟩ to select.



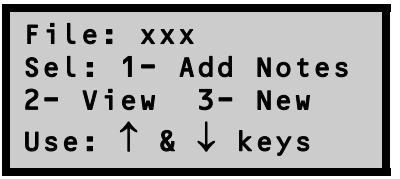
Press ⟨**ON/YES**⟩ to enable the *Auto-Print* function.

NOTES

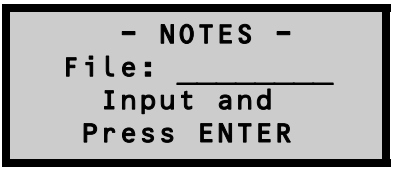
The *Notes* function allows the user to record information without the need for a notebook or other materials. Information is entered directly into the gauge. This information is stored under a file name designated by the user.

The “notes” can be recalled and printed at a later time. Refer to the *Print* function on page 3–7.

Press ⟨**NOTES**⟩.

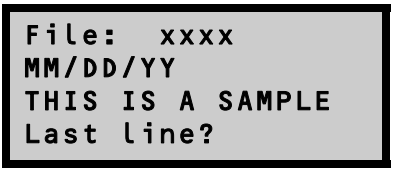


Press ⟨**3**⟩ to set-up a new “notes” program:



Input the file name. If numeric keys are needed, press the ⟨**2nd FUNCT.**⟩ key. Press ⟨**START/ENTER**⟩ when completed.

Use the alphanumeric keys to enter the “notes” information. Press ⟨**START/ENTER**⟩ when completed.



Press ⟨**CE/NO**⟩ to continue entering information.

Press ⟨**ON/YES**⟩ to exit and return to the opening “notes” menu.

Press ⟨**CE/NO**⟩ to return to the *Ready* mode.

PROGRAM

The *Program* function allows the user of the Model 4300 to pre-program the gauge for specific readings at specific locations.

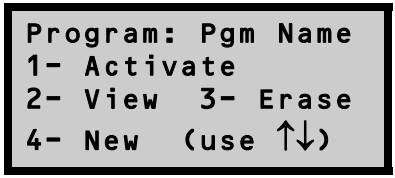
For example: There are 8 access tubes installed in a research field; moisture measurements are required on a daily basis at 1.0-, 1.5-, 2.5-, and 3.5-foot depths; and several of the tube locations require a different calibration.

The Model 4300 can be programmed to accommodate the above requirements using the *Program* function.

The programming procedure consists of several steps, listed below and discussed on the following pages.

- ✓ Input the number of access tubes to be used.
- ✓ Enter the starting number for the first tube (default = 1).
- ✓ Determine if the measurement depths are the same for all tubes (they can be different).
- ✓ Enter the measurement depths.
- ✓ Determine if specific tubes require different calibrations.
- ✓ Input messages to be displayed (or questions asked):
  - at each tube,
  - at each depth, or
  - at the end of the program.
- ✓ Input the calibrations.
- ✓ Input the messages or questions.
- ✓ Name the program.

Press ⟨**SPECIAL**⟩ and press ⟨**1**⟩.

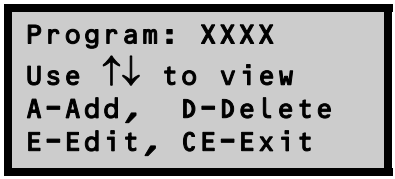


ACTIVATE PROGRAM

To activate a program from the *Program* menu, use the arrow keys to display the program name. When the control unit displays the program name that you wish to activate, press ⟨**1**⟩.

VIEW PROGRAM

The *View Program* feature allows for the adding, deleting and editing of program messages. Press ⟨**AUTO-NOTES**⟩ and ⟨**2**⟩.



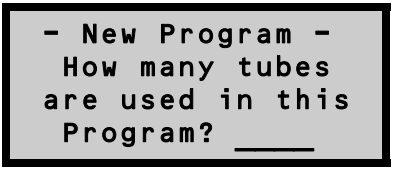
Use the up and down arrows to display program names.

ERASE PROGRAM

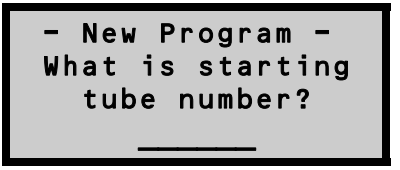
Erase the displayed program file by pressing ⟨**3**⟩. The control unit will ask if the file should be erased. To erase the file, press ⟨**ON/YES**⟩. To abort the erasure, press ⟨**CE/NO**⟩. The control unit will return to the *Ready* mode.

INPUT A NEW PROGRAM

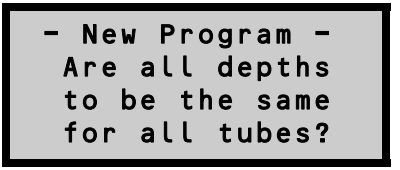
Press ⟨**4**⟩.



Input the number of access tubes. Press ⟨**START/ENTER**⟩.



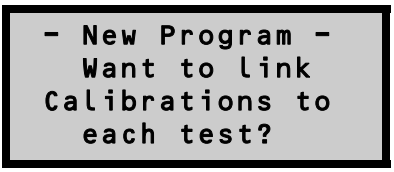
Input the first tube number (or press ⟨**START/ENTER**⟩ to default to "1").



Press ⟨**ON/YES**⟩ if the depths are the same for each tube.

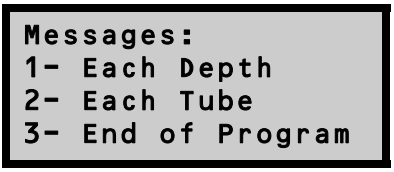
Enter the depths. Press ⟨**ON/YES**⟩ at the last depth request.

After entering the measurement depths, the display will be:



Press ⟨**ON/YES**⟩ if specific calibrations are required.

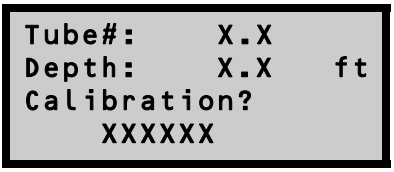
The next display will be:



Select when messages (or questions) will be displayed during program execution with the numeric keys.

For example, if a message is to be displayed at each tube press ⟨**2**⟩. At this time the program format has been determined. You must select the required calibrations and input any messages for display.

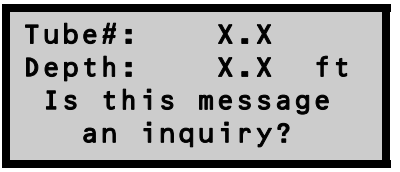
If the programmer requested that calibrations be linked to the measurements, the control unit prompts the selection of the specific calibration.



Enter the correct calibration. The alphabetic keys will be active. If the user wishes to input numeric digits press ⟨**2nd FUNCT.**⟩.

Press ⟨**START/ENTER**⟩ to continue.

Input the first line of the message for the particular tube and depth. Press ⟨**START/ENTER**⟩.



The message can be configured as a question where the gauge will wait for a response. Press ⟨**ON/YES**⟩ if the message is to be displayed as a question.

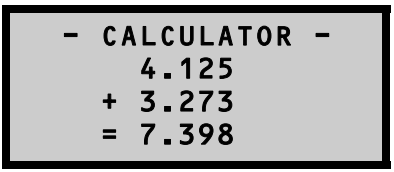
Repeat the above sequence for each depth and each tube. After all data is entered, input a name for the program. The program will be activated upon exiting.

CALCULATOR

The Model 4300 is equipped with a four-function *calculator*. The function keys are located on the two left columns of the keypad. When the *Calculator* function is active, these keys are enabled.

Press ⟨**CALC.**⟩.

Use the ⟨**+**⟩, ⟨**–**⟩, ⟨**×**⟩, ⟨**÷**⟩ keys located on the left two columns of the keypad. The ⟨**=**⟩ key is located on the ⟨**START/ENTER**⟩ key.



Results may be stored in memory by pressing ⟨**MS**⟩.

Results may be retrieved from memory by pressing ⟨**MR**⟩.

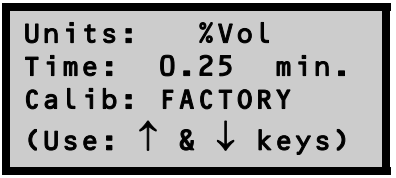
The current entry may be cleared by pressing ⟨**CE/NO**⟩ once. The calculator memory can be cleared by pressing ⟨**CE/NO**⟩ two times.

Exit the calculator mode by pressing ⟨**EXIT**⟩.

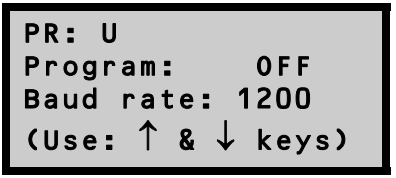
CONTROL STATUS

The control parameters on the 4300 can be checked using the *Status* function. This function provides the advantage of checking parameters without accessing individual functions. Press ⟨**STATUS**⟩.

Use the up and down arrow keys. Press the down arrow for the display:



Press the down arrow three times for:



Press the down arrow three times for:

Continue to press the up or down key to view the remaining parameters. Press ⟨**CE/NO**⟩ to exit.

CHAPTER 5

SPECIAL FUNCTIONS

This chapter gives brief explanations of the *special* functions available on the Model 4300 Depth Moisture Gauge.

CONTENTS

PROGRAM FUNCTION

Please refer to page 4–8 for detailed information on using the *Program* function.

STAT TEST

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

A stat test consists of twenty counts. The recommended count time is 1-minute.

After the 20 counts, the standard deviation is calculated. This standard deviation is compared to a theoretical standard deviation value. Ideally, this ratio should be one. However, the 4300 pre-scale (or divide) for one minute counts is 16. This results in an ideal ratio of (0.25).

The acceptable limits for the ratio are:

30 second count	0.25 to 0.49
1 minute count	0.18 to 0.35
4 minute count	0.09 to 0.17

To execute a stat test, place the gauge in an area free of other gauges or radioactive sources. Press ⟨**SPECIAL**⟩. Press ⟨**2**⟩ to display:

Press ⟨**2**⟩ to begin a new stat test.

```
 - STAT TEST -
Time: x.xx  min
 Do you want to
  change time?
```

If the current count time is acceptable, press ⟨**CE/NO**⟩.

```
   Statistical
 Stability Test -
 Position probe &
   Press START
```

Ensure the probe is locked in the shield and that no other gauges or radioactive sources are nearby. Press ⟨**START/ENTER**⟩.

After the 20 counts have been completed, the gauge will display the average counts and indicate if the test passed or failed. The individual count data may be viewed or printed at this time.

```
 Avg cnts: XXXX
R:  XX.XX (PASS)
 Do you want to
 View Stat data?
```

Press ⟨**ON/YES**⟩.

Select the method of viewing the data. If a printout is desired, refer to page 5–7 for location of the serial port and baud rate configuration.

NOTE

If the stat test fails, repeat the test two more times. If the test fails two out of three attempts, contact your Troxler Service Department.

Figure 5–1. Sample Stat Test Printout

```
################################
#   TROXLER ELECTRONIC LABS    #
#   4300 Depth Moisture Gauge  #
#        company name          #
################################

*******************************
  Statistical Stability Test
*******************************
Count time:  1.00 min.
*******************************
Gauge Serial #: 718
   7/24/99       5:11 PM

READING|COUNTS    READING|COUNTS
--------------------------------
   1     848         2      859
   3     841         4      853
   5     856         6      857
   7     862         8      860
   9     848         10     850
   11    852         12     855
   13    852         14     857
   15    857         16     838
   17    860         18     855
   19    851         20     856
   Average Counts:   853
   Ratio:       0.210
          (PASS)
*******************************
```

DRIFT TEST

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

The drift test consists of five tests. Wait 3–4 hours after the completion of the stat test before performing the drift test.

NOTE

The count time is based on the last stat test. The drift test count time will be four times the stat test count time. The gauge should not be turned off between the stat test and drift test. The stat test must be current.

Press ⟨**SPECIAL**⟩. Press ⟨**3**⟩ for:

```
- DRIFT TEST -
 Is STAT test
   current?
```

Press ⟨**ON/YES**⟩ to start a new drift test.

After the five counts have been completed, the gauge will display the average counts and indicate if the test passed or failed. The individual count data may be viewed or printed at this time.

```
Avg Cnts: xxxx
Drift: x.xx% P
   Want to view
 DRIFT test data?
```

The pass/fail criteria is 1.0%. If the drift test fails, repeat the test two more times. If the test fails two out of three attempts, contact your Troxler Service Department.

Figure 5–2. Sample Drift Test Printout

```
################################
#   TROXLER ELECTRONIC LABS    #
#   4300 Depth Moisture Gauge  #
#        company name          #
################################

*******************************
        DRIFT TEST
*******************************
Gauge Serial #:  178
Current Stat test results:
    7/24/99        5:11 PM

    Count time: 1.00 min.
     Average Counts: 853
     Ratio: 0.210
               (PASS)
*******************************
-------------------------------
Drift test results:
   7/24/99        5:35 PM

       READING|COUNTS
-------------------------------

          1   |   848
          2   |   841
          3   |   856
          4   |   862
          5   |   848

   Average Counts:   858
   Drift:       0.50%
          (PASS)
*******************************
```

UNITS

Please refer to page 2–7 for detailed information on this function.

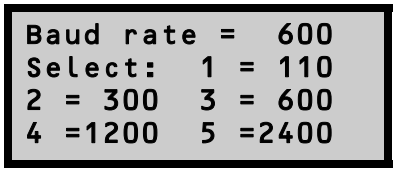
BAUD RATE

The printer is shipped with the baud rate set at 1200 baud. Since the printer and the control unit baud rates must be the same, Troxler recommends that you should check the control unit baud rate. Also, if you change the control unit baud rate to 2400 baud, then you must also set the printer rate to 2400 baud. See page F–4 for the Troxler default printer settings. See the printer manual for details on setting up the printer.

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

The baud rate, or communication speed, should be set to match the peripheral device. Refer to the peripheral device owner's manual for the proper settings.

Press ⟨**SPECIAL**⟩. The user may scroll through the menu options, pressing ⟨**5**⟩ to select.



Input the baud rate that matches the printer or computer.

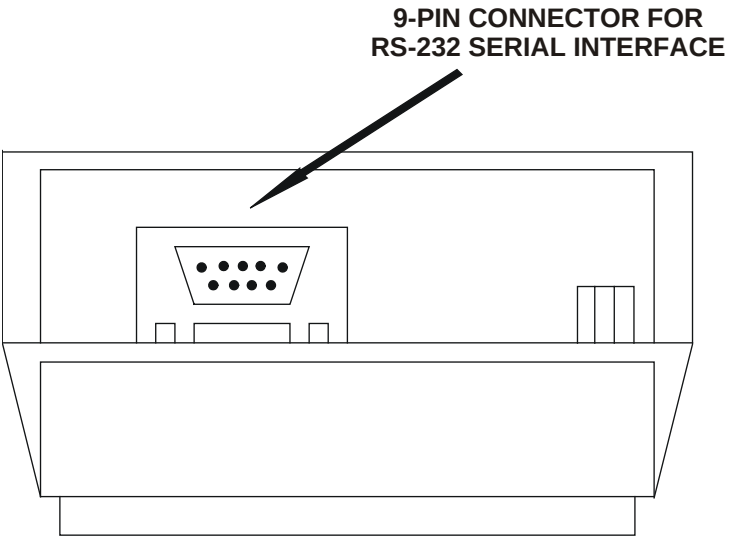


Figure 5–3. Model 4300 Control Unit Connections

PRINT FORMAT

The *Print Format* function allows the user to configure project printout formats. Data may be printed or transmitted in ASCII format (see Figure 5–4) or in a format suitable for use by the popular spreadsheets (see Figure 5–5).

Press ⟨**SPECIAL**⟩. The user may scroll through the menu options, pressing ⟨**6**⟩ to select.

```
  -Print Format-
Select:
1- ASCII
2- Spreadsheet
```

Sample printouts are shown on the following pages. Input the format required for your applications.

Figure 5–4. Sample ASCII Printout

```
################################
#   TROXLER ELECTRONIC LABS    #
#   4300 Depth Moisture Gauge  #
#        company name          #
################################

********************************
"PROJECT NAME: SECTION 548 "
"Date:  5/29/99  Serial # 847925
Tube: 1.1
10:13 AM  5/29/91  Count:  255
 M: 0.1%Vol Depth: 100  cm
Count time: 0.25 min
Calib: FACTORY  (5/09/99)
IRRIGATE 1A
--------------------------------
Tube: 2.1
10:26 AM  5/29/99  Count:  255
 M: 0.1%Vol Depth: 100  cm
Count time: 0.25 min
Calib: FACTORY  (5/09/99)
DRY TEST
--------------------------------
Tube: 3.1
10:45 AM  5/29/99  Count:  255
 M: 0.1%Vol Depth: 100  cm
Count time: 0.25 min
Calib: FACTORY  (5/09/99)
AUTO IRRIGATE
********************************
```

Figure 5–5. Sample Spreadsheet Input File

```
################################
#   TROXLER ELECTRONIC LABS    #
#   4300 Depth Moisture Gauge  #
#        company name          #
################################
"PROJECT NAME: SECTION 548 "
"Date:  5/29/91  Serial # 847925"

"Test#" "Tube" "Time" "Date"
"Count" "Moisture" "Units" "Depth" "Cnt
Tim" "Calibr." "Cal Date"

  1    "1.1   " "10:13 AM" "5/29/91"
  255      0.1   " %Vol"  100  "cm"
  0.25 "min"  "FACTORY" " 5/09/91 "

  2    "2.1   " "10:26 AM" "5/29/91"
  255      0.1   " %Vol"  100  "cm"
  0.25 "min"  "FACTORY" " 5/09/91 "

  3    "3.1   " "10:45 AM" "5/29/91"
  255      0.1   " %Vol"  100  "cm"
  0.25 "min"  "FACTORY" " 5/09/91 "
```

AUTO-READ

Refer to page 4–2 for information on this function.

AUTO-STORE

Refer to page 4–4 for information on this function.

AUTO-PRINT

Refer to page 4–5 for information on this function.

PRECISION

The *Precision* function allows the user to specify the degree of measurement precision. The precision must be greater than "0" and the gauge must be able to obtain the precision using a count time of 60 minutes or less.

Input the desired precision value. The gauge will request a sample moisture value. Input a sample value close to the actual moisture in the material (for example, 10 %Vol). The gauge will then calculate the time required to reach the specified precision on future measurements.

To access this function, press ⟨**SPECIAL**⟩. The user may scroll through the menu options, pressing ⟨**2nd FUNCT.**⟩ and ⟨**P**⟩ to select.

Input the required precision and press ⟨**START/ENTER**⟩. The display is:

The moisture value can be manually input or the gauge can take a reading and use the measured moisture value. Select the method of entering the sample moisture value.

After the gauge has a moisture value, the control unit will calculate the count time. Press ⟨**ON/YES**⟩ to use the count time for future readings.

QUADRATIC MODE

The Model 4300 fits a linear curve to the calibration data. In the event that a quadratic fit is required, the *Quadratic* function can be enabled.

Refer to Appendix C for more detailed information on performing calibrations.

Press ⟨**SPECIAL**⟩. The user may scroll through the menu options, pressing ⟨**2nd FUNCT.**⟩ and ⟨**Q**⟩ to select this function.

Press ⟨**1**⟩ to perform a new quadratic calibration or view an existing quadratic calibration.

NOTE

If no quadratic calibrations are stored, the function will not respond to the review or erase command.

Press ⟨**2**⟩ to perform an offset on an existing quadratic calibration.

Press ⟨**3**⟩ to erase an existing quadratic calibration.

RECOVER ERASE

In the event that data is inadvertently erased, the *Recover Erase* function may recover the lost information.

NOTE

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

To use *Recover Erase*, press ⟨**SPECIAL**⟩. The user may scroll through the menu options, pressing ⟨**2nd FUNCT.**⟩ and ⟨**R**⟩ to select.

```
RECOVER: 1- Calib
2- Project
3- Notes
4- Program
```

Select the type of file to be recovered with the appropriate numeric key.

Use the arrow keys to scroll through the file names, pressing ⟨**START/ENTER**⟩ to attempt recovery. The control unit will indicate the success of the recovery and return to the *Ready* mode.

CLOCK/CALENDAR

Refer to page 2–5 for information on changing the time or date.

CUSTOMER NAME

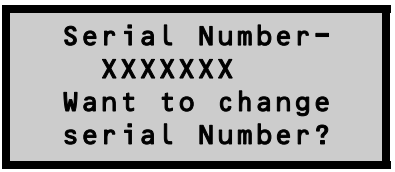
Refer to page 2–6 for information on changing the time or date.

SERIAL NUMBER

The *Serial Number* function allows the user or technician to re-enter the gauge serial number after clearing memory.

Press ⟨**SPECIAL**⟩. The user may scroll through the menu options, pressing ⟨**2nd FUNCT.**⟩ and ⟨**M**⟩ to select this function.

A code is required to prevent unauthorized access to this function. Input the access code located after the *Table of Contents* and press ⟨**START/ENTER**⟩.



Press ⟨**ON/YES**⟩.

Input the serial number and press ⟨**START/ENTER**⟩.

ERASE STANDARD COUNTS

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

Press ⟨**SPECIAL**⟩. The user may scroll through the menu options, pressing ⟨**2nd FUNCT.**⟩ and ⟨**F**⟩ to select this feature.

```
Sure you want
to erase all
Standard Counts
   in gauge?!
```

Press ⟨**ON/YES**⟩.

```
All Standard
Counts are
erased.
```

ENTER CALIBRATION

Refer to page C–23 for entering a factory calibration or page C–24 for information on performing a calibration transfer.

DIAGNOSTICS

The *Diagnostics* function is for qualified service personnel only!

For additional information on the *Diagnostics* function, contact Troxler Customer Service.

NOTES

APPENDIX A

THEORY OF OPERATION

This appendix provides information on the theory of operation and calibration principles of the Model 4300 Depth Moisture Gauge.

CONTENTS

GAUGE THEORY

The probe consists of a 0.37 GBq (10 mCi) americium-241:beryllium (Am-241:Be) source, a 3He tube, and counting electronics. The nuclear source yields about 17,000 neutrons per second. The fast neutrons emitted are *thermalized*, or slowed, by the hydrogen (water) in the material.

Since it is insensitive to fast neutrons, the 3He detector counts the thermalized neutrons, which form a cloud around the detector (see Figure A–1). A direct relationship exists between water content and counts. In other words, if counts are taken with the probe in two materials that differ in water content, the counts taken in the high water content mix will be higher than the counts in the low water content mix. This association is linear, allowing for simple calibration of the probe.

The radius of measurement is the distance through which 98% of the counted thermalized neutrons pass before reaching the detector. The radius of measurement normally decreases with an increasing moisture content (see Figure A–2).

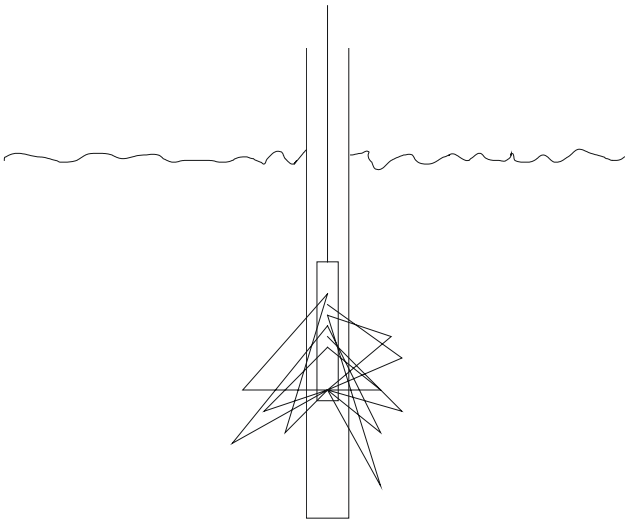


Figure A–1. Thermalized Neutrons

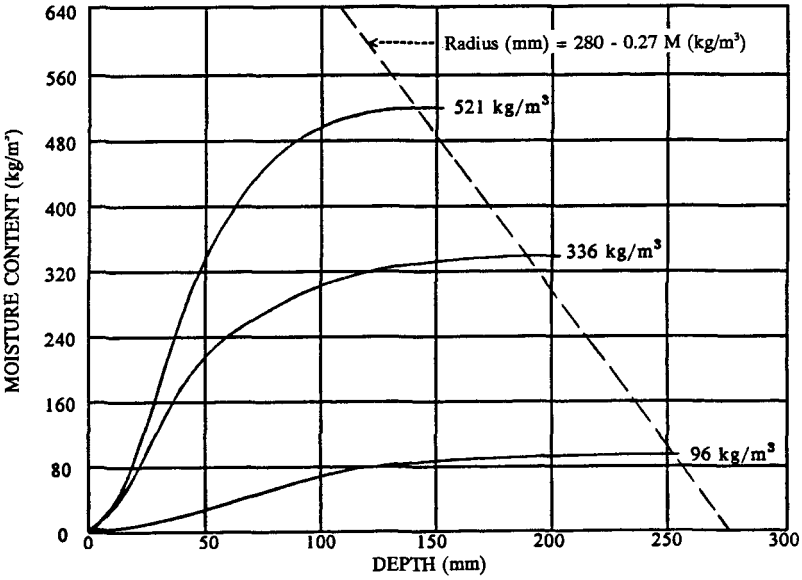


Figure A–2. Effect of Moisture on Radius of Measurement

The equation that relates the radius of measurement to the moisture content *[0-640 kg/m3 (0-40 pcf)]* is:

Radius (mm) = 280 – 0.27 M (kg/m3)
Radius (in) = 11 – 0.17 M (pcf)

where: *Radius* = radius of measurement
M = moisture content

Most soil type materials contain elements that will absorb neutrons or contain substances that are high in hydrogen (in other forms besides water). As a result of these materials, the Model 4300 requires calibration for accurate moisture measurements.

CALIBRATION THEORY

The 4300 is designed to obtain moisture data from many different soil type materials. As a result of the different properties of various materials, the probe must be calibrated for use in each material.

In some cases, the factory calibration supplied with each probe may be used to obtain accurate moisture readings. Soils with high chlorine, boron, or organic content affect the moisture measurement and may require an offset or new calibration for the gauge. Offsets are performed to correct discrepancies in probe readings due to variations in soil characteristics, moisture range, chemical content, etc. If the readings are slightly different from the actual moisture content, the factory calibration can be adjusted to increase the measurement accuracy with the offset function. If measuring to determine a relative change in moisture, an offset should provide sufficient accuracy.

New (field) calibrations provide the most accurate calibration for the probe in a given soil type and moisture range. Therefore, utilize this calibration method when the intent of measurement is to record the absolute moisture content. Also, high contents of chlorine, boron and organic materials in the soil may require a new calibration for the gauge. The field calibration process is similar to the calibration process performed at the factory, but is created using actual field data points entered into the control unit.

A typical calibration consists of multiple readings (at least two but more for greater accuracy) at varying moisture levels. Ideally, the moisture levels should cover the entire range of moisture likely to be encountered in the field. Samples can be obtained using core sampling techniques or laboratory preparation.

After preparing the samples, the gauge is used to take measurements (or counts) at the sample site, usually creating a partial calibration file to be completed after laboratory testing of the samples. Using gravimetric measurement procedures in the laboratory, dry the samples and calculate the actual moisture level.

Enter the laboratory moisture levels into the gauge to complete the calibration file. The gauge counts will be correlated to the actual moisture level by means of a calibration curve. The 4300 uses a straight line calibration curve to fit a set of *n* data pairs (X_i, Y_i),

where:

X_i is the moisture content of sample
Y_i is the count ratio of the gauge.

The mathematical form of the fit equation is:

$$Y = A_0 + A_1 (X).$$

The values of A_0 and A_1 are obtained by solving the following simultaneous equations:

$$A_0(n) + A_1 \sum_{i=1}^{n} Xi = \sum_{i=1}^{n} Yi$$

and

$$A_0 \sum_{i=1}^{n} X_i + A_1 \sum_{i=1}^{n} X_I^2 = \sum_{i=1}^{n} X_i Y_i$$

The degree of correlation of the straight line fit is given by the coefficient, *C*, where:

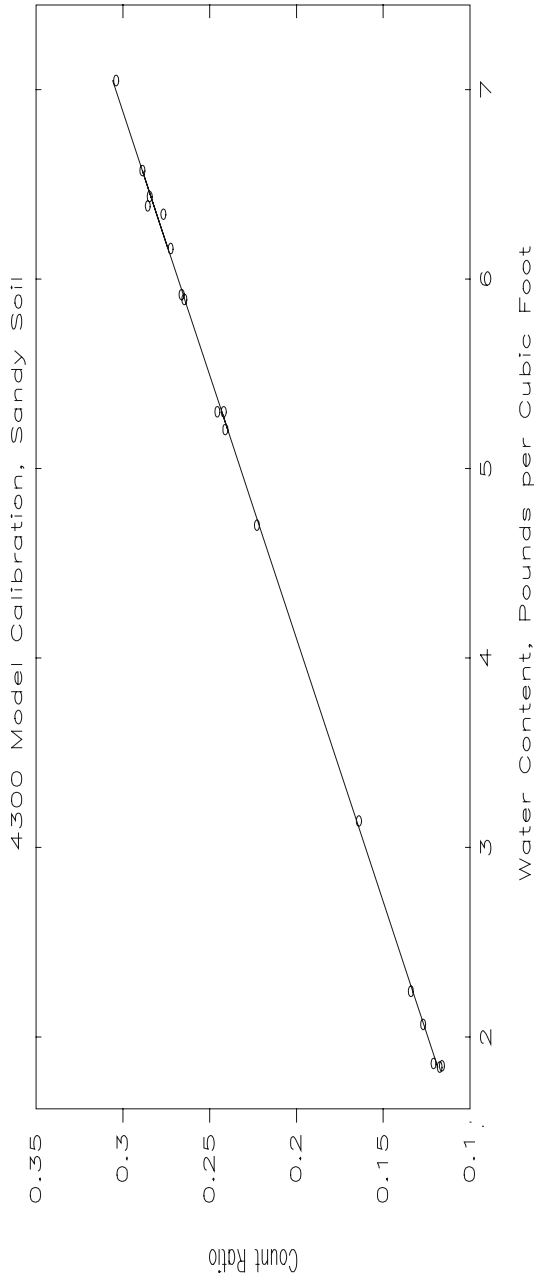
$$C = \sqrt{1 - \frac{\sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2}{\sum_{i=1}^{n} (Y_i - \overline{Y})^2}}$$

A result of $C = 1$ corresponds to a perfect fit, and values less than 1 indicate correspondingly poorer fits.

Y is the average of all Y values. $\hat{Y}_i$ is the curve-determined count ratio corresponding to moisture content X_i.

Figure A–3 on the next page shows a typical field calibration curve.

Figure A–3. Typical Field Calibration Curve



TROXLER

APPENDIX B

RADIATION THEORY AND SAFETY

This appendix is required reading for anyone who will operate the Model 4300 Depth Moisture Gauge. It covers radiation theory along with a brief explanation of radiation statistics and radiation terminology.

CONTENTS

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 radiation safety class.

ATOMIC STRUCTURE

All materials consist of chemical elements that cannot decompose by ordinary chemical methods. Some examples are:

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

Each element contains an atom (see Figure B–1) with a unique structure. The atom consists of protons, neutrons, and electrons. The protons and neutrons are grouped together in the nucleus. The electrons orbit the nucleus. An atom is normally electrically neutral because the positive charge of protons cancel out the negative charge of electrons.

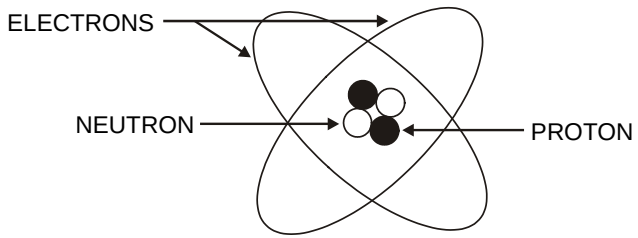


Figure B–1. Diagram of an Atom

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

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

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

RADIATION THEORY

Radioactivity is the spontaneous breakdown of unstable nuclei (radionuclides) with the resulting emission of radiation. The basic unit of radiation used in the U.S. is the curie (Ci) . The curie is defined as 3.7×10^{10} disintegrations of nuclei per second. In the "special form," encapsulated sealed source used in the 4300, the unit of measure is the microcurie (1/1,000,000 of a curie). The SI unit of radiation is the becquerel (Bq). The becquerel equals one disintegration per second. Therefore, one curie equals 3.7×10^{10} becquerel.

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 approximately 432 years.

RADIATION TERMINOLOGY

The rad or "radiation absorbed dose," is the unit of absorbed dose equal to 0.01 joules/kg in any medium. To account for the effect of various types of radiation on biological tissue, the roentgen equivalent man (rem) or more appropriate for Troxler users – the *millirem* – is used when measuring radiation dose. The unit rem is derived from multiplying the radiation absorbed dose (rad) by a quality factor (QF) . One rad is equal to the exposure of one rem of gamma radiation. For example, the average neutron energy of an Am-241:Be source is about 4.5 MeV. The quality factor (QF) for this radiation is about 10. Therefore, an absorbed dose of 1 rad of neutron radiation produces a dose equivalent (absorbed dose x QF) of 10 rem.

RADIATION STATISTICS

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

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

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

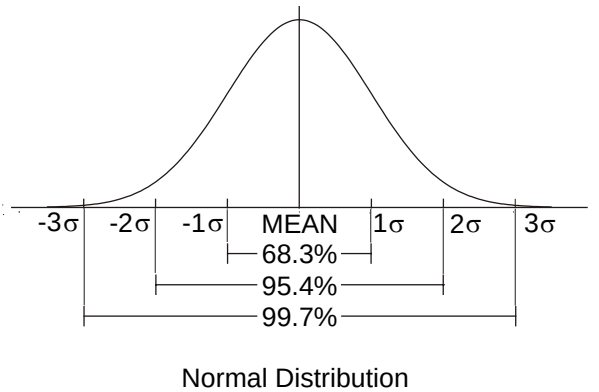


Figure B–2. Variation of Radioactive Emission

Using the average of a larger number of counts to approximate the true mean, the distribution shows that 68.3% of the time the count rate obtained will be within 1 standard deviation of the mean. The figure above shows the probability of counts falling within three standard deviations of the mean. The user may perform a statistical stability test (stat test) to compare the experimental standard deviation to the theoretical standard deviation (see page 5–2).

RADIATION SAFETY

This section provides a brief discussion of general radiation safety. The radiation exposure profile for the Model 4300 gauge is also included, along with a discussion of the source encapsulation.

TYPES OF RADIATION

The radioactive source in the Model 4300 produces four types of radiation:

Alpha Particles
Beta Particles
Gamma Rays (Photons)
Neutrons

The alpha and beta particles are stopped by the source capsule. Only the gamma and neutron radiation contribute to any occupational radiation exposure.

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

Neutron radiation allows measurement of the hydrogen (moisture) content in a material because the neutrons are slowed by collisions with materials containing hydrogen atoms (such as water, polyethylene, etc). Neutrons have no charge and are very penetrating.

LIMITING EXPOSURE

Government agencies set occupational exposure limits. The current limit in the United States and many other countries is 5,000 mrem per year. Under average conditions, a full time employee working with the 4300 will receive less than 200 mrem per year. By comparison, people in the U.S. receive an average of 360 mrem per year from natural background radiation and medical radiation.

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

Time
Distance
Shielding

These methods are a part of the "ALARA" (**A**s **L**ow **A**s **R**easonably **A**chievable) philosophy of radiation protection.

Time

The simplest way to reduce exposure is to keep the time spent around a radioactive source to a minimum. If time is cut in half, then exposure is cut in half, provided all other factors remain 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. Doubling the distance from a radiation source reduces the exposure to one-fourth its original value. If the distance is tripled, the exposure is reduced by a factor of nine, etc. (see Figure B–3).

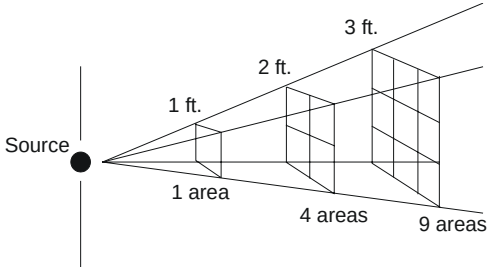


Figure B–3. Effect of Distance on Exposure

Shielding

Shielding is any material used to reduce the radiation reaching the user from a radioactive source. While some types of radiation such as alpha particles may be stopped by a single sheet of paper, other radiation such as gamma rays and neutrons require much more shielding. Dense materials, such as lead, shield gamma rays. Materials containing large amounts of hydrogen, such as polyethylene, shield neutrons. The Model 4300 has shielding built into the system to reduce the exposure.

MONITORING RADIATION

Anyone working with or near radioactive materials is subject to the limits on occupational exposure mentioned earlier and must complete a radiation safety training course to be designated an authorized user. To verify that occupational exposures do not exceed the regulated limits, authorized users may be monitored using personnel dosimeters. The most common types of dosimeters are TLD badges and film badges. Troxler recommends using TLD badges, since they can measure both gamma and neutron radiation. Film badges are not suitable for measuring neutrons.

In Canada, nuclear gauge users are not normally classified as *Atomic Radiation Workers*. In such cases, the general public dose limit of 0.5 rem/yr would apply. Users may not be required to wear a dosimeter. To establish the personnel monitoring requirements for your application, consult the conditions of your radioactive materials license and the CNSC regulatory document R91 “Monitoring and Dose Recording for the Individual.”

4300 RADIATION PROFILE

Table B–1 and Table B–2 show the radiation profiles for the Model 4301 and 4302 gauges, respectively. The tables list the radiation dose equivalent rates (in mrem/hour) for each side of the gauge and transport case shown in Figure B–4.

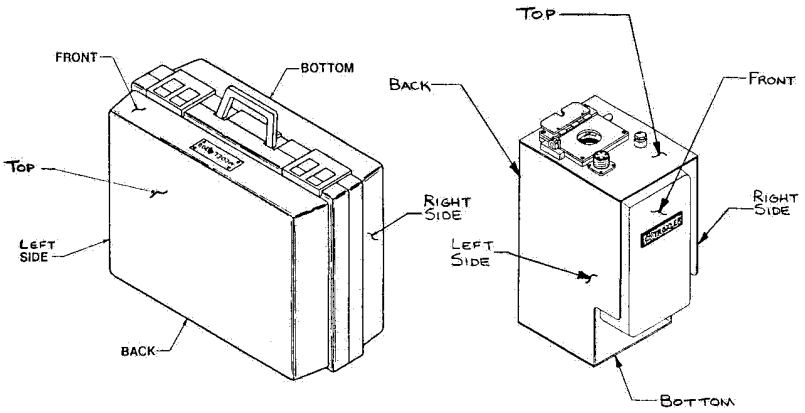


Figure B–4. Gauge and Transport Case

Table B–1. Model 4301 Radiation Profile

Gauge	Surface			30 cm			1 Meter		
	Gamma	Neutron	Total	Gamma	Neutron	Total	Gamma	Neutron	Total
Front	*	0.25	0.25	*	*	*	*	*	*
Back	*	0.60	0.60	*	0.20	0.20	*	*	*
Left Side	0.13	0.60	0.73	*	0.20	0.20	*	*	*
Right Side	*	0.40	0.40	*	*	*	*	*	*
Top	*	0.15	0.15	*	*	*	*	*	*
Bottom	0.30	0.45	0.75	*	0.25	0.25	*	*	*
Gauge w/ Transport Case									
Front	*	*	*	*	*	*	*	*	*
Back	*	0.30	0.30	*	*	*	*	*	*
Left Side	*	0.25	0.25	*	*	*	*	*	*
Right Side	*	0.30	0.30	*	0.15	0.15	*	*	*
Top	*	0.25	0.25	*	0.15	0.15	*	*	*
Bottom	*	0.30	0.30	*	0.15	0.15	*	*	*

Table B–2. Model 4302 Radiation Profile

Gauge	Surface			30 cm			1 Meter		
	Gamma	Neutron	Total	Gamma	Neutron	Total	Gamma	Neutron	Total
Front	*	0.40	0.40	*	0.20	0.20	*	*	*
Back	*	0.45	0.45	*	0.20	0.20	*	*	*
Left Side	0.11	0.55	0.66	*	0.20	0.20	*	*	*
Right Side	0.16	0.55	0.71	*	0.20	0.20	*	*	*
Top	*	0.25	0.25	*	*	*	*	*	*
Bottom	1.0	0.55	1.55	0.12	0.20	0.32	*	*	*
Gauge w/ Transport Case									
Front	*	0.20	0.20	*	*	*	*	*	*
Back	*	0.30	0.30	*	*	*	*	*	*
Left Side	*	*	*	*	*	*	*	*	*
Right Side	*	0.35	0.35	*	0.15	0.15	*	*	*
Top	*	0.30	0.30	*	*	*	*	*	*
Bottom	*	0.30	0.30	*	0.15	0.15	*	*	*

1. Values are in mrem/hr.
2. * Indicates a reading of less than 0.1 mrem/hr.
3. Gamma measurements made with a Ludlum Model 14C survey meter, calibrated May, 1988.
4. Neutron measurements made with a Nuclear Research Corp. Model NP-2 meter, calibrated March, 1988.
5. Dose rates measured by the State of North Carolina Department of Environment, Health and Natural Resources, Division of Radiation Protection.

SOURCE ENCAPSULATION

The source in the Model 4300 meets regulatory requirements of U.S. and international authorities as “SPECIAL FORM,” sealed source material.

The neutron source (americium-241:beryllium) is compressed and welded inside stainless steel capsules. The sources are encapsulated to prevent leakage of the radioactive material and to meet radiation safety requirements.

Proper use of this instrument (following the instructions in this manual) and the shielding design of the instrument will keep the exposure levels at a minimum under normal conditions. The user may, however, be required to wear personnel dosimetry when using the 4300.

EMERGENCY PROCEDURES

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

The gauge owner should complete the emergency contact information on the lines furnished below.

The company RSO is _____ .
Call the RSO at _____ .

The regulatory agency is _____ .
Call the agency at _____ .

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

✓ Locate the gauge and/or source.

✓ Do not touch or move the gauge.

✓ Immediately cordon off an area around the nuclear gauge and/or source. A radius of fifteen feet (5 m) will be sufficient. Do not leave the area unattended.

✓ Keep all unauthorized personnel from the nuclear gauge.

✓ If a vehicle is involved, it must be stopped until the extent of contamination, if any, can be established.

✓ The gauge user should perform a visual inspection of the nuclear gauge to determine if the source housing and/or shielding has been damaged.

✓ Use a survey meter to measure the dose rate at a distance of one meter (3 ft) from the gauge.

✓ Contact the company RSO (name and number given at the beginning of this section). Provide the RSO with the following:

- ♦ the date, time, and location of the accident,
- ♦ the gauge model and serial number,
- ♦ the nature of the accident,
- ♦ the location and condition of the gauge and/or source,
- ♦ the dose rate at one meter (3 ft) from the gauge.

✓ If you are unable to reach the RSO, then call your regulatory agency (name and number given at the beginning of this section).

✓ Follow the instructions of the RSO. The RSO 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.

✓ Before shipping a damaged gauge to Troxler, obtain a RGA (returned goods authorization) number from the Troxler RSO.

NOTES

APPENDIX C

CALIBRATIONS AND OFFSETS

This appendix provides information on calibrating the Model 4300 Depth Moisture Gauge. The user should refer to the following American Society of Testing and Materials (ASTM) standards for additional information:

D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

D4643 – Standard Test Method for Determination of Water Content of soil by the Microwave Oven Method.

CONTENTS

INTRODUCTION

The Model 4300 Depth Moisture Gauge is designed to obtain moisture data from many different soil type materials. As a result of the different properties of various materials, the probe must be calibrated for use in each material (see page A–4).

The procedure for determining the validity of the factory calibration or the need for either an offset or new calibration and an outline of the calibration procedure is as follows:

✓ Determine the desired location and depth of the moisture reading.

✓ Bore the hole for the access tube and obtain core samples. Follow the instructions in Appendix D.

✓ Determine the actual moisture content of the sample using laboratory methods.

✓ Take moisture readings using the Model 4300. Compare these readings to the laboratory results.

✓ If the readings differ slightly, “offset” the factory calibration. If the readings differ significantly, continue with a new calibration.

✓ To obtain a new calibration, take several more samples and probe readings at different moisture levels (the samples must cover the moisture range for the material).

✓ Load the new calibration data into the Model 4300.

EQUIPMENT NEEDED

In order to obtain precise calibrations, soil moisture samples must be consistently prepared. Use of the same methods each time a sample is analyzed will ensure the best possible calibration results.

RECOMMENDED EQUIPMENT

The following equipment will be needed during soil sample analysis and probe calibration:

- Balance or electronic scale capable of weighing up to 1000 grams, readable to 0.1 gram.
- Drying Oven, capable of heating to 350° F (177° C).
- Soil Core Sampling Device with a known volume.
- Air-tight container for sample storage.
- Additional soil removal tools.

SUGGESTED EQUIPMENT

The following equipment is not required, but will aid in sample preparation and analysis:

- Putty knives and assorted brushes for removing caked soil from sampling device.
- Calculator

ANALYZING CORE SAMPLES

Refer to Appendix D for detailed information on taking a core sample from a proposed measurement location.

The Model 4300's accuracy is dependent on the accuracy of the calibration for a particular soil and moisture range. To ensure that the calibration accurately represents the soil and moisture range, core samples must be obtained and analyzed. These core samples must cover the anticipated moisture range of the soil.

NOTE

This procedure assumes the Troxler Core Removal Tool (PN 105478) will be used to obtain soil samples. The Troxler tool, based on a design by the U.S. Department of Agriculture's Soil Conservation Service, removes a sample 2.50 inches long and 1.40 inches in diameter. The sample has a volume of 60 cm^3.

DETERMINING ACTUAL MOISTURE CONTENT

NOTE

Refer to the following ASTM standards for more information on determining actual moisture content:

D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

D4643 – Standard Test Method for Determination of Water Content of Soil by the Microwave Oven Method.

After taking a core sample, use the following procedure for analyzing the sample to determine the actual moisture content:

✓ Obtain the weight of the air-tight containers that will be used to hold the samples. Record the weight of each container.

✓ Insert putty knives into the slots on the core removal bit. This ensures that the core will contain the correct volume of soil. Clean the extra soil from the bit below the sample. Remove the lower putty knife and remove the sample.

✓ Place the sample into the air-tight container and transport to the lab or other facility.

✓ Weigh the container and the sample. Record the weight.

✓ Place the sample into a drying oven. Bake the sample at 105 C until no weight loss is observed (see *ASTM D-2216* or *D-4643*).

✓ After drying, weigh the sample. Record the weight. Dry the sample again and weigh. Compare the weights.

✓ Calculate the bulk dry density (Db).

$$Db = \frac{Mass\,of\ Dry\,Sample\,(g)}{Volume\,of\ Sample\,(cm^3)}$$

✓ Calculate the percent moisture by dry weight (*Pd*) using:

$$Pd = \frac{Wt.wet - Wt.dry}{Wt.dry - Wt.pan} \times 100$$

Where:

Wt.wet = weight of sample and container before drying
Wt.dry = weight of sample and container after drying
Wt.pan = weight of empty container

✓ Calculate the percent moisture by volume (*Pv*) using:

$$Pv = Pd \times Db$$

Where:

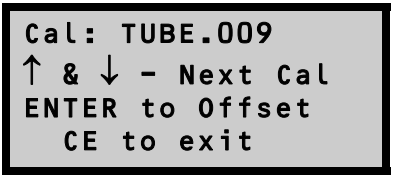
Pd = Percent moisture by dry weight
Db = Bulk density (g/cm3)

OFFSETTING A CALIBRATION

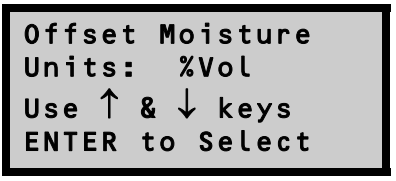
If the analysis of a soil sample indicates that the actual moisture is slightly different from the gauge reading, the current calibration can be adjusted to compensate for the difference. This adjustment is called an offset.

Press ⟨**CALIB./OFFSET**⟩.

Press ⟨**2**⟩.



Select a calibration to offset. Press ⟨**START/ENTER**⟩.



Select the units. Press ⟨**START/ENTER**⟩.

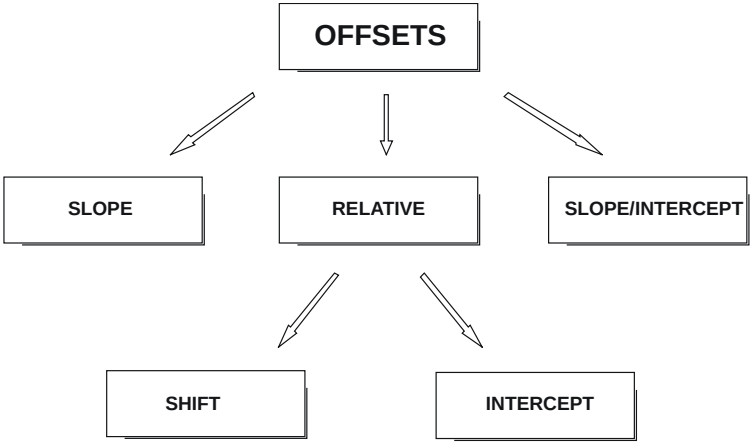


Figure C–1. Offset Options

The *Slope Offset* can be used when the actual moisture content (determined by laboratory methods) is higher than the gauge moisture measurement. This result may indicate that the soil contains neutron absorbers.

The *Relative Offset* can be used when the actual moisture content is lower than the gauge moisture measurement. This result may be an indication that hydrogen nuclei (bound hydrogen) are present in the soil in forms other than water. The relative offset can be performed using one of two methods: the curve can be shifted if the actual moisture difference is a constant percentage or weight by volume or the curve intercept can be changed if the actual moisture is different at one moisture level.

The *Slope/Intercept Offset* is basically a two-point calibration. This offset uses two samples from the same location at different moisture levels.

SLOPE OFFSET

After obtaining a core sample and determining the actual soil moisture, take a gauge reading and record the counts.

At the last display on page C–6, press ⟨**1**⟩.

Input the sample moisture previously determined using laboratory methods. Press ⟨**START/ENTER**⟩.

Input the counts from the gauge reading. Press ⟨**START/ENTER**⟩.

The gauge will request if the current standard count is to be used. If not, take a new standard count. The offset coefficients will be displayed. Review the data if desired and save the offset.

RELATIVE OFFSET

Take a core sample and determine the actual soil moisture. Take a gauge reading and record the counts.

At the last display on page C–6, press ⟨**2**⟩.

```
 Method to input
 Relative Offset:
1- Shift
2- Int
```

Relative Offset - Shift

To perform a *Relative/Shift Offset*, press ⟨**1**⟩.

```
 Input amount to
   shift Calib
    _____ %Vol
  (Press ENTER)
```

Input the amount to shift the calibration curve and press ⟨**START/ENTER**⟩.

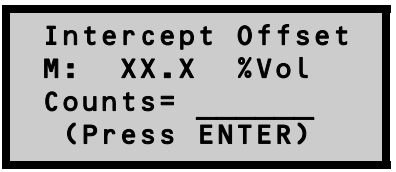
```
 Relative Offset
A0=  X.XXXXXX
A1=  X.XXXXXX
  (Press ENTER)
```

The offset coefficients will be displayed. Review the data if desired and save the offset.

Relative Offset – Intercept

To perform a *Relative/Intercept Offset,* press ⟨**2**⟩ at the display on the top of page C–9.

Input the core sample moisture. Press ⟨**START/ENTER**⟩.



Input the counts from the gauge reading. Press ⟨**START/ENTER**⟩.

The control unit allows the standard count to be updated (press ⟨**2**⟩). To use the current standard count press ⟨**1**⟩.

The control unit displays the offset calibration constants (*A0* and *A1*). After viewing the new constants, press ⟨**START/ENTER**⟩.

The gauge then allows the user to review the offset input data To review, press ⟨**ON/YES**⟩ at the inquiry screen. Otherwise, press ⟨**CE/NO**⟩.

The gauge then allows the user to store the offset. To store the offset, press ⟨**ON/YES**⟩ at the prompt.

The control unit requests the offset name. Enter the name and press ⟨**START/ENTER**⟩.

The control unit indicates the storage and allows the user to activate the offset. To activate the offset, press ⟨**ON/YES**⟩ at the prompt.

The gauge indicates the activation and returns to the *Ready* mode.

SLOPE/INTERCEPT OFFSET

The *Slope/Intercept Offset* requires two core samples and two measurements. The moisture values should have a minimum of 15% moisture difference.

To perform a *Slope/Intercept Offset*, press ⟨**3**⟩ at the last display on page C–6.

Input the Low Moisture sample value. Press ⟨**START/ENTER**⟩.

Input the counts from the gauge reading. Press ⟨**START/ENTER**⟩.

The gauge will request if the current standard count is to be used. If not, take a new standard count by pressing ⟨**2**⟩.

Input the High Moisture sample value. Press ⟨**START/ENTER**⟩.

Input the counts from the gauge reading. Press ⟨**START/ENTER**⟩.

Press ⟨**1**⟩ to use the current standard count. If not, take a new Standard Count.

The offset coefficients will be displayed. Note that a slope/intercept offset is the same as a new two-point calibration if the calibration is linear. Review the offset data and store the offset.

PERFORMING CALIBRATIONS

NOTE

This section must be read and fully understood by any user who is attempting to perform a calibration procedure. If further questions arise that are not covered in this section, contact your Troxler Representative or the Troxler Moisture Product Specialist at the factory.

All soils and soil-like materials have different chemical compositions. Some soils contain neutron absorbers that will result in lower moisture gauge readings than indicated by samples. Other soils contain hydrogen-bearing materials that result in higher moisture readings. Since the 4300 measures moisture by measuring the amount of hydrogen present in the material, the gauge must be adjusted to compensate for the differing chemical compositions.

The gauge is shipped with a factory calibration that is based on varying moisture levels in sand. This calibration may not accurately reflect the type of material where the gauge is to be used. As a result, the 4300 is equipped with a custom calibration procedure.

To correctly measure moisture in soils, calibration factors must be entered into the gauge. The first value represents the actual moisture determined by analyzing a core sample taken at the access tube location. After the sample is obtained, the access tube is installed and a gauge reading is taken at the same location and depth. Both values are stored by the gauge and a calibration curve is calculated. Multiple samples and readings will be required, preferably at varying moisture levels. It should be noted that the accuracy of the gauge will usually improve as the number of samples increase over a wide range of moisture.

Additional information on the principles of operation of the Model 4300 can be found in Appendix A.

The Model 4300 offers several methods of performing, reviewing and activating calibrations.

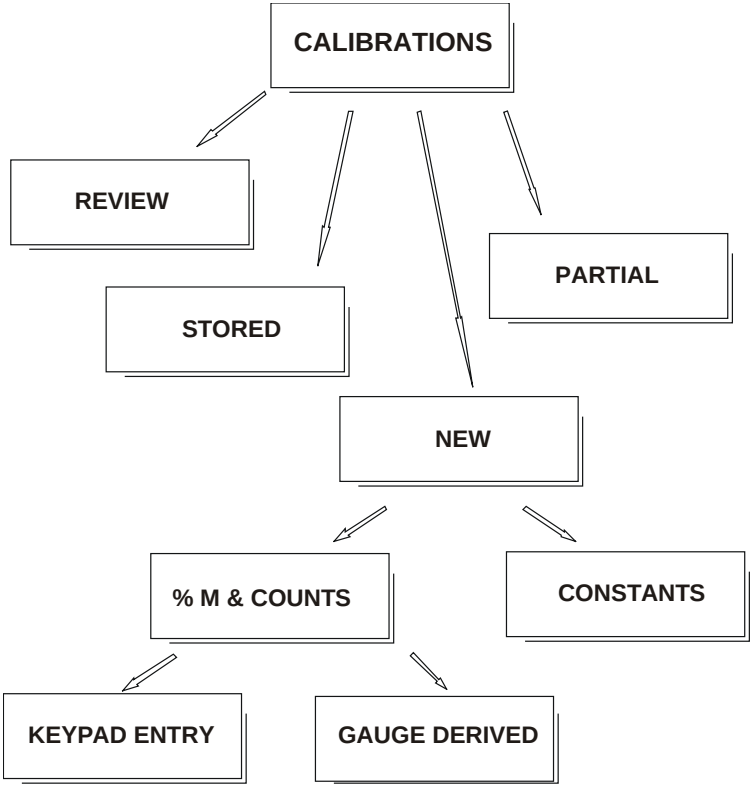


Figure C–2. Calibration Options

Stored calibrations can be *REVIEWED* on the screen or printed as described on page C–19.

STORED calibrations can be recalled and activated as described on page C–20.

PARTIAL calibrations can be recalled and completed as described on page C–21.

NEW calibrations can performed using several methods:

- *Calibration constants* can be entered directly into the gauge to develop a new calibration.
- Actual *moisture values* and *gauge counts* can be used to generate a new calibration.

NEW CALIBRATION

NOTE

The following calibration procedure will result in a linear (or straight-line) calibration curve. If a quadratic calibration curve is desired, enable the *Quadratic* function. See page 5–12 for more information.

To perform a new calibration, press ⟨**CALIB./OFFSET**⟩.

```
Select Function:
1- Calibration
2- Offset
3- Erase
```

Press ⟨**1**⟩.

```
1- Review Calib.
2- Stored Calib.
3- New Calib.
4- Partial Calib
```

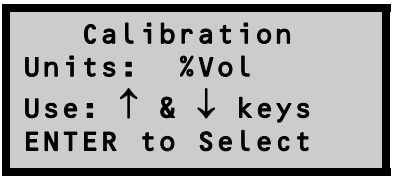
Press ⟨**3**⟩ for a new calibration.

```
Select data to
be entered:
1- Constants
2- M & Counts
```

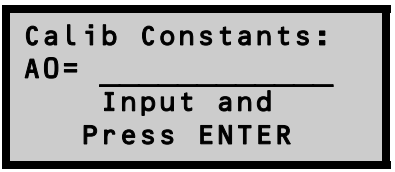
Manually Entering Calibration Constants

If a calibration has been performed by taking samples and gauge readings and manually calculating the constants, the following method will allow the constants to be entered into the gauge. Also, use this method to re-enter constants from the factory calibration sheet.

At the display on the bottom of the previous page, press ⟨**1**⟩.



Select the correct unit of measurement. Press ⟨**START/ENTER**⟩.



Constants A_0 and A_1 represent the coefficients obtained when a linear expression is fit to the data points.

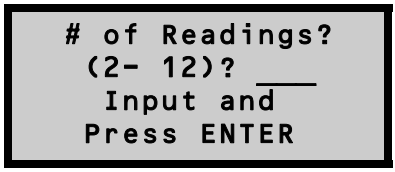
If a quadratic expression has been fit to the data points, the constants can be entered using the quadratic mode under the *Special* functions. Activate the calibration if needed.

Input the constants (A_0 and A_1) and assign a name to the new calibration.

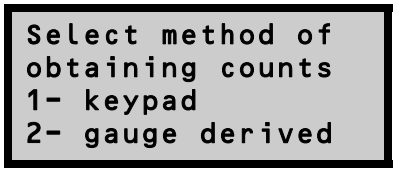
Gauge-Generated Calibrations

The 4300 will automatically calculate a new straight-line calibration curve based on the actual moisture obtained from core samples and the gauge readings taken at the core location. If a quadratic curve is desired refer to the *Quadratic* mode under *Special* functions.

At the display on the bottom of page C–15 press ⟨**2**⟩.



Input the number of core samples (or readings) that will be used to determine the calibration. Press ⟨**START/ENTER**⟩. The more readings, the better the accuracy of the calibration.



Two methods may be used to enter the gauge readings: manual entry of the actual moisture and gauge counts (press ⟨**1**⟩) or the gauge can record the counts by taking actual readings (⟨**2**⟩).

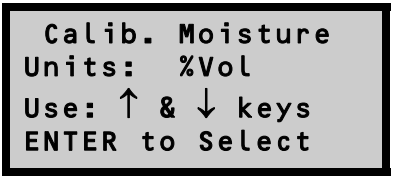
If the actual sample moisture has been determined press ⟨**ON/YES**⟩.

NOTE

If the results are not available, create a partial file by pressing ⟨CE/NO⟩. The operator will be able to enter the actual moisture data at a later time.

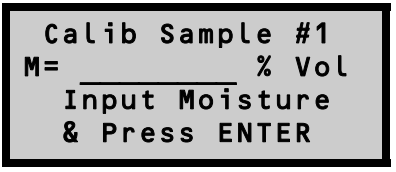
For more information on gauge-derived counts, see the *Gauge-Derived* section on page C–18.

KEYPAD. If the operator chose to enter gauge readings via the keypad, the gauge displays:

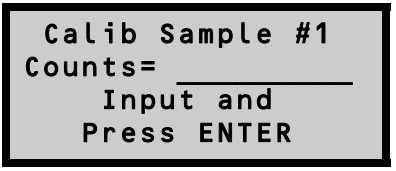


Select the correct *Units of Moisture* and press ⟨**START/ENTER**⟩.

If the operator chose to create a partial file (no moisture now), ignore the following screen.



With the numeric keys, enter the *actual sample moisture* obtained by laboratory methods. Press ⟨**START/ENTER**⟩ when complete.



Enter the counts obtained by the gauge. Press ⟨**START/ENTER**⟩ when complete.

Continue to enter the "moisture" and "counts" values for each sample. Input an identifying name for the calibration.

GAUGE-DERIVED. The control unit prompts the operator to position the probe at the proper access tube depth. After positioning, start readings by pressing ⟨**START/ENTER**⟩.

The control unit indicates the count progress in seconds. Upon count completion, the control unit displays the count.

For each additional calibration measurement, press ⟨**START/ENTER**⟩. The control unit displays the current standard count.

To accept this count, press ⟨**1**⟩.

To take a new standard count, press ⟨**2**⟩. Lock the probe in the retracted standard count position and press ⟨**START/ENTER**⟩. The control unit will indicate the progress of the standard count, then displays the new count. To continue with the calibration process, press ⟨**START/ENTER**⟩.

Position the probe at the next access tube depth and press ⟨**START/ENTER**⟩.

Repeat the above procedure for each additional calibration measurement depth.

The control unit requests the calibration file name. With the now active alphabetic keys, enter the file name (up to 8 characters). Press ⟨**START/ENTER**⟩.

The control unit stores the calibration file and returns to the *Ready* mode.

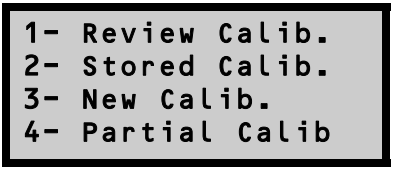
REVIEWING A CALIBRATION

Calibrations that have been stored in the gauge may be recalled and viewed later.

Press ⟨**CALIB./OFFSET**⟩.

```
Select Function:
1- Calibration
2- Offset
3- Erase
```

Select calibration by pressing ⟨**1**⟩.



Press ⟨**1**⟩ to review a calibration.

Use the up and down keys to select the calibration to review. Press ⟨**START/ENTER**⟩.

The units of measurement and calibration constants will be displayed on the screen.

ENABLING A STORED CALIBRATION

Calibrations that have been stored can be recalled and enabled at any time.

NOTE

If the *Program* function is used, calibrations can be automatically recalled and enabled (see page 4–8).

Press ⟨**CALIB./OFFSET**⟩.

Select calibration by pressing ⟨**1**⟩.

```
1- Review Calib.
2- Stored Calib.
3- New Calib.
4- Partial Calib
```

Press ⟨**2**⟩ to recall a stored calibration.

```
   Cal: FACTORY
 Use ↑ & ↓ Keys
  Press ENTER
  to Activate
```

Use the up and down keys to select the calibration to activate. Press ⟨**START/ENTER**⟩.

COMPLETING A PARTIAL CALIBRATION

Calibrations that were started, but were not completed (as a result of waiting for laboratory results), can have the remaining data entered at a later time.

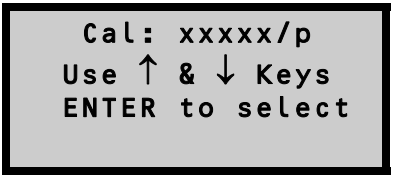
Press ⟨**CALIB./OFFSET**⟩.

```
Select Function:
1- Calibration
2- Offset
3- Erase
```

Select calibration by pressing ⟨**1**⟩.

```
1- Review Calib.
2- Stored Calib.
3- New Calib.
4- Partial Calib
```

Press ⟨**4**⟩ to complete the partial calibration.



Use the up and down keys to select the calibration to complete. Press ⟨**START/ENTER**⟩. Select the units and input the laboratory-obtained moisture values for each count.

ENTERING CALIBRATIONS

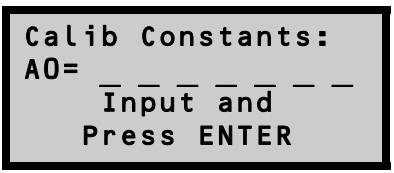
FACTORY CALIBRATIONS

NOTE
This function is for technical service personnel only!

To re-enter factory calibration constants, press ⟨**SPECIAL**⟩. The user may scroll through the menu options, pressing ⟨**2nd FUNCT.**⟩ and ⟨**G**⟩ to select.

Press ⟨**1**⟩.

Enter the numeric *access code* from the front of the manual and press ⟨**START/ENTER**⟩.



The control unit assumes factory calibration units of *%Vol*. When prompted by the control unit, input each calibration constant and press ⟨**START/ENTER**⟩. The control unit stores the factory calibration and returns to the *Ready* mode.

CALIBRATION TRANSFER

In some applications, it may be desirable to use two or more 4300 gauges to measure moisture in the same material. This is not unusual where different gauges are assigned to individuals who may be responsible for monitoring moisture levels for a given project. Also, in the event that one gauge malfunctions, another gauge can be used without performing a new calibration on the new gauge.

When more than one gauge is used to determine the moisture of a particular soil type, each gauge must be calibrated for that soil. This process may involve preparing calibration samples and manually calibrating each individual gauge. Performing individual gauge calibrations is labor intensive, time consuming, and may involve transporting the gauges between sites. Additionally, the gauges will be out of use during the time required for calibration.

Calibration Transfer overcomes calibration problems associated with using multiple gauges for one particular soil type. This procedure allows the transfer of a central "Master" or "Donor" gauge calibration to a "Field" or "Recipient" gauge, without the need for an additional gauge calibration. Calibration transfer reduces gauge downtime, reduces labor and helps ensure more precise and uniform moisture measurements among all gauges.

The first step of the calibration transfer process is to input the "Master" gauge factory calibration constants into "Field" gauge. After entering the factory calibration constants, enter the constants from the "Master" gauge calibration that is to be transferred.

By determining the correlation between the two factory calibrations ("Field" and "Master"), the "Field" gauge will develop a transfer calibration from the "Master" gauge calibration.

On the "Master" Gauge…

Press ⟨**CALIB./OFFSET**⟩. Press ⟨**1**⟩ to select calibration.

```
1- Review Calib.
2- Stored Calib.
3- New Calib.
4- Partial Calib
```

Press ⟨**1**⟩ to review a calibration.

```
Cal:  FACTORY
↑ & ↓ - Next cal
ENTER to Review
  CE to exit
```

Use the up and down keys to scroll through the factory calibration names. To select press ⟨**START/ENTER**⟩. Record the calibration constants.

Repeat the above steps for each calibration that is to be transferred, recording the *units* and the *constants*.

On the "Field" Gauge…

Press ⟨**SPECIAL**⟩. Press the up arrow key once. Press ⟨**2nd FUNCT.**⟩ and ⟨**G**⟩ for the *Enter Calib* function.

Press ⟨**2**⟩. Input the factory calibration constants from the "Master" gauge.

The control unit displays the transfer calibration units, choose the units that correspond to the calibration file for transfer. Enter the previously recorded transfer calibration constants as prompted.

Enter the transfer calibration name. The control unit stores the transfer calibration and inquires about activation.

To activate the transfer calibration, press ⟨**ON/YES**⟩. Measurements can be performed with this calibration “Field” gauge.

Otherwise, press ⟨**CE/NO**⟩.

The control unit returns to the *Ready* mode.

APPENDIX D

INSTALLING ACCESS TUBES

This appendix provides instructions for installing access tubes in soil type materials. A brief explanation on determining tube length, hole depth, as well as illustrations showing the correct assembly and installation procedure, are included.

CONTENTS

TUBE DIAMETERS AND LENGTHS

Before taking moisture readings with the Model 4300 Depth Moisture Gauge, install an access tube at each site

Ideally, tubing diameters should conform to the tube sizes listed below. Purchasing low quality tubing or tubing that has been roughly handled is not a good practice. The wall thickness of poorly manufactured tubing differs greatly, and roughly handled tubing can have dents and bends that will interfere with the gauge probe.

MODEL	Inside Diameter	Outside Diameter
4301 (1.50")	1.55" (39.4 mm)	1.63" (41.4 mm)
4302 (1.85")	1.90" (48.3 mm)	2.00" (50.8 mm)

The recommended tube material is aluminum. Other materials can be used in special situations but are not generally recommended. If access tubes are to be installed into highly corrosive soils (high alkaline or sodium), stainless steel, PVC, or polyethylene tubing can be substituted.

Using stainless steel, PVC, or polyethylene tubing will alter gauge readings. The high iron content of stainless steel absorbs neutrons and results in lower gauge precision. PVC tubing decreases the gauge readings by at least fifteen percent. The high hydrogen content of polyethylene results in high moisture readings. The gauge must be recalibrated for use with these tubings.

EVALUATING ALTERNATIVE TUBE MATERIALS

If alternative tube materials are to be used, the following procedure will provide a good indication of the loss in the number of counts associated with using materials other than aluminum.

- ✓ Seal the bottom of the access tube.
- ✓ Place the tube in a 55-gallon barrel of water and secure it in the middle of the barrel.
- ✓ Place the gauge on the access tube and lower the probe to the middle of the barrel.
- ✓ Take several readings with the gauge and obtain the average of the counts.
- ✓ Compare the average to Count #5 on the factory calibration sheet supplied with the gauge. The percent (%) difference in counts should reflect the expected change in counts as compared to aluminum access tubing.

AVAILABLE TUBE LENGTHS

Aluminum access tubing is available in 10-foot lengths and can be cut to any desired length. Use caution when cutting tubing to ensure that the wall is not deformed. Remove any sharp edges or burrs.

ACCESS TUBE INSTALLATION

Access tubes must be kept dry! Any water in the access tube will result in inaccurate moisture readings. See the following section for sealing the bottom of the access tube.

NOTE

All access tubes should be tested using a *dummy probe*. Pass the dummy probe through the tube to ensure that the neutron probe will pass freely through the tube.

The top of all access tubes should be the same distance from the top of the soil. This includes the tubes used for taking standard counts. It should be at least 24 inches (61 cm) above the surface of the soil. The U.S. Soil Conservation Service recommends 36 inches (91 cm).

To determine the height above the soil surface, follow the below listed steps. For the purposes of this example, 36 inches will be used.

- ✓ Determine the depths where moisture measurements are required.

- ✓ Add 6 inches to the lowest depth to determine the amount of access tube that will be below the surface.

- ✓ Add 36 inches to the above number to determine the length of the access tube. Cut the tube to the proper length.

After determining the access tube depth, use an auger to bore the initial hole. The hole diameter should match the outside diameter of the tube. Ideally, the hole should be slightly smaller to ensure a good fit between the tube and the soil. Air gaps along the wall of the tube should be avoided if possible. Allowing the soil to settle around the tube will reduce the amount of air gaps around the tube and result in more accurate measurements.

SEALING THE ACCESS TUBE

Refer to Figure D–1 for assembling the tube seal. After assembling all the parts, turn the nut on the bottom of the assembly finger tight. Use a wrench and turn the nut one more turn. Insert the seal assembly into the bottom of the tube and turn the nut eight additional turns until the rubber stopper completely seals the tube.

Do not weld the tube closed! Do not thread the tube or attempt to use a pipe plug.

After installing the lower seal, the top of the tube should be sealed with a tapered rubber stopper or other device that will prevent water and debris from entering the tube.

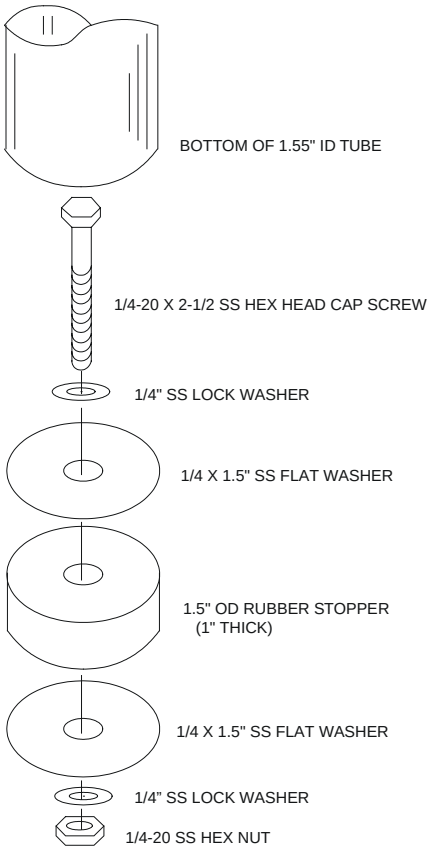


Figure D–1. Assembling the Tube Seal

TAKING A CORE SAMPLE

After installing the tube, a core sample should be taken from the general vicinity of the tube. It is very important that the sample be taken at the same depth where measurements are required.

The core sample is used to determine the soil type, moisture content and whether the factory calibration will be adequate. The sample can be obtained using a core removal tool (supplied as an option), which removes a sample 2.50 inches long and 1.40 inches in diameter. This sample has a volume of 63.1 cm^3.

NOTE

The core removal tool is based on a design by the U.S. Department of Agriculture's Soil Conservation Service.

Use the auger to bore the hole to the measurement depth. Use caution when boring the hole so that it does not become too deep. Periodically remove the auger and clean the loose dirt that has built up around the end of the tool. Clear the loose dirt away from the hole.

After boring the hole, insert the core removal tool. Before inserting the tool, clean the "bit"' of any debris. The "bit"' may be lubricated with any "oil-free" spray lubricant. This will ensure that the sample is easily removed.

Place the core removal tool into the hole. Using a large hammer or mallet, strike the top of the core removal tool to drive it into the soil. Rotate the tool during this operation to "cut"' the core. If a Troxler core removal tool is used, drive the bit into the soil approximately 4.00 inches.

Remove the tool with a rotating motion. The core sample will break loose from the underlying material.

Refer to Appendix C for detailed procedures on determining the actual moisture content of the material. Probe calibrations are also discussed in Appendix C.

APPENDIX E

TROUBLESHOOTING AND SERVICE

This appendix contains important information for troubleshooting and servicing the Model 4300 Depth Moisture Gauge. The following procedures should be performed to keep the 4300 in good working order. In the event that a serious problem with the gauge arises, contact your nearest Troxler Service Center or representative for instructions.

CONTENTS

TROUBLESHOOTING

GAUGE TURNS ITSELF OFF AFTER BEING TURNED ON (or will not turn on)

- ✓ Gauge may be wet – do not turn on until moisture is removed from the gauge interior. Use a hair dryer on low heat to dry gauge interior.
- ✓ Probe or the probe cable may be damaged. Disconnect cable at shield and try again.
- ✓ Control unit cable may be damaged. Disconnect cable from control unit and try again.
- ✓ Fuse may be blown. Check fuse on top plate of gauge.
- ✓ Battery in probe unit has insufficient charge. Charge gauge for 16 hours and try again.

GAUGE FAILS STANDARD COUNTS

- ✓ Gauge must be on access tubing to take standard count.
- ✓ Check for 3-meter clearance around gauge.
- ✓ Ensure that other radioactive sources are at least 100 feet from gauge.
- ✓ Check that probe is locked in **SAFE** position.
- ✓ Take five consecutive standard counts. Accept each count. The last count should “pass.” If not, contact Troxler Service.

GAUGE COUNTS ARE SATISFACTORY, BUT MEASUREMENTS ARE IN ERROR

✓ Check for correct standard count in gauge memory. Ensure appropriate calibration is enabled.

✓ Re-check calibration procedures (see page C–2).

✓ Perform a STAT test (statistical stability test). If test passes, proceed with the job. If test fails, record the Stat test averages and ratios, and repeat stat test. If stat test fails two out of three times, contact Troxler Service.

GAUGE WILL NOT COMMUNICATE WITH PRINTER

✓ Check the cable for continuity. Check baud rates. Check cable pin-out (see page F–4).

✓ Ensure that the proper cable is being used:
Gauge-to-Printer Cable, PN 105084
Gauge-to-Computer Cable, PN 105085

✓ Make sure all other parameters match:
– Data bits = 8, Start bits = 1
– Stop bits = 2, Parity = none
– Protocol = DSR/DTR

Make sure printer is a serial (RS-232) printer.

GAUGE COUNTS ARE ERRATIC

✓ Perform a STAT test (statistical stability test). If test passes, proceed with the job. If test fails, record the stat test averages and ratios, and repeat stat test. If stat test fails two out of three times contact Troxler Service.

BATTERIES DO NOT HOLD CHARGE

✓ Refer to the battery charging procedure on page E–6.

✓ Check charger output voltage.

✓ If charger output voltage is correct, but batteries do not hold charge after a 16-hour recharge, replace the batteries.

CONTROL UNIT WILL NOT OPERATE WHEN DISCONNECTED FROM THE SHIELD UNIT

✓ Replace battery in the control unit.

CANNOT STORE PROJECT or OTHER NON-SPECIFIC SOFTWARE MALFUNCTION

✓ Memory may be full, erase unused project data. Refer to page 3–8.

✓ Call Troxler Service if above erasure does not solve problem.

TROXLER SERVICE CENTERS

Troxler Corporate Headquarters
3008 Cornwallis Road
P.O. Box 12057
Research Triangle Park, NC 27709
Phone: 1.877.TROXLER (1.877.876.9537)
Outside the U.S.A.: +1.919.549.8661
Fax: +1.919.549.0761
Web: www.troxlerlabs.com

Technical Support
Phone: 1.877.TROXLER (1.877.876.9537)
E-mail: TroxTechSupport@troxlerlabs.com

Midwestern Branch Office
1430 Brook Drive
Downers Grove, IL 60515
Fax: 630.261.9341

Florida Service Center
2376 Forsyth Road
Orlando, FL 32807
Fax: 407.681.3188

Western Regional Branch Office
11300 Sanders Drive, Suite 7
Rancho Cordova, CA 95742
Fax: 916.631.0541

Southwestern Branch Office
2016 East Randol Mill Road
Suite 406
Arlington, TX 76011
Fax: 817.275.8562

Troxler European Subsidiary
Troxler Electronics GmbH
Gilchinger Strasse 33
D.82239 Alling nr.
Munich, Germany
Phone: ++49.8141.71063
Fax: ++49.8141.80731
E-mail: troxler@t-online.de

NOTE

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

BATTERY CHARGING

The Model 4300 Depth Moisture Gauge contains two battery systems. A rechargeable battery system is located in the shield unit of the gauge and a 9.0-volt dc alkaline battery is located in the control unit.

NOTE

When the control unit is connected to the shield, both the shield and the control unit operate using the shield's rechargeable batteries. If the control unit is disconnected from the shield, power is supplied by the alkaline battery.

A **BATTERY LOW** message will appear if the battery voltage drops below 7.00 volts. If the control unit is connected to the shield, the message refers to the rechargeable batteries in the shield. If the message appears when the control unit is disconnected, the alkaline battery is low and should be replaced.

Check the battery voltage by pressing the ⟨**STATUS**⟩ key. Press the down arrow key until the following display is visible:

```
Cont.Bat: xx.xx v
Shld.Bat: xx.xx v
Auto-Store: xxx
 (Use ↑ & ↓ keys)
```

If the **BATTERY LOW** message appears, a few hours remain before the gauge will turn itself off. The gauge will turn itself off when the voltage drops below 6.0 volts. Connect the charger and recharge the shield batteries for 14-16 hours. If the control unit battery is low, replace with a new battery.

In an emergency, alkaline batteries can be used in the shield. These batteries should not be recharged.

CAUTION

Do not mix alkaline and rechargeable batteries! Charging alkaline batteries may cause the batteries to explode!

REPLACEMENT PARTS

PART NO.	DESCRIPTION
104866	Front Panel Assembly
104663	Troxler Nameplate
104819	Scaler Cover
104848	Hinge
104868	Cover Pad
104867	Scaler Pad
104853	Scaler Case Weldment
104860	Scaler Case
104852	Pin Holder
104851	Pin Slide
104854	Shaft Holder
104857	Lower/Middle Shaft
104862	Plug Holder
104818	Front Panel
104856	Slider Shaft
104855	Link C
104842	4300 Nameplate
104817	Control Unit Case Machined
104826	Battery Cushion
102662	Scaler Label (3401-3411)
104864.xxxx*	Assembly, 4301 Base
103460	Cover Hinge
104769	Lever
104780.xxxx	Catch Plate X.X
104812	Handle
106922.1500	Cabinet Top X.X
104847	Lock Hasp
104785.xxxx	Top Plate X.X
104850	Cable Hook
104849	Cable Hook Plate
104797.xxxx	Base Column X.X
104861.xxxx	Lead Wrap X.X
104846.xxxx	Poly Standard X.X
103111	Pipe Seat Ring 3221 (1.5")
103136	Pipe Seat Ring 3220 (2.0")
104786.xxxx	Bottom Plate X.X
106921	Base Cabinet

NOTE: XXXX = 1500 for 1.5-in. probe & XXXX = 2000 for 2.0-in. probe.

PART NO.	DESCRIPTION
104864.xxxx	Assembly, 4301 Base (continued)
103185	Handle Stop 3220 Series
104793	Baseboard Cover Box
104830.xxxx	4300 X.X" Probe Assembly
104825	Probe Frame
103852	He3 Tube with dimple, 3/4"
103853	Point Source Holder Ring
104828	Modified Cable Clamp
104791.xxxx	Probe Cap X.X
104792	Probe Housing X.X
106919	Battery Plate Assembly
106916	Battery Plate Gasket
106917	Battery Plate
104874	Cable Clamp Package 4300
104839	4300 Shipping Case with Foam
104873	4300 Instruction Manual

ELECTRICAL

105671	4300 Base I/O VD (Board) Assy
105668	4300 Base BD Assembly
106920	NiCad Battery Pack, 3 C-Cell
104831	Control Unit Assembly
104708	4300 CPU Board Assembly
104711	4300 Control Unit I/O B Assy
104800	4300 Window Overlay
104707.2000	4300 Overlay
104934	4300 Control Cable
104830.xxxx	4300 Probe X.X" Probe Assembly
104781	Probe Board Assy 4300
104824	HV Transformer
104832	Probe Cable Assembly
103584	Connect Body
104828	Modified Cable Clamp
104410	AC Charger 12 VDC 500 MA (Domestic)
104155	AC Charger 13.6 VDC 500 MA (International)
104156	DC Charger

ACCESSORIES

PART NO.	DESCRIPTION
105397.0008	4300-8 Cbl Ext Option
105397.0018	4300-18 Cbl Ext Option
105397.0028	4300-28 Cbl Ext Option
105397.0038	4300-38 Cbl Ext Option
105397.0048	4300-48 Cbl Ext Option
105397.0058	4300-58 Cbl Ext Option
105397.0068	4300-68 Cbl Ext Option
105397.0078	4300-78 Cbl Ext Option
105397.0088	4300-88 Cbl Ext Option
105397.0100	4300-100 Cbl Ext Option
107057.0008	Cable Ext, w/ Repeater 4300
107057.0050	Cable Ext, w/ Repeater 4300, 50’
107057.0100	Cable Ext, w/ Repeater 4300, 100’
107057.0200	Cable Ext, w/ Repeater 4300, 200’
061432.1000	1.5" Dummy Probe Assembly
061433.1000	1.9" Dummy Probe Assembly
101920	2.0" Al(uminum) Tube 2.00 D x .05 WAL x 10’ 4/Box
101922	Tube, Access 1.5IDx10FT 4/Box (1.5" Aluminum Tube)
021140	Radiation sign kit
102868	Leak test kit w/ 4 Packets
102876.0005	Leak test packet (4)
102873	1 oz solution
104340	Printer
105084	4300 Gauge Printer RS232 Cable
105085	4300 Gauge/Computer Cable Assy
109661	Survey meter

RETURNING A GAUGE FOR SERVICE

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

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

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

NOTE

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

NOTE

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

LEAK TESTING

Unless specified otherwise by your radioactive material license, the 4300 gauge must be leak tested at intervals not exceeding twelve months to verify the integrity of the radioactive sources contained in the gauge.

Using the Troxler Model 3880 Leak Test Kit and accompanying instructions perform the following procedure:

- ✓ Write the Date, Gauge Model # and Serial # on the wipe disk.
- ✓ Turn the gauge on one side and locate the round hole where the probe exits the shield unit.
- ✓ Using the wipe disk, wipe the area inside the hole. Put the disk in the small zip-lock bag.
- ✓ Pack the disk, as instructed, in the envelope and mail to Troxler Electronic Laboratories, Inc. for analysis.
- ✓ Secure the gauge properly.

NOTES

APPENDIX F

MODEL 4300 SPECIFICATIONS

This appendix contains gauge and measurement specifications for the Model 4300 Depth Moisture Gauge.

CONTENTS

MEASUREMENT SPECIFICATIONS

GAUGE PRECISION AT 200 KG/M^3 (12.5 PCF)

Metric Calibration (kg/m^3)

0.25 min.	0.5 min.	1.0 min.	4.0 min.
± 4.8	± 3.4	± 2.4	± 1.2

Universal Calibration (% volume of water)

0.25 min.	0.5 min.	1.0 min.	4.0 min.
± 0.49	± 0.34	± 0.24	± 0.12

U.S Customary Calibration (PCF)

0.25 min.	0.5 min.	1.0 min.	4.0 min.
± 0.30	± 0.21	± 0.15	± 0.07

U.S. Irrigation Calibration (in/ft)

0.25 min.	0.5 min.	1.0 min.	4.0 min.
± 0.059	± 0.041	± 0.029	± 0.014

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

RADIOLOGICAL SPECIFICATIONS

Neutron Source	0.37 GBq (10 mCi) ± 10% Am-241:Be
Source Type	Sealed Source – Special Form
Source Housing	Stainless Steel, Double Encapsulated
Shielding	Polyethylene and Lead
Surface Dose Rate	See Radiation Profile on page B–8

The source manufacturer recommends a working life of 15 years for the source in this gauge.

ELECTRICAL SPECIFICATIONS

Time Accuracy and Stability	± 0.005%, ± 0.0002% / deg C.
Power Supply Stability	± 0.01% / deg C.
Charge Source	110/220 V ac,50-60 Hz/12 V dc
Liquid Crystal Display	4 line x 16 character
Keypad	30-key sealed membrane
Power Consumption	0.2 watts average
RAM	512 Kbits non-volatile
ROM	512 Kbits
Serial Printer Setup:	Baud Rate = 1200 Data Bits = 8 Parity = None Stop Bits = 2 Hshake = Busy-Line T/D Format = None Cols = 32 Zero = 0 Pound Sign=# _ (Underscore) Auto T&D = No Auto Seq = No Font = 5 x 8 Invert = No Mag = None Clock = Not Installed Buffer = Line Buffer

Gauge to PC Computer Cable

DB-9 Male D-Sub	DB-25 Female D-Sub
Rx (pin 2)	Tx (pin 2)
Tx (pin 3)	Rx (pin 3)
DTR (pin 4)	DSR (pin 6)
DSR (pin 6)	DTR (pin 20)
RTS (pin 7)	CTS (pin 5)
CTS (pin 8)	RTS (pin 4)
Gnd (pin 5)	Sig Gnd (pin 7)

Gauge to Weigh-Tronix® Printer Cable

DB-9 Male Sub-D	DB-25 Male D-Sub
Rx (pin 2)	Tx (pin 3)
Tx (pin 3)	Rx (pin 2)
DTR (pin 4)	DTR (pin 20)
DSR (pin 6)	DSR (pin 6)
RTS (pin 7)	RTS (pin 4)
CTS (pin 8)	CTS (pin 5)
Gnd (pin 5)	Gnd (pin 7)

MECHANICAL SPECIFICATIONS

Shield Size		8.7 x 6 x 13 in. 221 x 152 x 330 mm
Control		1.9 x 3.8 x 7.6 in. 48 x 97 x 193 mm
Probe Diameter	**(4301)**	1.5 in. (38.1 mm)
	(4302)	1.85 in. (47.0 mm)
Probe Length		12.25 in. (311.15 mm)
Weight		22 pounds (10 kg)
Shipping Weight		32 pounds (14.5 kg)
Storage Case Size		23 x 19 x 10.5 in. 58.4 x 48.3 x 26.7 cm
Operating Temperature		14 to 158 degrees F –10 to 70 degrees C
Storage Temperature		–70 to 185 degrees F –57 to 85 degrees C
Vibration Test		0.1 in. (2.54 mm) at 12.5 Hz
Drop Test		300 mm onto 25 mm steel ball
Access Tubing Sizes	**(4301)**	1.55 in. ID, 1.63 in. OD 39.4 mm ID, 41.4 mm OD
	(4302)	1.90 in. ID, 2.00 in. OD 48.3 mm ID, 50.8 mm OD

This gauge contains sensitive electronic components and radioactive materials. This gauge must not be subjected to stress, abuse or operation other than in accordance with the standard operating procedures listed in this manual.

APPENDIX G

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.

CONTENTS

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 Model 4300 nuclear gauges in the United States are listed below. For more detailed information about these requirements, consult the applicable regulations.

The source activity and radiation levels allow the Model 4300 Depth Moisture Gauge to be shipped as an excepted package. Excepted packages are excepted from specification packaging, labeling, marking (except the UN identification number) and shipping paper requirements. The major requirements that are applicable include:

- The outside of the package must be marked with the UN identification number: UN 2911.
- The outside of the inner package or gauge must bear the marking “Radioactive.”
- Full name and address of shipper and consignee must be marked on the package
- If shipped by air, the air waybill must state in the “Nature and Quantity of Goods” box “Radioactive material, excepted package, instruments, UN 2911.”
- If shipped by air, the package must be labeled with the *Radioactive Material, Excepted Package* label.
- Hazmat employee training and record-keeping requirements must be met.
- Reportable incident notification requirements must be met.

ACCIDENT NOTIFICATION REQUIREMENTS

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

HAZMAT TRAINING

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

CANADIAN SHIPPING REQUIREMENTS

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

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

APPENDIX H

UNIT CONVERSION

The Model 4300 Depth Moisture Gauge can display measurement results in either SI (metric) units or English units. Also, HM-181 of 49 CFR changes the standard units of radioactivity in the United States from the English unit of *curies* (*Ci*) to the SI unit of *becquerel* (*Bq*). This requires the shipper to convert the activity on the Bill of Lading from curies to becquerels (GBq). Until everyone is accustomed to the SI units, it is permitted to follow the SI units with the English units in parentheses to clarify the description [for example: 1.48 GBq (40 mCi)].

To help our users convert from English units to SI units, the table in this appendix provides SI conversion factors for common English units relevant to the Model 4300 gauge.

CONTENTS

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/m^3
1 pcf = 1.6×10^{-2} g/cm^3

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:

mCi	**to**	**GBq**
10		0.37
8.0		0.30
40		1.48

INDEX

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

NOTES

NOTES

TROXLER ELECTRONIC LABORATORIES, INC.

LIMITED WARRANTY

TROXLER ELECTRONIC LABORATORIES, INC., and subsidiary, TROXLER INTERNATIONAL, LTD., hereinafter referred to as "TROXLER," warrants this instrument, Model 4300, Serial Number _____, against defects in material and workmanship for a period of 12 months from date of shipment. For gauges sold through authorized TROXLER representatives, the date of shipment will be as of the transfer from representative to purchaser. During the applicable warranty period, TROXLER's obligation under this warranty shall be limited exclusively to the repair at no charge, except for shipping to and from TROXLER'S plant, of any instrument which may prove defective under normal use and which TROXLER's examination shall disclose to its satisfaction to be thus defective. Normal use is defined for the purpose of this warranty as operation under normal load, usage, and conditions with proper care and maintenance and competent supervision. In no event shall TROXLER be held liable for damages, delays, or losses consequential, incidental, or otherwise attributable to the failure of this instrument or radioactive material contained therein. TROXLER's liability being specifically limited to repair as stated hereinabove. This warranty is automatically initiated except where modified by contractual or other written and signed agreement.

THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF, AND THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, AND TROXLER NEITHER ASSUMES, NOR AUTHORIZES ANYONE TO ASSUME FOR IT ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF THE INSTRUMENT. THIS WARRANTY SHALL NOT APPLY TO THE INSTRUMENT OR ANY PART THEREOF, WHICH HAS BEEN SUBJECTED TO DAMAGE BY ACCIDENT, NEGLIGENCE, ALTERATION, ABUSE, MISUSE, OR SERVICE NOT AUTHORIZED IN WRITING BY TROXLER. SUCH DAMAGE TO INCLUDE BUT NOT BE LIMITED TO BURNING OF CIRCUIT BOARDS AND HARNESS FROM IMPROPER SOLDERING TECHNIQUES AND DAMAGE TO THE INSTRUMENT DUE TO PURCHASER'S FAILURE TO PERFORM MAINTENANCE AS OUTLINED IN THE AUTHORIZED OPERATOR'S MANUAL. DUE TO THE NATURE OF THEIR USE, MECHANICAL ACCESSORY PARTS AND BATTERIES ARE WARRANTED FOR 90 DAYS ONLY FROM DATE OF SHIPMENT.

TROXLER ELECTRONIC LABORATORIES, INC.
Troxler International, Ltd.
Troxler Electronics (Canada), Ltd.
3008 Cornwallis Road
Post Office Box 12057
Research Triangle Park, NC 27709 USA

NOTICE TO CONSUMERS

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

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