

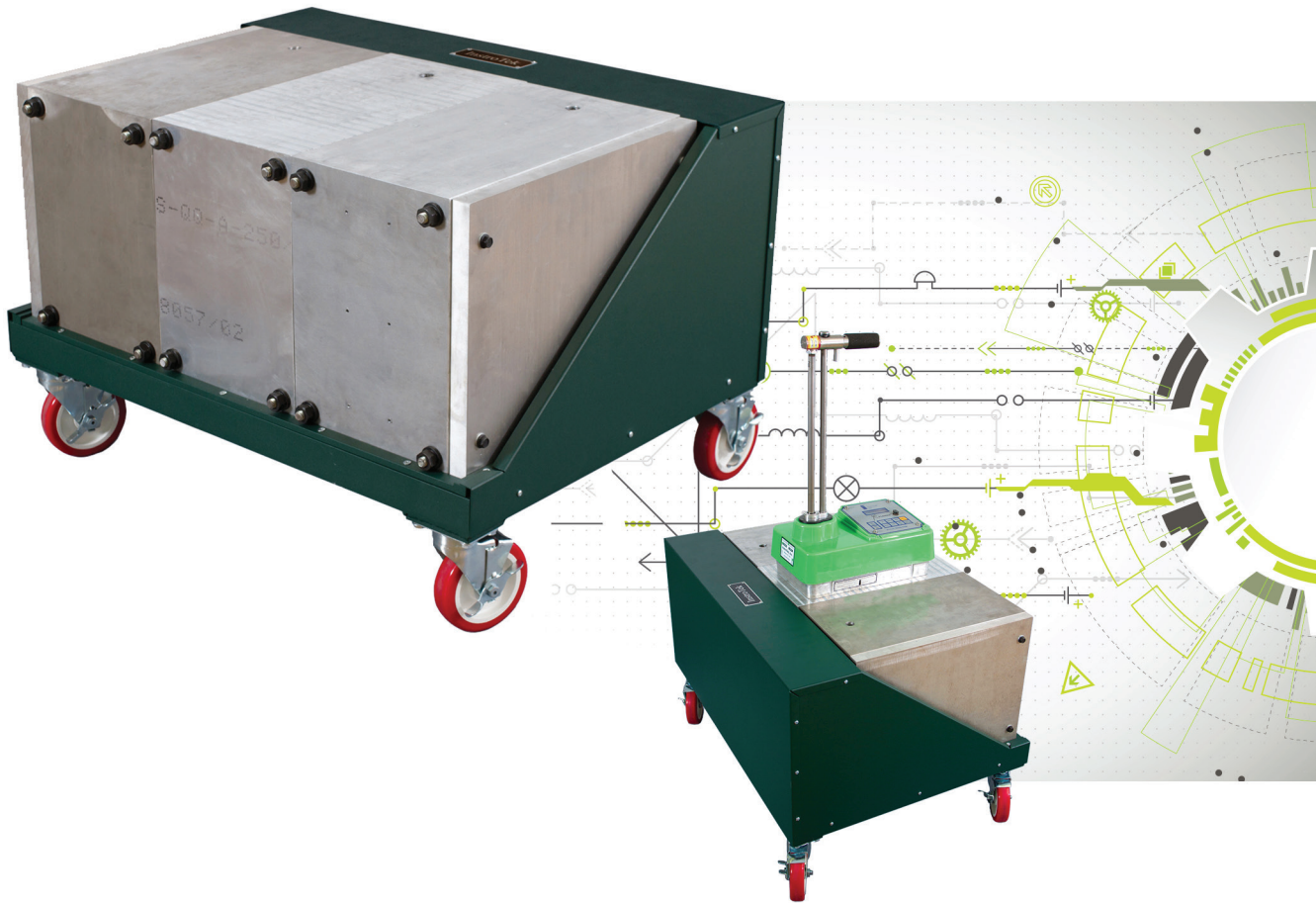


**InstronTek<sup>®</sup>  
Inc.**

innovators in instrumentation technology

# **CALIBRATOR<sup>™</sup>**

Full 3-Block Calibration System



## **OPERATING MANUAL**

[www.InstronTek.com](http://www.InstronTek.com)

# CaliBrator™

## Operation Guide



Copyright September 2014  
Manual Version: 3  
*Hardware Version: 1 & later*  
*Software Version: 12.5.62 & later*

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# Table of Contents

- Introduction** ----- 1
  - Unpacking the CaliBrator* ----- 2
  - Precautions before Calibration* ----- 2
  - Site Preparation and Gauge Placement* ----- 3
- Calibration Procedures (All gauge types)** ----- 5
  - Gauge Placement Guide* ----- 6
- To Install CaliBrator Software** ----- 9
- To Register CaliBrator Software** ----- 11
- Setting up the CaliBrator Software** ----- 13
  - Personalizing the Software:* ----- 13
  - Creating a New Bay* ----- 15
  - Calibrating a Soil Nuclear Density Gauge* ----- 17
  - Calibrating a Two System Soil Nuclear Density Gauge* ----- 23
  - Calibrating a 4640 Density Gauge* ----- 29
  - Downloading Constants to a Gauge* ----- 32
  - Gauges that allow for constant download using the CaliBrator Software:* ----- 32
    - All Gauges:* ----- 32
    - InstroTek Xplorer 3500, SmartPanel, and CPN/InstroTek Elite* ----- 33
    - CPN/InstroTek MC-1 (DR & DRP)* ----- 34
    - Troxler 3430* ----- 35
    - Troxler 3440* ----- 36
  - Manually Inputting Constants to a Gauge:* ----- 37
    - InstroTek 3500, SmartPanel (3411), and CPN/InstroTek Elite* ----- 37
    - CPN MC-1 DRP* ----- 37
    - CPN MC-3* ----- 38
    - Troxler 3430* ----- 38
    - Troxler 3440* ----- 39
    - Troxler 4640* ----- 39
    - Troxler 3450* ----- 40
    - Humboldt EZ* ----- 40
  - Gauges that require an EPROM:* ----- 41
- Calibration Quality Control** ----- 43
- Theory of Operation** ----- 45
  - Gauge Calibration Theory* ----- 45
  - Density Calibration* ----- 45
  - Moisture Calibration* ----- 46
- Maintenance** ----- 47
- Warranty** ----- 49



## Introduction

We are happy and proud to share this Nuclear Moisture/Density Gauge calibration technology with you. CaliBrator is the first semi portable calibration system in the industry and represents another great innovation from InstroTek.

InstroTek, Inc. would like to thank you for selecting the CaliBrator as your nuclear gauge calibration system.

We value your input and would like to hear from you with comments and suggestions on how we can better serve you with this and other products.

The American Society for Testing and Materials (ASTM), American Association of State Highway Transportation Officials (AASHTO) and many worldwide standards and norms specify a nuclear density gauge calibration or verification at interval of 12 months. In the absence of local calibration facilities, commonly gauges are required to be shipped to calibration facilities for calibration and service. Strict shipping formalities, weeks without a gauge, imposes a burden and cost on gauge users, especially when it involves international shipment across borders.

With the CaliBrator, service facilities can now provide a full calibration service to their customers at a fraction of the price and without the space restriction usually required for large sets of blocks. The CaliBrator is optimized to provide the most accurate results for calibration of gauges.

This guide is designed as a reference for the operation of the CaliBrator Calibration System. A thorough understanding of the operation and application of Nuclear Moisture/Density gauges is necessary prior to use of the CaliBrator. InstroTek provides training on routine maintenance and trouble shooting on gauges, prior to and as part of the purchase of the CaliBrator.

*IMPORTANT: Please follow the nuclear gauge manufacturer recommendations, your licensing agency requirements and your company safety plans with regard to operations, safe keeping and safety concerns of these devices.*

**CAUTION: All CaliBrator operations should be done from the end opposite the gauge source, stepping away three feet while the source rod is in the measure position.**

## Unpacking the CaliBrator

When the CaliBrator arrives it will be crated and attached to a wooden pallet. Ensure no damage to the CaliBrator has occurred from the shipping of the unit—if damage is noticed or suspected, please notate this on the Bill of Lading and do not accept the shipment until a resolution is reached between you and the carrier responsible for delivery of the system. Please contact InstroTek to report any damage to this product.

Carefully remove all the packaging from the unit. To remove the unit from the wooden pallet, use a forklift to raise the unit enough to clear the wooden pallet, remove the pallet from beneath the unit, and then carefully lower the unit to the floor.

**CAUTION: Care must be exercised as the CaliBrator weighs approximately ~350 kg (~700 lbs).** Once the CaliBrator has been removed from the pallet, it is equipped with heavy duty casters to allow movement of the system around the floor.

*Note: Small scratches should be expected on the CaliBrator working surface due to an extensive quality control process utilizing measurements with multiple gauges prior to shipment.*

## Precautions before Calibration

Calibration is a process of calculating new parameters (constants) for the nuclear gauge. Calibration is an involved process and should be performed by advanced users with a high degree of experience and understanding of gauge measurement and operations. Furthermore, it is important that calibration is performed on gauges that are well maintained and are in good operating condition.

*IMPORTANT: Calibration does not solve or fix service problems with the gauge.*

After obtaining counts on all three blocks, the CaliBrator software can be utilized to generate new constants. The new constants are entered in the gauge through the keypad or by direct download from the CaliBrator software, depending on the gauge model. After constants are entered into the gauge, the gauge has to be checked on a block of known density at all depths to ensure the constants were entered correctly and to verify the accuracy of the calibration.

**Caution: The CaliBrator should be placed at least three feet from any vertical surface or objects. Refer to ASTM D7013 for proper calibration facility setup.**

## Site Preparation and Gauge Placement

Select a flat, level and dry surface with a minimum of three (3) feet from any vertical structure.

*Note: Asphalt or concrete floors are good examples of the surface to place the CaliBrator blocks. Follow ASTM D7013 for calibration facility setup and to minimize influences during the calibration process.*



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## Calibration Procedures (All gauge types)

The calibration process includes the three blocks and utilizes CaliBrator Software. Contact InstroTek to obtain your specific product registration for operating this software.

*Note: Only trained, qualified and experienced users should perform the Calibration and you should follow the gauge manufacturers recommendations and requirements of your nuclear materials license for operating, maintaining and using your gauge.*

**Caution: Do not attempt to calibrate the gauge that has service problems. Calibration does not correct service problems of the gauge**

**Caution: Always follow manufacturer's recommendations for routine maintenance of gauges and perform these steps prior to calibrating the gauge**

1. Ensure the gauge is stable. This may be done by powering on the gauge for approximately 20 minutes and allowing the electronics to warm up and the gauge to stabilize to the environment where the gauge will be calibrated.
2. Place the gauge on the polyethylene standard block—on a flat, level and dry surface with a minimum of three feet from any vertical surface—and obtain an extended standard count. **DO NOT TAKE STANDARD COUNTS ON THE CALIBRATOR BLOCKS.** Follow gauge manufactures recommendations for acceptable limits. Some gauge models have built in stability (STAT test) procedures in the gauge software. Record the average of the density standard count (DS) and the moisture standard count (MS).
3. Adjust the measurement time in the gauge to 4 minute counts. Measurements with 4640 and 3450 gauges in BS mode are 20 minutes instead of 4 minutes (refer to the manufacturer's operation manual for details on setting a 20 minute measurement time).
4. Place the gauge in backscatter (BS) position on the low density block (block "L" on the CaliBrator) and start a four minute measurement. Record the density count (DC) and moisture count (MC). The moisture count on this block at BS corresponds to zero moisture content which will be used for calculation of the moisture constants.

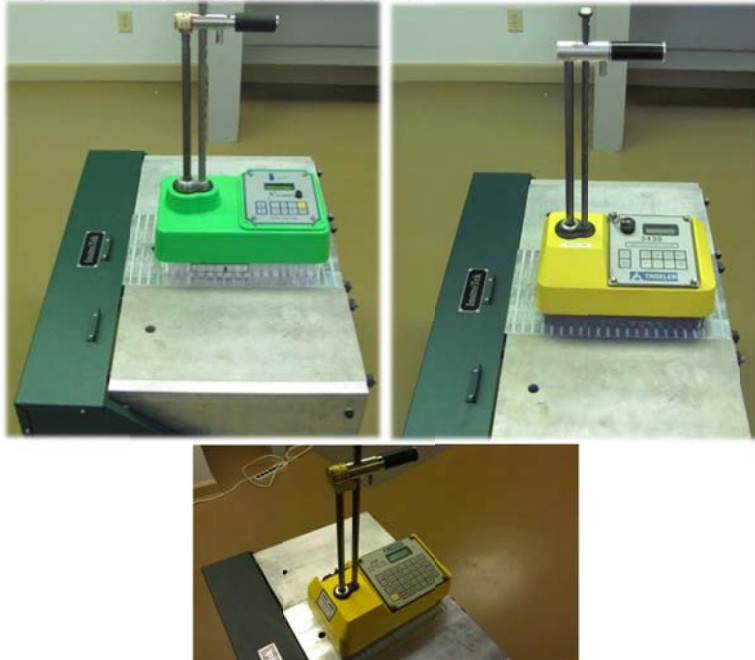
5. Take four minute measurements on all other depths and record only the density counts (DC).
6. Place the gauge back in BS position and take a second BS measurement. This is not necessary for 4640 and 3450 gauges.
7. Place the gauge on the medium density block (block "M" on the CaliBrator) in BS position and take a four minute measurement. Record the density count (DC) and moisture count (MC). MC is the high moisture count that is going to be used for calibration of the moisture system. Measurements with 4640 and 3450 gauges are 20 minutes instead of 4 minutes (refer to the manufacturer's operation manual for details on setting a 20 minute measurement time).
8. Repeat steps 5 and 6 for the medium density block and record the density counts (DC) at all available depths. Average the moisture counts for all transmission depths.
9. Place the gauge on high density block (block "H" on the CaliBrator) in BS position, take a 4 minute measurement and record only the density count (DC). Measurements with 4640 and 3450 gauges are 20 minutes instead of 4 minutes (refer to the manufacturer's operation manual for details on setting a 20 minute measurement time).
10. Repeat steps 5 and 6 on the high density block
11. Place the gauge on the polyethylene reference block—on a flat, level and dry surface with a minimum of three feet from any vertical surface—and take an extended standard count to determine the drift in the gauge during the calibration period. Follow gauge manufacturer's recommendations for acceptable drift limits. Some gauge models have built in Drift test procedures in the gauge software. Record the average of the density standard count (DS) and the moisture standard count (MS).
12. Use the average of the STAT test counts and Drift test counts (step 2 and 11) for your calibration standard count.

## **Gauge Placement Guide**

Refer to the following pictures to ensure proper gauge placement on the CaliBrator:

**For Backscatter Measurements:**

*InstroTek 3500, Troxler 3401, 3411, 3430, 3430+, 3440, 3450 and 3440+*



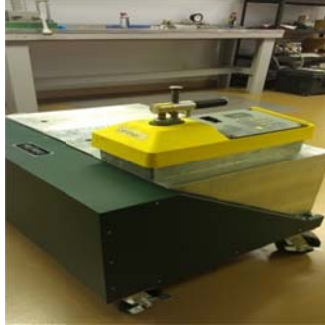
The gauge is placed in front of the source rod hole.

*CPN MC-1, MC3 Elite & MC-3, and the Humboldt 5001*



The gauge is placed at the top edge of the block.

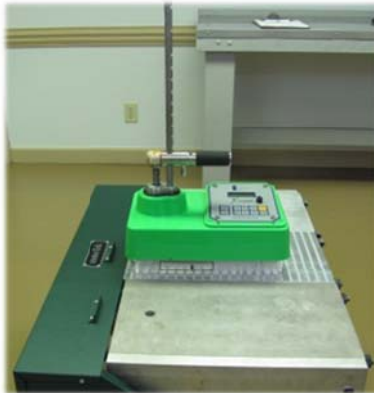
*Troxler 4640*



The gauge is placed at the top edge of the block.

**For Direct Transmission Measurements:**

*All Gauges*



The gauge is placed over the source rod hole for moisture and density counts in direct transmission mode; the source rod is lowered into the hole and pulled towards the display for good contact between the source rod and the block.

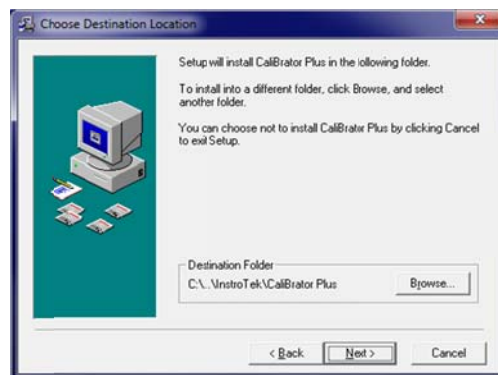
## To Install CaliBrator Software

(Note: actual computer images may vary slightly depending on version of the software being install and the computer Operating System)

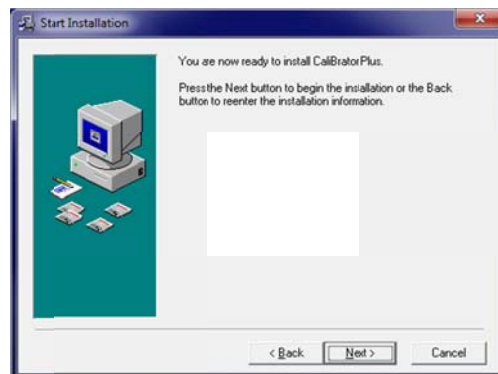
1. Close all other programs before starting this install;
2. Run the Installer (CaliBrator.EXE) sent to you by InstroTek;
3. Follow all the onscreen prompts;



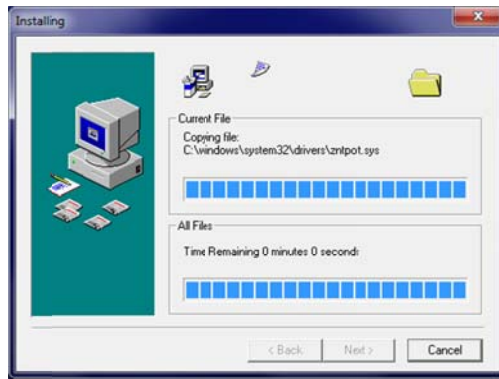
Review the warnings and Click "Next" to continue.



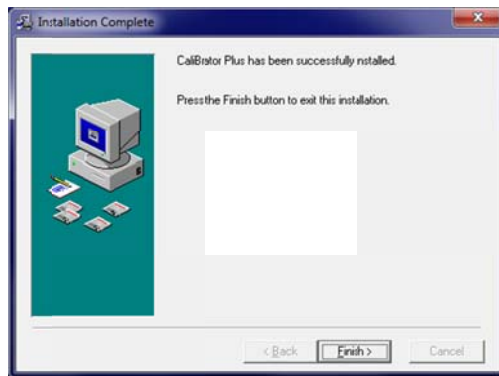
You may choose to install the software in a different location than the default, click "Browse..." to navigate to the location on your computer you wish to install the software.



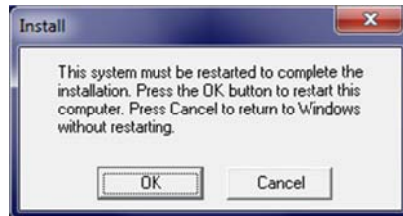
Click "Next" to start installing the software files.



The installer software will install the necessary files; click "Next" when complete.



The software is now installed; click "Finish" to finish the installer.

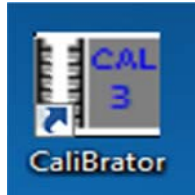


Some computer systems require a restart after installing the CaliBrator Software; click "OK" to automatically restart your system.

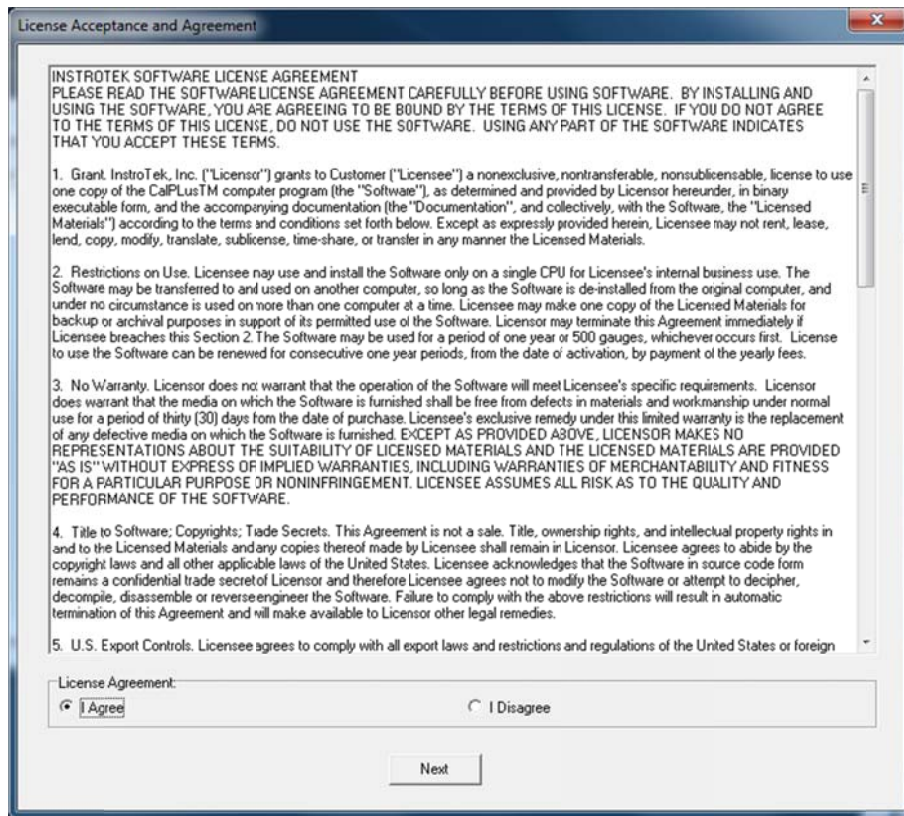
4. Click OK to restart your computer;
5. CaliBrator is now installed;
6. You are now ready to register your copy of CaliBrator.

## To Register CaliBrator Software

1. Double click on the CaliBrator Icon that was placed on your desktop;



2. When CaliBrator Software loads you will be prompted to read and agree to the terms of use;



3. Click the Agree Option if you agree to the terms of use;
4. Click Next;



5. A registration window will open;

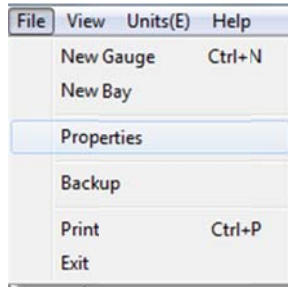


6. Copy and Paste the Product Code (typically starts with \$\$\$) that is located in this box to an email, you will also need to include the Product Sub Code in your email;
7. Email this Product Code to [sales@instrotek.com](mailto:sales@instrotek.com) (or to your account representative);
8. InstroTek will provide you with an Activation Code;
9. You may also call 919.875.8371 (8am to 5pm EST, Monday through Friday (excluding holidays) – Raleigh, NC, USA) and speak with a customer service expert to obtain this registration code. You will still need to have your Product Code available.

## Setting up the CaliBrator Software

### Personalizing the Software:

1. When the CaliBrator Software is first used you will need to set up software to display your service center information;
2. To do this click "File" then "Properties";

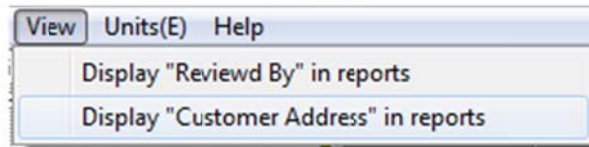


3. This will display the Properties Menu. From this menu you can personalize the software to suite your service center needs;

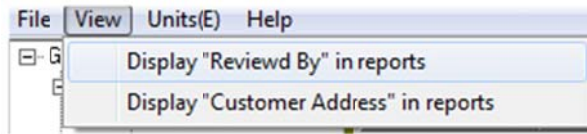
See next page for Properties Option Pane information

See previous page for Properties Option Pane.

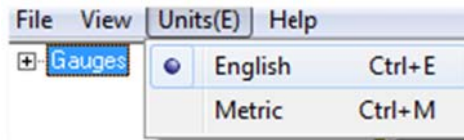
- 1- Company Name and Address: Your company name and address. The company name will appear at the top of your Calibration Reports.
- 2- Certificate Prefix: The CaliBrator Software will generate a number for every certificate created for tracking purposes and for some accreditation agencies; the prefix can be used to differentiate between different service centers of the same company.
- 3- Calibration Procedure: If your service center uses calibration procedure numbers you may include it here for information purposes.
- 4- Default Serial Port: This is the Communication Port on your PC the download cable is connected.
- 5- Start New Page after row: This setting is used to adjust the number of lines that display on a printed page; you should adjust this number if you find a single line being printed on a different page.
- 6- Customer Information: If your service center needs to print the Customer's information on the Calibration Report, you will need to enter the information here, select "Display Customer Address in Reports" from the "View" menu, and then refresh the Calibration Report by selecting it from the list of calibrated gauges. (To turn this feature off, simply select the option to uncheck.)



- 7- Paragraphs 1-4: Use these boxes to input calibration report statements you wish to disclose to the customer. These statements will appear at the end of the second page before the signature. If you leave a box blank nothing will appear on the report where that paragraph is formatted to display.
  - 8- Uncertainty Message: Use this text box to write an uncertainty statement for your calibrations. This statement will display before the technician signature.
  - 9- Click the OK button to save your changes.
4. Service centers that employ a calibration procedure that requires a calibration report to be reviewed by a supervisor or someone other than the technician performing the calibration, you may add a "Reviewed By" signature line to your Calibration Reports by selecting the "Display Reviewed By in reports" from the "View" menu. (To turn this feature off, simply select the option to uncheck.)

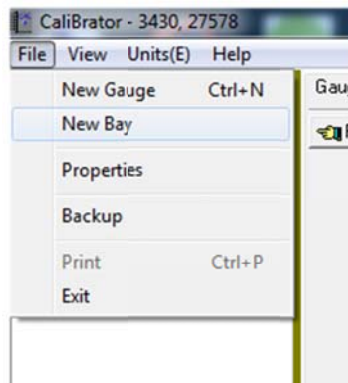


- To change between English (lbs/ft<sup>3</sup>) and Metric (kg/m<sup>3</sup>) units select the units you wish to display form the “Units” menu. You may also use the shortcut keys Ctrl+E for English and Ctrl+M for Metric. *Note: some gauges require English units to be downloaded into them; refer to the gauge manufacturer’s operation guide for specific gauge requirements.*

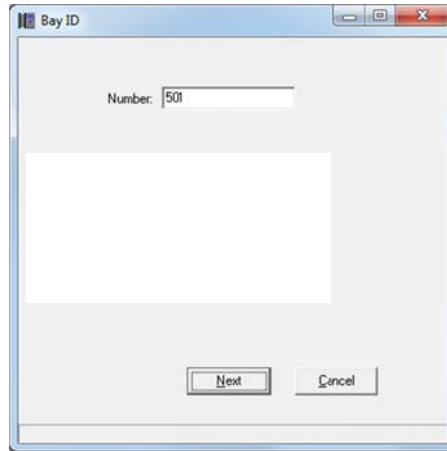


### Creating a New Bay

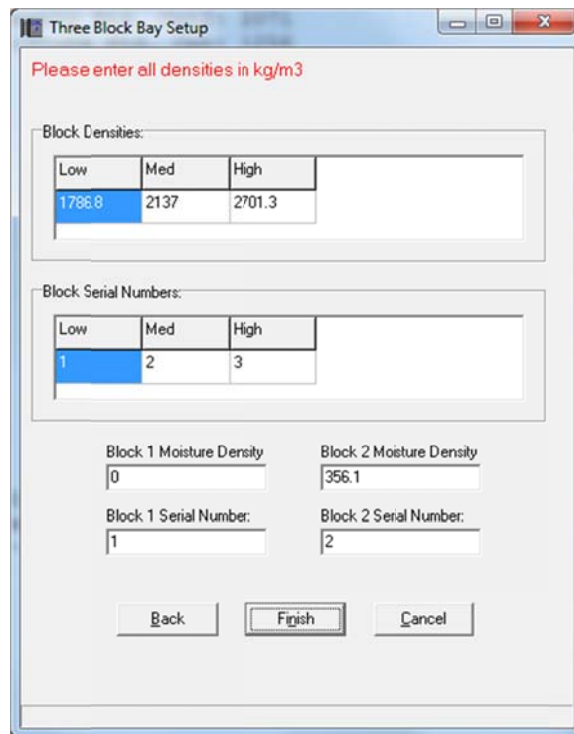
- When the CaliBrator Software is first used you will need to set up a bay based on the CaliBrator(s) you will be using to calibrate your nuclear gauges. Click “File” and “New Bay”;



- The New Bay dialog box will appear. Type the Serial Number of your CaliBrator into the box labeled “Number”;



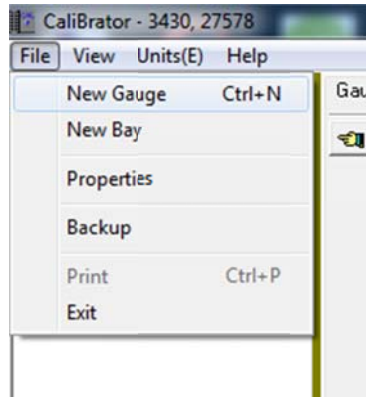
3. Click Next;
4. You will need to input the densities of each block in the CaliBrator in kg/m<sup>3</sup>. The Block Serial Numbers are typically the CaliBrator Serial Number followed by an "L", "M", or "H" which corresponds to the Low, Medium, and High density blocks; The block densities are provided on your block certification documents shipped with the CaliBrator



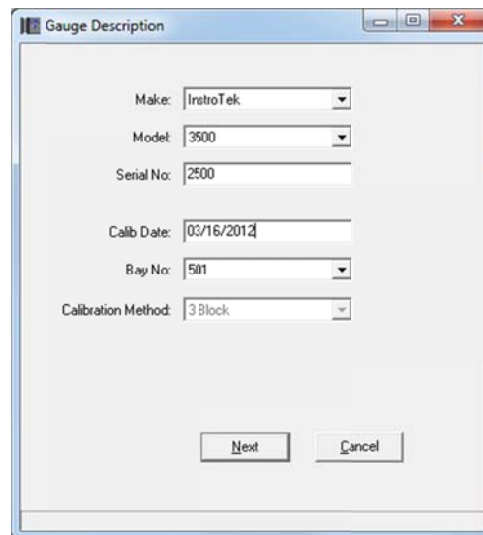
5. Click Finish;
6. Your CaliBrator is now set up in the CaliBrator Software.

## Calibrating a Soil Nuclear Density Gauge

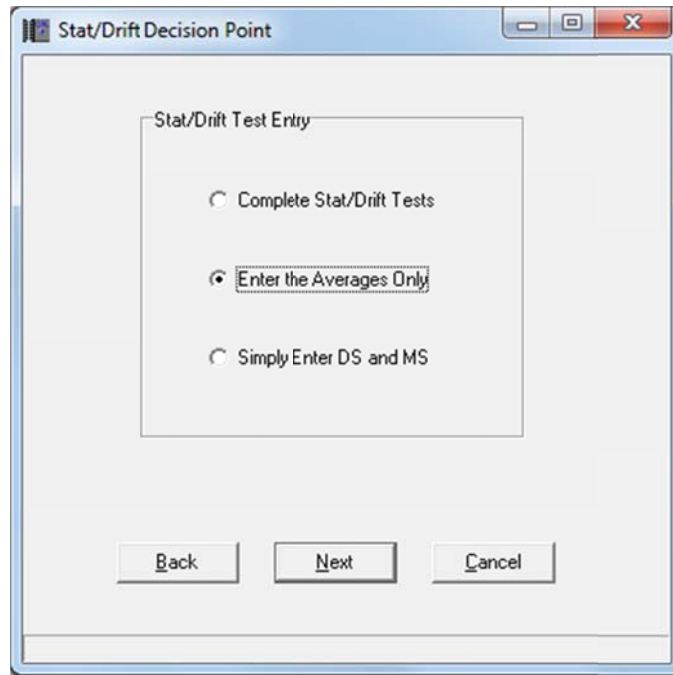
1. Open the CaliBrator Software if not already open. Click "File" and "New Gauge";



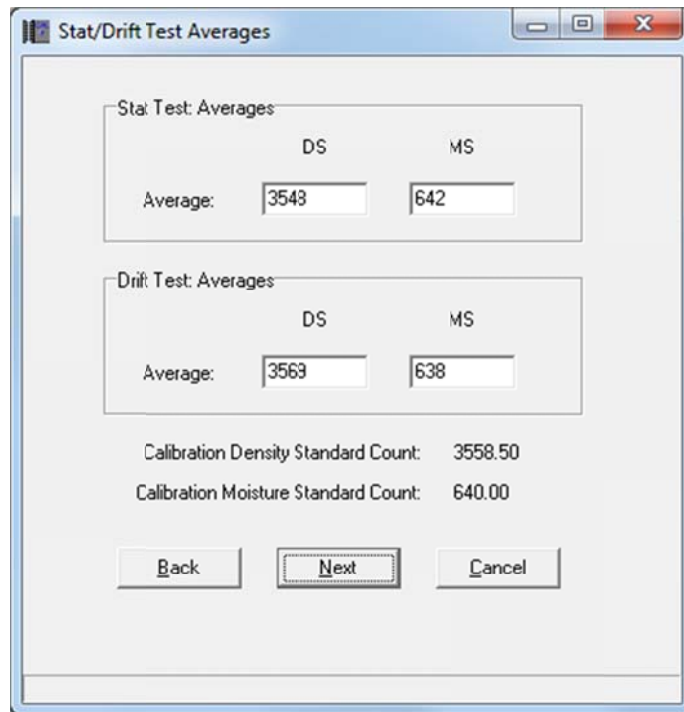
2. The New Gauge dialog box will appear. Select the Make and Model of the gauge, type the Serial Number of your gauge into the box labeled "Serial No.", type the calibration date (mm/dd/yyyy) into the box labeled "Calib Date", select the Bay No. (this is the serial number of your CaliBrator);



3. Click Next;
4. Select the method used to calculate the Calibration Standard Count (typically the "Enter the Averages Only", where you used the STAT and Drift functions built into the gauge);



5. Click Next;
6. Input the STAT and Drift Averages;



7. Click Calculate;
8. Click Next;

- Input the density counts at each depth and for each block. Enter the first backscatter in the first row and the second backscatter in the last row. You will leave blank any row that is not on your gauge (example: a 12x2 gauge will leave all the odd depths blank).

The screenshot shows the 'FormGauge6' window with a 'Calibration Counts' table. The table has four columns: an unlabeled column for depth/block, 'Low', 'Med', and 'High'. The rows are labeled BS, 2, 3, 4, 5, 6, 7, and 8. The data entered is as follows:

	Low	Med	High
BS	1046	678	477
2	3540	2281	1422
3			
4	3575	2193	1272
5			
6	2902	1659	887
7			
8	2017		

Buttons at the bottom: Back, Calculate, Cancel, Save & Exit.

- Click Calculate;

The screenshot shows the 'FormGauge6' window after calculation. The 'Calibration Counts' table now includes calculated values for 'Med' and 'High' in the 'BS' and 'BS Av' rows. The data is as follows:

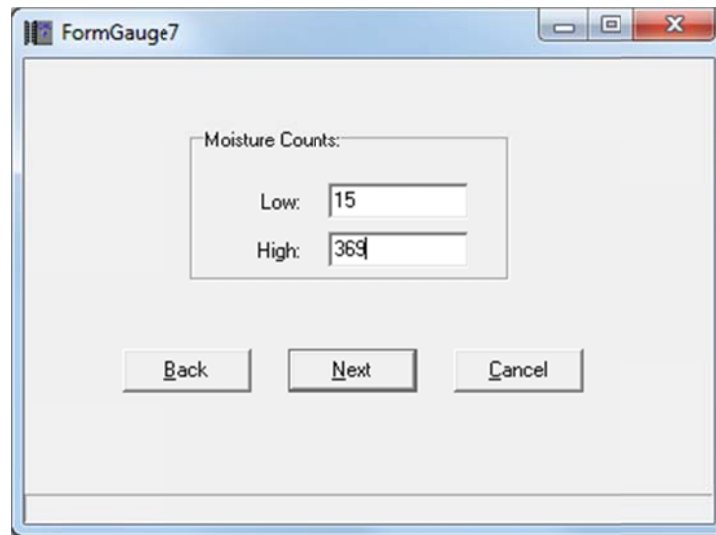
	Low	Med	High
8	2017	1058	524
9			
10	1276	612	281
11			
12	753	338	155
BS	1050	681	477
BS Av	1048	680	477

Buttons at the bottom: Back, Next, Cancel, Save & Exit. The 'Next' button is highlighted.

- The software will calculate the average backscatter value;
- Click Next;

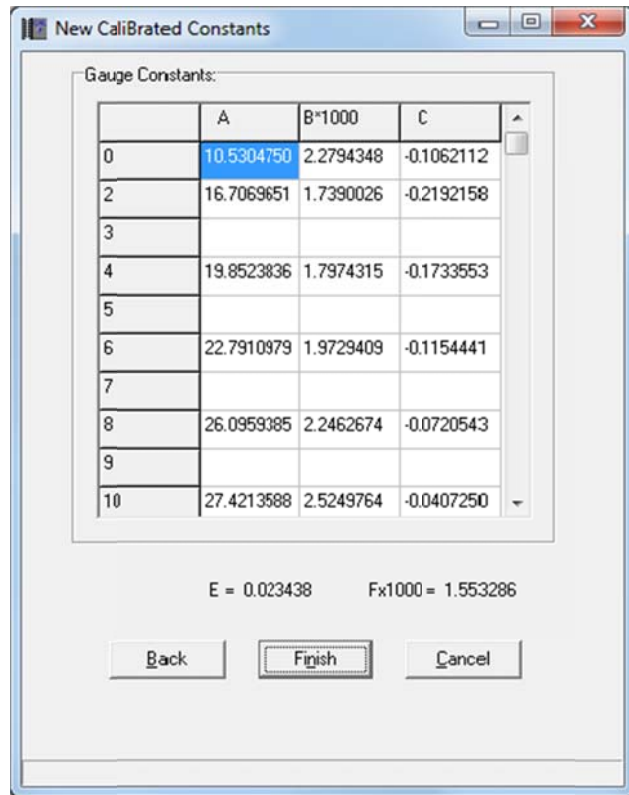


15. Input the moisture counts (MC), Low from the L block and High from the M block;

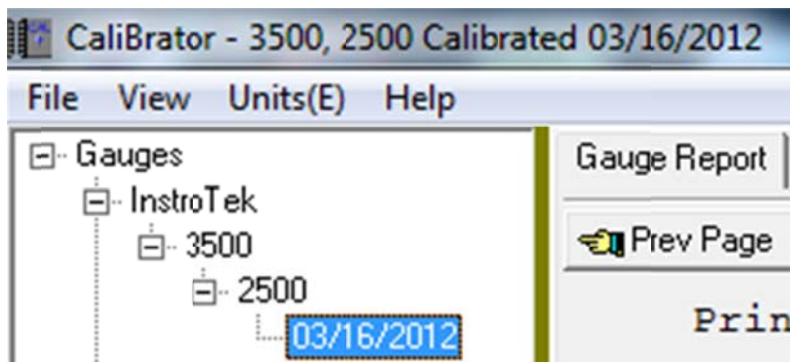


The screenshot shows a software window titled "FormGauge7". Inside the window, there is a section labeled "Moisture Counts:" containing two input fields. The "Low:" field contains the number "15" and the "High:" field contains the number "369". Below these fields are three buttons: "Back", "Next", and "Cancel".

16. Click Next;
17. The software has now generated new constants for you. Review the constants and the counts to ensure they look appropriate for the gauge you are calibrating and that no mistakes have been made in data entry. If a depth that you entered data is blank, the software could not generate constants for this depth, click the "Back" button and review your density count inputs for that depth. If the density counts were inputted correctly, retake the measurements at that depth to ensure the gauge is stable and repeating the counts. If the gauge repeats the counts first obtained, check the gauge and ensure it is operating correctly.



18. Click Finish;
19. The software will generate a printable report for you. (You may click on the calibration date under the Make, Model, and Serial Number to reprint a different calibration.) Click "File" and "Print" to print your Calibration Report.

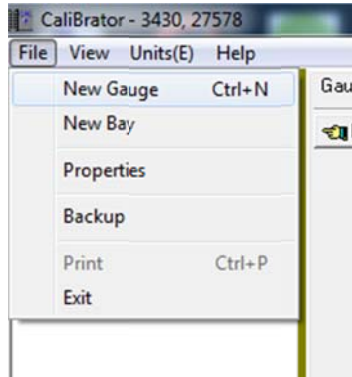


An example of the on-screen report.

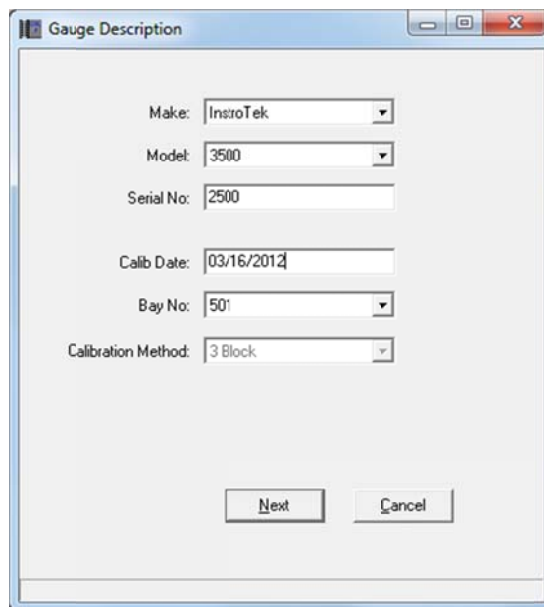
Gauge Report		Density Tables	Moisture Tables	Exp Std Cnt	Hex Report	Download
<a href="#">Prev Page</a>		<a href="#">Next Page</a>				
Print Date: 10/09/2012			Cert#: NC10001		Page 1/2	
<b>InstroTek, Inc.</b> <b>Gauge Calibration Report</b>						
Gauge Model: 3500			Density Std. Cnt: 3559			
Serial Number: 2500			Moisture Std. Cnt: 640			
Calib. Date: 03/16/2012			Expires: 03/16/2013		Bay Number: 501	
Block Type	Low	Med	High			
Density	111.5	133.4	168.6			
S/N	501L	501M	501H			
Depth	Density	Calibration	Counts			
-----	-----	-----	-----			
BS	1048	680	477			
2	3540	2281	1422			
4	3575	2193	1272			
6	2902	1659	887			
8	2017	1058	524			
10	1276	612	281			
12	753	338	155			
<b>Gauge Constants:</b>						
Depth	A	Bx1000	C	@125 pcf	Repeatability	
-----	-----	-----	-----	-----	-----	
BS	10.53047	2.27943	-0.10621	0.49		
2	16.70697	1.73900	-0.21922	0.25		
4	19.85238	1.79743	-0.17336	0.23		
6	22.79110	1.97294	-0.11544	0.23		
8	26.09594	2.24627	-0.07205	0.24		
10	27.42136	2.52498	-0.04072	0.28		
12	27.65952	2.83579	-0.02639	0.34		
<b>Moisture Parameters:</b>						
Block Type	Low	High	E	Fx1000	@15 pcf	Repeatability
Density	0	22.2				
S/N	501L	501M				
	Moisture	Cal Counts	Gauge Constants			
	-----	-----	-----	-----	-----	
	15	369	0.02344	1.55329	0.25	

## Calibrating a Two System Soil Nuclear Density Gauge

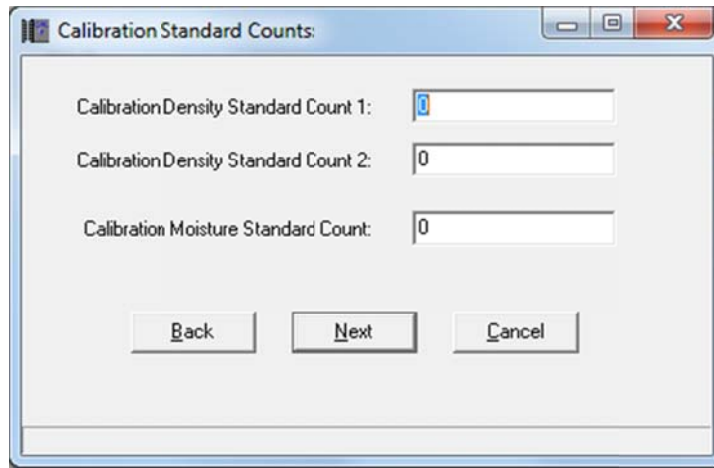
1. Obtain the previous constants from the gauge (refer to the manufacturer's operation manual for guidance).
2. Open the CaliBrator Software if not already open. Click "File" and "New Gauge";



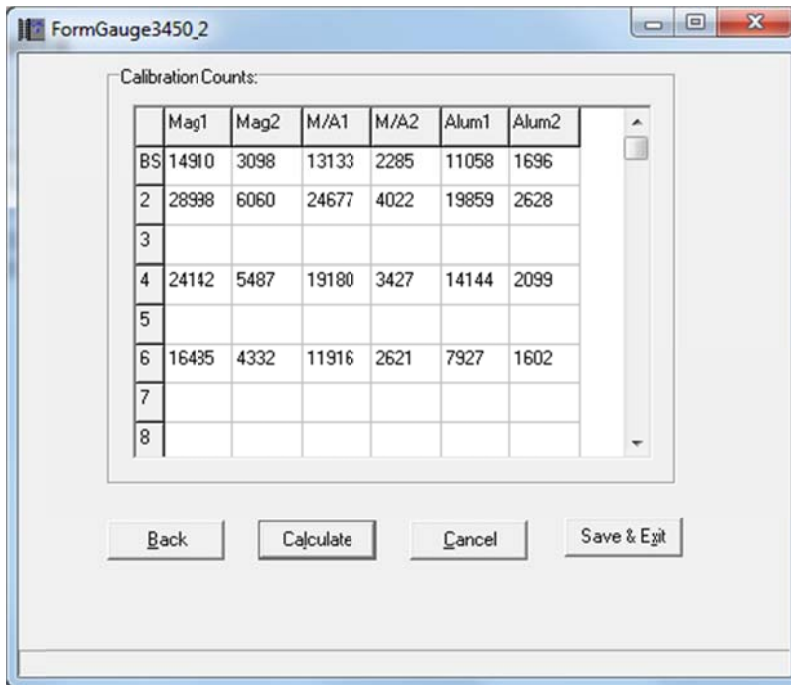
3. The New Gauge dialog box will appear. Select the Make and Model of the gauge, type the Serial Number of your gauge into the box labeled "Serial No.", type the calibration date (mm/dd/yyyy) into the box labeled "Calib Date", select the Bay No. (this is the serial number of your CaliBrator);



4. Click Next;
5. Input the calibrated standard count averages for each system;



6. Click Next;
7. Input the density counts at each depth and for each block. Enter the 20 minute backscatter count in the first row and leave the second backscatter in the last row blank. You will leave blank any row that is not on your gauge (example: a 12x2 gauge will leave all the odd depths blank).



8. Click Calculate;

FormGauge3450\_2

Calibration Counts:

	Mag1	Mag2	M/A1	M/A2	Alum1	Alum2
8	10030	3218	6572	1914	3950	1218
9						
10	5728	2291	3465	1392	2014	978
11						
12	3276	1639	1921	1085	1196	843
BS	14898	3110	13042	2259	10032	1685
BS	14904	3104	13088	2272	10545	1686

Buttons: Back, Next, Cancel, Save & Exit

9. The software will calculate the average backscatter value;
10. Click Next;
11. Input the moisture counts (MC), Low from the L block and High from the M block;

FormGauge7

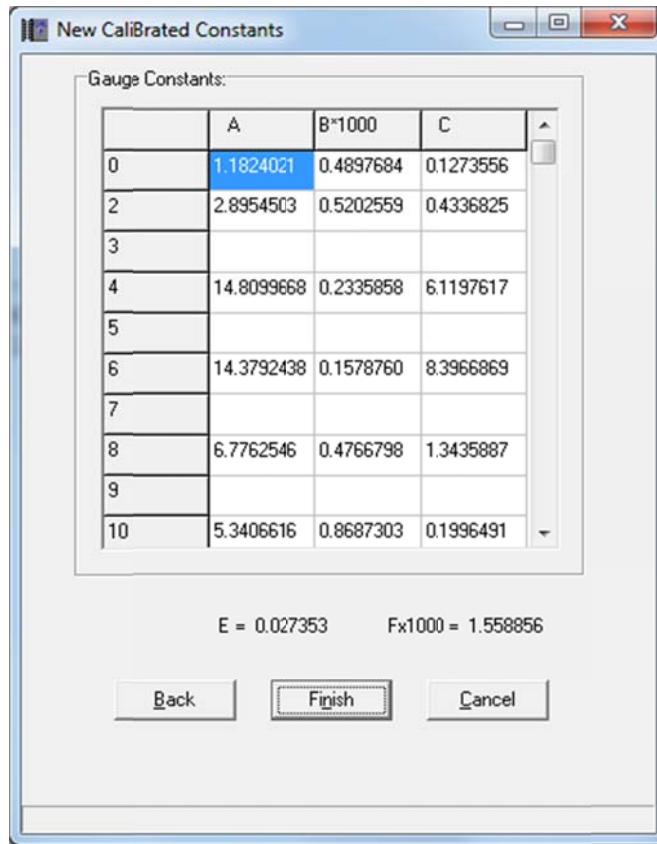
Moisture Counts:

Low:

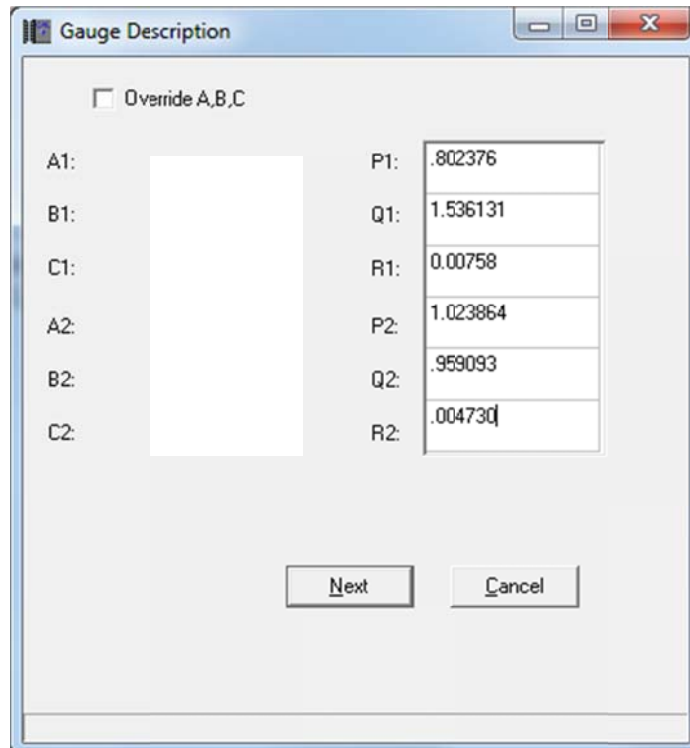
High:

Buttons: Back, Next, Cancel

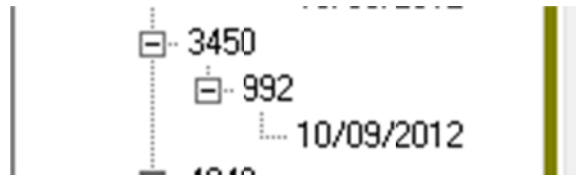
12. Click Next;
13. The software has now generated new constants for you. Review the constants to ensure they look appropriate for the gauge you are calibrating. If a depth that you entered data is blank, the software could not generate constants for this depth, click the "Back" button and review your density count inputs for that depth. If the density counts were inputted correctly, retake the measurements at that depth to ensure the gauge is stable and repeating the counts. If the gauge repeats the counts first obtained, check the gauge to make sure it is operating correctly.



14. Click Finish;
15. The Thin-Layer System constants input box will display;



16. Input the P<sub>1</sub>, Q<sub>1</sub>, R<sub>1</sub>, P<sub>2</sub>, Q<sub>2</sub>, and R<sub>2</sub> constants from the original factory calibration report;
17. Click Next;
18. If the Calibration fails with the default settings, the Thin-Layer System constants input box will re-display, check the "Override A,B,C" box, and input a new set of initial guesses. You may try the A, B and C constants for each system from the original factory calibration report;
19. Click Next;
20. The software will generate a printable report for you. (You may click on the calibration date under the Make, Model, and Serial Number to reprint a different calibration.) Click "File" and "Print" to print your Calibration Report.



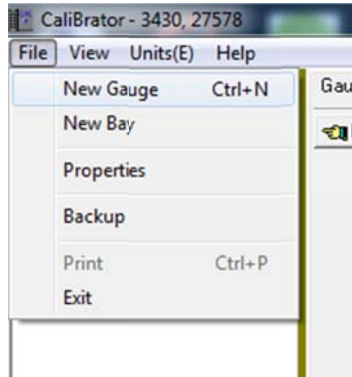


An example of the on-screen report.

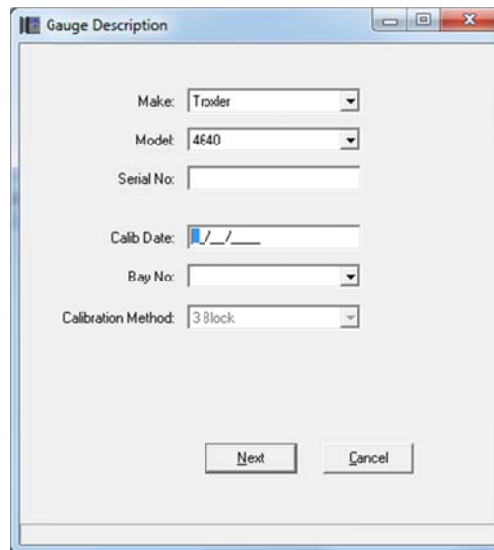
Gauge Report   Density Tables   Moisture Tables   Exp Std Cnt   Hex Report   Download				
Prev Page		Next Page		
Print Date: 10/09/2012	Cert#: NC10005	Page 1/3		
<b>InstroTek, Inc.</b>				
<b>Gauge Calibration Report</b>				
Gauge Model: 3450	Density Std. Cnt1: 6195			
Serial Number: 992	Density Std. Cnt2: 2071			
Calib. Date: 10/09/2012	Moisture Std. Cnt: 1256			
Bay Number: 1				
<b>Density Calibration Counts:</b>				
Depth	Low	Med	High	
	1786.8	2137	2701.3	
S/N	1	2	3	
-----	-----	-----	-----	
0	3550	2769	1979	
2	6899	4934	3041	
4	30913	24336	16558	
6	21424	15736	9621	
8	13528	9272	5248	
10	8189	5448	3101	
12	5034	3416	2177	
<b>Gauge Constants:</b>				
Depth	A	Bx1000	C	@125 pcf Repeatability
-----	-----	-----	-----	-----
0	1.55852	0.77237	-0.03086	0.57
2	4.27464	0.89097	0.05214	0.31
4	12.36955	0.39467	2.42283	0.20
6	10.54839	0.62471	0.90950	0.19
8	9.61851	0.93658	0.20440	0.20
10	7.85472	1.17883	-0.01043	0.24
12	6.38379	1.45343	-0.11837	0.33
<b>Moisture Parameters:</b>				

## Calibrating a 4640 Density Gauge

1. Obtain the previous constants from the gauge (refer to the manufacturer's operation manual for guidance).
2. Open the CaliBrator Software if not already open. Click "File" and "New Gauge";



3. The New Gauge dialog box will appear. Select the Make and Model of the gauge, type the Serial Number of your gauge into the box labeled "Serial No.", type the calibration date (mm/dd/yyyy) into the box labeled "Calib Date", select the Bay No. (this is the serial number of your CaliBrator);



4. Click Next;
5. Input the standard counts for system 1 and system 2. Input the A11, A12, A13, A21, A22, and A23 constants found in the gauge from the factory calibration. Input the density counts for each system on each block. There are two detector systems in the 4640;

Gauge Description

Std Count 1: 4188

Std Count 2: 1261

A11: 1.29437      A21: 1.16578

A12: 1.86449      A22: 0.9709

A13: 0.00072      A23: 0.00373

Calibration Cnts:	Mag	Mag/Alum	Alum
System 1	10886	9251	7533
System 2	2350	1536	1018

Next      Cancel

6. Click Next;
7. If the software cannot generate constants based on default settings, the following screen will appear. Input a new set of initial guesses; you may try the A, B and C constants for both systems from the original factory calibration report;
8. Click Next to allow the software to retry generating the calibration constants;

Gauge Description

**Calibration Failed. Please modify default values:**

A1: 0.166380155      A2: 7.888744756

B1: -0.013794821      B2: 0.006206508

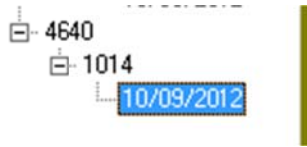
C1: -3.281887083      C2: 2.112524734

Back      Next      Cancel

9. If the software can generate constants based on default settings, the software will generate a printable report for you. (You may click on the calibration date

under the Make, Model, and Serial Number to reprint a different calibration.)

Click "File" and "Print" to print your Calibration Report.



An example of the on-screen report.

Gauge Report | Density Tables | Moisture Tables | Exp Std Cnt | Hex Report | Download

Prev Page | Next Page

Print Date: 10/09/2012      Cert#: NC10004      Page 1/2

**InstroTek, Inc.**  
**Gauge Calibration Report**

Gauge Model: 4640      Calib. Date: 10/09/2012  
Serial Number: 1014      Bay Number: 501

**Gauge Calibration Counts**

S/N System	110.7 501L Low	139.2 501M Med	168.1 501H High	Std
Sys1	10886	9251	7533	4188
Sys2	2350	1536	1018	1261

**Gauge Parameters**

A1 = -0.13446  
 B1 = -0.01514  
 C1 = -3.30359  
 A11 = 1.29437  
 A12 = 1.86449  
 A13 = 0.00072  
 A2 = 8.23068  
 B2 = 0.00500  
 C2 = 2.90186  
 A21 = 1.16578  
 A22 = 0.97090  
 A23 = 0.00373

## Downloading Constants to a Gauge

Gauges that allow for constant download using the CaliBrator Software:

**InstroTek:**

3500/Elite/SmartPanel – Page ##

**CPN/InstroTek:**

MC1 (DR & DRP) – Page ##

**Troxler:**

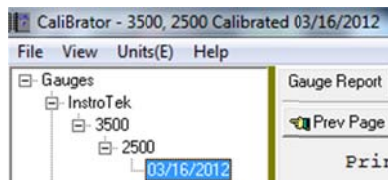
3411 (with SmartPanel) – Page ##

3430 – Page ##

3440 – Page ##

**All Gauges:**

1. Load the CaliBrator Software if not already open. Navigate to and click on the calibration date under the Make, Model, and Serial Number you wish to download the constants;



2. Click the "Download" Tab;



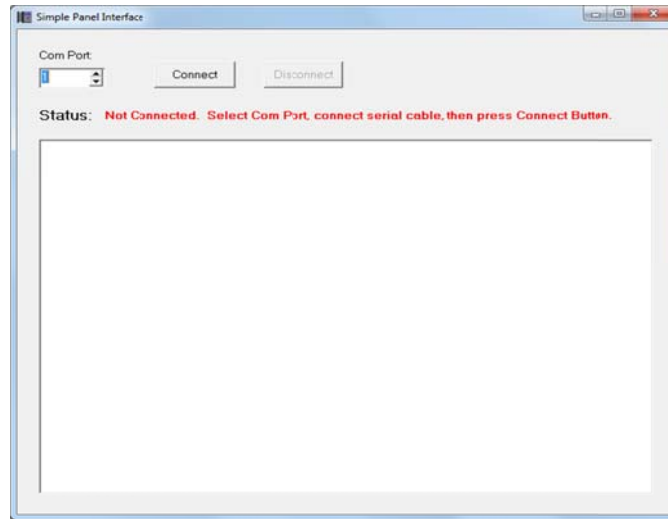
3. From this point forward you will need to jump to the portion of this Manual that has the instructions for the model gauge you are downloading the constants;

### InstroTek Xplorer 3500, SmartPanel, and CPN/InstroTek Elite

1. Remove the front panel from the gauge; leave the front panel connected to the base;
2. Connect the download cable to the RS-232 port on the back of the front panel;
3. Click the "3500/Elite/SmartPanel" Button in the software;



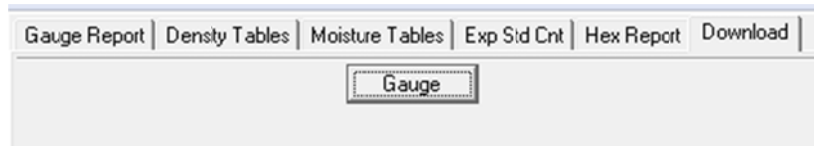
4. The Download box will open, select the COM port the download cable is connected (refer to your computer's system setup for this information);



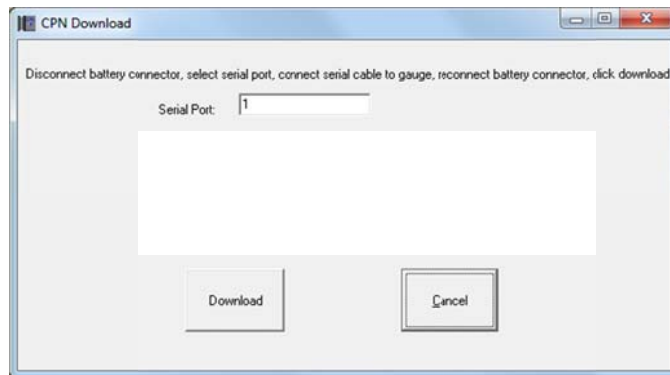
5. Click the "Connect" button;
6. Press the Reset button on the back of the front panel;
7. The software will begin to download the constants;
8. Click "Disconnect" when the download has completed;
9. Unplug the download cable from the back of the front panel;
10. Press the "Reset" button on the back of the front panel if the gauge does not restart after removing the cable. Replace the front panel to the gauge base;
11. The constants are now downloaded and stored in your gauge; you may QC the gauge to ensure your calibration is correct.

### CPN/InstroTek MC-1 (DR & DRP)

1. Remove the gauge stack (gauge electronics);
2. Disconnect the gauge stack from the main harness;
3. Disconnect the battery;
4. Connect the download cable to the middle port on the gauge stack;
5. Wait 20 seconds;
6. Connect the battery;
7. "Master Reset" will display, the gauge is ready to accept the new constants;
8. Click the "Gauge" Button in the software;



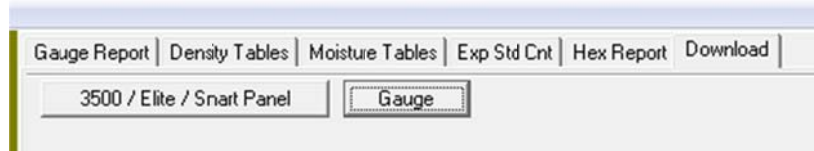
9. The Download box will open, select the COM port the download cable is connected (refer to your computer's system setup for this information);



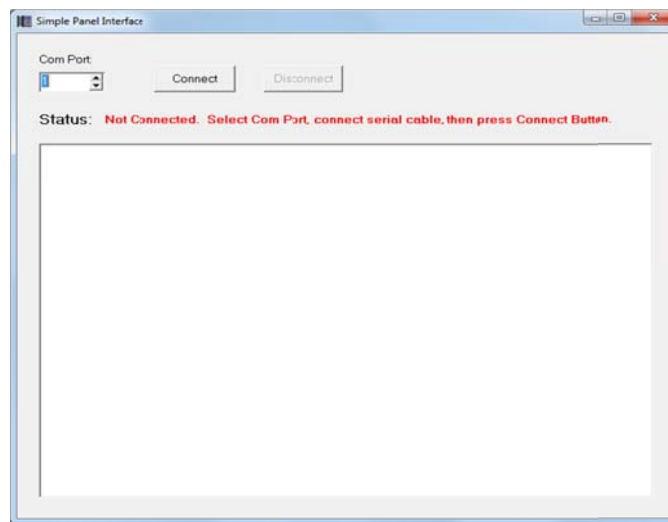
10. Click the "Download" button;
11. When the download is complete the Download box will close;
12. Unplug the download cable from the gauge stack;
13. Connect the main harness to the gauge stack;
14. Install the gauge stack on the gauge base;
15. You may QC the gauge to ensure your calibration is correct.

## Troxler 3430

1. Remove the front panel from the gauge; leave the front panel connected to the base;
2. Connect the download cable (with the 3430 extension) to the port on the top of the front panel;
3. Click the "Gauge" Button in the software;



4. The Download box will open, select the COM port the download cable is connected (refer to your computer's system setup for this information);



5. Click the "Connect" button;
6. Use the arrow keys to navigate to the "Calibration Constants" menu on the 3430;
7. When prompted, enter the Calibration Code (4678) using the UP and DOWN buttons, press ENTER when complete;
8. Press the START/ENTER button on the 3430 to enable it to accept the constants;
9. Click the "Start" button in the CaliBrator Software;
10. When the download is complete, disconnect the download cable from the 3430, click the "Disconnect" button in the CaliBrator Software, then Replace the front panel to the gauge base;
11. An indication that the constants were successfully downloaded is the 3430 will display "12 inches" after the download regardless of what it was previously set;
12. The constants are now downloaded and stored in your gauge; you may QC the gauge to ensure your calibration is correct.

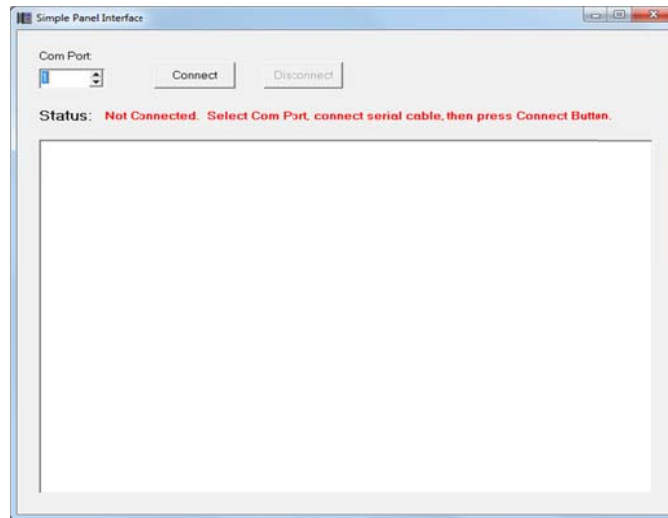


## Troxler 3440

1. Ensure the BAUD RATE in the 3440 is set to 2400, refer to the 3440 operation manual for guidance on changing this setting;
2. Remove the front panel from the gauge; leave the front panel connected to the base;
3. Connect the download cable to the port on the left side of the LCD;
4. Click the "Gauge" Button in the software;



5. The Download box will open, select the COM port the download cable is connected (refer to your computer's system setup for this information);



6. Click the "Connect" button;
7. The gauge will need to be put in "Remote Control" Mode. Press SHIFT then SPECIAL on the 3440 keypad, key in "19" (number one then number nine), enter the Special Menu Access Code (4688), select option the "Remote Control" option (menu item number 11);
8. Click the "Start" button in the CaliBrator Software. An indication that the constants are successfully downloading is the 3440 may display the constants (not all 3440s will do this);
9. When the download is complete, disconnect the download cable from the 3440, click the "Disconnect" button in the CaliBrator Software, replace the front panel to the gauge base, power off, then power on the gauge;
10. The constants are now downloaded and stored in your gauge; you may QC the gauge to ensure your calibration is correct.

## Manually Inputting Constants to a Gauge:

### InstroTek 3500, SmartPanel (3411), and CPN/InstroTek Elite

1. Press MENU on the front panel;
2. Use the UP and DOWN keys, select Calibration Constants;
3. Input the Calibration Constants Access Code (4659) then press ENTER;
4. Input the constants for moisture (E & F) using the UP and DOWN buttons to change the number, press ENTER to save your changes;
5. Use the UP and DOWN keys to select the depth to input the density constants (A, B, & C);
6. Press the ENTER key to save your changes;
7. The constants are now stored in your gauge; you may QC the gauge to ensure your calibration is correct.

### CPN MC-1 DRP

1. The MC-1 DRP needs to have software version 87SE, if not contact InstroTek for an update;
2. Press the MAX/ENTER and START/EXIT keys simultaneously;
3. Press the STEP key until you see "Change Constant?" displayed on the LCD;
4. Press the ENTER key, the gauge will ask for an access code (2008), use STEP and STD to select numbers, press ENTER to accept the code;
5. The gauge will display which constants to change (moisture or density), use the STEP key to scroll to the constant to change;
6. Use the STEP and STD keys to change the constants;
7. Press the ENTER key to accept the changes;
8. Repeat steps 5 through 7 for each depth/constant you wish to change;
9. Press EXIT when all changes are complete;
10. The constants are now stored in your gauge; you may QC the gauge to ensure your calibration is correct.

### **CPN MC-3**

1. While holding yellow "Step" button press "Calib(3)" button on bottom right of keypad. This will access the calibration menu. (Note: While in this menu the "Step" button either moves the cursor or changes the depth selection. "Enter" will grant access to what the cursor is currently on or will finalize an edited value such as A, B, or C constants. "Clear" will return you to the main calibration menu or will exit you from the main calibration menu.);
2. Press "Enter" on wet coefficients to access A, B, and C for each respective depth;
3. Once in this menu select the depth you wish to change constants at by pressing "Enter" once you have selected a depth using the "Step" button;
4. Once you access this depth edit the values for A, B, and C to reflect the new constants from your new calibration report. Press "Enter" once done editing each value(A, B, C) to move onto the next value to edit. Once done editing values for the selected depth the cursor will automatically return to depth selection;
5. Once you are done editing A, B, and C values for each depth press the red "Clear" button once to go back to the calibration menu;
6. Press "Step" once to move the cursor to "h2o coefficients" then press "Enter" to access these coefficients;
7. Moisture coefficients "A" and "B" are edited the same way as above. Press enter once done editing "A" and "B" to return to the calibration menu;
8. Press "Clear" to exit calibration menu. You are now done with updating your MC<sub>3</sub> with new calibration constants;
9. The constants are now stored in your gauge; you may QC the gauge to ensure your calibration is correct.

### **Troxler 3430**

1. Press SPECIAL on the 3430 keypad;
2. Use the arrow keys to navigate to the "Calib. Constants" menu;
3. Input the calibration constant access code (4678), press ENTER;
4. Input the moisture (E & F) constants, use the arrow keys to change the constant and the ENTER key to accept the changes;

5. Select the depth and enter the density (A, B, & C) constants, use the arrow keys to change the constant and the ENTER key to accept the changes;
6. Press the OFF/NO key to return to the ready screen when the changes are complete;
7. The constants are now stored in your gauge; you may QC the gauge to ensure your calibration is correct.

#### **Troxler 3440**

1. Press SHIFT then SPECIAL on the 3440 keypad;
2. Key in "19" (number one then number nine);
3. Enter the Special Menu Access Code (4688);
4. Use the arrow keys to navigate to the "Calib. Constants" menu;
5. If prompted, input the calibration constant access code (5936), press ENTER;
6. Follow the screen prompts to input the moisture (E & F) constants, use the number keys to change the constant and the ENTER key to accept the changes;
7. Follow the screen prompts to select the depth and input the density (A, B, & C) constants, use the number keys to change the constant and the ENTER key to accept the changes;
8. Press the OFF/NO key to return to the ready screen when the changes are complete;
9. The constants are now stored in your gauge; you may QC the gauge to ensure your calibration is correct.

#### **Troxler 4640**

1. Press SHIFT then SPECIAL on the 4640 keypad;
2. Key in "19" (number one then number nine);
3. Enter the Extended Functions Menu Access Code (528);
4. Choose option 4 to enter the Calibration Constants menu;
5. Input the constants from the new calibration report;
6. Return to the Extended Functions Menu and choose option 5 "Calibration Date";
7. Input the calibration date from the new calibration report;

8. It is also a good practice to ensure the current Date and Time are correct (refer to the manufacturer's operation manual for guidance).
9. Return to the Extended Functions Menu and choose option 7 "Calibration STD";
10. Input the calibration standard counts from the new calibration report;
11. The constants are now stored in your gauge; you may QC the gauge to ensure your calibration is correct.

### **Troxler 3450**

1. Press SHIFT then SPECIAL on the 3450 keypad;
2. Key in ".9" (decimal key then number nine);
3. Enter the Factory Menu Access Code (8148);
4. Choose option 3 to enter the Calibration Constants menu;
5. Input the constants from the new calibration report;
6. Return to the Factory Menu and choose option 2 "Calibration Date";
7. Input the calibration date from the new calibration report;
8. It is also a good practice to ensure the current Date and Time are correct (refer to the manufacturer's operation manual for guidance).
9. Return to the Factory Menu and choose option 4 "Calibration STD";
10. Input the calibration standard counts from the new calibration report;
11. The constants are now stored in your gauge; you may QC the gauge to ensure your calibration is correct.

### **Humboldt EZ**

1. Turn Power ON;
2. Press MAIN MENU;
3. Press F<sub>3</sub> (Engineering);
4. Press F<sub>1</sub> (Calibrate);
5. Enter Password F<sub>2</sub>, F<sub>2</sub>, F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub>;
6. Press F<sub>4</sub> to change constants;
7. Press F<sub>1</sub> to change the A, B, & C constants;

8. Press F<sub>2</sub> to move between the A, B, & C constants, press F<sub>1</sub> to select which number in the constant to change, press F<sub>2</sub> to increment up and F<sub>3</sub> to increment down;
9. Press F<sub>4</sub> to move to the next depth;
10. After the calibration constants have been changed, press MAIN MENU;
11. Remove the Protect Jumper (JPI);
12. Press F<sub>3</sub> (Save User Constants);
13. Replace the Protect Jumper (JPI);

Note: The JPI is a small black plastic jumper located at the upper right-hand side between the keyboard and the CUP board. Refer to the manufacturer's operation manual for more guidance.

**Gauges that require an EPROM:**

Troxler 3411B and Humboldt 5001 series (not including the EZ) utilize an EPROM (Erasable Programmable Read Only Memory) Chip. The service center performing the calibration will need to invest in an EPROM programmer and software to complete the programming. Contact InstroTek for more information about these items. InstroTek can provide the service center with a programmed chip, provided the service center has sent the calibration report to InstroTek. There is a fee for each gauge that requires an EPROM to be programmed along with shipping and handling fees. Please contact InstroTek for more information about this service.

The EPROM can be damaged by static electricity, thus, be sure to ground yourself while removing or installing the EPROMs into the gauges.

Ensure when removing the EPROM care is taken to notate the position of the notch on the EPROM—when installing the new EPROM the notch needs to be in the same position.

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## Calibration Quality Control

Calibration involves numerous steps that have to be performed accurately by the operator. To ensure counts collected during the calibration process are correct and the new calibration constants are properly burned or entered into the gauge, it is important that a newly calibrated gauge be checked. The best method to Quality Control (QC) or verify the gauge moisture and density calibration is to use an independent block such as the InstroTek ValiDator. If a ValiDator is not available, we recommend you re-take one minute readings on all three CaliBrator blocks at all measurement depths. The current criteria for acceptability of the calibration, in ASTM and AASHTO standards, is to ensure the gauge density readings are within  $\pm 16 \text{ kg/m}^3$  ( $1 \text{ lb/ft}^3$ ) on the blocks that the gauge was calibrated on.

When verifying a calibrated gauge on the CaliBrator blocks, keep in mind that different manufacturers use different normalization factor for their gauges. Normalization factor is simply defined as the value multiplied by the metal block densities to generate the most accurate "Average Soil" calibration response or curve. Since these gauges are not used for measurement of metals in the construction industry, normalization factors are used as a way to correct or shift the metal curve to produce an "Average Soil" curve. Normalization factors are largely dependent on the block material composition. However, gauge geometry also has an effect on the normalization factors used by each gauge manufacturer.

When using the CaliBrator blocks for QC or verification of the gauge calibration, the factors in the Table of CaliBrator Normalization Factors should be used. To determine the correct QC values for a particular gauge, simply multiply the factors in the table below for each gauge model by the actual block density provided by InstroTek for the CaliBrator blocks. There are no normalization factors for moisture. Therefore the gauge should read the moisture value provided for the block and the range for this reading according to ASTM and AASHTO standards should  $\pm 8 \text{ kg/m}^3$  ( $0.5 \text{ lb/ft}^3$ )

Example: To determine the correct gauge wet density (WD) range for Troxler 3430 on Magnesium (low) block,

Gauge Wet Density (WD) =  $0.988 \times \text{Actual block density}$

If the provided low block density is  $1778 \text{ kg/m}^3$  ( $111.0 \text{ lb/ft}^3$ ), then the gauge readings should be  $1757 \text{ kg/m}^3$  ( $109.7 \text{ lb/ft}^3$ ). In this case the QC or the verification range for this block after calibration for Troxler 3430 should be  $1741$  to  $1773 \text{ kg/m}^3$  ( $108.7$  to  $110.7 \text{ lb/ft}^3$ ) at all gauge depths.



If the wet density and moisture reading on your gauge is outside the acceptable range, repeat the count at the failed depth. If the new count and density readings are still outside the QC range, check the following:

- 1- The standard count vs. calibration standard count. Retake your verification standard count, if more than  $\pm 0.5\%$  different from the calibration standard count.
- 2- Counts taken on the block at the failure depth vs. calibration counts at the same depth. Retake a four minute count at the failed depth and compare the calibration count at the same depth. The counts should be within  $\pm 0.5\%$
- 3- Make sure the constants in the gauge match the values reported for the calibration
- 4- If counts have changed significantly from the time the calibration was performed. Check the gauge electronics and re-calibrate if necessary.

Note: when gauges are calibrated, they will have different normalization factors, as displayed below. These factors are used in the CaliBrator program to normalize the calibration curve obtained by using metal blocks to appear like average soil or asphalt (for 4640 and 3450 thinlayer mode). When measuring a specific gauge on the CaliBrator block, multiply these factors by the density values provided on your certificate and compare the values to the readings displayed on the gauge.

Table of CaliBrator Normalization Factors

Gauge Model	Magnesium (Low)	Aluminum Polyethylene (Med)	Aluminum (High)
CPN MC Series	0.976	0.971	0.974
Humboldt 5001 Series and EZ	0.979	0.990	0.957
InstroTek 3500 Xplorer	0.988	0.990	0.964
Troxler 3401, 3411, 3430, 3440, 3430+, 3440+, 3450	0.988	0.990	0.964
Troxler 3450 Thinlayer mode	0.988	0.995	0.949

Troxler 4640	0.988	0.995	0.949
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## Theory of Operation

### Gauge Calibration Theory

Nuclear density gauges utilize two systems that are used to calculate an in-place density and moisture content of construction materials. The density system generally uses Cesium 137 and detector tubes which output analog signals that are converted to counts by a micro-processor inside the gauge. Moisture systems use a neutron source of Americium-241: beryllium and a detector tube that also generate signals that are converted to counts. The calibration process establishes a relationship between these raw counts and known densities and moisture content references. In the construction density range, the higher the density, the lower the counts. For moisture, the counts increase with increasing moisture content.

### Density Calibration

Currently most gauge manufacturers recommend a three block calibration. The density calibration method used by most manufacturers utilizes an exponential equation that models the relationship between the known densities and the counts. CPN, Humboldt, InstroTek and Troxler use an equation such as.

$$CR = A \exp(-BD) - C$$

Where A, B and C are gauge parameters, CR is the count ratio and D is the material density. The A, B and C values are commonly known as calibration constants. To determine these unknown constants from the above equation, counts on a minimum of three known density blocks are required. Once these values are determined during calibration, in the field a count is collected on the test material, the resulting wet density displayed on the screen is calculated by rearranging the above equation:

$$D = \frac{1}{B} \ln\left(\frac{A}{CR + C}\right)$$

### Moisture Calibration

Gauge moisture calibration is performed by utilizing at least two blocks of known hydrogen density covering a range of moisture in the construction materials. The two blocks routinely used for moisture calibration are magnesium (0 lb/ft<sup>3</sup>) and a combination block of magnesium or aluminum and polyethylene. The gauge standard count along with the counts on these blocks are used in a linear equation such as

to calculate the parameters  $MCR = E + FM$  E (intercept) and F (slope). MCR is the count ratio, which is the ratio of the measured counts and the daily reference standard count. The daily reference standard count is performed on a high-density polyethylene block provided with each gauge. M is the test material moisture content. The E and F parameters are placed in the gauge memory and are used in the field with the count ratio obtained on the test material to calculate the moisture content from the equation.

$$M = \left( \frac{MCR - E}{F} \right)$$

## Maintenance

The CaliBrator does not need any routine maintenance other than surface cleaning using a mild cleaner (such as 409<sup>®</sup>) to remove any grease or dirt that may build up on the top surface or around the source rod hole.

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## Warranty

1. **INSTROTEK** extends a **1-YEAR LIMITED WARRANTY** on the CaliBrator to the original purchaser of this equipment. This warranty covers defects in *material, workmanship, operation under the conditions of normal use, and proper maintenance*. *This warranty includes all components EXCEPT for any normal wear components.*
2. **INSTROTEK** will replace, free of charge, any part found to be defective within the warranty period. This warranty is void if inspection shows evidence of abuse, misuse, or unauthorized repair.
3. *THIS WARRANTY COVERS REPLACEMENT OF DEFECTIVE MATERIALS AND WORKMANSHIP ONLY.* It *DOES NOT COVER* shipping charges and/or duties or taxes in the transport to *and* from the factory or authorized service center. If return of the product to the owner is necessary, please include return shipping instructions, contact name, phone number, and a description of the action needed.
4. **INSTROTEK's** liability is in all cases limited to the replacement price of this product. **INSTROTEK SHALL NOT BE LIABLE FOR ANY OTHER DAMAGES, WHETHER CONSEQUENTIAL, INDIRECT, OR INCIDENTAL ARISING FROM USE OF THIS PRODUCT.**
5. Call InstroTek, Inc. for shipping details at (919) 875-8371.



***Contact us for top quality, best value and superior service!***

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