

InstroTek<sup>®</sup> Incorporated

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# ValiDator User Guide



**InstroTek<sup>®</sup>  
Inc.**

**Innovators In Instrumentation Technology**



# ValiDator™ & VeriFier™ Software User Guide

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**InstroTek®**, Incorporated

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U.S. Patent #'s 5,923,726 and 6,050,725

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## **Congratulations!**

We are happy and proud to share this Nuclear Moisture/Density Gauge calibration technology with you. ValiDator is the first portable verification and calibration system in the industry. InstroTek, Inc. would like to thank you for selecting the *ValiDator* as your field verification and calibration device. The ValiDator Technology is covered by US Patent numbers 5,923,726 and 6,050,725 including International patents.

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

This guide is designed as a reference for the operation of the *Verification and Calibration System*. A thorough understanding of the operation and application of Nuclear Moisture/Density gauges is necessary.

Please follow the nuclear gauge manufacturer recommendations with regard to operation and safety concerns of these devices. All ValiDator operations should be done from the end opposite the gauge source, stepping away three feet while the source rod is in the measure position.

### **Why the ValiDator?**

The American Society for Testing and Materials (ASTM) standards specifies a nuclear density gauge calibration verification or re-calibration interval of 12-18 months. In the absence of a field portable validation device, this commonly would require returning a gauge to the manufacturer or other calibration facilities. Strict shipping formalities, weeks without a gauge, and expensive calibration fees creates a burden on gauge field availability.

Gauge owners have never had the option before of performing the verification and re-calibration in the field. The *ValiDator* from InstroTek, Inc. is designed to optimize the management of your gauge resources and help reduce inconsistencies when multiple gauges are on-site. Multiple gauges calibrated on the same device will reduce conflicts between results.

### **How to use the ValiDator?**

As easy as taking a field measurement, just place your CPN, Humboldt, InstroTek or Troxler gauge on the ValiDator device and take a reading. Compare the gauge wet density and moisture (M pcf) to the pass/fail range on the ValiDator Calibration Sheet and your verification is complete.

Even if the gauge Verification fails, the *CaliBrator* option would allow you to eliminate the present delay in calibration turn-around-time. Calibrate one depth or all in minutes.



## Supported Nuclear Gauges

It is important when you Verify or Calibrate your gauge that the correct chart and values are selected. If there are gauges in your fleet that are not supported on this list, you may establish guidelines for Verification of these gauges. (Reference Verification Procedures For Gauges not Supported page 31)

### CPN

MC3 New, MC1 DR New: Gauges manufactured with two GM detectors. Standard counts are generally between 30000 & 40000 counts.

MC3, MC1 DR: Gauges manufactured before approximately 1996 with one GM detector. InstroTek currently does not support these gauges. Standard counts are generally between 10000 & 20000. Please contact InstroTek for more information on this gauge model or reference Verification Procedures for Gauges not supported page 31.

MC1: InstroTek currently does not support verification of this gauge. Please contact InstroTek for more information on this gauge model or reference Verification Procedures For Gauges not Supported page 31.

MC2: InstroTek currently does not support verification of this gauge. Please contact InstroTek for more information on this gauge model or refer to manual section Verification Procedures for Gauges not supported page 31.

### Humboldt

5001 B, 5001C, 5001P, and EZ are supported.

***Note: For 5001 gauges with serial numbers less than 500 please contact InstroTek.***

### InstroTek

Model 3500 Xplorer is supported.

### Troxler

3401 & 3411: These gauges are only different in electronic functionality. Both these gauges are supported by the ValiDator.

3430 & 3440: These gauges are only different in electronic functionality. Both these gauges are supported by the ValiDator.

3411 New (Very few gauges were produced, serial numbers greater than 17000)

3450: Please contact InstroTek for instructions on how to calibrate these gauges.

4640: Not supported by the ValiDator I. The ValiDator II available from InstroTek is specifically designed for calibration of 4640B gauges. Please contact InstroTek for information on how these gauges can be calibrated



# User Guide Introduction

## Term Definitions

ValiDator:	Device used to verify and calibrate nuclear gauges.
Validation:	Utilizing the ValiDator device to evaluate a gauge calibration accuracy at multiple depths, at an assigned density.
Verification:	The process of using the Validation System to verify the calibration accuracy of a nuclear density gauging device.
Calibration:	The process of re-establishing the calibration parameters for a nuclear density gauging device.
Calibration Constants:	Parameters established by the calibration program and used by a density gauge to calculate density and moisture.
ValiDator Density:	Factory established densities assigned to a specific Validator device. Each measurement depth 0-12 has an assigned density.

The ValiDator calibration is not exchangeable between ValiDator units.

### **Safety**

- Always operate in accordance with the nuclear gauge manufacturer recommendations.
- Stand opposite the source rod when operating the ValiDator Device.
- Move three feet (one meter) back when the source rod is extended into the measurement position.
- Use proper lifting techniques when loading and unloading the ValiDator.
- Be aware of heavy machinery operating in the area of testing.

**Important: Follow the requirements of your nuclear materials license when operating, maintaining and using nuclear gauges.**



## Quick Start Instructions

The quick start instructions will benefit the new and the experienced operators using the ValiDator System. The System Operation portion of this manual contains detailed information about all aspects of the ValiDator system. The Validation system is designed for use with various nuclear gauges manufactured by CPN (MC3 & MC1-DR), Humboldt (5001 Series), InstroTek (3500) and Troxler (3401,3411,3430 and 3440).

### Procedure:

*Important: Observe manufacturers recommendations regarding safety precautions when operating density gauges. Stand opposite the source rod at a distance of three feet or 1 meter when measurements are being taken. Follow the requirements of your nuclear materials license.*

**Standard Counts for Daily or Rapid Verification:** If you are evaluating your gauges frequently for Quality Assurance, or will not be calibrating on-site, a daily 4 minute standard count may be used for the Standard counts on the Evaluation Form for Verification. Take one 4-minute count at all other depths.

**Standard Counts for Combination Verification and Calibration:** If you will be performing a scheduled Verification or Calibration and would like to optimize the data collection process, perform an Extended Standard Count. (CPN: 20 minute count recording the Wet Count and H<sub>2</sub>O Count. Humboldt and Troxler: Perform a Stat Test and record the average Density and Moisture count.) Record the Standard Counts on the Evaluation form. Two 4-minute counts should be averaged for Backscatter (BS) and Depth 12 measurements, due to the relatively lower precision at these positions.

### I. Verification Process

- A. Align gauge on the ValiDator. For lowering the Source rod slide the gauge back until the rod is over the access hole. (See Gauge Placement page 11)
- B. Set count time for four (4) minutes. *Note: All moisture verification is done at the Backscatter position.*
- C. Backscatter measurements should be taken with the gauge aligned with the surface stops; two four-min. counts should be averaged for better precision.
- D. Direct Transmission measurements require that the gauge placement be adjusted to minimize the void between the source rod and the inside of the ValiDator. After lowering the source rod move it towards the control panel end of the gauge and to the left side alignment stops. Two 4 min. readings at depth 12 should be averaged for better precision.
- E. Complete a four (4) minute reading and record the gauge results WD, M, DC and MC on the ValiDator Evaluation Form (page 13). Make additional blank copies of this form for future use.
- F. The Wet Density (WD) and Moisture (M) readings from the gauge should fall between the range indicated on the gauge specific ValiDator Calibration Data Table.
- G. If the resulting densities indicate the gauge passes, consider the verification process complete. The gauge is now verified for field use.
- H. If the gauge fails Validation, review precautions and repeat Validation steps A-G
- I. A second failure would indicate that a calibration is needed.

## II. Calibration Process

*Note: Gauge Calibration is a sophisticated process and should only be attempted by advanced gauge users. Please refer to the Calibration Section of the Manual for calibrating gauges.*

### **Precautions before You Begin**

**Nuclear gauge:**      *Note: Do not take a Standard Count on the ValiDator.*

- Clean Base
- Record the Current passing standard count in the field location where Validation is to be performed.
- Count time set to four (4) minute counts
- Stable Gauge Electronics (Run the manufacturer recommended diagnostics if field results are questionable.)
- No other gauges should be within 30ft (10 meters) of the testing area.
- When taking measurements stand opposite the source side of the unit a distance of three feet (1 meter) away.
- Gauge positioned correctly on the ValiDator. (Refer to Gauge Placement page 11)
- Gauges meet the requirements for Supported gauges? (Refer to User Guide page 5)

**ValiDator Device:**

- Top surface free of debris
- Placed on solid level surface, three feet from any vertical structure.
- \* Tailgates, Carpeted floors, upper floors of buildings, trailers, and uneven surfaces are not acceptable.

### **Equipment**

Items required for Verification and Calibration: ValiDator Device, ValiDator Density Data (In shipping case), ValiDator Evaluation Form (page 13 of user guide), stable nuclear gauge, current gauge calibration data (for calibration option)

## **Gauge Placement**

Nuclear gauges differ between manufacturers. It is important to align each gauge using the positioning stops on the top and left of the ValiDator.

## **Backscatter & Moisture Readings**

All Backscatter (Depth 0) and Moisture readings should be taken with the gauge flush with the stop at the top and on the left as shown below.



## **Direct Transmission (Depths 2-12) Readings**

Direct Transmission (Depths 2-12) readings require the gauge to be positioned such that the void between the source rod and the inside of the ValiDator block is minimized. Slide the gauge back until you can drop the source rod in the hole on top of the ValiDator. Once the source rod drops in the hole, make sure to keep the gauge flush with the left stop and slide the gauge back away from the top stop until it can't move any further





# Validator Evaluation Form

Validator S/N \_\_\_\_\_ Verification/Calibration Date: \_\_\_\_\_

Gauge S/N \_\_\_\_\_ Operator: \_\_\_\_\_

Gauge Model \_\_\_\_\_

Daily Standard Counts DS \_\_\_\_\_ MS \_\_\_\_\_

Calibration Standard Counts DS \_\_\_\_\_ MS \_\_\_\_\_

Count Time 15 sec 1min 4 (Recommended) 16 20 Circle one

<u>Depth</u>	Pass	<u>WD</u>	Fail	<u>DC</u>	Gauge at Backscatter Stop		<u>MC</u>	
					Pass	<u>M</u>		Fail
BS	P	_____	F	_____	P	_____	F	_____
BS	P	_____	F	_____	P	_____	F	_____
BS Avg.	P	_____	F	_____	P	_____	F	_____
2	P	_____	F	_____				
3	P	_____	F	_____				
4	P	_____	F	_____				
5	P	_____	F	_____				
6	P	_____	F	_____				
7	P	_____	F	_____				
8	P	_____	F	_____				
9	P	_____	F	_____				
10	P	_____	F	_____				
11	P	_____	F	_____				
12	P	_____	F	_____				
12	P	_____	F	_____				
12 Avg.	P	_____	F	_____				

Notes/Re-counts: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## Example of a Gauge Calibration Sheet

① Factory Calibration Company Name

Gauge Model: 3411  
 Serial Number: 832.②  
 ③

Ref standard count: density - 3311  
 moisture - 668 ④

Calib date: 10-29-2002 ⑤ Bay - 47  
 Print date: 10-29-2002

\*\*\* Density calibration count data \*\*\*

Depth	Magnes 111.2 ⑦	Mag/Al 137.2	Alum 170.0
-----	-----	-----	-----
BS	1588	1035	688
2	5182	3367	2102
4	5229	3225	1868
6	4249	2427	1287
8	2959 ⑧	1544	753
10	1876	884	397
12	1096	475	205

\*\*\* Density performance parameters \*\*\*

Pos	A	B	C	Y'	Slope	Prec
---	---	---	---	---	---	---
BS	6.546	0.02647	-0.12228	137.2	21.0	0.41
2	15.633	0.02248	-0.24209	137.2	70.1	0.22
4	17.947 ⑥	0.02306	-0.15413	137.2	76.7	0.20
6	21.763	0.02658	-0.10946	137.2	69.1	0.20
8	24.413	0.03088	-0.07260	137.2	52.6	0.21
10	26.825	0.03586	-0.04471	137.2	36.0	0.24
12	26.046	0.04054	-0.02801	137.2	22.0	0.29

\*\*\* Moisture calibration count data \*\*\*

Mag	Mag/poly	SR
---	---	---
0.0	35.9	
22	409	399

\*\*\* Moisture performance parameters \*\*\*

E	F	Rat	Prec	SR	Exerr
-----	-----	-----	-----	-----	-----
0.03293 ⑨	0.01614	3.13	0.32	-0.9	0.9

---

## **Example Gauge Calibration Sheet Key**

- 1) Make (CPN, Humboldt or Troxler)
- 2) Model
- 3) Serial Number
- 4) Calibration Standard Counts
- 5) Calibration Date
- 6) Factory Density Constants (A, B, C Parameters)
- 7) Calibration Block Densities lb/ft<sup>3</sup> or kg/m<sup>3</sup>
- 8) Calibration Block Counts
- 9) Factory Moisture Constants  
(E & F or A & B)



## **Chapter 1: Getting Started**

Unpacking-Inspection-Warranty

List of Equipment & Accessories

Application Summary



## Unpacking and Inspection

Inspect the exterior of the shipping container for damage. Save the carton if damage is observed.

Remove system components from the container and inspect for damage. If damage is discovered notify the shipping agent and InstroTek immediately, saving all packaging for evaluation.

### List of Equipment & Accessories

- User Guide
- ValiDator (Calibration Box)
- ValiDator Density Data (Laminated Sheets)
- Quick Start Instructions
- NIST Certificate

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

### List of Optional Accessories

- VeriFier Software (1 CD)
- 3430 and 3440 constant download cable
- InstroTek 3500 gauge constant download cable
- Prom Eraser

## Warranty

InstroTek products are guaranteed against defective material and workmanship for a period of 12 months from the date of receipt by the customer.

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.

This warranty covers replacement of defective materials and workmanship only. It does not cover shipping charges, duties or taxes in the transport to and from the factory or authorized service center.

If return of the product is necessary please include return shipping directions, contact name, phone & fax number and a description of the action needed.

Call InstroTek to verify shipping address: (919) 875-8371



## Application Overview

### Verification & Calibration Process

There are several steps necessary to accomplish a gauge verification and calibration. Gauge calibration verification is the most fundamental use of the ValiDator device. Position a density gauge on top of the ValiDator device, take a four (4) minute density reading and evaluate the resulting density using the laminated gauge specific ValiDator Density Data Table provided.

The steps below describe a procedure within the Verification and Calibration process. Density and Moisture gauge data is required by the VeriFier Software and should reflect the most recent calibration. If not available, this data may be obtained from the organization that completed this calibration.

Calibration constants are used by the gauges to perform the calculations necessary to process raw count data into a density. Density and moisture tables may be used for any gauge, but are more common with units that do not have internal memory or an internal processor. Gauge manufacturers use NVRAM (Non-Volatile Random Access Memory) or EPROM's (Erasable Programmable Read-only Memory) in their gauges.

Calibration constants may be entered into a gauge (CPN MC3, Humboldt EZ, InstroTek 3500 and Troxler 3430,3440) using the operator keypad. Units that employ EPROM's (Troxler 3411 and Humboldt 5001 series) may operate using density tables while an EPROM is programmed and mailed for installation. InstroTek can program EPROM's for your gauges. Simply fax or mail the Calibration Constants Report and InstroTek will program and ship your EPROM by Priority Mail for a nominal charge. You can also purchase a Prom Programmer Package to burn proms at your facility. There is an option available on 3401 and 3411 gauges that you can use to allow direct entry of constants through the keypad. SmartPanel from InstroTek is a "drop in" replacement for the existing 3401 and 3411 scalars. SmartPanel upgrades the 3401 and 3411 gauges with many features, including direct entry of calibration constants through the keypad. For more information on the InstroTek SmartPanel, please visit our website at [www.InstroTek.com](http://www.InstroTek.com).



## **Chapter 2: Software Installation**

Hardware Requirements

Operating System

Windows 98, 2000 and XP

Upgrading Version

Moving Program and Database



# Hardware Requirements

Computer Requirements: Windows 98, 2000, XP

## Installing *VeriFier* Software on a PC

Object: Allow the operator to access the software and re-calibrate a nuclear gauge.

Support: Before loading any software, consult with your organization PC Manager or operating system manuals.

Locate your program disk included with your *Validator* system. Please read license agreement before opening software package. This software should only be loaded on one computer. Access codes will be needed to complete installation.

**NOTE:** **Validator and its' associated software is licensed to a single user. Use of the Validator and its' associated software is not allowed for calibration of gauges from other organizations.**

### Windows

1. Install the CD into the Drive and allow time for auto start to load.
2. Follow prompts, click finish when complete.
3. Call for registration codes:
  - Enter Main Registration Code
  - Click on Calibrate and enter Calibration Registration Code
  - Enter Password "calibratenow" or "calnow"
  - Provide Product Key to InstroTek service Representative
  - Enter Product Code

### Renewal of 30 Verifier Count software

1. You may purchase software renewal in blocks of 30.
2. From the Calibration pull down menu select Manager.
3. Record the Product Key, (28 numbers, symbols and letters including dashes and decimals) and number of calibrations remaining. Call InstroTek for code.
4. Receive Code and enter to renew calibrations.

## **Upgrading Software Version**

You may load the new software version directly over the existing version and not lose your existing data.

- Close all Windows programs.
- Follow the Install instructions for the version operating system used.
- Follow prompts

## **Moving Software**

- VeriFier software may only be installed on one computer.
- Moving to another computer is possible. Please contact InstronTek for procedures and access codes.



## **Chapter 3: System Operation**

Calibration Accuracy Verification Process

Verification

Calibration

Supported Nuclear Gauges



# Calibration Accuracy Verification & Calibration Process

## Verification Process

Verification of the gauge is necessary to determine the status of the gauge calibration. Gauges are calibrated when they are shipped from the manufacturer. Without performing periodic verification, it is not possible to assess the accuracy of your gauge calibration. ASTM standards require gauges to be verified for calibration accuracy at least once every 12 months and also the calibration is checked on newly acquired or repaired nuclear gauges. With the ValiDator, gauges may be verified to meet this requirement.

## Verification

**Definition:** Use the reference densities assigned to a ValiDator device for evaluating the calibration accuracy of a density gauge.

**Resources:** ValiDator Device, Gauge Field Evaluation Form, ValiDator Calibration Tables, \*Density Gauge, \*\*Stable surface.

**Important:** Follow the requirements of your nuclear materials license when operating, maintaining and using your gauge.

## Calibration

Calibration is a process of calculating new parameters for the nuclear gauge. Calibration is a sophisticated process. Advanced users with a high degree of experience and understanding of gauge measurement and operations should only perform this process. It is recommended that one individual in an organization be responsible for the calibration process. The Verifier Software with counts taken on the ValiDator can be used to generate new moisture and density calibration constants for the gauge.

**Resources:** InstroTek VeriFier Software, PC, Completed Evaluation Form, \*Density Gauge, Gauge Calibration Constants, \*\*Stable surface

**Note:** *The VeriFier Software used for calibrating your gauge assumes that the current gauge calibration information is obtained and entered accurately.*

## Moisture Calibration

The ValiDator is engineered to provide moisture verification and calibration in pcf or kg/m<sup>3</sup>. The nuclear gauge moisture calibration process differs from density in that the moisture calibration is a straight line and rarely will need to be re-calibrated. However, the verifier software provides the capability for the moisture calibration of the gauge.

\*Density Gauge: A gauge qualified for evaluation should meet the requirements below:

- gauge base should be free of asphalt or debris that would cause the unit to rock,
  - pass the manufacturers recommended statistical stability and drift tests, and
  - pass a standard count at the evaluation site.
  - no other nuclear gauges should be within thirty (30) feet.
  - make sure proper recommended maintenance steps are taken prior to calibrating gauges.
- \*\*Stable Surface:
- be at least three (3) feet (1M) from any vertical structure.
  - dry and level,
  - have a density of greater than 100pcf (1602 Kg/m<sup>3</sup>).
  - Parking lots and construction sites are ideal surfaces for testing.

Unacceptable surfaces would be as follows: trailer floors, truck tailgates, second story floors, wet surfaces with standing water or carpeted floors.

## **Verification Procedures**

### **Gauge Evaluation**

- The gauge base should be free of dirt and debris, no other nuclear gauges near by, 3 ft (1 m) from any vertical structure, on a stable surface.
- Pass the manufacturers statistical stability test or ASTM recommendations in D6938 and/or AASHTO T310
- Complete and pass a four (4) minute standard count in the area where verification tests are being conducted

**Refer to the gauge operator's manual for gauge cleaning, routine maintenance and evaluation procedures.**

### **Site Preparation and Gauge Placement**

- Select a flat, level and dry surface with a density greater than 100 lb/ft<sup>3</sup> (1602 Kg/m<sup>3</sup>) three (3) feet from any vertical structure. Note: Soil, asphalt or concrete are good examples of the surface to place the ValiDator for testing. Parking lots or open fields are recommended locations for testing.
- Remove ValiDator from shipping case, place unit on selected area, position handle at bottom stop.
- Take a Daily or Calibration Standard Count (see page 9 for difference) and Record on ValiDator Evaluation Form. Do not take the Standard Count on the ValiDator.
- Align the density gauge on the top of the ValiDator using the specific guides on top of the ValiDator device. (See Gauge Placement page 11) Backscatter readings should be measured in contact with alignment stop. After lowering the source rod for direct transmission, position the gauge to the rear of the ValiDator device against side stops to reduce the air void between the source and material being read.
- Select the specific ValiDator Density data table for the model nuclear gauge under test.

NOTE: Do not take standard counts on top of the ValiDator.

## Verification Procedure for Gauges Not Supported By The ValiDator

For gauges not supported you can establish a history and determine when each individual gauge falls outside a  $\pm 1\%$  limit. Observe the following procedure to establish a verification process for gauges not supported.

### Example:

Depth	A	B	C	D	E	F
Date	12/7/98	6/7/99		12/7/98	6/7/99	
	S/N 7022	S/N 7022	Difference PCF			Dif.
			$B - A$			$E - D$
BS	150.2	150.6	0.4	5.6	5.7	0.1
2	118.5	117.6	-0.9			
4	136.2	135.2	-1.0			
6	132.1	132.0	-0.1			
8	125.0	125.5	0.5			

1. Send your gauge to a calibration facility for a calibration.
2. When you receive the gauge take a four-minute Standard Count. Use the following form or generate your own spread-sheet program.
3. Take four minute WD and M readings on the ValiDator at each depth and enter in column A and D as baseline readings.
4. At a later date, for example, every six months take readings and store in B and E.
5. Compare A to B, D to E and place in C and F
6. If any of the WD numbers are outside of  $\pm 1 \text{ lb/ft}^3$  ( $\pm 16 \text{ Kg/m}^3$ ) difference or M outside  $\pm 0.5 \text{ lb/ft}^3$  ( $\pm 8 \text{ Kg/m}^3$ ), take readings again. If it fails again, the gauge needs to be calibrated.

**Note:** *This procedure assumes that the Calibration received is accurate. For re-calibrating these gauges contact InstroTek.*







## Verification Measurements and Data Evaluation

Reports may be generated using the VeriFier Software.

- Complete a single four (4) minute reading at the desired depth(s) under evaluation, and record the Wet Density (WD) Density Count (DC) Moisture (M) Moisture Count (MC) on the ValiDator Evaluation Form (Introduction page VI). **Note: For better precision at Depth 0 (BS) and 12 it is recommended that you take (2)-four minute counts and record the average on the form.**
- Use the ValiDator Density Table to evaluate the Wet Density and Moisture of the depth being tested for the pass/fail range. If the Wet Density and Moisture fall within this range the gauge passes the verification process. Note: All gauge moisture measurements are performed from the backscatter position. The ValiDator moisture value is determined using the BS measurement stop.
- If a failure is indicated repeat the testing process reviewing the precautions listed on page 10.
- Failing a second time would indicate an inaccuracy in the gauge calibration and the need for calibration.
- Before moving on to Calibration, complete a statistical analysis using manufacturer recommendations or ASTM Standard Test Methods detailed in 6938 and D2950 sections on standardization and reference checks. Record this information on the ValiDator Evaluation Form page 13. (The Analysis is commonly referred to as a Statistical Stability Test or Stat Test. If this test passes you may use the Density and Moisture Average for your Calibration Standard Count.) Before calibration, make certain the gauge meets gauge manufacturers requirement for routine maintenance and care.
- Utilize VeriFier Software (if available), to perform a new calibration.

## Verification using VeriFier Software

To utilize the features of the VeriFier Software, you must enter the current gauge calibration and ValiDator density data into the software. Follow Step I: Entering Gauge Calibration Data on page 37 and Step II entering ValiDator Densities on page 38.

### Step I: Verification Data Entry

1. Enter the current gauge calibration data into VeriFier software. (follow procedure Step I page 37)
2. Enter the ValiDator densities from laminated sheet. (Step II, page 38)
3. Enter counts from ValiDator Evaluation Form taken by the gauge on the ValiDator.
  - 3.1. Daily Density and Moisture Standard Counts
  - 3.2. Verification Date
  - 3.3. Failure Cutoff, default value is 2pcf (32 Kg/m<sup>3</sup>)
4. Enter Gauge Counts from Evaluation Form
  - 4.1. Enter Moisture Count at Backscatter
  - 4.2. Enter Density Count at all depths
5. Click on Calculate to display the Calculated Density and Error. This density should be similar to the WD from the ValiDator Evaluation form.
6. To Change measurement units Click on Options and select desired units.
7. To print a Verification report click on Report.
8. To customize your report click on Options then Customize.

VeriFier (Gauge: Troxler 3430,27578 - ValiDator: 98121050)

Gauge ValiDator Options CalBration About Units: English

Daily Std Count:  Moisture Std Count:

Validation Date:  Failure Cutoff:

Depth	Gauge Count	ValiDator Density	Calculated Density	Error (pcf)
Moisture	119	9.0	9.3	0.25
0.0	685	142.2	142.7	0.55
2.0	2572	142.7	142.5	-0.21
3.0	3300	129.2	129.4	0.23
4.0	2045	152.1	151.7	-0.40
5.0	1975	147.3	146.5	-0.76

**Selected Density is the Validator Density. Factory Calibration**  
**This is the density that your gauge will read.**

## Calibration Procedures

The calibration process utilizes the optional VeriFier Software. Contact InstroTek to obtain your specific password for operating this program. *Note: Only trained, qualified and experienced users should perform the Calibration and you should follow the requirements of your nuclear materials license for operating, maintaining and using your gauge.*

The nuclear gauge's current calibration data is necessary to complete the calibration process. If not available at your organization, contact the gauge calibration facility that performed this calibration for a copy.

For loading the Verifier Software see Chapter 3: Software Installation

### Step I: Entering Gauge Calibration Data

*(An example of the Gauge Calibration Sheet may be found on page 14)*

1. From the **Gauge** pull down menu select **New** if this is the first time this gauge data is being entered.
2. Enter Password. (This was obtained from InstroTek on installation. Please contact InstroTek if lost.)
3. Enter Gauge General Information; Make, Model (Select the model defined on page 5), Serial Number, Factory Calibration Standard Count (This is the Calibration Standard Count on the Gauge Calibration Sheet of the Gauge under test.)
4. Enter Gauge Calibration Data

**Caution: If this Data is entered incorrectly the gauge calibration may be inaccurate.**

**Caution: Do Not use the AC depth in the Verifier program for CPN Gauges.**

- a) Calibration Constants: The A, B, and C values used by the gauge to calculate Wet Density and E and F or A and B to calculate Moisture (M pcf)
  - b) Calibration Block Densities: **Note: *Calibrations completed at facilities other than the specific gauge manufacturer may require correcting the densities before recalibrating using the ValiDator.*** If the densities for your Mg block indicated on your calibration sheet is less than 110 pcf (1762 kg/m<sup>3</sup> or 1.762 g/cm<sup>3</sup>), then the densities need to be normalized. To normalize the densities divide the Mg block density by .980, divide the Mag/Al block density by .974 and divide the Alum block density by .964. If the units are kg/m<sup>3</sup>, then divide by 16.018 and follow the above normalization procedures. If the units are in g/cm<sup>3</sup>, then multiply by 62.4 and follow the above normalization procedures.
  - c) Calibration Block Counts: These are the Density counts from the gauge calibration sheet.
  - d) Moisture Constants: Depending on the gauge manufacturer these are the E and F or A and B constants used by the gauge to calculate Moisture in Pcf or Kg<sup>3</sup>/m<sup>3</sup>.
5. Change data or Select a different Gauge:
- a) From the Gauge pull down menu select **Modify** if the gauge data requires updating or correction.
  - b) From the Gauge pull down menu select **Pick** to review and select a specific gauge.

## **Step II: Entering ValiDator Calibration Densities**

*(Use the laminated ValiDator Density Data supplied with your ValiDator. These sheets are manufacturer, model, and ValiDator specific. For large organizations a multiple ValiDator function is available. Insure that before a calibration is attempted that the correct ValiDator is selected.)*

1. Select **ValiDator** from the pull down menu, and Select **New**. Enter ValiDator Serial number, and From the Model pull down select the appropriate model from the laminated ValiDator Calibration Table
2. Enter the Moisture content from the laminated sheet and all the depths and densities found on your sheet. You may enter Pcf or Kg<sup>3</sup>/m, but not both. The options menu allows you to change units.
3. To change ValiDator Densities choose **Modify**.
4. Selecting another ValiDator select **Pick**

Enter the ValiDator serial number from the ValiDator Density Sheet

Select the appropriate Make and Model for the gauge under test.

Moisture Content from laminated sheets supplied with the ValiDator

Density Assigned to ValiDator Calibration supplied with ValiDator

Depth	Density
0.0	142.2
2.0	142.7
3.0	129.2
4.0	152.1
5.0	147.3

**Step III: Entering Calibration Counts**

*(This procedure will calculate new Calibration constants from the counts taken on the ValiDator. It is extremely important to accurately input this data.)*

1. From the Calibration pull down menu select **CaliBrate** and enter the Password at the prompt. Contact InströTek for a misplaced password.
2. Enter the Calibration Standard Count that you established while collecting Verification data.
3. Enter the Calibration date. This is the date you collected the data on the ValiDator for calibration.
4. Enter the Gauge count for the appropriate depth in the first column. This is the Density Count (DC) from the ValiDator Evaluation form.
5. Enter the Moisture count taken at Backscatter. This is the (MC) from the evaluation form.
6. After the Gauge count data is entered, click on the 3 or 5 block calibrate button depending on the number of blocks used in the previous calibration. Generally, CPN and Troxler gauges use a three (3) block calibration, while Humboldt gauges are five (5) block calibrated.
7. Print the Calibration report by Selecting Calibration from the Verifier screen and click on Report.

*Note: Performing a different calibration method (3 block instead of a 5 block) other than the one used for the current calibration will produce faulty constants. If an error in the final calibration is noted you may revert back to the original by pressing **CTRL+E**.*

**Daily Standard Count**  
This is an extended density and moisture Standard Count from the average of (5) four-minute standard counts

**Calibration Date**  
This is the date that the calibration was done.

**Gauge Count**  
Density Counts from each depth taken on the ValiDator. Depths 0 and 12 are the average of (2) four-minute readings.

**Calib. Moisture Count**  
Moisture count taken at backscatter

Depth	Gauge Count	A	B x 1000	C
0.0	797	4.99572	1.48617	-0.105924
2.0	2698	15.3774	1.31361	-0.185168
3.0	3481	17.6393	1.35673	-0.162872
4.0	2197	20.1084	1.42057	-0.138181
5.0	2004	20.7065	1.50533	-0.110405
6.0	1886	21.3802	1.60806	-0.0874333

#### Step IV: Programming New Constants in the Gauge

MC3: Press the Step and Calib. Key on the front panel. Select Wet Coefficients, using the select key to change the depth. The A, B, C and A, B coefficients may be entered by pressing the Enter key.

3430: Press the special key and use the arrow keys to select Calib. Constants. Enter the code 4678 using the arrow keys. Enter the E and F constants (moisture constants), select depth and enter the A, B and C constants. Use the arrow keys to choose the depth.

3440: Press Shift-Special 1 then 9 and enter the code 4688. Some gauges require a secondary code, which is 5936. Select Calibration Constants from menu and follow the screen prompts and enter the E & F moisture constants and select the depths for entering the A, B and C constants.

3500 and SmartPanel, press menu, use up and down keys, select *calibration constants*, Enter code (4659) and enter, enter constants for moisture (E and F) and A, B and C constants for all depths.

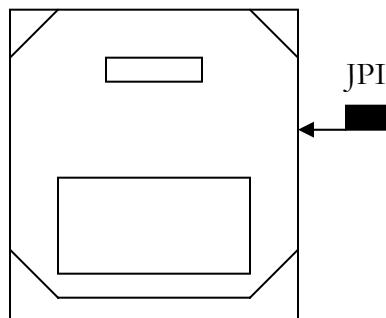
3411B and Humboldt 5001 units utilize an EPROM (Eraceable Programmable Read Only Memory) Chip. Fax the new constants report to InstroTek and we will program a chip for you. On receipt of the programmed chip remove the old chip noting the position of the reference notch on the top. Use a small screwdriver to leverage the chip from the socket. You may also purchase a Prom Programmer Package for burning proms at your facility.

Humboldt EZ:

### Changing A, B, C, E & F constants in the H5001EZ gauge.

1. Turn Power ON. (The processor will automatically initialize. Wait approximately 5 seconds)
2. Change A, B, C, E & F constants:
  - a. MAIN MENU
  - b. F3 (ENGINEERING)
  - c. F1 (CALIBRATE)
  - d. Enter Password (F2, F2, F2, F3, F4)
  - e. F4 (Change A, B, C, E or F)
  - f. F1 (A, B & C Parameters)
  - g. You will see for example  $A = 2.82232$  and the letter 'A' will be blinking. You can press F2 (INCREASE) to change from the 'A' constant to the 'B' or 'C'.
  - h. By pressing F1, you can shift the cursor to the value to be changed.
  - i. You can then increment or decrement using the F2 or F3 keys respectively.
  - j. Press F4 to go to the next depth.
  - k. To exit, press MAIN MENU.
  - l. Remove right protect jumper (JPI)
  - m. Press F3 (SAVE USER CONSTANTS).
  - n. Replace right protect jumper (JPI).

Note: JPI is a small black plastic jumper located at the upper right-hand side between keyboard and CPU board as shown below.



### Step V: Requesting EPROM Programming from InstroTek.

1. Mail or Fax the following:
  - a) The Calibration report and Verification report insuring the Calibration data reflects the new calibration information. From the Verifier program.
  - b) Your ValiDator Evaluation Form, readings taken on the ValiDator.
  - c) The Gauge Calibration Sheet from the calibration in the gauge during verification.
2. Fees: There is a fee for each gauge that requires an EPROM Programmed.
3. Freight: InstroTek will ship using regular shipping methods (average two or three day delivery). Air shipment is available upon request at applicable rates.

## **Step VI: EPROM Removal and Installation**

*(Static charges may damage silicone chips. Ground yourself while installing EPROM.)*

1. Loosen the front panel for the gauge requiring EPROM installation.
2. Locate the EPROM on the circuit board of the front panel. (IC that has a sticker with the gauge serial number and last calibration date.)
3. Make a note to the position of the notch in the top of the chip.
4. Remove the old chip with a small flat blade screwdriver or chip removal tool.
5. Reverse this process for installation.

## **Step VII: Quality Control**

*At any point that the Calibration is in error you may revert back to the old calibration by pressing **Ctrl+E**.*

1. To insure proper programming and installation of EPROM and Calibration Constants, the gauge should be Verified on the ValiDator using the ValiDator Evaluation Form.
2. An additional method to check the calibration before requesting the EPROM or entering constants is to use the Calculate Density feature to calculate densities using the new calibration.

### **Additional Features:**

Select **G**auge from the pull down menu to access the functions described below.

**P**ick is used to choose another gauge from your database.

**M**odify is used to change or update the information for a specific gauge in the database.

**N**ew is for entering new gauge data

### **Density Tables**

Allow for the manual calculation of wet density using the gauge count ratio.

$$CR = \frac{\text{Density Measure Count}}{\text{Density Standard Count}}$$

### **Calculate Density**

Functions as the processor of a gauge in calculating a density from a raw count. Calculates the count ratio and uses the calibration counts to calculate the density. Uses: Calibrations may be verified before entering the calibration constants in the gauge. Verification of field readings may be accomplished with using the raw counts to check for operator-induced errors, (i.e. source position switch in the wrong position) plug in the standard count and density count and calculate the density. This function requires activation of the appropriate gauge serial number in the Verifier software.

### **Gauge Management**

**Management:** This option will allow you to manage your gauges more effectively. The software will report the last verification date, the last calibration date and the next leak test date. The data is sorted by the gauge's Next Leak Test date, and highlighted if the date is over six months for leak test and one year for calibration.

**Leak Test:** The software will allow you to enter the last leak test date for each gauge in the database. The software will keep up with this information and will alert you of the next leak test date (six months) under the *Management* report option. Overdue leak test will be highlighted in red

**Expected Standard Count:** This calculation is based on the decay of CS-137 gamma source. The limit on these standard counts are based on the gauge manufacturer's limit of  $\pm 1\%$  of the actual standard count. The software will automatically access the most recent calibration date and standard counts for the calculations. *Note: Gauge counts may change due to many different factors. Radioactive decay is the only variation that could be estimated accurately and does not necessarily correct for all deviations in the gauge.*

**Notes:** The notes function will allow you to document repairs and items used to identify service trends or any gauge related information



## **Chapter 4: Theory of Operation**

Verification

Calibration

Density

Moisture

## Verification Theory

ASTM requirements dictate calibration verification at an interval of 12-18 months. The ValiDator is a known and stable density reference that can be used for verification of gauge calibration accuracy. The ValiDator device is calibrated by InstroTek, Inc., assigning reference densities to each of the measurement depths. Gauge measurements are taken on the ValiDator and the results compared to the documented ValiDator density range, which indicates pass or fail. The ranges are based on a  $\pm 1.5\%$  limit about the actual density of the ValiDator. The limits are based on the combined errors in gauges due to precision, composition and surface roughness errors.

If a calibration is needed, the optional Verifier Software may be used to calculate new calibration coefficients derived from the counts taken on the ValiDator device. New calibration parameters are calculated using a fitting routine according to the gauge manufacturer calibration method.

## 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

The final stage of the gauge manufacturing process is the 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 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. In the field when a count is collected on the test material, the resulting wet density displayed on the screen is calculated by:

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

### 3-Block Method or 5-Block Method:

Presently there are no authorities that certify nuclear gauge calibration. Therefore, gauge manufactures and numerous other calibration facilities use a different number of blocks to facilitate the calibration process. The Validation and Calibration process simulate counts to replicate the number of blocks used in the most recent calibration. CPN, InstroTek and Troxler use the Three-block method and Humboldt uses the Five-block method.

## 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 and polyethylene (~ 35 lb/ft<sup>3</sup>, ~560 kg/m<sup>3</sup>). The gauge standard count along with the counts on these blocks are used in a linear equation such as

$$MCR = E + FM$$

to calculate the parameters 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.

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