



Troxler Electronic Laboratories, Inc. - Troxler International, Ltd.
 3008 Cornwallis Road, P.O. Box 12057, Research Triangle Park, NC 27709 - USA
 Telephone: 919/549-8661 Telefax: 919/549/0761

Troxler Model 3450A Main Calibration Report (Page 1 of 6)

Gauge Serial number: 42 Calibration Date: 3/12/2012
 Density Standard Counts: 6791 1623 Water Standard Count: 1122 Bay: 74

The density counts used in this calibration are shown hereunder. "Pos" refers to the source position below the surface of the standard, in millimeters.

Pos	Magnes standard	Mag/Al standard	Alumin standard
-----	-----	-----	-----
BS	3142	2309	1688
051	5990	4017	2565
102	31188	24343	17448
152	22130	15847	10178
203	14155	9309	5470
254	8579	5286	3059
305	5160	3136	2021

The density system calibration constants and precision for each source position of this gauge are listed hereunder. The gauge precision ("Prec") is the measurement precision under a set of repeatability conditions of measurement (VIM Sec. 2.21.) Density precision is evaluated at 2002 kilograms per cubic meter. The calibration constant B*1000 is listed in units of cubic meter per kilogram.

Pos	A	B*1000	C	Prec
---	-----	-----	-----	-----
BS	2.248	1.21877	-0.10762	8.9
051	5.509	1.24934	-0.09443	5.0
102	11.221	0.51033	0.88301	3.3
152	11.272	0.76857	0.30284	3.0
203	11.236	1.07510	0.02658	3.1
254	11.659	1.44987	-0.09987	3.6
305	13.722	1.93903	-0.15377	4.6

The water system calibration counts, constants, precision ("Prec"), and anticipated errors for this gauge are listed hereunder. The "SR" valuer refers to a count made on the magnesium/polyethylene standard with 1.3 mm. shims beneath the gauge. "SR Error" is the anticipated error in the water system readings due to surface texture imperfections and "Exerr" is the anticipated error from the combination of gauge imprecision and texture imperfections. The calibration constant F is listed in units of cubic meter per kilogram, and the precision and errors are listed in units of kilogram per cubic meter. The precision is evaluated at 250.0 kilograms per cubic meter.

Magnesium Standard count	Mag/Poly Standard count	SR count	E	F*1000	Prec	SR	Exerr
-----	-----	-----	-----	-----	-----	-----	-----
37	678	660	0.03298	0.98162	5.7	-16.3	15.1



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The following counts were made with the gauge directly on the denoted standards:

	Mag	Mg/Al	Alum	Background
	-----	-----	-----	-----
System 1:	16613	14753	12452	000
System 2:	3142	2309	1688	000

Listed hereunder are the thin layer measurement-related calibration constants for density measurement systems 1 and 2. The A, B, and C values are the density calibration constants for the individual density measurement systems, either system 1 or system 2, and should not be confused with the A, B, and C values for this gauge in soil or asphalt mode. The P, Q, and R values are the calibration constants for the equation that relates top layer thickness with the thin layer 'K' value for the related density system (system 1 or system 2), where the independent variable is the thickness and 'K' is the dependent variable. The 'K' value is a proportional factor that relates how much the density read by the related system contributes to the final top layer value read by the gauge. The B value is in cubic meters per kilogram, and Q is in inverse millimeters.

	A	B*1000	C	P	Q	R
	-----	-----	-----	-----	-----	-----
System 1:	-0.37244	-0.573957	-3.46421	1.34047	0.07730	0.00351
System 2:	6.80374	0.659726	0.20624	1.34047	0.04050	0.00351

Thin layer-related density measurement precisions are evaluated at 2245 kilograms per cubic meter. The precision of the System 1 measurement is 8.1 kilograms per cubic meter, and the precision of System 2 is 9.9 kilograms per cubic meter.

The precision of the gauge's top layer density measurement, however, is dependent on both density and top layer thickness. Therefore, the precisions for different top layer thicknesses are listed hereunder, with the thickness values in millimeters.

Thickness	Precision	Thickness	Precision	Thickness	Precision
-----	-----	-----	-----	-----	-----
25.4	14.6	38.1	11.0	50.8	9.5
63.5	8.6	76.2	8.1	88.9	7.6
101.6	8.6				



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The density standards utilized in this calibration listed hereunder are traceable to the National Institute of Standards & Technology (NIST) as documented in Troxler Reports R-703 and R-705. The uncertainties for these standards are expressed as expanded uncertainty values at approximately the 95% confidence level using a coverage factor of $k = 2$.

Standard Material	Standard Serial No.	Density (kg/m ³)	Density Expanded Uncert. (kg/m ³)	Date of Measurement	Date of Expiration
Magnesium	199	1773.4	5.6	10/19/2009	10/19/2014
Mag/Alum	208	2190.6	6.2	10/20/2009	10/20/2014
Aluminum	198	2710.7	10.3	10/20/2009	10/20/2014

When the gauge is used to measure density in soil or asphalt modes, to account for the influence of the elemental composition of these blocks on instrument response (as prescribed in ASTM D2950, Section A1.3, and D6938, Section A1.1.1), the densities for the metallic block are multiplied by elemental composition correction factors prior to the calculation of the density calibration parameters shown on Page 1 of this document. These correction factors are 0.988 for magnesium, 0.974 for magnesium/aluminum, and 0.964 for aluminum.

Additionally, the gravimetric densities of the metallic blocks used in this calibration are multiplied by elemental correction factors prior to the calculation of the thin layer calibration parameters listed in this report. These correction factors are 0.988 for magnesium, 0.989 for magnesium/aluminum, and 0.949 for aluminum.

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Gauge Serial number: 42 Calibration Date: 3/12/2012
Density Standard Counts: 6791 1623 Water Standard Count: 1122 Bay: 74

The layer plate standards assigned to this calibration bay are traceable to the National Institute of Standards & Technology (NIST) as documented in Troxler Report R-711. The uncertainties for these standards are expressed as expanded uncertainty values at approximately the 95% confidence level using a coverage factor of $k = 2$. The density of these plates and their uncertainties are listed in the table hereunder. The thickness of each plate is also listed in this table, where the expanded uncertainty in of these thicknesses is 0.011 millimeters.

For this calibration, the thin layer system is not recalibrated, so the plates listed hereunder are not used to compute thin layer constants.

Plate Metal	Plate Serial No.	Plate Thickness (mm)	Plate Density (kg/m ³)	Density Expanded	Date of Measurement	Date of Expiration
				Uncert. (kg/m ³)		
Mag	MA1005	25.517	1764.9	0.75	10/17/2011	10/17/2016
Alum	0.000	0000.0	1.14	1/1/1980	1/1/1985	

The measurements used to establish the water mass per unit volume values for the standards utilized in this calibration are traceable to the National Institute of Standards & Technology (NIST) as documented in Troxler Report R-704. The uncertainty for this standard is expressed as an expanded uncertainty value at approximately the 95% confidence level using a coverage factor of $k = 2$. Water mass per unit volume is defined as the mass of water contained in a unit volume of material, and is represented in the table hereunder as 'M'.

Standard Material	Standard Serial No.	M Value (kg/m ³)	M Expanded	Date of Measurement	Date of Expiration
			Uncert. (kg/m ³)		
Mag/Poly	198	581.7	8.6	11/1/2011	11/1/2016

The maximum estimated measurement uncertainties (EMUs) of this gauge are listed hereunder. The uncertainties apply to measurements of one minute in duration on typical soil, and are expressed as expanded uncertainty values at approximately the 95% confidence level using a coverage factor of $k = 2$. These values relate only to the source rod positions for which this gauge has been manufactured to operate. EMU values are in kilograms per cubic meter. These EMU's are for soil/asphalt mode only; density EMU's are listed first:

Pos	Max EMU	Pos	Max EMU	Pos	Max EMU	Pos	Max EMU
BS	39.5	51	25.6	76	22.3	102	19.0
127	17.5	152	16.1	178	18.8	203	21.5
229	24.6	254	27.8	279	33.2	305	38.6

The maximum EMU for M measurements is 36.9 kilograms per cubic meter.



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Gauge Serial number: 42 Calibration Date: 3/12/2012
Density Standard Counts: 6791 1623 Water Standard Count: 1122 Bay: 74

More maximum estimated measurement uncertainties (EMUs) of this gauge are listed hereunder. These uncertainties apply to measurements of one minute in duration on a thin layer of asphalt of known thickness, and are expressed as expanded uncertainty values at approximately the 95% confidence level using a coverage factor of $k = 2$. The EMU values are in kilograms per cubic meter, with the top layer thickness values in millimeters.

Nominal Top Layer Thickness	Maximum EMU for a Lower Top Layer Density	Maximum EMU for a Higher Top Layer Density
25.4	91.0	53.0
31.8	87.0	64.0
38.1	76.0	58.0
44.5	81.0	52.0
50.8	87.0	53.0

This gauge was calibrated using the method described in Troxler Report W-713.

This instrument was found to be mechanically sound and electronically stable prior to and after its calibration. This calibration was performed in an environment with a temperature between 14.4 °C and 25.6 °C. All data listed in this report are applicable to this instrument only. This instrument was calibrated by pm using the Three Block Calibration process. This process is fit for the intended use of the instrument.

This calibration was performed by pm at Troxler Electronic Labs
2016 E. Randol Mill Rd., Suite 406, Arlington, TX 76011

Special considerations and limitations of use for this device and its calibration are described in the Manual of Operation and Instruction provided with this instrument.



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Gauge Serial number: 42 Calibration Date: 3/12/2012
 Density Standard Counts: 6791 1623 Water Standard Count: 1122 Bay: 74

Supplementary Gauge Calibration Information

The factory calibration constants can be re-entered into the gauge if the need arises. This capability is accessed through the Extended Functions menu. When re-entering the calibration constants, enter the values exactly as shown below:

E = 0.032977 F = 0.981617

Depth	A	B	C
BS	2.2478	1.218772	-0.107621
051	5.5091	1.249343	-0.094427
102	11.2208	0.510328	0.883012
152	11.2722	0.768569	0.302842
203	11.2360	1.075100	0.026582
254	11.6593	1.449871	-0.099874
305	13.7223	1.939033	-0.153767

A1 = -0.37244 | A2 = 6.80374 | P1 = 1.340470 | P2 = 1.340470
 B1 = -.0091936 | B2 = .0105675 | Q1 = 1.963530 | Q2 = 1.028667
 C1 = -3.46421 | C2 = 0.20624 | R1 = 0.003512 | R2 = 0.003512

Listed hereunder is a range of projected density standard counts at future dates. These projected ranges are computed based solely upon the known decay rate of the density source

Date	System 1	System 2
	Projected density Standard Count Range	Projected density Standard Count Range
4/1/2012	{6715 , 6850}	{1605 , 1637}
5/1/2012	{6702 , 6837}	{1602 , 1634}
6/1/2012	{6689 , 6824}	{1599 , 1631}
7/1/2012	{6676 , 6811}	{1596 , 1628}
8/1/2012	{6663 , 6798}	{1592 , 1625}
9/1/2012	{6650 , 6785}	{1589 , 1622}
10/1/2012	{6638 , 6772}	{1586 , 1618}
11/1/2012	{6625 , 6759}	{1583 , 1615}
12/1/2012	{6612 , 6746}	{1580 , 1612}
1/1/2013	{6600 , 6733}	{1577 , 1609}
2/1/2013	{6587 , 6720}	{1574 , 1606}
3/1/2013	{6575 , 6708}	{1571 , 1603}
4/1/2013	{6562 , 6695}	{1568 , 1600}



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Troxler Model 3450 As Left Calibration Report (Page 1 of 2)

Gauge Serial number: 42 Measurement Date: 3/12/2012
 System 1 Standard Count: 6798 System 2 Standard Count: 1637
 Water Standard count: 1127 Bay: 74

Listed hereunder are the results of a gauge accuracy check for this instrument for soil and asphalt measurement modes. The results are listed in terms of measurement error (as defined in VIM Section 2.16), where the measurement error is the value read by the instrument minus the value assigned to the standard upon which the measurement was made. Measurement errors for density are listed in kilograms per cubic meter, as are measurement errors for water mass per unit volume measurements (denoted by M.) "Pos " refers to the source position below the surface of the standard, in millimeters.

Pos	Magnes standard	Mag/Al standard	Alumin standard
BS	7	1	-5
051	-4	8	16
102	0	8	-5
152	2	0	14
203	-4	16	8
254	2	4	0
305	-8	-10	11

M measurement errors: On mag. = -2 kg/m^3 On mag/poly = 1 kg/m^3

Listed hereunder are the results of a gauge accuracy check for this instrument for thin layer measurement mode. The results are listed in terms of measurement error (as defined in VIM Section 2.16), where the measurement error is the value read by the instrument minus the value assigned to the standard upon which the measurement was made. Measurement errors for density are listed in kilograms per cubic meter.

Configuration	Thin Layer Measurement Error
Directly on Magnesium Block	0
Directly on Mag/Aluminum Block	-3
Directly on Aluminum Block	6
25 mm Mag Plate on Aluminum Block	66

All measurements were one minute in duration, except for the standard counts, which were four minutes in duration. These measurements were made at the conclusion of the factory calibration for this gauge.



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Troxler Model 3450 As Left Calibration Report (Page 2 of 2)

System 1 Standard Count: 6798 System 2 Standard Count: 1637
Water Standard count: 1127 Bay: 74

This instrument was evaluated using the method described in Troxler Report W-700. The quantity values and uncertainties of the standards used in this calibration are listed in the Main Calibration Report for this instrument. The maximum estimated measurement uncertainties (EMUs) of a gauge of this variety that has undergone a Troxler factory calibration are listed and in the Main Calibration Report for this instrument.

This calibration was performed in an environment with a temperature between 14.4 °C and 25.6 °C.

This "as left" calibration was performed by Peter Matthews at Troxler Electronic Labs, 2016 E. Randol Mill Rd., Suite 406, Arlington, TX 76011.

This report shall not be reproduced except in full, without the written approval of Troxler Electronic Laboratories, Inc. This process is fit for the intended use of the gauge, compliant with the requirements of ASTM D6938, Section A1.1.1.

Approved Signatory

Date



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Gauge Safety Inspection Report

Model: 3450

SN: 42

RO#: 22338

Inspected at: TX

- ☒ 1 - Auto (Orbital) weld
☐ 2 - Manual Weld

Inspection Date: 3/7/2012

Handle Condition

- ☒ 1 - Normal
☐ 2 - Abused (comments)

Overall Gauge Condition

- ☐ 1 - Good
☒ 2 - Normal
☐ 3 - Poor (comments)
☐ 4 - Abused (comments)

AmBe Plug - As Found

- ☐ Tight
☐ Loose
☒ Not applicable

Sliding Block - As Found

- ☒ 0 - Fully Closed
☐ 1 - <= 25% Open
☐ 2 - 26-50% Open
☐ 3 - 51-75% Open
☐ 4 - 75-100% Open
☐ 5 - Fully Open

Reason Not Fully Closed

- ☐ 1 - Excessive Dirt
☐ 2 - Weak Spring
☐ 3 - Both
☐ 4 - Other (Comments)

AmBe Plug - Fixed

- ☐ Yes (Loctite applied)
☐ No (already done)
☒ Not required

Only required for gauges with
tall plugs & serial numbers
less than 39000.

Sliding Block Cracks

- ☒ Uncracked
☐ Cracked
☐ Not applicable

(Only models 3450 or 3451)

Source Rod Wear

- ☐ 0 - None
☒ 1 - Slight
☐ 2 - Some.
☐ 3 - Medium
☐ 4 - Significant.
☐ 5 - Extreme (comments)

Cause of Rod Wear

- ☐ 0 - None
☐ 1 - Sliding Block
☐ 2 - Bearing/Wiper
☒ 3 - Both
☐ 4 - Other (comments)

I. Concavity

- ☐ 0 - None
☒ 1 - Slight
☐ 2 - Some.
☐ 3 - Medium
☐ 4 - Significant
☐ 5 - Extreme (comments)

II. Porosity/Pitting

- ☐ 0 - None
☒ 1 - Slight
☐ 2 - Some
☐ 3 - Medium
☐ 4 - Significant.
☐ 5 - Extreme (comments)

III. Cracks

- ☒ 0 - None
☐ 1 - 1 to 20%
☐ 2 - 21 - 40%
☐ 3 - 41 to 60%
☐ 4 - 61 to 80%
☐ 5 - 81 to 100%

COMMENTS: