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Nuclear Gauge Testing Manual

Edition 3, Amendment 6

April 2021

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1 Scope

This manual is applicable to the use of both the nuclear surface moisture-density gauge and the nuclear thin-layer density gauge.

- Nuclear surface moisture-density gauges have been designed specifically to measure the density and/or moisture content of earthen materials (for example, soil or crushed rock), asphalt and concrete. These earthen materials may be unbound or treated with stabilising agents such as cement, foamed bitumen or lime.
- Nuclear thin-layer density gauges have been designed specifically for the density measurement of thin layers of asphalt.

Within this manual, both gauge types, or combinations of these gauge types, are referred to as nuclear gauges.

2 Content

The manual contains four sections as follows:

- a) Section 1 *Introduction*
- b) Section 2 *Calibration*
- c) Section 3 *Test methods*, and
- d) Section 4 *Operating instructions*.

3 Definitions

3.1 Standard definitions

The standard definitions listed in Table 3.1 shall apply to the *Nuclear Gauge Testing Manual*.

Table 3.1 – Standard definitions

Term	Definition
Plant-mixed stabilisation	Involves the stationary pug mill mixing of a stabilisation agent with an unbound granular material sourced from a quarry or reclaimed construction and demolition waste (usually concrete). The quality of unbound granular pavement material used in plant mixing must conform to an unbound pavement specification.
Sample	The material to be forwarded for examination and/or testing which is representative of a lot. A sample is either a single entity (a spot sample) or, more usually, a representative sample, and derived by combining sample increments of approximately equal quantities from a lot, and thoroughly mixing to provide a single uniform sample and then dividing the sample into a suitable quantity for examination and/or testing.
Test location	The location, described in terms of longitudinal, lateral and, if required, vertical distance from where a single insitu test is performed.
Unbound materials	Quarry materials, natural gravels or recycled materials produced for base and sub-base pavement construction.

3.2 Definitions in other publications

Further relevant definitions are contained in the following Austroads publication and Transport and Main Roads Technical Specifications:

- a) *Austroads Glossary of Terms*
- b) MRTS01 – *Introduction to Technical Specifications*
- c) MRTS04 – *General Earthworks*
- d) MRTS05 – *Unbound Pavements*
- e) MRTS06 – *Reinforced Soil Structures*
- f) MRTS07A – *Insitu Stabilised Subgrades using Quicklime or Hydrated Lime*
- g) MRTS07B – *Insitu Stabilised Pavements using Cement or Cementitious Blend*
- h) MRTS07C – *Insitu Stabilised Pavements using Foamed Bitumen*
- i) MRTS08 – *Plant-Mixed Heavily Bound (Cemented) Pavements*
- j) MRTS09 – *Plant-Mixed Foamed Bitumen Stabilised Pavements*
- k) MRTS10 – *Plant-Mixed Lightly Bound Pavements*
- l) MRTS30 – *Asphalt Pavements*

3.3 Standard abbreviations

The standard abbreviations listed in Table 3.3 shall apply to the *Materials Testing Manual*.

Table 3.3 – Standard abbreviations

Abbreviation	Definition
BS	Backscatter
CPN	Campbell Pacific Nuclear
MRTS	Main Roads Technical Specification

3.4 Abbreviations in other publications

Further relevant abbreviations are contained in the *Austroads Glossary of Terms*.

4 Referenced Documents

4.1 Australian Standards

Table 4.1 lists the Australian Standards including Austroads Test Methods referenced in the *Materials Testing Manual*.

Table 4.1 – Referenced Australian Standards

Reference	Title
AS 1012.14	<i>Methods of testing concrete, Method 14: Method for securing and testing cores from hardened concrete for compressive strength and mass per unit volume</i>
AS 1289.2.1.1	<i>Methods of testing soils for engineering purposes, Method 2.1.1: Soil moisture content tests – Determination of the moisture content of a soil – Oven drying method (standard method)</i>

Reference	Title
AS 1289.2.1.2	<i>Methods of testing soils for engineering purposes, Method 2.1.2: Soil moisture content tests – Determination of the moisture content of a soil – Sand bath method (subsidiary method)</i>
AS 1289.2.1.4	<i>Methods of testing soils for engineering purposes, Method 2.1.4: Soil moisture content tests – Determination of the moisture content of a soil – Microwave-oven drying method (subsidiary method)</i>
AS 1289.2.1.5	<i>Methods of testing soils for engineering purposes, Method 2.1.5: Soil moisture content tests – Determination of the moisture content of a soil – Infrared lights method (subsidiary method)</i>
AS 1289.2.1.6	<i>Methods of testing soils for engineering purposes, Method 2.1.6: Soil moisture content tests – Determination of the moisture content of a soil – Hotplate drying method</i>
AS 1289.2.3.1	<i>Methods of testing soils for engineering purposes, Method 2.3.1: Soil moisture content tests – Establishment of correlation – Subsidiary method and the standard method</i>
AS 1289.5.8.4	<i>Methods of testing soils for engineering purposes, Method 5.8.4: Soil compaction and density tests – Nuclear surface moisture-density gauges – Calibration using standard blocks</i>
AS 2891.1.2	<i>Methods of sampling and testing asphalt, Method 1.2: Sampling – Coring method</i>
AS/NZS 2891.9.2	<i>Methods of sampling and testing asphalt, Method 9.2: Determination of bulk density of compacted asphalt – Pressurisation method</i>
AS/NZS 2891.14.3	<i>Methods of sampling and testing asphalt, Method 14.3: Field density tests – Calibration of nuclear thin-layer density gauge using standard blocks</i>
AS/NZS 2891.14.4	<i>Methods of sampling and testing asphalt, Method 14.4: Field density tests – Calibration of nuclear surface moisture-density gauge – Backscatter mode</i>

5 Principles of measurement

5.1 Nuclear gauge components

The essential components of a nuclear gauge comprise a source of gamma radiation for density measurement, a source of neutron radiation for moisture content measurement, detectors of gamma radiation and slow neutron radiation as appropriate, and electronics to convert the detected radiation into measures of density / moisture content.

5.2 Density measurement

Nuclear gauges utilise the emission and detection of gamma radiation for the measurement of the density of a material. Gamma radiation is a form of high energy radiation which readily penetrates most materials. In the transmission of gamma rays between a source and detector, a proportion of these rays will be absorbed and scattered in accordance with the density of the material between the source and detector. As the density of this material increases, the number of gamma rays absorbed and scattered increases and the number reaching the detector decreases.

A relationship then exists between the detected gamma radiation and the density of the material. This relationship is commonly expressed in the following form:

$$\text{DCR} = Ae^{B\rho} - C$$

where **DCR** = density count ratio
 ρ = density of the material
A, B, C = calibration constants for the nuclear gauge

The electronics of the gauges referenced in this manual use this exponential relationship to display density directly for a given value of count ratio.

An isotope of cesium (Cs - 137) is used as the source of gamma radiation in nuclear gauges for the measurement of density. The quantity of radioactive material used in the gamma source is usually either 0.296 or 0.37 GBq.

5.3 Moisture content measurement

Nuclear surface moisture-density gauges utilise the emission and detection of neutron radiation for the measurement of the moisture content of a material. Neutrons are emitted into a material and collisions occur between these neutrons and the nuclei of atoms within the material. These collisions will successively reduce the energy of these neutrons until they are slowed sufficiently to allow them to be detected by a 'slow neutron' detector.

The most effective collision by far in producing slow neutrons is that between a neutron and a nuclei of about the same mass (that is, hydrogen). The number of slow neutrons produced in a material is then proportional to the number of hydrogen atoms in the material. For most soil type materials where hydrogen is present only in the form of water, the number of slow neutrons detected is directly proportional to the moisture content of the material.

A relationship can then be established between the detected slow neutron radiation and the moisture content of the material. This relationship is commonly expressed in the following form:

$$\text{MCR} = F(W) + E$$

where **MCR** = moisture count ratio
W = moisture content of the material
E, F = calibration constants for the nuclear gauge

The electronics of the gauges referenced in this manual use this equation to display moisture content directly for a given value of count ratio.

An isotope of americium (Am - 241) in combination with beryllium (Be) is used as the source of neutrons for nuclear surface moisture-density gauges for the measurement of moisture content. The quantity of radioactive material used in the neutron source is usually either 1.48 or 1.85 GBq.

5.4 Density measurement modes

Nuclear surface moisture-density gauges are designed to use the emission and detection of gamma radiation for determining density in two measurement modes – direct transmission and backscatter.

The direct transmission method involves placing the source and detector on opposite sides of the material to be measured (that is, detector on the surface and source within the material). The gamma radiation emitted from the source then passes through the material to be measured before it is detected. This method is partially destructive in that it requires a hole to be formed in the material to

locate the source. However, it does provide a measure of the average density of the material between the source and detector. Measurement positions are normally provided to 300 mm in increments of 25 mm.

The backscatter method commonly utilises one measurement position (for example, BS in Troxler, Humboldt and Instron gauges) or two measurement positions (for example, BS and AC in CPN gauges). It involves placing the source and detector on the same side of the material to be measured (that is, on the surface). The gamma radiation emitted from the source must then be scattered back towards the detector if it is to be detected. This method is performed rapidly and is truly non-destructive. However, it has restricted measurement depth and its measurements are biased toward the surface of the material with about 80 to 90 percent of its measurement coming from the top 50 mm of material for the BS measurement position. Hence, it does not provide a true measure of the average density of the material. The backscatter method is also very sensitive to surface roughness and is less precise than the direct transmission method.

Due to its sensitivity to surface roughness and inferior accuracy and precision, the backscatter method has been excluded from this manual as an option for the density measurement of soil type materials. However, it has been retained as the preferred option for the density measurement of asphalt and concrete where problems associated with surface roughness and measurement depth are reduced, and where its rapid and non-destructive nature compensate for its inferior accuracy and precision.

The nuclear thin-layer density gauge uses two backscatter geometries to provide independent measures of material density. Mathematical computation of responses from the two geometries, then allows a reduction in the influence from the underlying layer on density measurement. Use of this gauge is restricted to asphalt having a nominal maximum size not greater than 40 mm and a nominal layer thickness between 25 and 100 mm. This is the only nuclear gauge method allowed for the density measurement of compacted asphalt having a layer thickness between 25 and 50 mm.

For nuclear thin-layer density gauges a relationship has been developed to combine numerically the independent measures of material density to calculate the overlay density. This relationship is commonly expressed in the following form,

$$\rho_T = \frac{K_2\rho_1 - K_1\rho_2}{K_2 - K_1}$$

where ρ_T = density of the overlay material
 ρ_1 = system 1 density of the material
 ρ_2 = system 2 density of the material
 K_1, K_2 = values that quantify the influences of the density of the overlay material and of the underlying material on the density measured by the gauge.

The values of K_1, K_2 are calculated using the overlay thickness and depth factor calibration constants determined for each density system in the gauge.

5.5 Moisture measurement mode

The emission of neutron radiation and detection of 'slow neutron' radiation for the determination of moisture content is not designed for direct transmission measurement. It is conducted only in a backscatter mode with the source and detector positioned close together to provide a linear relationship between detected radiation and moisture content.

The effective measurement depth for moisture content varies according to the moisture content of the material and decreases with increasing moisture content. For a moisture content range of 0.1 to 0.3 t/m³, the measurement depth is about 250 to 200 mm respectively. However, detection of 'slow neutrons' relies on diffusion to the detector and, as such, moisture content measurements are biased towards the surface of the material. This bias will not affect the accuracy of moisture content measurement, provided that the water within the material is evenly distributed.

6 Calibration

6.1 Standard blocks calibration

Standard blocks calibration is a prerequisite for nuclear gauge measurement of both density and moisture content. It allows the conversion of nuclear gauge count data to measures of density and moisture content. Standard blocks calibration is described in Section 2 of this manual and is performed in accordance with the relevant Australian Standard as follows:

- Nuclear surface moisture-density gauge (direct transmission) AS 1289.3.8.4
- Nuclear thin-layer density gauge AS 2091.14.3
- Nuclear surface moisture-density gauge (backscatter) AS 2091.14.4.

The standard blocks calibration determined for a nuclear gauge will vary according to the particular type of standard blocks set chosen and the number, uniformity and composition of the standard blocks within the set. While standard blocks calibration methods allow the use of any one of two types of block sets, it places few conditions on the blocks selected for each set and makes no attempt to align the calibrations obtained from different block sets.

It is accepted that standard blocks calibration of nuclear gauges will not be undertaken by each user and will be restricted to those organisations and laboratories having the appropriate facilities. However, the user is required to arrange for standard blocks calibration and undertake calibration checks in accordance with the procedures and time frames specified in this manual.

6.2 Calibration adjustment – material bias

It is recognised that the density and moisture content results obtained from traditional tests (for example, sand replacement core density) will differ from those results obtained from a nuclear gauge calibrated against standard blocks. The cause of this difference is due to a combination of factors relating to calibration (accuracy, precision), testing (test precision, commonality of tested material), material condition (surface roughness, density / moisture gradients, homogeneity) and material type (chemical composition). The contribution of each of these factors is not easily determined and will vary from job to job.

This difference (traditional test result - nuclear gauge test result) can be either positive or negative but tends to be positive for most materials (that is, nuclear gauge test tends to provide lower density results than those obtained using traditional tests). For many materials, this difference is small and can be ignored. However, for some materials it is substantial, and adjustment of the standard blocks calibration may be necessary.

The approach adopted within this manual in relation to adjustment of the standard blocks calibration is as follows:

- For moisture content measurement of earthen materials, calibration adjustment is always made via a material bias for soil moisture content as determined from comparative nuclear gauge and oven drying moisture content results.
- For wet density measurement of earthen materials, calibration adjustment is made via a material bias for soil wet density as determined from comparative nuclear gauge and sand replacement wet density result. For materials used in pavement layers and stabilised materials, calibration adjustment is always made.
- For density measurement of asphalt, calibration adjustment is always made via a material bias for asphalt density as determined from comparative nuclear gauge and core sample compacted density results.
- For density measurement of concrete, calibration adjustment is always made via a material bias for concrete density as determined from comparative nuclear gauge and core sample density results.

The procedure adopted for calibration adjustment involves determining that value which, when applied to the nuclear gauge result, most closely approximates the traditional test result in the average case. The basic assumption behind this procedure is that the real difference between the nuclear gauge and traditional test results is constant over the property range and that a single adjustment only needs to be applied.

The calibration adjustment procedure also includes certain checks to ensure that the limited data used in adjustment of the standard blocks calibration is not erroneous viz.

- The nuclear gauge test results are validated by plotting the count ratio and test data from the nuclear gauge to ensure all data points lie on the plot. For thin-layer gauges the test results are validated by plotting the count ratio and test data for both density systems of the nuclear gauge to ensure all data points lie on the plot.
- The traditional test results used in determining the calibration adjustment are checked by determining their scatter around the adjusted standard blocks calibration in terms of an estimate of the standard error. Analysis of such data reveals that the standard error should not be greater than 0.155 t/m³ for soil wet density, 0.025 t/m³ for asphalt density, 0.035 t/m³ for concrete density and 0.012 t/m³ for soil moisture content.
- The calibration adjustment for a material type or condition is checked regularly by obtaining additional calibration data and using these data to upgrade and confirm the adjustment. Minimum requirements are included for the frequency of such checks.

7 Test methods and operating instructions

Section 3 of this manual contains test methods for determining the insitu dry density of soil materials, the insitu density of asphalt, the insitu density of concrete and the associated material biases for soil moisture content, soil wet density, asphalt density and concrete density. Section 4 of this manual contains operating instructions for taking a standard count, performing a statistical count, setting the test parameters and taking a measurement. The operating instructions relate to the makes and models of nuclear gauge listed in Table 2.

The test methods and operating instructions are based on specific information contained within the manufacturer's instruction manual for a gauge, together with best practice guidelines developed over four decades of nuclear gauge use within the Department of Transport and Main Roads. In general,

standardised procedures have been developed for all nuclear gauge makes / models, particularly in the areas of gauge verification and stability analysis, count periods, gauge orientation and site preparation. Consequently, while there may be some procedural differences from the manufacturer's recommendation for some gauges, such differences will only enhance the accuracy and precision of the nuclear gauge results obtained.

For the testing of soils and crushed rock materials, results are obtained from two orientations of the nuclear gauge at each test site to determine site density and/or moisture content. The use of two orientations at 90° provides a larger testing area with little increase in overall testing time. It also allows a check to be performed on the results obtained from the nuclear gauge. Based on an analysis of data from these two orientations, the difference in dry density results between the two orientations at 90° should be no more than 0.075 t/m³. The use of two orientations then provides an improved estimate of the average density / moisture content of the site.

For the testing of asphalts and concrete, results are obtained from two orientations of the nuclear gauge at each test site to determine site density. The use of two orientations at 180° provides a larger testing area with little increase in overall testing time. It also allows a check to be performed on the results obtained from the nuclear gauge. Based on an analysis of data from these two orientations, the difference in density results between the two orientations at 180° should be no more than 0.075 t/m³. The use of two orientations then provides an improved estimate of the average density of the site.

Various procedures are suggested by nuclear gauge manufacturers to check the performance of nuclear gauges. Standard count checks, gauge function checks and density system consistency checks have been adopted for all gauge makes / models identified within this manual to assess gauge performance. Any variation in the acceptance limits used by the manufacturer and this manual are due to differences in the methods used for data analysis rather than differences in the required levels of performance.

8 Safety

Nuclear gauges contain radioactive substances which continuously emit gamma and neutron radiation. Although the quantity of radioactive material is small, it is important that the use of nuclear gauges is in accordance with the users approved Radiation Safety and Protection Plan.

9 Approved gauges

The nuclear gauges approved for use on Queensland Department of Transport and Main Roads projects are shown in Table 9.

Table 9 – Approved gauges

Topcon	Campbell Pacific Nuclear	Humboldt	InstroTek
3450	MC3 Elite	HS-5001SD	Xplorer 3500
3440P	MC1 Elite	5001EZ	
3430P	MC3	5001C	
3440		5001P	
3430			
4640B			

1 Standard blocks calibration

1.1 General

Prior to the use of a nuclear gauge for density and/or moisture content testing, standard blocks calibration of the density and/or moisture systems of the nuclear gauge shall be performed in accordance with the relevant Australian Standard as follows:

- Nuclear surface moisture-density gauge (direct transmission) AS 1289.5.8.4
- Nuclear thin-layer density gauge AS 2891.14.3
- Nuclear surface moisture-density gauge (backscatter) AS 2891.14.4

Additional standard blocks calibrations of the nuclear gauge shall be undertaken at least once every two years and following any major repair or component replacement.

1.2 Density system consistency check

Density system consistency checks shall be performed at least monthly to confirm the density standard blocks calibration for each calibrated source rod position. Such checks are performed on a density standard block as described in the relevant Australian Standard or a secondary block of naturally occurring stone.

A secondary block shall conform with the following:

- minimum dimensions of length 500 mm, width 290 mm and depth not less than 200 mm and at least 50 mm deeper than the greatest depth at which the check will be conducted
- placed in a fixed location, which is at least 1 m from any vertical projection and sufficiently clear of other nuclear gauges or radiation sources so as to have no effect on nuclear gauge density measurement of the block
- for backscatter measurement, the nuclear gauge base is fully confined within the top surface of the block and clear of any direct transmission access hole, and
- for direct transmission measurement, the block contains an access hole of diameter 30 mm maximum drilled normal to the top surface of the block. The access hole is located to ensure the nuclear gauge base is confined fully within the top surface of the block during both direct transmission and backscatter measurement.

Measurement positions are marked on the block for direct transmission and backscatter measurement (where required) to ensure that all measurements for a nuclear gauge will be made on exactly the same position on the block.

1.2.1 Initial measurement

An initial density measurement of the standard density / secondary block for a nuclear gauge is made prior to its use in the field and within one month of its standard blocks calibration being determined.

The procedure shall be as follows:

- a) Determine a standard count and perform a Standard Count Check as detailed in Clause 5.1 of Test Method N01, N04 or N06 as appropriate (refer to Section 3 of this manual).
- b) Perform a Gauge Function Check – Statistical Performance as detailed in Clause 5.2 of Test Method N01, N04 or N06 as appropriate (refer to Section 3 of this manual).
- c) Position the nuclear gauge within the appropriate marked position on the block.

- d) Move the source rod to the calibrated position to be checked and take eight 1-minute density readings or equivalent combination, in accordance with the appropriate Operating Instruction detailed in Section 4 of the manual.
- e) Record the mean density as the initial gauge density of the block for the calibrated position (ρ_i).
- f) Repeat steps (d) and (e) for each of the remaining calibrated source rod positions (Note: for a nuclear thin-layer density gauge, the check is performed for test thicknesses of 25 (25.4) mm, 50 mm, 75 mm and 100 mm).

1.2.2 Subsequent measurement

For each calibrated source rod position, further density measurements of the block using the nuclear gauge are made prior to use in the field, at intervals not exceeding one month or if it is suspected that the gauge is malfunctioning. The procedure shall be as follows:

- a) Determine a standard count and perform a Standard Count Check as detailed in Clause 5.1 of Test Method N01, N04 or N06 as appropriate (refer to Section 3 of this manual).
- b) Perform a Gauge Function Check – Statistical Performance as detailed in Clause 5.2 of Test Method N01, N04 or N06 as appropriate (refer to Section 3 of this manual).
- c) Position the nuclear gauge within the appropriate marked position on the block.
- d) Move the source rod to the calibrated position to be checked and take at least four 1-minute density readings, or equivalent combination, in accordance with the appropriate Operating Instruction detailed in Section 4 of this manual.
- e) Record the mean density as the current gauge density of the block for the calibrated position (ρ_c).
- f) Repeat steps (d) and (e) for each of the remaining calibrated source rod positions (Note: For a nuclear thin-layer density gauge, the check is performed for test thicknesses of 25 (25.4) mm, 50 mm, 75 mm and 100 mm).

1.2.3 Gauge acceptance

Accept the density standard blocks calibration for a particular source rod position provided that the difference between ρ_i and ρ_c is no greater than 0.020 t/m³ for direct transmission measurements and 0.050 t/m³ for backscatter measurements. Otherwise, withdraw the gauge from service for the calibrated position until the reason for the fault is determined and the fault rectified. Depending on the type of repair undertaken, the gauge may require standard blocks recalibration.

1.2.4 Gauge relocation

If a gauge is relocated to an area remote from the standard density / secondary block, and a different block will be used for this check, the value(s) of ρ_i for this block shall be determined as follows:

- a) During the 24-hour period prior to transporting the gauge, determine the final gauge density of the block (ρ_f) for each of the calibrated source rod positions as detailed in steps (a) to (f) of Clause 1.2.1 (Note: for a nuclear thin-layer density gauge, the check is performed for test thicknesses of 25 (25.4) mm, 50 mm, 75 mm and 100 mm).
- b) Assess the gauge for acceptance as detailed in Step 1.2.3 using ρ_i and ρ_f .
- c) Provided that this check allows acceptance of the density standard blocks calibration for the gauge, perform an initial density measurement (ρ_{12}) on the new block as detailed in steps (a)

to (f) of Clause 1.2.1, prior to its use in the field and within one month of its arrival at the new location (Note: for a nuclear thin-layer density gauge, the check is performed for test thicknesses of 25 (25.4) mm, 50 mm, 75 mm and 100 mm).

- d) Perform subsequent density system consistency checks (ρ_{c2}) on the new block for each of the calibrated source rod positions as detailed in steps (a) to (f) of Clause 1.2.2, prior to its use in the field and at intervals not exceeding one month or if it is suspected that the gauge is malfunctioning.

1.2.5 Relocated gauge acceptance

Accept the density standard blocks calibration for a particular source rod position provided that the difference between ρ_{i2} and ρ_{c2} is no greater than $0.020 - (\rho_i - \rho_f)$ t/m³ for direct transmission measurements and $0.050 - (\rho_i - \rho_f)$ t/m³ for backscatter measurements. Otherwise, withdraw the gauge from service for the calibrated position until the reason for the fault is determined and the fault rectified. Depending on the type of repair undertaken, the gauge may require standard blocks recalibration.

Superseded 6 May 2022

Test Method N01: Compacted density of soil and crushed rock

1 Source

This method was developed in-house using techniques evolved through internal departmental research investigations and incorporates information provided by nuclear gauge manufacturers.

2 Scope

This method sets out the procedure for the determination of the compacted density of soils and crushed rock materials using a nuclear surface moisture-density gauge in the direct transmission mode. Insitu dry density is determined from measured values of wet density and moisture content.

For wet density measurement, an adjustment is made to the standard blocks wet density for all materials used in pavements (for example, unbound materials such as quarry materials or natural gravels, insitu stabilised materials or plant-mixed stabilised materials) and for all other stabilised materials. For nuclear gauge moisture content measurement, an adjustment is made to the standard blocks moisture content as determined from comparative nuclear gauge and oven drying moisture content results.

Where it is not practical to use a nuclear gauge to measure insitu moisture content, the standard oven drying method or a subsidiary method can be used. The use of a subsidiary method is conditional on a correlation established with the oven drying method in accordance with Test Method AS 1289.2.3.1.

3 Apparatus

The following apparatus is required:

- 3.1 Nuclear gauge of an approved make and model as listed in Section 1, sub-section 6 of the *Nuclear Gauge Testing Manual* and capable of the following:
 - a) direct transmission measurement in 25 mm increments from 50 mm to 300 mm
 - b) uncertainty of the predicted density at the depth used for the test not exceeding 0.06 t/m³, and
 - c) uncertainty of the predicted water content not exceeding 0.07 t/m³.
- 3.2 Reference blocks supplied by the manufacturer with the nuclear gauge and traceable to the nuclear gauge.
- 3.3 Drill, a rotary hammer drill or a drill rod and hammer capable of forming a hole at least 16 mm in diameter.
- 3.4 Guide plate, a flat metal template at least the same size as the base of the nuclear gauge, with a hole in one end for the drill rod.
- 3.5 Fines, dry fine sand or dry native fines passing a 0.600 mm test sieve.

4 Calibration and biasing

4.1 Standard blocks calibration

Calibrate the nuclear gauge on standard blocks at least once every two years for both wet density measurement and moisture content measurement as detailed in AS 1289.5.8.4 (Note 11.1). For wet density measurement, obtain a separate calibration for each test depth.

4.2 Material moisture bias

4.2.1 Where the insitu moisture content of a material is to be measured using a nuclear gauge, determine a moisture bias for the particular nuclear gauge and material source (and, if applicable, material type and subtype) as detailed in Test Method N02 (Note 11.2).

This bias is to be re-determined whenever any of the following apply:

- a) the nominal depth of the layer being tested changes by more than 50 mm
- b) the insitu moisture content has changed by more than 2 percent from the average value at the time the moisture bias was determined, or
- c) there is a change in the source rock or the source of any fine component.

4.2.2 In addition to the requirements of Step 4.2.1, check the moisture bias in accordance with Test Method N02 as follows:

- a) following the compaction of every 10,000 tonnes of material, or
- b) if the moisture bias has not been used with the nuclear gauge for two months or more.

4.3 Material wet density bias

4.3.1 Determine a wet density bias for the particular nuclear gauge, material source (and, if applicable, material type and subtype) and test depths as detailed in Test Method N03 (Note 11.2). This bias is to be re-determined whenever any of the following apply:

- a) there is a change in the source rock or the source of any fine component.

4.3.2 In addition to the requirements of Step 4.3.1, check the wet density bias in accordance with Test Method N03 as follows:

- a) whenever any assigned MDD is re-determined as detailed in *Materials Testing Manual* Test Method Q144A Section 2
- b) following the compaction of every 10,000 tonnes of material, or
- c) if the wet density bias has not been used with the nuclear gauge for two months or more.

5 Operational checks

To ensure that the nuclear gauge is operating normally, checks are to be undertaken routinely or following repair as follows:

5.1 Standard count check (frequency: each day of use)

5.1.1 Remove the nuclear gauge and reference block from the store and place the reference block on the designated test location (Note 11.3).

5.1.2 Take a standard count in accordance with the appropriate standard count operating instruction detailed in Section 4: *Operating Instructions: Operational Checks* of the *Nuclear Gauge Testing Manual* and ensure the following:

- a) the nuclear gauge is correctly located on the reference block
- b) the source rod handle is correctly located in the shielded position, and
- c) density standard count and moisture standard count values are recorded (Notes 11.4 and 11.5).

- 5.1.3 Calculate the average of the previous four recorded and accepted density standard counts and the average of the previous four recorded and accepted moisture standard counts.
- 5.1.4 Calculate the limits for density and moisture as follows and record:

$$L = \overline{SC} - 2\sqrt{\frac{\overline{SC}}{PS}}$$

$$U = \overline{SC} + 2\sqrt{\frac{\overline{SC}}{PS}}$$

- where \overline{SC} = average density standard count (DS) or average moisture standard count (MS)
- L = lower limit for density (L_p) or moisture (L_w)
- U = limit for density (U_p) or moisture (U_w)
- PS = nuclear gauge prescale factor (refer to Table 1)

- 5.1.5 If the recorded standard count values lie within the range L_p to U_p for density and L_w to U_w for moisture, the density or moisture standard count is accepted and the nuclear gauge may be used for testing.
- 5.1.6 If the recorded standard count value lies outside the range L_p to U_p for density or L_w to U_w for moisture, repeat Steps 5.1.2 to 5.1.5. If either standard count is again outside the appropriate range, remove the nuclear gauge from service and have it repaired by a licensed service agent (Note 11.6)

5.2 Gauge function check – statistical performance (frequency: monthly)

- 5.2.1 Remove the nuclear gauge and reference block from the store and place the reference block on the designated test location (Note 11.3).
- 5.2.2 Take at least 16 density and moisture counts in accordance with the appropriate statistical count operating instruction detailed in Section 4: *Operating Instructions: Operational Checks of the Nuclear Gauge Testing Manual* and ensure the following:
- the nuclear gauge is correctly located on the reference block
 - the source rod handle is correctly located in the shielded position, and
 - density and moisture count values are recorded (Notes 11.4 and 11.7).
- 5.2.3 Calculate the mean and standard deviation of the density counts and moisture counts.

- 5.2.4 Calculate the density ratio and moisture ratio using the following formula and record the values in the nuclear gauge logbook:

$$r = \frac{s}{\sqrt{\bar{C}}}$$

where r = density ratio (r_p) or moisture ratio (r_w)
 s = standard deviation of the density or moisture counts
 \bar{C} = mean density count (\bar{C}_p) or mean moisture count (\bar{C}_w)

- 5.2.5 If the density ratio and moisture ratio lie within the limits given in Table 2, the nuclear gauge is verified to be operating normally and may be used for testing.
- 5.2.6 If either, the density ratio or the moisture ratio, lie outside the relevant limits given in Table 2, repeat Steps 5.2.2 to 5.2.5. If either ratio is again outside the limits, remove the nuclear gauge from service and have it repaired by a licensed service agent.

5.3 Density system consistency check (frequency: monthly)

Perform a density system consistency check in accordance with Section 2 Clause 1.2 of the *Nuclear Gauge Testing Manual*.

6 Configuration

On each day of use, configure the nuclear gauge before testing any material by undertaking a standard count and setting or checking test parameters for the particular material (and, if applicable, material type and subtype) as follows:

6.1 Standard count

- 6.1.1 Remove the nuclear gauge and reference block from the transport case and place the reference block on the surface of the particular material (and, if applicable, material type and subtype) under test (Note 11.8).
- 6.1.2 Take a standard count in accordance with the appropriate standard count operating instruction detailed in Section 4: *Operating Instructions: Operational Checks* of the *Nuclear Gauge Testing Manual* and ensure the following:
- the nuclear gauge is correctly located on the reference block
 - the source rod handle is correctly located in the shielded position, and
 - density and moisture standard count values are recorded with the test data and, where the functionality exists, stored in the nuclear gauge microprocessor.

6.2 Test parameters

Check or set user definable test parameters in accordance with the appropriate test parameters operating instruction detailed in Section 4: *Operating Instructions: Testing – Soils* of the *Nuclear Gauge Testing Manual* (Note 11.9).

7 Test site selection and preparation

Determine test locations and prepare each test site as follows:

- 7.1 Use Random Stratified Sampling: Selection of Location – Available Area (unless otherwise specified) as detailed in *Materials Testing Manual* Test Method Q050 to determine each test location.
- 7.2 At a designated test location, use the guideplate to define a test site that is flat and free from depressions (Note 11.10). The guideplate may be used to trim the surface of some materials, provided the surface is not de-densified by such action.
- 7.3 Sweep all loose material from the test site and sprinkle fine sand or native fines on the surface. Move the guideplate over the surface until the voids are just filled, ensuring that the sand or fines does not form an added layer.
- 7.4 Place the guideplate on the test site and drill a hole at least 50 mm beyond the specified measurement depth (Note 11.11). Where the measurement depth is not stipulated in the appropriate specification, select a depth in keeping with the following criteria:
 - a) the measurement depth for unbound pavement layers is 15 mm to 29 mm less than the nominal layer thickness where alternative vertical tolerance A is specified, up to the maximum direct transmission measurement depth of 300 mm. (Note 11.12)
 - b) the measurement depth for unbound pavement layers is 25 mm to 49 mm less than the nominal layer thickness, where alternative vertical tolerance B is specified, up to the maximum direct transmission measurement depth of 300 mm (Note 11.12)
 - c) the measurement depth for plant-mixed stabilised layers is 15 mm to 39 mm less than the nominal depth of the layer up to the maximum direct transmission measurement depth of 300 mm, or
 - d) the measurement depth for in situ stabilised layers (subgrade or pavement) is 5 mm to 29 mm less than the nominal depth of the layer up to the maximum direct transmission measurement depth of 300 mm.
- 7.5 Remove the guideplate and repair the prepared test site using some additional sand or fines if required.
- 7.6 Use the guideplate to mark the test site to allow the placement of the nuclear gauge over the test site and to align the source rod to the hole (Note 11.13).

8 Testing

Testing shall be performed as follows:

- 8.1 Place the nuclear gauge on the marked test site, lower the source rod into the formed hole and move the source rod to the required measurement depth.
- 8.2 Ease the source rod against the hole wall by moving the nuclear gauge in the direction of the source rod handle.
- 8.3 Confirm the firm seating of the nuclear gauge on the test site by rotating the nuclear gauge several degrees left or right if required (Note 11.14). Maintain contact between the source rod and the formed hole.
- 8.4 Take a 1-minute count in accordance with the appropriate measurement operating instruction detailed in Section 4: *Operating Instructions: Testing – Soils of the Nuclear Gauge Testing*

Manual. Record relevant density and moisture test data while meeting the requirements of Table 3.

- 8.5 Rotate the nuclear gauge through 90° ensuring that the test site is not disturbed. Repeat Steps 8.2 to 8.4 and then move the source rod to the shielded position (Note 11.13).
- 8.6 Compare the dry density values from the two orientations. If the difference exceeds 0.075 t/m³, examine and further prepare the test site as necessary and repeat Steps 8.1 to 8.5.
- 8.7 If the dry density difference again exceeds 0.075 t/m³, abandon the test site and select a new site immediately adjacent.
- 8.8 Where the insitu moisture content is to be measured using the standard oven drying method or a subsidiary method, obtain a moisture content sample as detailed in *Materials Testing Manual* Test Method Q061.
- 8.9 Determine the oven dry moisture content of the sample obtained as detailed in *Materials Testing Manual* Test Method AS 1289.2.1.1 or one of the subsidiary Test Methods AS 1289.2.1.2, AS 1289.2.1.4, AS 1289.2.1.5 or AS 1289.2.1.6 for which a relationship with Test Method AS 1289.2.1.1 has been established as detailed in Test Method AS 1289.2.3.1.

9 Calculations

Calculations shall be as follows:

9.1 Nuclear gauge density and moisture measurement

- 9.1.1 Determine the compacted dry density for the test site by averaging the dry density values obtained at the 0° and 90° orientations.
- 9.1.2 Where any relevant biases have not been applied via the nuclear gauge microprocessor, adjust the average nuclear gauge dry density calculated in Step 9.1.1 by applying these biases as follows:

$$\rho_d = \bar{\rho}_{Gd} + B_p - B_w$$

where

- ρ_d = compacted dry density (t/m³)
- $\bar{\rho}_{Gd}$ = average nuclear gauge dry density (t/m³)
- B_p = material wet density bias (t/m³)
- B_w = material moisture bias (t/m³)

- 9.1.3 Determine the insitu moisture content for the test site by averaging the measured moisture content values obtained at the 0° and 90° orientations.

- 9.1.4 Where a moisture bias has not been applied via the nuclear gauge microprocessor, adjust the average standard blocks moisture content calculated in Step 9.1.3 by applying this bias as follows:

$$w = \frac{(\overline{W}_G + B_w)100}{\rho_d}$$

- where w = insitu moisture content (%)
 \overline{W}_G = average standard blocks moisture content (t/m³)
 B_w = material moisture bias (t/m³)
 ρ_d = compacted dry density (t/m³)

9.2 Nuclear gauge density and standard oven drying or subsidiary moisture measurement

- 9.2.1 Determine the insitu wet density for the test site by averaging the wet density values obtained at the 0° and 90° orientations.
- 9.2.2 Where any relevant biases have not been applied via the nuclear gauge microprocessor, adjust the average standard blocks wet density calculated in Step 9.2.1 by applying these biases as follows:

$$\rho = \rho_G + B_\rho$$

- where ρ = insitu wet density (t/m³)
 ρ_G = average standard blocks wet density (t/m³)
 B_ρ = material wet density bias (t/m³)

- 9.2.3 Determine the insitu moisture content for the test site as follows:

$$W = \frac{\rho w}{100 + w}$$

- where W = insitu moisture content (t/m³)
 ρ = insitu wet density (t/m³)
 w = insitu oven dry or subsidiary moisture content (%)

- 9.2.4 Determine the compacted dry density for the test site as follows:

$$\rho_d = \rho - W$$

- where ρ_d = compacted dry density (t/m³)
 ρ = insitu wet density (t/m³)
 W = insitu moisture content (t/m³)

10 Reporting

The following shall be reported:

- a) compacted dry density or insitu wet density to the nearest 0.01 t/m³
- b) insitu moisture content to the nearest 0.1% and the test method used
- c) date tested, depth tested, lot number, test site number, and chainage and offset
- d) source and description of the material together with the layer type and layer depth
- e) the report number for the wet density bias and moisture bias, and
- f) the number of this test method, that is N01.

11 Notes on method

- 11.1 Recalibrate the nuclear gauge following any major repair or component replacement.
- 11.2 For pavement materials, it is necessary to determine the moisture bias and wet density bias for each material type and subtype obtained from a particular source.
- 11.3 A location is to be selected which is at least 2 m from any large object and 10 m from any other nuclear gauge. Mark this location and use for all counts associated with operational checks.
- 11.4 Keep a record for each gauge to record operational check data (standard count and gauge function check) and the date of measurement.
- 11.5 Where there are no previous four standard counts taken within the previous five weeks of the current date or when moving the nuclear gauge to a new operating location and there is a new designated test location, it may be necessary to take four new standard counts as detailed in Steps 5.1.1 to 5.1.2.
- 11.6 It is expected that a standard count value will lie outside the range L_p to U_p about once in every 20 standard count checks. To have consecutive values outside this range is expected only once in 400 standard count checks. However, as the return of the gauge for checking and possible repair can be expensive and disruptive, it is acceptable to perform a gauge function check as detailed in subsection 5.2. If verified that the gauge is not operating normally, remove the nuclear gauge from service and have it repaired by a licensed service agent.
- 11.7 Where an accepted form of statistical analysis is performed by the microprocessor, it is not necessary to record individual count values. Only record the density and moisture ratio values and omit Steps 5.2.3 and 5.2.4.
- 11.8 When using the nuclear gauge within 2 m of a large object or in a trench, take a separate standard count at each test site.
- 11.9 The scope of user definable test parameters is dependent on the make and model of nuclear gauge. Such parameters include:
 - a) counting time, units and measurement mode
 - b) maximum dry density
 - c) material density bias, and
 - d) material moisture bias.

- 11.10 The test site is formed by two overlapping rectangles at right angles to each other, with each rectangle being at least the size of the guideplate and the hole being common within the overlapping area in Figure 1.
- 11.11 Where the underlying layer consists of the same material type and subtype as that in the layer under test, select the measurement depth that is closest to the nominal layer thickness. Under these conditions, it is acceptable for the source rod to penetrate into the underlying layer.
- 11.12 The vertical tolerances are found in MRTS05 *Unbound Pavements* Clause 8.4.4.3 and Annexure MRTS05.1 *Unbound Pavements* Clause 3.2.1.
- 11.13 To improve operator safety, it is recommended that the source rod containing radioactive materials not be extended out of its shielded (SAFE) position prior to placing it into the formed hole. Where possible, align the gauge to allow the placing of the source rod directly into the formed hole from the shielded position. The source rod should be returned to its shielded (SAFE) position at the completion of measurements.
- 11.14 If unable to obtain firm seating of the nuclear gauge, prepare a new test site immediately adjacent to the original site.

Table 1 – Nuclear gauge prescale factors

Nuclear gauge make / model	Prescale factor
CPN/except Elite series	1
CPN/Elite series	8
Troxler/except Model 3450	16
Troxler/Model 3450	8
Humboldt/All	16
InstroTek/Xplorer series	16

Table 2 – Gauge function check – density and moisture ratio limits

Nuclear gauge make/model	Lower limit	Upper limit
CPN/except Elite series	0.75	1.25
CPN/Elite series	0.25	0.45
Troxler/except Model 3450	0.17	0.33
Troxler/Model 3450	0.225	0.465
Humboldt/All	0.60	1.40
InstroTek/Xplorer series	0.18	0.35

Table 3 – Minimum test data

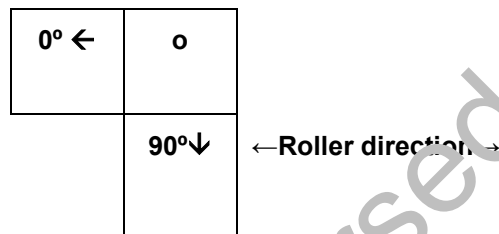
Measurement	Routine test		Material bias or bias check	
	Nuclear gauge density and moisture	Nuclear gauge density and oven dry/ subsidiary moisture	Density	Moisture
density standard count	✓	✓	✓	
moisture standard count	✓			✓
wet density (t/m ³)		✓	✓	✓
dry density (t/m ³)	✓	✓*	✓*	✓*
moisture content (t/m ³)	✓#			✓
moisture content (%)	✓			
density count	✓	✓	✓	
moisture count	✓			✓
relative compaction	✓^			

* These values are only recorded as a means of monitoring the validity of the test results (refer to Step 8.6).

This value is only recorded when the moisture bias is not applied by the microprocessor.

^ This value is only valid when all relevant biases have been applied by the microprocessor.

Figure 1 – Test site



Test Method N02: Material bias – soil moisture content

1 Source

This method was developed in-house using techniques evolved through internal departmental research investigations and incorporates information provided by nuclear gauge manufacturers.

2 Scope

This method sets out the procedure for the determination of the moisture bias associated with the measurement of insitu moisture content of soils and crushed rock materials using a nuclear gauge. The moisture bias represents the average moisture content difference between the nuclear gauge and oven drying tests for a particular nuclear gauge and material. Differences in the moisture content values obtained by the nuclear gauge and oven drying tests are due to differences in the material sampled by both tests, the effect of moisture gradients, the presence of any bound water on nuclear gauge results and any moisture losses from the sample prior to oven drying.

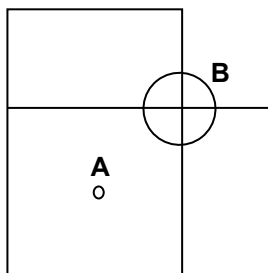
Included in the method is a procedure for monitoring the applicability of an existing moisture bias and for providing ongoing adjustment of the bias to reflect subtle changes in material composition.

This method makes no provision for concurrent determination of wet density bias, and where both moisture content bias and wet density bias are required, reference test Method N03.

3 Procedure

The procedure shall be as follows:

- 3.1 Select at least six test sites within the lot under consideration using Random Stratified Sampling: Selection of Location – Available Area (unless otherwise specified) as detailed in Materials Testing Manual Test Method Q050 (Note 7.1). For stabilised materials, work to determine the wet density must be completed to a stage where the wet density has been determined within 24 hours after the end of the work shift where stabilisation works were completed for the corresponding lot. Number each test site and any bias check test site consecutively in chronological order.
- 3.2 At each test site, undertake the following:
 - 3.2.1 Measure the nuclear gauge moisture content, and dry density and wet density as detailed in Test Method N01, except that no material moisture bias and material wet density bias are applied. The moisture content and wet density values obtained are referred to as the standard blocks moisture content and standard blocks wet density. Record the measured moisture content and moisture content, dry density and wet density values for both the 0° and 90° orientations.
 - 3.2.2 Obtain a moisture content sample as detailed in Materials Testing Manual Test Method Q061.



A: probe access hole location (small circle)

B: oven dry moisture content test location (large circle)

- 3.2.3 Determine the oven dry moisture content of the sample obtained as detailed in Test Method AS 1289.2.1.1. For stabilised materials, moisture content samples must be returned to a laboratory and placed in drying ovens within the same work shift as the stabilisation works for the corresponding lot.

4 Calculations

Calculations shall be as follows:

4.1 Field test data

- 4.1.1 Determine the moisture count, standard blocks moisture content and standard blocks wet density for each site by averaging the corresponding measurements for the 0° and 90° orientations.

- 4.1.2 Calculate the oven dry moisture content for each site as follows:

$$W_o = \frac{\rho_G W_o}{100 + w_o}$$

where W_o = oven dry moisture content (t/m³)
 ρ_G = standard blocks wet density (t/m³)
 w_o = oven dry moisture content (%)

4.2 Data validation

- 4.2.1 Calculate the moisture count ratio for each site to four significant figures as follows:

$$CR_w = \frac{C_w}{SC_w}$$

where CR_w = moisture count ratio
 C_w = moisture count
 SC_w = moisture standard count

- 4.2.2 Plot the standard blocks moisture content against the corresponding moisture count ratio using the data from all test sites (Note 7.2).
- 4.2.3 If any data pair does not lie on the linear plot, reject the standard blocks and oven dry moisture data for this test site.

4.3 Data acceptance

- 4.3.1 Calculate the average standard blocks moisture content and average oven dry moisture content for all remaining test sites.

- 4.3.2 Calculate the moisture standard error as follows:

$$SE_w = \sqrt{\frac{\sum (W_o - W_G - \bar{W}_o + \bar{W}_G)^2}{n - 2}}$$

where SE_w = moisture standard error (t/m³)

W_o	=	oven dry moisture content at each test site (t/m ³)
W_G	=	standard blocks moisture content at each test site (t/m ³)
\overline{W}_o	=	average oven dry moisture content for the test sites (t/m ³)
\overline{W}_G	=	average standard blocks moisture content for the test sites (t/m ³)
n	=	number of test sites

4.3.3 If the moisture standard error does not exceed 0.020 t/m³, accept the data and calculate the moisture bias as detailed in Subsection 4.4.

4.3.4 If the moisture standard error exceeds 0.020 t/m³, perform the following:

- a) For each moisture data pair (oven dry and standard blocks), calculate the moisture error as follows:

$$E_w = \left| (W_o - W_G) - (\overline{W}_o - \overline{W}_G) \right|$$

where E_w = moisture error (t/m³)

W_o = oven dry moisture content at each test site (t/m³)

W_G = standard blocks moisture content at each test site (t/m³)

\overline{W}_o = average oven dry moisture content for the test sites (t/m³)

\overline{W}_G = average standard blocks moisture content for the test sites (t/m³)

- b) Eliminate the moisture content data pair (oven dry and standard blocks), with the largest moisture error.
- c) Re-analyse the data by repeating Steps 4.3.1 to 4.3.4, except that:
- If data from three or more test sites are eliminated, reject all test data and repeat the complete procedure.
 - If there is acceptable data from less than six test sites, reject all test data and repeat the complete procedure.
 - If all test data are again rejected, it is not appropriate to calculate a single wet density bias for the material.

4.4 Determination of moisture bias

Moisture bias may be calculated directly in t/m³ or expressed as a K value. Choose the form of moisture bias which is applicable to the particular nuclear gauge used.

4.4.1 Moisture bias (t/m³)

Calculate the moisture bias as follows:

$$B_w = \overline{W}_o - \overline{W}_G$$

where B_w = moisture bias (t/m³)

\overline{W}_o = average oven dry moisture content for all accepted test sites (t/m³)

$$\bar{W}_G = \text{average standard blocks moisture content for all accepted test sites (t/m}^3\text{)}$$

4.4.2 Moisture bias (K value)

There are a number of options for determining the K value, depending on the functionality of the nuclear gauge. The K value can be either calculated external to the nuclear gauge and stored in the microprocessor or calculated internally by the microprocessor using input values of average oven dry moisture content and average standard blocks moisture content.

External calculation

Calculate the moisture bias as a K value using the appropriate method as follows:

for a Humboldt nuclear gauge, calculate and record to the nearest 0.01;

$$K = \frac{\bar{W}_o - \bar{W}_G}{\bar{P}_G - \bar{W}_o}$$

or for a Troxler nuclear gauge, calculate and record to the nearest whole number;

$$K = \frac{(\bar{W}_o - \bar{W}_G)1000}{\bar{P}_G - \bar{W}_o}$$

- where
- K = K value
 - \bar{W}_o = average oven dry moisture content for all accepted test sites (t/m³)
 - \bar{W}_G = average standard blocks moisture content for all accepted test sites (t/m³)
 - \bar{P}_G = average standard blocks wet density for all accepted test sites (t/m³)

Internal calculation

i) Calculate the average oven dry moisture content as follows:

$$w_o = \frac{100\bar{W}_o}{\bar{P}_G - \bar{W}_G}$$

- where
- w_o = average oven dry moisture content for all accepted test sites (%)
 - \bar{W}_o = average oven dry moisture content for all accepted test sites (t/m³)
 - \bar{W}_G = average standard blocks moisture content for all accepted test sites (t/m³)
 - \bar{P}_G = average standard blocks wet density for all accepted test sites (t/m³)

ii) Calculate the average standard blocks moisture content as follows:

$$w_G = \frac{100\bar{W}_G}{\bar{P}_G - \bar{W}_G}$$

- where
- w_G = average standard blocks moisture content for all accepted test sites (%)
 - \bar{W}_G = average standard blocks moisture content for all accepted test sites (t/m³)

\bar{P}_G = average standard blocks wet density for all accepted test sites (t/m³)

5 Bias check

Bias checks shall be performed as follows:

- 5.1 Monitor the moisture bias by performing three additional standard blocks moisture and oven dry moisture content tests following the compaction of 10,000 tonnes of material. Select the three test sites from within the lot that contains the last of the 10,000 tonnes and perform testing as detailed in Section 3.
- 5.2 Determine and validate the nuclear gauge moisture count and standard blocks moisture content data as detailed in Steps 4.1 to 4.2.3.
- 5.3 Add the new moisture data pairs to the previously accepted data while removing three existing and consecutive moisture data pairs commencing at the lowest test site number (Note 7.3).
- 5.4 Analyse the revised moisture data for acceptance as detailed in Subsection 4.3, except that no more than one of the new moisture data points may be eliminated.
- 5.5 Calculate an amended moisture bias for the accepted data as detailed in Subsection 4.4.

6 Reporting

The following shall be reported:

- a) moisture bias using one of the following conventions:
 - to the nearest 0.01 t/m³
 - a K value to the nearest 0.01 unit for a Humboldt nuclear gauge
 - a K value to the nearest whole number for a Troxler or Instrotek nuclear gauge, or
 - K value inputs, viz. average oven dry moisture content to the nearest 0.1% and average standard blocks moisture content to the nearest 0.1%.
- b) source and description of the material, together with the layer type and layer depth
- c) a tabulation containing the standard blocks and oven dry moisture data used to determine the bias (including any eliminated data), together with the date tested, depth tested, lot number, test site number, and chainage and offset
- d) the date the bias was reported and, in the case of an amended moisture bias, the report number and date for the previous report, and
- e) the number of this test method, that is N02.

7 Notes on method

- 7.1 In order to determine a moisture bias that is representative of the lot, distribute sampling locations throughout the lot.
- 7.2 The relationship between nuclear gauge moisture content and moisture count ratio is essentially linear over the expected moisture content range within a lot.
- 7.3 When there are only six existing data points, remove only two so that seven data points are available for analysis.

Test Method N03: Material bias – soil wet density

1 Source

This method was developed in-house using techniques evolved through internal departmental research investigations and incorporates information provided by nuclear gauge manufacturers.

2 Scope

This method sets out the procedure for the determination of the wet density bias associated with the measurement of compacted density of soils and crushed rock materials using a nuclear gauge. The wet density bias represents the average wet density difference between the nuclear gauge and sand replacement tests for a particular nuclear gauge, material and test depth. Differences in the wet density values obtained by the nuclear gauge and sand replacement tests are due to differences in the material sampled by both tests, the effect of chemical composition and test site characteristics (for example, density and moisture gradients, surface condition, particle size, homogeneity) on nuclear gauge results and inadequacies in the sand replacement test for some materials.

Included in the method is a procedure for monitoring the applicability of an existing wet density bias and for providing ongoing adjustment of the bias to reflect subtle change in material composition.

This method also caters for concurrent determination of a moisture bias as detailed in Test Method N02.

3 Procedure

The procedure shall be as follows:

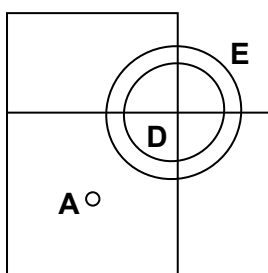
3.1 Select at least six test sites within the lot under consideration using Random Stratified Sampling: Selection of Location - Available Area (unless otherwise specified) in accordance with Materials Testing Manual Test Method Q050 (Note 7.1). For stabilised materials, work to determine the wet density must be completed to a stage where the wet density has been determined within 24 hours after the end of the work shift where stabilisation works were completed for the corresponding lot. Number each test site and any bias check test site consecutively in chronological order.

3.2 At each test site, undertake the following:

3.2.1 Measure the nuclear gauge wet density as detailed in Test Method N01, ensuring that any relevant alignment and gauge biases are applied but that no material wet density bias is applied. This wet density is referred to as the standard blocks wet density. Record the measured density counts, dry density and wet density values for both the 0° and 90° orientations.

Where a moisture content bias is required in conjunction with a wet density bias, obtain and record nuclear gauge moisture counts and moisture content values as detailed in Test Method N02.

3.2.2 Select a position for a sand replacement test at either position D for a 150 mm diameter hole or position E for a 200 mm diameter hole.



A: probe access hole location (small circle)

D: 150 mm dia. sand replacement test location (medium circle)

E: 200 mm dia. sand replacement test location (large circle)

3.2.3 Remove any fine sand or fines from the nuclear gauge test position as selected in Step 3.2.2. Undertake a sand replacement test as detailed in Test Method Q141B and determine the wet density and oven dry moisture content. Excavate to one of the following depths while avoiding the probe access hole and any associated surface cracking:

- a) the full depth of the layer where the sampled material is from a pavement or earthworks, or
- b) the depth used in the nuclear gauge measurement of wet density where the sampled material is from earthworks and no layer depth is applicable.

For stabilised materials, moisture content samples must be returned to a laboratory and placed in drying ovens within the same work shift as the stabilisation works for the corresponding lot.

4 Calculations

Calculations shall be as follows:

4.1 Field test data

Determine the density count and standard blocks wet density for each site by averaging the corresponding measurements for the 0° and 90° orientations.

4.2 Data validation

4.2.1 Calculate the density count ratio for each site to four significant figures as follows:

$$CR_p = \frac{C_p}{SC_p}$$

where CR_p = density count ratio
 C_p = density count
 SC_p = density standard count

4.2.2 Plot the standard blocks wet density against the corresponding density count ratio using the data from all test sites (Note 7.2).

4.2.3 If any data point does not lie on the linear plot, reject the standard blocks and sand replacement wet density data for this test site.

4.3 Data acceptance

4.3.1 Calculate the average standard blocks wet density and average sand replacement wet density for all remaining test sites.

4.3.2 Calculate the wet density standard error as follows:

$$SE_p = \sqrt{\frac{\sum (\rho_s - \rho_G - \bar{\rho}_s + \bar{\rho}_G)^2}{n - 2}}$$

- where SE_p = wet density standard error (t/m^3)
- ρ_s = sand replacement wet density at each test site (t/m^3)
- ρ_G = standard blocks wet density at each test site (t/m^3)
- $\bar{\rho}_s$ = average sand replacement wet density for all test sites (t/m^3)
- $\bar{\rho}_G$ = average standard blocks wet density for all test sites (t/m^3)
- n = number of test sites

4.3.3 If the wet density standard error does not exceed $0.055 t/m^3$, accept the data and calculate the wet density bias as detailed in Subsection 4.4.

4.3.4 If the wet density standard error exceeds $0.055 t/m^3$, perform the following:

- a) For each density data pair (sand replacement and standard blocks), calculate the wet density error and follows:

$$E_p = |(\rho_s - \rho_G) - (\bar{\rho}_s - \bar{\rho}_G)|$$

- where E_p = wet density error (t/m^3)
- ρ_s = sand replacement wet density at each test site (t/m^3)
- ρ_G = standard blocks wet density at each test site (t/m^3)
- $\bar{\rho}_s$ = average sand replacement wet density for the test sites (t/m^3)
- $\bar{\rho}_G$ = average standard blocks wet density for the test sites (t/m^3)

- b) Eliminate the wet density data pair (sand replacement and standard blocks), with the largest wet density error.

c) Re-analyse the data by repeating Steps 4.3.1 to 4.3.4, except that:

- i. If data from three or more test sites are eliminated, reject all test data and repeat the complete procedure.
- ii. If there is acceptable data from less than six test sites, reject all test data and repeat the complete procedure.
- iii. If all test data are again rejected, it is not appropriate to calculate a single wet density bias for the material.

4.4 Wet density bias

Calculate the wet density bias as follows:

$$B_p = \bar{\rho}_s - \bar{\rho}_G$$

- where B_p = wet density bias (t/m^3)
- $\bar{\rho}_s$ = average sand replacement wet density for all accepted test sites (t/m^3)
- $\bar{\rho}_G$ = standard blocks wet density for all accepted test sites (t/m^3)

5 Bias check

Bias checks shall be performed as follows:

- 5.1 Monitor the wet density bias by performing three additional standard blocks wet density and sand replacement wet density tests following the compaction of 10,000 tonnes of material. Select the three test sites from within the lot that contains the last of the 10,000 tonnes and perform the testing as detailed in Section 3.
- 5.2 Determine and validate the nuclear gauge density count and standard blocks wet density data as detailed in Steps 4.1 to 4.2.3.
- 5.3 Add the new density data pairs to the previously accepted data while removing three existing and consecutive density data pairs commencing at the lowest test site number (Note 7.3).
- 5.4 Analyse the revised wet density data for acceptance as detailed in Subsection 4.3, except that no more than one of the new density data pairs may be eliminated.
- 5.5 Calculate an amended wet density bias for the accepted data as detailed in Subsection 4.4.

6 Reporting

The following shall be reported:

- a) wet density bias to the nearest 0.01 t/m^3
- b) source and description of the material together with the layer type and layer depth
- c) a tabulation containing the standard blocks and sand replacement wet density data used to determine the bias (including any eliminated data), together with the date tested, depth tested, lot number, test site number, and chainage and offset
- d) the date the bias was reported, and
- e) the number of this test method, that is N03.

7 Notes on method

- 7.1 In order to determine a wet density bias that is representative of the lot, distribute the sampling locations throughout the lot.
- 7.2 The relationship between nuclear gauge wet density and density count ratio is essentially linear over the expected density range within a lot.
- 7.3 Where there are only six existing data points, remove only two so that seven data points are available for analysis.

Test Method N04: Compacted density of asphalt

1 Source

This method was developed in-house using techniques evolved through internal departmental research investigations and incorporates information provided by nuclear gauge manufacturers.

2 Scope

This method sets out the procedure for the determination of the compacted density of asphalt using a nuclear gauge. The method is based on the backscatter mode of measurement and records the wet density output from the nuclear gauge as the compacted density of the asphalt.

An adjustment is made to the standard blocks wet density calibration as determined from comparative nuclear gauge wet density and core compacted density results.

3 Apparatus

The following apparatus is required:

- 3.1 Nuclear gauge of an approved make and model as listed in Section 1 of the Nuclear Gauge Testing Manual and with a calibration density uncertainty of less than 0.08 t/m³ for gauges used in backscatter mode and for thin-layer gauges such as model 4640B.
- 3.2 Reference block, as supplied by the manufacturer with the nuclear gauge and traceable to the nuclear gauge.
- 3.3 Guideplate or straightedge.
 - 3.3.1 Guideplate, a flat metal template at least the same size as the base of the nuclear gauge.
 - 3.3.2 Straightedge, a steel straightedge about 300 mm long and 5 mm thick.
- 3.4 Dry fine sand passing a 0.600 mm test sieve.

4 Calibration and biasing

Calibration and biasing shall be performed as follows:

4.1 Standard blocks calibration

Calibrate the nuclear gauge on standard blocks at least once every two years for density measurement as detailed in the relevant Australian Standard as follows (Note 11.1):

- Nuclear thin-layer density gauge AS 2891.14.3
- Nuclear moisture-density gauge (backscatter) AS 2891.14.4

4.2 Asphalt density bias

- 4.2.1 Determine a density bias for the particular nuclear gauge, asphalt mix and gauge layer thickness setting (thin-layer gauge only) as detailed in Test Method N05.

This bias is to be re-determined whenever any of the following apply:

- a) there is a change to the mix design, or
- b) there is a change to the gauge layer thickness setting.

- 4.2.2 In addition to the requirements of Steps 4.2.1, check any applied density bias in accordance with Test Method N05 as follows:
- whenever there is a change in site conditions (for example, surface roughness, nominal layer thickness, composition of underlying layer, density of underlying layer)
 - following the compaction of every 10,000 tonnes of material (such that the check is within the lot that contains the last of the 10,000 tonnes), or
 - if the density bias has not been used with the nuclear gauge for two months or more.

5 Operational checks

To ensure that the nuclear gauge is operating normally, checks are to be undertaken routinely or following repair as follows:

5.1 Standard count check (frequency: each day of use)

- Remove the nuclear gauge and reference block from the store and place the reference block on the designated test location (Note 11.2).
- Take a standard count for each density detection system in accordance with the appropriate standard count operating instruction detailed in Section 4: Operating Instructions: Operational Checks of the Nuclear Gauge Testing Manual and ensure the following:
 - the nuclear gauge is correctly located on the reference block
 - the source rod handle is correctly located in the shielded position, and
 - the density standard count values are recorded (Note 11.3).
- Calculate the average of the previous four recorded and accepted density standard counts (Note 11.4).
- Calculate the density limits for each density detection system as follows and record the limits (Note 11.3):

$$L_{\rho} = \overline{SC} - 2\sqrt{\frac{\overline{SC}}{PS}}$$

$$U_{\rho} = \overline{SC} + 2\sqrt{\frac{\overline{SC}}{PS}}$$

where \overline{SC} = average density standard count (DS)

L_{ρ} = lower limit for density

U_{ρ} = upper limit for density

PS = nuclear gauge prescale factor (Refer to Table 1)

- If the recorded standard count value for each system lies within the range L_{ρ} to U_{ρ} , the density standard count is accepted and the nuclear gauge may be used for testing.
- If either recorded standard count value lies outside the range L_{ρ} to U_{ρ} repeat Steps 5.1.2 to 5.1.5. If either standard count is again outside the range, remove the nuclear gauge from service and have it repaired by a licensed service agent (Notes 11.4 and 11.5).

5.2 Gauge function check – statistical performance (frequency: monthly)

- 5.2.1 Remove the nuclear gauge and reference block from the store and place the reference block on the designated test location (Note 11.2).
- 5.2.2 Take at least 16 density counts for each density detection system in accordance with the appropriate statistical count operating instruction detailed in Section 4: Operating Instructions: Operational Checks of the Nuclear Gauge Testing Manual and ensure the following:
- the nuclear gauge is correctly located on the reference block
 - the source rod handle is correctly located in the shielded position, and
 - the density count values are recorded (Notes 11.3 and 11.6).
- 5.2.3 Calculate the mean and standard deviation of the density counts.
- 5.2.4 Calculate the density ratio for each density detection system as follows and record the value (Note 11.3):

$$r_p = \frac{s}{\sqrt{\bar{C}_p}}$$

where r_p = density ratio
 s = standard deviation of the density counts
 \bar{C}_p = mean density count

- 5.2.5 If the density ratio for each system lies within the limits given in Table 2, the nuclear gauge is verified to be operating normally and may be used for testing.
- 5.2.6 If any density ratio lies outside the relevant limits given in Table 2, repeat Steps 5.2.2 to 5.2.5. If any ratio is again outside the limits, remove the nuclear gauge from service and have it repaired by a licensed service agent.

5.3 Density system consistency check (frequency: monthly)

Perform a density system consistency check in accordance with Section 2, Subsection 1.2 of the Nuclear Gauge Testing Manual.

6 Configuration

On each day of use configure the nuclear gauge before testing by undertaking a standard count and setting or checking test parameters appropriate to the asphalt mix design as follows:

6.1 Standard count

- 6.1.1 Remove the nuclear gauge and reference block from the transport case and place the reference block on the surface of the particular asphalt mix under test (Note 11.7).
- 6.1.2 Take a standard count in accordance with the appropriate standard count operating instruction detailed in Section 4: Operating Instructions: Operational Checks of the Nuclear Gauge Testing Manual and ensure the following:
- the nuclear gauge is correctly located on the reference block
 - the source rod handle is correctly located in the shielded position, and
 - the density standard count value is recorded with the test data and, where the functionality exists, stored in the nuclear gauge microprocessor.

6.2 Test parameters

Check or set user definable test parameters in accordance with the appropriate test parameters operating instruction detailed in Section 4: Operating Instructions: Testing – Asphalt of the Nuclear Gauge Testing Manual (Note 11.8).

7 Test site selection and preparation

Determination of test locations and preparation of each test site shall be as follows:

- 7.1 Use Random Stratified Sampling: Selection of Location – Available Area (unless otherwise specified) as detailed in Test Method Q050 to determine each test location.
- 7.2 At a designated test location, use the guideplate or straightedge to define a test site which is flat and free from depressions.
- 7.3 Sweep all loose material from the test site and sprinkle fine sand on the surface. Move the guideplate or straightedge over the surface until the voids are just filled, ensuring that the sand does not form an added layer. Remove the guideplate or straightedge.

8 Testing

Testing shall be performed as follows:

- 8.1 Place the nuclear gauge on the prepared test site such that the longitudinal axis of the nuclear gauge is parallel to the direction of rolling.
- 8.2 Confirm that the nuclear gauge is firmly seated without rocking (Note 11.9). Move the source rod to the backscatter (BS) position.
- 8.3 Take a 1-minute count in accordance with the appropriate measurement operating instruction detailed in Section 4: Operating Instructions: Testing – Asphalt of the Nuclear Gauge Testing Manual. Record the wet density and the density count.
- 8.4 Rotate the nuclear gauge through 180° ensuring that the test site is not disturbed. Repeat Steps 8.2 to 8.3 and then move the source rod to the shielded position (Note 11.10).
- 8.5 Compare the wet density values from the two orientations. If the difference exceeds 0.075 t/m³, examine and further prepare the test site as necessary and repeat Steps 8.1 to 8.4.
- 8.6 If the wet density difference again exceeds 0.075 t/m³, abandon the test site and select a new site immediately adjacent.

9 Calculations

Calculations shall be as follows:

- 9.1 Determine the compacted density for the test site to the nearest 0.001 t/m³ by averaging the wet density values obtained at the 0° and 180° orientations.
- 9.2 Where the asphalt density bias has not been applied via the nuclear gauge microprocessor, adjust the compacted density calculated in Step 9.1 as follows:

$$D_c = \rho_G + B_p$$

where D_c = compacted density (t/m³)

ρ_G = average nuclear gauge wet density (t/m³)

$$B_p = \text{asphalt density bias (t/m}^3\text{)}$$

10 Reporting

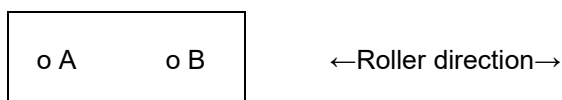
The following shall be reported:

- a) compacted density to the nearest 0.001 t/m³
- b) date tested, test mode, lot number, test site number, and chainage and offset
- c) source and type of the asphalt together with the mix code number and nominal layer depth
- d) for thin-layer gauges (such as Troxler 4640B) the gauge layer thickness setting to the nearest 1 mm
- e) report number for the asphalt density bias and, in the case of an amended bias, the date and report number for the previous report, and
- f) the number of this test method, that is N04.

11 Notes on method

- 11.1 Recalibrate the nuclear gauge following any major repair or component replacement.
- 11.2 A location is to be selected which is at least 2 m from any large object and 10 m from any other nuclear gauge. Mark this location and use for all counts associated with operational checks.
- 11.3 A record is to be kept for each gauge to record operational check data (standard count check and gauge function check) and the date of measurement. For nuclear gauges with two detection systems (for example, the nuclear thin-layer density gauge), record the check data for each system separately.
- 11.4 Where the previous four standard counts have not been taken within the previous five weeks of the current date or the nuclear gauge has been moved to a new operating location and has a new designated test location, it may be necessary to take four new standard counts as detailed in Steps 5.1.1 to 5.1.2.
- 11.5 It is expected that a standard count value will lie outside the range L_p to U_p about once in every 20 standard count checks. To have consecutive values outside this range is expected only once in 400 standard count checks. However, as the return of the gauge for checking and possible repair can be expensive and disruptive, it is acceptable to perform a gauge function check as detailed in Subsection 5.2. If the gauge is not verified as operating normally, remove the nuclear gauge from service and have it repaired by a licensed service agent.
- 11.6 Where an accepted form of statistical analysis is performed by the microprocessor, it is not necessary to record individual count values. Only the density ratio value needs to be recorded and Steps 5.2.3 and 5.2.4 may then be omitted.
- 11.7 Where the nuclear gauge is to be used within 2 m of a large object or in a trench, take a separate standard count at each test site.
- 11.8 The scope of user definable test parameters is dependent on the make and model of nuclear gauge. Such parameters include:
 - a) counting time, units and measurement mode
 - b) maximum density

- c) asphalt density bias, and
 - d) for thin-layer gauges (such as Troxler 4640B) the gauge layer thickness setting.
- 11.9 If the nuclear gauge cannot be firmly seated, prepare a new test site immediately adjacent to the original site.
- 11.10 The test area is formed by a single rectangle being at least the size of the guide plate with the source rod being over the surface of the asphalt at each end of the test area.



Position A is the source rod location for 0° measurement and position B is the source rod location for 180° measurement.

Table 1 – Nuclear gauge prescale factors

Nuclear gauge make/model	Prescale factor
CPN/except Elite series	1
CPN/Elite series	8
Troxler/except Models 3450 and 4640B	16
Troxler/Models 3450 and 4640B	8
Humboldt/All	16
InstroTek/Xplorer series	16

Table 2 – Gauge function check – density ratio limits

Nuclear gauge make/model	Lower limit	Upper limit
CPN/except Elite series	0.75	1.25
CPN/Elite series	0.25	0.45
Troxler/ except Models 3450 and 4640B	0.17	0.33
Troxler/Model 3450	0.225	0.465
Troxler/Model 4640B	0.25	0.45
Humboldt/All	0.60	1.40
InstroTek/All	0.18	0.35

Test Method N05: Asphalt density bias

1 Source

This method was developed in-house using techniques evolved through internal departmental research investigations and incorporates information provided by nuclear gauge manufacturers.

2 Scope

This method sets out the procedure for the determination of the asphalt density bias associated with the measurement of compacted density of asphalt using a nuclear gauge. The asphalt density bias represents the average density difference between nuclear gauge wet density and core compacted density for a particular nuclear gauge, asphalt mix and layer thickness. Differences between nuclear gauge wet density and core compacted density are due to differences in the material sampled by both tests and the effect of chemical composition and test site characteristics (for example, density gradients, surface condition, homogeneity) on nuclear gauge results.

Included in the method is a procedure for monitoring the applicability of an existing asphalt density bias and providing ongoing adjustment of the bias to reflect subtle changes in asphalt mix composition/site conditions.

3 Procedure

The procedure shall be as follows:

- 3.1 Select at least 10 test sites within the lot under consideration using Random Stratified Sampling: Selection of Location – Available Area (unless otherwise specified) as detailed in Test Method Q050 (Note 7.1). Number each test site and any bias check test site consecutively in chronological order.
- 3.2 At each test site, undertake the following:
 - 3.2.1 Measure the nuclear gauge wet density as detailed in Test Method N04, except that no asphalt density bias is applied. This wet density is referred to as the standard blocks wet density. For thin-layer gauges, the gauge layer thickness should be set to the nominal thickness of the layer. Record the measured density counts and wet density values to the nearest 0.001 t/m³ for both the 0° and 180° orientations (Note 7.2).
 - 3.2.2 Obtain a 150 mm diameter core sample centrally within the site in accordance with Test Method AS 2891.1.2.
 - 3.2.3 Measure the compacted density of the core sample in accordance with Test Method AS 2891.9.2, Q306B or Q306C as appropriate (Note 7.3).

4 Calculations

Calculations shall be as follows:

4.1 Field test data

Determine the density count and standard blocks wet density for each site by averaging the corresponding measurements for the 0° and 180° orientations (Note 7.2).

4.2 Data validation

Validate the density count, density standard count and standard blocks wet density data as follows (Note 7.4):

4.2.1 Calculate the density count ratio for each site to four significant figures as follows:

$$CR_p = \frac{C_p}{SC_p}$$

where CR_p = density count ratio
 C_p = density count
 SC_p = density standard count

4.2.2 Plot the standard blocks wet density against the corresponding density count ratio using the data from all test sites (Note 7.5).

4.2.3 If any data pair does not lie on the linear plot, reject the standard blocks and core compacted density wet density data for this test site.

4.3 Data acceptance

4.3.1 Calculate the average standard blocks wet density and average core compacted density for all remaining test sites.

4.3.2 Calculate the density standard error as follows:

$$SE_p = \sqrt{\frac{\sum (D_C - \rho_G - \bar{D}_C + \bar{\rho}_G)^2}{r-2}}$$

where SE_p = density standard error (t/m³)
 D_C = core compacted density at each test site (t/m³)
 ρ_G = standard blocks wet density at each test site (t/m³)
 \bar{D}_C = average core compacted density for the test sites (t/m³)
 $\bar{\rho}_G$ = average standard blocks wet density for the test sites (t/m³)
 r = number of test sites

4.3.3 If the density standard error does not exceed 0.025 t/m³, accept the data and calculate the asphalt density bias as detailed in sub-section 4.4.

4.3.4 If the density standard error exceeds 0.025 t/m³, perform the following:

- a) For each density data pair (core compacted density and standard blocks wet density), calculate the density error as follows:

$$E_p = \left| (D_C - \rho_G) - (\bar{D}_C - \bar{\rho}_G) \right|$$

- where E_p = density error (t/m³)
 D_C = core compacted density at each test site (t/m³)
 ρ_G = standard blocks wet density at each test site (t/m³)
 \bar{D}_C = average core compacted density for the test sites (t/m³)
 $\bar{\rho}_G$ = average standard blocks wet density for the test sites (t/m³)

- b) Eliminate the density data pair (core compacted density and standard blocks wet density) with the largest density error.
- c) Re-analyse the data by repeating Steps 4.3.1 to 4.3.4, except that:
- If data from more than 20% of test sites are eliminated, reject all test data and repeat the complete procedure.
 - If all test data are again rejected, it is not appropriate to calculate a single asphalt density bias for the material.

4.4 Asphalt density bias

Calculate the asphalt density bias using accepted data to the nearest 0.001 t/m³ as follows:

$$B_p = \bar{D}_C - \bar{\rho}_G$$

- where B_p = asphalt density bias (t/m³)
 \bar{D}_C = average core compacted density for the test sites (t/m³)
 $\bar{\rho}_G$ = average standard blocks wet density for the test sites (t/m³)

5 Bias check

Bias checks shall be performed as follows:

- Monitor the asphalt density bias by performing three additional nuclear gauge wet density and core compacted density tests following the compaction of 10,000 tonnes of material. Select the three test sites from within the lot that contains the last of the 10,000 tonnes and perform testing as detailed in Section 3.
- Determine and validate the nuclear gauge density count and standard blocks wet density data as detailed in Steps 4.1 to 4.2.3.
- Add the new density data pairs to the previously accepted data while removing three existing and consecutive density data pairs commencing at the lowest test site number (Note 7.6).

- 5.4 Analyse the revised density data for acceptance as detailed in sub-section 4.3, except that no more than one of the new density data pairs may be eliminated.
- 5.5 Calculate an amended asphalt density bias for the accepted data as detailed in sub-section 4.4.

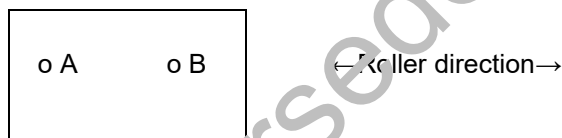
6 Reporting

The following shall be reported:

- a) asphalt density bias to the nearest 0.001 t/m³
- b) source and type of the asphalt together with the mix code number and nominal layer depth
- c) a tabulation containing the standard blocks wet density and core compacted density data used to determine the bias (including any eliminated data), together with the date tested, lot number, test site number, and chainage and offset
- d) the date the bias was calculated and, in the case of an amended asphalt density bias, the report number and date for the previous report, and
- e) for thin-layer gauges (such as Troxler 4640B) the gauge layer thickness setting to the nearest 1 mm, and
- f) the number of this test method, that is N05.

7 Notes on method

- 7.1 In order to determine an asphalt density bias which is representative of the lot, distribute sampling locations throughout the lot.
- 7.2 The test area is formed by a single rectangle being at least the size of the guide plate with the source rod being over the surface of the asphalt at each end of the test area.



Position A is the source rod location for 0° measurement and position B is the source rod location for 180° measurement.

- 7.3 For stone mastic asphalt and open graded asphalt, determine the core sample compacted density in accordance with Test Method Q306C. For dense graded asphalt, the core sample may be tested in accordance with Test Method AS 2891.9.2 or Q306B rather than Test Method Q306C, provided that its air void content is not less than the minimum specified level. Use the same compacted density method for both the bias determination and bias checks.
- 7.4 For thin-layer gauges with two detection systems, validate the density system 1 data (that is density count, density standard count and the standards blocks wet density) as detailed in Steps 4.2.1 to 4.2.4. Then validate the density system 2 data (that is density count, density standard count and the standards blocks wet density) as detailed in Steps 4.2.1 to 4.2.4.
- 7.5 The relationship between nuclear gauge wet density and density count ratio is essentially linear over the expected density range within a lot.
- 7.6 Where there are only eight existing data points, remove only two so that nine data points are available for analysis.

Test Method N06: Compacted density of concrete

1 Source

This method is based on ASTM C1040: *Standard test method for in-place density of unhardened and hardened concrete, including roller compacted concrete, by nuclear methods*. It varies from this method by only testing hardened concrete, using only the backscatter mode and incorporating practices from the *Nuclear Gauge Testing Manual* into the method.

2 Scope

This method sets out the procedure for the determination of the compacted density of hardened concrete using a nuclear gauge. The method is based on the backscatter mode of measurement and records the wet density output from the nuclear gauge as the compacted density of the concrete.

An adjustment is made to the standard blocks wet density calibration as determined from comparative nuclear gauge wet density and core density results.

3 Apparatus

The following apparatus is required:

- 3.1 Nuclear gauge of an approved make and model as listed in Section 1 of the *Nuclear Gauge Testing Manual* and with a calibration density uncertainty of less than 0.08 t/m³.
- 3.2 Reference block, as supplied by the manufacturer with the nuclear gauge and traceable to the nuclear gauge.
- 3.3 Guideplate or straightedge.
 - 3.3.1 Guideplate, a flat metal template at least the same size as the base of the nuclear gauge.
 - 3.3.2 Straightedge, a steel straightedge about 300 mm long and 5 mm thick.
- 3.4 Dry fine sand passing a 0.600 mm test sieve.

4 Calibration and biasing

Calibration and biasing shall be performed as follows:

4.1 Standard blocks calibration

Calibrate the nuclear gauge on standard blocks at least once every two years for density measurement as detailed in the relevant Australian Standard as follows (Note 11.1):

- Nuclear moisture-density gauge (backscatter) AS 2891.14.4

4.2 Concrete density bias

- 4.2.1 Determine a density bias for the particular concrete mix and nuclear gauge (backscatter) in accordance with Test Method N07. This bias is to be re-determined whenever there is a change to the mix design and is to be checked whenever there is a change in site conditions (for example, surface roughness, nominal layer thickness, composition of underlying layer, density of underlying layer).

- 4.2.2 In addition to the requirements of Step 4.2.1, check any applied density bias in accordance with Test Method N07 as follows:
- following the compaction of every 10,000 tonnes of material (such that the check is within the lot that contains the last of the 10,000 tonnes), and
 - if the wet density bias has not been used with the nuclear gauge for two months or more.

5 Operational checks

To ensure that the nuclear gauge is operating normally, checks are to be undertaken routinely or following repair as follows:

5.1 Standard count check (frequency: each day of use)

- Remove the nuclear gauge and reference block from the store and place the reference block on the designated test location (Note 11.2).
- Take a standard count for each density detection system in accordance with the appropriate standard count operating instruction detailed in Section 4: *Operating Instructions: Operational Checks* of the *Nuclear Gauge Testing Manual* and ensure the following:
 - the nuclear gauge is correctly located on the reference block
 - the source rod handle is correctly located in the shielded position, and
 - the density standard count values are recorded (Note 11.3).
- Calculate the average of the previous four recorded and accepted density standard counts (Note 11.4).
- Calculate the density limits for each density detection system as follows and record the limits (Note 11.3):

$$L_p = \overline{SC} - 2\sqrt{\frac{\overline{SC}}{PS}}$$

$$U_p = \overline{SC} + 2\sqrt{\frac{\overline{SC}}{PS}}$$

where \overline{SC} = average density standard count (DS)

L_p = lower limit for density

U_p = upper limit for density

PS = nuclear gauge prescale factor (Refer to Table 1)

- If the recorded standard count value for each system lies within the range L_p to U_p , the density standard count is accepted and the nuclear gauge may be used for testing.
- If either recorded standard count value lies outside the range L_p to U_p , repeat Steps 5.1.2 to 5.1.5. If either standard count is again outside the range, remove the nuclear gauge from service and have it repaired by a licensed service agent (Notes 11.4 and 11.5).

5.2 Gauge function check – statistical performance (frequency: monthly)

- Remove the nuclear gauge and reference block from the store and place the reference block on the designated test location (Note 11.2).

- 5.2.2 Take at least 16 density counts for each density detection system in accordance with the appropriate statistical count operating instruction detailed in Section 4: *Operating Instructions: Operational Checks* of the *Nuclear Gauge Testing Manual* and ensure the following:
- the nuclear gauge is correctly located on the reference block
 - the source rod handle is correctly located in the shielded position, and
 - the density count values are recorded (Notes 11.3 and 11.6).
- 5.2.3 Calculate the mean and standard deviation of the density counts.
- 5.2.4 Calculate the density ratio for each density detection system as follows and record the value (Note 11.3):

$$r_p = \frac{s}{\sqrt{\bar{C}_p}}$$

where r_p = density ratio
 s = standard deviation of the density counts
 \bar{C}_p = mean density count

- 5.2.5 If the density ratio for each system lies within the limits given in Table 2, the nuclear gauge is verified to be operating normally and may be used for testing.
- 5.2.6 If any density ratio lies outside the relevant limits given in Table 2, repeat Steps 5.2.2 to 5.2.5. If any ratio is again outside the limits, remove the nuclear gauge from service and have it repaired by a licensed service agent.

5.3 Density system consistency check (frequency: monthly)

Perform a density system consistency check in accordance with Section 2, sub-section 1.2 of the *Nuclear Gauge Testing Manual*.

6 Configuration

On each day of use, configure the nuclear gauge before testing by undertaking a standard count and setting or checking test parameters appropriate to the concrete mix design as follows:

6.1 Standard count

- 6.1.1 Remove the nuclear gauge and reference block from the transport case and place the reference block on the surface of the particular concrete mix under test (Note 11.7).
- 6.1.2 Take a standard count in accordance with the appropriate standard count operating instruction detailed in Section 4: *Operating Instructions: Operational Checks* of the *Nuclear Gauge Testing Manual* and ensure the following:
 - the nuclear gauge is correctly located on the reference block
 - the source rod handle is correctly located in the shielded position, and
 - the density standard count value is recorded with the test data and, where the functionality exists, stored in the nuclear gauge microprocessor.

6.2 Test parameters

Check or set user definable test parameters in accordance with the appropriate test parameters operating instruction detailed in Section 4: *Operating Instructions: Testing – Asphalt* of the *Nuclear Gauge Testing Manual* (Note 11.8).

7 Test site selection and preparation

Determination of test locations and preparation of each test site shall be as follows:

- 7.1 Use Random Stratified Sampling: Selection of Location – Available Area (unless otherwise specified) as detailed in Test Method Q050 to determine each test location. Test locations will be chosen to exclude joints, edges and, where applicable, steel reinforcement or tie bars (located with a metal detector or similarly appropriate device) (Note 11.9).
- 7.2 At a designated test location, use the guideplate or straightedge to define a test site which is flat and free from depressions.
- 7.3 Sweep all loose material from the test site and sprinkle fine sand on the surface. Move the guideplate or straightedge over the surface until the voids are just filled, ensuring that the sand does not form an added layer. Remove the guideplate or straightedge.

8 Testing

Testing shall be performed as follows:

- 8.1 Place the nuclear gauge on the prepared test site such that the longitudinal axis of the nuclear gauge is parallel to the direction of paving.
- 8.2 Confirm that the nuclear gauge is firmly seated without rocking (Note 11.10). Move the source rod to the backscatter (BS) position.
- 8.3 Take a 1-minute count in accordance with the appropriate measurement operating instruction detailed in Section 4: *Operating Instructions: Testing – Asphalt* of the *Nuclear Gauge Testing Manual*. Record the wet density and the density count.
- 8.4 Rotate the nuclear gauge through 180°, ensuring that the test site is not disturbed. Repeat Steps 8.2 to 8.3, and then move the source rod to the shielded position (Note 11.11).
- 8.5 Compare the wet density values from the two orientations. If the difference exceeds 0.075 t/m³, examine and further prepare the test site as necessary and repeat Steps 8.1 to 8.4.
- 8.6 If the wet density difference again exceeds 0.075 t/m³, abandon the test site and select a new site immediately adjacent.

9 Calculations

Calculations shall be as follows:

- 9.1 Determine the compacted density for the test site to the nearest 0.001 t/m³ by averaging the wet density values obtained at the 0° and 180° orientations.

- 9.2 Where the concrete density bias has not been applied via the nuclear gauge microprocessor, adjust the compacted density calculated in Step 9.1 as follows:

$$D_C = \rho_G + B_p$$

where	D_C	=	compacted density (t/m ³)
	ρ_G	=	average nuclear gauge wet density (t/m ³)
	B_p	=	concrete density bias (t/m ³)

10 Reporting

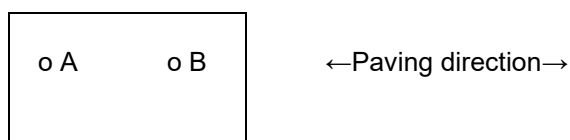
The following shall be reported:

- compacted density to the nearest 0.001 t/m³
- date tested, test mode, lot number, test site number, and chainage and offset
- source and type of the concrete together with the mix code number and nominal layer depth
- report number for the concrete density bias
- report number for the asphalt density bias and, in the case of an amended bias, the date and report number for the previous report, and
- the number of this test method, that is N06

11 Notes on method

- Re-calibrate the nuclear gauge following any major repair or component replacement.
- A location is to be selected which is at least 2 m from any large object and 10 m from any other nuclear gauge. Mark this location and use for all counts associated with operational checks.
- A record is to be kept for each gauge to record operational check data (standard count check and gauge function check) and the date of measurement.
- Where the previous four standard counts have not been taken within the previous five weeks of the current date or the nuclear gauge has been moved to a new operating location and has a new designated test location, it may be necessary to take four new standard counts as detailed in Steps 5.1.1 to 5.1.2.
- It is expected that a standard count value will lie outside the range L_p to U_p about once in every 20 standard count checks. To have consecutive values outside this range is expected only once in 400 standard count checks. However, as the return of the gauge for checking and possible repair can be expensive and disruptive, it is acceptable to perform a gauge function check as detailed in sub-section 5.2. If the gauge is not verified as operating normally, remove the nuclear gauge from service and have it repaired by a licensed service agent.
- Where an accepted form of statistical analysis is performed by the microprocessor, it is not necessary to record individual count values. Only the density ratio value needs to be recorded and Steps 5.2.3 and 5.2.4 may then be omitted.

- 11.7 Where the nuclear gauge is to be used within 2 m of a large object, take a separate standard count at each test site.
- 11.8 The scope of user definable test parameters is dependent on the make and model of nuclear gauge. Such parameters include:
- counting time, units and measurement mode
 - maximum density, and
 - concrete density bias.
- 11.9 An edge or joint should be at least 250 mm from any point on the source/detector axis. Reinforcing steel with less than 75 mm cover should not lie directly under the source/detector axis.
- 11.10 If the nuclear gauge cannot be firmly seated, prepare a new test site immediately adjacent to the original site.
- 11.11 The test area is formed by a single rectangle being at least the size of the guide plate with the source rod being over the surface of the concrete at each end of the test area.



Position A is the source rod location for 0° measurement and Position B is the source rod location for 180° measurement.

Table 1 – Standard count prescale factors

Nuclear gauge make / model	Prescale factor
CPN/except Elite series	1
CPN/Elite series	8
Troxler/except Model 3450 and 4640B	16
Troxler/Model 3450 and 4640B	8
Humboldt/All	16
InstroTek/Xplorer series	16

Table 2 – Gauge function check – density ratio limits

Nuclear gauge make / model	Lower limit	Upper limit
CPN/except Elite series	0.75	1.25
CPN/Elite series	0.25	0.45
Troxler, except Models 3450 and 4640B	0.17	0.33
Troxler Model 3450	0.225	0.465
Troxler Model 4640B	0.25	0.45
Humboldt	0.60	1.40
InstroTek	0.18	0.35

Test Method N07: Concrete density bias

1 Source

This method was developed in-house using techniques evolved through internal departmental research investigations and incorporates information provided by nuclear gauge manufacturers.

2 Scope

This method sets out the procedure for the determination of the concrete density bias associated with the measurement of compacted density of concrete using a nuclear gauge. The concrete density bias represents the average density difference between nuclear gauge wet density and core density for a particular nuclear gauge, concrete mix and layer thickness. Differences between nuclear gauge wet density and core density are due to differences in the material sampled by both tests and the effect of chemical composition and test site characteristics (for example, density gradients, surface condition, homogeneity) on nuclear gauge results.

Included in the method is a procedure for monitoring the applicability of an existing concrete density bias and providing ongoing adjustment of the bias to reflect subtle changes in concrete mix composition.

3 Procedure

The procedure shall be as follows:

- 3.1 Select at least 10 test sites within the lot under consideration using Random Stratified Sampling: Selection of Location – Available Area (unless otherwise specified) as detailed in Test Method Q050 (Note 7.1). Number each test site and any bias check test site consecutively in chronological order.
- 3.2 At each test site, undertake the following:
 - 3.2.1 Measure the nuclear gauge wet density as detailed in Test Method N06, except that no concrete density bias is applied. This wet density is referred to as the standard blocks wet density. Record the measured density counts and wet density values to the nearest 0.001 t/m³ for both the 0° and 180° orientations (Note 7.2).
 - 3.2.2 Obtain a core sample centrally within the site in accordance with Test Method AS 1012.14.
 - 3.2.3 Measure the density of the core sample in accordance with Test Method Q473.

4 Calculations

Calculations shall be as follows:

4.1 Field test data

Determine the density count and standard blocks wet density for each site by averaging the corresponding measurements for the 0° and 180° orientations (Note 7.2).

4.2 Data validation

Validate the density count, density standard count and standard blocks wet density data as follows:

4.2.1 Calculate the density count ratio for each site to four significant figures as follows:

$$CR_p = \frac{C_p}{SC_p}$$

where CR_p = density count ratio
 C_p = density count
 SC_p = density standard count

4.2.2 Plot the standard blocks wet density against the corresponding density count ratio using the data from all test sites (Note 7.3).

4.2.3 If any data pair does not lie on the linear plot, reject the standard block and core density wet density data for this test site.

4.3 Data acceptance

4.3.1 Calculate the average standard blocks wet density and average core density for all remaining test sites.

4.3.2 Calculate the density standard error as follows:

$$SE_p = \sqrt{\frac{\sum (\rho_C - \rho_G - \bar{\rho}_C + \bar{\rho}_G)^2}{n-2}}$$

where SE_p = density standard error (t/m³)
 ρ_C = core density at each test site (t/m³)
 ρ_G = standard blocks wet density at each test site (t/m³)
 $\bar{\rho}_C$ = average core density for the test sites (t/m³)
 $\bar{\rho}_G$ = average standard blocks wet density for the test sites (t/m³)
 n = number of test sites

4.3.3 If the density standard error does not exceed 0.035 t/m³, accept the data and calculate the concrete density bias as detailed in Subsection 4.4.

4.3.4 If the density standard error exceeds 0.035 t/m³, perform the following:

- a) For each density data pair (core density and standard blocks wet density), calculate the density error as follows:

$$E_p = \left| (\rho_C - \rho_G) - (\bar{\rho}_C - \bar{\rho}_G) \right|$$

- where E_p = density error (t/m³)
 ρ_C = core density at each test site (t/m³)
 ρ_G = standard blocks wet density at each test site (t/m³)
 $\bar{\rho}_C$ = average core density for the test sites (t/m³)
 $\bar{\rho}_G$ = average standard blocks wet density for the test sites (t/m³)

- b) Eliminate the density data pair (core density and standard blocks wet density) with the largest density error.
 c) If data from three or more test sites are eliminated, reject all test data and repeat the complete procedure.
 d) If all test data are again rejected, it is not appropriate to calculate a single concrete density bias for the material.
 e) Re-analyse the data by repeating Steps 4.3.1 to 4.3.4.

4.4 Concrete density bias

Calculate the concrete density bias using accepted data to the nearest 0.001 t/m³ as follows:

$$B_p = \bar{\rho}_C - \bar{\rho}_G$$

- where B_p = concrete density bias (t/m³)
 $\bar{\rho}_C$ = average core density for the test sites (t/m³)
 $\bar{\rho}_G$ = average standard blocks wet density for the test sites (t/m³)

5 Bias check

Bias checks shall be performed as follows:

- 5.1 Monitor the concrete density bias by performing three additional nuclear gauge wet density and core density tests following the compaction of 10,000 tonnes of material. Select the three test sites from within the lot that contains the last of the 10,000 tonnes and perform testing as detailed in Section 3.
 5.2 Determine and validate the nuclear gauge density count and standard blocks wet density data as detailed in Steps 4.1 to 4.2.3.
 5.3 Add the new density data pairs to the previously accepted data while removing three existing and consecutive density data pairs commencing at the lowest test site number (Note 7.4).
 5.4 Analyse the revised density data for acceptance as detailed in Subsection 4.3, except that no more than one of the new density data pairs may be eliminated.

- 5.5 Calculate an amended concrete density bias for the accepted data as detailed in Subsection 4.4.

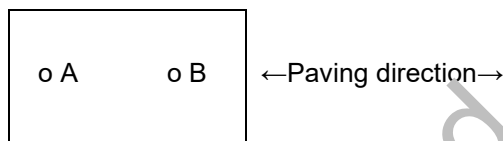
6 Reporting

The following shall be reported:

- 6.1 Concrete density bias to the nearest 0.001 t/m³.
- 6.2 Source and type of the concrete together with the mix code number and nominal layer depth.
- 6.3 A tabulation containing the standard blocks wet density and core density data used to determine the bias (including any eliminated data), together with the date tested, lot number, test site number, and chainage and offset.
- 6.4 The date the bias was calculated and, in the case of an amended concrete density bias, the report number and date for the previous report.
- 6.5 The number of this test method, that is N07.

7 Notes on method

- 7.1 In order to determine a concrete density bias that is representative of the lot, distribute sampling locations throughout the lot.
- 7.2 The test area is formed by a single rectangle being at least the size of the guide plate with the source rod being over the surface of the concrete at each end of the test area.



Position A is the source rod location for 90° measurement and position B is the source rod location for 180° measurement.

- 7.3 The relationship between nuclear gauge wet density and density count ratio is essentially linear over the expected density range within a lot.
- 7.4 Where there are only eight existing data points, remove only two so that nine data points are available for analysis.

Operating Instruction N101: Standard Count Troxler 3440

1 Set up

Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.

- ▶ Press and allow the nuclear gauge to complete the self-test routine.

2 Measurement

When <READY> is displayed:

- ▶ Press and the following is displayed:
- Standard Count-
 DS = XX
 MS = XX
 Take new count?
- ▶ Press and the following is displayed:
- Is gauge on Std.
 Block & Source
 rod in SAFE pos?
- ▶ Press and the following is displayed:
- Taking
 Standard Count-
 XX seconds
 remaining
- ▶ At the end of the counting period the following is displayed:
- MS = XX XX %P
 DS = XX XX %P
 Do you want to use
 the new STD

Record the following values:

- MS as the **moisture standard count**.
- DS as the **density standard count**.

- ▶ Press and the display will return to <READY>.


- ▶ Press if the nuclear gauge is not required for further use.

Operating Instruction N102: Statistical Count Troxler 3440

1 Set up


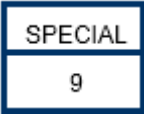
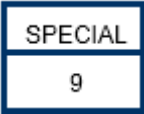
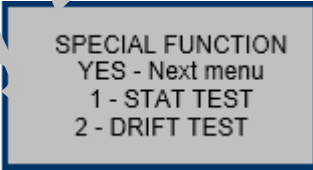

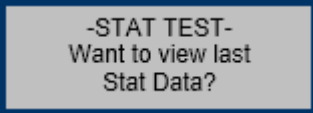
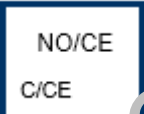


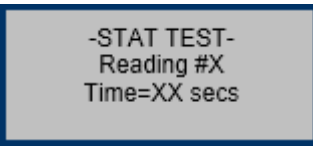
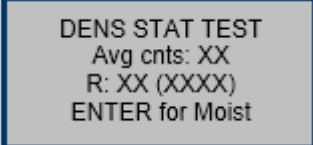
Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.


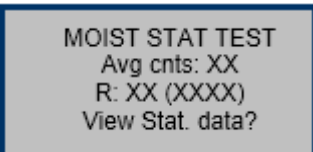
- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

2 Measurement

When <READY> is displayed:


- ▶ Press  and the following is displayed: 
 - ▶ Press  and the following is displayed: 
 - ▶ Press  and the following is displayed: 
 - ▶ Press  and the following is displayed: 
 - ▶ Press  and the following is displayed: 
- At the end of the counting period, the following will be displayed: 

Record R as the **density ratio**.

- ▶ Press  and the following is displayed: 

Record R as the **moisture ratio**.

▶ Press  and display will return to <READY>.

▶ Press  if the nuclear gauge is not required for further use.

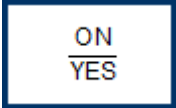
Superseded 6 May 2022

Operating Instruction N103: Standard Count Troxler 3430

1 Set up


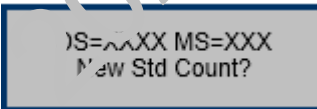
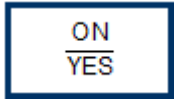

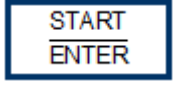

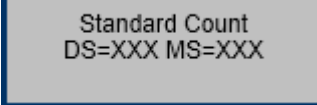
Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.


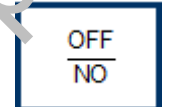
2 Measurement

When <READY> is displayed:

- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 
- At the end of the counting period the following will be displayed: 

Record the following values:

- DS as the **density standard count**.
- MS as the **moisture standard count**.

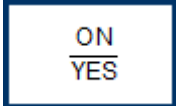
- ▶ Press  and the display will return to <READY>.
- ▶ Press  if the nuclear gauge is not required for further use.

Operating Instruction N104: Statistical Count Troxler 3430

1 Set up





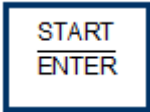
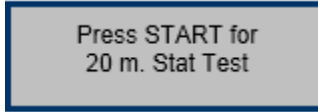
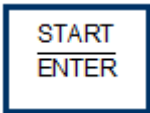
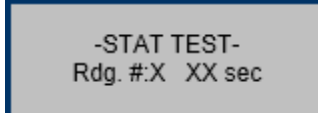
Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.


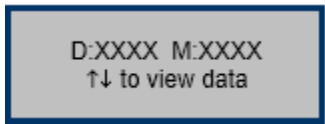

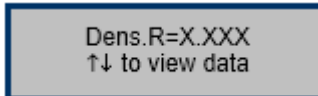
- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

2 Measurement


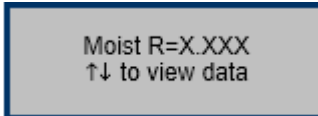
When <READY> is displayed:

- ▶ Press  and the following is displayed: 
- ▶ Press  repeatedly until the following is displayed: 
- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 

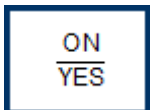
At the end of the counting period the following will be displayed:

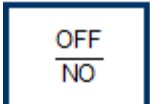
- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 

Record Dens. R as the **density ratio**.

- ▶ Press  repeatedly until the following is displayed: 

Record Moist R as the **moisture ratio**.

- ▶ Press  and the display will return to <READY>.


- ▶ Press  if the nuclear gauge is not required for further use.

Operating Instruction N107: Standard Count Troxler 4640B

1 Set up




Position the air gap spacer on the reference block. Position the nuclear gauge on the spacer so that the handle end rests over the two posts on the spacer.

Check that the source rod handle is correctly located in the shielded position.

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

2 Measurement

When <READY> is displayed:



- ▶ Press  and the following will be displayed:
- ```
-Standard Count-
XXXX XXXX
Take a new
Standard Count?
```
- ▶ Press  and the following will be displayed:
- ```
Place Gauge on
Spacer & both on
Block, Put Rod in
SAFE, Press ENTER
```
- ▶ Press  and the following will be displayed:
- ```
Taking
Standard Count.
XX seconds
remaining.
```

At the end of the counting period, the following will be displayed:

```
Std 1 Std 2
XXXX XXXX
X.XX%Z X.XX%Z
Use new Stds?
```

Record the following values:

- Std 1 as the **System 1 standard count**.
- Std 2 as the **System 2 standard count**.


- ▶ Press  and the display will return to <READY>.
- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N108: Statistical Count Troxler 4640B

### 1 Set up

Position the air gap spacer on the reference block. Position the nuclear gauge on the spacer so that the handle end rests over the two posts on the spacer.

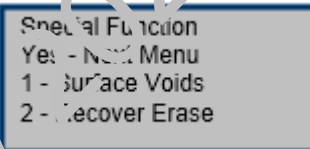
Check that the source rod handle is correctly located in the shielded position.

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

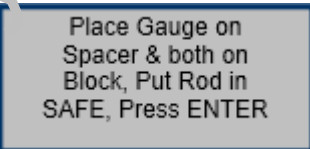
When <READY> is displayed:

- ▶ Press   and the following will be displayed:



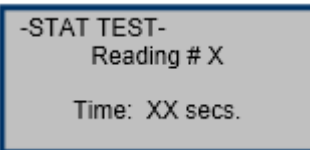
```
Special Function
Yes - NO? Menu
1 - Surface Voids
2 - Recover Erase
```

- ▶ Press  and the following will be displayed:



```
Place Gauge on
Spacer & both on
Block, Put Rod in
SAFE, Press ENTER
```

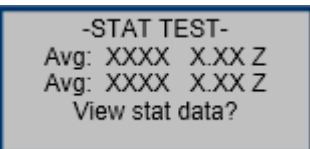
- ▶ Press  and the following will be displayed:



```
-STAT TEST-
Reading # X

Time: XX secs.
```


At the end of the counting period, the following will be displayed:




```
-STAT TEST-
Avg: XXXX X.XX Z
Avg: XXXX X.XX Z
View stat data?
```

Record the second value on the first line of displayed data as the **System 1 density ratio**.

Record the second value on the second line of displayed data as the **System 2 density ratio**.

- ▶ Press  and the display will return to <READY>.

- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N109: Standard Count CPN MC3




### 1 Set up

For a 50 mm thick reference block, place the transport case on its end with the CPN logo uppermost. Locate the reference block with the three studs upright on the case across the protective strips. Position the nuclear gauge on the block so that the studs on the block fit into the depressions in the gauge base.

For a 75 mm thick reference block, position the nuclear gauge on the reference block so that the studs fit into the depressions in the nuclear gauge base.

Check that the source rod handle is correctly located in the shielded position.

### 2 Measurement

- ▶ Press  
- At the end of the counting period:
- ▶ Press  repeatedly until the following is displayed:

|       |              |      |
|-------|--------------|------|
| cpm   | XXXX         | h2o  |
| Prv   | XXXX         | XXXX |
| Std   | XXXX         | XXXX |
| Xi    | XXXX         | XXXX |
| N     | 256          | 256  |
| STAND | new standard |      |
| EXIT  | exit         |      |

Record the following values.

- Std wet as **density standard count**.
- Std h2o as **moisture standard count**

## Operating Instruction N110: Statistical Count CPN MC3

### 1 Measurement

A statistical analysis is performed using data obtained during a standard count. The analysis is displayed together with the density and moisture standard counts.

Following completion of the standard count as detailed in Operating Instruction N109, the following will be displayed:

|       |              |      |
|-------|--------------|------|
| Cpm   | wet          | h2o  |
| Prv   | XXXX         | XXXX |
| Std   | XXXX         | XXXX |
| Xi    | XXXX         | XXXX |
| N     | 256          | 256  |
| START | new standard |      |
| CLEAR | Exit         |      |

Record the following values:

- Xi wet as the **density ratio**.
- Xi h2o as the **moisture ratio**.

Superseded 6 May 2022




## Operating Instruction N113: Standard Count Humboldt 5001EZ

### 1 Set-up

Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge closest to the source rod is in contact with the metal plate on the side of the block.


Check that the source rod handle is correctly located in the shielded position.

- ▶ Press  and allow the nuclear gauge to complete the initialising routine.


The following will be displayed:

```
*DATA XX/XX/XX
*SET UP XX:XX:XX
*ENGINEERING
 DEPTH=SAF
```

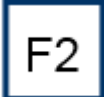
### 2 Measurement


- ▶ Press  and the following will be displayed:

```
*SET UP 2
*SET MEASUREMENT MODES
*SET RECL. COR.
*SET TARGETS
```


- ▶ Press  and the following will be displayed:

```
MEAS = FAST/NORM/SLOW
STD = 4MIN/16MIN
TYPE = ASPH/SOIL/THIN
DEPTH = AUTO/MANUAL
```

- ▶ Press  repeatedly until "4MIN" flashes.

- ▶ Press  and the following will be displayed:

```
DS = XXXX MM/DD/YY
MS = XXX MM:HH
* TAKE NEW STD
* USE CURRENT STD
```

- ▶ Press  and the following will be displayed:

```
TAKING STANDARD
TIME REMAINING X:XX
DS = X
MS = X DEPTH = SAF
```

- ▶ At the end of the counting period, the following will be displayed:


```
STD TEST RESULTS
DS = XXXX.X
MS = XXX.X
```

or

```
DS = XXXX %ERR = X.X
MS = XXX %ERR = X.X
*REJECT & TAKE NEW STD
*RETAIN THE NEW STD
```


Record the following displayed values if no error message is displayed:

- DS as the **density standard count**.
- MS as the **moisture standard count**.

▶ Press  and the display will return to the main menu.

If an error message is displayed:

▶ Press   and the display will return to the main menu.

▶ Press  if the nuclear gauge is not required for further use.


Superseded 6 May 2022

## Operating Instruction N114: Statistical Count Humboldt 5001EZ

### 1 Set-up

Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge closest to the source rod is in contact with the metal plate on the side of the block.


Check that the source rod handle is correctly located in the shielded position.

- ▶ Press  and allow the nuclear gauge to complete the initialising routine.


The following will be displayed:

```
*DATA XX/XX/XX
*SET UP XX:XX:XX
*ENGINEERING
DEPTH=SAF
```


### 2 Measurement


- ▶ Press  and the following will be displayed:

```
*SET UP
*SET MEASUREMENT MODES
*SET BRNCH COR.
SET TARGETS
```


- ▶ Press  and the following will be displayed:

```
MEAS = FAST/NORM/SLOW
STD = 4MIN/16MIN
TYPE = ASPH/SOIL/THIN
DEPT = AUTO/MANUAL
```

- ▶ Press  repeatedly until "16MIN" flashes.

- ▶ Press  and the following will be displayed:

```
DS = XXXX MM/DD/YY
MS = XXX MM:HH
* TAKE NEW STD
* USE CURRENT STD
```

- ▶ Press  and the following will be displayed:

```
TAKING STATISTICS
TIME REMAINING X:XX
DS = X
MS = X DEPTH = SAF
```

- ▶ At the end of the counting period, the following will be displayed:

```
STAT TEST RESULTS
DS = XXXX.X R = X.XXX
MS = XXX.X R = X.XXX
```

or


```
DS = XXXX %ERR = X.X
MS = XXX %ERR = X.X
*REJECT & TAKE NEW STD
*RETAIN THE NEW STD
```


Record the following displayed values:

- R in the DS row as the **density ratio**.
- R in the MS row as the **moisture ratio**.


If an error message is displayed:

▶ Press   to take new counts.

▶ Press  and the display will return to the main menu.


▶ Press  and the following will be displayed:


```
*SET UP 2
*SET MEASURE MODE
*SET TRENCH COR.
*SET TARGET
```

▶ Press  and the following will be displayed:

```
MEAS =FAST/NORM/SLOW
STD =4 MIN/16MIN
TYPE =ASPH/SOIL/THIN
DEPTH =AUTO/MANUAL
```

▶ Press  repeatedly until "4MIN" flashes.

▶ Press  and the display will return to the main menu.

▶ Press  if the nuclear gauge is not required for further use.


Superseded 6M

## Operating Instruction N115: Standard Count Humboldt 5001C



### 1 Set-up

Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

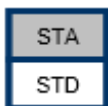
Check that the source rod handle is correctly located in the shielded position.



- ▶ Press  and allow the nuclear gauge to complete the initialising routine.

The following will be displayed:

### 2 Measurement

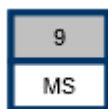
- ▶ Press  and the following will be displayed:

At the end of the counting period, the following will be displayed:


  


Record the displayed value as the **density standard count**.

- ▶ Press  and the following will be displayed:


Record the displayed value as the **moisture standard count**.


- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N116: Statistical Count Humboldt 501C



### 1 Set-up

Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.


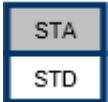
Check that the source rod handle is correctly located in the shielded position.

- ▶ Press  and allow the nuclear gauge to complete the initialising routine.

The following will be displayed:




  


### 2 Measurement

- ▶ Press   and the following will be displayed:


At the end of the counting period, the following will be displayed:

- ▶ Press  and record the displayed value as the **density ratio**.
- ▶ Press  and record the displayed value as the **moisture ratio**.
- ▶ Press  if the nuclear gauge is not required for further use.


## Operating Instruction N117: Standard Count Humboldt 5001P

### 1 Set-up

Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge closest to the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.



### 2 Measurement

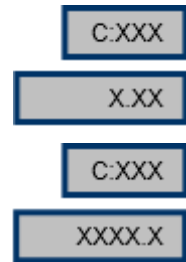
- ▶ Press  and allow the nuclear gauge to stabilise for at least 10 minutes before commencing the test.

The following will be displayed:



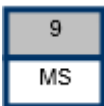


**Note:** The previously set depth will be displayed. It is not necessary to adjust the displayed depth.

- ▶ Press   simultaneously and the following will be displayed:



At the end of the counting period, the following will be displayed:

Record the displayed value as the **density standard count**.

- ▶ Press   and record the displayed value as the **moisture standard count**.
- ▶ Press  if the nuclear gauge is not required for further use.


## Operating Instruction N118: Statistical Count Humboldt 5001P

### 1 Set-up

Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge closest to the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.



### 2 Measurement

- ▶ Press  and allow the nuclear gauge to stabilise for at least 10 minutes before commencing the test.

The following will be displayed:





**Note:** The previously set depth will be displayed. It is not necessary to adjust the displayed depth.


- ▶ Press   simultaneously and the following will be displayed:



At the end of the counting period, the following will be displayed:

Record the displayed value as the **density ratio**.

- ▶ Press   and record the displayed value as the **moisture ratio**.

- ▶ Press  if the nuclear gauge is not required for further use.

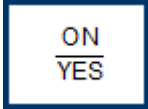


## Operating Instruction N119: Standard Count Instrotek Xplorer 3500

### 1 Set-up


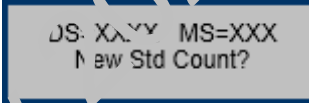
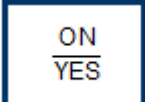

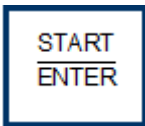
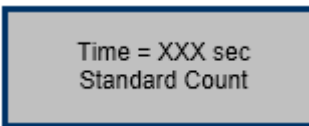
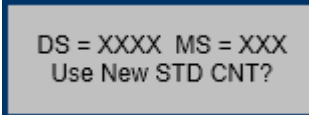
Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

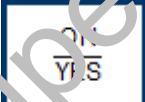
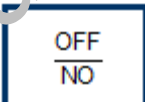
### 2 Measurement

When <READY> is displayed:

- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 
- ▶ Press  and the time will count down from 240 seconds and display: 
- At the end of the counting period, the following will be displayed: 

Record the following values:

- DS as the **density standard count**.
- MS as the **moisture standard count**.

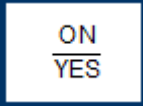
- ▶ Press  and display will return to <READY>.
- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N120: Statistical Count Instrotek Xplorer 3500

### 1 Set-up


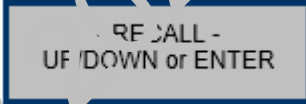

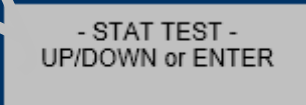
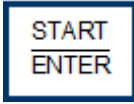
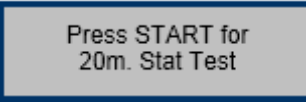
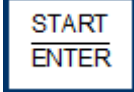
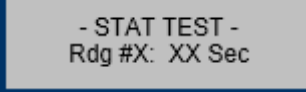
Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.


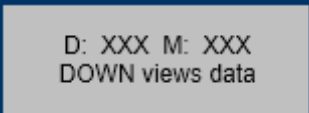

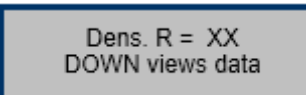
- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement


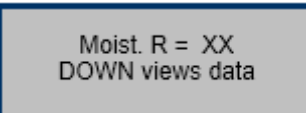
When <READY> is displayed:

- ▶ Press  and the following is displayed: 
- ▶ Press  repeatedly until the following is displayed: 
- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 

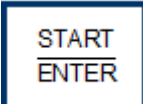
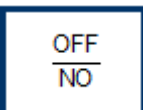
At the end of the counting period, the following is displayed:

- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 

Record Dens. R as the **density ratio**.

- ▶ Press  repeatedly until the following is displayed: 

Record Moist R as the **moisture ratio**.

- ▶ Press  and the display will return to <READY>.
- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N121: Standard Count Troxler 3440P

### 1 Set-up

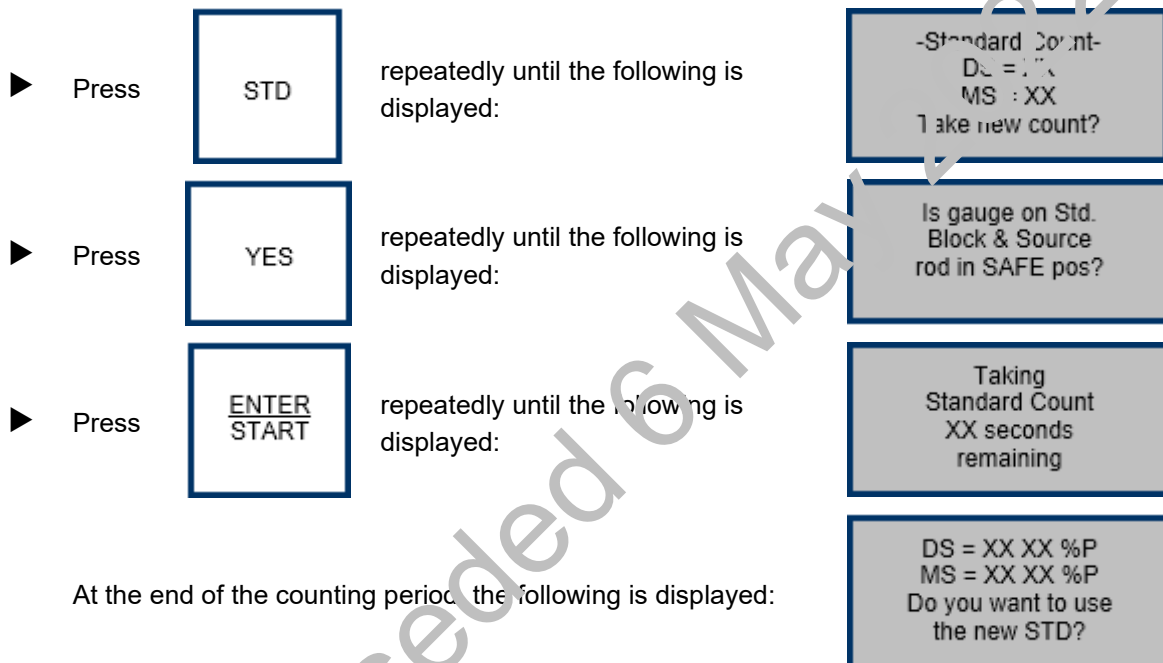
Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.

- ▶ Turn the power switch on and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

When <READY> is displayed:



Record the following values:

- MS as the **moisture standard count**.
- DS as the **density standard count**.

- ▶ Press YES and the display will return to <READY>.

- ▶ Turn the power switch off if the nuclear gauge is not required for further use.

## Operating Instruction N122: Statistical Count Troxler 3440P

### 1 Set-up




Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.


- ▶ Turn the power switch on and allow the nuclear gauge to complete the self-test routine.


### 2 Measurement

When <READY> is displayed:

- ▶ Press 
- ▶ Press  until stat test appears as an option
- ▶ Press  the following is displayed:
 

1. Take STAT Test
  2. Review STAT Test
  3. Print STAT Test


<ESC> to Exit
- ▶ Press  the following is displayed:
 

Place Gauge on  
Std. Block & Source  
Rod in SAFE Pos.  
Press <START>
- ▶ Press 

At the end of the counting period, the following will be displayed:

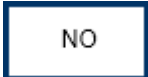

DENS STAT TEST  
Avg cnts: XXXX  
R: XX (XXXX)  
ENTER for Moist

Record R as the **density ratio**.

- ▶ Press  the following is displayed:
 

MOIST STAT TEST  
Avg cnts: XX  
R: XX (XXXX)  
View Stat. data?

Record R as the **moisture ratio**.

- ▶ Press  and display will return to the SETUP menu.
- ▶ Press  to exit.
- ▶ Turn the power switch off if the nuclear gauge is not required for further use.

## Operating Instruction N123: Standard Count Troxler 3430P

### 1 Set-up

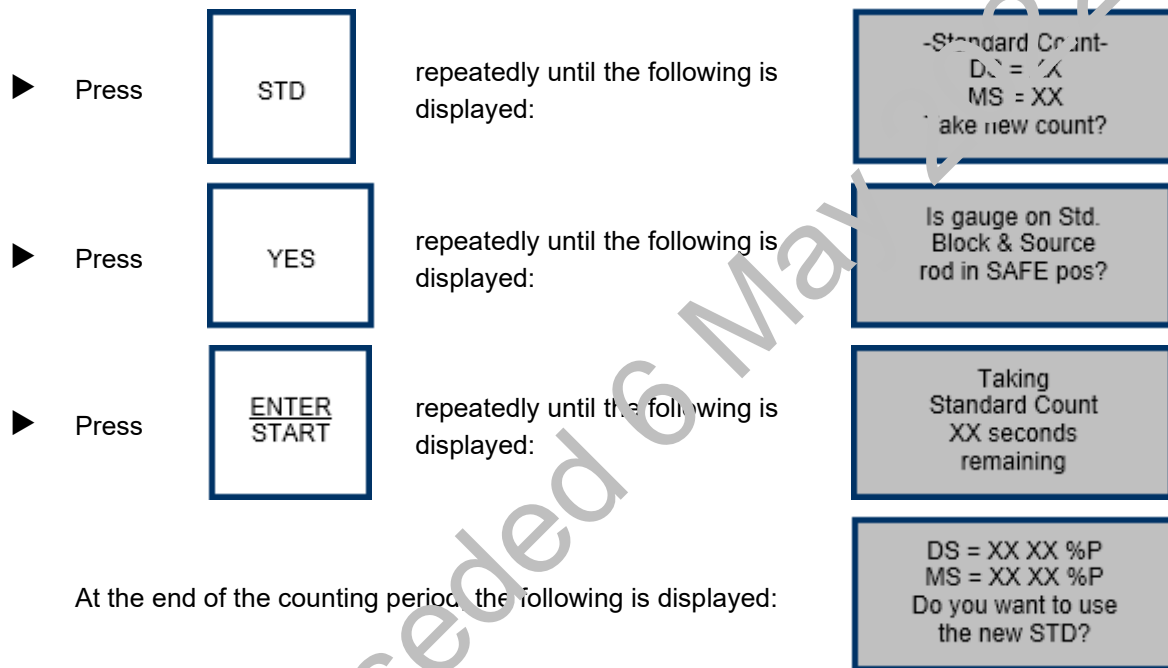
Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.

- ▶ Turn the power switch on and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

When <READY> is displayed:



Record the following values:

- MS as the **measured standard count**.
- DS as the **density standard count**.



- ▶ Turn the power switch off if the nuclear gauge is not required for further use.

## Operating Instruction N124: Statistical Count Troxler 3430P

### 1 Set-up




Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.


Check that the source rod handle is correctly located in the shielded position.


- ▶ Turn the power switch on and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

When <READY> is displayed:

- ▶ Press 
- ▶ Press  until stat test appears as an option
- ▶ Press  the following is displayed:
 


1. Take STAT Test
  2. Review STAT Test
  3. Print STAT Test
 <ESC> to Exit
- ▶ Press  the following is displayed:
 

Place Gauge on  
Std. Block & Source  
Rod in SAFE Pos.  
Press <START>
- ▶ Press 

At the end of the counting period, the following will be displayed:

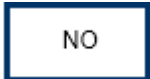

DENS STAT TEST  
Avg cnts: XXXX  
R: XX (XXXX)  
ENTER for Moist

Record R as the **density ratio**.

- ▶ Press  the following is displayed:
 

MOIST STAT TEST  
Avg cnts: XX  
R: XX (XXXX)  
View Stat. data?

Record R as the **moisture ratio**.

- ▶ Press  and display will return to the SETUP menu
- ▶ Press  to exit.

- ▶ Turn the power switch off if the nuclear gauge is not required for further use.

## Operating Instruction N125: Standard Count Troxler 3450

### 1 Set-up

Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.

- ▶ Press ON and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

When <READY> is displayed:

- ▶ Press STANDARD the following is displayed:
 

DS = X.XX X.XX  
 MS = X.XX  
 1 - Take raw count  
 2 - View counts
  - ▶ Press 1 the following is displayed:
 

Put Rod In STD Pos  
 Place Gauge On  
 Standard Block  
 Press ENTER
  - ▶ Press ENTER the following is displayed:
 

Taking  
 Standard Count  
 XX seconds  
 remaining
- At the end of the counting period, the following is displayed:
- DS1 = XXXX X.X%PASS  
 DS2 = XXXX X.X%PASS  
 MS = XXXX X.X%PASS  
 Use New Standard ?

Record the following values:

- MS as the **moisture standard count**.
- DS1 + DS2 as the **density standard count**.

- ▶ Press YES and the display will return to <READY>.
- ▶ Press OFF if the nuclear gauge is not required for further use.

## Operating Instruction N126: Statistical Count Troxler 3450

### 1 Set-up

Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

When <READY> is displayed:

- ▶ Press
- ▶ Press  to access the Gauge Status/Test menu:

- ▶ Press  and the following is displayed:

|                      |
|----------------------|
| 1 – Take STAT Test   |
| 2 – Review STAT Test |
| 3 – Print STAT Data  |
| Press ESC To Exit    |

- ▶ Press  and the following is displayed:

|                    |
|--------------------|
| Put Rod In STD Pos |
| Place Gauge On     |
| Standard Block     |
| Press ENTER        |

- ▶ Press  and the gauge displays the progress of the STAT test.

At the end of the counting period, the following will be displayed:

| STAT Test | Avg  | R    |
|-----------|------|------|
| D-1: PASS | xxxx | xxxx |
| D-2: PASS | xxxx | xxxx |
| M: PASS   | xxxx | xxxx |

Record  $R(D-1) + R(D-2)$  as the **density ratio**.

Record R as the **moisture ratio** for M.

- ▶ Press  to return to the <READY> screen.
- ▶ Press  if the nuclear gauge is not required for further use.

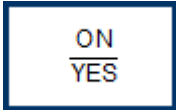


## Operating Instruction N127: Standard Count CPN MC1 and MC3 Elite

### 1 Set-up


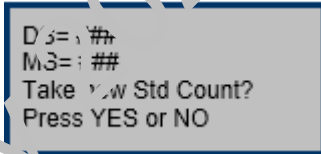
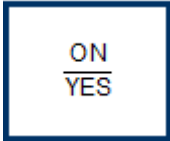



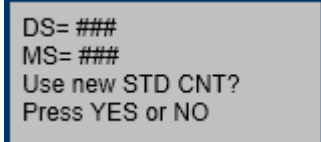
Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

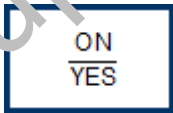
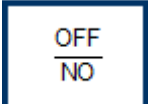
### 2 Measurement

When <READY> is displayed:

- ▶ Press  and the following is displayed:
- 
- ▶ Press  and the following is displayed:
- 
- ▶ Press  and the following is displayed:
- 
- At the end of the counting period, the following will be displayed:
- 

Record the following values:

- DS as the **density standard count**.
- MS as the **moisture standard count**.

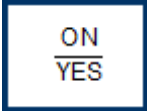
- ▶ Press  and the display will return to <READY>.
- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N128: Statistical Count CPN MC1 and MC3 Elite

### 1 Set-up




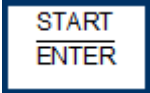
Position the nuclear gauge on the reference block between its raised edges, such that the side of the nuclear gauge furthest from the source rod is in contact with the metal plate on the side of the block.

Check that the source rod handle is correctly located in the shielded position.

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement


When <READY> is displayed:

- ▶ Press 
- ▶ Press  when the display reads: 
- ▶ Press 

After 20 minutes, the display will show the results of the test, you can scroll through to see each count.


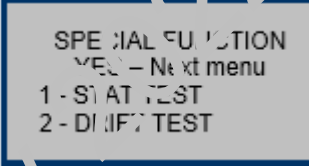
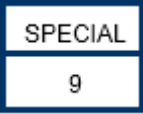
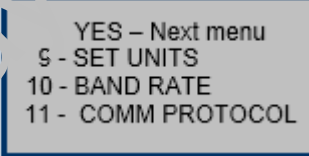
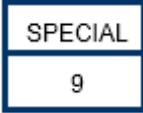
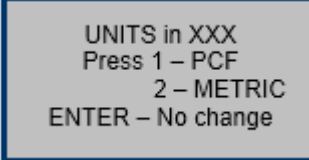
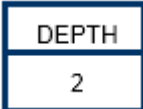

## Operating Instruction N201: Test Parameters (Soils) Troxler 3440

### 1 Set-up

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.


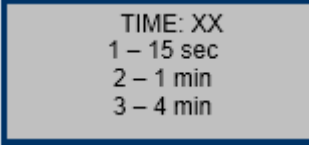
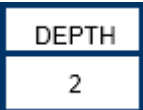
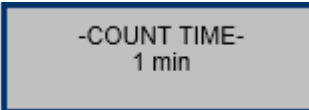
### 2 Units

When <READY> is displayed:

- ▶ Press  and the following is displayed: 
- ▶ Press  repeatedly until the following is displayed: 
- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 

The display will return to <READY>.

### 3 Count time

- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 

The display will return to <READY>.

#### 4 Soil mode

▶ Press 

|       |
|-------|
| SHIFT |
| x     |

▶ Press 

|      |
|------|
| MODE |
| 8    |

and the following is displayed:

|                  |
|------------------|
| MODE: XXXX       |
| Select: 1 – SOIL |
| 2 – ASPHALT      |
| (CE to exit)     |

▶ Press 

|        |
|--------|
| COUNTS |
| 1      |

And the following will be displayed briefly:

|             |
|-------------|
| SOIL MOI IF |
|-------------|

The display will return to <READY>.

#### 5 Maximum dry density

▶ Press 

|                      |
|----------------------|
| PROCTOR/<br>MARSHALL |
| +                    |

and the following is displayed:

|                             |
|-----------------------------|
| MA = XXXX kg/m <sup>3</sup> |
| PR = XXXX                   |
| VD = XXXX                   |
| Want to change?             |

To retain the value, go to 5.1.

To change the value, go to 5.2.

##### 5.1 Retain the value

▶ Press 

|       |
|-------|
| NO/CE |
| C/CE  |

to retain the displayed value of PR.

The display will return to <READY>. Go to 6.

##### 5.2 Change the value

▶ Press 

|      |
|------|
| YES  |
| EXIT |

to change the displayed value of PR.

And the following will be displayed:

|              |
|--------------|
| Select:      |
| 1 – MA       |
| 2 – PR       |
| 3 – Voidless |

▶ Press 

|       |
|-------|
| DEPTH |
| 2     |

 and the following is displayed:

Select source of Proctor value:  
 1 – Stored Value  
 2 – New Value

To enter a new value, go to 5.3.

To select a stored value, go to 5.4.

### 5.3 Enter a new value

▶ Press 

|       |
|-------|
| DEPTH |
| 2     |

 and the following is displayed:

Proctor:  
 XXXX kg/m<sup>3</sup>  
 Press [ENTER] when prompted

▶ Use the numbered keys to enter the required value to the nearest 1 kg/m<sup>3</sup>.

▶ Press 

|                 |
|-----------------|
| START/<br>ENTER |
| =               |

 and the following is displayed:

PR = XXXX kg/m<sup>3</sup>  
 Do you want to save this value for later use?

**Note:** It is not necessary to save the displayed value to enable it.

**If the value is not to be saved:**

▶ Press 

|       |
|-------|
| NO/CE |
| C/CE  |

 and the display will return to <READY>. Go to 6.

**To save the displayed value:**

▶ Press 

|      |
|------|
| YES  |
| 1:XX |

 and the following is displayed:

Select Proctor Memory Cell:  
 1:XX2:XX  
 3:XX4:XX

▶ Press the numbered key (1, 2, 3 or 4) to select a memory cell in which to store the value.

And the following will be displayed:

Proctor  
 XXXX kg/m<sup>3</sup>  
 ENABLED!  
 stored in cell X

The display will return to <READY>. Go to 6.

### 5.4 Select a stored value

▶ Press 

|        |
|--------|
| COUNTS |
| 1      |

 and the following is displayed:

|                                                    |
|----------------------------------------------------|
| Select desired<br>Proctor:<br>1:XX2:XX<br>3:XX4:XX |
|----------------------------------------------------|

▶ Press the numbered key (1, 2, 3 or 4) to select the required value:

And the following will be displayed:

|                                               |
|-----------------------------------------------|
| Proctor<br>XXXX kg/m <sup>3</sup><br>ENABLED! |
|-----------------------------------------------|

The display will return to <READY>.

### 6 Material wet density bias

▶ Press 

|        |
|--------|
| OFFSET |
| MR     |

 and the following is displayed:

|                                                                          |
|--------------------------------------------------------------------------|
| OFFSET- Select:<br>1 - Dens -ZZZ-<br>2 - Moist -ZZZ-<br>3 - Trench -ZZZ- |
|--------------------------------------------------------------------------|

▶ Press 

|        |
|--------|
| COUNTS |
| 1      |

The following will be displayed:

|                                                         |
|---------------------------------------------------------|
| Density Offset<br>DISABLED<br>Do you want to<br>ENABLE? |
|---------------------------------------------------------|

or

|                                                         |
|---------------------------------------------------------|
| Density Offset<br>ENABLED<br>Do you want to<br>DISABLE? |
|---------------------------------------------------------|

To disable the material wet density bias, go to 6.1.

To enable the material wet density bias, go to 6.2.

#### 6.1 Disable material wet density bias

▶ Press 

|       |
|-------|
| NO/CE |
| C/CE  |

 to confirm that the density offset is to remain disabled or 

|      |
|------|
| YES  |
| EXIT |

 to disable the density offset.

And the following will be displayed briefly:

|                            |
|----------------------------|
| Density Offset<br>DISABLED |
|----------------------------|

The display will return to <READY>. Go to 7.

## 6.2 Enable material wet density bias

- ▶ Press 

|      |
|------|
| YES  |
| EXIT |

 to enable the density offset or 

|       |
|-------|
| NO/CE |
| C/CE  |

 to confirm that the density offset is to remain enabled.

The following will be displayed:

|                        |
|------------------------|
| -Wet Density-Offset    |
| XXXX kg/m <sup>3</sup> |
| Want to change?        |

To retain the value, go to 6.2.1.

To change the value, go to 6.2.2.

### 6.2.1 Retain the value

- ▶ Press 

|       |
|-------|
| NO/CE |
| C/CE  |

 to retain the displayed value of wet density offset.

The following will be displayed briefly:

|                |
|----------------|
| Density Offset |
| ENABLED!       |

The display will return to <READY>.

### 6.2.2 Change the value

- ▶ Press 

|      |
|------|
| YES  |
| EXIT |

 and the following is displayed:

|                |
|----------------|
| - WD Offset -  |
| Select: + or - |
| 1 = +          |
| 2 = -          |

- ▶ Press 

|       |
|-------|
| COUNT |
| 1     |

 or 

|       |
|-------|
| DEPTH |
| 2     |

 and the following is displayed:

|                            |
|----------------------------|
| WD Offset                  |
| Press enter when completed |

- ▶ Use the numbered keys to enter the required value to the nearest 1 kg/m<sup>3</sup>.

- ▶ Press 

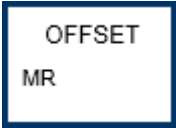
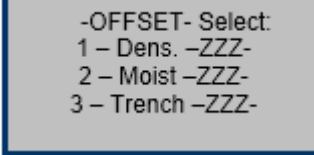
|        |
|--------|
| START/ |
| ENTER  |
| =      |

The following will be displayed:

|                |
|----------------|
| Density Offset |
| ENABLED!       |

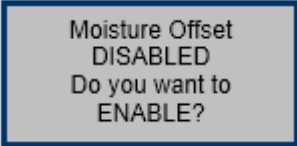
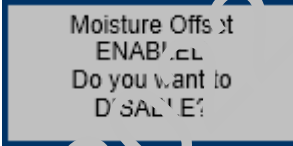
The display will return to <READY>.

## 7 Material moisture bias

► Press  and the following is displayed: 

► Press 

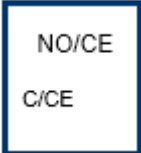
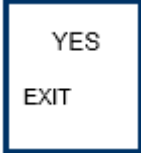
The following will be displayed:


 or 

To disable the material moisture bias, go to 7.1.

To enable the material moisture bias, go to 7.2.


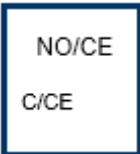
### 7.1 Disable material moisture bias

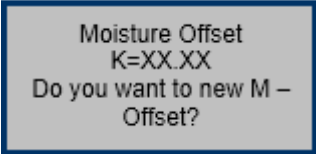
► Press  to confirm that the moisture offset is to remain disabled or  to disable the moisture offset.

And the following will be displayed briefly: 

The display will return to <READY>. Go to 8.

### 7.2 Enable material moisture bias

► Press  to enable the moisture offset or  to confirm that the moisture offset is to remain enabled.

And the following will be displayed: 

To retain the displayed K value, go to 7.2.1.

To change the displayed K value to a gauge-derived value, go to 7.2.2.

To change the displayed K value to a stored value, go to 7.2.3.



**7.2.1 Retain the value**

- ▶ Press  to retain the displayed K value.

The following will be displayed:

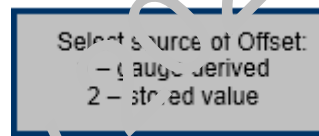


The display will return to <READY>. Go to 8.

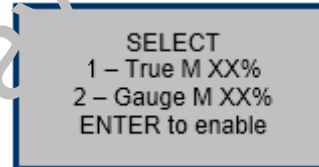
**7.2.2 Change to a gauge-derived value**

To change the moisture bias to a gauge-derived value:

- ▶ Press  and the following is displayed:



- ▶ Press  and the following is displayed:

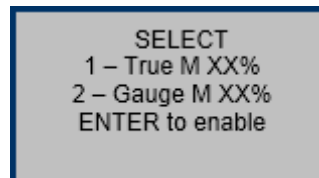



- ▶ Press  and the following is displayed:

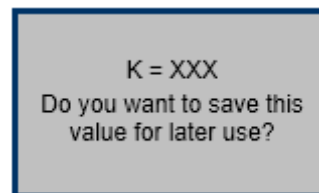


- ▶ Use the numbered keys to enter the average oven dry moisture content to the nearest 0.01%.

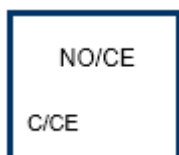
- ▶ Press  and the following is displayed:



- ▶ Press  and the following is displayed:



**If the value is not be saved:**

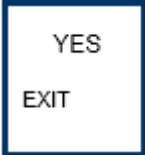
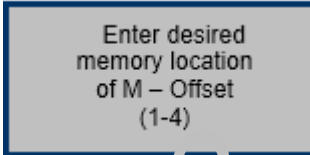
- ▶ Press 

And the following will be displayed:


Moisture Offset  
ENABLED  
K = XXXX

The display will return to <READY>. Go to 8.

**To save the displayed value:**

▶ Press  and the following is displayed: 

▶ Press a numbered key (1, 2, 3 or 4) to select a memory cell in which to store the value.

▶ Press 

And the following will be displayed:

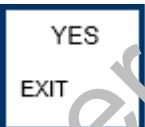
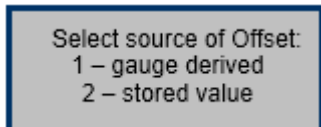
Moisture K  
SAVED  
K = X.XX  
Location 1


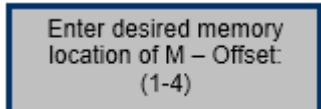
And the following will be displayed briefly:

Moisture Offset  
Enabled  
K = X.XX


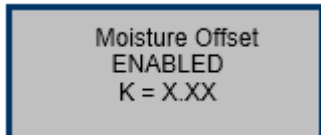
The display will return to <READY>. Go to 8.

**7.2.3 Change to a stored value**

▶ Press  and the following is displayed: 


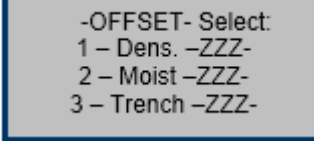
▶ Press  and the following is displayed: 

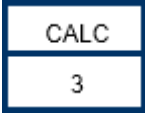

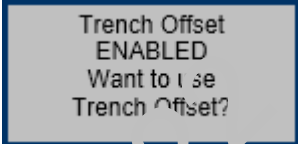
▶ Press a numbered key (1, 2, 3 or 4) to select the required memory location.

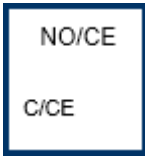
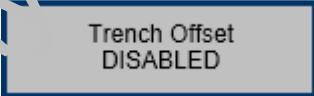
▶ Press  and the following is displayed: 

The display will return to <READY>.


## 8 Trench offset

▶ Press  and the following is displayed: 

▶ Press  and the following is displayed:  
 or 

▶ Press  to disable the trench offset.  
 The following will be displayed briefly: 

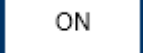
The display will return to <READY>.

▶ Press  if the nuclear gauge is not required for further use.

Superseded 6 May 2024

## Operating Instruction N202: Measurement (Soils) Troxler 3440

### 1 Set-up

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

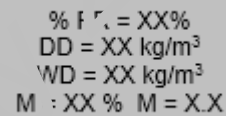
When <READY> is displayed:

- ▶ Press 

In the manual depth mode, the gauge will prompt for the source rod depth.

In the automatic depth mode, the gauge software reads the depth strip on the source rod to determine the source rod depth.

At the end of the counting period, the following will be displayed:



```



% PR = XX%
DD = XX kg/m³
WD = XX kg/m³
M : XX % M = X.X

```

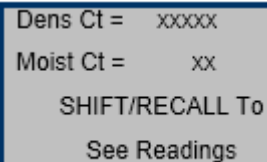
Record the following values:

- % PR as the **percent protector** to the nearest 0.1%.
- DD as the **dry density** to the nearest 0.001 t/m<sup>3</sup>.
- WD as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- M as the **moisture content (t/m<sup>3</sup>)** to the nearest 0.001 t/m<sup>3</sup>.
- % M as the **moisture content (%)** to the nearest 0.1%.

(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000).

- ▶ Press 
- ▶ Press 

And the following will be displayed:





```

Dens Ct = xxxxx
Moist Ct = xx
SHIFT/RECALL To
See Readings

```

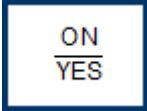
Record the following values as appropriate:

- Dens Ct as the **density count**.
- Moist Ct as the **moisture count**.

- ▶ Press  and the display will return to <READY>.
- ▶ Press  if the nuclear gauge is not required for further use.


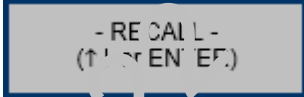

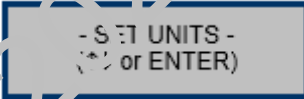

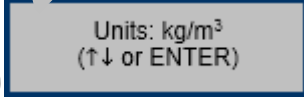


## Operating Instruction N203: Test Parameters (Soils) Troxler 3430

### 1 Set-up


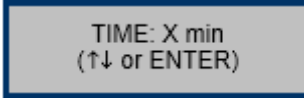


- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Units


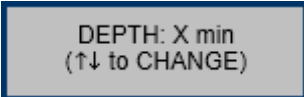

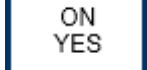
When <READY> is displayed:

- ▶ Press  and the following is displayed: 
- ▶ Press  repeatedly until the following is displayed: 
- ▶ Press  and the following is displayed: 
- ▶ Press  to set the desired unit.
- ▶ Press  and the display will return to <READY>.

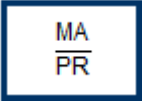



### 3 Count time

- ▶ Press  and the following is displayed: 
- ▶ Press  to set the desired count time.
- ▶ Press  and the display will return to <READY>.

### 4 Depth

- ▶ Press  and the following is displayed: 
- ▶ Press  repeatedly until the required test depth is displayed.
- ▶ Press  and display will return to <READY>.

## 5 Soil mode and maximum dry density

- ▶ Press  and the following is displayed: 
- ▶ Press  until PR is displayed. 

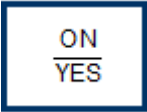
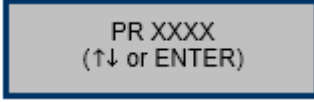


To retain the displayed value, go to 5.1.  
To change the displayed value, go to 5.2.

### 5.1 Retain the value

- ▶ Press  to retain the displayed value of PR.


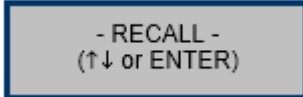

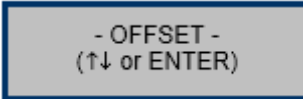
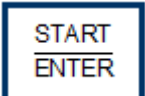
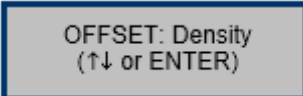
The display will return to <READY>. Go to 6.

### 5.2 Change the value

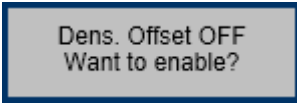
- ▶ Press  to change the displayed value of PR.
- The following is displayed: 
- For each digit:
- ▶ Press  repeatedly until the required number is displayed.
  - ▶ Press  to confirm each number.

The display will return to <READY>.

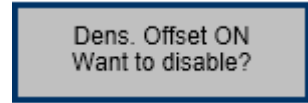
## 6 Material wet density bias

- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 

- ▶ Press  and the following is displayed:



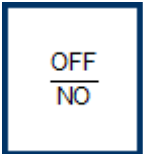
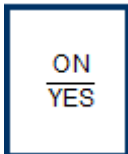
or



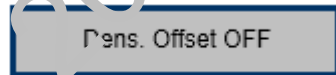
To disable the material wet density bias, go to 6.1.

To enable the material wet density bias, go to 6.2.

### 6.1 Disable material wet density bias

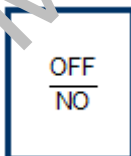
- ▶ Press  to confirm that the density offset is to remain disabled or  to disable the density offset.

And the following will be displayed:

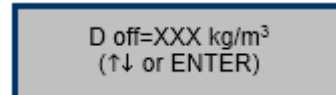


The display will return to <READY>. Go to 7.

### 6.2 Enable material wet density bias

- ▶ Press  to enable the density offset or  to confirm that the density offset is to remain enabled.

And the following will be displayed:



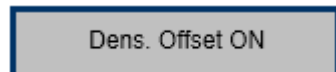
To retain the displayed value, go to 6.2.1.

To change the displayed value, go to 6.2.2.

#### 6.2.1 Retain the value



- ▶ Press 

The following will be displayed briefly:


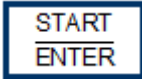


The display will return to <READY>. Go to 7.

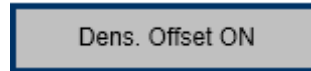
#### 6.2.2 Change the value

- ▶ Press  to enter a negative or wet density bias. or  to enter a positive wet density bias.

For each digit:

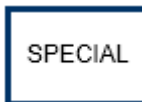
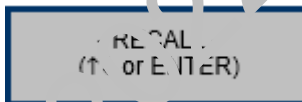

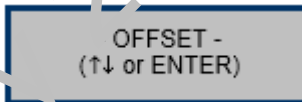
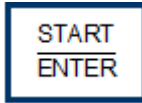
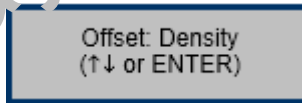

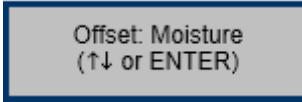

- ▶ Press  until the required number is displayed.
- ▶ Press  to confirm each number.

And the following will be displayed:



The display will return to <READY>.

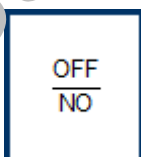
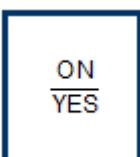
## 7 Material moisture bias

- ▶ Press  and the following is displayed: 
  - ▶ Press  and the following is displayed: 
  - ▶ Press  and the following is displayed: 
  - ▶ Press  and the following is displayed: 
  - ▶ Press  and the following is displayed:
- or

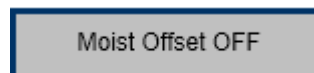
To disable the material moisture bias, go to 7.1.

To enable the material moisture bias, go to 7.2.

### 7.1 Disable material moisture bias

- ▶ Press  to confirm that the moisture offset is to remain disabled or  to disable the moisture offset.

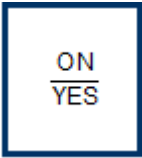
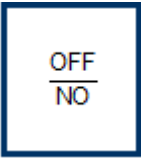
And the following will be displayed:



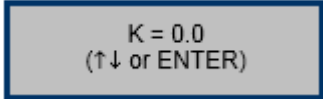
The display will return to <READY>. Go to 8.





### 7.2 Enable the material moisture bias


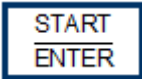
- ▶ Press  to enable the moisture offset or  to confirm that the moisture offset is to remain enabled.

And the following will be displayed:

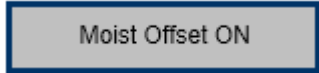


- ▶ Press  to enter a negative K value or  to enter a positive K value

For each digit:

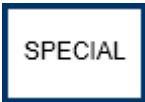
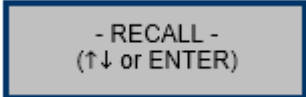

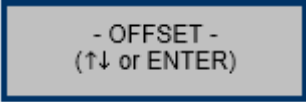
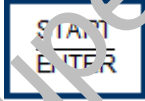
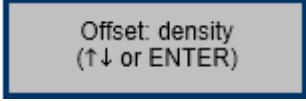

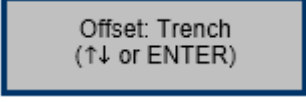
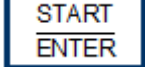
- ▶ Press  until the required number is displayed.
- ▶ Press  to confirm each number.

And the following will be displayed:

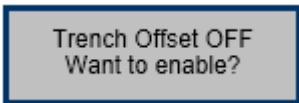


The display will return to <READY>.

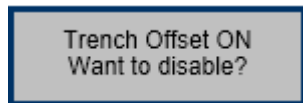
### 8 Trench offset

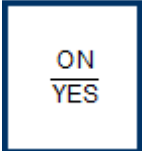
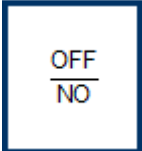
- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 
- ▶ Press  repeatedly until the following is displayed: 
- ▶ Press 

The following will be displayed:



or



► Press  to confirm that the trench offset is to remain disabled or  to disable the trench offset.

And the following will be displayed briefly:



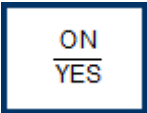
Trench Offset  
DISABLED

The display will return to <READY>.

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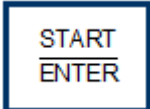
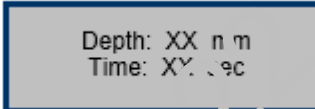
## Operating Instruction N204: Measurement (Soils) Troxler 3430

### 1 Set-up


- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

When <READY> is displayed:

- ▶ Press  and the following is displayed: 

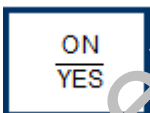
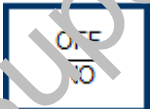
At the end of the counting period:

- ▶ Press  repeatedly until the required values are displayed.

Record the following values:

- WD as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- DD as the **dry density** to the nearest 0.001 t/m<sup>3</sup>.
- % PR as the **relative compaction** to the nearest 0.1%.
- Moist as the **moisture content (t/m<sup>3</sup>)** to the nearest 0.001 t/m<sup>3</sup>.
- % Moist as the **moisture content (%)** to the nearest 0.1%.
- M Count as the **moisture count**.
- D Count as the **density count**.



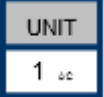
(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

- ▶ Press  and the display will return to <READY>.
- ▶ Press  if the nuclear gauge is not required for further use.


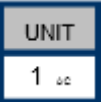




## Operating Instruction N207: Test Parameters (Soils) CPN MC3

### 1 Measurement units




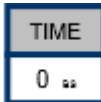

*Pre-March 1988 Nuclear Gauge:*

- ▶ Press   simultaneously until the density and moisture display is obtained.
- ▶ Press  until "gcc" is displayed.



*Post-March 1988 Nuclear Gauge:*

- ▶ Press   simultaneously.
- ▶ Press  until "gcc" is displayed.
- ▶ Press 
- ▶ Press  until "Density" is displayed.
- ▶ Press 

### 2 Count time

- ▶ Press    
- ▶ Press 

### 3 Maximum dry density

- ▶ Press  until "Md" is displayed.
- ▶ Press  and use the numbered keys to enter the maximum dry density to the nearest 0.001 t/m<sup>3</sup>.

▶ Press 

|       |
|-------|
| ENTER |
|-------|

#### 4 Material wet density bias

▶ Press 

|        |
|--------|
| D BIAS |
| 5 ±    |

▶ Press 

|    |
|----|
| ID |
| -  |

to enter a negative bias. Use the numbered keys to enter the material wet density bias to the nearest 0.001 t/m<sup>3</sup>.

▶ Press 

|       |
|-------|
| ENTER |
|-------|

#### 5 Material moisture bias

▶ Press 

|        |
|--------|
| M BIAS |
| 6 ±    |

To enter a positive bias:

▶ Press 

|    |
|----|
| ID |
| +  |

And use the numbered keys to enter the material moisture bias to the nearest 0.001 t/m<sup>3</sup>.

To enter a negative bias:

▶ Press 

|    |
|----|
| ID |
| -  |

and use the numbered keys to enter the material moisture bias to the nearest 0.001 t/m<sup>3</sup>.

▶ Press 

|       |
|-------|
| ENTER |
|-------|

Superseded 6 May 2022

## Operating Instruction N208: Measurement (Soils) CPN MC3

### 1 Measurement

▶ Press 

At the end of the counting period, the following will be displayed:

|      |      |        |        |
|------|------|--------|--------|
| RXXX | -XXX | XXX    | XXXX   |
| DaXX |      | TXX:XX | T0X:XX |
| gcc  | wet  | h2o    | dry    |
| Dn   | XXXX | XXXX   | XXXX   |
| Pr   | XXXX | XXXX   | XXXX   |
| %    |      | XXXX   | XXXX   |
| Md   |      |        | XXXX   |
| Bi   | XXX  | XXX    |        |

Record the following values, as appropriate:


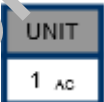
- Dn wet as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- Dn dry as the **dry density** to the nearest 0.001 t/m<sup>3</sup>.
- Dn h2o as the **moisture content (t/m<sup>3</sup>)** to the nearest 0.001 t/m<sup>3</sup>.
- %h2o as the **moisture content (%)** to the nearest 0.1%.
- %dry as the **relative compaction** to the nearest 0.1%.

*Pre-March 1988 Nuclear Gauge:*



▶ Press   simultaneously.


Record the following values, as appropriate:

- Ct wet as the **density count**.
- Ct h2o as the **moisture count**.


▶ Press   simultaneously to return to the density and moisture display.

*Post-March 1988 Nuclear Gauge:*

▶ Press   simultaneously.

▶ Press 



▶ Press  repeatedly until **Counts** is displayed.

▶ Press 


Record the following values as appropriate:


- ▶ • Ct wet as the **density count**.
- ▶ • Ct h2o as the **moisture count**.

To return to the density and moisture display:

▶ Press   simultaneously to return to the density and moisture display.

▶ Press 


▶ Press  repeatedly until **"Density"** is displayed.

▶ Press 

Superseded 6 May 2022

## Operating Instruction N211: Test Parameters (Soils) Humboldt 5001EZ

### 1 Start-up

- ▶ Press  and allow the nuclear gauge to complete the initialising routine.

The following will be displayed:

```
*DATA XX/XX/XX
*SET UP XX:XX:XX
*ENGINEERING
 DEPTH=SAF
```

- ▶ Press  and the following will be displayed:

```
*SET UP 2
*SET MEASUREMENT MODE
*SET TRNCH COR.
*SET TARGETS
```

### 2 Measurement units



- ▶ Press  and the following will be displayed:

```
*SET DATA
*SET TIME
UNITS = PCF/SI
```

- ▶ Press  repeatedly until "SI" flashes.


- ▶ Press  and the display will return to the main menu.

### 3 Count time

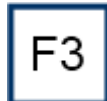
- ▶ Press  

The following will be displayed:

```
MEAS = FAST/NORM/SLOW
STD = 4MIN/16MIN
TYPE = ASPH/SOIL/THIN
DEPTH = AUTO/MANUAL
```



- ▶ Press  repeatedly until "NORM" flashes.

### 4 Soil mode


- ▶ Press  repeatedly until "SOIL" flashes.



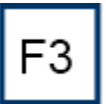

## 5 Depth

- ▶ Press  repeatedly until "AUTO" flashes.
- ▶ Press  and the display will return to the main menu.

## 6 Maximum dry density


- ▶ Press  and the following will be displayed:

```
MAXD = XXXX
*INCREASE
*DECREASE
```

- ▶ Press  OR 

to increase or decrease the displayed value until the required value (within the range 900 kg/m<sup>3</sup> to 3000 kg/m<sup>3</sup>) is obtained.

(To convert from t/m<sup>3</sup> to kg/m<sup>3</sup>, multiply the maximum dry density by 1000.)

- ▶ Press  and the display will return to the main menu.


## 7 Material wet density bias

There is no facility to set a material wet density bias using the keypad.


## 8 Material moisture bias



- ▶ Press  and the following will be displayed:

```
*SET UP 2
*SET MEASURE MODES
*SET TRENCH COR.
*SET TARGETS
```

- ▶ Press  and the following will be displayed:

```
MAXD= XXXX LWD = XXXX
KVAL = X.XXX SPG = X.XXX
*INCREASE
*DECREASE
```


- ▶ Press  repeatedly until the "KVAL" value flashes.


- ▶ Press  OR 

to increase or decrease the displayed value until the required K value is obtained.

A maximum value of 0.20 (in increments of 0.10) and a minimum value of -0.10 (in increments of 0.01) may be set.

To disable the material moisture bias, set a value of "0.0".


▶ Press  and the display will return to the main menu.

▶ Press  if the nuclear gauge is not required for further use.


Superseded 6 May 2022

## Operating Instruction N212: Measurement (Soils) Humboldt 5001EZ

### 1 Start-up

- ▶ Press  and allow the nuclear gauge to complete the initialising routine.

### 2 Measurement

- ▶ Press  and the following will be displayed:

|                    |               |
|--------------------|---------------|
| TAKING MEASUREMENT |               |
| TIME REMAINING     | X.XX          |
| DC = X             |               |
| MC = X             | DEPTH = X (X) |


|             |             |
|-------------|-------------|
| DD = XXXX.X | M = XX.X    |
| WD = XXXX.X | M = XXX.X   |
| %PR = XX.X  | M = XXXX    |
| *NEXT       | DEPTH = XXX |

At the end of the counting period, the following will be displayed:

Record the following values as appropriate:

- DD as the **dry density** to the nearest 0.001 t/m<sup>3</sup>.
- WD as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- %PR as the **relative compaction** to the nearest 0.1%.
- %M as the **moisture content** to the nearest 0.1%.
- M as the **moisture content** to the nearest 0.001 t/m<sup>3</sup>.


To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)


- ▶ Press  and the following will be displayed:

|             |              |
|-------------|--------------|
| DC = XXXX.X | DS = XXXX.X  |
| MC = XX.X   | MS = XXX.X   |
| VR = XX.XX  | %AV = X.XX   |
| *LAST       | MDEPTH = XXX |

Record the following values as appropriate:


- DC as the **density count**.
- MC as the **moisture count**.




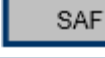

- ▶ Press  and the display will return to the main menu.

- ▶ Press  if the nuclear gauge is not required for further use.



## Operating Instruction N213: Test Parameters (Soils) Humboldt 5001C

### 1 Start-up

▶ Press  and allow the nuclear gauge to complete the initialising routine.

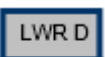



▶ Press    simultaneously until the following is displayed:  

### 2 Soil mode

▶ Press   repeatedly until "SOIL" is displayed

▶ Press  


### 3 Maximum dry density

▶ Press   and the following will be displayed:  



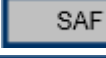

#### 3.1 Retain the value

▶ Press   to retain the displayed value of maximum dry density.

#### 3.2 Change the value

Press and hold  Use the numbered keys to enter the required value in kg/m<sup>3</sup>.


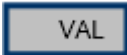

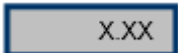
(To convert from t/m<sup>3</sup> to kg/m<sup>3</sup>, multiply the maximum dry density by 1000.)

▶ Press   repeatedly until the following is displayed:  



### 4 Material wet density bias

There is no facility to enter a material wet density bias using the keypad.


## 5 Material moisture bias


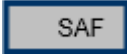


- ▶ Press  and the following will be displayed:   
 

### 5.1 Retain the value

- ▶ Press  to retain the displayed K value.  


### 5.2 Change the value


- ▶ Press  and use the numbered keys to enter the K value.  
and hold

- ▶ Press  repeatedly until the following is displayed:   
 

### 5.3 Disable the material moisture bias


To disable the moisture bias, enter a value of "0.0".

- ▶ Press  repeatedly until the following is displayed:   
 



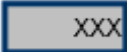
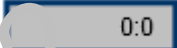
- ▶ Press  if the nuclear gauge is not required for further use.




## Operating Instruction N214: Measurement (Soils) Humboldt 5001C

### 1 Start-up

- ▶ Press  and allow the nuclear gauge to complete the initialising routine.

### 2 Measurement


- ▶ Press   simultaneously until the following is displayed:   



- ▶ Press  and the following will be displayed:   



At the end of the counting period, the following will be displayed:





Record the displayed value as the **dry density** to the nearest 0.001 t/m<sup>3</sup>.

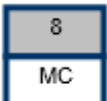
- ▶ Press  and record the displayed value as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.


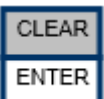
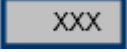

- ▶ Press  and record the displayed value as the **moisture content (t/m<sup>3</sup>)** to the nearest 0.001 t/m<sup>3</sup>.

- ▶ Press  and record the displayed value as the **moisture content (%)** to the nearest 0.1%.


- ▶ Press  and record the displayed value as the **relative compaction** to the nearest 0.1%.

- ▶ Press  and record the displayed value as the **density count**.

- ▶ Press  and record the displayed value as the **moisture count**.

- ▶ Press   simultaneously until the following is displayed:   



(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

- ▶ Press  if the nuclear gauge is not required for further use.



Superseded 6 May 2022

## Operating Instruction N215: Test Parameters (Soils) Humboldt 5001P

### 1 Start-up

- ▶ Press  and allow the nuclear gauge to stabilise for at least 20 minutes before commencing the test.




### 2 Depth

- ▶ Press  or  repeatedly until the required measurement depth is displayed.


### 3 Maximum dry density

- ▶ Press  

#### 3.1 Retain the value

- ▶ Press    to retain the displayed value of maximum dry density.

#### 3.2 Change the value

- ▶ Press and hold  and use the number and keys to enter the required value to the nearest 1 kg/m<sup>3</sup>.

(To convert from t/m<sup>3</sup> to kg/m<sup>3</sup>, multiply the maximum dry density by 1000.)

- ▶ Press    to store the value.

### 4 Material wet density bias

There is no facility to enter a material wet density bias using the keypad.

### 5 Material moisture bias





- ▶ Press  

#### 5.1 Retain the value

- ▶ Press    to retain the displayed K value.




## 5.2 Change the value

- ▶ Press and hold  and use the numbered keys to enter the K value.
- ▶ Press   to store the value.
- ▶ Press  if the nuclear gauge is not required for further use.


Superseded 6 May 2022

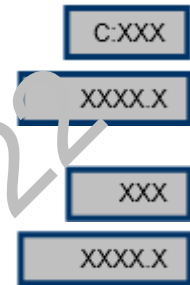
## Operating Instruction N216: Measurement (Soils) Humboldt 5001P

### 1 Start-up

- ▶ Press  and allow the nuclear gauge to stabilise for at least 10 minutes before commencing the test.






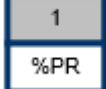
### 2 Measurement

- ▶ Press  and the following will be displayed:




At the end of the counting period, the following will be displayed:

Record the displayed value as the **density count**.

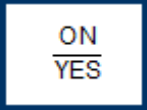
- ▶ Press  and record the displayed value as the **moisture count**.
- ▶ Press  and record the displayed value as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- ▶ Press  and record the displayed value as the **dry density** to the nearest 0.001 t/m<sup>3</sup>.
- ▶ Press  and record the displayed value as the **moisture content (t/m<sup>3</sup>)** to the nearest 0.001 t/m<sup>3</sup>.
- ▶ Press  and record the displayed value as the **moisture content (%)** to the nearest 0.001 t/m<sup>3</sup>.
- ▶ Press  and record the displayed value as the **relative compaction** to the nearest 0.1%.

(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

- ▶ Press  if the nuclear gauge is not required for further use.


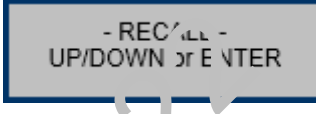

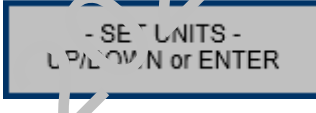

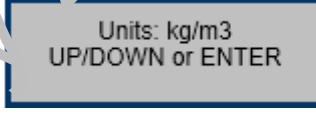
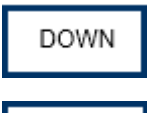
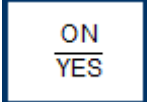
## Operating Instruction N217: Test Parameters (Soils) Instrotek Xplorer 3500

### 1 Set-up


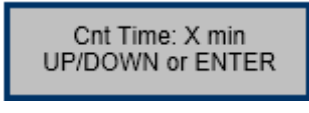

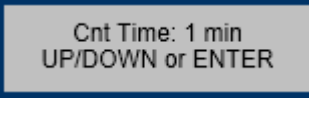
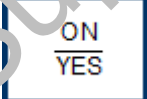
- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Units


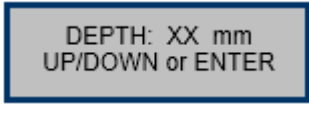
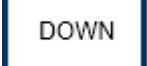
When <READY> is displayed:

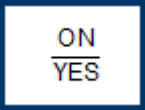
- ▶ Press  and the following is displayed: 
- ▶ Press  repeatedly until the following is displayed: 
- ▶ Press  and the following is displayed: 
- ▶ Press  to set the desired unit.
- ▶ Press  and the display will return to <READY>.

### 3 Count time

- ▶ Press  and the following is displayed: 
- ▶ Press  to set the desired count time. 
- ▶ Press  and the display will return to <READY>.

### 4 Depth

- ▶ Press  the following is displayed: 
- ▶ Press  repeatedly until the required test depth is displayed.

- ▶ Press  and display will return to <READY>.

## 5 Soil mode and maximum dry density

- ▶ Press  and the following is displayed:

ENTER selects PR  
DOWN selects MA

- ▶ Press  and the following is displayed:

PR: XXXXX  
Change value?

To retain the displayed value, go to 5.1.

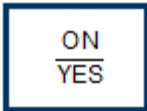
To change the displayed value, go to 5.2.

### 5.1 Retain value

- ▶ Press  to retain the displayed value.

The display will return to the <READY> screen. Go to 6.


### 5.2 Change the value


- ▶ Press  to change the displayed value of PR.

The following is displayed:

PR: XXXXX  
UP/DOWN or ENTER

For each digit:

- ▶ Press  repeatedly until the required number is displayed.

- ▶ Press  to confirm each number.

The display will return to <READY>. Go to 6.


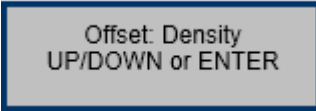

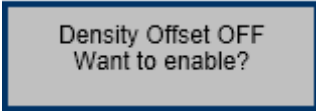

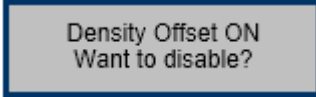
## 6 Material wet density bias

- ▶ Press  and the following is displayed:

- RECALL -  
UP/DOWN or ENTER

- ▶ Press  and the following is displayed:

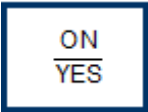
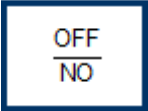
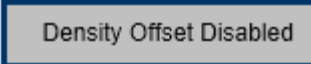
- OFFSET -  
UP/DOWN or ENTER

- ▶ Press  and the following is displayed: 
- ▶ Press  and the following is displayed: 
- or
- ▶ Press  and the following is displayed: 

To disable the material wet density bias, go to 6.1.

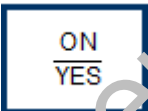
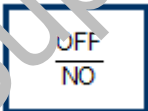
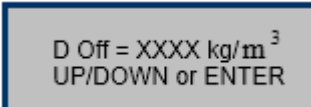
To enable the material wet density bias, go to 6.2.

### 6.1 Disable material wet density bias

- ▶ Press  to disable the density offset.
  - or
  - ▶ Press  to confirm that the density offset is to remain disabled.
- The following will be displayed briefly: 

The display will return to <READY>. Go to 7.


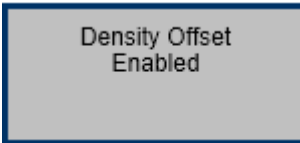
### 6.2 Enable material wet density bias

- ▶ Press  to enable the density offset.
  - or
  - ▶ Press  to confirm that the density offset is to remain enabled.
- And the following will be displayed: 

To retain the displayed value, go to 6.2.1.

To change the displayed value, go to 6.2.2.

**6.2.1 Retain the value**

▶ Press  and the following will be displayed: 

The display will return to <READY>. Go to 7.


**6.2.2 Change the value**

▶ Press  for a positive value.

or

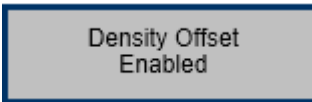
▶ Press  for a negative value.

For each digit:

▶ Press  until the desired number is displayed.


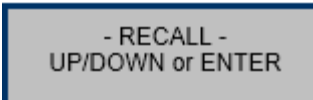
▶ Press  to confirm each number.


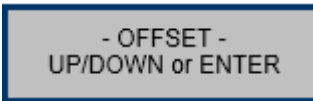
And the following will be displayed:

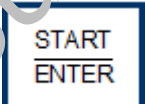
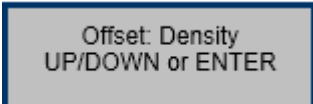



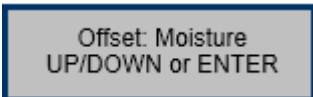
The display will return to <READY>.


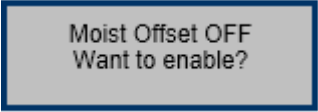
**7 Material moisture bias**

▶ Press  and the following is displayed: 


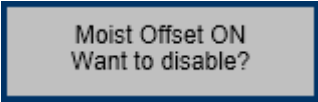
▶ Press  and the following is displayed: 

▶ Press  and the following is displayed: 

▶ Press  and the following is displayed: 

- ▶ Press  and the following is displayed: 

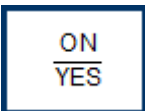
or

- ▶ Press  and the following is displayed: 

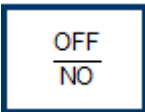
To disable the material moisture bias, go to 7.1.

To enable the material moisture bias, go to 7.2.

### 7.1 Disable the material moisture bias

- ▶ Press  to disable the moisture offset.

or

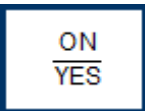
- ▶ Press  to confirm that the moisture offset is to remain disabled.

The following will be displayed:




The display will return to <READY>. Go to 8.

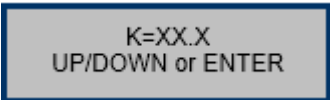
### 7.2 Enable the material moisture bias

- ▶ Press  to enable the moisture offset.

or

- ▶ Press  to confirm that the moisture offset is to remain enabled.

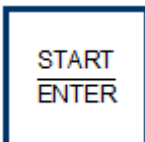

The following will be displayed:



To retain the displayed value, go to 7.2.1.


To change the displayed value, go to 7.2.2.

#### 7.2.1 Retain the value

- ▶ Press  and the following is displayed: 


The display will return to <READY>. Go to 8.

### 7.2.2 Change the value

▶ Press  for a positive value.  
or

▶ Press  for a negative value.

For each digit:

▶ Press  until the required number is displayed.

▶ Press  to confirm each number.

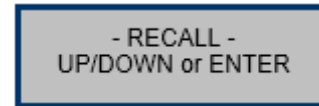
And the following will be displayed:



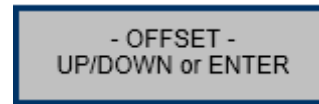
The display will return to <READY>.

### 8 Trench offset

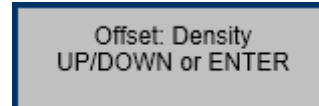
▶ Press  and the following is displayed:



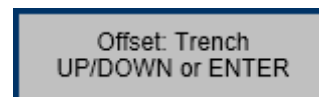
▶ Press  and the following is displayed:



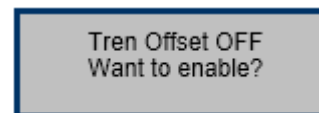
▶ Press  and the following is displayed:



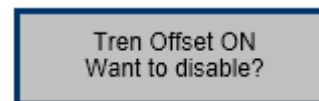
▶ Press  repeatedly until the following is displayed:

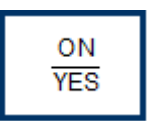


▶ Press  and the following is displayed:

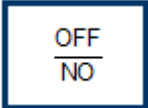


or



▶ Press  to disable the trench offset.  
or



- ▶ Press  to confirm that the trench offset is to remain disabled.

The following will be displayed:

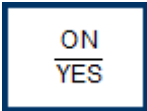


The display will return to <READY>.

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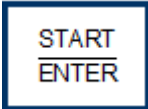
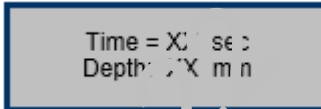
## Operating Instruction N218: Measurement (Soils) Instrotek Xplorer 3500

### 1 Set-up


- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

When <READY> is displayed:

- ▶ Press  and the following is displayed: 

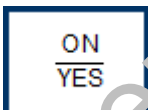

At the end of the counting period:

- ▶ Press  repeatedly until the required values are displayed.

Record the following values as appropriate:

- WD as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- DD as the **dry density** to the nearest 0.001 t/m<sup>3</sup>.
- % PR as the **relative compaction** to the nearest 0.1%.
- Moist as the **moisture content (t/m<sup>3</sup>)** to the nearest 0.001 t/m<sup>3</sup>.
- % M as the **moisture content (%)** to the nearest 0.1%.
- M Count as the **moisture count**.
- D Count as the **density count**.

(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

- ▶ Press  and the display will return to <READY>.
- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N219: Test Parameters (Soils) Troxler 3440P

### 1 Start up

- ▶ Turn the power switch on and allow the nuclear gauge to complete the self-test routine.

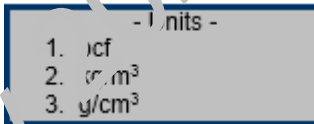
### 2 Measurement units

When <READY> is displayed:

- ▶ Press 

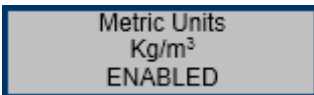
- ▶ Press 

The following will be displayed:



- ▶ Press 

The following will be displayed:

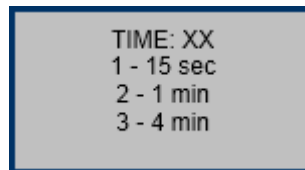


The display will return to <SETUP>.

### 3 Count time

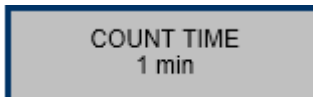
- ▶ Press 

- ▶ Press  and the following is displayed:



- ▶ Press 

The following will be briefly displayed:



The display will return to <READY>.

#### 4 Soil mode

▶ Press MODE

The following will be displayed:

MODE: XXXX  
 Select: 1 - ASPHALT  
           2 - SOIL  
 Press # to Select

▶ Press 2

The following will be displayed briefly:

Soil Mode  
 ENABLED

The display will return to <READY>.

#### 5 Material wet density bias

▶ Press OFFSET the following is displayed:

-OFFSET-  
 1 - Dens. -OFF-  
 2 - Moist -OFF-  
 3 - Trench -OFF-

▶ Press 1

The following will be displayed:

Density Offset  
 Xx kg/m<sup>3</sup>  
 1. Enable 2. Disable  
 3. Change Offset

To disable the material wet density bias, go to Step 5.1.

To enable the material wet density bias, go to Step 5.2.

To change the material wet density bias, go to Step 5.3.

##### 5.1 Disable material wet density bias

▶ Press 2

The following will be displayed briefly:

Density Offset  
 DISABLED

The display will return to <READY>. Go to 7.

### 5.2 Enable material wet density bias

▶ Press 1

The following will be displayed:

Density Offset  
ENABLED

### 5.3 Change material wet density bias

▶ Press 3 the following is displayed:

Density Offset  
xx kg/m  
Select (+ -)  
Input and <ENTER>

▶ Use the numbered keys to enter the required value to the nearest 1 kg/m<sup>3</sup>.  
(To convert from t/m<sup>3</sup> to kg/m<sup>3</sup>, multiply the material wet density bias by 1000.)

▶ Press ENTER  
START

The following will be displayed briefly:

Density Offset  
ENABLED

The display will return to <READY>.

## 6 Material moisture bias

▶ Press OFFSET the following is displayed:

-OFFSET--Select:  
1 - Dens. -OFF-  
2 - Moist. -OFF-  
3 - Trench -OFF-

▶ Press 2

The following will be displayed:

Moisture Offset  
1. xxxx 2. xxxx  
3. xxxx 4. xxxx  
5. New 6. Disable

### 6.1 Disable material moisture bias

▶ Press 6

The following will be displayed:

Moisture Offset  
DISABLED

The display will return to <READY>. Go to Step 8.

**6.2 Enable the material moisture bias**

- ▶ Press the number corresponding to any of the stored values.

**6.3 Change a material moisture bias value**

▶ Press  the following is displayed:

Select Offset Source  
 1. Manual Entry  
 2. Gauge Derived

**For manual entry:**

▶ Press  the following is displayed:

True Moisture %  
 x. x  
 Press <ENTER>

Use the numbered keys to enter the average oven dry moisture content to the nearest 0.01%.

▶ Press  the following is displayed:

Gauge Moisture %  
 0.00%  
 Press <ENTER>

Use the numbered keys to enter the average standard blocks moisture content to the nearest 0.01%.

▶ Press  the following is displayed:

K = xxxx  
 Do you want to save  
 this value for later use ?

To save the displayed value:

▶ Press  the following is displayed:

Select Memory Cell  
 1.            2.  
 3.            4.  
 Press # to Select

- ▶ Press a numbered key (1, 2, 3 or 4) to select a memory location in which to save the value.

The following will be displayed briefly:

K x.xx  
 ENABLED

If the value is not to be displayed:

▶ Press

The display will return to <READY>.

**For gauge derived:**

▶ Press  the following is displayed:

True Moisture %  
 x.xx  
 Press <ENTER>

Use the numbered keys to enter the true moisture content to the nearest 0.01%.

► Press **ENTER  
START** the following is displayed:

Place gauge on soil,  
Lower rod and  
Press any key

Place the gauge on the measurement site and press any key.

At the completion of the counting period, the following will be displayed:

K: ###  
Save This Value for  
Later Use ?

To save the value:

► Press **YES**

To enable the value without storing:

► Press **NO**

## 7 Trench offset

► Press **OFFSET** the following is displayed:

-OFFSET-  
1 - Dens. -OFF-  
2 - Moist. -OFF-  
3 - Trench -OFF-

► Press **3** the following is displayed:

Trench Offset  
M: 0 D: 0  
1. Enable 2. Disable  
3. Change Offset

To enable the trench offset:

► Press **1**

The following is displayed:

Trench Offset  
ENABLED

To disable the trench offset:

► Press **2**

The following is displayed:

Trench Offset  
DISABLED

To change the trench offset:

- ▶ Press 

|   |
|---|
| 3 |
|---|

The following is displayed:

|                                                                         |
|-------------------------------------------------------------------------|
| Place Gauge in<br>trench on Std.<br>Block in SAFE Pos.<br>Press <START> |
|-------------------------------------------------------------------------|

- ▶ Press 

|       |
|-------|
| ENTER |
| START |

At the end of the counting period, the display will return to <READY>.

- ▶ Turn the power switch off if the nuclear gauge is not required for further use.

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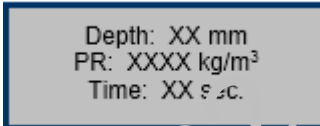
## Operating Instruction N220: Measurement (Soils) Troxler 3440P

### 1 Start up

- ▶ Turn the power switch on and allow the nuclear gauge to complete the self-test routine.

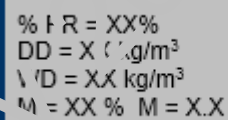
### 2 Measurement

When <READY> is displayed:

- ▶ Press  the following is displayed: 

In the manual depth mode, the gauge will prompt for the source rod depth. In automatic mode, the gauge software reads the depth strip on the source rod to determine the depth.




At the end of the counting period, the following will be displayed:



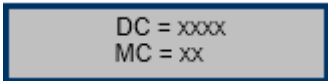
Record the following values as appropriate:

- % PR as the **relative compaction** to the nearest 0.1%.
- DD as the **dry density** to the nearest 0.001 t/m<sup>3</sup>.
- WD as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- M as the **moisture content (t/m<sup>3</sup>)** to the nearest 0.001 t/m<sup>3</sup>.
- % M as the **moisture content (%)** to the nearest 0.1%.

(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

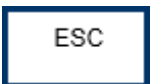
- ▶ Press 
- ▶ Press 
- ▶ Press 

The following will be displayed:



Record the following values as appropriate:

- DC as the **density count**.
- MC as the **moisture count**.

- ▶ Press  and the display will return to <READY>.
- ▶ Turn the power switch off if the nuclear gauge is not required for further use.

## Operating Instruction N221: Test Parameters (Soils) Troxler 3430P

### 1 Start up

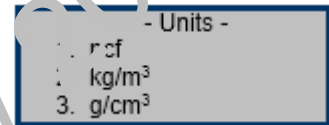
- ▶ Turn the power switch on and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement units

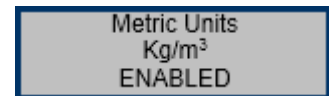
When <READY> is displayed:



The following will be displayed:

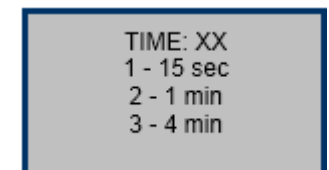


The following will be displayed briefly:

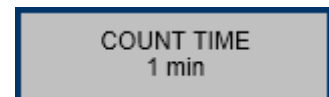


The display will return to <SETUP>.

### 3 Count time



The following will be displayed briefly:



The display will return to <READY>.

#### 4 Soil mode

▶ Press MODE

The following will be displayed:

MODE: XXXX  
 Select: 1 - ASPHALT  
 2 - SOIL  
 Press # to Select

▶ Press 2

The following will be displayed briefly:

Soil Mode  
 ENABLED

The display will return to <READY>.

#### 5 Material wet density bias

▶ Press OFFSET the following is displayed:

-OFFSET-  
 1 - Dens. -OFF-  
 2 - Moist -OFF-  
 3 - Trench -OFF-

▶ Press 1

The following will be displayed:

Density Offset  
 Xx kg/m<sup>3</sup>  
 1. Enable 2. Disable  
 3. Change Offset

To disable the material wet density bias, go to Step 5.1.

To enable the material wet density bias, go to Step 5.2.

To change the material wet density bias, go to Step 5.3.

##### 5.1 Disable material wet density bias

▶ Press 2

The following will be displayed briefly:

Density Offset  
 DISABLED

The display will return to <READY>. Go to 7.

### 5.2 Enable material wet density bias

▶ Press 1

The following will be displayed:

Density Offset  
ENABLED

### 5.3 Change material wet density bias

▶ Press 3 the following is displayed:

Density Offset  
xx kg/m<sup>3</sup>  
Select (+ -)  
Input and <ENTER>

▶ Use the numbered keys to enter the required value to the nearest 1 kg/m<sup>3</sup>.  
(To convert from t/m<sup>3</sup> to kg/m<sup>3</sup>, multiply the material wet density bias by 1000.)

▶ Press ENTER  
START

The following will be displayed briefly:

Density Offset  
ENABLED

The display will return to <READY>.

## 6 Material moisture bias

▶ Press OFFSET the following is displayed:

-OFFSET--Select:  
1 - Dens. -OFF-  
2 - Moist. -OFF-  
3 - Trench -OFF-

▶ Press 2

The following will be displayed:

Moisture Offset  
1. xxxx 2. xxxx  
3. xxxx 4. xxxx  
5. New 6. Disable

### 6.1 Disable material moisture bias

▶ Press 6

The following will be displayed:

Moisture Offset  
DISABLED

The display will return to <READY>. Go to Step 8.

**6.2 Enable the material moisture bias**

- ▶ Press the number corresponding to any the stored values.

**6.3 Change a material moisture bias value**

▶ Press  the following is displayed:

Select Offset Source  
 1. Manual Entry  
 2. Gauge Derived

**For manual entry:**

▶ Press  the following is displayed:

True Moisture %  
 x.xx  
 Press <ENTER>

Use the numbered keys to enter the average oven dry moisture content to the nearest 0.01%.

▶ Press  the following is displayed:

Gauge Moisture %  
 0.00%  
 Press <ENTER>

Use the numbered keys to enter the average standard blocks moisture content to the nearest 0.01%.

**For gauge derived:**

▶ Press  the following is displayed:

True Moisture %  
 x.xx  
 Press <ENTER>

Use the numbered keys to enter the true moisture content to the nearest 0.01%.

▶ Press  the following is displayed:

Place gauge on soil,  
 Lower rod and  
 Press any key

Place the gauge on the measurement site and press any key.

At the completion of the counting period, the following will be displayed:

K: ##.##  
 Save This Value for  
 Later Use ?

To save the value:

▶ Press

To enable the value without storing:

▶ Press

## 7 Trench offset

▶ Press OFFSET the following is displayed:

-OFFSET-

1 - Dens. -OFF-

2 - Moist. -OFF-

3 - Trench -OFF-

▶ Press 3 the following is displayed:

Trench Offset

M: 0 D: 0

1. Enable 2. Disable

3. Change Offset

To enable the trench offset:

▶ Press 1

The following is displayed:

Trench Offset  
ENABLED

To disable the trench offset:

▶ Press 2

The following is displayed:

Trench Offset  
DISABLED

To change the trench offset:

▶ Press 3

The following is displayed:

Place Gauge in  
trench on Std.  
Block in SAFE Pos.  
Press <START>

▶ Press ENTER  
START

At the end of the counting period, the display will return to <READY>.

- ▶ Turn the power switch off if the nuclear gauge is not required for further use.


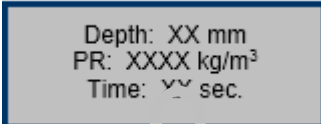
## Operating Instruction N222: Measurement (Soils) Troxler 3430P

### 1 Start up

- ▶ Turn the power switch on and allow the nuclear gauge to complete the self-test routine.

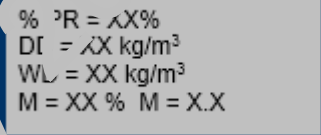
### 2 Measurement

When <READY> is displayed:

- ▶ Press  the following is displayed: 

In the manual depth mode, the gauge will prompt for the source rod depth. In automatic mode, the gauge software reads the depth strip on the source rod to determine the depth.




At the end of the counting period, the following will be displayed:



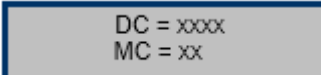
Record the following values as appropriate:

- % PR as the **relative compaction** to the nearest 0.1%.
- DI as the **dry density** to the nearest 0.001 t/m<sup>3</sup>.
- WL as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- M as the **moisture content (t/m<sup>3</sup>)** to the nearest 0.001 t/m<sup>3</sup>.
- % M as the **moisture content (%)** to the nearest 0.1%.

(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)


- ▶ Press 
- ▶ Press 
- ▶ Press 

The following will be displayed:



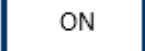
Record the following values as appropriate:

- DC as the **density count**.
- MC as the **moisture count**.

- ▶ Press  and the display will return to <READY>.
- ▶ Turn the power switch off if the nuclear gauge is not required for further use.

## Operating Instruction N223: Test Parameters (Soils) Troxler 3450

### 1 Set-up

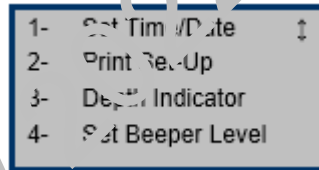
- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Unit

When <READY> is displayed:

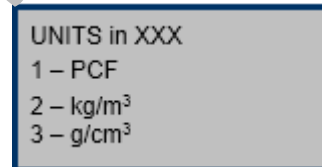
- ▶ Press 

- ▶ Press  to access the gauge setup menu.



Scroll through the menu using the arrow keys.

- ▶ Press  and the following is displayed:



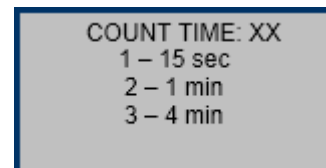
- ▶ Press  and the following is displayed:



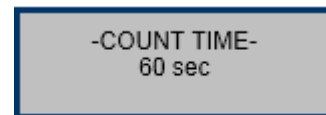
The display will return to the Gauge Setup menu.

### 3 Count time

- ▶ Press  and the following is displayed:



- ▶ Press  and the following is displayed:



The display will return to <READY>.



#### 4 Soil mode

▶ Press MODE and the following is displayed:

- MODE -

1 – Soil Mode  
2 – Asphalt Mode  
3 – Thin Layer Mode

▶ Press 1

And the following will be displayed briefly:

Soil Mode Enabled

The display will return to <READY>.

#### 5 Material wet density bias

▶ Press OFFSET and the following is displayed:

OFFSET Select

1 – Wet Density OFF  
2 – Moisture OFF  
3 – Trench OFF

▶ Press 1

The following will be displayed:

Wet Density Offset:  
xxxx kg/m<sup>3</sup>  
1 – Enable    2 – Disable  
3 – Change Offset

To disable the material wet density bias:

▶ Press 2 and the following is displayed:

Wet Density Offset  
DISABLED

To enable the material wet density bias:

▶ Press 1 and the following is displayed:

Wet Density Offset  
ENABLED

### 5.1.1 Change the value

- ▶ Press 3 and the following is displayed: Wet Density Offset  
xxxx kg/m<sup>3</sup>  
Select (+/-)
- ▶ Press + ↑ or - ↓
- ▶ Use the numbered keys to enter the required value to the nearest 1 kg/m<sup>3</sup>.
- ▶ Press ENTER

The following will be displayed:

Density Offset  
  
 ENABLED

The display will return to <READY>.

## 6 Material moisture bias

- ▶ Press OFFSET and the following is displayed: OFFSET Select:  
1 – Wet Density    OFF  
2 – Moisture        OFF  
3 – Trench           OFF
- ▶ Press 2

The following will be displayed:

Moisture Offset:  
 K = 0.00  
 1 – Enable    2 – Disable  
 3 – Change Offset

To disable the moisture offset:

- ▶ Press 2 and the following is displayed: Moisture Offset  
DISABLED

To enable the moisture offset:

- ▶ Press 1 and the following is displayed:

Moisture Offset  
ENABLED

### 6.1.1 Change the value

- ▶ Press 3 and the following is displayed:

Moisture Offset  
1 – Stored Offset  
2 – Gauge Derived  
3 – Keypad Entry

To select a stored offset:

- ▶ Press 1 and the following is displayed:

Moisture Offset  
Select K Value Cell:  
1 – 0.00    2 – 0.00  
3 – 0.00    4 – 0.00

- ▶ Use the numbered keys to enter the required value to the nearest 0.01%.  
The display will return to <READY>.

### 6.1.2 Change to a gauge-derived value

To change the moisture bias to a gauge-derived value:

- ▶ Press 3 and the following is displayed:

Moisture Offset  
1 – Stored Offset  
2 – Gauge Derived  
3 – Keypad Entry

- ▶ Press 2 and the following is displayed:

Gauge Derived  
Moisture Offset  
1 – Measure Moisture  
2 – Input True Moist

- ▶ Press 1 and the following is displayed:

Place Gauge On  
Surface To Be Tested  
Press START For 4  
One – Minute Counts

- ▶ Press START

The gauge displays the progress of the measurements. After each reading, the gauge displays the results. To continue to the next measurement:

▶ Press START

After the last measurement:

▶ Press ENTER and the following is displayed:

Moisture Offset  
 1 – Stored Partial  
 Moisture Offset  
 2 – Input True Moist

To enter the true moisture later:

▶ Press 1

To overwrite the partial offset:

▶ Press YES

To use the stored partial offset:

▶ Press NO

To enter the true moisture now:

▶ Press 2 and the following is displayed:

Input True Moisture  
 xxxxx %  
 ENTER When Done

## 7 Trench offset

▶ Press OFFSET and the following is displayed:

OFFSET Select:  
 1 – Wet Density    OFF  
 2 – Moisture        OFF  
 3 – Trench           OFF

▶ Press 3 and the following is displayed:

Trench: TMO = xxxx  
 TDO = xxxx    xxxx  
 1 – Enable    2 – Disable  
 3 – Change Offset

To disable the trench offset:

▶ Press 2 and the following is displayed:

Trench Offset  
 DISABLED

To enable the trench offset:

- ▶ Press  and the following is displayed:

Trench Offset  
ENABLED

To create a new trench offset:

- ▶ Press  and the following is displayed:

Set Rod To STD Pos  
Press START For  
1 Minute STD Count  
In Trench

Position the gauge inside the trench and:

- ▶ Press

The gauge will display the progress of the standard count operation.

After the standard count, the gauge displays:

New Trench Offset  
TMO = xxxx  
TDO = xxxx  
Want To Accept?

To enable the new trench offset:

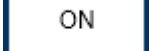
- ▶ Press

To create another trench offset:

- ▶ Press

## Operating Instruction N224: Measurement (Soils) Troxler 3450

### 1 Set-up

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

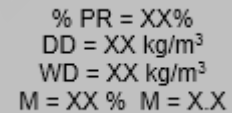
When <READY> is displayed:

- ▶ Press 

In the manual depth mode, the gauge will prompt for the source rod depth.

In the automatic depth mode, the gauge software reads the depth strip on the source rod to determine the source rod depth.

At the end of the counting period, the following will be displayed:



```

% PR = XX%
DD = XX kg/m³
WD = XX kg/m³
M = XX % M = X.X

```

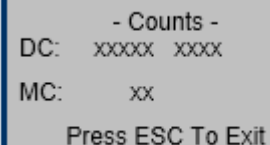
Record the following values:

- % PR as the **percent proctor** to the nearest 0.1%.
- DD as the **dry density** to the nearest 0.001 t/m<sup>3</sup>.
- WD as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- M as the **moisture content (t/m<sup>3</sup>)** to the nearest 0.001 t/m<sup>3</sup>.
- % M as the **moisture content (%)** to the nearest 0.1%.

(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

- ▶ Press 

And the following will be displayed:




```

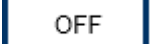
- Counts -
DC: xxxxxx xxxx
MC: xx
Press ESC To Exit

```

Record the following values as appropriate:

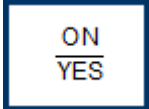
- If the reading is taken at 100 mm–300 mm depth, DC for system 1 (upper left reading) + DC for system 2 (upper right reading) as the **density count**.
- If the reading is taken at 50 mm or 75 mm, DC for system 2 (upper right reading) as the **density count**.
- MC as the **moisture count**.

- ▶ Press  and the display will return to <READY>.


- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N225: Test Parameters (Soils) CPN MC1 and MC3 Elite


### 1 Set-up

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.


### 2 Units

- ▶ Press  the first screen will be:
 

1. Recall  
 2. Set depth  
 UP/DOWN for next  
 Select #, ESC exit


- ▶ Press  the following is displayed:
 

11. Auto scroll  
 12. Set units  
 UP/DOWN for next  
 Select #, ESC exit

- ▶ Press  (button 1, then 2)
 

1. PCF  
 2. kg/m<sup>3</sup>  
 3. GCC  
 Select #, ESC exit


- ▶ After selecting the unit of measurement, the gauge returns to the menu screen.

- ▶ Press  returns to the ready screen
 

11. Auto scroll  
 12. Set units  
 UP/DOWN for next  
 Select #, ESC exit


GAUGE READY  
 COUNT TIME: # min  
 Depth: ### Offset: N  
 <date> <time>

### 3 Count time

- ▶ Press  and the following is displayed:
 

Cnt Time: ## min.  
 UP/DOWN TO CHANGE  
 YES to Accept  
 ESC to Exit

- ▶ Press UP and DOWN to set the desired count time.

- ▶ Press  returns to the ready screen
 


GAUGE READY  
 COUNT TIME: # min  
 Depth: ### Offset: N  
 <date> <time>


#### 4 Depth


The Elite gauge is equipped with an automatic non-magnetic depth indicator. The depth is automatically read as you lower the source into the measure position and the appropriate constants are selected to calculate the density.

The gauge can be placed into manual depth mode by disabling the Automatic depth mode from the MENU functions.

#### 5 Soil mode and maximum dry density

▶ Press  and the following is displayed:

▶ Press  for Proctor.

▶ Press 

1. Proctor  
2. Max. Dens  
Select #, ESC to exit

PR: ### PCF  
Change value?  
Press YES or NO  
ESC to Exit



Enter value for  
Proctor: ### PCF  
ENTER to accept  
ESC to Exit

Use the number buttons to change the value. Once you have entered the PR value, the gauge will return to ready screen.

#### 6 Offset

There are three offset options for gauge: density, moisture, and trench.

To use the offset mode:

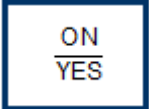
- ▶ Press 
- ▶ Press 
- ▶ Scroll **UP** and **DOWN** to select the offset you want to enable.
- ▶ For entering a negative number, use the **DOWN** button; for a positive number, use the **UP** button.

Note: When an offset is enabled, a **Y** on the gauge ready screen will appear next to the offset.



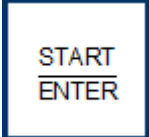
## Operating Instruction N226: Measurement (Soils) CPN MC1 and MC3 Elite

### 1 Set-up

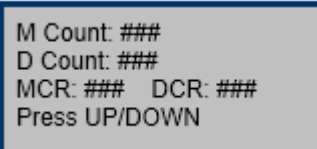
- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

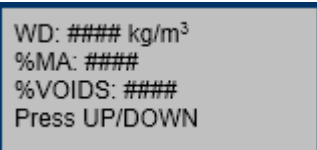
### 2 Measurement

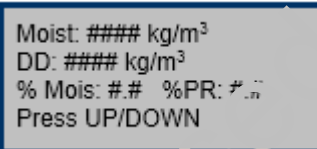
When the ready screen is displayed:

- ▶ Press  and the following is displayed.
- Depth: XX m n  
 Time: XX se :

At the end of the counting period, the gauge will display:

▶ 

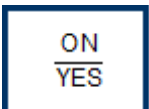
▶ 

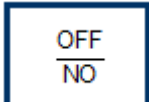
▶ 

Record the following values:

- WD as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- DD as the **dry density** to the nearest 0.001 t/m<sup>3</sup>.
- % PR as the **relative compaction** to the nearest 0.1%.
- Moist as the **moisture content (t/m<sup>3</sup>)** to the nearest 0.001 t/m<sup>3</sup>.
- % Moist as the **moisture content (%)** to the nearest 0.1%.
- M Count as the **moisture count**.
- D Count as the **density count**.

(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

- ▶ Press  and the display will return to the ready screen.

- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N301: Test Parameters (Asphalt) Troxler 3440

### 1 Set-up

- ▶ Press 

|    |
|----|
| ON |
|----|

 and allow the nuclear gauge to complete the self-test routine.

### 2 Units

When <READY> is displayed:

- ▶ Press 

|       |
|-------|
| SHIFT |
| X     |
- ▶ Press 

|         |
|---------|
| SPECIAL |
| 9       |

 and the following is displayed:
 

|                  |
|------------------|
| SPECIAL FUNCTION |
| YES - Next menu  |
| 1 - STAT TEST    |
| 2 - DRIFT TEST   |
- ▶ Press 

|      |
|------|
| YES  |
| EXIT |

 repeatedly until the following is displayed:
 

|                    |
|--------------------|
| YES - Next menu    |
| 9 - SET UNITS      |
| 10 - BAND RATE     |
| 11 - COMM PROTOCOL |
- ▶ Press 

|         |
|---------|
| SPECIAL |
| 9       |

 and the following is displayed:
 

|                   |
|-------------------|
| UNITS in XXX      |
| Press 1 - PCF     |
| 2 - METRIC        |
| ENTER - No change |
- ▶ Press 

|       |
|-------|
| DEPTH |
| 2     |

 and the following is displayed:
 

|                 |
|-----------------|
| UNITS IN METRIC |
|-----------------|

The display will return to <READY>.

### 3 Count time

- ▶ Press 

|      |
|------|
| TIME |
| -    |

 and the following is displayed:
 

|            |
|------------|
| TIME: XX   |
| 1 - 15 sec |
| 2 - 1 min  |
| 3 - 4 min  |
- ▶ Press 

|       |
|-------|
| DEPTH |
| 2     |

 and the following is displayed:
 

|              |
|--------------|
| -COUNT TIME- |
| 1 min        |

The display will return to <READY>.

#### 4 Asphalt mode

▶ Press 

|       |
|-------|
| SHIFT |
| x     |

▶ Press 

|      |
|------|
| MODE |
| 8    |

 and the following is displayed: 

|                                                               |
|---------------------------------------------------------------|
| MODE: XXXX<br>Select: 1 – SOIL<br>2 – ASPHALT<br>(CE to exit) |
|---------------------------------------------------------------|

▶ Press 

|       |
|-------|
| DEPTH |
| 2     |

 and the following is displayed: 

|                                                      |
|------------------------------------------------------|
| ASPHALT: XXXX<br>Select: 1 – % MA<br>2 – 100% - % MA |
|------------------------------------------------------|

▶ Press 

|       |
|-------|
| COUNT |
| 1     |

 and the following is displayed: 

|                                                         |
|---------------------------------------------------------|
| ASPHALT: % MA<br>Do you want to enable %<br>voids also? |
|---------------------------------------------------------|

▶ Press 

|      |
|------|
| YES  |
| EXIT |

 and the following is displayed: 

|                          |
|--------------------------|
| ASPHALT: % MA<br>% VOIDS |
|--------------------------|

or

▶ Press 

|       |
|-------|
| NO/CE |
| C/CE  |

 and the following is displayed: 

|               |
|---------------|
| ASPHALT: % MA |
|---------------|

The display will return to <REALY>.

▶ Press 

|       |
|-------|
| SHIFT |
| x     |

▶ Press 

|      |
|------|
| MODE |
| 8    |

 and the following is displayed: 

|                                                               |
|---------------------------------------------------------------|
| MODE: XXXX<br>Select: 1 – SOIL<br>2 – ASPHALT<br>(CE to exit) |
|---------------------------------------------------------------|

▶ Press 

|       |
|-------|
| DEPTH |
| 2     |

 and the following is displayed: 

|                                                      |
|------------------------------------------------------|
| ASPHALT: XXXX<br>Select: 1 – % MA<br>2 – 100% - % MA |
|------------------------------------------------------|

▶ Press 

|       |
|-------|
| DEPTH |
| 2     |

 and the following is displayed: 

|                                                       |
|-------------------------------------------------------|
| ASPHALT: 100% MA<br>Do you want to enable %<br>voids? |
|-------------------------------------------------------|

▶ Press 

|      |
|------|
| YES  |
| EXIT |

 and the following is displayed: 

|                             |
|-----------------------------|
| ASPHALT: 100% MA<br>% VOIDS |
|-----------------------------|

or

|       |
|-------|
| NO/CE |
| C/CE  |

 and the following is displayed: 

|                  |
|------------------|
| ASPHALT: 100% MA |
|------------------|

The display will return to <READY>.

## 5 Maximum density

▶ Press 

|                      |
|----------------------|
| PROCTOR/<br>MARSHALL |
| +                    |

 and the following is displayed: 

|                                                                            |
|----------------------------------------------------------------------------|
| MA = 1.XX (kg/m <sup>3</sup> )<br>PR = XXX<br>V1 = XX.X<br>Want to change? |
|----------------------------------------------------------------------------|

To retain value, go to 5.1.

To change value, go to 5.2.

### 5.1 Retain the value

▶ Press 

|       |
|-------|
| NO/CE |
| C/CE  |

 to retain the displayed value of MA.

The display will return to <READY>. Go to 6.

### 5.2 Change the value

▶ Press 

|      |
|------|
| YES  |
| EXIT |

 to change the displayed value of MA.

And the following will be displayed:

|              |
|--------------|
| Select:      |
| 1 – MA       |
| 2 – PR       |
| 3 – Voidless |

▶ Press 

|       |
|-------|
| COUNT |
| 1     |

 and the following is displayed: 

|                                     |
|-------------------------------------|
| Select source of<br>Marshall value: |
| 1 – Stored Value                    |
| 2 – New Value                       |

To enter a new value, go to 5.3.

To select a stored value, go to 5.4

### 5.3 Enter a new value

▶ Press 

|       |
|-------|
| DEPTH |
| 2     |

 and the following is displayed: 

|                                                                      |
|----------------------------------------------------------------------|
| Marshall:<br>XXXX kg/m <sup>3</sup><br>Press ENTER<br>when completed |
|----------------------------------------------------------------------|

- ▶ Use the numbered keys to enter the required value to the nearest 1 kg/m<sup>3</sup>.

▶ Press 

|                 |
|-----------------|
| START/<br>ENTER |
| =               |

 and the following is displayed: 

|                                                                                 |
|---------------------------------------------------------------------------------|
| MA = XXXX kg/m <sup>3</sup><br>Do you want to save this<br>value for later use? |
|---------------------------------------------------------------------------------|

If the value is not to be saved:

▶ Press 

|       |
|-------|
| NO/CE |
| C/CE  |

 and the display will return to <READY>. Go to 6.

To save the displayed value:

▶ Press 

|      |
|------|
| YES  |
| EXIT |

 and the following is displayed: 

|                                                           |
|-----------------------------------------------------------|
| Select Marshall<br>Memory Cell:<br>1: XX2:XX<br>3: XX4:XX |
|-----------------------------------------------------------|

- ▶ Press the numbered key (1, 2, 3 or 4) to select a memory cell in which to store the value.

And the following will be displayed:

|                                                                    |
|--------------------------------------------------------------------|
| Marshall<br>XXXX kg/m <sup>3</sup><br>ENABLED!<br>stored in cell X |
|--------------------------------------------------------------------|

The display will return to <READY>. Go to 6.

#### 5.4 Select a stored value

▶ Press 

|        |
|--------|
| COUNTS |
| 1      |

 and the following is displayed: 

|                                                       |
|-------------------------------------------------------|
| Select desired<br>Marshall:<br>1: XX2:XX<br>3: XX4:XX |
|-------------------------------------------------------|

- ▶ Press the numbered key (1, 2, 3 or 4) to select the required value:

And the following will be displayed:

|                                                                    |
|--------------------------------------------------------------------|
| Marshall<br>XXXX kg/m <sup>3</sup><br>ENABLED!<br>stored in cell X |
|--------------------------------------------------------------------|

The display will return to <READY>.

#### 6 Voidless density

▶ Press 

|                      |
|----------------------|
| PROCTOR/<br>MARSHALL |
| +                    |

 and the following is displayed: 

|                                                                          |
|--------------------------------------------------------------------------|
| MA = XXXX kg/m <sup>3</sup><br>PR = XXXX<br>VD = XXXX<br>Want to change? |
|--------------------------------------------------------------------------|

- ▶ Press 

|      |
|------|
| YES  |
| EXIT |

 and the following is displayed: 

|                                             |
|---------------------------------------------|
| SELECT:<br>1 - MA<br>2 - PR<br>3 - VOIDLESS |
|---------------------------------------------|
  
- ▶ Press 

|      |
|------|
| CALC |
| 3    |

 and the following is displayed: 

|                                                                            |
|----------------------------------------------------------------------------|
| Voidless Density<br>XXXX kg/m <sup>3</sup><br>Press enter when<br>complete |
|----------------------------------------------------------------------------|
  
- ▶ Use the numbered keys to enter the required value to the nearest 1 kg/m<sup>3</sup>.
  
- ▶ Press 

|                 |
|-----------------|
| START/<br>ENTER |
| =               |

And the display will return to <READY>.

## 7 Material wet density bias

- ▶ Press 

|        |
|--------|
| OFFSET |
| MR     |

 and the following is displayed: 

|                                                                            |
|----------------------------------------------------------------------------|
| -OFFSET- Select:<br>1 - Dens. -ZZZ-<br>2 - Moist -ZZZ-<br>3 - Trench -ZZZ- |
|----------------------------------------------------------------------------|
  
- ▶ Press 

|        |
|--------|
| COUNTS |
| 1      |

The following will be displayed:

|                                                         |    |                                                         |
|---------------------------------------------------------|----|---------------------------------------------------------|
| Density Offset<br>DISABLED<br>Do you want to<br>ENABLE? | or | Density Offset<br>ENABLED<br>Do you want to<br>DISABLE? |
|---------------------------------------------------------|----|---------------------------------------------------------|

To disable the material wet density bias, go to 7.1.  
To enable the material wet density bias, go to 7.2

### 7.1 Disable material wet density bias

- ▶ Press 

|       |
|-------|
| NO/CE |
| C/CE  |

 to confirm that the density offset is to remain disabled. or 

|      |
|------|
| YES  |
| EXIT |

 to disable the density offset.

And the following will be displayed briefly:

|                            |
|----------------------------|
| Density Offset<br>DISABLED |
|----------------------------|

The display will return to <READY>.

## 7.2 Enable material wet density bias

- ▶ Press 

|      |
|------|
| YES  |
| EXIT |

 to enable the density offset. or 

|       |
|-------|
| NO/CE |
| C/CE  |

 to confirm that the density offset is to remain enabled.

The following will be displayed:

|                                                                  |
|------------------------------------------------------------------|
| -Wet Density-Offset<br>XXXX kg/m <sup>3</sup><br>Want to change? |
|------------------------------------------------------------------|

To retain the value, go to 7.2.1.

To change the value, go to 7.2.2.

### 7.2.1 Retain the value

- ▶ Press 

|       |
|-------|
| NO/CE |
| C/CE  |

 to retain the displayed value of Wet Density Offset.

The following will be displayed briefly:

|                            |
|----------------------------|
| Density Offset<br>ENABLED! |
|----------------------------|

The display will return to <READY>.

### 7.2.2 Change the value

- ▶ Press 

|      |
|------|
| YES  |
| EXIT |

 and the following is displayed:

|                                                   |
|---------------------------------------------------|
| - WD Offset -<br>Select: + or -<br>1 = +<br>2 = - |
|---------------------------------------------------|

- ▶ Press 

|       |
|-------|
| COUNT |
| 1     |

 or 

|       |
|-------|
| DEPTH |
| 2     |

 and the following is displayed:

|                                            |
|--------------------------------------------|
| WD Offset<br>Press enter when<br>completed |
|--------------------------------------------|

- ▶ Use the numbered keys to enter the required value to the nearest 1 kg/m<sup>3</sup>.

- ▶ Press 

|                 |
|-----------------|
| START/<br>ENTER |
| =               |


The following will be displayed:

|                            |
|----------------------------|
| Density Offset<br>ENABLED! |
|----------------------------|

The display will return to <READY>.


## Operating Instruction N302: Measurement (Asphalt) Troxler 3440

### 1 Set-up

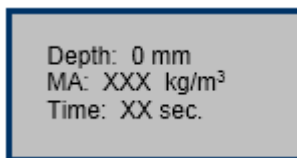
- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

When <READY> is displayed:

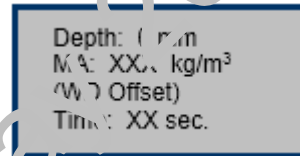
- ▶ Press 

The following will be displayed:



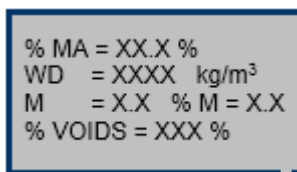
(asphalt density bias labelled)

or



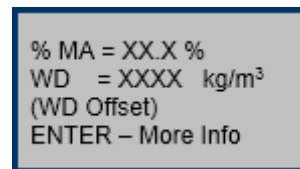
(asphalt density bias enabled)

At the end of the counting period, the following will be displayed:



(asphalt density bias disabled)

or

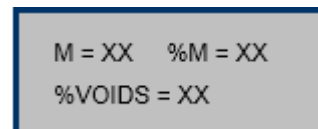


(asphalt density bias enabled)

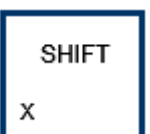
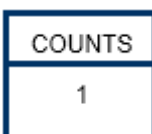
If more information is required:

- ▶ Press 

And following will be displayed:



Record WD as the **wet density**.

- ▶ Press  



And following will be displayed:

Dens ct. = XXXX  
Moist ct. = XX  
SHIFT/RECALL to  
see Readings

Record Dens Ct as the **density count**.

- ▶ Press 

|       |
|-------|
| NO/CE |
| C/CE  |

 and the display will return to <READY>.
  
- ▶ Press 

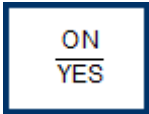
|     |
|-----|
| OFF |
|-----|

 if the nuclear gauge is not required for further use.

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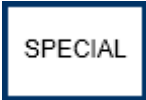



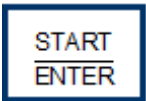
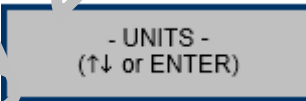

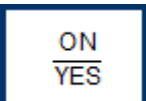
## Operating Instruction N303: Test Parameters (Asphalt) Troxler 3430

### 1 Set-up


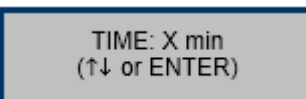

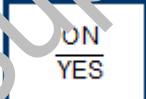
- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Units


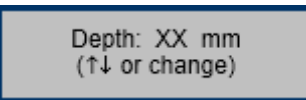

When <READY> is displayed:

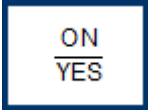
- ▶ Press  and the following is displayed: 
- ▶ Press  repeatedly until the following is displayed: 
- ▶ Press  and the following is displayed: 
- ▶ Press  to set the desired unit.
- ▶ Press  and the display will return to <READY>.

### 3 Count time

- ▶ Press  and the following is displayed: 
- ▶ Press  to set the desired count time.
- ▶ Press  and the display will return to <READY>.

### 4 Depth

- ▶ Press  and the following is displayed: 
- ▶ Press  repeatedly until the required test depth is displayed.

- ▶ Press  and the display will return to <READY>.

## 5 Asphalt mode and maximum density

- ▶ Press  and the following is displayed:

ZZ: XXXX (↑↓)  
Change ZZ value?

- ▶ Press  until "MA" is displayed.

MA: XXXX (↑↓)  
Change MA value?

To retain the displayed value, go to 5.1.  
To change the displayed value, go to 5.2

### 5.1 Retain the value

- ▶ Press  to retain the displayed value.

The display will return to <READY>. Go to 6.


### 5.2 Change the value

- ▶ Press  to change the display value of MA

The following will be displayed:

MA: XXXX  
(↑↓ or ENTER)

For each digit:

- ▶ Press  repeatedly until the required number is displayed.

- ▶ Press  to confirm each number.

The display will return to <READY>.

## 6 Asphalt density bias

- ▶ Press  and the following is displayed:

- RECALL -  
(↑↓ or ENTER)

- ▶ Press  repeatedly until the following is displayed:

- OFFSET -  
(↑↓ or ENTER)

▶ Press  and the following is displayed:

▶ Press

The following will be displayed:

or

To disable the asphalt density, go to 6.1

To enable the asphalt density bias, go to 6.2.

**6.1 Disable asphalt density bias**

▶ Press  to confirm that the density offset is to remain disabled or  to disable the density offset.

The following will be displayed briefly:

The display will return to <READY>. Go to 7.

**6.2 Enable asphalt density bias**

▶ Press  to disable the density offset or  to confirm that the density offset is to remain disabled.

And the following will be displayed:

To retain the display, go to 6.2.1.

To change the display, go to 6.2.2.



**6.2.1 Retain the value**

▶ Press


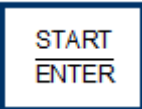
The following will be displayed:

The display will return to <READY>. Go to 7.

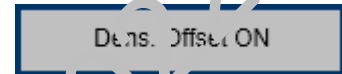
### 6.2.2 Change the value

- ▶ Press  to enter a positive asphalt density bias or  to enter a negative asphalt density bias.

For each digit:


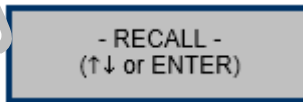

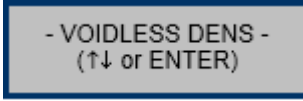

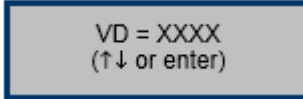
- ▶ Press  until the required number is displayed.
- ▶ Press  to confirm each number.

The following will be displayed briefly:





The display will return to <READY>.

## 7 Asphalt voidless density

- ▶ Press  and the following is displayed: 
- ▶ Press  repeatedly until the following is displayed: 
- ▶ Press  and the following is displayed: 

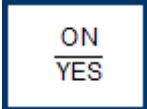
For each digit:

- ▶ Press  until the required number is displayed.
- ▶ Press  to confirm each number.

The display will return to <READY>.

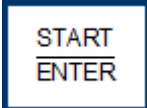
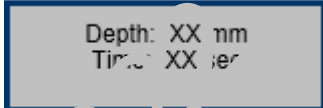
## Operating Instruction N304: Measurement (Asphalt) Troxler 3430

### 1 Set-up


- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

When <READY> is displayed:

- ▶ Press  and the following is displayed: 

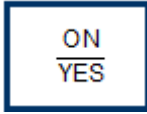
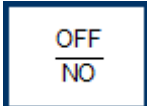
At the end of the counting period:

- ▶ Press  repeatedly until the required values are displayed.

Record the following values as appropriate:


- WD as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- D as the **density count**.

(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)


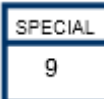
- ▶ Press  and the display will return to <READY>.
- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N307: Test Parameters Troxler 4640B


### 1 Start-up

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.


### 2 Measurement units

- ▶ Press   and the following will be displayed:

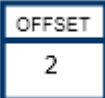
SPECIAL FUNCTION  
YES - next menu  
1 - Surface Velocity  
2 - Recover Erase

- ▶ Press  and the following will be displayed:

Unit in ZZ  
Pres: 1 - IS  
2 - METRIC  
ENTER - no change

- ▶ Press  and the following will be displayed:

Density in kg/m<sup>3</sup>  
Select: 1 - kg/m<sup>3</sup>  
2 - g/cm<sup>3</sup>  
Enter - no change


- ▶ Press  and the following will be displayed:

UNITS - METRIC  
Density in g/cm<sup>3</sup>


(Units of g/cm<sup>3</sup> are equivalent to t/m<sup>3</sup>)

The display will return to <READY>.


### 3 Count time

- ▶ Press  and the following will be displayed:

-Count Time-  
XX min.  
Do you want to change?

- ▶ Press  and the following will be displayed:


Set: 1- 0.5 min.  
2- 1 min.  
3- 2 min.  
4- 3 min.

- ▶ Press  and the following will be displayed:

-Count Time-  
1 minutes!


The display will return to <READY>.

#### 4 Layer thickness

▶ Press  and the following will be displayed:

Layer Thickness:  
 X.XX cm.  
 Input and  
 Press ENTER


▶ Use the numbered keys to enter the layer thickness to the nearest 0.1 cm.  
 (The minimum value that can be set is 2.54 cm).

▶ Press  and the following will be displayed briefly:

Layer Thickness:  
 X.XX cm.

The display will return to <READY>.

#### 5 Marshall and maximum (voidless) density


▶ Press  and the following will be displayed:

MA: X.XXX g/cm<sup>3</sup>  
 VD: X.XXX g/cm<sup>3</sup>  
 Do you want  
 to change?

If MA and VD values of "0.000 g/cm<sup>3</sup>" are displayed:


▶ Press 

If values other than "0.000 g/cm<sup>3</sup>" are displayed:

▶ Press  and the following will be displayed:


MARSHALL  
 X.XXX g/cm<sup>3</sup>  
 Input and  
 Press ENTER

▶ Press 

▶ Press  and the following will be displayed:

VOIDLESS DENSITY  
 X.XXX g/cm<sup>3</sup>  
 Input and  
 Press ENTER

▶ Press 

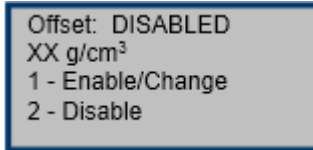
▶ Press  and the display will return to <READY>.



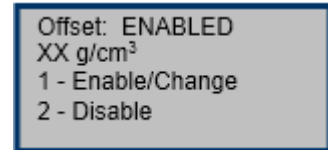
## 6 Asphalt density bias



The following will be displayed:



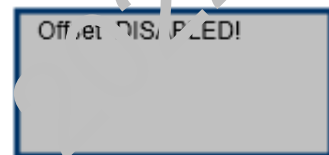
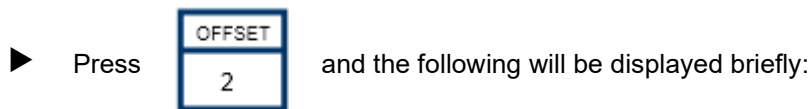
or



To disable the asphalt density bias, go to Step 6.1.

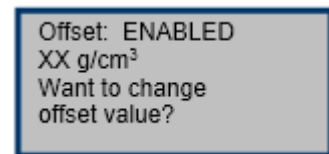
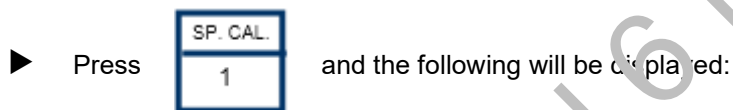
To enable the asphalt density bias, go to Step 6.2.

### 6.1 Disable asphalt density bias



The display will return to <READY>.

### 6.2 Enable asphalt density bias



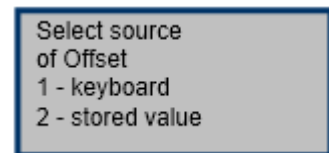
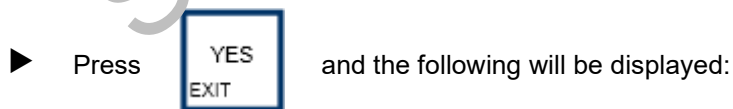
To retain the displayed value, go to Step 6.2.1.

To change the displayed value, go to Step 6.2.2.

#### 6.2.1 Retain the value




#### 6.2.2 Change the value





To enter a new value, go to Step 6.2.2.1.

To select a stored value, go to Step 6.2.2.2.

### 6.2.2.1 Enter a new value

▶ Press  and the following will be displayed:


Offset value:  
--- g/cm<sup>3</sup>  
Select 1 = +  
2 = -

▶ Press  to enter a positive bias. or  to enter a negative bias.

The following will be displayed:

Offset value:  
x --- g/cm<sup>3</sup>  
Input and  
press ENTEF


▶ Use the numbered keys to enter the asphalt density bias to the nearest 0.001 g/cm<sup>3</sup>.

▶ Press  and the following will be displayed:


Offset: ENABLED  
XX g/cm<sup>3</sup>  
Do you want to  
save this value?

**Note:** It is not necessary to save the displayed value to enable it.

**If the value is not to be saved:**

▶ Press  and the display will return to <READY>.


**To save the displayed value:**

▶ Press  and the following will be displayed:

Enter permanent  
Memory location  
to save Offset:  
(1 – 12)? --

▶ Use the numbered keys to enter the memory location.


**Note:** Record the memory location and bias to facilitate subsequent retrieval of saved values.

▶ Press  and the following will be displayed briefly:

Offset: ENABLED  
x XX g/cm<sup>3</sup>  
Saved in memory  
location X

The display will return to <READY>.

### 6.2.2.2 Select a stored value

▶ Press  and the following will be displayed:

Offset: # X -  
XX g/cm<sup>3</sup>  
1 – to select  
2 – for next

▶ Press 

|        |
|--------|
| OFFSET |
| 2      |

 repeatedly until the required memory location and value is displayed.

▶ Press 

|          |
|----------|
| SP. CAL. |
| 1        |

 and the following will be displayed briefly:

|                                         |
|-----------------------------------------|
| Offset: ENABLED<br>XX g/cm <sup>3</sup> |
|-----------------------------------------|

The display will return to <READY>.

▶ Press 


|     |
|-----|
| OFF |
|-----|

 if the nuclear gauge is not required for further use.

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## Operating Instruction N308: Measurement (Asphalt) Troxler 4640B

### 1 Start-up

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

When <READY> is displayed:

- ▶ Press 

The following will be displayed:

```
MA: XXXX g/cm³
Thick: XX.XX cm
Avg: XX
Time: XX secs
```

or

```
MA: XX.XX g/cm³
Thick: XX.XX cm
Avg: XX, Offset
Time: XX secs.
```

(asphalt density bias disabled)

(asphalt density bias enabled)

At the end of the counting period, the following will be displayed:


```
Dens: XXXX kg/m³
%MA: XX.XX%
100-%MA: XXX.XX%
%VOID: X.XX%
```


Record Dens as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.

- ▶ Press   and the following will be displayed:

```
Dens: XXX.X kg/m³
%MA: XX.XX%
%VOID: X.XX%
Cnts XXXX XXXX
```

Record Cnts as the **density count** values for System 1 and System 2.


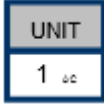
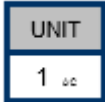
- ▶ Press  and the display will return to <READY>.

- ▶ Press  if the nuclear gauge is not required for further use.







## Operating Instruction N309: Test Parameters (Asphalt) CPN MC3

### 1 Measurement units






*Pre-March 1998 Nuclear Gauge:*

- ▶ Press   simultaneously until the density and moisture display is obtained.
- ▶ Press  until "gcc" is displayed.



*Post-March 1998 Nuclear Gauge:*

- ▶ Press   simultaneously.
- ▶ Press  until "gcc" is displayed.
- ▶ Press 
- ▶ Press  until "Density" is displayed.
- ▶ Press 

### 2 Count time

- ▶ Press    
- ▶ Press 

### 3 Maximum density

- ▶ Press  until "Md" is displayed.
- ▶ Press  and use the numbered keys to enter "0.0"

▶ Press 

|       |
|-------|
| ENTER |
|-------|

#### 4 Asphalt density bias

▶ Press 

|        |
|--------|
| D BIAS |
| 5 .    |

To enter a positive bias:

▶ Press 

|    |
|----|
| ID |
| +  |

 and use the numbered keys to enter the asphalt density bias to the nearest 0.001 t/m<sup>3</sup>.

▶ Press 

|       |
|-------|
| ENTER |
|-------|

To enter a negative bias:

▶ Press 

|    |
|----|
| ID |
| -  |

 and use the numbered keys to enter the asphalt density bias to the nearest 0.001 t/m<sup>3</sup>.

▶ Press 

|       |
|-------|
| ENTER |
|-------|

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## Operating Instruction N310: Measurement (Asphalt) CPN MC3

### 1 Measurement


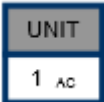
- ▶ Press 

At the end of the counting period, the following will be displayed:


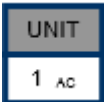
|      |      |         |        |
|------|------|---------|--------|
| RXXX | XXX  | XXX     | XXXX   |
| DaXX |      | ETOX:XX | T0X:XX |
| gcc  | wet  | h2o     | dry    |
| Dn   | XXXX | XXXX    | XXXX   |
| Pr   | XXXX | XXXX    | XXXX   |
| %    |      | XXXX    | XXXX   |
| Md   |      |         | XXXX   |
| Bi   | XXX  | XXX     |        |

Record Dn wet as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.






*Pre-March 1988 Nuclear Gauge:*

- ▶ Press   simultaneously.


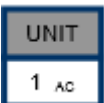
Record Ct wet as the **density count**.




- ▶ Press   simultaneously to return to the density display.

*Post-March 1988 Nuclear Gauge:*

- ▶ Press   simultaneously.
- ▶ Press 
- ▶ Press  repeatedly until "**Counts**" is displayed.
- ▶ Press 

Record CT wet as the **density count**.

- ▶ Press   simultaneously to return to the density display.

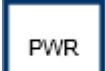
- ▶ Press 
- ▶ Press  repeatedly until "**Density**" is displayed.
- ▶ Press 

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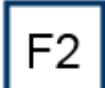
## Operating Instruction N313: Test Parameters (Asphalt) Humboldt 5001EZ

### 1 Start-up

- ▶ Press  and allow the nuclear gauge to complete the initialising routine.

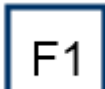
The following will be displayed:

```
*DATA XX/XX/XX
*SETUP XX:XX:XX
*ENGINEERING
 DEPTH=SAF
```

- ▶ Press  and the following will be displayed:


```
*SET UP 2
*SET MEASUREMENT METHOD : F
*SET TRNCH COR.
*SET TARGET?
```

### 2 Measurement units

- ▶ Press  and the following will be displayed:

```
*SET DATE
*SET TIME
*UNITS = PCF/SI
```

- ▶ Press  repeatedly until "SI" flashes.


- ▶ Press  and the display will return to the main menu.

### 3 Count time


- ▶ Press  

The following will be displayed:



```
MEAS =FAST/NORM/SLOW
STD =4MIN/16MIN
TYPE =ASPH/SOIL/THIN
DEPTH =AUTO/MANUAL
```

- ▶ Press  repeatedly until "NORM" flashes.


### 4 Asphalt mode



- ▶ Press  repeatedly until "ASPH" flashes.

## 5 Depth

- ▶ Press  repeatedly until "AUTO" flashes.
- ▶ Press  and the display will return to the main menu.

## 6 Maximum density


- ▶ Press  and the following will be displayed:
 


MAXD =            XXXX  
 \*INCREASE  
 \*DECREASE
- ▶ Press  to decrease the displayed value until a value of 900 kg/m<sup>3</sup> is obtained.
- ▶ Press  and the display will return to the main menu.





## 7 Asphalt density bias

There is no facility to set an asphalt density bias using the keypad.

## 8 Material moisture bias


- ▶ Press  and the following will be displayed:
 

\*SET UP 2  
 \*SET MEASURE MODES  
 \*SET TRENCH COR.  
 \*SET TARGETS
- ▶ Press  and the following will be displayed:
 

MAXD = XXXX      LWD= XXXX  
 KVAL = X.XXX      SPG=X.XXX  
 \*INCREASE  
 \*DECREASE
- ▶ Press  repeatedly until the **KVAL** value flashes.
- ▶ Press  repeatedly until a displayed value of "0.0" is obtained.
- ▶ Press  and the display will return to the main menu.
- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N314: Measurement (Asphalt) Humboldt 5001EZ

### 1 Start-up

- ▶ Press  and allow the nuclear gauge to complete the initialising routine.

### 2 Measurement

- ▶ Press  and the following will be displayed:

```
TAKING MEASUREMENT
TIME REMAINING X:XX
DC = X
MC = X DEPTH=BAC
```

And the end of the counting period, the following will be displayed:



```
MEASURE ASPH RESULTS
WD = XXXX.XX %MA = XXX.X
AC = X.X MAXD = XXXX
*NEXTM DEPTH=BAC
```

Record WD as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.  
(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

- ▶ Press  and the following will be displayed:


```
DC = XXXX.X DS = XXXX.X
MC = XX.X MS = XXX.X
VR = XX.XX %AV = X.XX
*LAST MDEPTH=BAC
```

Record DC as the **density count**.

- ▶ Press  and the display will return to the main menu.
- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N315: Test Parameters (Asphalt) Humboldt 5001C


### 1 Start-up



▶ Press  and allow the nuclear gauge to complete the initialising routine.

▶ Press    simultaneously until the following is displayed:



  


### 2 Asphalt mode

▶ Press  repeatedly until "ASPH" is displayed.



▶ Press  

### 3 Maximum density


▶ Press   and the following will be displayed:



  

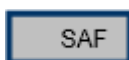


If a value of "0.0" is displayed:

▶ Press   to retain the displayed value.

If a value other than "0.0" is displayed:


▶ Press and hold  and use the numbered keys to enter a value of "0.0"

▶ Press   repeatedly until the following is displayed:


### 4 Asphalt density bias

There is no facility to enter an asphalt density bias using the keypad.



▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N316: Measurement (Asphalt) Humboldt 5001C


### 1 Start-up

- ▶ Press  and allow the nuclear gauge to complete the initialising routine.

### 2 Measurement

- ▶ Press   simultaneously until the following is displayed:




- ▶ Press  and the following will be displayed:



At the end of the counting period, the following will be displayed:




Record the displayed value as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.  
(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

- ▶ Press  and record the displayed value as the **density count**.


- ▶ Press   simultaneously until the following is displayed:





- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N317: Test Parameters (Asphalt) Humboldt 5001P

### 1 Start-up

- ▶ Press  and allow the nuclear gauge to complete the initialising routine.

### 2 Depth

- ▶ Press  or  repeatedly until the required measurement depth is displayed.


### 3 Maximum density

- ▶ Press 

If a value of "0.0" is displayed:

- ▶ Press   to retain the displayed value.

If a value other than "0.0" is displayed:

- ▶ Press and hold  and use the numbered keys to enter a value of "0.0".

- ▶ Press   to retain the displayed value.



### 4 Asphalt density bias

There is no facility to enter the asphalt density bias using the keypad.


### 5 Material moisture bias

- ▶ Press 


If a value of "0.0" is displayed:

- ▶ Press   to retain the displayed value.

If a value other than "0.0" is displayed:

- ▶ Press and hold  and use the numbered keys to enter a value of "0.0".


▶ Press   to store the value.

▶ Press  if the nuclear gauge is not required for further use.


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## Operating Instruction N318: Measurement (Asphalt) Humboldt 5001P

### 1 Start-up

- ▶ Press  and allow the nuclear gauge to stabilise for at least 10 minutes before commencing the test.


### 2 Measurement

- ▶ Press  and the following will be displayed:




At the end of the counting period, the following will be displayed:

Record the displayed value as the **density count**.

- ▶ Press  and record the displayed value as the **wet density** to the nearest 0.01 t/m<sup>3</sup>.

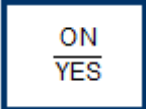
(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

- ▶ Press  if the nuclear gauge is not required for further use.




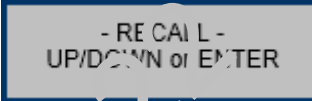

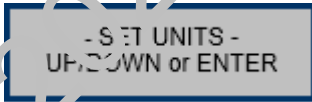
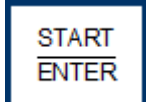
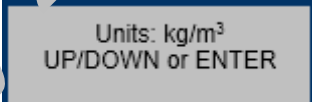

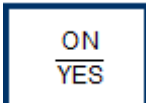
## Operating Instruction N319: Test Parameters (Asphalt) Instrotek Xplorer 3500

### 1 Start-up


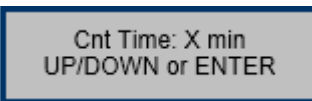

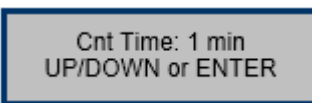
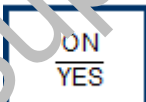
- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Units


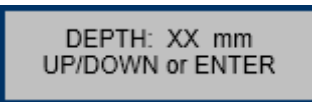

When <READY> is displayed:

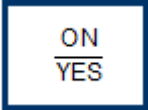
- ▶ Press  and the following is displayed: 
- ▶ Press  repeatedly until the following is displayed: 
- ▶ Press  and the following is displayed: 
- ▶ Press  to set the desired unit.
- ▶ Press  and the display will return to <READY>.

### 3 Count time

- ▶ Press  and the following is displayed: 
- ▶ Press  to set the desired count time. 
- ▶ Press  and the display will return to <READY>.

### 4 Depth

- ▶ Press  the following is displayed: 
- ▶ Press  repeatedly until the required test depth is displayed.

- ▶ Press  and the display will return to <READY>.

## 5 Asphalt mode and maximum density

- ▶ Press  and the following is displayed:

ENTER selects PR  
DOWN selects MA

- ▶ Press  and the following is displayed:

MA: XXXXX  
Change value?

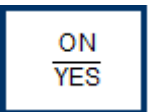
To retain the displayed value, go to 5.1.  
To change the displayed value, go to 5.2

### 5.1 Retain value

- ▶ Press  to retain the displayed value.

The display will return to <READY>. Go to 6.


### 5.2 Change the value

- ▶ Press  to change the displayed value of MA.

The following is displayed:

MA: XXXXX  
UP/DOWN or ENTER

For each digit:

- ▶ Press  repeatedly until the required number is displayed.

- ▶ Press  to confirm each number.

The display will return to <READY>.

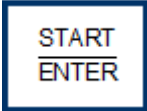
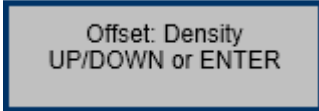

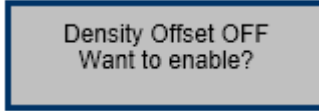

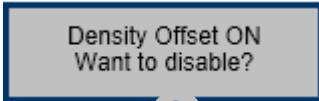
## 6 Material wet density bias

- ▶ Press  and the following is displayed:

- RECALL -  
UP/DOWN or ENTER

- ▶ Press  and the following is displayed:

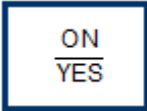
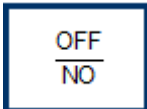
- OFFSET -  
UP/DOWN or ENTER

- ▶ Press  and the following is displayed: 
  - ▶ Press  and the following is displayed: 
- or
- ▶ Press  and the following is displayed: 


To disable the material wet density bias, go to 6.1.

To enable the material wet density bias, go to 6.2.

### 6.1 Disable material wet density bias

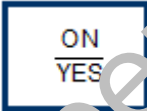
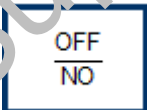
- ▶ Press  to disable the density offset.
- or
- ▶ Press  to confirm that the density offset is to remain disabled.

The following will be displayed:

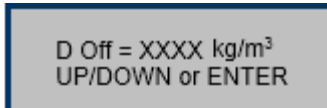


The display will return to <READY>.

### 6.2 Enable material wet density bias

- ▶ Press  to disable the density offset.
- or
- ▶ Press  to confirm that the density offset is to remain enabled.

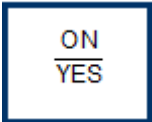
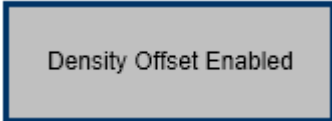
The following will be displayed:



To retain the displayed value, go to 6.2.1.



To change the displayed value, go to 6.2.2.

### 6.2.1 Retain the value


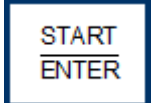
- ▶ Press  and the following will be displayed: 

The display will return to <READY>.

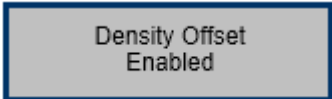
### 6.2.2 Change the value

- ▶ Press  for a positive value.
- or
- ▶ Press  for a negative value.

For each digit:

- ▶ Press  until the required number is displayed.
- ▶ Press  to confirm each number.

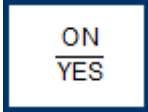
The following will be displayed briefly:



The display will return to <READY>.


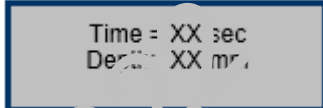
## Operating Instruction N320: Measurement (Asphalt) Instrotek Xplorer 3500

### 1 Start-up


- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

When <READY> is displayed:

- ▶ Press  and the following is displayed: 

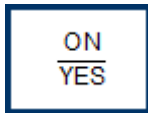
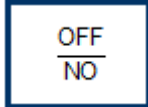
At the end of the counting period:

- ▶ Press  repeatedly until the required values are displayed.

Record the following values as appropriate:

- WD as the **wet density** to the nearest 0.001 t/m<sup>3</sup>
- D Count as the **density count**.

(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

- ▶ Press  and the display will return to <READY>.
- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N321: Test Parameters (Asphalt) Troxler 3440P

### 1 Start up

- ▶ Turn the power switch on and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement units

When <READY> is displayed:

▶ Press

▶ Press

The following will be displayed:

```
- Units -
1 p/f
2 kg/m3
3. g/cm3
```

▶ Press

The following will be displayed briefly:

```
Metric Units
Kg/m3
ENABLED
```

The display will return to <SETUP>.

### 3 Count time

▶ Press

▶ Press  and the following is displayed:

```
TIME: XX
1 - 15 sec
2 - 1 min
3 - 4 min
```

▶ Press

The following will be briefly displayed:

```
COUNT TIME
1 min
```

The display will return to <READY>.

#### 4 Asphalt mode

▶ Press MODE

The following will be displayed:

MODE: XXXX  
 Select: 1 - ASPHALT  
           2 - SOIL  
 Press # to Select

▶ Press 1

The following will be displayed briefly:

Aspha Mode  
 ENABLED

The display will return to <READY>.

#### 5 Material wet density bias

▶ Press OFFSET the following is displayed:

-OFFSET-  
 1 - Dens. -OFF-  
 2 - Moist -OFF-  
 3 - Trench -OFF-

▶ Press 1

The following will be displayed:

Density Offset  
 xx kg/m<sup>3</sup>  
 1. Enable 2. Disable  
 3. Change Offset

To disable the material wet density bias, go to Step 5.1.

To enable the material wet density bias, go to Step 5.2.

To change the material wet density bias, go to Step 5.3.

##### 5.1 Disable material wet density bias

▶ Press 2

The following will be displayed briefly:

Density Offset  
 DISABLED

The display will return to <READY>. Go to 7.

**5.2 Enable material wet density bias**

▶ Press 1

The following will be displayed:

Density Offset  
ENABLED

**5.3 Change material wet density bias**

▶ Press 3 the following is displayed:

Density Offset  
xx kg/m<sup>3</sup>  
Select (+/-)  
Input and [ENTER]

▶ Use the numbered keys to enter the required value to the nearest 1 kg/m<sup>3</sup>.  
(To convert from t/m<sup>3</sup> to kg/m<sup>3</sup>, multiply the material wet density bias by 1000.)

▶ Press ENTER  
START

The following will be displayed briefly:

Density Offset  
ENABLED

The display will return to <READY>.

**6 Material moisture bias**

▶ Press OFFSET the following is displayed:

-OFFSET--Select:  
1 - Dens. -OFF-  
2 - Moist. -OFF-  
3 - Trench -OFF-

▶ Press 2

The following will be displayed:

Moisture Offset  
1. xxxx 2. xxxx  
3. xxxx 4. xxxx  
5. New 6. Disable

**6.1 Disable material moisture bias**

▶ Press 6



The following will be displayed:



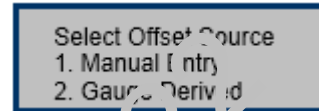
The display will return to <READY>. Go to Step 8.

**6.2 Enable the material moisture bias**

- ▶ Press the number corresponding to any of the stored values.

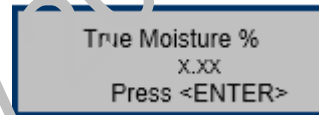
**6.3 Change a material moisture bias value**

- ▶ Press  the following is displayed:



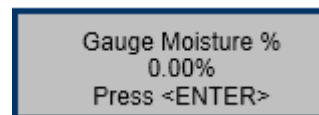
For manual entry:

- ▶ Press  the following is displayed:



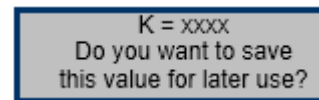
Use the numbered keys to enter the average oven dry moisture content to the nearest 0.01%

- ▶ Press  the following is displayed:



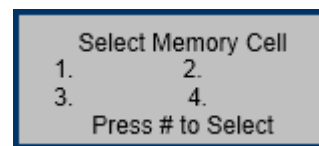
Use the numbered keys to enter the average standard blocks moisture content to the nearest 0.01%.

- ▶ Press  the following is displayed:



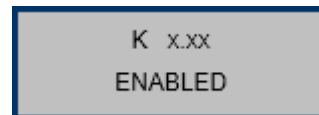
To save the displayed value:

- ▶ Press  the following is displayed:



- ▶ Press a numbered key (1, 2, 3 or 4) to select a memory location in which to save the value.

The following will be displayed briefly:



If the value is not to be displayed:

- ▶ Press

The display will return to <READY>.

**For gauge derived:**

▶ Press  the following is displayed:

True Moisture %  
 x.xx  
 Press <ENTER>

Use the numbered keys to enter the true moisture content to the nearest 0.01%.

▶ Press  the following is displayed:

Place gauge on soil,  
 Lower rod and  
 Press any key

Place the gauge on the measurement site and press any key.

At the completion of the counting period, the following will be displayed:

K: ##.##  
 Save This Value for  
 Later Use

To save the value:

▶ Press

To enable the value without storing:

▶ Press

**7 Trench offset**

▶ Press  the following is displayed:

-OFFSET-  
 1 - Dens. -OFF-  
 2 - Moist. -OFF-  
 3 - Trench -OFF-

▶ Press  the following is displayed:

Trench Offset  
 M: 0 D: 0  
 1. Enable 2. Disable  
 3. Change Offset

To enable the trench offset:

▶ Press

The following is displayed:

Trench Offset  
 ENABLED

To disable the trench offset:

▶ Press

The following is displayed:

Trench Offset  
DISABLED

To change the trench offset:

▶ Press 3

The following is displayed:

Place Gauge in  
trench on Std.  
Block in SAFE Pos.  
Press <START>

▶ Press ENTER  
START

At the end of the counting period, the display will return to <READY>.

▶ Turn the power switch off if the nuclear gauge is not required for further use.

Superseded 6 May 2022


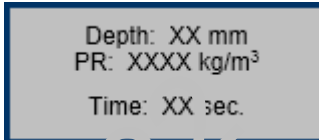
## Operating Instruction N322: Measurement (Asphalt) Troxler 3440P

### 1 Start up

- ▶ Turn the power switch on and allow the nuclear gauge to complete the self-test routine.

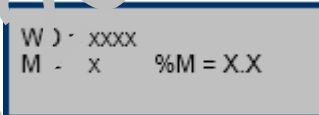
### 2 Measurement

When <READY> is displayed.




- ▶ Press  the following is displayed: 

In the manual depth mode, the gauge will prompt for the source rod depth. In automatic mode, the gauge software reads the depth strip on the source rod to determine the depth.

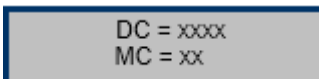
At the end of the counting period, the following will be displayed:



Record WD as the **wet density**:


- ▶ Press 
- ▶ Press 
- ▶ Press 

The following will be displayed:



Record the following values as appropriate:

- DC as the **density count**.
- MC as the **moisture count**.

- ▶ Press  and the display will return to <READY>.
- ▶ Turn the power switch off if the nuclear gauge is not required for further use.

## Operating Instruction N323: Test Parameters (Asphalt) Troxler 3430P

### 1 Start-up

- ▶ Turn the power switch on and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement units

When <READY> is displayed:

- ▶ Press

- ▶ Press

The following will be displayed:

```
- Units -
1.pcf
2.kg/m³
3.g/cm³
```

- ▶ Press

The following will be displayed briefly:

```
Metric Units
Kg/m³
ENABLED
```

The display will return to <SETUP>.

### 3 Count time

- ▶ Press

- ▶ Press

and the following is displayed:

```
TIME: XX
1 - 15 sec
2 - 1 min
3 - 4 min
```

- ▶ Press

And the following will be briefly displayed:

```
COUNT TIME
1 min
```

The display will return to <READY>.

#### 4 Asphalt mode

▶ Press MODE

The following will be displayed:

MODE: XXXX  
 Select: 1 - ASPHALT  
           2 - SOIL  
 Press # to Select

▶ Press 1

The following will be displayed briefly:

Asphalt Mode  
 ENABLED

The display will return to <READY>.

#### 5 Material wet density bias

▶ Press OFFSET the following is displayed.

-OFFSET-  
 1 - Dens. -OFF-  
 2 - Moist -OFF-  
 3 - Trench -OFF-

▶ Press 1

The following will be displayed:

Density Offset  
 xx kg/m<sup>3</sup>  
 1. Enable 2. Disable  
 3. Change Offset

To disable the material wet density bias, go to Step 5.1.

To enable the material wet density bias, go to Step 5.2.

To change the material wet density bias, go to Step 5.3

##### 5.1 Disable material wet density bias

▶ Press 2

The following will be displayed briefly:

Density Offset  
 DISABLED

The display will return to <READY>. Go to 7.

### 5.2 Enable material wet density bias

▶ Press 1

The following will be displayed:

Density Offset  
ENABLED

### 5.3 Change material wet density bias

▶ Press 3 the following will be displayed:

Density Offset  
xx kg/m<sup>3</sup>  
Select (+/-)  
Input and <ENTER>

▶ Use the numbered keys to enter the required value to the nearest 1 kg/m<sup>3</sup>.  
(To convert from t/m<sup>3</sup> to kg/m<sup>3</sup>, multiply the material wet density bias by 1000.)

▶ Press ENTER  
START

The following will be displayed briefly:

Density Offset  
ENABLED

The display will return to <READY>.

## 6 Material moisture bias

▶ Press OFFSET the following will be displayed:

-OFFSET--Select:  
1 - Dens. -OFF-  
2 - Moist. -OFF-  
3 - Trench -OFF-

▶ Press 2

The following will be displayed:

Moisture Offset  
1. xxxx 2. xxxx  
3. xxxx 4. xxxx  
5. New 6. Disable

### 6.1 Disable material moisture bias

▶ Press 6

The following will be displayed:

Moisture Offset  
DISABLED

The display will return to <READY>. Go to Step 8.

**6.2 Enable the material moisture bias**

- ▶ Press the number corresponding to any of the stored values.

**6.3 Change a material moisture bias value**

▶ Press 5 the following will be displayed:

Select Offset Source  
 1. Manual Entry  
 2. Gauge Derived

**For manual entry:**

▶ Press 1 the following will be displayed:

True Moisture %  
 (XX)  
 Press <ENTER>

Use the numbered keys to enter the average oven dry moisture content to the nearest 0.01%.

▶ Press ENTER  
START the following will be displayed:

Gauge Moisture %  
 0.00%  
 Press <ENTER>

Use the numbered keys to enter the average standard blocks moisture content to the nearest 0.01%.

▶ Press ENTER  
START the following will be displayed:

K = xxxx  
 Do you want to save  
 this value for later use ?

To save the displayed value:

▶ Press YES the following will be displayed:

Select Memory Cell  
 1.        2.  
 3.        4.  
 Press # to Select

- ▶ Press a numbered key (1, 2, 3 or 4) to select a memory location in which to save the value.

The following will be displayed briefly:

K x.xx  
 ENABLED

If the value is not to be displayed:

▶ Press NO

The display will return to <READY>.

**For gauge derived:**

▶ Press 2 the following is displayed:

True Moisture %  
 x.xx  
 Press <ENTER>



Use the numbered keys to enter the true moisture content to the nearest 0.01%.

▶ Press ENTER  
START the following is displayed:

Place gauge on soil,  
Lower rod and  
Press any key

Place the gauge on the measurement site and press any key.

At the completion of the counting period, the following will be displayed:

K: ##.##  
Save This Value for  
Later Use ?

To save the value:

▶ Press YES

To enable the value without storing:

▶ Press NO

## 7 Trench offset

▶ Press OFFSET the following is displayed:

-OFFSET-  
1 - Dens. -OFF-  
2 - Moist. -OFF-  
3 - Trench -OFF-

▶ Press 3 the following is displayed:

Trench Offset  
M: 0 D: 0  
1. Enable 2. Disable  
3. Change Offset

To enable the trench offset:

▶ Press 1

The following is displayed:

Trench Offset  
ENABLED

To disable the trench offset:

▶ Press 2

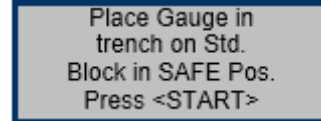
The following is displayed:

Trench Offset  
DISABLED

To change the trench offset:

- ▶ Press 

The following is displayed:



Place Gauge in  
trench on Std.  
Block in SAFE Pos.  
Press <START>

- ▶ Press 

At the end of the counting period, the display will return to <READY>.

- ▶ Turn the power switch off if the nuclear gauge is not required for further use.

Superseded 6 May 2022


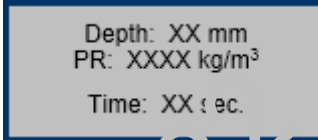
## Operating Instruction N324: Measurement (Asphalt) Troxler 3430P

### 1 Start up

- ▶ Turn the power switch on and allow the nuclear gauge to complete the self-test routine.

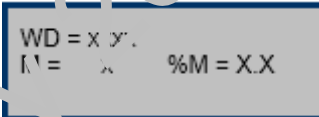
### 2 Measurement

When <READY> is displayed:




- ▶ Press  the following is displayed: 

In the manual depth mode, the gauge will prompt for the source rod depth. In automatic mode, the gauge software reads the depth strip on the source rod to determine the depth.

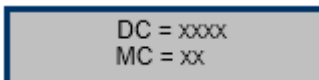
At the end of the counting period, the following will be displayed:



Record WD as the **wet density**:


- ▶ Press 
- ▶ Press 
- ▶ Press 

The following will be displayed:



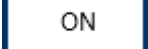
Record the following values as appropriate:

- DC as the **density count**.
- MC as the **moisture count**.

- ▶ Press  and the display will return to <READY>.
- ▶ Turn the power switch off if the nuclear gauge is not required for further use.



## Operating Instruction N325: Test Parameters (Asphalt) Troxler 3450

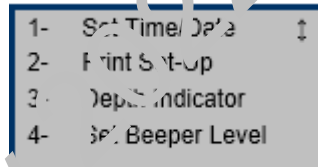
### 1 Set-up

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Units

When <READY> is displayed:

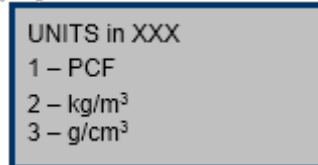
- ▶ Press  and
- ▶ Press  to access the Gauge Setup menu.



1- Set Time/Depth ↑  
2- Print Set-up  
3- Depth Indicator  
4- % Beeper Level

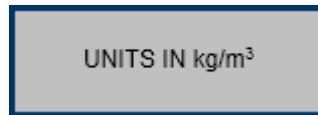
Scroll through the menu using the arrow keys.

- ▶ Press  and the following is displayed:



UNITS in XXX  
1 – PCF  
2 – kg/m<sup>3</sup>  
3 – g/cm<sup>3</sup>


- ▶ Press  and the following is displayed:

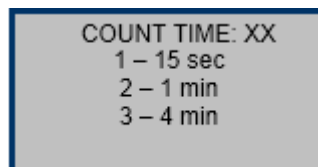


UNITS IN kg/m<sup>3</sup>

The display will return to the Gauge Setup menu.

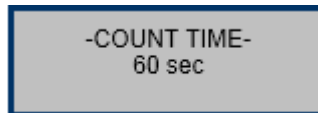
### 3 Count time

- ▶ Press  and the following is displayed:



COUNT TIME: XX  
1 – 15 sec  
2 – 1 min  
3 – 4 min

- ▶ Press  and the following is displayed:



-COUNT TIME-  
60 sec

The display will return to <READY>.

#### 4 Asphalt mode

▶ Press MODE and the following is displayed:

- MODE -

1 – Soil Mode  
2 – Asphalt Mode  
3 – Thin Layer Mode

▶ Press 2

And the following will be displayed briefly:

Asphalt Mode Enabled

The display will return to <READY>.

#### 5 Material wet density bias

▶ Press OFFSET and the following is displayed:

OFF SET Select

1 – Wet Density OFF  
2 – Moisture OFF  
3 – Trench OFF

▶ Press 1

The following will be displayed:

Wet Density Offset:  
xxx kg/m<sup>3</sup>  
1 – Enable    2 – Disable  
3 – Change Offset

To disable the material wet density bias:

▶ Press 2 and the following is displayed:

Wet Density Offset  
DISABLED

To enable the material wet density bias:

▶ Press 1 and the following is displayed:

Wet Density Offset  
ENABLED

### 5.1.1 Change the value

- ▶ Press 3 and the following is displayed: Wet Density Offset  
xxxx kg/m<sup>3</sup>  
Select (+/-)
- ▶ Press + ↑ or - ↓
- ▶ Use the numbered keys to enter the required value to the nearest 1 kg/m<sup>3</sup>.
- ▶ Press ENTER

The following will be displayed:

Density Offset  
ENABLED

The display will return to <READY>.

## 6 Material moisture bias

- ▶ Press OFFSET and the following is displayed: OFFSET Select:  
1 – Wet Density    OFF  
2 – Moisture        OFF  
3 – Trench           OFF
- ▶ Press 2

The following will be displayed:

Moisture Offset:  
K = 0.00  
1 – Enable    2 – Disable  
3 – Change Offset

To disable the moisture offset:

- ▶ Press 2 and the following is displayed: Moisture Offset  
DISABLED

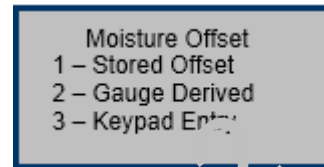
To enable the moisture offset:

- ▶ Press 1 and the following is displayed:



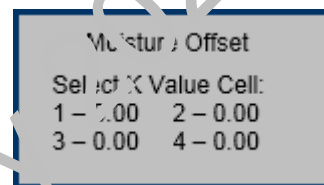
### 6.1.1 Change the value

- ▶ Press 3 and the following is displayed:



To select a stored offset:

- ▶ Press 1 and the following is displayed:



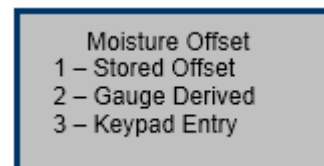
- ▶ Use the numbered keys to enter the required value to the nearest 0.01%.

The display will return to <READY>.

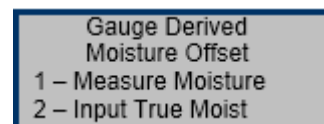
### 6.1.2 Change to a gauge-derived value

To change the moisture bias to a gauge-derived value:

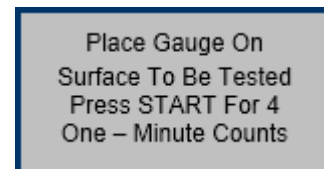
- ▶ Press 3 and the following is displayed:



- ▶ Press 2 and the following is displayed:



- ▶ Press 1 and the following is displayed:



- ▶ Press START

The gauge displays the progress of the measurements. After each reading, the gauge displays the results. To continue to the next measurement:

- ▶ Press START

After the last measurement:

- ▶ Press **ENTER** and the following is displayed:

Moisture Offset  
 1 – Stored Partial  
 Moisture Offset  
 2 – Input True Moist

To enter the true moisture later:

- ▶ Press **1**

To overwrite the partial offset:

- ▶ Press **YES**

To use the stored partial offset:

- ▶ Press **NO**

To enter the true moisture now:

- ▶ Press **2** and the following is displayed:

Input True Moisture  
 xxxxx %  
 ENTER When Done

## 7 Trench offset

- ▶ Press **OFFSET** and the following is displayed:

OFFSET Select:  
 1 – Wet Density OFF  
 2 – Moisture OFF  
 3 – Trench OFF

- ▶ Press **3** and the following is displayed:

Trench: TMO = xxx  
 TDO = xxx xxx  
 1 – Enable 2 - Disable  
 3 – Change Offset

To disable the trench offset:

- ▶ Press **2** and the following is displayed:

Trench Offset  
 DISABLED



To enable the trench offset:

- ▶ Press  and the following is displayed:

Trench Offset  
ENABLED

To create a new trench offset:

- ▶ Press  and the following is displayed:

Set Rod To STD Pos  
Press START For  
1 Minute STD Count  
In Trench

Position the gauge inside the trench and:

- ▶ Press

The gauge will display the progress of the standard count operation.

After the standard count the gauge displays:

New Trench Offset  
TMO = xxxx  
TDO = xxxx  
Want To Accept?

To enable the new trench offset:

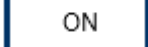
- ▶ Press

To create another trench offset:

- ▶ Press

## Operating Instruction N326: Measurement (Asphalt) Troxler 3450

### 1 Set-up

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

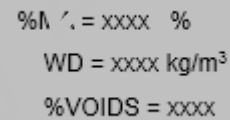
When <READY> is displayed:

- ▶ Press 

In the manual depth mode, the gauge will prompt for the source rod depth.

In the automatic depth mode, the gauge software reads the depth strip on the source rod to determine the source rod depth.

At the end of the counting period, the following will be displayed:



```

%MA = xxxx %
WD = xxxx kg/m³
%VOIDS = xxxx

```

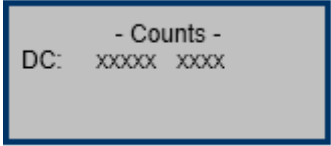
Record the following values:

- %MA as the **percent Marshall** to the nearest 0.1%.
- WD as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- %VOIDS = 100 x 1-WD/VOIDLESS (when enabled).

(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

- ▶ Press 

And the following will be displayed:



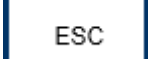

```

- Counts -
DC: xxxxx xxxxx

```

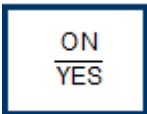
Record the following values as appropriate:

- DC for system 2 (upper right reading) as the **density count**.


- ▶ Press  and the display will return to <READY>.
- ▶ Press  if the nuclear gauge is not required for further use.

## Operating Instruction N327: Test Parameters (Asphalt) CPN MC1 and MC3 Elite


### 1 Set-up

- ▶ Press  and allow the nuclear gauge to complete the self-test routine.


### 2 Units

- ▶ Press  the first screen will be:
 

1. Recall  
 2. Set depth  
 UP/DOWN for next  
 Select #, ESC exit

- ▶ Press  the following is displayed:
 


11. Auto scroll  
 12. Set units  
 UP/DOWN for next  
 Select #, ESC exit

- ▶ Press  (button 1, then 2)
 

1. PCF  
 2. kg/m<sup>3</sup>  
 3. GCC  
 Select #, ESC exit


- ▶ After selecting the unit of measurement, the gauge returns to the menu screen.

11. Auto scroll  
 12. Set units  
 UP/DOWN for next  
 Select #, ESC exit

- ▶ Press  returns to ready screen
 


GAUGE READY  
 COUNT TIME: # min  
 Depth: ### Offset: N  
 <date> <time>

### 3 Count time

- ▶ Press  and the following is displayed:
 

Cnt Time: ## min.  
 UP/DOWN TO CHANGE  
 YES to Accept  
 ESC to Exit

- ▶ Press UP and DOWN to set the desired count time.

- ▶ Press  returns to ready screen
 

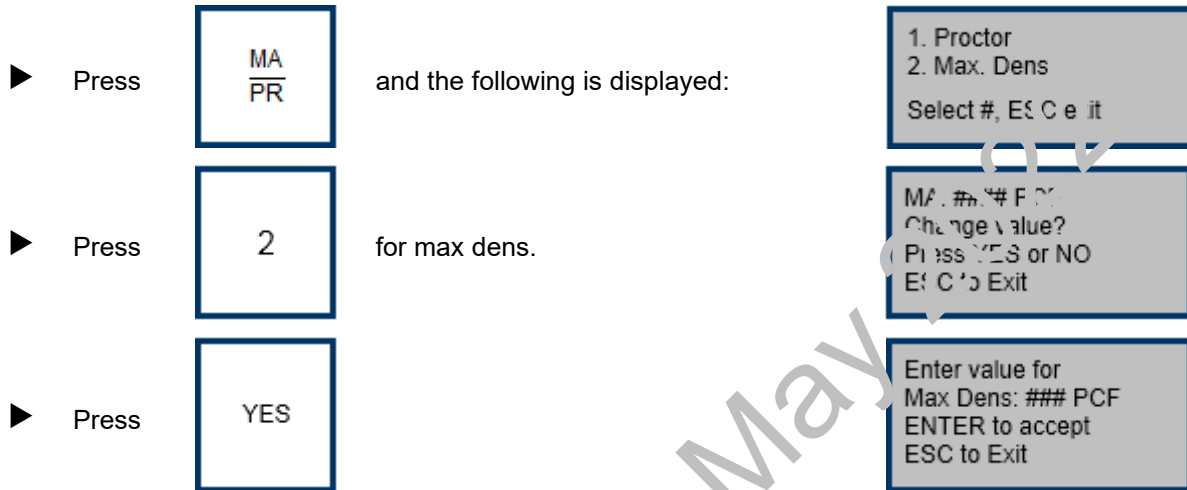
GAUGE READY  
 COUNT TIME: # min  
 Depth: ### Offset: N  
 <date> <time>

#### 4 Depth

The Elite gauge is equipped with an automatic non-magnetic depth indicator. The depth is automatically read as you lower the source into the measure position and the appropriate constraints are selected to calculate the density.

The gauge can be placed into manual depth mode by disabling the automatic depth mode from the MENU functions.

#### 5 Asphalt mode and maximum density

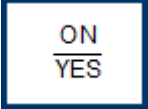


Use the number buttons to change the value. Once you have entered the PR value, the gauge will return to ready screen.

Superseded 6 May 2016

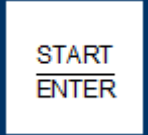
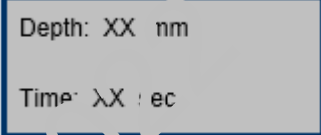
## Operating Instruction N328: Measurement (Asphalt) CPN MC1 and MC3 Elite

### 1 Set-up

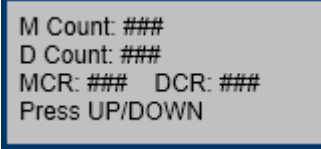

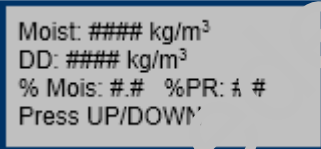
- ▶ Press  and allow the nuclear gauge to complete the self-test routine.

### 2 Measurement

When the ready screen is displayed:

- ▶ Press  and the following is displayed:
- 

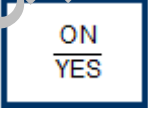
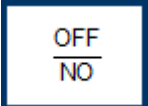
At the end of the counting period, the gauge will display:

- ▶ 
- ▶ 
- ▶ 

Record the following values:

- WD as the **wet density** to the nearest 0.001 t/m<sup>3</sup>.
- D Count as the **density count**.

(To convert from kg/m<sup>3</sup> to t/m<sup>3</sup>, divide the displayed value by 1000.)

- ▶ Press  and the display will return to the ready screen.
- ▶ Press  if the nuclear gauge is not required for further use.