FUNCTION CHECK OF A NUCLEAR DENSITY/MOISTURE GAUGE

1. SCOPE

This test sets out the gauge function check procedure for a nuclear density/moisture gauge.

2. APPARATUS

(a) Nuclear density/moisture gauge - complete with manufacturer's handbook.

(b) Radiation monitoring film badges.

(c) Log book

(d) Reference block

(e) Radiation warning sign

(f) Broom or brush

(g) VicRoads Nuclear Gauge Safety Manual

(h) Worksheet

3. SAFETY

The radioactive sources in the nuclear gauge are of low activity but they are sufficiently radioactive to constitute a significant health hazard unless adequately shielded and properly handled. The procedures listed in the VicRoads Nuclear Gauge Safety Manual must be followed strictly.

4. PROCEDURE

(a) Place the reference standard block on a dry, flat surface at least two metres away from any building or other large structure and at least ten metres from any other radioactive source. The surface can be asphalt or concrete paving, crushed rock or similar material with moisture content not more than 0.24 t/m^3. For consistency of reading, these checks should be performed at the same location, where possible, each time they are made.

(b) Clean the surface of the reference block and correctly position the gauge on the reference block.

(c) Perform a standard count check in accordance with AS 1289.5.8.1, or AS 1289.5.8.4, as appropriate.

(d) The following tests are made with the gauge on the manufacturer's reference block, the source in the safe position, and in accordance with the procedure specified by the gauge manufacturer. Count times are nominated at each appropriate step.

(e) For gauges that provide a test for statistical stability:

    (i) Commence a stability test and record the start time.

    (ii) On completion of the readings, record the mean count and stability ratio for each density and moisture system.

    (iii) If required, view and record the individual count data.

    (iv) Proceed to Step (g).

(f) For other gauges:

    (i) Obtain and record a series of 20 one-minute density counts and moisture counts, and record the start time.

    (ii) Calculate the mean (C) and standard deviation (S_C) of the density counts, and the mean (P) and standard deviation (S_P) of the moisture counts.

    (iii) Calculate the density and moisture Stability Ratios, as follows:

$$\text{Density Stability Ratio} = S_C / \sqrt{C}$$

$$\text{Moisture Stability Ratio} = S_P / \sqrt{P}$$

(g) Compare the stability ratios obtained at either step (e) or (f) to the values given in Table 1. If either Stability Ratio indicates the gauge is unstable or of questionable stability, repeat steps (d) to (f) as appropriate. If the

stability ratios do not indicate the gauge is stable, the gauge shall be withdrawn from service until the reason for the fault is determined and the fault rectified.

(h) Leave the gauge switched on for three hours since commencing the stability test, and then proceed to Step (i) or (j), as appropriate. Note that the drift test described below is not appropriate for gauges that will not remain switched on for three hours when the keypad is not used.

(i) For gauges that provide a test for electronic drift :

  (i) Commence a drift test three hours after commencing the stability test, and record the start time.

  (ii) On completion of the readings, record the mean count and drift percentage for each density and moisture system.

  (iii) If required, view and record the four-minute count data.

  (iv) Proceed to Step (k).

(j) For other gauges that do not turn off automatically after a set period, carry out the drift test as follows:

  (i) Obtain a series of 5 four-minute density standard counts and moisture standard counts, and record the start time.

  (ii) Calculate the mean of the standard density counts (D), and the mean of the standard moisture counts (Q).

  (iii) Calculate the density and moisture drifts, as follows :

$$\text{Density Drift} = \frac{100(C - D)}{\frac{C + D}{2}}$$

$$\text{Moisture Drift} = \frac{100(P - Q)}{\frac{P + Q}{2}}$$

(k) If the density drift is more than ± 0.5% or the moisture drift is more than ±1 %. repeat steps (i) or (j) so that all readings are completed within four hours of commencing the stability test. If the drift for either density or moisture is outside the limits, the gauge shall be withdrawn from service until the reason for the fault is determined and the fault rectified.

(l) Two gauge models (Troxler 3401/3411-B) provide a test for the oscillator and time base circuits of the scaler module. With the TEST/MEAS switch on TEST and the source in the SAFE position a count of 8192 for Troxler 3401 gauges and 14646 for Troxler 3411-B gauges should be obtained for both mositure and density registers for each of the FAST, NORMAL or SLOW time periods.

TABLE 1 is included on Page 3

TABLE 1 STABILITY RATIO LIMITS FOR DENSITY AND MOISTURE

Prescale Factor (Notes A,B,C)	1	8	16	16
Gauge	CPN MC-2 CPN MC-3	Troxler 4640-B Troxler 3450 (note D)	Troxler 3440 Troxler 3430 Troxler 3411 Troxler 3401 (note D)	Humboldt 5001C Humbolt 5001P Humbolt 5001 EZ Humbolt 5001B
Target value	1.0	0.35	0.25	1.0
Stable	0.75 — 1.25	0.25 — 0.45	0.18 — 0.35	0.60 — 1.40
Question	0.60 — < 0.75 or > 1.25 — 1.40	0.20 — < 0.25 or > 0.45 — 0.50	0.12 — < 0.18 or > 0.35 — 0.40	0.50 — < 0.60 or > 1.40 — 1.5
Unstable	less than 0.60, greater than 1.40	less than 0.20, greater than 0.50	less than 0.12, greater than 0.40	less than 0.50, greater than 1.50

NOTES:

NOTE A:

Very many units of the nuclear decay products are counted by the detectors in nuclear gauges.   Most gauges divide the actual counts by a factor, known as the gauge prescale factor, prior to displaying a count rate reading.

NOTE B:

The value of prescale is found in the manufacturer's handbook, in the section on statistical stability test.

NOTE C:

The target value and limits for the ratio of the standard deviation of the displayed counts to the predicted standard deviation from the mean count are often not centred on 1.0. CPN gauges display the actual counts and the target value, including the "chi-squared distribution" value, is 1.0. Troxler gauges have a prescale of either 8 or 16 applied to the actual counts and the target value is either 0.35 or 0.25, respectively. Humbolt gauges have a prescale of 16 applied to the actual counts, however the stability ratios are computed as if the prescale factor was not applied, so the target value is 1.0.

NOTE D:

For gauge models where the test result is calculated by the gauge microprocessor, the gauge displays "PASS" for stability ratio values within the stable range, and displays "FAIL" for all other values of stability ratio.