# METHODS OF SAMPLING AND TESTING
# MT 313-04
# PROCEDURE FOR COMPARING NUCLEAR GAUGES TO CORE DENSITIES OF BITUMINOUS PAVING MIXTURES

## 1 Scope:

**1.1** This is a mandatory statewide procedure for comparing density determined by the nuclear gauge with the density of a bituminous core for each lift of plant mix.

## 2 Apparatus:

**2.1** *A motor driven core machine* - capable of obtaining a 10.16 cm (4 inch) diameter core the full depth of the bituminous paving mixture.

**2.2** *A nuclear density device* - capable of giving results to the 1 kg/m$^3$ (0.1 lb./ft.$^3$).

**2.3** *Hot plate* - capable of obtaining a temperature above the melting point of paraffin. (Conventional hot plate is sufficient.)

**2.4** *Balance* - sensitive to 0.5 g or less.

**2.5** *Wire basket* - constructed to hold the test specimen while being weighed in water.

**2.6** *A container* - with overflow device for immersing the wire basket in water and maintaining a constant water level.

**2.7** An apparatus for suspending the wire basket from the center of the scale pan of the balance.

**2.8** *Thermometer* - for maintaining the water temperature at 77ºF ± 2ºF (25ºC ± 1ºC).

## 3 Test Procedure:

**3.1** A 100 meter (300 foot long) section (the width of the paver) of the bituminous material will be selected. SEVEN to TEN test sites will be selected at random from this 100 meter (300 foot) section. (See MT 606 for random sampling procedure.) The exact test locations will be recorded on a work sheet.

**3.2** The statistical stability of the nuclear gauge shall be determined prior to making density comparisons (refer to the manufacturer's recommended procedure or see MT-212).

**3.3** Prior to making a gauge-core comparison, a standard count must be taken with the standard count block placed on the material to be tested. (Refer to the manufacturer's recommended procedure.) This standard count must be validated (see MT-212, 3.4.5).

**3.4** Sand native to the material being tested will be used for seating. This sand will be minus No. 30 sieve material oven dried to a constant weight. Enough seating sand should be used to fill all the voids between the nuclear gauge and the bituminous mixture. Care must be exercise not to use too much seating sand as excess sand can influence the density readings.

**3.5** The procedure for gauge operation will be according to MT-212. Four one-minute tests at 90□ intervals will be taken and the results averaged. After the rotation, check the source rod to ensure it is positively indexed in the backscatter position. The testing pattern will be as illustrated in Fig. 1.

**3 Test Procedure: (continued)**

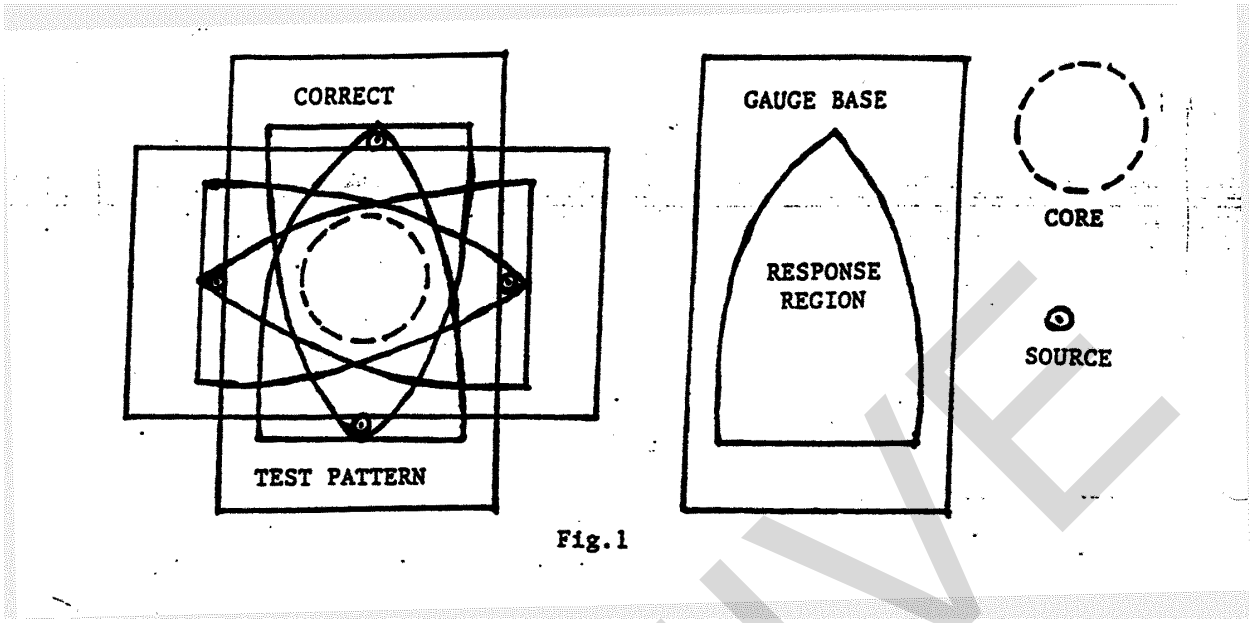


Fig.1

**3.6** A bituminous core will be removed from the center of the imprint left by the nuclear gauge as indicated above.

**3.7** The bulk specific gravity will be determined according to MT-314 Method A or Method B. Note: If the percent water absorbed by the specimen exceeds 2 percent as calculated in MT-314, Section 7.2 use Method A only. Record the result to 1kg/m$^3$ (0.1 lb./ft.$^3$).

For determination of the bulk specific gravity of the top lift, the core has to be split on the meet line and the top lift used for determining the bulk specific gravity.

**3.8** All information shall be recorded on the work sheets and a copy sent to the Materials Bureau.

**3.9** The cores will be retained in the district or area laboratory until completion of the paving project.

**4 Computations and Interpretation of Results:**

**4.1** The correlation is determined as follows:

**4.1.1** Average the four nuclear tests at each test site, round to 1 kg/m$^3$ (0.1 lb./ft.$^3$), and record.

**4.1.2** Subtract the nuclear test average from the core density determined at that site and record the difference to 1 kg/m$^3$ (0.1 lb./ft.$^3$).

**4.1.3** Average the differences being careful to include the algebraic sign (+ or -) of each difference. Record to the nearest 1 kg/m$^3$ (0.1 lb./ft.$^3$).

**4.1.4** If the average difference is positive, add that amount to all wet density readings; if the difference is negative, subtract the average difference from all wet density readings. DO NOT ADJUST THE MARSHALL DENSITY. Negative correlations need not be regarded with suspicion unless the gauge density exceeds core density by more than 32 kg/m$^3$ (2.0 lb./ft.$^3$). Consult the Materials Bureau in this case.

**4.2 Example:**

A Troxler Model 3411-B Or 3440 nuclear gauge is to be correlated. As Indicated In Part 3.5, Correlate Only In The Backscatter Position.

| Test Number | Core Density lb./ft.$^3$ | Core Density kg/m$^3$ | Backscatter Density Average lb./ft.$^3$ | Backscatter Density Average kg/m$^3$ | Difference lb./ft.$^3$ | Difference kg/m$^3$ |
|---|---|---|---|---|---|---|
| 1 | 144.6 | 2316 | 142.0 | 2275 | 2.6 | 42 |
| 2 | 145.0 | 2323 | 143.6 | 2300 | 1.4 | 22 |
| 3 | 141.9 | 2373 | 139.9 | 2241 | 2.0 | 32 |
| 4 | 142.7 | 2286 | 140.1 | 2244 | 2.6 | 42 |
| 5 | 144.6 | 2316 | 138.5 | 2219 | 6.1 | 98 |
| 6 | 144.0 | 2307 | 143.6 | 2300 | 0.4 | 6 |
| 7 | 142.2 | 2278 | 141.3 | 2263 | 0.9 | 14 |
| 8 | 143.3 | 2295 | 140.8 | 2255 | 2.5 | 40 |
| | | | | | 8/18.5 | 8/296 |
| | | | | | = 2.31 | = 37 |

Thus 36 kg/m$^3$ (2.3 lb./ft.$^3$) will be added to each wet density reading on this lift.

*Note - The 97 kg/m$^2$ (6.1 lb./ft.$^3$) difference in test number 5 is NOT discarded since the technician had no reason to suspect a problem with the gauge reading or the core density.*

**IMPORTANT:** The correlation factor should be less than 80 kg/m$^3$ (5 lb./ft.$^3$). When the correlation is greater than or equal to five PCF, the following should be checked:

**4.2.1** Possible error in core or gauge procedure, especially gauge seating and standard count.

**4.2.2** Possible defect in nuclear gauge - recheck standard count and statistical stability.

**4.2.3** Possible error in equipment or procedure that was used for core density determination. Possible core damage.

**4.2.4** Possible thin-lift effects. Refer to Materials Manual Procedure MT-212, item 9, on thin lift corrections. Thin lift adjustments must not be made on plant mix acceptance tests without first consulting the Materials Bureau.

***Note - CORRECTIONS OF MORE THAN 80 kg/m$^3$ (5 lb./ft.$^3$) MUST BE APPROVED BY THE MATERIALS BUREAU.***