# METHODS OF SAMPLING AND TESTING
# MT 219-19
# METHOD OF TEST FOR CONTROLLING COMPACTION USING A CONTROL-STRIP TEST SECTION WITH NUCLEAR GAUGES
# (*Montana Test Method)*

## 1 Scope

1.1 This test method is intended to control the density of compacted courses of embankment and borrow containing oversized particles and/or recycled asphalt pavement (RAP), pulverized bituminous surfacing, and cold recycled bituminous surfacing using nuclear gauges. Density control is performed in place after compaction. Cold recycled bituminous surfacing may be produced in-place or off-site in a central plant.

## 2 Referenced Documents

***MT Materials Manual***
MT 212 Determination of Moisture and Density of In-Place Materials
MT 230 Moisture-Density Relations of Soils using a 10 lb. Rammer
MT 321 Determining Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures – "Rice Gravity

## 3 Definitions

3.1 *Control-Strip A - Embankment, Borrow, or Pulverized Bituminous Surfacing* – A section approximately three hundred (300) feet long by the typical section width of two lanes on a firm sub-grade.

3.2 *Control-Strip B - Cold Recycled Bituminous Surfacing* – A section approximately three hundred (300) feet long by one paver width on a firmly compacted base.

3.3 *Test Section - Embankment, Borrow, or Pulverized Bituminous Surfacing* - Individual sections each approximately two thousand (2000) feet long, as constructed, on which the surfacing aggregates will be placed, using the same layer thickness, compaction watering, and procedures used in constructing the Control-Strip A above.

3.4 *Test Section - Cold Recycled Bituminous Surfacing* – Individual sections each approximately two thousand (2000) feet long by one paver width on which Cold Recycled Bituminous Surfacing will be placed, using the same layer thickness, compaction and procedure used in construction the Control-Strip B above.

3.5 *Constant Mass* – Constant mass has been reached when there is less than a 0.1 percent change in mass after additional drying time: for an oven at 110 ± 5° C (230 ± 9° F), an additional 30 minutes of drying; for an uncontrolled heating source such as hot plates, an additional 20 minutes of drying; or for microwaves, an additional 10 minutes of drying.

## 4 Apparatus

4.1 *Nuclear moisture/density gauge* containing radioactive sources, electronics and rechargeable batteries

4.2 *Standard Count Reference Block*

4.3 *AC Charger 115v/60Hz and DC Adapter 12v negative ground*

4.4 *Transport case* designed and labeled for each specific gauge

4.5 *Scraper Plate/Drill Rod Guide*

4.6 *Drill Rod and Drill Rod Extractor*

4.7 *Nuclear Gauge Operators Manual and Gauge Booklet*

## 5 Operational Procedures

5.1 *Control-Strip A - Embankment, Borrow, or Pulverized Bituminous Surfacing*

At the beginning of compaction operations, the density requirements shall be determined by compacting a Control-Strip of an approved thickness. The procedure MT 230 (Proctor Test) establishes the dry density for aggregates being used in the Control-Strip (Note 1).

*Note 1 – The moisture and density of the Control-Strip will be determined by approved nuclear equipment under field conditions.*

*5.1.1* After each application of the roller, wet density and moisture determinations are made with the nuclear device at a minimum of three (3) random locations. Density and moisture determinations for aggregate surfacing are to be taken at the appropriate depth relative to lift thickness using the "direct transmission" option with the nuclear gauge. These locations may be marked with a small quantity of minus 30 mesh dry sand - the finer the better. This sand should be screened from the material that is being compacted and dried to constant mass. This sand serves to identify each test location and is an aid for seating the nuclear device to preclude air voids between the bottom surface of the probe and the coarser aggregate particles that may be extruding above the surface of the lift. To avoid any errors in reading due to the build-up of sand beneath the nuclear device, approximately the same quantity of sand is used at each of the three test locations. The test locations are marked so that the same locations are tested after each pass.

*5.1.2* An average dry density is computed and plotted on a chart of dry density versus the number of roller passes. Rolling is discontinued when the curve plotted for dry density versus roller passes levels off. When the density plot levels off, density and moisture readings are taken at seven additional locations. Ten test sites in the 300 feet long Control-Strip are calculated to yield satisfactory statistical results. The average dry density is computed from the ten sets of readings and this serves as the standard of compaction. A new Control-Strip is required when the aggregate characteristics change appreciably, the aggregate is produced from a different source, or there has been a change in the rolling equipment or procedures used. Each new lift will require a new Control-Strip to determine if there is any change in Control-Strip density. If a different nuclear device is used, a new Control-Strip might have to be established.

5.2 *Test Sections for Embankment, Borrow, or Pulverized Bituminous Surfacing*

The remainder of the project is divided into Test Sections as described above in Section 3.3. After placing and compacting a lift of surfacing aggregate, employing the same thickness and procedures used in the Control-Strip, moisture and density readings are taken at ten randomly selected locations. Dry density determinations are made for each set of readings.

*5.2.1* Whenever the minimum density results are not met, immediate corrective action must be taken by additional rolling or additional water and rolling. The densities of the completed Test Sections must be determined without delay for applicable comparison (under the same conditions) with the Control-Strip density (Note 2). Similarly, proper use of the most suitable roller can decrease time in attaining proper density in the Test Section. The contractor should be encouraged to use various methods in establishing density in the Control-Strip.

*Note 2 – (Not a specification requirement) The effective use of water and the method used in compacting the Control-Strip can influence the time and the compactive effort required to attain satisfactory density. Appropriate compaction equipment for the material should be used at all times.*

5.3 *Control-Strip B - Cold Recycled Bituminous Surfacing*

All roller equipment will be approved by the engineer prior to the construction of the Control-Strip as specified in the Standard Specification. Whenever a Control-Strip is required on cold recycled bituminous surfacing a comparison will be made between the established Control-Strip density

and the Maximum Mixture Specific Gravity (Rice Gravity) as determined by MT 321. This should be done to ensure a reasonable Control-Strip density is established and is in line with the specified compaction percentage.

*5.3.1* Three test sites will be randomly selected on the Control-Strip. Each site will be marked with minus 30 mesh dry seating sand used to seat the nuclear gauge. This sand should be screened from the material that is being compacted and dried to constant mass. Compaction of the Control-Strip shall commence as soon as possible after cold recycling of the mixture and be uniform over the entire Control-Strip. A test will be taken on each test site with a nuclear gauge after each pass of the compaction equipment. Density determinations for cold recycled bituminous surfacing are to be taken using the "backscatter" option with the nuclear gauge. When testing cold recycled bituminous surfacing in backscatter mode, consult the nuclear gauge operator's manual to determine if "Asphalt mode" should be enabled.

*5.3.2* This procedure will continue until the density increase is less than one (1) pound per cubic foot. After completion of the rolling, then two more tests sites are established so that a total of five density tests are averaged for the Control-Strip density.

*5.3.3* Each new lift will require a new Control-Strip to determine if there is any change in Control-Strip density. If a different nuclear device is used, a new Control-Strip must be established.

5.4 *Test Sections for Cold Recycled Bituminous Surfacing*

The remainder of the project is divided into 2000 ft. Test Sections. After placing and compacting a lift of cold recycled bituminous surfacing, employing the same thickness and procedures used in the Control-Strip, density readings are taken at five randomly selected locations. The average density of each Test Section will be evaluated based upon the results of five tests in each Test Section. Whenever the minimum density results are not met, immediate corrective action must be taken by additional rolling or re-recycling. The densities of the completed Test Sections must be determined without delay for applicable comparison (under the same conditions) with the Control-Strip density.

## 6 Form and Report

6.1 Use form MDT-CON-203-03-3 (Embankment and Excavation Compaction – Summary of Test Data) controlling the compaction of surfacing aggregates. This form may also be used for Control-Strip paving.

6.2 Lab. Form No. 1006-A, Summary of Compaction Data for Surfacing, is applicable for all types of nuclear devices. It is requested that the serial number of the device being used and the Laboratory Number of each pit, be entered on this form.