

METHODS OF SAMPLING AND TESTING
MT 219-04
METHOD OF TEST FOR
CONTROLLING THE COMPACTION OF SURFACING AGGREGATES AND PLANT MIX PAVING
USING A CONTROL-STRIP TEST-SECTION TECHNIQUE WITH NUCLEAR GAUGES
(Montana Test Method)

1 Scope

- 1.1 This test method is intended to control the density of compacted courses of surfacing aggregates and plant mix pavement using nuclear gauges.

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 311 Marshall Method for Field Control of Hot Mix Asphalt Paving

3 Definitions

- 3.1 *Control-Strip A - Surfacing Aggregates* – 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 - Plant Mix Paving* – A section approximately three hundred (300) feet long by one paver width on a firmly compacted base. Please refer to Table 1 on page 3 as a guide for maximum rolling times.
- 3.3 *Test-Section Surfacing Aggregates* – 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 Plant Mix Paving* – Individual sections each approximately two thousand (2000) feet long by one paver width on which plant mix material will be placed, using the same layer thickness, compaction and procedure used in construction the Control-strip B above.

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 *Operators Manual and Gauge Booklet*

5 Operational Procedures

- 5.1 *Control-Strip Surfacing Aggregates* – 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-density of the control strip will be determined by the use of 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. 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 weight. 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 Surfacing Aggregates* – The remainder of the project is divided into Test-Sections described above. 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.

- 5.3 *Control Strip Plant Mix Paving* – 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 plant mix surfacing a comparison will be made between the established Control-Strip density and the Marshall density as determined by MT-311 (Marshall Method of Hot Mix Asphalt Paving). This should be done to ensure a reasonable Control-Strip density is established.
- 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 weight. Compaction of the Control-Strip shall commence as soon as possible after placement of the bituminous mixture and be uniform over the entire Control-Strip before the temperature of the mix falls below 175°F. A test will be taken on each test site with a nuclear gauge after each pass of the compaction equipment.
- 5.3.2 This procedure will continue until the density increase is less than one (1) pound per cubic foot at a temperature greater than 175°F. 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 might have to be established.
- 5.4 *Test Section Plant Mix Paving* – The remainder of the project is divided into 2000 ft. test sections. After placing and compacting a lift of Plant Mix Paving, 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. 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 Forms and Reports

- 6.1 Use [Lab Form No. 1000A](#) for 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.

Table 1. Maximum Available Rolling Times*

Recommended Minimum Laydown Temperature						
Base Temp.°F	Mat Thickness					
	½"	¾"	1"	1½"	2"	3" and Greater
+35-40	-	-	-	305	295	280
+40-50	-	-	310	300	285	275
+50-60	-	310	300	295	280	270
+60-70	310	300	290	285	275	265
+70-80	300	290	285	280	270	265
+80-90	290	280	275	270	265	260
+90	280	275	270	265	260	255
Maximum Available Rolling						
Time, minutes	4	6	8	12	15	15

* Table from Superintendents Manual on Compaction of Hot Mix Asphalt Pavement (1978)
 Where dashes appear in the table, conditions are such that it is doubtful that specification density can be achieved so work would cease. The table has come to be known as "cessation requirements."

As an example to illustrate the use of the table: assume we are placing a 1½" thick mat and the base temperature is between 50°F and 60°F. A laydown temperature of 295°F is needed to provide 12 minutes before the mat cools to an average temperature of 175°F. If it is a warmer day, with a base temperature of 70°F to 80°F, a laydown temperature of 280°F would provide 12 minutes of rolling time. On a day warm enough to have a base temp of 70°F to 80°F, the air temperature would probably be above 40°F and there would be some sunshine, so it would probably take 2 or 3 more minutes to cool to 175°F, probably 15 minutes.