

**STATE OF OHIO
DEPARTMENT OF TRANSPORTATION**

**SUPPLEMENT 1055
ASPHALT MAT DENSITY BY GAUGE TESTING**

April 18, 2014

1055.01	General
1055.02	Equipment and Operation
1055.03	Minimum Density Target Determination
1055.04	Testing Procedures
1055.05	Reporting
1055.06	Failure to Follow Requirements
Appendix	Gauge Operation and Procedures

1055.01 General. This supplement defines equipment, procedures and reporting methods for asphalt mat density testing and acceptance. The Field Quality Control Supervisor (FQCS) must maintain a copy of this specification at the paving site. Use the density gauge equipment and quality control (QC) procedures below to determine the density of an asphalt mat. The reporting method defined below creates an all inclusive document for both quality control and quality assurance (QA) testing by the Contractor and Department.

The FQCS is the Contractor's representative on site responsible to obtain and control density as defined below by being proactive in using available methods, materials or equipment to do so. Achieving the minimum density target as quickly as possible upon project start and then controlling density according to the below methods is the goal of this specification. Lack of proactiveness may be seen as placing asphalt not achieving requirements with no attempt at changes in methods, materials or equipment. Failure to proactively implement methods, materials and equipment to quickly obtain and control density as intended in this specification may mean an application of 1055.06.

1055.02 Equipment and Operation. Use a nuclear density gauge in the Backscatter Method meeting the requirements of ASTM D 2950 or a Pavement Quality Indicator (PQI) Model 300 or Model 380 manufactured by TransTec Systems.

Nuclear density gauge operation – When performing tests operate the gauge using 1 minute wet density readings. Do not alter the test time or number of readings at a test location. Take readings where the pavement surface is flat and no surface moisture is evident

Assure nuclear gauges were calibrated in the past two years. Maintain a copy of the calibration sheet with each nuclear gauge. Standardize nuclear gauges using the procedure in Appendix B. Ensure the standard count is within 2% of the most recent calibration or replace the gauge. Document the count and difference on the forms **TE -Min Density Target Nuclear, Appendix C and TE-Mat Density QCQA, Appendix E.**

PQI electronic density gauge operation – When performing tests set the device in the single reading and shallow penetration modes. A density measurement will consist of the average of five readings taken in accordance with the reading pattern described in the procedure in the appendix A. Take readings where the pavement surface is flat and no surface moisture is evident.

Verify the PQI 300 gauge operation daily using the PQI test block. Follow the manufacturer instructions to establish an upper and lower limit at job's start as a baseline verification. Ensure each day's verification result is within the upper and lower limits of the baseline verification. Document the verification limits and verification on the forms **TE-Min Density Target Elec Gauge, Appendix D and TE-Mat Density QCQA, Appendix E.**

Verify the PQI 380 gauge operation daily using the Standardization plate issued with the gauge. Follow the Manufacturer's instructions for performing the standardization. Ensure each day's standardization result is within the limits established by the manufacture and published on the calibration documents. Document each day's standardization result and limits on the **TE forms Min Density Target Elec Gauge, Appendix D and Mat Density QCQA, Appendix E.**

1055.03 Minimum Density Target Determination.

Nuclear density gauge – Determine a minimum density target in the first four hours of production or when a mix change necessitates a target density change. Calculate a minimum density target from the gauge test unit weights and the percent density of companion cores obtained from the same test locations as the gauge and Contractor tested according to Supplement 1036. Determine the minimum density target using a gauge reading and companion core result from each of a minimum of 3 separate locations. Do not calculate and enter a gauge offset into a gauge control panel. Instead, record readings and calculations on form **TE – Min Density Target Nuclear, Appendix C.** Re-establish the minimum density target if the difference between the daily gauge calibration standardization count and the most recent calibration count values exceed 2% or if a different nuclear gauge is to be used.

PQI electronic density gauge – Determine a minimum density target in the first four hours of production or when a mix change necessitates a target density change. Calculate a minimum density target from the gauge test unit weights and the percent density of companion cores obtained at the same test locations as the gauge and Contractor tested according to Supplement 1036. Determine the minimum density target using gauge readings and a companion core result from each of a minimum of 5 separate locations. Do not calculate and enter a gauge offset into a gauge control panel. Instead, record readings and calculations on form **TE – Min Density Target Electronic Gauge, Appendix D.** Re-establish the minimum density target if the day's gauge verification result is not within the upper and lower limits or if a different electronic gauge is to be used.

1055.04 Testing Procedures. Perform QC testing to maintain mat density between 93.0 and 96.5 percent. For QC results outside these limits immediately adjust compaction and immediately retest until the target is achieved. Stop placement if signs of flushing are occurring or if excess aggregate breakage is occurring. Maintain adequate compaction and verify by QC tests as follows:

- A. For a different JMF re-do the startup procedure.
- B. If mix properties change, are out of specification or plant problems occur re-do the startup procedure after problems are resolved and record results on the given forms.

Areas missed due to a gauge failure or other inability to obtain required QC tests must be tested for QC and QA according to the below procedures when equipment is available.

Startup - At the start of production, immediately determine the maximum achievable density by taking gauge measurements in a single location under multiple rollers and rolling passes. Ensure basic compaction

practices such as proper mix temperatures, rollers tight to the paver and adequate number of rollers vs. paver speed are followed. Take measurements as frequently as possible to determine the maximum achievable density. Stop compacting if mat distress is evident. Correlate the final gauge readings with cores taken according to 1055.03 and tested immediately.

Maintain the maximum achievable density by the same compaction practices until the minimum density target is determined. Determine the minimum density target according to 1055.03 using the JMF Maximum Specific Gravity (MSG) until an actual test MSG is available. When an actual test MSG is available recalculate the density of each previous core and report the new densities and adjusted minimum density target on the required forms. Use plant MSG results even if any plant QC tests have an „out of specification“ situation. Re-do the startup procedure when „in specification“ test MSG results are achieved. If core results are below 93.0 percent adjust the mix or compaction as necessary and allowable per specification and repeat the startup procedure.

If a project includes 448.03 Density, acceptance will include any density deductions according to Supplement 1055.04

Quality Control Testing - Use the minimum density target as a guide to maintain mat density above 93.0 percent in QC. Place a label on the pavement at each required test location. The Contractor is expected to perform more QC tests than required but only record required QC tests. Record all required tests and locations on the required form. Take the first required QC test at a location of approximately 1000 feet (300 meters) and one test at each location of approximately every 1000 feet (300 meters) thereafter. Sequentially alternate the transverse location of the required test at each 1000 foot (300 meters) location by starting at the left side of the mat for test one, middle for test two and right for test three and then repeat accordingly for additional locations. Take right and left tests centering the gauge at one foot (0.3 meters) from the mat edge. Adjust compaction as needed to obtain the desired target unit weight at each test location and retest with the gauge to verify it is achieved.

Quality Assurance Testing – Quality assurance testing will begin after the first production day, regardless the status of achieving the minimum density target. A minimum of once in each production day or night the Department will randomly select two locations for QA testing. One location will be at a location previously tested and marked in QC testing. The other random location will be on the mat after the first 500 feet (150 meters) of that day. Only select QA test locations within the traffic control zone. The QC technician will perform the testing in the presence of Department personnel. Perform three gauge tests (right, center, left) at each Department selected QA test location, average the three test readings and calculate the average percent density. Take right and left tests centering the gauge at one foot (0.3 meters) from the mat edge. Department personnel will place their initials on the QC form, appendix E, beside data tested in their presence.

Each QA test will represent one half (1/2) day’s production. If only one of the two daily QA average densities is below 92.0 percent but above 91.0 percent do nothing. If one of the two daily QA average densities is below 91.0 percent use Table 1055.04-1 to determine the percent deduction pay adjustment due to density for that one half (1/2) day’s production.

Table 1055.04-1

Density (%)	Payment Deduction
90.0 to 90.9	5%
89.0 to 89.9	15%
88.0 to 88.9	30%
Less than 88.0	remove

If both QA average densities are below 92.0 percent use Table 1055.04-2 to determine the percent deduction pay adjustment due to density for each one half (1/2) day's production.

Table 1055.04-2

Density (%)	Payment Deduction
91.0 to 91.9	5%
90.0 to 90.9	10%
89.0 to 89.9	15%
88.0 to 88.9	30%
Less than 88.0	remove

1055.05 Reporting. Use form **TE XX Mat Density QC QA, Appendix E**, for reporting results, whether as part of startup, QC by the Contractor or QA tests selected by Department personnel. Use forms **TE Min Density Target Nuclear, Appendix C**, or **TE Min Density Elec Gauge, Appendix D** for determining the minimum density target. Verbally report QC test results to the Project Inspector (when available) and Contractor FQCS. Give a copy of all reports to the Project Engineer and fax copies to the DET no later than the workday following the production day of the material represented by the report.

1055.06 Failure to Follow Requirements. Should the District and Quality Control Qualification Committee (QCQC) of 403 determine that requirements of this specification are not being followed as intended or that actual density of the mat is predominantly not as reported acceptance of the mat will revert to 446 requirements (without incentive payment) and the Field Quality Control Supervisor approval of personnel on the project will be revoked. QC requirements above are still required. The Department will perform the testing of the cores and assess the Contractor liquidated damages of two hundred and fifty dollar (\$250) for each lot tested.

Appendix A: Operation of Density Gauges

PQI300 Electro-magnetic Density Gauge Testing

Preparation

Pick five locations on the asphalt that are dry.

Readings

- A. Turn the PQI300 on. Select the type of pavement you will be calibrating the PQI300 from the menu choices. A “B”, “I” or “T” will be displayed with in [].
- B. Choose #2 (run) from the startup menu.
- C. Using the “B” key, press the key until “Single Mode” appears on the screen.
- D. Using the “F” key, press it to select shallow or deep penetration mode. An S or D will be displayed within brackets [].
- E. Place the PQI300 in the first location on the asphalt mat. Using a crayon marker draw a circle around the PQI300. The round sensor plate may be used as a guide. Press the ENT key, (DO NOT TOUCH THE PQI) and wait for a reading to complete. Record the density reading.

HINT: Better readings are taken if no hands or objects are in contact with the PQI300.

- F. Move the PQI approximately 2 inches up and to the right on the outside of the circle. Consider this position as the 2 o’clock location. Press the ENT key to take another reading and record it in the table given in the back of this manual.

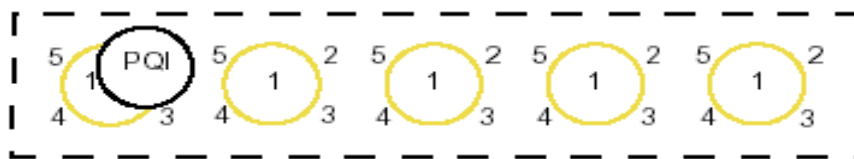


Figure A PQI Measurement Pattern

- G. Move the PQI300 clockwise around the marked circle to about the 4 o’clock position. Press the ENT key to take another reading and record it in the table.
- H. Continue to move the PQI300 in clockwise steps around the marked circle stopping at the 8 o’clock and 10 o’clock positions to take and record density readings. Following the pattern in Fig. A, move the PQI300 to the next circle location, record a density reading in the center and at each clock position, in turn, until the table is complete.

PQI 380 Electro-magnetic Density Gauge Testing

Preparation

Pick five locations on the asphalt mat that are dry.

Readings

- A. Turn on the PQI380. Press the “Start PQI” button.
- B. Select “Mix”
- C. Enter your specific mix information in one of the available memory slots.
- D. When all information is programmed, select “Back” and then “Control Menu”.
- E. From the Control Menu, select “Modes”
- F. Select “Single” to set the gauge to Single reading mode.
- G. Select “Control Menu” to return to the Control Menu
- H. Select “GO” to start measurements.
- I. Place the PQI380 in the first location on the Asphalt mat. Using a crayon marker draw a circle around the PQI380. The round sensor plate may be used as a guide. Press the “Measure” button, (DO NOT TOUCH THE PQI) and wait for a reading to complete. Record the density reading.

HINT: Better readings are taken if no hands or objects are in contact with the PQI380.

- J. Move the PQI380 approximately 2 inches up and to the right on the outside of the circle. Consider this position as the 2 o’clock location. Press the “Measure” button to take another reading and record it in the table given in the back of this manual.



Figure B PQI Measurement Pattern

- K. Move the PQI380 clockwise around the marked circle to about the 4 o’clock position.
- L. Press the “Measure” button to take another reading and record it in the table.
- M. Continue to move the PQI380 in clockwise steps around the marked circle stopping at the 8 o’clock and 10 o’clock positions to take and record density readings. Following the pattern in Fig. B, move the PQI380 to the next circle location, record a density reading in the center and at each clock position, in turn, until the table is complete.

Appendix B

Nuclear Density Gauge Calibration

To compensate for the source decay and to check proper operation of the gauge, take a standard count daily.

Place the reference standard block on a dry, flat surface of asphalt. The location should be at least 10 feet from any building or vertical structure and 33 feet from any other nuclear gauge or radioactive source.

Ensure that the top surface of the reference standard block and bottom of the gauge are clean of debris. Place the gauge between the grooves on the reference standard block. Place the source rod on your left and the right side of the gauge against the metal butt plate on the block. Ensure that the source rod is in the SAFE position.

Take the standard count and ensure it is within 2 percent of the calibration. Record results on all forms where required.

Run standardization at a four minute count.

Appendix C

TE- Min Density Target Nuclear

MINIMUM DENSITY TARGET REPORT: Nuclear Gauge

Project: _____ Route: _____
 Location: _____ Date: _____ Day#: _____
 Mix Type: _____ JMF# _____ Plant# _____ District #: _____
 FQCS: _____ Density Technician: _____
 MSG (F): _____ Weather & Temperature: _____
 () Day () Night
 Number of lifts: _____
 Gauge# / Model # _____
 Daily Standard Count: _____ Calibration Std. Count/ % Diff: _____

Nuclear Gauge Readings (PCF)				
Location	1	2	3	Average
PCF				

(a)

Core Density Test Results (see TE-199 for detail)				
Location	1	2	3	Average
% Density				

(b)

Apply the following to obtain the nuclear gauge Minimum Density Target:

Minimum Density Target (PCF) = 93 X Gauge Reading Average PCF / Average % Density of cores.

Minimum Density Target = 93 X (a) / (b) EQUA
LS (c) PCF

Remarks _____

Test conducted by:		Date:	
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Appendix D

TE- Min Density Target Elec Gauge

MINIMUM DENSITY TARGET REPORT: Electro-Mag Gauge

Project: _____ Route: _____

Location: _____ Date: _____ Day#: _____

Mix Type: _____ JMF# _____ Plant# _____ District #: _____

FQCS: _____ Density Technician: _____

MSG _____ Weather & Temperature: _____

(F): _____ Gauge#/Model # _____

() Day () Night

Upper/lower verification limit _____ / _____

Electro-Mag Gauge Readings PCF					
Location	1	2	3	4	5
center					
2 o'clock					
4 o'clock					
8 o'clock					
10 o'clock					
Location Average					
Overall Ave:		(a)			

Core Density Test Results (see TE-199 for detail)					
Location	1	2	3	4	5
% Density					
Average:		(b)			

Apply the following to obtain the nuclear gauge Minimum Density Target:

Minimum Density Target (PCF) = 93 X Gauge Reading Average PCF / Average % Density of cores.

Minimum Density Target = 93 X (a) / (b) EQUAL S (c)

Remarks _____

Test conducted by:		Date:	
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TE- Mat Density QCQA**DAILY MAT DENSITY QCQA REPORT**

Project: _____ Route: _____

Location: _____ Date: _____ Day#: _____ Page _____ of _____

Mix Type: _____ JMF# _____ Plant# _____ Dist #: _____

FQCS: _____ Field Technician: _____

Gauge #/model _____ Weather/Temperature: _____

Daily Standard Count (nuclear): _____ Calibration Std. Count / % Diff. _____ / _____

Daily Verification Result (elec): _____ Upper/lower verification limit _____ / _____

Minimum Density Target (\bar{c}) _____ PCF**Gauge Readings (Contractor QC)**

#	Longitudinal Location	Transverse Location (circle)	Actual Gauge Reading (\bar{d}), pcf	% Density = $\frac{\bar{d}}{\bar{c}}$ X 93 (1055.04 target range 93.0-96.5)	
		L C R			
		L C R			
		L C R			
		L C R			
		L C R			
		L C R			
		L C R			
		L C R			
		L C R			
		L C R			
		L C R			
		L C R			
		L C R			
ODOT QA TESTS		PCFs L C R AVE		% Density*	ODOT INITIALS
		/ / /			
		/ / /			

* Ave Gauge PCF / Minimum Density Target PCF X 93 = % Density

Tests performed by: _____

Date Submitted: _____