ATT-66/96, DENSITY TEST, ASBC CONTROL STRIP METHOD

1.0 SCOPE

This test procedure describes the method of determining the required minimum number of "passes" with approved compaction equipment, to reach an apparent Maximum Wet Density of asphalt stabilized base course materials, measured using a nuclear moisture-density gauge.

2.0 EQUIPMENT

2.1 Testing Equipment

nuclear moisture-density gauge
reference standard — carrying case
calibration tables — charge cord
operating instructions gauge log book

DATA SHEETS: Control Strip Rolling Pattern, MAT 6-45
Control Strip Rolling Pattern Graph, MAT 6-46
Test Section Density, MAT6-47

2.2 Contractor's Compacting Equipment

If the ASBC is placed on granular base course, the contractor must have on site the following specified compacting equipment:

1. Two vibratory steel rollers weighing not less than 6 t each and having vibratory capacities of at least 1500 vibrations per minute, with a minimum dynamic or centrifugal force of 8000 kg, operated in the vibratory mode, and at a speed not exceeding 8 km/h; or

2. One vibratory steel roller meeting the criteria described in step (1) above, plus one of the following:

    a) Six wobbly-wheel pneumatic-tired rollers with tires inflated to a pressure of from 165 kPa to 235 kPa, ballasted with at least a level load, and towed at a speed not exceeding 8 km/h; or

    b) Two self-propelled pneumatic-tired rollers, each ballasted to its maximum capacity, weighing not less than 10 t, having a tire pressure of from 365 kPa to 435 kPa, and travelling at a speed not exceeding 8 km/h; or

    c) A combination of 4 wobbly-wheel pneumatic-tired rollers and 1 self-propelled pneumatic-tired roller, all of which meet the appropriate criteria described above.

For ASBC on cement stabilized base course, the contractor must have on-site the compacting equipment options described in step 2 above, except that unless otherwise specifically approved in writing by the Engineer, the vibratory steel roller is to be operated in the static mode.

3.0 PROCEDURE

The **Radioisotope Licence** states that "only persons properly trained in work with radioactive substances and informed of the hazards involved are allowed to handle those substances". The nuclear density gauge operator must have nuclear testing equipment training. The driver of the vehicle transporting the gauge must also have a **valid Dangerous Goods Certificate of Training.**

3.1 Equipment Preparation

1. Immediately upon the arrival of the gauge on the job and before each control strip or test section, determine if the gauge is functioning properly by performing the "Checkout Procedure" as directed in ATT-11, DENSITY TEST, In-Place Nuclear Method. This procedure comprises of:

    a) "Circuitry Check". This is used to identify problems with the electronics. This test is not routinely performed with Troxler 3401 gauges.

    b) Density Standard Counts. These counts are used to determine the "Percent Drift" caused by component aging and drift within the instrument.

2. When testing in cool weather, the gauge must be placed outside for at least 30 minutes before testing is to begin for the day. Rapid changes in temperature affects the gauge readings.

3.2 Site Preparation

Proper site preparation is the most important step in the nuclear density test. Surface voids cause inconsistent and incorrect readings and should be reduced to a minimum.

The surface to be tested must be smooth and flat. This is best achieved immediately after the compaction equipment has been removed from the test site. The gauge should never "rock" on an irregular surface. In order to achieve the same surface condition, **dry** native fines (-1250 Fm material) must be used to fill the surface voids.

3.3 ASBC Control Strip

An "ASBC Control Strip" is a layer of Asphalt Stabilized Base Course of specified depth, constructed on a section of prepared surface selected by the Project Manager or senior technologist. The length of the control strip section is 400 m, or as selected by the Project Manager.

The specified compaction equipment and methods described in Section 2.2 are used to determine the minimum number of "passes" to reach an apparent maximum wet density. To determine the minimum number of "passes," nuclear backscatter density readings are taken after each known number of "passes" until a Control Maximum Wet Density is reached.

A "Pass" is defined as one complete coverage of an ASBC control strip with all the specified minimum compaction equipment.

As portions of the lift are being spread, the mix must be initially compacted with one vibratory steel roller as specified in Section 2.2, step 1, or the equipment specified in Section 2.2, step 2(a) or (b) or (c) so that when the entire lift has been spread, a minimum of 2 full passes have been completed over all the Control Strip area.

After the mix for the lift has been completely spread, start taking density measurements for the control strip while the contractor uses all the specified compaction equipment described in Section 2.2.

When pneumatic self-propelled rollers or wobbly type rollers are used for compaction, they must lead the steel vibratory compactor.

Each site of an ASBC Control Strip is usually tested after every second pass; however, the frequency should be increased when near the peak wet density.

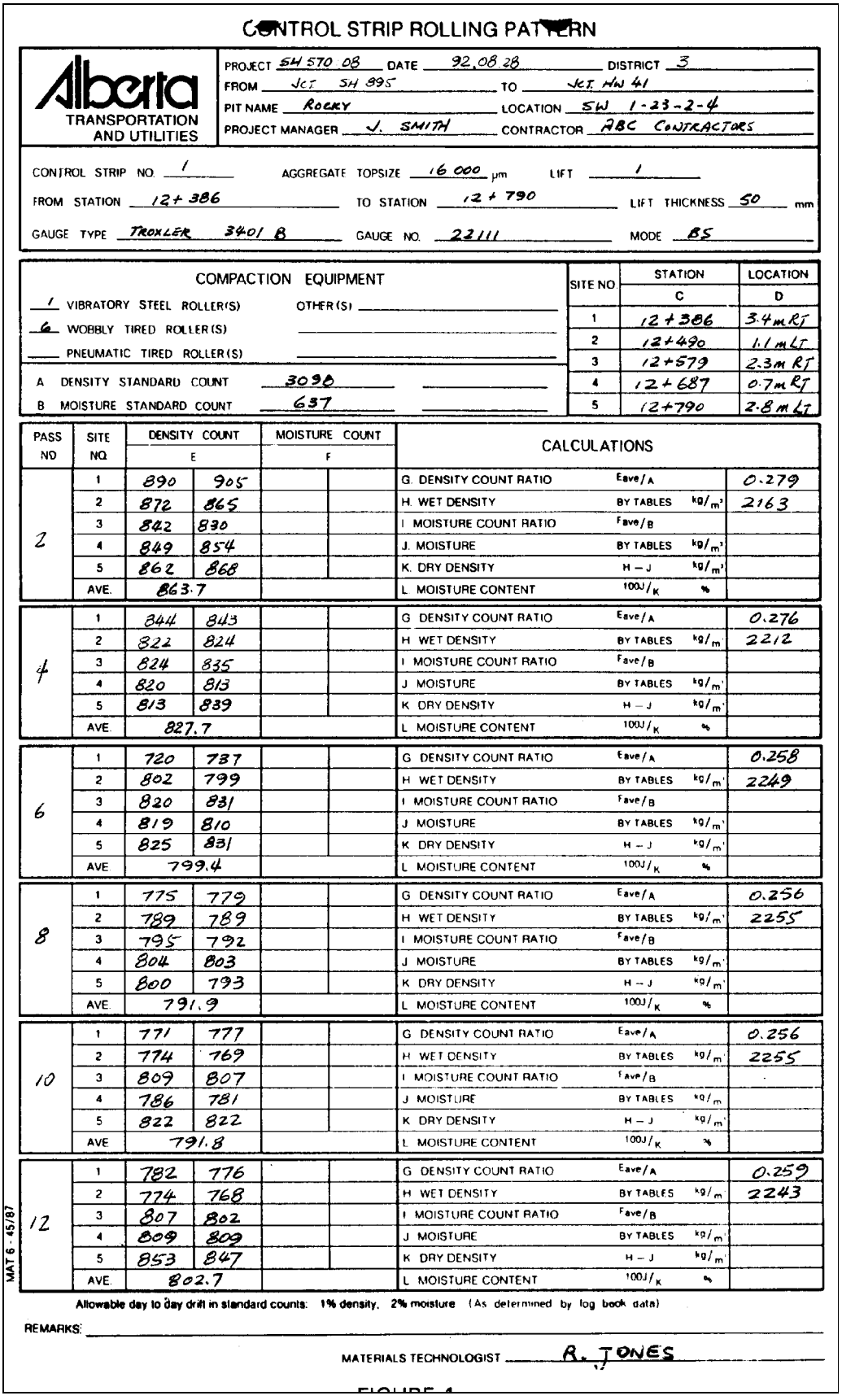
Continue taking density measurements until a Control Maximum Wet Density is achieved. If the contractor uses a paver to lay the mix, commence the measurements for the ASBC control strip immediately behind the paver.

Test the "control strip" as follows:

1. Once the density standard counts have been taken, select 5 evenly spaced test sites within the "ASBC Control Strip". The test sites should be representative, have minimum segregation, have no ravelling and their surfaces should be smooth.

2. Record opposite the corresponding site number, the station (column "C") and location (column "D") of each site, as shown in Figure 1 (MAT 6-45).

3. After the material for the lift has been completely spread, allow one series of passes of the specified compaction equipment, then proceed to the test site.



CONTROL STRIP ROLLING PATTERN

Alberta TRANSPORTATION AND UTILITIES

PROJECT SH 570 08 DATE 92.08 28 DISTRICT 3
FROM Jct SH 895 TO Jct. HW 41
PIT NAME Rocky LOCATION SW 1-23-2-4
PROJECT MANAGER J. SMITH CONTRACTOR ABC CONTRACTORS

CONTROL STRIP NO. 1 AGGREGATE TOPSIZE 16 000 µm LIFT 1
FROM STATION 12+386 TO STATION 12+790 LIFT THICKNESS 50 mm
GAUGE TYPE TROXLER 3401 B GAUGE NO. 22111 MODE BS

COMPACTION EQUIPMENT

1 VIBRATORY STEEL ROLLER(S) OTHER(S) _____
6 WOBBLY TIRED ROLLER(S)
___ PNEUMATIC TIRED ROLLER(S)

A DENSITY STANDARD COUNT 3090
B MOISTURE STANDARD COUNT 637

SITE NO.	STATION C	LOCATION D
1	12+386	3.4m RT
2	12+490	1.1m LT
3	12+579	2.3m RT
4	12+687	0.7m RT
5	12+790	2.8m LT

PASS NO	SITE NO	DENSITY COUNT E		MOISTURE COUNT F		CALCULATIONS			
2	1	890	905			G. DENSITY COUNT RATIO	Eave/A		0.279
	2	872	865			H. WET DENSITY	BY TABLES	kg/m³	2163
	3	842	830			I. MOISTURE COUNT RATIO	Fave/B		
	4	849	854			J. MOISTURE	BY TABLES	kg/m³	
	5	862	868			K. DRY DENSITY	H − J	kg/m³	
	AVE.	863.7				L. MOISTURE CONTENT	100J/K	%	
4	1	844	843			G. DENSITY COUNT RATIO	Eave/A		0.276
	2	822	824			H. WET DENSITY	BY TABLES	kg/m³	2212
	3	824	835			I. MOISTURE COUNT RATIO	Fave/B		
	4	820	813			J. MOISTURE	BY TABLES	kg/m³	
	5	813	839			K. DRY DENSITY	H − J	kg/m³	
	AVE.	827.7				L. MOISTURE CONTENT	100J/K	%	
6	1	720	737			G. DENSITY COUNT RATIO	Eave/A		0.258
	2	802	799			H. WET DENSITY	BY TABLES	kg/m³	2249
	3	820	831			I. MOISTURE COUNT RATIO	Fave/B		
	4	819	810			J. MOISTURE	BY TABLES	kg/m³	
	5	825	831			K. DRY DENSITY	H − J	kg/m³	
	AVE.	799.4				L. MOISTURE CONTENT	100J/K	%	
8	1	775	779			G. DENSITY COUNT RATIO	Eave/A		0.256
	2	789	789			H. WET DENSITY	BY TABLES	kg/m³	2255
	3	795	792			I. MOISTURE COUNT RATIO	Fave/B		
	4	804	803			J. MOISTURE	BY TABLES	kg/m³	
	5	800	793			K. DRY DENSITY	H − J	kg/m³	
	AVE.	791.9				L. MOISTURE CONTENT	100J/K	%	
10	1	771	777			G. DENSITY COUNT RATIO	Eave/A		0.256
	2	774	769			H. WET DENSITY	BY TABLES	kg/m³	2255
	3	809	807			I. MOISTURE COUNT RATIO	Fave/B		
	4	786	781			J. MOISTURE	BY TABLES	kg/m³	
	5	822	822			K. DRY DENSITY	H − J	kg/m³	
	AVE.	791.8				L. MOISTURE CONTENT	100J/K	%	
12	1	782	776			G. DENSITY COUNT RATIO	Eave/A		0.259
	2	774	768			H. WET DENSITY	BY TABLES	kg/m³	2243
	3	807	802			I. MOISTURE COUNT RATIO	Fave/B		
	4	809	809			J. MOISTURE	BY TABLES	kg/m³	
	5	853	847			K. DRY DENSITY	H − J	kg/m³	
	AVE.	802.7				L. MOISTURE CONTENT	100J/K	%	

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Allowable day to day drift in standard counts: 1% density, 2% moisture (As determined by log book data)

REMARKS: _____

MATERIALS TECHNOLOGIST R. JONES

FIGURE 1

Figure 1

4. Mark the site by placing a flagged nail at least 0.3 m in front of the proposed site or spray paint the site outside the gauge seating location.

5. Use dry native fines to fill the site's surface voids. Brush off the excess fines.

6. Place the gauge on the prepared site. Do not set the gauge on the nail as it may affect the reading.

7. Take two backscatter density measurements as directed in test method ATT-11.

8. Record opposite the corresponding site number, the density readings for the Pass No. as Density Count (column "E").

9. Proceed to the other 4 test sites and repeat steps 4 to 8 of this Section.

10. Calculate the average of the ten density readings for that pass.

11. Calculate the Wet Density as follows:

    a) Determine the Density Count Ratio (line "G") using the formula:

    $$\text{Density Count Ratio} = \frac{\text{Average Backscatter Density Count}}{\text{Density Standard Count}}$$

    b) Use the Backscatter Density Calibration Table and the Density Count Ratio (line "G") to obtain the Wet Density (line "H").

12. After each "series of passes" (pass #1, 3, 5, etc.) of the specified compaction equipment, repeat steps 5 to 11 of this Section.

    NOTE: Site preparation may not be required after a few series of passes. All readings must be taken at the exact same locations with the gauge sitting in the same position as the first set of readings.

13. The ASBC Control Strip is complete when after the completion of three consecutive series of passes, the average wet density between each series of passes:

    a) Increases by less than 10 kg/m^3

    b) Continually decreases, or

    c) Remains constant.

3.3.1 ASBC Control Minimum Number of "Passes" and Control Wet Density

Since compaction actually begins as soon as the material for the lift is spread and testing does not start until the entire lift is spread, the test does not indicate the true number of passes required to achieve maximum density. It only identifies the number of "Passes" required after the lift is spread out.

1. Plot the Wet Density obtained in each series of passes on the vertical ordinate, versus the Number of Passes on the horizontal ordinate, as shown in Figure 2 (MAT 6-46).

2. Connect the points with a smooth curve.

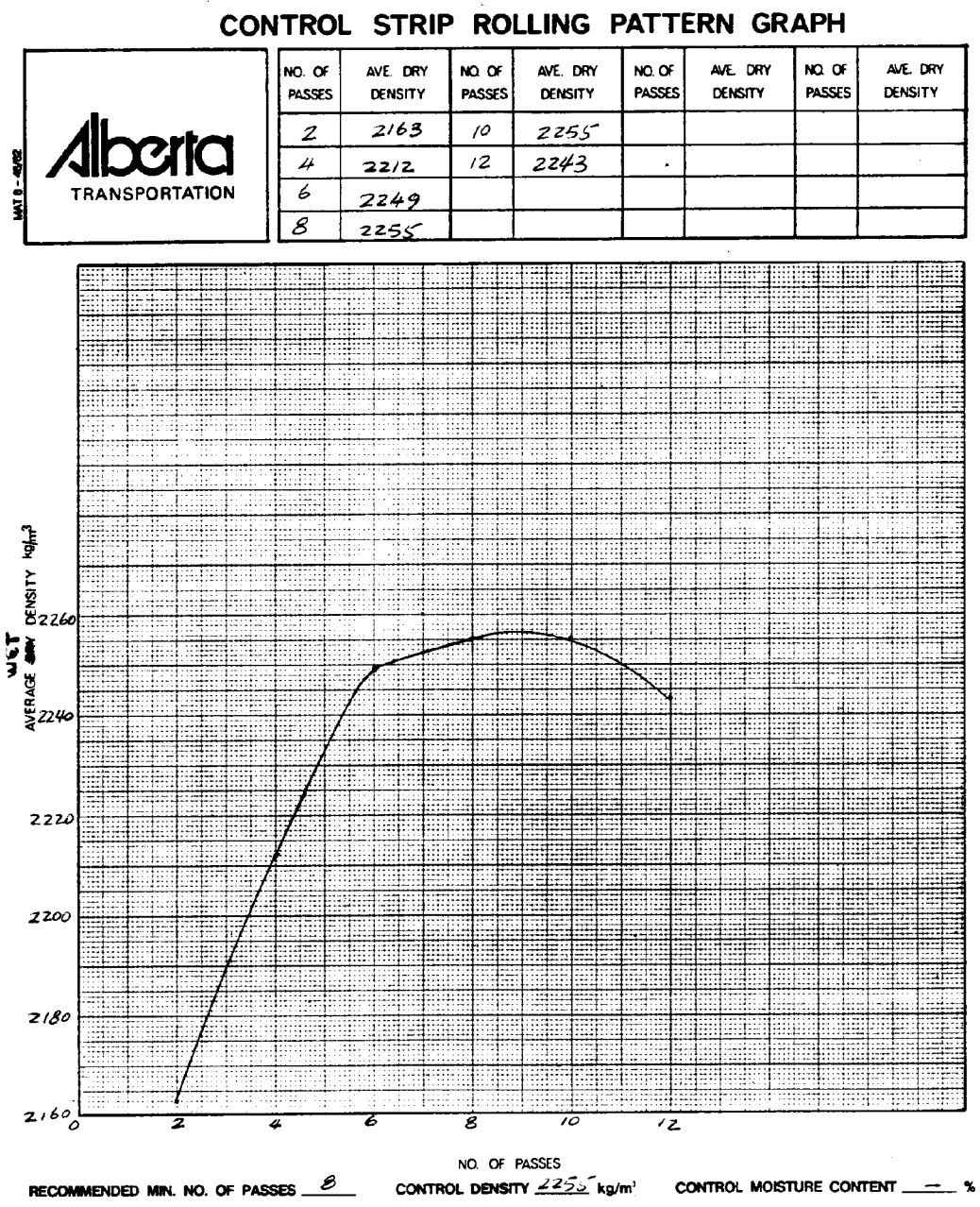

Figure 2

3. From the peak of the curve, pick off the minimum number of passes required to obtain the Control Maximum Wet Density. Record on the bottom of the data sheet the recommended Minimum No. of Passes and the Control Maximum Wet Density.

3.4 ASBC Test Section Wet Density

Once the Control Minimum Number of "Passes" and the Control Maximum Wet Density have been established using a given combination of equipment, the Contractor must use the same equipment, spreading technique and Minimum Number of Passes for the general construction operation.

The Department may at any time take nuclear wet density measurements to determine if the Control Maximum Wet Density has been attained. If the average wet density of ten randomly selected test sites is less than 98.0% of the Control Maximum Wet Density, the Project Manager or his representative will instruct the Contractor to:

a) Carry out more passes until at least the minimum specified compaction is attained, or

b) Construct a new Control Strip to establish a new Control Maximum Wet Density and a new Control Minimum Number of Passes.

Areas such as entrances where all of the specified equipment cannot work practically, must be compacted with one vibratory steel wheeled roller as specified in Section 2.2, step 1. Each area must be compacted until the average of five sites is at least 95% of the Control Maximum Wet Density. For each site, the distance from any edge of the area must be at least 0.5 m, to avoid testing thin or tapered layers.

Test a "test section" as follows:

1. Check a stretch of road for visually failed areas, and have those areas repaired.

2. Use test method ATT-56, NON-BIASED SAMPLE PLANS to **randomly** choose ten (10) test sites within the Test Section.

   NOTE: Five (5) test sites may be used if the Contractor is working in a small area such as an approach or an intersection.

3. Record the station (line "C") and location (line "D") of each test site, as shown in Figure 3 (MAT 6-47).

TEST SECTION DENSITY

Alberta TRANSPORTATION

PROJECT SH 570:08 DATE 92.09.03 DISTRICT 3
FROM Jct. SH 895 TO Jct. Hwy 41
PIT NAME Rocky LOCATION SW 1-23-2-4
PROJECT MANAGER J. SMITH CONTRACTOR ABC CONTRACTORS

TEST SECTION NUMBER 1 AGGREGATE TOPSIZE 16 000 µm LIFT 1
FROM STATION 12 + 800 TO STATION 13 + 200 LIFT THICKNESS 50 mm
GAUGE TYPE TROXLER 3401 B NO. 22 111 MODE BS

COMPACTION EQUIPMENT

VIBRATORY STEEL ROLLER (S) 1 PNEUMATIC TIRED ROLLER (S) —
WOBBLY TIRED ROLLER (S) 6 OTHER —

A DENSITY STANDARD COUNT 3091 B MOISTURE STANDARD COUNT 635

	SITE NO.	1	2	3	4	5	6	7	8	9	10	AVERAGE
C	STATION	12+840	12+880	12+880	12+980	13+028	13+056	13+068	13+108	13+136	13+160	
D	LOCATION	℄	3.4 LT	4.4 RT	1.6 RT	1.7 RT	1.7 LT	5.5 RT	4.4 LT	4.3 RT	℄	
E_1	DENSITY READINGS	792	779	829	800	788	787	780	785	760	767	
E_2		803	767	834	814	782	796	778	791	755	772	
E	AVE. DENSITY COUNT	797.5	773.0	831.5	807.0	785.0	791.5	779.0	788.0	757.5	769.5	788.0
F_1	MOISTURE READINGS											
F_2												
F	AVE. MOISTURE COUNT											

CALCULATIONS

G	DENSITY COUNT RATIO $\frac{E}{A}$	0.258	0.250	0.269	0.261	0.254	0.256	0.252	0.255	0.245	0.249	
H	WET DENSITY (BY TABLES) kg/m³	2248	2280	2205	2235	2262	2253	2273	2260	2298	2284	2260
I	MOISTURE COUNT RATIO $\frac{F}{B}$											
J	MOISTURE (BY TABLES) kg/m³											
K	DRY DENSITY H-J kg/m³											
L	MOISTURE CONTENT 100J/K %											
M	SITE PERCENT COMPACTION $\frac{100K}{N}$ %	99.7	101.1	97.8	99.1	100.3	99.9	100.8	100.2	101.9	101.3	100.2
N	CONTROL DENSITY kg/m³	2255	REMARKS —									
Ø	TEST SECTION DENSITY kg/m³ AVERAGE OF K	2260										
P	TEST SECTION PERCENT COMPACTION $\frac{100Ø}{N}$ %	100.2	MATERIALS TECHNOLOGIST R. JONES									

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FIGURE 2

Figure 3

4. Prepare test site 1, then take two backscatter density readings as directed in test method ATT-11. Record as Density Readings in lines "E_1" and "E_2".

   NOTE: Both readings must be taken with the gauge sitting in the same position.

5. Calculate the average density reading for the site and record as Average Density Count (line "E").

6. Repeat steps 4 and 5 for each of the remaining nine test sites.

7. Calculate the wet density of each site as directed in steps 11 (a) and (b) of Section 3.3.

8. Obtain from the Control Strip Rolling Pattern Graph (MAT 6-46), the Control Maximum Wet Density, and record it in line "N".

9. Determine the percent compaction of each site (line "M") using the formula:

$$Site\ \%\ Compaction = \frac{Wet\ Density\ (line\ "H")}{Control\ Maximum\ Wet\ Density\ (line\ "N")} \times 100\ \%$$

10. Determine the average Site % Compaction (line "M") and record it in the "Average" column.

11. Determine the average Wet Density (line "H") of the Test Section and record it in the "Average" column.

12. Transpose the average Wet Density to the Test Section Wet Density (line"O").

13. Calculate the percent compaction of the ASBC Test Section (line "P") using the formula:

$$Test\ Section\ \%\ Compaction = \frac{Test\ Section\ Wet\ Density}{Control\ Maximum\ Wet\ Density} \times 100\ \%$$

NOTE: The Test Section % Compaction (line "P") should be equal to the Average % Compaction. If not, check for calculation errors.