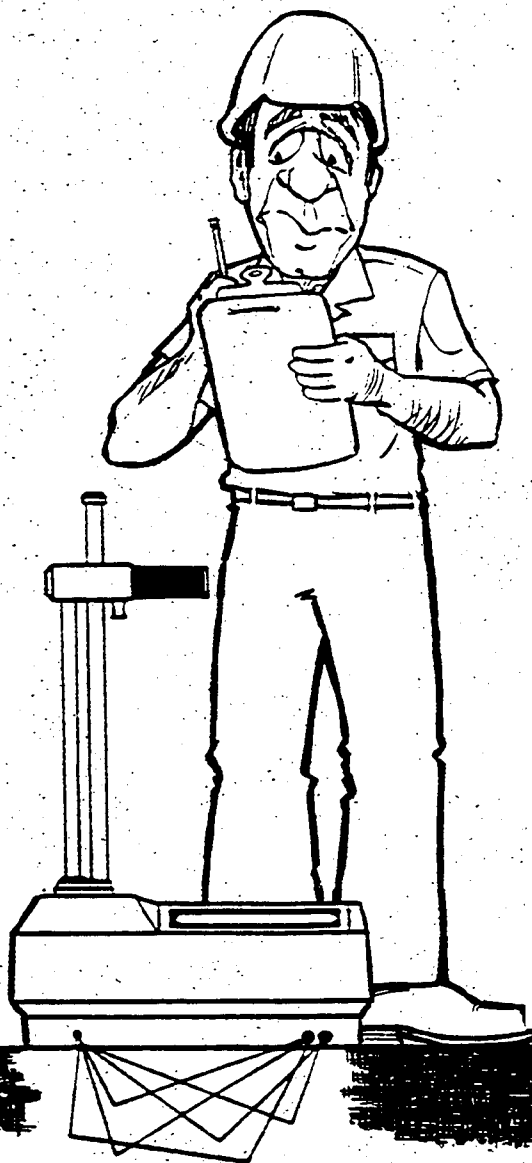


**Missouri Cooperative Highway Research Program
Final Report**

90-1

Missouri Highway and Transportation Department



**Density of
thin lift
bituminous
mixtures by
nuclear methods**

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16. Abstract <p>Densities of bituminous mixtures, as determined by eight nuclear density gauges, were compared to the densities of cores at the same test locations. The densities determined by the two methods did not agree and varied with each gauge. However, the differences were relatively constant suggesting that good agreement could be obtained by use of a correction factor with the nuclear gauge results.</p> <p>The average of 16 nuclear density readings and four cores (four nuclear density readings per core location) were used to establish a daily correction factor. Analysis of the test results indicate that the MHTD inspector can use this method of correction to determine bituminous mixture density with confidence.</p> <p>A correction factor for each day's production is recommended. The previous day's correction factor can be used to estimate density until cores can be cut and a new daily correction factor determined.</p> <p>Relying on <u>uncorrected</u> nuclear density readings for acceptance testing is not recommended. Some cores should always be cut to verify the accuracy of the gauge and actual density of the compacted bituminous mixture.</p> <p>Gauge position in relation to the roller direction and the use of a filler material did not significantly affect the results of gauges during this study.</p>			
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**DENSITY OF THIN LIFT BITUMINOUS MIXTURES
BY NUCLEAR METHODS**

**Final Report
Department Study 90-1**

**Prepared by
Missouri Highway and Transportation Department
Materials and Research**

May 1991

**In Cooperation with U.S. Department of Transportation
Federal Highway Administration**

The opinions, findings and conclusions expressed in the publication are not necessarily those of the Federal Highway Administration.

EXECUTIVE SUMMARY

The Missouri Highway and Transportation Department (MHTD) currently has a procedure (MHTD Test Method No. T41-9-79) for determining density of compacted bituminous mixtures by nuclear methods. However, due to the fact that 16 cores are needed for correlation between nuclear methods and bulk specific gravity methods, the nuclear method is not used. The current nuclear procedure is considered too time consuming and expensive.

Nuclear equipment for density determination now available claims better accuracy, more repeatability and the capability of reading only the bituminous layer in question.

It has long been recognized that a more frequent check on the compacted density of bituminous mixtures would be beneficial. Therefore, an HPR study was proposed to evaluate the new equipment and hopefully develop a more useable test procedure.

Eight nuclear gauges were evaluated including the older model equipment currently owned by the MHTD. Over 8500 density readings were taken on seven construction projects, representing most of the standard types of bituminous mixtures produced for use on MHTD contract projects.

The results of the study show that it is feasible to correlate a nuclear gauge with the four daily cores currently being cut and then apply the correction factor to the next day's production to

estimate the density. A new correction factor is recommended for each day's production. This will allow monitoring of compaction by nuclear methods without increasing the number of cores to be cut.

Three of the eight gauges evaluated are recommended for the MHTD approval. They are:

CPN: MC-1DR

Humboldt: 5001P

Troxler: 3430

The Seaman: C-200 and Troxler: 4640-B, are not recommended for use by the MHTD because they operate in the backscatter mode only.

Two "top of the line" gauges, the Troxler: 3440 and CPN: MC-3, have thin lift capabilities, however, their performance in this study did not justify their additional cost.

The Troxler Model 3401-B, currently owned by the MHTD, is not recommended for bituminous work because the manual data recording and manual calculations are time consuming and present the opportunity for errors.

This report recommends the MHTD implement nuclear density testing of bituminous mixtures and the MHTD purchase direct readout equipment.

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Introduction

The Missouri Highway and Transportation Department's (MHTD) current procedure for determining the density of bituminous mixtures is to cut 4-inch diameter cores. A set of four cores constitutes one density sample for thin lift bituminous mixtures. Generally the cores are cut the day after laydown at locations spaced 100 feet apart and staggered across the lane width. Therefore, density determination of the compacted mat is typically completed after being exposed to traffic.

From this typical scenerio a case could be built for implementing the use of a nuclear gauge to determine density of thin lift bituminous mixtures in a timely manner.

- More density tests could be performed at random locations, providing greater quality control, in less time.
- Density testing could be completed prior to exposure to further densification by traffic.
- Existing traffic control could protect inspectors from hazards and reduce labor costs in setting up and taking down traffic control.
- Rolling patterns could be adjusted immediately as laydown conditions change.

Overall the benefits would enhance the quality of the roadway constructed since bituminous mix design criteria is based on achieving adequate density of the bituminous mixture.

If the benefits are so rewarding, why are the nuclear density gauges not being used to monitor laydown operations?

The answer to that question is multifaceted. From a technical standpoint, attention could be directed to the nuclear density gauges used by MHTD (the Troxler 3401-B) and the recommended test method.

The majority of those gauges were purchased in 1974, and by today's standards are not very "user friendly." The time required to take the actual density test is only one minute. However, the hand calculations, keeping track of appropriate calibration tables, and interpolating ratios is time consuming and wearisome.

MHTD Test Method T41-9-79, "Density of Bituminous Mixtures with Nuclear Gauges", requires that a minimum of 16 core locations be correlated with 16 nuclear test results to establish a correction factor when operating the gauge in the backscatter mode. This correction factor is used to correct nuclear density tests taken on the remainder of the project. The Troxler 3401-B, as with all nuclear gauges, is influenced predominantly by the first 4 to 6 inches beneath them. As the thickness of the mat being tested fluctuates or the density of the substrate changes, the established calibration factor changes.

The current MHTD test method and machine are not conducive to timely and confident test results.

The "new generation" nuclear density gauges currently marketed boast thin lift features capable of "looking" only at the layer thickness specified, and the results of the density tests are displayed immediately upon completion of the test. If the correlation method could be simplified, then perhaps the method coupled with a "new generation" gauge could provide the testing agency with timely and confident results.

The purpose of this study was to determine if:

- The "new generation" gauges performed as advertised,
- The results obtained from the nuclear gauges were repeatable,
- The MHTD Test Method T41-9-79 could be revised to include fewer core densities to establish a correction factor, and
- A useable quality control procedure could be implemented in the field.

The results of this study are included in the **Discussion** section of this report.

Discussion

Equipment Evaluated - Eight nuclear density gauges representing four different manufacturers were evaluated during this study.

They were:

<u>Manufacturer</u>	<u>Model</u>
CPN	MC-1DR
CPN	MC-3
Humboldt Scientific	5001P
Seaman Nuclear	C-200
Troxler Electronics	3401-B
Troxler Electronics	3430
Troxler Electronics	3440
Troxler Electronics	4640-B

The Troxler 3401-B gauge was owned by MHTD and the other seven gauges were submitted by the manufacturers for inclusion in this study. The CPN: MC-3, Seaman: C-200, Troxler: 3440, and Troxler: 4640-B each contained internal software capable of evaluating thin lifts. The other four gauges generated a wet density value which was recognized as the bulk density of the bituminous mixture.

The nuclear sources of the Seaman: C-200 and Troxler: 4640-B were not designed to penetrate the material being tested, thereby limiting their use to density determination in the backscatter mode only. The source rod on the other six gauges was capable of penetrating the surface being tested, offering backscatter and direct transmission readings. Direct transmission readings are generally taken on compacted soils and aggregate bases.

Photographs of the gauges and a brief discussion of the operation of each gauge is included in Appendix A.

Gauge Operation - The basic operation of each gauge was similar. Generally, the nuclear source was positioned close to the surface of the compacted bituminous mat, and the gauge detector tubes were activated to begin counting reflected gamma photons. Those counts, in one form or another, were displayed to the user. Most gauge software made this data available in a pounds per cubic foot format and provided entry of a target density in order to display the percent compaction. Metric units were available on some models.

To activate the more sophisticated "thin lift mode" software, the base or substrate density had to be known. Base density was generally obtained with the same nuclear gauge requiring the data. Lift thickness was determined by punching a small diameter rod through the fresh mat and measuring the penetration.

These values were held constant during the course of testing at each site, realizing that the base density and lift thickness could vary slightly with gauge location.

Nuclear gauges were operated in general accordance with the manufacturer's published recommendations regarding testing of thin lift bituminous mixtures. If no specific instructions were provided, the testing was accomplished in general accordance with ASTM D 2950-82, "Test Method for Density of Bituminous Concrete In Place by Nuclear Method".

Standard Count Determination

All radioactive sources decay at different rates as gamma radiation is produced. A standard count must be taken to adjust the gauge to compensate for this decay. A standard reference block was included with each gauge. Typically this block was composed of a dense polyethylene plastic. The Troxler 4640-B used a one inch thick magnesium plate for a standard reference block.

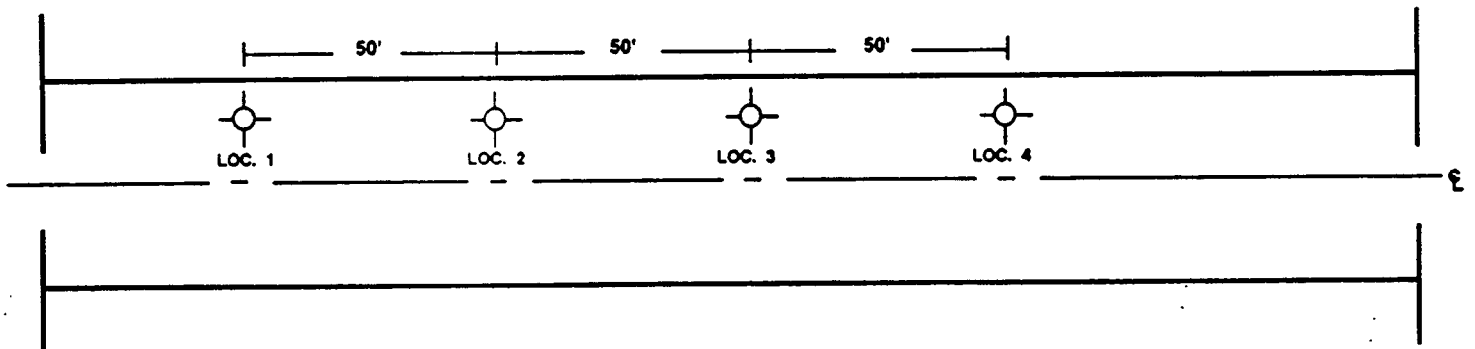
During this study, a standard count was taken each day the gauge was operated. Generally, the procedure included placing the standard reference block on the surface to be tested, then positioning the gauge on the block. A four minute count, taken with the source rod in the "safe" or shielded position, was stored internally by the machine, for future density calculations. The Troxler 3401-B gauge did not have the capability of internally storing this data, therefore, the standard count was recorded on a data sheet for wet density calculations.

The Seaman C-200 gauge did not utilize a standard count in the density calculations, but used the ratios of a one inch air gap reading and a reading when in direct contact with the surface for density determination. A standard reference block was provided to monitor source decay on a routine basis.

Standard counts were also taken at the end of the day's operation to determine if the detection system had changed appreciably

after being exposed to the heat from the bituminous mat. The results are discussed in the **Analysis of Results** portion of this report.

Test Procedure - At each test site four locations were selected 50 feet apart. Each location was checked for flatness to insure that the gauge would properly seat. A typical site layout is illustrated in Figure 1. Four, one minute nuclear density tests were taken at each location. The gauge source and detector were aligned parallel to the direction of the lane length for the first test. The gauge was then rotated 90 degrees after each one minute density test. This process is illustrated in Figure 2. Each nuclear gauge tested each of the four locations in this manner resulting in 16 nuclear density tests per test site per gauge.



Typical Test Site Layout
Figure 1

Gauge positions during testing

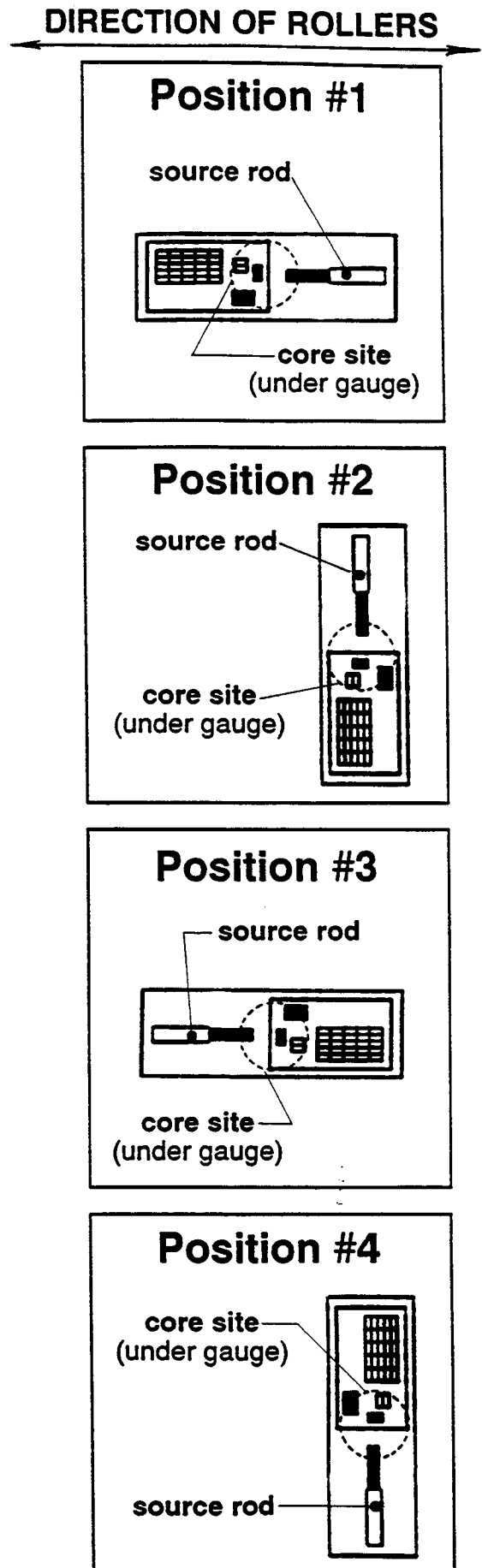


Figure 2

At the completion of all nuclear density tests at a site, a four inch diameter core was cut from the four test locations, directly beneath the gauge. The cores were returned to the Central Laboratory for bulk density determination in accordance with AASHTO T166-88, Method A, "Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens." The results of the nuclear density tests and core density determinations are summarized in Appendixes B and C.

The majority of the testing began after the finish roller had completed the rolling pattern and the mixture was cooling. All cores were obtained before traffic was allowed on the bituminous mat.

Twelve test sites deviated from this procedure when a filler material, either mineral filler or Portland cement, was used to fill surface voids prior to nuclear density testing. A series of nuclear density tests were first performed at these locations without filler material. The filler material was then spread on the surface and the same locations were retested. The results of this comparison are discussed in the **Analysis of Results** section of this report.

Bituminous Mixtures Tested - An attempt was made to perform nuclear density tests on a variety of bituminous mixtures to determine the accuracy of the gauges as the characteristics of the mixture components changed and as surface texture changed.

Mixture components including limestones, dolomite, steel slag and ground rubber, did not adversely affect the performance of the gauge.

Surface textures were divided into two groups for analysis. The first group represented a more coarse, open textured surface. Bituminous mixtures tested in this group included MHTD's Type I-B, Type B and Bituminous Base. The second group represented a smoother texture with fewer surface voids, and included MHTD's Type I-C, Type C and Bituminous Pavement mixtures. The mixtures tested and their location within the state are summarized in Appendix E.

Analysis of Data

Statistical analysis of the data was performed using SAS (Statistical Analysis Systems) computer programs. (SAS Institute Inc., SAS User's Guide: Statistics, Version 5 Edition, SAS Institute, Inc., Cary, NC, 1985.) Core densities were considered to be the actual density at each location. Each analysis is discussed below.

Precision - The Analysis of Variance (ANOVA) procedure, was used to measure the precision of individual models of nuclear density gauges. This procedure evaluated the variation between the four nuclear density readings at each test location. Occasionally data was not collected when a gauge would not operate due to a

low battery. The results are tabulated in Table 1 in ascending order of index of precision values.

TABLE 1
Summary of ANOVA Procedure

<u>Model</u>	<u>Index of Precision σ</u>	<u>2σ</u>	<u>Mean \bar{x}</u>	<u>Range $\bar{x} \pm 2 \sigma$</u>
MC-3	1.2	2.4	139.6	137.2-142.0
C-200	1.3	2.6	139.4	136.8-142.0
5001P	2.0	4.0	140.1	136.1-144.1
MC-1DR	2.2	4.4	136.7	132.3-141.1
4640-B	2.5	5.0	140.7	135.7-145.7
3440	2.6	5.2	143.1	137.9-148.3
3401-B	2.9	5.8	141.4	135.6-147.2
3430	3.2	6.4	143.0	136.6-149.4

The range is a measure of dispersion around the average that 95 percent of the readings can be expected to fall within. The greater the range, the greater the possible variation between individual readings.

Based on the results of the ANOVA procedure, it appears that the index of precision for all gauges is unacceptable. The results do, however, confirm that a single nuclear density reading would not be recommended due to the wide range of values possible. The average of multiple nuclear density readings would produce a more favorable comparison to actual density.

Accuracy - All data was analyzed using the paired comparison t-test procedure. This procedure compared the average of the sixteen nuclear density readings for each gauge with the average

of four core densities representing each test site. The paired comparison t-test analysis is a determination of whether or not the average difference between nuclear and core densities is significantly different from zero at a given level of significance. The paired comparison t values are tabulated in Table 2 in ascending order.

TABLE 2
Summary of Paired Comparison Analysis

<u>Model</u>	<u>Mean Diff. Between Nuclear and Core</u>	<u>Standard Error (SE)</u>	<u>t = Mean/SE</u>	<u>No. of Observ.</u>
Troxler: 3401-B	0.64	0.36	1.76	66
Troxler: 3430	-0.86	0.48	-1.80	63
Troxler: 4640-B	1.16	0.48	2.39	67
Troxler: 3440	-1.27	0.42	-3.04	67
CPN:MC-3	2.31	0.58	3.97	66
Humboldt: 5001P	1.80	0.38	4.77	67
Seaman: C-200	2.68	0.37	7.21	63
CPN:MC-1DR	5.25	0.49	10.78	67

Values of t greater than +2.00 or less than -2.00 are considered significant at a 95 percent probability level. (Croxtan, Frederick E. and Dudley J. Cowden, Applied General Statistics, 2nd edition, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1955, p. 751.) No correction factor had been applied to the nuclear readings analyzed for the CPN: MC-1DR, Humboldt: 5001P, Troxler: 3401-B, and Troxler: 3430 gauges. However, the CPN: MC-3, Seaman: C-200, Troxler: 3440, and Troxler: 4640-B results were considered corrected by way of internal software as discussed

previously. Based on this analysis, it appears that these models would still require additional correction.

Correction Factors - The correction factor is a value added to or subtracted from the nuclear reading to correct the nuclear density to the actual (core) density. Typically, the correction factor is established by taking a series of nuclear density readings and comparing those to core densities from the same locations. The correction factor is the numeric difference in pounds per cubic foot between core and nuclear densities.

Historically, MHTD has required that a minimum of four cores be cut from a compacted thin layer of bituminous mixture to constitute a density sample for acceptance. Generally, four randomly selected locations will adequately represent a bituminous mixture for a given lot size. For the same reason, four cores were used to establish a correction factor. The results of this procedure are discussed in the **Proposed Testing Procedure** section of this report.

Surface Voids - As previously mentioned, nuclear density gauges are influenced predominately by the first 4 to 6 inches beneath them. Additionally the texture of the surface affects the output.

To determine the influence of surface voids, 12 locations were tested first without filler, and then with a filler material.

The filler material was either Portland cement or mineral filler, both available on most construction sites throughout the state. The 12 locations were separated into groups representing four surface preparation conditions; smooth textured surfaces with and without filler material, and coarse textured surfaces with and without filler material.

Standard deviations were calculated for individual gauges on the difference between average nuclear density readings and average core densities for the four surface preparation conditions. This difference between the nuclear and core densities was previously defined as the correction factor. The results are presented in Table 3. Based on the standard deviations tabulated in Table 3, filling surface voids did not consistently improve the accuracy of the gauges.

TABLE 3

Summary of Standard Deviations of Correction Factors

<u>Gauge Model</u>	<u>Condition No.*</u>	<u>Standard Deviations</u>
		<u>16 Nuclear, 4 Cores</u>
CPN: MC-1DR	1	1.19
	2	2.21
	3	1.19
	4	1.19
CPN: MC-3	1	3.70
	2	3.71
	3	4.81
	4	5.03
Humboldt: 5001P	1	0.76
	2	0.75
	3	0.73
	4	0.64
Seaman: C-200	1	0.46
	2	1.08
	3	0.77
	4	0.35
Troxler: 3401-B	1	1.56
	2	0.88
	3	0.80
	4	0.66
Troxler: 3430	1	0.53
	2	0.94
	3	1.40
	4	1.06
Troxler: 3440	1	2.41
	2	2.06
	3	3.31
	4	3.11
Troxler 4640-B	1	2.41
	2	2.97
	3	4.18
	4	4.64

*Condition Numbers Represent:

- 1 - Smooth Textured Surfaces Without Filler
- 2 - Smooth Textured Surfaces With Filler
- 3 - Coarse Textured Surfaces Without Filler
- 4 - Coarse Textured Surfaces With Filler

Comparison of Longitudinal and Transverse Readings - The nuclear density results were further analyzed to determine if any significant effects were observable regarding placement of the gauge in relation to the direction of the rolling pattern. This was to determine whether minute transverse cracks, which may be introduced in the mat during the rolling process, create a path for the gamma photons to quickly reach the detector tubes, resulting in a lower density reading.

The longitudinal direction readings (readings 1 and 3) at each location were compared to the transverse direction readings (readings 2 and 4), for each gauge. Readings 1 and 3 were averaged and compared to readings 2 and 4. The ANOVA procedure was used to calculate an F-ratio to determine significance. The results are tabulated in Table 4.

TABLE 4

**Summary of ANOVA Procedure
For Longitudinal and Transverse Readings**

<u>Model</u>	<u>F-Ratio</u>
CPN: MC-1DR	0.88
CPN: MC-3	0.16
Humboldt: 5001P	0.21
Seaman: C-200	0.01
Troxler: 3401-B	4.75
Troxler: 3430	2.35
Troxler: 3440	0.98
Troxler: 4640-B	0.26

An F-ratio greater than 3.84 for the number of readings evaluated is considered significant at a 95 percent probability level.

(Bowker, Albert H. and Gerald J. Lieberman, Engineering Statistics, 2nd ed., Prentice-Hall, Inc., Englewood Cliffs, NJ, 1972, p. 606.)

Based on this analysis, there was no significant difference between transverse or longitudinal direction readings with the exception of the Troxler 3401-B.

Standard Count Analysis - The paired comparison t-test was performed on the beginning and ending standard counts in an attempt to monitor the influence of change of temperature on the gauge. The results of the paired comparison analysis are tabulated in Table 5. No significant changes were noted in most of the gauges. There was a statistical difference between beginning and ending standard counts for the CPN: MC-3 and Troxler: 4640-B. For the number of observations considered, a value less than -2.09 for the CPN: MC-3 and a value less than -2.08 for the Troxler: 4640-B is considered significant at a 95 percent probability level. (Croxtton, Frederick E. and Dudley J. Cowden, Applied General Statistics, 2nd ed., Prentice-Hall, Inc., Englewood Coiffs, NJ, 1955, p. 751.) A summary of the standard counts taken during this study are reported in Appendix C.

TABLE 5

Summary of Paired Comparison Analysis
For Standard Count Data

<u>Model</u>	<u>Mean Difference Between Beginning And Ending Std. Counts</u>	<u>Standard Error (SE)</u>	<u>t = Mean/SE</u>	<u>No. of Observ.</u>
CPN: MC-1DR	5.95	45.98	0.13	22
CPN: MC-3	-105.00	29.85	-3.52	21
Humboldt: 5001P	44.04	45.15	0.98	24
Seaman: C-200	3.69	3.39	1.09	16
Troxler: 3401-B	5.25	4.23	1.24	24
Troxler: 3430	-2.48	3.11	-0.80	21
Troxler: 3440	-38.63	41.21	-0.94	24
Troxler: 4640-B	-49.59	5.69	-8.72	22

Proposed Testing Procedure

All gauges, regardless of their sophistication, required at least one series of tests to establish some sort of correlation between nuclear and core densities. Sometimes this correlation is termed calibration factor, density bias, or correction factor by the various manufacturers.

The proposed nuclear density testing procedure is:

1. Select four test locations at random after rolling is completed.
2. Take four, one minute nuclear density tests at each of the four test locations, rotating the nuclear gauge 90 degrees after each one minute test.
3. Cut one core from each of the four locations before the compacted mixture is exposed to traffic.
4. Determine the core densities in accordance with AASHTO T166-83, Method A.

5. Establish a correction factor by taking the difference between the average core density and the average of the nuclear density readings.
6. Apply the correction factor to the remaining nuclear density tests taken that day which are not represented by a core. Actual corrected densities would not be available until completion of the correction factor calculations for the day.
7. A new correction factor for each day's production is recommended to account for variations in thickness and density of the substrate.
8. A filler material is not required to fill surface voids on MHTD mixtures unless, at the discretion of the MHTD inspector, the surface texture conditions warrant filling surface voids. Whatever the mixture type or surface texture conditions, the nuclear density tests should be conducted using the same surface preparation as used while establishing the correction factor.

Field Evaluation of Proposed Test Procedure

This proposed test procedure does not appear to offer density results in a timely manner since correction factor calculations are not completed until the day following laydown. However, the nuclear gauge operator, familiar with that gauge's output, should be able to predict a reasonable correction factor during the initial laydown operation. On subsequent days of production the

density could be estimated using the previous day's correction factor.

To determine if this proposed procedure yields satisfactory results, the proposed test procedure was simulated in the field on test sites 44 through 67. Using data generated from the Troxler 3401-B, the correction factor for location number 44 (CF₄₄) was +4.3 pcf. This value was obtained by subtracting the average density of four cores from the average of 16 nuclear density readings. A data sheet with this information is illustrated in Figure 3.

At location number 45, representing the next day's production, the average nuclear density reading (ND₄₅) was 138.1 pcf. By adding CF₄₄ (+4.3 pcf), the density at location number 45 is estimated to be 142.4 pcf. The actual core densities (CD₄₅) averaged 141.8 pcf.

Nuclear density tests taken on this day would be corrected by +3.7 PCF (CF₄₅), the difference between CD₄₅ (141.8 pcf) and ND₄₅ (138.1 pcf). CF₄₅ would be used the next day at location number 46 to estimate densities. This procedure would continue with the generated results tabulated in Table 6.

Bituminous Layer Construction Test Results

Route C026-RTRK County Cole Date 10-22-90
 Project No. HPPDFAC Gauge/Model No. TROXLER 3401-B
 Mixture No. BB90-217 Density Standard Count 2869
 Bulk Specific Gravity ("d") = 2.382 Unit Weight = 148.6 pcf

Test Number	Location No.44	Nuclear Density (PCF)	Core Density (PCF)	Correction Factor (PCF)	Corrected Density (PCF)	Percent Compaction
1	STA 55+50	138.0	142.4			
2	"	138.8				
3	"	137.0				
4	"	137.0				
5	STA 56+00	137.0	141.1			
6	"	138.0				
7	"	136.0				
8	"	137.3				
9	STA 56+50	133.0	140.9			
10	"	137.0				
11	"	137.3				
12	"	136.8				
13	STA 57+00	139.5	143.6			
14	"	141.3				
15	"	140.0				
16	"	140.0				
	AVERAGE	137.8	142.0	4.2	142.0	95.6

Figure 3

TABLE 6

**Results of Proposed Test Procedure
Using Troxler 3401-B**

<u>Location Number</u>	<u>Nuclear Density (PCF)</u>	<u>Correction Factor (PCF)</u>	<u>Estimated Density (PCF)</u>	<u>Core Density</u>
45	138.1	CF ₄₄ = 4.3	142.4	141.8
46	140.4	CF ₄₅ = 3.7	144.1	144.4
47	140.9	CF ₄₆ = 4.0	144.9	145.3
48	139.8	CF ₄₇ = 4.4	144.2	143.0
49	140.5	CF ₄₈ = 3.2	143.7	142.9
50	139.9	CF ₄₉ = 2.4	142.3	142.3
51	137.0	CF ₅₀ = 2.4	139.4	141.1

The paired comparison t-test was performed to determine if a statistical significance existed between estimated nuclear densities and core densities. Values of t greater than 3.18 or less than -3.18 for the smooth textured surfaces and greater than 2.37 or less than -2.37 for the coarse texture surfaces are considered significant at a 95 percent probability level.

(Croxtton, Frederick E. and Dudley J. Cowden, Applied General Statistics, 2nd ed., Prentice-Hall, Inc., Englewood Cliffs, NJ, 1955, p. 751.) Results of this analysis are tabulated in Table 7.

TABLE 7

Summary of Percent Difference
Between Estimated and Actual Core Densities

<u>Model</u>	<u>Surface Texture*</u>	<u>Mean Diff. Between Est. Core Density</u>	<u>Standard Error (SE)</u>	<u>t = Mean/SE</u>
CPN: MC-1DR	S	0.95	0.97	0.98
	C	-0.05	0.42	0.13
CPN:MC-3	S	0.54	2.22	0.24
	C	0.84	2.27	0.37
Humboldt: 5001P	S	-0.84	0.51	-1.65
	C	-0.40	0.61	-0.65
Seaman: C-200	S	No Data Collected - Gauge Malfunction		
	C	-0.16	0.42	-0.39
Troxler: 3401-B	S	-0.81	1.43	-0.57
	C	-0.34	0.48	-0.70
Troxler: 3430	S	0.34	0.63	0.54
	C	0.004	0.68	0.00
Troxler: 3440	S	0.96	1.16	0.83
	C	0.60	1.60	0.37
Troxler: 4640-B	S	0.72	2.22	0.32
	C	-0.29	1.53	-0.19

*S = Smooth Textured Surfaces
C = Coarse Textured Surfaces

Regardless of the gauge model, this procedure was capable of accurately estimating the density of smooth and coarse textured bituminous mixtures.

Conclusions

Based on the results of this study, the following conclusions are made:

The results displayed by the gauge must be compared to actual core densities to establish a correction factor. Four cores coupled with 16 nuclear density tests can provide a suitable

correction factor for a day's production. A new correction factor for each day's production is recommended. Density can be estimated using the previous day's production until a new daily correction factor is determined.

The possible variation of a single nuclear density reading is unacceptable. Averaging multiple readings would produce a more favorable comparison to actual density.

All gauges evaluated in this study require a correction factor. The "new generation" thin lift density gauges are not necessarily more accurate than gauges without the thin lift mode.

Gauge position in relation to the direction of rolling does not significantly affect the results of the nuclear tests.

Using a filler material such as Portland cement or mineral filler to improve the accuracy of the gauge is not warranted. However, the use of a filler material is left up to the discretion of the MHTD inspector. If filler is used to establish a correction factor, its use should be continued on nuclear density tests using that correction factor.

Monitoring compaction is a continuous process. A nuclear density gauge, used as a quality control tool on bituminous mixtures, can enhance the quality of the roadways constructed by providing timely density results.

Recommendations

The following nuclear density gauges are recommended to monitor the density of MHTD bituminous mixtures: CPN: MC-1DR, Humboldt: 5001P, and Troxler: 3430. These gauges would provide the versatility of testing either in the direct transmission or backscatter mode.

The additional cost of obtaining a "new generation" nuclear gauge with the thin layer capability is not justified. Their performance in this study was generally no better than the standard gauges and a correction factor was still necessary to adjust nuclear density readings to core densities.

The Seaman: C-200 and Troxler: 4640-B are not recommended for purchase by the MHTD since they operate in the backscatter mode only.

The proposed test procedure described in this report is recommended for implementation. Applicable portions of MHTD test method T41-9-94 should be changed to incorporate the proposed test procedure.

Obtaining nuclear density tests and cutting cores for a correction factor before traffic is allowed on the mixture is emphasized.

A correction factor should be established for each day's production to compensate for variations in compacted bituminous mixture thickness and the density of the underlying layers. Relying solely on nuclear density readings, without the benefit of a current correction factor, is not recommended.

APPENDIX A
DISCUSSION OF GAUGE OPERATIONS

Gauge Operations - The following is a description of the operation of the nuclear density gauges as used in the thin lift study. The gauges were operated in general accordance with the manufacturer's recommendations regarding thin lift density determination.

No attempt was made to describe or evaluate all of the features of each gauge.

Note: Calibrations were performed at the factory for each gauge prior to their use in this study.

CPN: MC-1DR

The CPN MC-1DR model was perhaps the simplest gauge to operate primarily because there were only three keys; "Start", "Step", and "Standard". The available output is limited to the wet density, total moisture, dry density, percent moisture, density count, and moisture count. All information was presented in English units. No thin lift option was available on this model.

To start a test, the source rod was lowered to the "AC" position and the "start" key was depressed. One minute tests were taken for all density tests. Changing the test time was not an option. The depth of the source rod was automatically input and displayed during the test. Upon completion of the test, the results were displayed two at a time on the liquid crystal diode (LCD) screen. The "step" key was used to scroll through the available results.

To take a standard count the gauge was positioned on the standard reference block with the source rod in the "safe" position. The "standard" key was then depressed and the previous standard density and moisture counts were displayed. Depressing the "start" key at this point would activate a new four minute standard count.

The two line display screen automatically turns off after approximately 30 seconds of non-use. Depressing the "step" key activates the screen with the most recent data displayed.



CPN: MC-3

The CPN Model MC-3 had a "Thin Layer" mode which was used in the study. Our procedure for implementing this mode was to first determine the density of the substrate, prior to placement of the overlay, using the MC-3 in the backscatter position.

A series of multiple key strokes activated a "thin layer" screen which prompted the user for the overlay lift thickness and substrate density. Once these values were entered, the thin lift mode was activated.

The typical series of one minute density tests were then performed for one day. Cores representing those density tests were cut and core densities were determined early the next morning. The average difference between nuclear and core density was entered as the density bias (or correction factor) for future tests on that material. The density bias was a direct addition or subtraction to the nuclear density result. The final gauge set-up included the use of the thin layer mode and the density bias.

The LCD display screen goes blank after approximately 60 seconds, to conserve power. Depressing the "step" key activates the screen with the current data displayed.

The standard count was obtained by placing the gauge on the standard reference block. When the "standard" key was depressed, the screen displayed the previous and current standard counts, and instructions to continue. Depressing the "start" key initiated a four minute standard count. At the completion of the standard count, the screen was updated with the current data.



HUMBOLDT: 5001P

The operation of the Humboldt Model 5001P was fairly straightforward. The gauge did not offer thin lift density capability per se, but the instruction manual provided a formula for calculating a correction factor. The manual stated, however, that "unless the thickness of the compacted layer can be very carefully controlled or measured, the correction should not be used at less than 1.5 inches." The correction factor suggested was not used since the majority of the overlays tested were 1.25 inches in thickness.

The depth of the source rod was keyed into the machine and was displayed on one of two LCD display screens labeled "depth". The density test was initiated by depressing one of the three Measurement Keys; "Slow" (four minutes), "Normal" (one minute), and "Fast" (15 seconds). After completion of the density test, the results are displayed on the "Data" screen following the appropriate keystrokes such as "WD" for Wet Density and "% MA" for percent of Marshall Density.

The four minute standard count was taken with the gauge on the Standard reference block and with the source rod in the safe position. The new standard count was stored in memory and used to process subsequent measurements.



SEAMAN: C-200

The Seaman C-200 gauge was the only one evaluated which used radium rather than Cesium 137 for the source of the gamma radiation. Additionally, the radioactive source was not attached to a rod which penetrated the body of the gauge.

The C-200 used the air-gap ratio procedure, as discussed in ASTM D2950 Section 8, for determining density. The position of the carrying handle determined if the source was in the shielded, contact, or air-gap position.

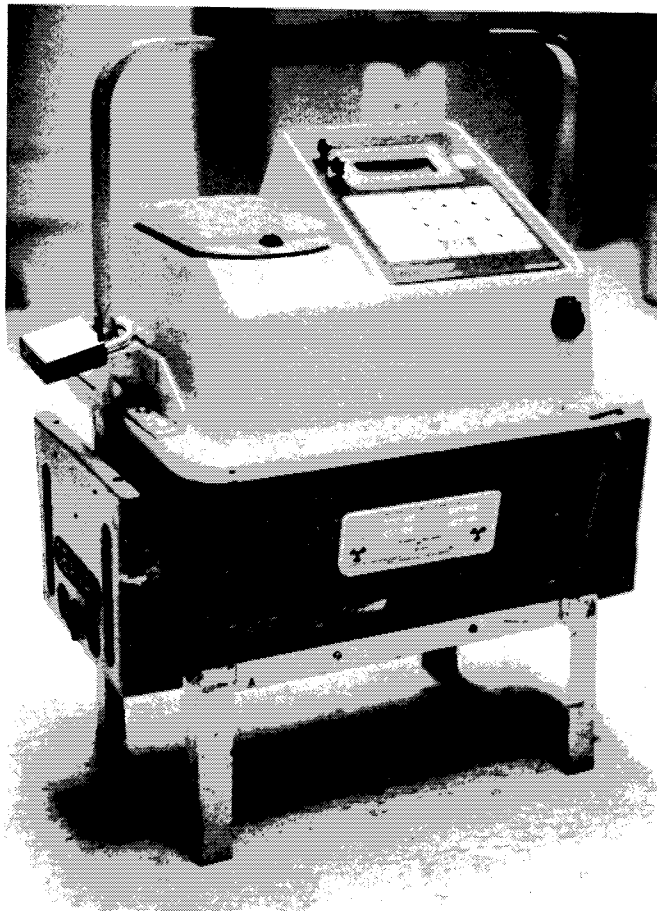
Thin lift density measurement capability was offered in the C-200. To utilize this option the overlay thickness and substrate density are required. The substrate density was determined with the gauge and the thickness was measured to the nearest 0.25 inch.

Density tests began with a one minute contact count by pushing the handle toward the rear of the machine, placing the source in contact with the surface. After completion of this count, the single line LCD display screen would indicate that the count was finished. The handle was then moved toward the front of the machine for the air gap count. This action lifted the gauge from the surface creating the air gap and unshielded the source in the base of the gauge. Once in position, the one minute air gap count was initiated.

Upon completion of the air gap count, overlay density was displayed by depressing the "Top Lift Density" key.

The operator's manual indicated that air-gap counts were not necessary for every density test if the air gap counts are consistent (± 50 counts per minute). During this study air gap counts were taken on all tests.

The four minute standard count was taken with the source in the contact position, the gauge sitting on the standard reference stand, and the standard reference block sitting on the material being tested.



TROXLER: 3401-B

The Troxler 3401-B gauge provided the density counts and the operator was required to perform all calculations, including wet density determination. Gauge operation was very simple since the controls consisted of three switches and the LCD display screen was a single line. The three switches select the test time, control the output of the display screen, and initiate the density count.

A four minute standard count was performed at the beginning of each day with the source in the shielded position and the gauge on the standard reference block.

One minute density counts were taken with the source rod in the backscatter position and the result of that test was manually recorded. To determine the wet density, the one minute density count is divided by the standard density count established at the beginning of the day on the reference block. The wet density corresponding to this ratio was selected from the backscatter calibration chart established for the gauge.



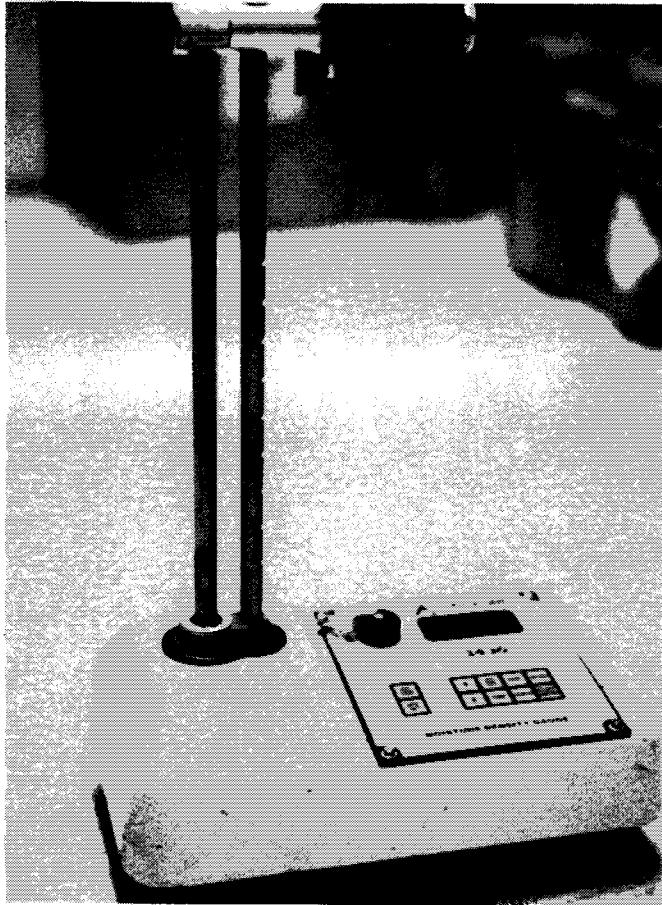
TROXLER: 3430

The Troxler Model 3430 evaluated in this study was a prototype recently developed by Troxler Electronics. The gauge was simple and straightforward to use and the test results were direct readout on a two line LCD screen. Special functions available were not necessarily applicable to thin lift density measurements.

Prior to starting a test, the depth of the source rod and time of test were entered from the keyboard. Two arrow keys on the keyboard were used to scroll through the available options to choose backscatter for the depth and one minute for the time. This configuration was stored in the gauge memory until it was changed.

The source rod was lowered to the backscatter position and the "start" key was depressed to take a one minute density measurement.

Four minute standard counts were performed each day of gauge operation with the standard reference block placed on the surface being tested, and the source rod in the shielded position. At the completion of the standard count, the result was automatically stored in memory for future test calculations. All calculations are performed internally by gauge software.



TROXLER 3440

The Troxler 3440 offered a Nomograph option which used the lift thickness and the substrate density or overlay density in the calculations. Initially all tests were performed with the Nomograph Function, inputting the overlay thickness and the substrate density. During the course of the study, Troxler representatives indicated that more accurate results could be realized if the overlay density was input when initiating the Nomograph option. This procedure required performance of one series of nuclear tests, averaging those nuclear tests, cutting cores, determining average core density, and inputting this data in the Nomograph Function the next day. This procedure was followed for the remainder of the study with the exception of the first series of tests performed on a new mixture, where no core densities were available. In that case, the measured substrate density was put in the Nomograph Function.

Once the Nomograph Function was enabled, the operation of the gauge included lowering the source rod to the backscatter position and depressing the "Start" key to begin the one minute density test. The result of the density test was displayed on the four line LCD display screen. The depth of the source rod was automatically entered through an electrical sensor on the index rod.

Four minute standard counts were performed each day of gauge operation with the standard reference block placed on the surface

being tested, and the source rod in the shielded position. At the completion of the standard count, the result was automatically stored in memory for future test calculations. All calculations are performed internally by gauge software.



TROXLER 4640-B

The Troxler 4640-B source rod was not capable of penetrating the surface of the material being tested, and is designed specifically for thin lift density determinations only.

The results of the nuclear density tests were determined using either the factory calibration of the gauge or a special calibration generated in the field.

To perform a nuclear density test using the factory calibration the overlay thickness and the specified test time was entered. Generally the instructions displayed on the four line LCD display screen were self-explanatory, indicating what keystrokes were necessary to enter data.

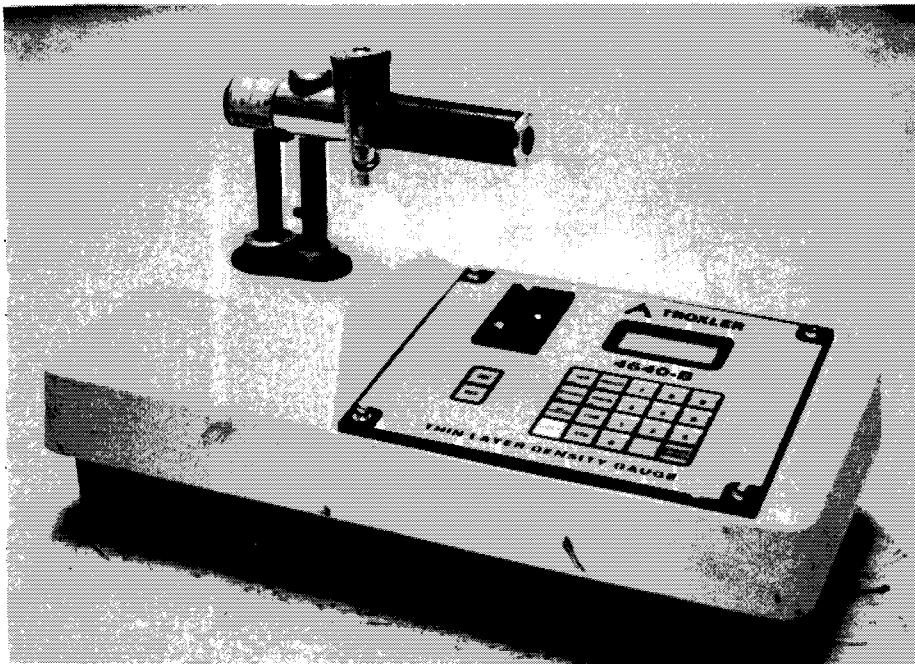
The source rod was then lowered to the backscatter position, and the "start" key depressed to begin the one minute test. After completion of the test, the results were automatically displayed. The factory calibration was used on approximately one-third of the test sites.

The special calibration function was used to establish a unique calibration curve for the bituminous mixtures tested on a particular project. The special calibration function prompted the user to perform nuclear density tests and then enter the core density data from the same test locations. As a minimum, 16

nuclear density tests and four core densities were taken to establish a special calibration.

Future nuclear tests on that particular mixture were then evaluated using the special calibration for the mixture. New mixtures required the generation of new special calibrations.

Four minute standard counts were performed on each day of gauge operation, with the source rod in the shielded position. The gauge was placed on an air gap spacer which was positioned on a magnesium standard reference block, resting on the surface being tested.



APPENDIX B
SUMMARY OF NUCLEAR DATA

Nuclear Density Data

CPN: MC-1DR

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
1	117.68	120.13	121.25	123.16	120.59	122.40	124.58	122.42	121.58	122.70	122.08	121.27	139.68	141.61	139.20	141.95
2	138.85	138.66	138.94	138.50	140.48	139.50	140.10	139.64	136.07	137.87	136.63	136.90	155.93	152.61	155.80	153.91
3	138.04	137.71	136.63	136.82	133.93	134.84	132.37	134.79	137.30	136.21	136.57	137.53	138.64	138.59	139.19	138.42
4	141.31	140.69	140.22	141.28	154.95	152.06	150.81	152.82	147.45	147.14	147.35	146.00	148.17	148.90	148.14	149.35
5	149.61	147.45	148.89	149.49	144.97	145.97	143.22	145.74	143.41	143.22	144.94	144.97	145.76	146.49	146.06	148.09
6	142.88	144.90	145.46	146.89	146.28	145.48	146.63	146.60	153.40	153.81	152.24	152.20	152.46	153.52	152.30	151.02
7	149.37	148.70	148.65	149.53	145.63	147.26	145.84	146.89	146.39	147.15	146.58	146.32	148.78	148.69	150.69	150.37
8	136.06	136.33	136.68	139.83	142.30	143.83	143.02	143.27	148.26	149.14	148.13	148.60	140.57	141.47	141.13	141.55
9	102.61	110.46	111.70	111.94	137.65	137.29	136.71	136.71	109.93	134.58	135.53	134.29	112.21	118.13	117.66	118.96
10	143.47	143.74	143.38	142.86	139.72	140.69	139.56	139.92	138.99	140.97	131.35	141.28	132.11	133.71	132.39	133.39
11	137.81	135.13	135.18	135.57	137.17	137.47	137.24	137.32	134.30	135.03	134.75	134.33	134.92	135.32	134.96	134.69
12	140.86	140.05	140.71	139.55	141.14	140.31	141.05	141.38	142.23	141.63	140.93	142.92	145.04	144.85	144.26	144.86
13	139.82	140.76	139.78	140.32	142.20	141.77	142.19	142.70	141.91	142.32	141.89	142.55	143.52	143.28	143.43	143.61
14	139.17	139.61	139.10	140.34	140.67	141.50	140.52	140.27	140.20	132.36	140.83	137.71	142.33	142.12	141.93	141.81
15	136.99	138.76	138.03	137.44	139.36	138.50	138.98	139.59	125.89	123.03	125.61	122.32	142.10	141.84	142.19	140.37
16	141.19	141.23	141.55	140.62	141.81	141.44	141.09	141.92	141.29	139.94	140.61	139.81	140.76	141.35	141.34	140.73
17	139.30	139.01	139.62	139.09	138.12	138.51	137.30	138.02	141.52	141.89	139.95	139.95	142.31	143.39	142.87	142.08
18	132.86	133.11	132.42	132.23	131.05	131.65	132.75	132.49	135.58	134.93	135.47	134.60	134.47	133.22	134.32	134.30
19	136.65	135.61	136.92	136.36	135.75	134.80	136.59	136.26	135.34	135.71	136.83	135.86	137.18	136.02	137.43	135.85
20	131.99	132.19	131.74	133.04	136.11	138.06	137.76	137.61	137.42	137.24	137.79	136.55	135.41	137.27	135.45	136.92
21	132.30	133.02	132.25	133.11	131.94	131.25	130.97	130.68	133.69	134.30	133.93	135.19	128.81	129.50	129.75	130.63
22	137.27	138.17	137.63	137.86	137.77	137.61	136.40	137.14	133.11	136.48	136.25	136.02	134.25	135.73	135.28	133.66
23	134.36	135.37	134.48	135.13	136.08	135.19	135.78	135.11	135.68	136.38	136.65	135.71	132.54	133.25	132.94	133.06
24	133.61	134.85	134.06	133.57	133.36	133.66	133.15	132.58	131.43	130.31	132.67	132.88	136.64	135.29	137.42	135.68
25	134.78	135.19	134.84	134.19	135.01	136.31	135.54	135.55	137.60	137.73	137.53	137.78	137.42	135.19	137.15	136.14
26	131.13	131.90	132.40	132.60	132.93	132.04	133.34	133.26	137.48	137.91	137.34	137.03	133.02	135.07	133.91	133.44
27	129.88	130.12	130.42	129.97	131.69	132.75	132.33	132.97	132.30	132.17	132.02	133.26	130.74	132.98	131.27	132.06
28	136.37	137.00	135.90	135.47	134.62	135.20	134.49	135.66	133.14	133.41	134.21	133.67	134.95	135.74	136.00	136.13
29	129.50	129.49	129.56	129.29	134.38	135.98	136.21	135.62	134.17	135.24	135.02	133.85	136.21	135.53	134.52	134.67
30	136.74	137.39	136.27	137.02	136.65	137.16	135.83	137.15	133.61	133.81	133.74	134.35	135.94	136.21	135.75	136.30
31	137.14	135.86	135.60	136.99	137.33	136.75	138.53	137.89	138.03	138.37	139.86	138.71	136.97	137.31	136.64	136.94
32	138.71	137.71	139.13	138.37	138.84	138.04	138.54	139.66	135.11	135.18	136.47	134.42	136.25	135.74	136.31	136.33
33	136.22	135.91	136.28	136.49	132.77	134.24	134.43	131.71	135.91	135.09	135.99	134.82	138.19	151.47	148.00	138.73
34	138.49	137.45	138.76	137.98	137.11	135.18	136.78	136.81	136.30	137.00	138.00	136.26	130.12	130.33	128.97	129.39

Nuclear Density Data
CPN: MC-1DR

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
35	135.82	136.40	134.79	136.65	138.24	137.25	139.27	137.72	138.29	138.42	138.81	138.62	134.36	135.01	135.86	135.72
36	134.41	133.86	134.64	133.61	137.22	134.81	136.21	135.83	134.45	135.01	135.05	134.46	133.20	133.25	133.94	132.88
37	135.25	134.21	135.90	135.71	138.24	138.31	137.71	138.05	136.12	134.77	136.88	136.68	126.52	135.86	139.74	135.13
38	139.97	138.96	139.51	139.55	136.86	136.84	137.32	136.42	134.66	133.67	133.82	133.69	135.98	135.03	135.55	135.28
39	142.35	142.21	142.01	141.17	137.37	138.82	137.87	136.37	135.96	136.98	136.73	139.14	128.13	138.54	131.00	136.62
40	162.40	162.90	160.13	159.87	159.49	160.29	159.89	160.31	136.55	139.09	139.15	135.95	157.41	158.13	157.61	158.87
41	129.20	129.96	129.07	129.71	130.96	129.84	131.40	130.99	132.77	131.64	132.68	130.31	132.21	131.87	133.79	133.69
42	125.36	125.71	125.96	124.69	131.01	128.23	132.38	130.87	136.30	132.57	135.36	133.18	126.83	127.42	129.15	128.19
43	137.35	135.15	137.07	135.17	135.09	135.20	136.15	133.49	131.88	131.73	133.53	134.38	134.63	134.37	136.19	134.00
44	133.67	133.30	132.84	132.25	132.81	133.16	132.86	132.13	131.63	131.89	131.44	132.92	134.94	134.59	135.29	135.98
45	131.06	130.58	129.76	132.60	136.20	136.27	137.23	137.46	134.36	134.53	132.24	133.71	131.21	131.89	131.43	130.95
46	137.04	137.93	137.62	137.62	133.50	133.32	135.43	136.45	134.75	135.42	137.37	134.27	137.48	137.96	137.23	137.17
47	135.35	135.86	135.95	136.34	133.98	136.38	146.47	134.77	138.65	138.11	138.52	146.75	148.77	138.23	140.12	138.88
48	135.32	134.69	136.77	136.31	131.95	137.11	136.05	142.59	135.09	137.77	135.98	138.29	135.09	135.92	135.41	136.09
49	134.32	137.56	135.92	142.83	139.37	135.26	132.75	131.65	133.91	146.47	139.39	136.50	133.91	136.04	136.98	137.06
50	130.61	133.94	131.99	139.55	137.02	136.54	141.00	136.86	136.76	131.38	143.06	132.11	135.44	136.65	143.77	136.53
51	131.16	132.32	134.73	147.03	127.73	130.88	128.91	131.63	129.55	131.38	132.71	131.37	135.20	133.51	138.55	131.90
52	131.15	133.38	133.41	133.58	134.84	136.41	136.25	137.05	135.58	144.06	141.21	135.88	135.22	135.54	136.71	135.58
53	147.87	137.48	136.47	137.22	131.82	133.41	132.33	132.24	131.49	138.22	131.22	132.93	132.33	131.91	135.94	143.23
54	131.87	132.92	134.87	140.36	126.57	137.19	138.00	132.86	132.19	133.59	131.69	133.44	126.57	131.35	131.18	128.12
55	137.24	146.06	146.38	146.67	130.52	130.86	138.10	141.23	133.95	140.03	143.60	133.71	131.00	138.57	135.86	139.86
56	135.76	136.20	136.60	134.92	135.73	134.77	134.26	136.08	133.71	133.28	135.38	134.92	136.52	137.56	137.57	136.47
57	134.78	132.95	132.63	134.28	138.97	138.54	138.09	137.53	136.61	136.03	134.80	135.39	133.34	134.09	133.22	133.98
58	139.38	141.51	140.74	139.59	138.19	136.68	137.44	137.93	137.02	138.09	138.32	137.57	139.08	139.07	140.02	140.74
59	136.88	139.65	138.24	139.02	138.17	138.22	138.80	139.08	141.42	141.68	143.28	145.89	139.27	141.49	142.29	141.37
60	136.64	139.20	139.63	149.83	135.06	142.27	143.00	139.28	137.56	142.09	138.42	140.59	136.93	135.85	137.73	138.45
61	135.07	136.22	135.85	136.60	134.58	135.70	135.45	134.80	135.25	137.47	136.20	138.28	135.69	136.70	138.95	136.70
62	132.21	134.25	134.51	135.68	138.85	137.49	142.26	140.97	138.31	136.58	139.27	144.33	138.46	136.85	140.29	135.09
63	136.47	137.37	135.89	135.95	120.71	136.02	134.93	135.76	135.31	136.66	141.62	137.21	138.41	139.27	142.19	146.75
64	134.13	135.52	135.78	136.34	137.39	137.63	137.96	136.29	137.95	141.05	138.97	139.07	136.29	136.29	138.78	139.16
65	136.10	136.32	135.75	137.15	133.79	134.61	133.34	139.39	135.76	127.67	134.16	132.47	133.85	132.52	134.90	141.64
66	133.11	134.18	137.73	137.23	131.73	132.93	133.96	131.03	136.04	134.32	142.29	141.24	130.29	137.56	137.79	131.10
67	141.51	149.24	148.09	149.62	133.02	139.13	140.37	143.22	138.29	150.16	139.44	145.01	134.91	138.55	138.18	138.98

Nuclear Density Data
CPN: MC-3

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
1	118.80	120.40	121.00	122.90	139.00	140.60	139.80	140.00	118.90	121.60	121.00	120.40	121.50	123.40	122.10	124.50
2	138.70	138.60	138.00	139.00	162.10	158.80	160.20	159.30	147.70	146.00	147.20	143.20	136.70	134.60	135.20	136.20
3	137.90	140.40	138.90	138.50	133.20	134.20	134.20	133.80	137.30	138.10	138.30	137.90	139.00	138.50	139.70	140.70
4	139.90	140.20	139.10	136.10	160.60	161.30	160.90	161.60	156.20	156.70	156.50	152.00	151.60	152.70	148.50	149.70
5	148.80	148.00	148.40	149.50	144.50	142.50	145.60	144.40	144.30	144.40	144.80	142.30	148.90	145.40	147.40	146.50
6	142.20	143.10	147.30	142.60	146.81	145.40	145.60	146.60	154.80	152.90	153.90	153.60	150.70	150.90	151.20	151.20
7	150.40	149.00	150.20	151.10	159.80	162.00	161.40	159.00	147.70	147.20	148.10	146.70	150.10	148.80	151.30	151.70
8	135.10	135.70	137.40	139.50	144.60	144.60	144.90	141.80	129.10	131.90	132.30	132.30	141.50	141.10	140.90	140.70
9	130.30	129.90	131.30	128.00	138.10	137.80	138.30	136.50	135.10	134.90	136.00	135.90	136.00	136.20	136.70	137.90
11	135.20	132.80	132.80	131.90	135.20	135.00	135.50	134.40	131.90	132.80	131.20	132.70	132.60	132.90	131.90	133.60
12	139.40	140.30	138.70	139.10	139.90	140.00	139.70	141.40	149.40	150.90	140.00	137.40	144.40	144.20	145.70	144.20
13	138.50	139.80	140.60	138.60	141.40	143.00	141.30	141.30	142.40	140.90	142.80	140.70	143.20	142.70	143.10	143.40
14	140.60	140.10	140.50	140.50	141.80	141.40	141.50	142.40	141.50	142.10	141.60	142.60	142.70	143.00	144.10	142.80
15	0.00	0.00	0.00	0.00	140.30	138.90	139.60	140.80	123.90	122.20	124.40	124.30	143.40	141.60	145.30	141.90
16	144.00	144.00	141.60	142.50	141.50	141.90	141.10	141.40	143.00	142.30	141.50	143.00	142.60	142.00	143.60	142.00
17	138.70	138.60	136.80	138.50	137.10	138.30	137.00	137.60	141.80	140.50	140.30	139.20	140.20	141.80	142.40	141.70
18	130.30	130.70	128.80	129.70	129.80	129.00	129.30	130.50	133.30	132.80	132.80	133.40	123.40	132.50	132.30	130.10
19	142.20	141.70	144.40	142.00	139.70	139.60	140.80	138.80	140.90	139.30	140.10	139.50	140.00	139.80	140.50	140.50
20	136.20	136.90	135.60	136.10	142.10	142.90	141.40	143.10	142.40	141.90	142.60	142.60	141.90	141.90	140.20	140.90
21	135.80	136.80	136.40	136.40	134.10	134.40	135.40	134.50	136.70	139.30	137.40	132.10	132.30	131.90	131.50	132.20
22	142.10	141.80	141.60	143.00	140.50	142.10	140.90	141.20	140.40	140.30	138.90	140.10	139.80	136.80	137.20	139.10
23	138.30	139.50	139.60	138.10	139.40	141.00	140.20	138.90	140.10	139.60	141.90	141.00	137.20	136.50	138.30	136.80
24	132.20	131.00	132.40	131.80	130.90	130.30	130.30	131.00	129.10	130.90	130.50	129.10	135.50	135.70	135.50	134.10
25	138.60	139.30	137.80	138.30	138.90	140.90	140.10	142.30	141.60	141.40	142.40	142.40	141.70	138.10	142.20	140.70
26	135.90	136.50	136.00	137.90	136.70	137.60	136.80	135.00	143.80	141.80	143.70	143.80	137.60	139.00	137.70	138.00
27	128.60	127.30	126.50	128.30	131.10	130.00	130.50	128.60	131.50	130.50	130.40	131.20	130.90	130.80	130.60	129.60
28	134.50	134.70	134.30	134.80	133.10	133.70	132.80	132.30	132.90	132.50	131.10	131.90	134.00	133.90	133.80	134.40
29	134.00	134.50	134.40	135.20	140.90	141.60	141.40	141.40	139.70	139.80	140.40	139.70	142.30	141.40	141.70	140.80
30	142.40	141.30	142.00	143.50	142.40	138.40	143.20	142.30	138.40	138.60	140.60	140.10	141.80	142.20	141.50	142.10
31	142.70	141.20	141.60	140.40	143.00	141.80	142.70	142.50	144.30	144.90	144.80	144.70	143.00	141.90	144.20	142.10
32	145.00	145.00	144.70	146.70	144.00	146.00	145.30	144.30	141.80	141.50	140.60	142.00	141.90	142.00	141.40	141.30
33	144.50	142.90	143.90	144.30	137.50	140.10	137.40	138.00	141.80	141.70	143.20	142.20	145.00	146.00	145.70	145.80
34	144.30	144.30	145.50	145.40	143.80	142.40	143.70	143.90	142.60	143.20	143.90	142.30	135.00	134.40	135.10	135.00
35	138.30	138.70	138.70	138.50	142.20	140.60	141.50	139.50	139.90	140.80	140.90	141.60	136.30	136.40	137.30	137.40

Nuclear Density Data
CPN: MC-3

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
36	136.60	136.70	136.00	138.20	140.40	139.50	140.30	139.20	137.50	137.30	136.30	137.20	136.80	135.10	136.80	136.70
37	139.00	138.50	139.30	139.20	142.80	144.00	141.60	142.00	141.20	139.50	141.40	140.10	140.50	138.60	141.40	139.00
38	143.90	143.90	144.80	145.20	141.60	140.10	140.90	140.60	136.80	137.80	138.20	134.80	140.90	138.90	140.30	139.70
39	153.90	155.70	157.30	157.90	152.60	156.00	153.30	154.80	155.50	155.40	151.70	152.80	156.30	156.70	155.50	153.90
40	153.30	154.10	155.70	154.20	155.80	158.60	155.70	156.80	161.20	163.90	163.10	158.90	180.30	171.10	170.50	170.80
41	127.50	130.20	128.40	129.90	130.40	130.20	130.50	131.10	132.50	130.00	133.30	130.70	132.80	132.30	134.10	134.00
42	125.70	122.60	125.60	125.00	129.50	130.10	130.50	127.70	134.10	132.80	136.40	130.60	126.40	126.70	127.40	128.80
43	135.50	133.90	136.70	134.60	134.80	133.90	135.40	134.00	133.70	133.70	132.80	132.40	134.20	134.90	135.20	134.40
44	145.00	143.40	145.40	144.20	144.70	143.80	144.30	144.70	144.10	142.70	142.20	142.60	145.70	147.40	146.30	147.70
45	142.90	142.00	141.90	144.00	147.90	147.50	145.60	148.50	145.10	144.30	143.00	145.90	139.30	142.70	143.60	145.10
46	144.70	144.90	145.40	145.40	144.30	142.40	142.80	141.50	142.10	142.30	142.90	142.60	145.20	145.50	146.00	145.70
47	142.90	146.00	145.40	145.60	142.70	145.10	142.80	145.80	146.60	146.50	147.30	145.80	145.30	147.20	146.50	148.60
48	135.50	135.80	136.10	133.90	132.40	134.90	130.70	134.60	135.20	134.20	134.20	134.60	135.10	135.90	133.50	134.20
49	133.00	130.80	132.50	133.20	130.70	132.20	132.60	132.10	133.50	134.10	134.00	135.10	133.70	132.30	133.10	130.70
50	138.90	138.70	139.70	138.80	145.10	143.00	147.50	141.20	142.40	138.00	146.00	139.60	142.50	140.30	141.70	141.80
51	138.90	140.00	142.00	142.30	138.30	138.30	136.80	138.00	137.70	139.00	139.50	138.60	145.40	138.90	144.50	137.30
52	129.80	130.70	131.50	130.00	134.80	134.90	133.90	134.70	134.70	137.80	135.70	135.40	134.60	134.60	134.60	134.00
53	134.60	132.60	133.20	133.40	129.60	131.10	131.80	131.30	129.70	127.20	130.20	128.50	130.00	132.20	130.90	134.90
54	138.50	138.90	137.80	138.50	136.50	135.90	135.80	136.70	138.80	138.10	138.70	137.10	133.30	133.80	133.80	133.00
55	144.00	144.20	145.00	145.00	136.30	136.50	137.20	138.60	142.20	142.20	141.60	140.30	138.50	137.60	139.20	140.00
56	147.10	146.50	147.40	147.40	146.20	145.70	146.30	145.30	145.70	146.20	145.50	144.00	148.30	149.40	148.30	149.50
57	143.40	144.40	144.30	145.80	149.20	147.90	148.00	149.10	147.00	148.30	148.30	148.60	143.10	144.30	145.00	145.10
58	147.00	147.20	148.80	148.40	146.00	146.80	147.60	145.90	145.70	146.00	147.00	149.40	147.20	147.90	148.10	148.10
59	148.00	146.40	148.20	148.60	144.70	144.50	145.20	145.80	150.00	149.30	149.40	149.70	149.30	149.00	149.10	148.30
60	135.20	135.50	137.30	135.80	134.60	134.70	134.40	136.60	135.40	138.10	136.30	137.10	135.60	136.90	134.60	135.90
61	134.10	134.10	134.30	134.00	132.50	133.70	134.10	133.30	135.10	135.80	136.50	135.70	135.60	134.00	135.90	136.40
62	140.20	140.90	140.60	139.70	144.60	142.30	147.50	143.00	145.30	142.30	146.00	138.60	145.30	142.40	145.50	140.50
63	142.20	142.30	143.60	141.10	139.70	141.50	143.10	139.70	137.70	140.60	141.40	140.50	143.00	143.40	143.90	144.10
64	131.90	133.60	132.40	132.10	135.50	136.00	136.00	135.80	137.00	136.70	138.30	137.60	136.30	135.50	135.80	136.10
65	135.60	134.80	134.70	134.60	133.00	132.20	132.50	131.30	131.70	130.00	131.10	129.80	133.30	131.70	133.40	131.10
66	141.20	140.30	140.00	140.20	137.30	137.00	137.90	138.40	140.70	140.30	140.80	139.50	135.00	135.50	135.70	135.50
67	146.30	144.00	145.90	145.50	139.20	138.20	140.30	139.60	141.10	142.30	142.30	141.50	139.90	139.00	139.40	139.40

Nuclear Density Data
Humboldt: 5001P

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
1	138.60	140.30	143.70	144.50	145.40	145.80	145.70	146.10	144.10	143.60	144.90	143.60	142.60	143.40	145.50	142.90
2	159.50	156.20	158.00	158.80	139.10	145.10	144.70	145.60	141.30	139.90	142.10	139.30	134.00	143.20	142.80	136.60
3	138.60	140.40	140.90	142.80	138.60	138.90	139.20	137.70	140.50	140.50	140.60	140.70	140.70	141.70	141.80	141.90
4	144.20	144.80	146.50	147.60	151.10	152.20	154.10	152.40	149.30	149.40	147.60	148.20	151.30	148.30	147.80	153.40
5	150.10	151.30	151.70	150.80	147.60	147.50	147.80	148.30	148.10	149.80	149.30	140.40	145.70	149.80	149.80	150.10
6	154.70	154.70	155.40	153.50	155.50	154.70	156.40	153.60	151.50	150.40	151.50	149.00	149.20	148.10	151.00	147.70
7	151.40	151.40	151.40	153.10	145.90	150.30	151.20	149.00	148.10	148.90	150.20	150.20	149.10	150.60	153.30	154.10
8	143.30	145.20	144.80	144.60	149.00	149.10	147.40	148.90	154.30	156.20	150.60	154.30	154.30	141.10	146.80	147.30
9	130.10	131.60	135.70	131.80	139.20	137.20	140.30	138.80	138.20	139.00	139.20	138.40	130.80	132.90	132.60	133.60
10	145.30	145.00	145.20	145.40	139.10	142.60	142.40	142.30	140.60	143.80	142.80	142.90	138.50	138.90	137.90	138.30
11	143.50	144.80	144.90	136.10	143.30	136.80	137.00	138.30	132.20	144.50	144.30	137.20	143.50	145.70	144.30	145.00
12	145.70	144.60	144.60	144.50	144.80	145.90	146.40	144.80	145.20	143.60	144.30	145.70	148.00	148.10	149.60	147.70
13	141.50	142.00	142.90	143.50	146.00	145.20	145.30	144.30	143.50	147.30	145.20	147.50	143.50	146.20	144.60	145.10
14	143.30	142.90	143.90	143.60	145.20	144.70	145.20	146.60	145.90	136.20	137.40	137.80	140.30	145.90	146.00	145.90
15	139.80	143.90	147.30	147.30	141.30	146.50	142.20	142.40	145.60	143.00	147.50	146.50	144.90	141.90	149.50	141.50
16	141.30	147.40	142.70	143.70	142.80	149.00	144.20	145.40	143.00	148.30	143.90	141.70	142.20	142.80	143.30	144.90
17	141.50	143.30	140.80	139.50	140.00	144.20	139.50	140.00	144.40	143.40	145.50	144.30	142.30	146.20	142.80	141.20
18	135.50	135.50	135.60	136.40	131.70	134.20	134.50	134.90	136.50	138.80	136.10	136.70	138.80	138.00	137.40	138.00
19	138.50	141.50	141.50	138.40	141.70	143.00	142.60	143.10	136.80	137.70	139.50	140.90	139.50	143.20	138.80	140.70
20	134.00	137.40	136.20	137.30	142.00	142.70	140.90	142.00	139.60	138.40	141.20	139.80	139.40	139.70	140.40	140.00
21	133.10	135.20	135.80	135.50	134.20	135.10	133.90	134.50	136.20	139.10	135.40	135.30	134.70	137.60	135.30	132.40
22	133.10	139.40	138.10	145.60	138.70	140.20	139.30	138.60	135.60	141.80	137.10	137.10	126.10	134.40	141.10	134.30
23	128.60	137.50	139.40	136.30	131.90	141.70	141.80	136.50	137.60	136.80	139.00	138.60	134.40	133.70	138.00	134.30
24	129.80	137.00	135.10	137.40	137.70	135.20	136.60	135.60	131.60	136.80	138.10	133.00	141.30	138.80	139.40	138.00
25	137.50	137.20	137.00	140.40	138.70	140.60	139.50	140.10	137.60	138.60	142.10	137.80	138.00	141.20	142.00	137.10
26	134.60	135.10	137.70	136.70	138.20	137.50	138.40	137.80	139.60	141.70	142.80	139.80	139.20	139.00	139.70	139.50
27	135.10	136.00	136.20	136.30	139.20	137.60	138.00	138.90	137.30	138.40	137.90	137.50	137.00	137.10	138.40	136.40
28	141.40	141.20	141.90	141.40	141.80	140.70	140.10	141.70	141.30	140.30	139.70	141.80	140.50	141.00	141.70	141.70
29	141.40	144.30	143.10	133.60	146.90	149.30	147.40	146.80	140.50	143.00	143.70	143.00	144.70	146.10	146.30	147.50
30	141.70	144.60	145.70	144.30	144.30	142.90	142.90	144.40	137.70	140.50	138.20	144.60	140.40	142.10	141.20	143.50
31	149.80	140.60	139.90	141.40	141.30	140.70	140.00	140.20	143.40	143.60	140.30	140.50	139.40	140.50	145.00	140.00
32	141.00	142.80	142.20	143.10	142.20	142.60	142.40	141.70	133.70	143.10	141.80	141.30	147.80	144.90	148.70	137.70
33	140.00	141.30	139.60	134.40	136.70	137.20	136.60	136.30	138.10	138.80	138.80	138.60	140.70	141.50	139.60	139.50
34	140.10	140.60	140.30	141.00	146.10	145.50	141.40	137.80	137.60	139.40	139.60	138.50	129.60	131.40	130.90	132.10

Nuclear Density Data
Humboldt: 5001P

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
35	139.60	141.10	140.00	141.20	142.40	142.90	141.80	140.90	141.10	140.70	141.70	141.30	139.90	138.70	138.30	138.70
36	138.50	137.90	138.20	137.70	123.70	138.80	139.30	134.40	123.40	137.40	138.20	137.00	136.60	136.60	138.50	139.10
37	139.00	138.60	138.30	136.80	138.40	141.70	141.50	141.00	132.80	139.00	139.50	136.20	135.60	137.80	138.10	138.20
38	143.10	142.10	141.40	143.20	145.00	140.40	139.10	139.70	141.30	139.50	138.10	140.40	141.80	140.70	140.50	138.40
39	155.00	154.40	157.20	155.30	151.40	153.30	153.50	153.70	159.80	156.70	160.80	155.30	152.20	154.80	153.90	154.20
40	156.50	154.20	157.80	157.20	157.80	157.80	157.40	156.80	157.10	158.70	157.50	158.30	153.20	154.30	155.30	155.60
41	134.90	134.60	135.00	134.50	135.00	136.70	135.30	135.40	135.60	135.80	135.50	134.70	136.30	138.20	138.80	138.30
42	128.80	129.20	130.60	129.80	134.10	133.40	132.50	134.40	136.00	138.00	138.10	138.60	116.00	129.70	129.50	130.80
43	139.10	138.40	140.40	137.20	134.80	135.60	135.40	133.70	133.70	136.10	134.90	136.60	134.30	139.90	139.50	138.80
44	137.40	137.10	138.20	136.70	137.00	135.00	136.30	133.00	134.70	133.50	133.80	133.90	138.00	139.60	139.70	140.10
45	135.90	135.90	138.40	135.50	140.60	134.80	138.60	140.60	138.80	137.60	138.10	136.80	136.80	138.40	136.60	136.60
46	140.50	140.90	142.00	140.60	137.60	138.30	137.70	139.00	136.90	132.50	140.90	138.60	141.10	140.40	141.20	141.20
47	140.00	139.40	139.20	139.10	136.60	140.10	140.60	140.70	132.10	141.40	141.80	140.90	141.50	143.80	142.50	141.50
48	141.10	138.30	139.30	137.60	140.20	138.70	137.50	139.30	141.70	140.40	139.30	139.30	132.80	136.70	137.30	137.40
49	137.90	137.60	138.40	138.20	140.00	136.80	139.00	137.90	141.10	139.00	137.30	137.40	138.40	139.70	139.10	137.10
50	138.60	137.80	135.50	137.40	141.20	139.20	141.00	140.30	140.30	138.60	140.90	136.10	139.80	140.10	139.70	139.30
51	137.30	135.10	136.40	136.40	135.70	134.60	135.00	134.90	136.70	136.10	136.10	136.80	138.90	137.10	137.10	136.40
52	134.00	135.40	134.60	134.40	138.00	138.60	138.90	136.80	138.90	138.60	137.90	137.90	138.60	138.10	137.90	138.40
53	136.80	137.70	137.30	136.40	134.80	135.70	135.30	135.20	132.70	133.70	131.90	132.80	129.90	135.90	134.80	134.80
54	136.10	134.90	135.00	135.00	134.40	132.10	133.80	134.40	135.30	135.70	136.60	134.50	131.60	131.10	132.10	131.10
55	139.30	140.10	141.30	141.10	134.50	135.50	134.50	134.50	129.00	137.40	137.60	137.70	132.90	134.50	135.50	135.10
56	138.20	139.00	138.60	137.30	133.00	139.10	137.90	137.90	130.40	137.40	137.80	137.20	140.60	140.70	138.90	140.20
57	136.40	137.50	139.00	137.70	140.90	139.50	141.30	139.50	140.70	138.80	139.30	138.50	136.50	138.20	138.10	137.90
58	143.20	143.70	143.70	142.40	140.20	140.10	140.50	140.80	140.80	139.80	140.30	140.60	142.90	140.60	141.80	140.80
59	139.30	140.80	141.10	141.80	140.50	142.10	140.60	141.00	144.20	142.20	142.80	143.40	144.00	144.50	144.40	143.60
60	136.00	139.30	139.20	138.70	139.20	139.00	139.10	139.40	139.80	140.20	140.40	140.70	138.40	137.80	138.20	138.80
61	139.90	138.80	140.80	140.10	138.80	139.40	139.30	140.30	139.20	140.30	140.30	139.10	141.80	140.40	138.90	139.60
62	137.00	137.90	137.30	138.30	144.20	141.20	142.30	140.50	141.80	141.10	138.90	141.30	139.30	140.20	141.10	139.90
63	137.30	137.40	137.40	138.70	136.80	136.60	138.00	137.20	138.80	138.20	137.60	138.60	141.80	140.90	130.50	139.40
64	136.40	136.40	137.50	138.00	138.00	137.10	138.30	138.10	139.20	138.10	140.50	138.40	138.80	139.70	138.40	139.10
65	138.00	137.80	138.50	138.10	134.50	136.10	136.20	135.50	135.30	134.00	135.80	133.90	136.40	137.80	135.10	135.30
66	134.80	135.00	135.40	134.30	135.50	134.30	135.00	134.20	136.20	135.90	136.80	135.60	128.40	131.80	132.20	132.40
67	142.00	140.90	141.20	141.70	136.10	136.00	135.40	134.80	138.00	139.40	139.00	138.80	136.00	136.30	136.20	136.40

Nuclear Density Data
Seaman: C-200

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
1	140.40	140.10	137.70	140.70	145.70	144.50	143.40	146.50	139.60	143.00	142.40	144.10	142.40	142.60	145.20	144.60
2	139.30	140.60	139.50	140.10	141.20	140.70	141.40	140.00	136.60	137.90	139.00	138.60	138.70	135.20	136.90	138.40
3	139.40	138.20	138.90	138.40	134.60	130.10	135.70	134.50	139.10	139.20	138.50	136.60	141.80	141.70	141.70	141.00
4	146.10	146.70	146.80	147.70	154.40	154.60	155.60	157.80	152.70	153.70	154.60	153.60	151.10	152.00	153.70	153.80
5	152.80	153.90	151.80	155.90	150.30	148.30	149.20	147.20	148.70	151.30	150.00	151.70	152.90	151.30	151.30	151.60
6	148.80	148.20	146.00	148.20	149.20	151.30	153.00	152.80	158.60	159.60	157.20	156.40	158.70	158.90	159.00	159.70
7	155.20	154.50	157.10	155.30	151.80	149.80	152.00	152.10	152.60	151.80	151.80	150.30	154.60	151.50	156.30	157.20
8	146.80	140.10	143.20	146.00	148.60	150.00	149.30	150.00	156.60	155.50	156.50	155.20	148.00	147.90	148.20	148.20
9	133.80	133.20	133.20	129.50	143.20	141.30	140.90	140.10	137.50	133.50	135.40	137.30	137.50	138.10	140.40	139.70
10	145.90	146.50	145.70	145.10	141.70	142.20	142.90	143.30	141.80	142.70	142.60	140.70	136.00	133.20	134.80	132.90
11	137.10	138.10	137.10	137.90	140.10	139.90	139.90	138.00	135.30	137.30	136.30	137.60	136.30	138.10	137.60	136.90
12	142.90	145.70	145.30	146.30	140.50	141.60	144.30	145.10	149.60	147.30	147.80	150.30	144.50	143.70	144.70	144.60
13	139.00	141.50	144.30	143.30	148.70	147.50	147.70	147.10	147.50	148.20	147.00	147.70	147.50	148.00	142.40	149.40
14	141.80	142.10	142.40	142.10	144.00	145.70	143.40	144.80	144.10	144.70	143.30	147.00	146.70	144.10	145.70	146.20
15	140.20	143.30	141.30	140.80	143.50	141.90	142.00	143.90	147.30	146.40	147.40	144.70	145.60	145.60	145.80	146.40
16	142.10	143.20	143.10	146.60	145.60	145.20	145.70	145.80	145.20	145.10	144.20	146.40	146.60	146.40	145.50	145.80
17	138.20	139.10	141.70	140.10	139.30	139.00	139.10	139.90	143.20	140.60	143.50	144.10	142.50	141.60	144.70	144.40
18	132.20	133.30	132.60	132.30	131.10	131.40	131.90	132.00	135.30	135.40	136.20	134.60	133.60	135.50	136.70	135.90
19	138.20	137.90	135.60	137.20	137.30	135.60	137.80	137.10	137.90	136.20	136.10	137.10	138.50	137.70	137.50	135.80
20	133.50	133.60	133.00	132.80	139.50	139.90	139.60	141.10	137.80	137.50	137.90	136.90	138.60	137.90	137.50	137.30
21	132.70	133.70	131.90	131.90	131.20	132.00	129.90	131.80	135.00	134.60	135.10	132.40	128.30	130.60	129.70	128.00
22	139.40	141.00	137.40	138.40	138.90	138.60	137.00	139.70	135.40	135.50	136.60	135.00	136.10	137.60	135.30	133.20
23	135.00	134.70	135.00	133.80	136.00	135.20	136.30	137.80	136.00	137.60	136.30	136.70	133.40	133.60	133.70	134.70
24	133.30	134.80	135.20	135.50	135.40	135.50	135.80	136.40	131.10	130.90	134.00	132.40	137.80	137.40	139.00	136.70
25	135.10	134.60	134.40	135.10	137.30	138.90	135.70	137.40	139.50	139.50	137.00	139.80	138.50	138.70	137.10	139.10
26	133.10	133.90	134.10	133.10	135.10	131.00	134.00	134.50	137.40	139.00	139.30	137.80	134.80	137.20	135.90	133.60
27	130.70	126.80	131.60	131.90	136.40	134.30	135.60	135.80	133.20	134.90	135.40	132.20	134.10	134.00	133.10	136.60
28	139.60	139.60	140.50	139.30	139.80	137.70	138.10	140.20	137.30	136.90	137.40	137.40	139.10	138.70	138.30	138.50
29	130.40	128.10	132.40	134.00	139.80	139.90	138.90	140.60	137.90	137.30	139.20	138.50	137.80	138.30	139.50	138.30
30	139.90	140.50	140.70	141.20	140.20	139.70	139.80	139.60	135.00	137.00	137.20	137.20	140.50	138.00	139.40	139.50
31	137.10	138.70	137.60	138.90	140.70	139.60	140.50	137.90	141.20	139.90	140.00	140.10	140.60	139.00	139.60	139.70
32	139.10	143.10	142.90	140.80	143.10	141.90	142.10	141.60	138.30	137.50	136.00	135.90	139.10	138.00	139.00	140.10
33	138.80	142.20	140.70	139.30	133.00	134.40	132.70	135.90	137.60	136.90	136.70	138.70	140.60	142.30	141.40	141.90
34	139.50	140.80	138.60	139.40	137.00	138.30	139.10	138.70	140.90	138.80	138.80	141.50	131.00	132.40	131.70	131.20

Nuclear Density Data
Seaman: C-200

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
35	137.00	138.20	138.30	138.90	141.80	141.90	142.00	139.40	141.70	141.10	140.20	141.20	136.80	138.40	137.10	136.70
36	135.50	136.50	136.60	134.10	141.80	139.00	140.80	140.90	136.30	138.10	137.20	138.30	135.70	137.10	135.00	135.80
37	138.00	137.30	137.60	138.00	139.50	142.00	139.80	139.90	137.40	136.40	137.60	139.30	137.10	136.80	138.00	138.00
38	148.60	142.70	143.20	142.80	140.40	136.90	137.30	137.90	134.90	137.10	136.00	135.30	132.80	137.80	137.30	137.00
39	162.80	165.30	165.20	161.90	160.00	159.70	157.10	160.00	160.20	160.60	159.90	157.30	161.90	162.60	164.80	157.70
40	160.40	160.10	161.20	163.20	166.30	167.20	164.70	165.50	162.80	168.20	171.00	168.60	165.90	168.20	172.80	165.70
41	131.70	132.70	130.60	131.70	131.60	135.00	133.40	132.10	133.50	133.20	133.50	131.80	136.40	136.30	136.10	137.90
42	128.10	126.30	127.80	126.90	133.50	133.10	133.90	131.00	136.00	136.20	137.80	133.50	128.70	129.50	130.60	132.80
43	139.50	139.10	141.10	138.60	137.40	134.50	138.70	137.30	135.80	136.70	136.30	137.30	138.30	138.50	138.50	137.50
44	137.10	136.60	136.30	134.90	134.00	133.40	135.00	132.80	133.80	132.20	134.80	136.90	136.60	138.60	136.70	138.10
45	135.90	136.30	132.10	132.60	139.00	138.80	140.00	137.60	136.00	135.80	136.10	135.50	134.20	134.90	132.50	134.80
46	137.80	137.70	138.40	137.00	138.60	137.30	139.30	136.90	136.20	134.60	136.80	138.00	139.60	137.50	137.70	139.90
47	136.60	139.00	138.30	136.20	137.30	137.80	134.40	136.60	142.40	139.10	141.60	139.80	140.80	139.90	138.50	142.20
48	138.30	139.40	138.20	138.90	136.00	138.90	138.10	139.30	137.70	139.00	135.60	138.90	138.70	136.90	136.90	137.30
49	135.90	138.20	137.40	135.50	134.80	138.10	136.80	135.10	137.50	136.80	139.70	136.90	137.50	136.20	137.60	134.60
50	133.40	131.60	134.20	133.70	138.50	135.80	141.10	138.40	141.60	137.30	137.80	137.00	135.80	135.30	136.90	133.10
51	133.10	132.70	133.20	135.80	132.30	132.00	132.70	132.00	130.90	132.00	131.80	132.30	136.00	136.90	136.40	135.40
52	131.90	131.30	133.10	134.30	134.80	134.30	135.90	136.20	137.30	136.40	135.30	135.30	134.80	135.00	132.90	135.00
53	135.80	135.20	135.30	133.70	132.10	132.20	133.70	134.00	130.60	131.30	131.60	129.60	132.60	130.00	137.00	132.70
56	137.40	137.20	139.10	138.10	135.70	136.20	137.20	133.90	134.20	133.40	137.60	135.60	137.30	139.30	137.60	140.60
57	135.70	137.60	135.60	133.90	139.20	138.30	139.00	138.30	139.50	138.70	138.80	138.60	132.60	135.30	135.20	136.30
58	140.40	140.40	140.20	140.10	140.20	138.40	139.90	137.90	137.70	138.80	139.60	139.80	140.40	140.20	140.00	137.90
59	139.60	139.20	138.00	141.60	138.40	139.50	137.80	138.20	141.80	142.70	143.30	141.00	142.00	140.90	141.40	140.70
60	140.50	139.10	139.70	137.40	139.30	137.00	136.30	139.00	138.00	140.40	140.30	140.80	138.70	139.90	138.10	135.40
61	137.10	138.80	137.30	136.20	135.80	137.40	136.40	137.30	138.50	138.00	139.90	140.40	138.80	138.10	137.10	137.90
62	134.10	134.60	134.30	134.30	141.40	138.20	138.40	138.60	141.50	136.80	139.30	140.10	139.80	139.10	139.90	137.20
63	137.00	136.80	136.50	137.20	135.00	134.10	134.10	134.80	135.70	136.00	135.50	134.90	139.90	140.70	138.80	138.80
64	133.50	132.50	134.50	134.10	136.40	137.70	137.50	137.40	138.10	137.20	137.60	138.50	136.80	137.80	136.30	138.00
65	137.50	136.80	136.80	136.20	136.10	134.10	134.10	131.10	132.10	132.30	129.90	132.30	133.30	133.00	134.40	133.50

Nuclear Density Data
Troxlner: 3401-B

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
1	144.80	144.80	143.80	144.00	146.00	148.80	148.30	150.70	146.00	144.00	150.00	146.30	145.50	147.30	146.00	146.30
2	138.00	140.30	139.00	142.00	139.50	142.00	143.30	144.00	136.50	139.30	136.31	139.80	133.80	138.30	140.00	138.80
3	141.80	143.80	143.00	141.30	139.80	139.80	141.00	139.30	141.80	143.50	142.50	141.30	144.30	141.30	141.30	143.50
4	145.30	148.80	148.30	149.50	156.00	158.00	153.00	156.00	153.80	154.50	153.00	154.50	155.00	154.00	155.00	154.50
5	153.50	155.00	155.80	155.50	151.50	153.50	153.50	150.80	151.50	151.50	150.80	153.00	152.50	157.00	153.00	153.00
6	151.00	143.00	148.30	153.00	152.80	153.80	152.80	152.80	154.50	156.80	155.50	156.50	157.50	161.00	160.50	156.80
7	153.00	154.00	156.00	153.80	149.50	153.00	149.30	150.00	151.00	151.50	150.30	150.30	156.00	154.50	154.50	154.50
8	146.30	144.80	144.30	146.80	152.00	150.80	150.50	151.00	154.50	156.00	155.00	156.50	148.80	149.30	151.80	152.80
9	137.50	133.00	128.80	130.80	144.80	144.30	144.80	136.30	141.50	141.30	143.00	140.80	142.50	142.00	141.50	136.00
10	148.80	146.80	147.50	148.80	144.80	144.80	143.00	145.30	144.80	144.50	146.30	145.30	140.00	140.80	141.80	141.00
11	133.70	142.50	142.00	140.70	143.20	142.00	142.50	143.00	136.30	140.50	140.20	141.50	141.50	141.70	143.20	141.00
12	139.00	146.00	145.30	146.30	146.80	146.80	147.30	146.80	146.50	147.50	145.30	147.50	144.80	149.30	149.50	150.30
13	143.50	143.80	145.30	146.00	147.30	149.00	146.80	146.50	147.00	146.80	147.50	148.50	147.50	149.00	147.00	148.30
14	144.80	145.30	147.00	145.30	145.30	146.80	147.50	147.30	142.50	142.00	145.50	140.00	148.50	148.30	148.80	147.50
15	145.50	144.80	145.30	145.00	140.00	146.50	145.00	144.80	147.50	150.00	143.00	145.00	148.80	143.00	149.00	147.50
16	150.00	148.80	148.50	148.00	149.50	147.00	147.00	148.00	140.80	145.30	146.30	147.50	137.00	148.30	147.50	147.00
17	141.30	143.00	145.30	145.00	142.00	142.50	143.30	141.30	142.50	148.00	146.30	146.50	146.50	150.50	146.50	146.30
18	138.80	140.00	136.50	139.20	136.30	136.80	137.80	138.30	134.00	139.20	139.50	142.00	140.50	141.50	139.30	139.80
19	136.30	139.80	140.80	141.00	126.00	140.80	140.00	140.80	141.00	140.30	140.00	140.30	138.50	141.30	141.30	142.50
20	141.80	136.80	137.00	137.30	139.80	142.80	143.50	143.00	140.50	141.00	142.00	141.00	139.80	141.00	141.30	141.30
21	138.00	137.80	137.30	139.00	130.30	137.00	136.50	136.80	130.40	139.30	138.50	138.30	126.30	135.00	135.30	135.20
22	142.80	143.80	142.00	141.50	136.00	142.50	141.80	142.00	134.30	140.30	140.50	139.50	137.80	137.80	138.50	138.00
23	131.00	139.30	140.30	139.30	140.00	139.50	139.50	140.00	122.30	139.50	140.30	141.30	135.50	138.00	137.00	137.50
24	138.50	140.50	138.50	140.00	132.30	138.50	139.50	139.30	126.40	136.50	136.50	137.30	142.80	141.80	142.50	141.00
25	139.80	139.30	140.00	139.30	140.50	141.50	140.30	142.00	144.30	142.50	141.80	143.00	136.80	140.30	141.00	140.30
26	124.20	137.00	138.30	137.00	139.80	139.00	139.30	138.00	124.70	143.80	144.00	144.30	138.80	139.50	140.00	140.00
27	138.00	138.00	136.00	137.80	127.30	139.20	139.80	138.50	128.80	139.50	138.80	140.30	126.30	137.80	137.80	138.30
28	143.00	142.50	143.30	143.50	120.80	142.00	141.50	143.30	126.50	141.50	139.50	140.50	130.80	142.50	142.00	142.00
29	137.00	137.30	137.30	136.50	142.80	142.00	142.00	142.00	141.50	141.50	140.30	140.89	142.50	142.50	142.50	141.80
30	144.30	143.50	142.00	144.50	141.50	142.00	143.80	144.50	137.80	140.30	141.00	140.80	143.00	142.50	143.00	143.50
31	143.00	143.80	142.50	143.00	141.30	143.80	143.80	148.00	142.50	143.80	144.80	143.80	144.00	143.00	142.00	143.00
32	137.80	145.30	143.30	141.80	144.50	142.80	144.30	144.50	136.00	140.30	141.00	145.00	141.30	141.50	141.80	143.50
33	143.00	142.50	143.30	143.80	128.00	137.30	137.50	137.50	141.30	139.80	140.50	144.50	141.80	144.80	141.50	144.30
34	121.30	141.50	143.50	143.00	142.00	142.80	141.50	141.30	123.30	143.00	143.30	141.80	125.80	135.30	135.50	135.20

Nuclear Density Data
Troxler: 3401-B

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
35	134.50	141.00	142.00	141.50	126.00	142.80	144.00	144.00	142.80	143.00	148.30	143.80	136.50	140.50	140.80	140.30
36	139.20	140.30	140.30	141.00	142.80	141.50	143.00	143.00	139.50	140.00	141.00	141.80	139.80	140.50	140.30	139.00
37	139.00	140.50	141.50	141.00	145.00	145.00	143.80	144.00	141.00	140.50	141.50	141.80	141.00	144.00	145.00	141.80
38	142.50	140.50	146.50	144.50	134.30	160.50	152.80	143.00	134.50	138.80	139.50	139.50	138.80	142.80	143.00	142.50
39	158.00	158.50	167.50	158.00	162.00	164.00	167.00	163.00	155.80	158.00	157.50	160.80	159.00	157.50	157.80	161.50
40	157.00	157.50	158.00	160.50	161.50	161.50	161.00	160.80	160.50	166.30	163.50	160.00	162.00	162.50	163.00	161.50
41	134.00	136.80	135.50	137.00	136.00	135.20	135.50	137.50	137.00	137.00	137.80	136.50	139.30	141.30	140.30	138.30
42	133.70	132.00	132.70	131.80	140.30	136.50	137.80	137.50	140.80	139.00	141.50	140.80	132.50	134.50	135.00	133.50
43	142.50	140.80	143.80	141.80	139.80	139.20	136.00	139.00	139.50	139.20	139.50	139.50	140.80	140.30	141.80	142.00
44	138.00	138.80	137.00	137.00	137.00	138.00	136.00	137.30	133.00	137.00	137.30	136.80	139.50	141.30	140.00	140.00
45	137.80	136.80	136.80	136.50	135.30	139.30	140.00	139.50	137.80	138.00	138.00	139.80	137.80	138.30	138.50	139.00
46	140.30	143.00	141.30	142.50	140.50	139.50	140.50	139.20	140.00	138.30	139.20	140.50	138.00	142.00	140.80	140.30
47	139.50	141.00	140.50	139.30	138.80	139.50	141.30	140.30	141.80	141.50	142.50	142.50	137.30	142.80	143.00	143.30
48	138.80	140.30	141.30	139.80	137.30	139.30	139.00	142.00	140.00	141.30	145.30	140.80	137.00	138.50	138.00	137.80
49	137.50	140.50	137.50	138.30	138.50	138.50	140.30	144.50	134.00	139.30	140.00	148.50	128.80	147.50	148.80	145.00
50	137.00	138.80	136.50	139.00	142.50	140.00	141.30	139.50	141.00	138.00	144.80	139.30	140.30	138.50	141.80	140.30
51	137.30	137.80	137.30	136.30	135.20	135.20	135.80	134.80	137.30	136.30	135.30	138.50	135.50	137.30	144.50	138.00
52	135.30	135.00	135.50	135.00	135.80	139.80	137.30	138.50	122.80	139.30	139.80	138.50	121.80	138.00	137.80	137.30
53	137.30	137.80	137.80	137.50	134.50	135.30	135.30	134.50	133.30	132.00	133.70	133.70	111.80	129.30	135.50	132.30
54	136.50	137.00	135.30	135.00	134.80	134.00	134.00	134.30	135.00	135.80	135.80	135.20	129.80	132.50	132.50	132.70
55	141.00	139.50	141.50	140.00	134.30	135.00	135.20	134.30	139.00	139.20	138.00	140.30	134.80	135.00	135.20	134.50
56	135.30	138.50	138.80	138.00	137.50	138.50	138.50	138.30	138.80	137.00	138.80	137.30	141.30	142.80	140.00	142.50
57	139.20	138.30	139.20	140.00	141.30	141.30	140.80	140.00	139.30	140.80	139.20	138.80	138.00	140.80	139.30	139.50
58	143.30	142.00	143.00	144.00	141.50	140.00	142.50	141.00	138.50	140.30	139.80	140.00	139.80	141.80	142.50	143.30
59	139.00	141.80	141.30	143.00	141.00	141.80	144.50	143.50	143.30	143.50	143.80	143.00	130.00	144.00	144.80	144.80
60	140.50	141.00	141.00	141.80	138.50	141.00	139.30	139.20	142.00	141.50	140.30	142.80	130.50	137.00	139.80	139.00
61	139.50	139.80	139.80	139.50	140.50	139.50	145.00	139.50	139.20	140.30	140.00	139.50	133.30	139.80	140.00	140.30
62	138.50	139.50	138.00	137.80	143.80	140.80	140.80	139.20	141.60	140.30	144.30	141.00	140.80	141.00	141.80	141.00
63	139.00	139.00	139.00	138.30	139.30	137.00	137.50	137.30	139.20	138.00	139.00	139.30	141.00	140.50	141.30	139.80
64	137.30	136.30	136.00	136.50	135.80	138.30	138.80	138.80	122.80	139.30	139.80	138.50	137.30	139.80	139.00	138.50
65	139.00	137.00	138.00	137.00	134.50	135.30	134.00	136.00	133.80	132.50	135.00	135.00	131.80	132.20	135.80	135.80
66	136.50	136.80	138.80	138.00	135.20	135.30	135.00	136.30	135.00	135.80	135.80	135.20	131.50	133.00	133.80	133.80
67	141.30	143.30	142.50	141.50	136.50	136.50	136.80	136.80	139.50	140.00	140.80	139.30	136.80	137.30	136.30	136.50

Nuclear Density Data
Troxlter: 3430

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
1	154.00	145.70	157.50	145.40	148.20	148.60	148.80	148.30	158.10	157.90	148.50	147.90	145.70	151.40	146.20	148.00
2	136.10	138.20	139.30	138.10	150.10	138.70	140.50	138.60	127.90	136.70	134.70	138.50	135.10	134.70	135.20	135.90
3	143.00	150.30	145.00	143.90	140.60	143.00	142.80	142.50	147.00	144.50	146.10	142.20	148.40	143.00	145.20	143.90
4	149.60	150.60	152.30	151.60	159.60	162.20	158.50	158.60	159.00	153.60	157.10	156.50	161.10	157.20	156.80	159.30
5	156.20	161.50	159.70	159.90	155.60	155.90	155.90	157.80	156.60	154.60	157.20	156.60	154.70	155.30	155.30	156.80
6	162.20	161.40	162.00	164.20	163.90	162.10	164.00	164.80	159.90	158.40	160.80	157.90	155.00	155.00	155.90	160.10
7	160.60	158.50	158.00	159.10	153.50	155.70	160.20	152.00	132.70	156.10	157.40	155.30	161.10	158.80	160.20	162.90
8	149.30	149.10	151.80	147.20	158.20	156.00	155.10	158.00	159.40	163.40	162.10	158.60	150.20	152.10	149.80	153.80
9	135.90	134.50	136.70	135.60	144.90	144.00	146.90	144.80	140.30	141.60	143.80	150.20	143.80	148.30	143.20	143.80
10	148.30	149.20	148.60	147.50	144.10	146.20	145.80	145.20	144.80	148.80	147.40	146.50	141.10	142.70	141.30	139.70
11	143.60	143.10	142.50	142.50	144.70	144.60	145.30	142.70	139.80	141.60	141.70	142.40	142.20	144.00	142.20	142.90
12	147.30	147.50	146.70	148.00	146.60	144.90	148.40	156.90	144.20	150.70	149.40	149.50	151.10	154.90	151.00	150.50
13	144.50	147.40	148.80	146.20	145.90	149.80	153.20	149.40	143.60	151.80	148.40	154.50	148.40	149.30	151.10	149.60
14	147.30	147.20	143.70	151.70	146.70	151.40	150.10	149.40	147.50	139.90	148.30	137.50	149.30	149.40	151.70	149.30
15	147.40	145.10	144.30	145.90	149.80	146.90	148.60	148.40	141.90	150.70	153.00	153.10	147.50	143.00	149.80	152.50
16	150.70	148.40	151.00	150.40	141.90	148.60	148.20	149.10	141.80	147.00	146.00	147.60	149.10	146.50	147.90	152.00
17	122.90	145.10	142.20	148.00	136.00	157.60	145.30	147.20	146.60	151.70	147.00	149.60	146.60	151.70	151.10	151.40
18	127.20	139.80	143.50	140.30	135.10	134.00	136.40	138.50	129.90	143.70	143.90	145.00	139.50	140.20	140.80	140.00
19	139.20	144.70	146.40	141.90	143.90	144.60	145.10	144.10	139.60	143.40	140.90	144.30	144.00	145.70	146.60	139.60
20	142.00	141.90	134.70	137.50	145.10	151.20	145.10	143.50	142.90	145.70	142.50	144.20	147.20	147.10	141.50	141.50
21	132.60	140.20	138.20	138.90	137.60	138.30	137.90	138.00	133.10	139.50	139.50	140.70	139.10	134.60	131.00	136.10
22	141.60	143.40	142.30	141.40	142.20	143.30	142.90	144.30	139.70	140.50	149.50	141.90	140.70	139.90	144.20	143.80
23	138.60	140.40	139.30	139.30	138.80	139.30	141.99	139.30	140.10	141.50	141.40	142.40	138.20	137.10	138.10	137.90
24	140.50	142.00	140.50	139.60	139.01	139.50	139.60	139.00	139.70	138.00	137.30	138.10	141.20	140.80	141.60	142.90
25	128.60	141.40	141.00	139.80	140.50	142.20	141.10	140.60	127.30	142.60	143.70	143.70	141.40	141.70	141.70	140.50
26	138.50	139.50	139.90	138.70	140.10	139.30	139.40	140.00	148.80	143.70	143.60	144.60	142.00	141.50	141.50	140.30
31	123.60	145.40	144.60	145.30	144.30	143.40	143.80	142.60	137.20	147.50	145.30	145.70	127.70	145.40	144.20	145.10
32	145.30	140.60	154.50	152.30	152.00	149.30	145.80	145.70	142.40	141.60	141.60	140.10	148.20	142.60	146.40	144.50
33	125.40	146.50	143.10	143.30	111.40	134.60	135.00	136.20	143.60	142.50	143.20	142.70	136.90	144.20	143.10	143.80
34	145.40	145.40	145.50	144.70	142.80	143.30	142.90	142.60	143.70	144.40	144.40	144.30	135.70	136.50	136.00	135.50
35	143.00	144.60	143.10	144.30	144.00	144.50	144.30	146.00	142.00	146.30	145.00	146.30	141.30	143.50	142.00	143.90
36	141.20	140.90	143.90	142.00	144.60	143.50	143.70	145.20	142.40	142.30	143.40	144.30	143.20	142.00	141.10	141.50
37	145.30	143.20	142.90	142.60	145.70	144.40	146.20	144.40	142.10	141.70	142.10	143.60	149.00	137.00	140.30	138.90
38	146.20	144.00	145.50	146.40	143.40	144.50	143.50	143.00	138.20	140.00	142.90	139.60	144.30	142.70	143.10	143.60

Nuclear Density Data
Troxlner: 3430

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
39	161.20	160.90	165.60	166.40	161.70	164.10	165.50	166.00	152.40	164.20	160.20	160.50	161.90	163.90	163.00	163.20
40	165.70	175.40	172.60	173.20	162.90	162.20	159.80	160.50	179.50	175.40	173.60	173.60	175.70	182.70	168.10	168.10
41	135.50	136.80	136.50	138.00	137.20	136.70	137.80	135.90	138.10	136.50	138.60	138.00	141.60	140.50	141.10	140.30
42	134.20	133.50	133.80	133.60	138.30	137.40	138.60	137.70	140.80	142.90	143.50	140.00	133.10	133.80	134.80	135.50
43	145.40	142.30	142.70	141.40	138.80	139.60	138.50	138.70	140.80	143.00	140.70	140.70	140.00	142.10	142.60	142.10
44	123.90	138.70	137.10	137.20	138.20	137.40	137.50	138.60	128.70	136.90	137.00	136.10	137.10	139.70	141.90	141.60
45	127.90	133.70	133.60	132.00	143.20	141.50	142.30	141.90	114.70	139.30	139.60	139.80	131.30	137.30	138.00	137.20
46	145.90	142.80	143.70	142.50	141.70	140.50	140.10	141.60	145.50	139.80	141.40	140.40	142.70	141.60	142.90	141.60
47	147.00	140.70	140.90	141.30	141.20	142.60	141.30	142.40	142.20	142.50	143.20	144.10	144.50	142.60	145.00	143.90
48	141.50	141.60	141.00	141.70	137.40	138.50	138.60	140.80	134.10	141.70	140.20	141.20	137.30	138.10	138.40	138.70
49	134.20	141.60	140.60	141.40	129.30	139.00	138.10	138.80	141.80	140.00	140.50	139.60	126.30	139.30	140.80	140.90
50	134.70	139.10	138.50	138.40	138.40	140.00	142.60	139.30	143.20	138.40	141.70	138.40	143.50	139.90	141.30	140.20
51	137.20	138.00	137.90	136.80	136.10	135.60	137.10	135.90	132.20	135.30	136.30	138.00	137.80	140.40	140.40	137.90
52	134.80	136.20	137.40	136.80	138.10	139.00	140.50	139.90	140.50	141.80	140.50	140.20	134.90	140.10	138.80	139.70
53	139.60	137.50	141.20	138.60	136.80	137.10	136.80	138.80	133.40	134.90	136.60	135.00	136.60	137.20	137.70	135.30
54	133.30	137.10	138.10	135.90	133.00	135.90	134.90	134.90	138.60	138.60	137.50	138.40	127.50	133.70	133.00	133.00
55	141.30	143.00	141.60	141.90	135.40	137.10	136.10	136.40	140.00	140.10	139.30	140.70	136.70	136.10	136.50	136.50
56	138.60	140.10	140.10	139.90	144.60	138.60	140.30	139.60	138.90	136.90	136.80	138.40	147.50	142.40	141.40	143.00
57	141.20	139.90	139.90	137.60	130.90	140.70	141.30	141.40	131.60	141.80	141.50	139.50	115.30	137.60	136.00	137.40
58	144.50	143.60	144.30	142.60	141.50	141.50	143.80	141.30	140.50	139.90	142.30	140.90	142.20	143.30	143.70	143.00
59	140.20	141.80	140.70	142.50	142.40	142.50	142.40	142.80	141.90	144.50	145.60	144.40	144.30	146.00	145.90	145.70
60	140.60	140.90	142.20	142.30	136.60	135.80	137.80	140.20	139.70	143.70	142.40	142.40	140.10	140.00	139.50	141.60
61	139.40	140.60	141.50	139.40	142.20	141.00	140.70	141.10	139.60	142.30	142.50	141.20	143.70	142.10	140.90	141.10
62	136.90	139.20	140.20	137.90	148.60	142.30	144.80	143.40	126.60	142.30	142.20	141.60	143.30	141.90	143.20	141.70
63	138.90	139.40	140.20	138.30	138.80	137.40	137.80	138.00	134.20	139.90	138.30	139.30	136.60	140.10	141.80	141.60
64	141.40	139.60	138.10	138.40	138.90	139.80	139.40	136.30	142.00	141.40	141.40	140.60	135.70	140.10	140.70	141.40
65	140.60	139.20	134.60	139.50	136.70	137.70	136.90	139.00	133.30	134.70	136.50	134.90	137.10	137.90	138.30	138.40
66	138.40	137.50	137.30	137.20	136.60	136.50	136.70	136.50	133.80	137.60	138.60	136.80	127.90	133.40	134.90	133.80
67	148.00	142.40	143.50	142.30	137.10	136.90	137.60	140.70	140.70	142.40	142.30	140.80	137.20	137.70	138.40	138.20

Nuclear Density Data
Troxlter: 3440

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
1	147.20	148.00	146.50	147.40	148.90	145.80	151.70	153.10	147.20	149.30	148.40	146.80	144.30	146.70	145.20	145.60
2	138.30	136.70	138.30	136.90	132.40	136.90	141.80	137.30	134.60	137.80	136.70	136.60	137.90	132.90	135.40	134.40
3	143.90	146.20	147.00	147.90	144.60	145.90	136.70	149.80	151.10	146.80	151.80	147.20	151.90	149.10	155.40	146.80
4	155.00	153.00	155.70	154.30	162.10	161.50	160.30	161.60	160.50	159.50	161.20	159.40	159.90	160.90	159.10	159.80
5	158.80	157.00	154.10	158.30	156.50	155.80	155.80	156.20	154.40	156.60	155.50	157.10	152.20	159.00	160.00	156.80
6	143.40	143.30	148.50	151.20	139.80	151.80	143.90	146.90	149.30	151.10	150.10	151.10	148.60	149.20	149.50	150.00
7	144.50	149.50	151.30	145.40	141.20	148.80	147.00	144.90	146.90	148.30	148.10	146.00	146.50	152.00	153.00	154.30
8	145.70	147.00	149.50	151.90	150.80	153.30	151.70	152.90	155.60	157.90	164.80	156.30	155.00	156.00	156.80	156.10
9	137.60	136.00	137.70	136.60	146.80	147.60	157.90	159.60	142.20	142.90	142.80	145.50	147.50	146.40	146.30	145.90
10	141.20	146.60	146.60	145.80	140.70	145.30	143.10	144.00	145.70	144.00	144.40	143.60	136.30	136.80	137.90	137.90
11	135.40	140.10	134.90	135.80	0.00	142.50	142.50	140.90	136.80	142.80	138.10	126.20	142.80	141.70	142.20	142.20
12	136.10	160.30	151.00	149.80	151.80	150.40	151.70	151.00	151.80	151.70	150.70	151.60	143.70	149.70	156.50	159.50
13	144.80	146.50	144.80	145.90	152.10	152.40	151.00	150.10	148.90	145.80	153.50	152.30	153.80	152.50	152.60	151.50
14	134.40	148.00	145.70	138.30	148.10	133.30	148.10	152.20	141.10	140.80	148.00	138.70	150.00	149.10	153.00	148.40
15	143.20	147.10	136.40	143.20	140.40	143.70	146.50	144.80	134.00	149.30	140.90	147.10	132.10	143.80	145.90	142.20
16	150.20	149.80	144.90	139.80	136.80	139.40	149.40	149.20	144.10	145.60	146.60	147.40	147.40	139.60	144.30	144.50
17	139.20	141.50	141.40	141.10	141.60	141.50	141.40	139.00	144.30	145.20	144.40	146.00	142.20	148.20	146.30	147.30
18	132.80	133.30	133.80	133.10	131.00	134.90	132.90	131.30	136.80	125.70	135.30	134.70	131.30	134.90	135.60	136.00
19	142.90	142.90	141.90	144.80	142.30	142.20	143.50	140.60	141.20	142.40	142.50	141.10	142.60	142.60	145.00	143.10
20	135.00	134.50	135.20	136.60	144.70	145.20	144.10	146.50	139.20	143.90	142.50	143.60	142.70	143.50	142.90	144.60
21	139.00	139.90	136.20	138.40	136.40	135.50	137.20	136.10	141.40	138.90	139.60	140.30	131.80	135.90	134.30	134.00
22	141.70	145.10	142.80	145.40	144.20	144.00	144.20	145.80	142.60	141.80	141.10	140.90	138.10	139.50	137.40	137.40
23	133.80	138.80	139.50	140.30	134.70	138.70	142.10	140.50	140.90	141.40	140.40	142.70	137.60	136.80	137.90	136.30
24	142.00	139.90	142.80	141.40	138.20	139.50	139.00	141.10	138.00	138.00	137.70	136.40	144.00	143.60	144.90	142.10
25	137.00	137.80	139.60	139.00	140.80	142.30	139.80	139.40	141.40	142.50	141.00	141.00	132.40	139.30	140.50	138.20
26	134.70	134.80	134.30	135.10	134.70	135.80	137.80	140.10	145.90	143.70	146.50	143.60	136.20	139.70	137.40	137.60
27	133.80	135.30	134.00	135.60	138.00	138.10	138.30	139.10	137.40	137.40	138.30	138.80	137.50	138.90	137.40	135.90
28	143.70	143.70	146.40	144.40	140.30	143.60	141.80	141.80	140.90	141.20	139.70	141.60	145.40	142.60	144.80	142.60
29	130.90	132.80	132.60	133.00	141.20	145.40	144.40	152.80	145.80	139.30	139.80	138.30	140.10	141.60	141.20	146.50
30	127.60	147.20	145.80	145.40	147.20	146.20	144.30	142.30	121.90	144.20	143.00	140.30	135.60	145.30	146.30	142.10
31	140.10	139.90	141.00	141.30	141.10	141.80	141.30	139.10	139.50	141.90	142.30	143.00	140.00	138.20	140.10	139.00
32	142.50	145.30	143.50	144.50	143.10	143.00	140.80	141.60	135.70	139.20	136.00	136.80	137.90	140.30	139.60	138.60
33	140.60	141.90	142.10	140.90	133.60	134.50	133.20	134.90	138.30	142.10	139.60	139.40	141.60	142.00	141.10	143.20
34	142.40	141.60	141.30	143.10	139.80	141.30	140.10	138.90	138.70	141.70	141.80	141.20	129.00	128.80	129.60	131.70

Nuclear Density Data
Troxlner: 3440

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
35	139.00	144.70	143.90	143.90	149.10	147.50	147.90	148.10	145.60	146.10	144.90	146.10	142.80	148.70	141.40	143.00
36	133.50	141.60	141.60	143.00	137.60	138.40	145.40	145.00	138.30	145.50	141.70	144.90	139.02	143.50	141.20	140.60
37	141.50	142.30	137.50	140.90	146.80	147.80	145.80	147.30	143.10	142.40	142.70	143.50	142.90	143.70	143.00	143.70
38	145.90	147.20	146.30	147.40	145.10	144.80	145.00	143.00	134.50	138.80	139.50	139.50	138.80	142.80	143.00	142.50
39	167.80	164.20	167.20	165.00	167.30	165.70	167.90	169.20	170.50	168.00	166.10	163.10	160.40	162.70	161.80	162.50
40	164.40	164.20	167.70	171.60	170.50	172.20	175.21	169.90	172.60	178.40	177.50	174.50	171.10	174.10	173.70	174.60
41	131.80	135.10	135.20	135.70	135.90	135.40	136.30	136.30	135.20	136.00	136.60	137.50	139.40	138.10	139.30	139.10
42	131.40	131.20	133.10	131.10	135.20	135.40	135.70	135.40	139.90	140.30	139.30	139.20	130.80	132.80	131.40	132.50
43	140.80	141.90	141.70	139.50	137.30	138.00	139.00	138.30	139.60	140.90	139.20	138.70	142.30	139.70	142.10	141.40
44	146.00	145.00	145.30	144.40	142.80	143.50	144.60	144.20	143.80	142.80	144.90	144.90	147.10	147.90	147.30	148.30
45	144.70	145.60	145.50	145.70	148.80	147.00	148.50	148.70	145.20	146.10	146.10	147.70	143.70	146.10	144.20	145.70
46	148.20	151.10	150.80	143.80	146.40	146.70	147.00	147.60	147.80	146.50	146.30	146.50	148.20	147.30	149.70	148.60
47	146.90	148.10	147.60	148.40	147.00	147.50	147.90	148.70	148.70	148.10	149.80	149.40	151.00	151.60	150.90	149.70
48	138.80	139.50	138.80	140.20	136.80	140.40	138.60	138.00	137.40	140.50	140.80	139.90	138.40	136.90	139.40	138.10
49	138.60	138.90	140.20	139.60	136.50	139.40	139.10	139.00	139.00	139.80	139.70	140.20	139.70	138.40	140.70	138.40
50	141.60	141.40	142.20	141.90	146.40	143.30	147.80	144.40	146.40	142.50	147.20	144.30	144.30	145.90	144.30	143.80
51	141.80	141.50	142.70	142.50	140.10	140.80	139.30	140.00	139.60	140.20	140.70	141.20	144.40	145.30	146.30	142.70
52	135.90	134.40	135.30	136.50	138.20	137.50	137.40	139.90	140.00	141.40	138.70	139.30	139.00	139.00	138.60	137.10
53	137.20	138.50	137.40	139.50	137.00	137.00	135.60	136.00	136.40	132.70	132.50	133.50	134.70	135.10	136.50	134.80
54	141.00	141.10	141.20	139.30	137.70	138.30	139.20	138.60	141.30	141.30	140.10	140.50	135.10	136.20	136.70	135.20
55	148.00	146.10	146.00	146.30	139.30	139.80	139.60	138.80	144.40	143.10	144.80	143.40	140.00	140.20	141.20	139.00
56	148.00	145.10	146.20	145.80	146.80	144.50	146.10	146.30	142.60	146.30	145.10	144.70	149.10	149.10	149.10	148.90
57	146.40	145.20	145.00	146.50	145.70	149.60	148.30	148.80	147.40	148.40	147.50	147.60	146.00	147.10	146.50	146.80
58	151.10	151.00	152.10	141.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	150.50	0.00	0.00
59	148.90	149.80	150.30	149.70	147.80	148.50	148.90	145.80	115.70	150.70	150.50	151.00	149.70	152.30	151.80	151.60
60	139.90	140.20	140.10	140.10	140.40	141.90	141.00	140.10	141.40	142.10	141.30	143.20	138.30	139.00	139.10	138.70
61	137.60	140.20	139.90	140.20	140.40	140.80	139.30	140.30	139.80	142.60	140.80	140.70	140.20	140.40	141.10	141.00
62	141.40	141.00	139.70	142.00	148.50	143.80	147.70	145.20	146.60	144.90	146.30	141.80	144.80	144.60	144.90	144.60
63	140.00	143.10	141.00	141.90	141.40	140.20	140.10	140.90	140.30	141.20	141.90	141.30	144.00	144.70	143.70	143.40
64	136.30	136.00	135.70	137.20	139.30	140.30	139.00	138.50	140.90	140.00	140.70	140.40	138.20	139.80	138.30	140.00
65	139.90	139.70	137.50	139.00	137.00	136.30	136.50	136.70	133.40	132.50	135.40	133.20	135.60	136.80	136.90	135.10
66	140.40	141.10	143.10	141.60	138.70	139.50	139.30	138.30	141.80	141.90	141.30	141.40	134.30	136.20	138.50	137.10
67	138.00	146.90	148.10	0.00	139.50	140.50	140.70	139.40	143.60	143.50	144.40	142.50	139.60	138.20	140.20	138.90

Nuclear Density Data
Troxtler: 4640-B

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
1	139.00	140.20	140.10	138.70	145.90	139.60	140.70	141.40	137.20	137.30	137.80	137.90	140.40	141.10	141.20	141.20
2	141.20	138.70	141.80	139.90	142.00	140.40	140.70	139.70	135.60	138.30	138.10	136.40	137.60	137.10	137.80	139.70
3	139.30	139.60	138.30	138.60	133.00	136.50	136.60	134.70	136.80	126.40	138.10	123.40	140.30	140.00	139.90	139.60
4	142.00	138.90	142.30	135.80	149.90	151.10	148.90	153.00	147.90	145.00	148.30	144.60	149.50	151.90	150.10	149.70
5	149.60	148.30	150.00	149.90	145.40	144.60	147.30	145.20	145.50	144.20	144.50	147.90	147.90	147.30	147.00	147.20
6	156.40	157.80	158.30	156.80	156.70	158.50	156.00	157.40	148.80	151.70	150.40	151.10	145.50	148.40	151.70	157.40
7	154.80	154.80	154.80	155.60	153.20	153.20	152.40	153.70	153.80	150.70	152.20	152.30	154.60	154.20	156.20	156.10
8	139.00	140.90	142.50	142.20	146.50	147.00	146.00	147.70	151.60	151.90	157.00	153.00	145.60	145.80	144.30	145.00
9	131.40	131.60	131.80	131.10	138.60	137.70	138.70	139.00	137.80	133.30	136.30	135.70	136.00	137.10	138.00	136.30
10	140.60	143.80	141.60	142.00	141.40	141.30	140.60	139.60	140.00	141.60	138.70	140.40	133.40	134.60	134.50	131.90
11	136.20	129.50	134.40	136.40	136.30	139.70	137.90	138.40	135.40	135.40	135.20	137.60	135.40	135.20	137.50	134.30
12	143.70	141.30	141.40	142.80	142.40	144.10	141.50	140.50	143.40	146.20	141.20	144.30	145.10	149.00	146.20	144.70
13	141.00	139.90	139.40	141.90	142.50	141.00	140.30	141.30	138.90	139.10	136.80	138.10	144.50	140.90	143.60	144.50
14	140.70	143.50	141.40	142.70	143.70	141.70	143.00	143.50	143.30	143.90	144.00	145.50	144.70	142.80	145.00	146.20
15	138.40	138.60	138.80	140.10	140.10	141.10	140.50	140.70	142.70	130.30	145.40	141.70	141.80	140.20	141.10	142.80
16	143.60	143.60	143.50	146.90	143.00	143.90	140.40	143.60	143.70	144.70	143.60	142.70	143.00	142.90	143.10	142.90
17	137.40	136.90	135.40	140.20	137.90	137.60	138.10	137.40	140.20	140.70	140.00	137.90	141.80	140.50	141.60	141.00
18	132.20	131.30	129.70	131.30	133.00	132.40	132.20	132.30	134.40	135.10	135.70	136.50	133.50	131.00	132.00	132.00
19	138.10	137.20	137.00	139.00	136.80	136.10	139.00	137.90	138.80	137.10	137.00	138.00	137.80	139.40	138.90	139.60
20	133.20	135.20	130.00	134.90	135.70	142.90	137.00	140.60	140.50	138.60	140.90	139.90	138.80	140.50	136.70	135.90
21	133.40	130.60	132.00	134.00	131.10	134.20	131.90	131.00	136.50	138.20	133.90	135.50	130.90	132.50	131.60	129.80
22	139.60	139.80	139.10	138.40	137.70	140.50	139.80	141.00	137.20	140.50	138.00	138.90	135.30	138.80	136.30	137.00
23	138.50	137.10	136.80	139.10	134.30	131.70	135.50	138.60	138.50	139.10	138.60	138.10	136.30	138.90	138.60	135.90
24	134.90	134.80	135.70	137.20	134.20	136.70	134.00	131.00	131.20	135.10	134.70	139.10	136.60	138.20	137.40	137.50
25	139.60	141.20	139.30	139.20	140.80	141.20	139.40	139.70	142.10	143.20	143.40	142.50	142.00	141.40	142.10	138.90
26	136.60	136.80	135.30	136.30	136.90	134.70	136.90	138.30	142.80	141.80	142.90	141.30	138.50	141.60	140.60	138.50
27	129.30	129.90	129.80	132.30	133.80	133.10	132.60	133.20	133.20	135.40	132.10	133.20	132.90	131.50	131.90	132.40
28	137.00	131.80	135.50	134.00	132.70	134.70	133.00	136.00	131.50	131.60	132.20	133.10	134.20	135.50	137.30	134.90
29	134.90	133.20	136.10	136.50	142.60	143.60	143.30	142.40	141.00	140.40	142.00	142.30	142.30	139.50	141.40	142.70
30	143.20	146.60	142.30	142.40	144.40	144.50	142.90	138.70	140.60	140.60	140.20	141.70	141.10	142.90	141.10	141.70
31	144.00	141.00	142.80	144.20	142.80	140.90	142.10	145.10	145.90	145.90	145.00	146.90	145.40	142.20	146.20	144.00
32	146.20	145.70	146.80	145.80	146.80	145.50	146.00	145.50	143.60	140.90	140.80	142.20	142.40	140.90	142.30	142.80
33	139.30	140.50	139.90	139.30	135.00	135.30	134.30	137.20	137.80	139.30	139.00	137.30	142.70	141.90	143.30	141.40
34	148.30	146.10	148.30	147.00	145.70	145.30	148.60	143.70	147.10	144.00	145.70	146.60	139.40	140.30	141.80	139.50

Nuclear Density Data
Troxler: 4640-B

TEST SITE	RDG11	RDG12	RDG13	RDG14	RDG21	RDG22	RDG23	RDG24	RDG31	RDG32	RDG33	RDG34	RDG41	RDG42	RDG43	RDG44
35	136.60	137.90	135.90	137.70	140.90	140.80	138.80	141.30	142.40	138.40	140.50	141.40	134.20	136.20	137.70	133.90
36	138.50	135.50	135.50	135.10	139.30	135.70	138.60	136.90	137.10	137.20	134.40	135.60	136.50	137.30	135.10	135.30
37	141.70	140.60	141.70	136.80	142.20	145.30	143.00	141.00	141.70	142.10	141.70	140.00	142.30	142.70	140.90	138.30
38	145.30	146.30	145.60	142.10	143.50	142.40	139.20	140.50	139.90	137.40	138.40	137.60	140.20	139.50	139.20	138.80
39	159.70	161.70	162.80	160.10	160.20	158.80	156.50	159.10	159.10	160.70	161.20	156.90	159.80	158.30	159.90	163.20
40	159.10	157.90	159.90	159.60	159.80	163.20	162.40	161.30	167.40	167.00	166.30	166.50	167.80	166.30	163.80	165.20
41	129.00	133.20	131.00	132.20	131.20	131.90	129.50	127.50	132.40	131.10	133.10	126.60	132.10	132.40	134.40	137.10
42	126.60	125.00	127.50	122.50	128.70	129.20	130.90	122.80	134.30	136.60	135.30	134.50	129.30	131.20	128.00	125.40
43	137.30	134.60	135.30	134.30	126.60	134.40	134.00	130.10	132.00	133.00	133.50	134.30	133.80	133.70	135.00	136.00
44	145.90	144.40	147.40	142.90	146.70	144.00	146.80	145.10	144.30	145.80	143.70	137.60	149.80	146.60	147.00	148.40
45	143.30	145.10	140.40	143.00	146.30	148.60	148.80	145.00	146.20	145.40	146.80	144.40	142.30	142.20	143.10	146.30
46	147.50	146.70	149.40	150.30	146.80	144.50	148.50	145.90	147.90	148.10	147.60	147.10	149.80	150.50	149.40	150.10
47	149.90	149.90	149.10	150.60	147.60	149.00	146.80	149.10	152.20	150.90	149.90	147.00	149.60	150.50	150.80	149.40
48	195.20	137.60	135.40	137.20	131.90	136.20	136.30	135.90	138.20	137.10	135.20	136.70	137.30	137.40	137.10	134.70
49	133.00	138.30	134.90	135.40	132.70	137.30	134.70	133.00	135.30	137.40	135.50	135.60	135.00	134.00	136.80	135.60
50	139.00	140.10	140.20	140.80	145.20	140.20	144.80	138.50	144.40	137.80	145.40	140.00	144.00	138.90	143.30	144.30
51	141.60	137.40	142.10	142.00	138.20	137.60	139.10	136.60	137.40	139.80	136.00	136.40	142.10	143.10	142.30	140.20
52	133.80	133.70	134.00	135.20	136.40	136.60	136.50	137.70	138.40	136.90	137.60	136.30	137.10	135.30	134.30	137.90
53	135.10	133.50	134.40	131.70	133.30	133.20	134.20	134.80	132.00	130.70	132.00	128.70	132.70	129.20	131.80	133.40
54	138.50	138.10	136.20	137.70	134.30	134.90	135.70	135.40	137.80	137.00	138.10	137.10	133.10	134.90	131.50	132.50
55	145.30	144.90	141.50	143.20	137.10	138.00	137.00	135.20	139.50	139.40	141.00	137.50	139.30	137.00	138.00	140.20
56	149.90	147.30	146.90	147.40	147.20	147.30	147.50	147.30	148.30	145.50	147.80	148.40	149.80	146.60	147.00	148.40
57	145.50	145.50	144.30	143.10	149.20	150.40	150.70	150.10	149.70	148.20	148.60	148.40	144.30	146.90	144.20	148.00
58	151.70	150.80	153.80	153.40	151.30	150.20	150.60	148.60	151.10	150.20	150.80	149.90	153.70	151.00	152.00	152.60
59	152.60	153.30	151.30	151.60	150.00	150.10	150.80	150.70	154.50	153.30	151.00	153.60	152.50	152.80	153.10	151.80
60	139.20	140.40	139.40	140.30	137.40	139.00	138.90	140.30	140.60	140.30	140.90	141.20	139.60	139.20	138.90	139.90
61	139.10	137.50	137.30	139.10	138.30	137.00	135.30	139.90	137.30	137.70	137.00	139.20	137.90	138.30	139.50	135.80
62	142.70	142.70	140.70	141.40	145.70	138.80	146.80	140.50	145.40	137.80	146.70	141.30	146.70	141.90	147.20	141.70
63	144.80	144.70	142.80	143.60	140.30	140.40	139.80	0.00	141.00	139.60	142.50	142.30	144.60	145.90	144.30	144.30
64	134.90	134.30	134.90	135.50	137.80	138.10	137.40	138.20	139.90	139.20	139.90	140.70	139.00	137.20	136.60	136.80
65	135.60	136.10	133.70	133.60	135.80	135.30	135.50	134.90	133.60	138.20	134.30	131.60	134.30	132.60	132.70	135.40
66	139.80	140.60	140.30	142.20	137.20	137.40	138.00	137.80	141.00	140.10	140.90	137.60	136.90	137.10	136.30	136.40
67	147.70	145.10	146.50	145.10	140.10	139.60	140.10	139.50	143.30	140.60	142.00	141.40	142.40	143.20	142.10	142.30

APPENDIX C
SUMMARY OF CORE DATA

SUMMARY OF CORE DATA
HPR 1991-60
Density of Thin Lift Bituminous Mixtures
by Nuclear Methods

Test Site	Core No. 1		Core No. 2		Core No. 3		Core No. 4	
	Density (PCF)	Thickness (In.)	Density (PCF)	Thickness (In.)	Density (PCF)	Thickness (In.)	Density (PCF)	Thickness (In.)
1	142.8	1.895	145.1	1.990	142.8	1.585	144.0	1.830
2	144.9	1.730	145.0	2.035	144.1	1.635	140.2	2.505
3	141.0	1.450	139.6	1.360	141.3	1.390	141.9	1.550
4	148.9	1.530	154.3	1.350	152.0	1.470	151.3	1.400
5	152.6	1.790	150.1	1.775	150.8	1.920		
6	151.3	2.140	151.6	1.820	155.8	1.765	155.5	1.970
7	152.3	2.000	149.6	1.780	149.1	1.750	150.8	1.705
8	147.9	2.265	149.8	2.510	152.8	2.945	147.0	2.955
9	137.4	1.315	141.8	1.520	141.3	2.800	142.7	2.205
10	145.2	2.025	142.1	1.895	144.6	2.045	140.1	1.845
11	138.5	1.695	139.9	1.605	137.4	1.385	136.0	1.265
12	141.9	1.410	142.3	1.540	143.6	1.455	140.6	1.495
13	141.6	2.545	143.8	2.465	144.9	2.650	145.1	2.600
14	141.6	1.750	142.5	1.685	141.6	1.790	142.5	1.680
15	138.6	1.305	141.7	2.245	143.6	2.050	143.8	2.295
16	142.1	1.845	143.2	1.645	142.0	1.820	142.6	1.835
17	141.0	1.440	138.5	1.305	141.9	1.380	140.3	1.630
18	136.7	1.825	134.8	1.435	138.4	1.230	138.1	0.990
19	139.2	1.685	137.0	1.580	137.5	1.790	140.0	2.155
20	136.5	2.055	140.8	1.885	139.5	1.870	138.8	1.965
21	136.9	1.980	135.7	1.830	137.3	1.870	133.6	1.800
22	139.9	1.800	140.6	2.080	139.0	1.925	137.9	2.030
23	137.3	1.940	139.9	2.025	139.4	2.150	136.3	2.105
24	139.2	1.915	140.2	2.145	137.6	1.885	139.1	1.565
25	136.7	1.800	138.4	1.740	137.5	1.790	138.4	1.785
26	136.2	1.705	135.6	1.685	140.9	1.840	137.8	1.900
27	137.3	1.620	137.9	1.560	139.0	1.640	138.9	1.495
28	140.8	1.305	139.4	1.360	140.3	1.330	140.8	1.245
29	132.9	1.325	139.1	1.190	138.0	1.310	138.2	1.290
30	139.0	1.150	139.9	1.340	137.8	1.365	140.0	1.445
31	140.8	1.250	142.5	1.350	145.0	1.250	142.9	1.300
32	141.2	1.300	141.9	1.600	138.2	1.700	139.5	1.600
33	139.8	1.615	136.8	1.700	138.8	1.610	141.8	1.735
34	139.8	1.800	138.8	1.750	139.5	1.800	134.7	1.700
35	140.4	1.500	140.9	1.295	140.5	1.375	137.2	1.110
36	138.7	1.410	140.2	1.350	137.8	1.350	137.7	1.440
37	140.5	1.965	142.5	2.045	141.2	1.570	139.7	1.665
38	141.1	1.495	140.4	1.485	138.0	1.560	139.3	1.270
39	161.7	0.850	157.9	0.775	161.1	0.840	161.3	0.775
40	164.6	0.960	166.1	1.025	166.3	1.125	170.6	1.180
41	139.1	2.180	139.8	2.075	141.2	1.910	144.8	2.220
42	136.7	1.870	142.1	2.120	144.1	1.880	137.5	1.990
43	145.0	1.950	143.3	2.030	140.2	1.495	143.4	2.180
44	142.4	2.020	141.1	2.060	140.9	2.080	143.6	2.010
45	141.6	1.930	143.1	2.115	142.1	2.005	140.2	1.810

Test Site	Core No. 1		Core No. 2		Core No. 3		Core No. 4	
	Density (PCF)	Thickness (In.)	Density (PCF)	Thickness (In.)	Density (PCF)	Thickness (In.)	Density (PCF)	Thickness (In.)
46	146.0	3.945	144.0	3.300	142.9	4.005	144.6	3.515
47	144.5	4.085	144.4	3.430	146.0	3.455	146.4	3.510
48	142.6	1.905	143.8	1.905	142.8	1.955	142.6	2.000
49	142.5	1.940	142.0	1.735	143.5	1.980	143.6	2.205
50	138.6	1.875	145.1	1.880	143.8	1.850	141.6	1.610
51	141.5	1.640	139.3	1.680	142.0	1.450	141.7	1.345
52	139.5	2.185	139.8	2.005	142.0	2.175	141.1	2.020
53	141.5	1.975	139.4	1.885	138.7	1.920	138.8	1.840
54	140.1	2.195	137.4	2.255	139.9	2.090	136.2	2.025
55	144.6	2.090	138.4	2.140	142.5	2.200	139.3	2.215
56	142.4	2.020	141.1	2.060	140.9	2.080	143.6	2.010
57	141.6	1.930	143.1	2.115	142.1	2.005	140.2	1.810
58	146.0	3.945	144.0	3.300	142.9	4.005	144.6	3.515
59	144.5	4.085	144.4	3.430	146.0	3.455	146.4	3.510
60	142.6	1.905	143.8	1.905	142.8	1.955	142.6	2.000
61	142.5	1.940	142.0	1.735	143.5	1.980	143.6	2.205
62	138.6	1.875	145.1	1.880	143.8	1.850	141.6	1.610
63	141.5	1.640	139.3	1.680	142.0	1.450	141.7	1.345
64	139.5	2.185	139.8	2.005	142.0	2.175	141.1	2.020
65	141.5	1.975	139.4	1.885	138.7	1.920	138.8	1.840
66	140.1	2.195	137.4	2.255	139.9	2.090	136.2	2.025
67	144.6	2.090	138.4	2.140	142.5	2.200	139.3	2.215

APPENDIX D
SUMMARY OF STANDARD COUNTS

SUMMARY OF DENSITY STANDARD COUNTS
HPR-1991 60

Test Site Number	Model No.	Beginning Count	Ending Count
1	3401-B	2887	2880
2	3401-B	2894	2911
3	3401-B	2889	2880
4	3401-B	2891	2814
6	3401-B	2867	2867
9	3401-B	2889	2883
10	3401-B	2891	2868
11	3401-B	2896	
12	3401-B	2871	2869
14	3401-B	2892	2878
17	3401-B	2878	2871
19	3401-B	2878	2869
25	3401-B	2884	2886
27	3401-B	2874	2880
29	3401-B	2871	2884
31	3401-B	2865	2868
35	3401-B	2870	2881
39	3401-B	2871	2868
41	3401-B	2882	2870
44	3401-B	2869	2857
46	3401-B	2865	2824
48	3401-B	2864	2879
50	3401-B	2862	2878
52	3401-B	2848	2869
55	3401-B	2876	2868
1	3430	3172	3180
2	3430	3171	3178
3	3430	3167	3187
4	3430	3164	3185
6	3430	3175	
9	3430	3179	3174
10	3430	3166	3173
11	3430	3185	
12	3430	3172	3174
14	3430	3202	3164
17	3430	3168	3163
19	3430	3157	3165
25	3430	3171	3176
28	3430	3171	
31	3430	3181	3158
35	3430	3171	3160
39	3430	3160	3161
41	3430	3163	3170
44	3430	3156	3165
46	3430	3154	3169
48	3430	3143	3167
50	3430	3159	3157
52	3430	3183	3183
54	3430	3166	3168

SUMMARY OF DENSITY STANDARD COUNTS
HPR-1991 60

Test Site Number	Model No.	Beginning Count	Ending Count
1	3440	3690	3677
2	3440	3705	3691
3	3440	3695	3689
4	3440	3690	3683
6	3440	3682	3682
9	3440	3675	3678
10	3440	3693	3687
11	3440	3688	3681
12	3440	3685	3680
14	3440	2697	3683
17	3440	3675	3688
19	3440	3684	3680
25	3440	3682	3683
27	3440	3690	3688
29	3440	3682	3684
32	3440	3681	3668
35	3440	3681	3686
39	3440	3694	3681
41	3440	3680	3685
45	3440	3673	
46	3440	3687	3687
48	3440	3680	3685
50	3440	3689	3686
53	3440	3683	3679
54	3440	3681	3685
1	4640-B	6612	6689
2	4640-B	6691	6745
3	4640-B	6661	6699
4	4640-B	6633	6728
6	4640-B	6694	6727
9	4640-B	6623	6681
10	4640-B	6642	6722
11	4640-B	6693	
12	4640-B	6662	6708
14	4640-B	6668	6690
17	4640-B	6627	6699
21	4640-B	6679	6710
25	4640-B	6714	6714
27	4640-B	6650	6689
29	4640-B	6639	6700
30	4640-B	6635	6700
35	4640-B	6644	6712
40	4640-B	6689	
41	4640-B	6626	6684
45	4640-B	6618	
46	4640-B	6674	6678
48	4640-B	6645	6713
50	4640-B	6707	6705
53	4640-B	6642	6691
54	4640-B	6617	6692

SUMMARY OF DENSITY STANDARD COUNTS
HPR-1991 60

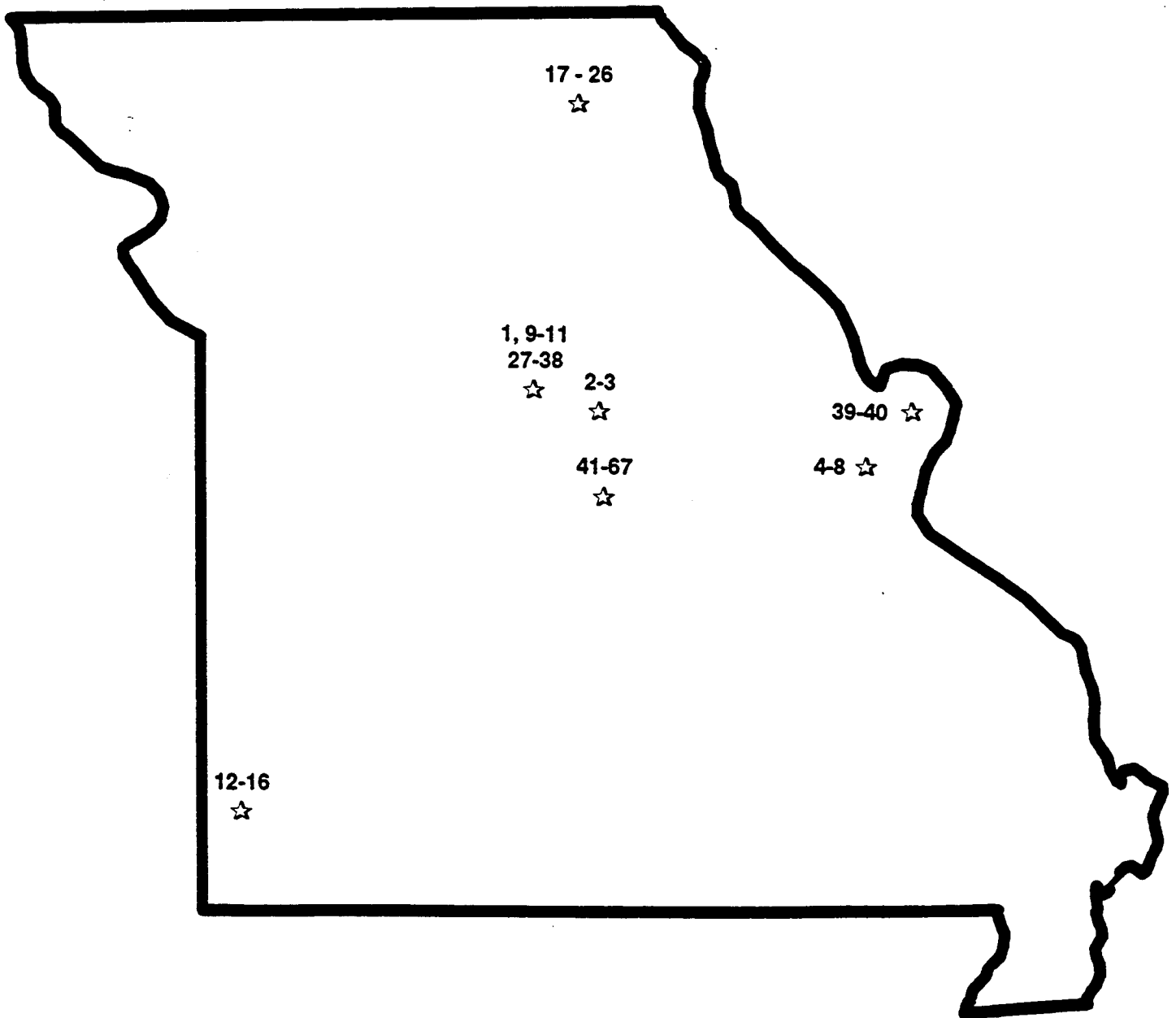
Test Site Number	Model No.	Beginning Count	Ending Count
1	5001P	3611	3611
2	5001P	3611	3611
3	5001P	3601	3592
4	5001P	3593	3613
6	5001P	3628	3621
9	5001P	3620	3617
10	5001P	3599	3607
11	5001P	3621	
12	5001P	3609	3613
14	5001P	3622	3614
17	5001P	3612	3609
19	5001P	3615	3611
25	5001P	3609	3602
27	5001P	3605	2524
29	5001P	3603	3605
31	5001P	3600	3591
35	5001P	3620	3597
39	5001P	3599	3593
41	5001P	3579	3607
44	5001P	3607	3621
46	5001P	3620	3606
48	5001P	3602	3601
50	5001P	3597	3624
52	5001P	3614	3622
54	5001P	3607	3614
1	C200	1946	1946
2	C200	1919	1938
3	C200	1938	1932
4	C200	1938	1936
6	C200	1943	1935
9	C200	1972	1941
10	C200	1938	1937
12	C200	1951	1953
14	C200	1957	1945
17	C200	1947	1964
19	C200	1937	1943
25	C200	1942	1916
27	C200	1945	1942
29	C200	1941	1947
31	C200	1958	1939
35	C200	1946	1945
1	MC-1DR	43169	
2	MC-1DR	43332	43037
3	MC-1DR	43112	43351
4	MC-1DR	43407	43247
6	MC-1DR	42965	
9	MC-1DR	42949	43232
10	MC-1DR	43453	43103

SUMMARY OF DENSITY STANDARD COUNTS
HPR-1991 60

Test Site Number	Model No.	Beginning Count	Ending Count
11	MC-1DR	43103	
12	MC-1DR	42932	43177
14	MC-1DR	43022	43042
17	MC-1DR	43001	43001
19	MC-1DR	43327	43175
25	MC-1DR	43273	43203
27	MC-1DR	43310	43175
29	MC-1DR	42979	43048
31	MC-1DR	43048	43150
35	MC-1DR	43001	43209
39	MC-1DR	43074	43031
41	MC-1DR	42886	43068
44	MC-1DR	43088	43255
46	MC-1DR	43339	43209
48	MC-1DR	43089	43179
50	MC-1DR	43443	43209
52	MC-1DR	42962	43255
54	MC-1DR	43601	43141
1	MC-3	39279	39552
2	MC-3	39618	39716
3	MC-3	39610	39636
4	MC-3	39400	39566
6	MC-3	39557	39527
9	MC-3	39217	
11	MC-3	39265	
12	MC-3	39251	39525
14	MC-3	39207	39243
18	MC-3	39484	39513
21	MC-3	39513	39576
25	MC-3	39401	39561
27	MC-3	39205	39237
29	MC-3	39143	39415
31	MC-3	39288	39595
35	MC-3	39283	39551
39	MC-3	38973	39264
41	MC-3	39346	39447
45	MC-3	39187	
46	MC-3	39255	39174
48	MC-3	39272	39232
50	MC-3	39481	39473
53	MC-3	39261	39388
54	MC-3	39141	38982

APPENDIX E
SUMMARY OF BITUMINOUS MIXTURES
AND TEST SITES

**TEST SITES IN MISSOURI
HPR 1991-60
DENSITY OF THIN LIFT BITUMINOUS MIXTURES
BY NUCLEAR METHODS**



NUMBERS INDICATE TEST SITE NUMBER,

☆ - INDICATES APPROXIMATE LOCATION OF TEST SITE

SUMMARY OF TEST SITES
 HPR 1991-60
 Density of Thin Lift Bituminous Mixtures
 by Nuclear Methods

Test Site	Route	County	Project No.	Mix No.
1	I-70	BOONE	IR-70-3(146)	IB90-250
2	WW	BOONE-CALLAWAY	RS-BRS-340(9)	BB90-158
3	WW	BOONE-CALLAWAY	RS-BRS-340(9)	IC90-300
4	I-44	ST. LOUIS	IR-44-4(111)	IB90-171
5	I-44	ST. LOUIS	IR-44-4(111)	IB90-171
6	I-44	ST. LOUIS	IR-44-4(111)	IB90-171
7	I-44	ST. LOUIS	IR-44-4(111)	IB90-171
8	I-44	ST. LOUIS	IR-44-4(111)	B90-203
9	I-70	BOONE	IR-70-3(146)	IB90-250
10	I-70	BOONE	IR-70-3(146)	IB90-250
11	I-70	BOONE	IR-70-3(146)	I90-172
12	71	JASPER-NEWTON	HES-71-1(31)	IC90-311
13	71	JASPER-NEWTON	HES-71-1(31)	IC90-311
14	71	JASPER-NEWTON	HES-71-1(31)	IC90-311
15	71	JASPER-NEWTON	HES-71-1(31)	IC90-311
16	71	JASPER-NEWTON	HES-71-1(31)	IC90-311
17	6	KNOX	F-6-3(9)	C90-233
18	6	KNOX	F-6-3(9)	C90-233
19	6	KNOX	F-6-3(9)	C90-233
20	6	KNOX	F-6-3(9)	C90-233
21	6	KNOX	F-6-3(9)	C90-233
22	6	KNOX	F-6-3(9)	C90-233
23	6	KNOX	F-6-3(9)	C90-233
24	6	KNOX	F-6-3(9)	C90-233
25	6	KNOX	F-6-3(9)	C90-233
26	6	KNOX	F-6-3(9)	C90-233
27	I-70	BOONE	IR-70-3(146)	IC90-253
28	I-70	BOONE	IR-70-3(146)	IC90-253
29	I-70	BOONE	IR-70-3(146)	IC90-253
30	I-70	BOONE	IR-70-3(146)	IC90-253
31	I-70	BOONE	IR-70-3(146)	IC90-253
32	I-70	BOONE	IR-70-3(146)	IC90-253
33	I-70	BOONE	IR-70-3(146)	IC90-253
34	I-70	BOONE	IR-70-3(146)	IC90-253
35	I-70	BOONE	IR-70-3(146)	IC90-253
36	I-70	BOONE	IR-70-3(146)	IC90-253
37	I-70	BOONE	IR-70-3(146)	IC90-253
38	I-70	BOONE	IR-70-3(146)	IC90-253
39	366	ST. LOUIS	M-4936(605)	LS90-115
40	366	ST. LOUIS	M-4936(605)	LS90-115
41	HPPDFAC	COLE	CO26-RTRK	BB90-217
42	HPPDFAC	COLE	CO26-RTRK	BB90-217
43	HPPDFAC	COLE	CO26-RTRK	BB90-217
44	HPPDFAC	COLE	CO26-RTRK	BB90-217
45	HPPDFAC	COLE	CO26-RTRK	BB90-217
46	HPPDFAC	COLE	CO26-RTRK	BB90-217

SUMMARY OF TEST SITES
(Continued)
HPR 1991-60
Density of Thin Lift Bituminous Mixtures
by Nuclear Methods

Test Site	Route	County	Project No.	Mix No.
47	HPPDFAC	COLE	CO26-RTRK	BB90-217
48	HPPDFAC	COLE	CO26-RTRK	BB90-217
49	HPPDFAC	COLE	CO26-RTRK	BB90-217
50	HPPDFAC	COLE	CO26-RTRK	BB90-217
51	HPPDFAC	COLE	CO26-RTRK	BB90-217
52	HPPDFAC	COLE	CO26-RTRK	BP90-73
53	HPPDFAC	COLE	CO26-RTRK	BP90-73
54	HPPDFAC	COLE	CO26-RTRK	BP90-73
55	HPPDFAC	COLE	CO26-RTRK	BP90-73
56	HPPDFAC	COLE	CO26-RTRK	BB90-217
57	HPPDFAC	COLE	CO26-RTRK	BB90-217
58	HPPDFAC	COLE	CO26-RTRK	BB90-217
59	HPPDFAC	COLE	CO26-RTRK	BB90-217
60	HPPDFAC	COLE	CO26-RTRK	BB90-217
61	HPPDFAC	COLE	CO26-RTRK	BB90-217
62	HPPDFAC	COLE	CO26-RTRK	BB90-217
63	HPPDFAC	COLE	CO26-RTRK	BB90-217
64	HPPDFAC	COLE	CO26-RTRK	BP90-73
65	HPPDFAC	COLE	CO26-RTRK	BP90-73
66	HPPDFAC	COLE	CO26-RTRK	BP90-73
67	HPPDFAC	COLE	CO26-RTRK	BP90-73

PROJECT=	IR-70-3(146)	ROUTE=	I-70	COUNTY=	Boone	DATE=	7/25/90
PRODUCT CODE / FACILITY CODE / PRODUCER-LOCATION	IDENT.	SP. GR	ABS	FORMATION	LEDGES	%	CHERT
100210ACLS / 3008600115 / City Qy., Columbia, MO	90-2726	2.605	1.8	Burl. LS	1-3		
100207ACLS / 3008600115 / City Qy., Columbia, MO	90-2626	2.621	1.8	Burl. LS	1-3		
1002MSACHSLS / 3003000115 / Beck #1, Holts Summit, MO	90-3213	2.698		Callaway LS			
1002HLACHL / 3032400210 / Mississippi Line, Ste. Genevieve, MO	90-872	2.241		Hyd. Lime			

1015ACVG..0200 / 3014052924 / Elf Asphalt, Kansas City, KS	90-1865	.997		AC-20			

MATERIAL	90	90	90	90	90	90	90
IDENT.	2726	3213	872	2726	2626	3213	872

90250	PERCENT		33.0	34.0	32.0	1.0	GRAD
1"	100.0	100.0	100.0	33.0	34.0	32.0	100.0
3/4"	67.8	100.0	100.0	22.4	34.0	32.0	89.4
1/2"	8.8	99.7	100.0	2.9	33.9	32.0	69.8
3/8"	5.3	78.5	100.0	1.7	26.7	32.0	61.4
#4	4.5	14.1	100.0	1.5	4.8	32.0	39.3
#8	3.9	4.2	73.4	1.3	1.4	23.5	27.2
#16	3.6	3.2	46.5	1.2	1.1	14.9	18.2
#30	3.3	2.6	29.9	1.1	.9	9.6	12.6
#50	2.9	2.2	19.5	1.0	.7	6.2	8.9
#100	2.4	1.9	12.1	.8	.6	3.9	6.3
#200	1.5	1.6	7.9	.5	.5	2.5	4.5

LABORATORY	D=	2.472	%	VOIDS=	5.22	FILM	MIX COMPOSITION
CHARACTERISTICS	d=	2.343	V.M.A.	=	14.65	THICK.=	9.9
AASHTO T-167	STABIL=	545	%	FILLED=	64.4	-200/AC=	1.1

CALIBRATION NUMBER	=		MASTER GAUGE	BACKGROUND COUNT =		CURVE COEFFICIENTS - A1 = -	
MASTER GAUGE SERIAL NO.	=		SAMPLE WEIGHT	=		A2 =	

				MIN. AGG.		96.0 %	
				ASPHALT CONTENT		4.0 %	


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PROJECT= RS-BRS-340(9)          ROUTE= WW          COUNTY= Callaway-Boone    DATE= 6/21/90
=====
PRODUCT CODE / FACILITY CODE / PRODUCER-LOCATION      | IDENT. | SP.GR. | %ABS. | FORMATION / LEDGES / % CHERT
=====
10041088LS / 3008300115 / City Oy. (Medusa Agg.), Columbia, MO  90- 3908  2.646  4.3  Burlington / 6-7
=====
1002FABBFA / 3009500115 / Columbia Sd. Co., Columbia, MO      90- 3909  2.634                Mo. River
=====
=====
=====
=====
=====
=====
=====
=====
1015ACVG..0200 / 3014052924 / Elf Asphalt, Walcott, KS          90- 1865  .997                AC-20
=====
90158
=====
MATERIAL 90 90 90 90
IDENT. 3908 3909                PERCENT 85.0 15.0
=====
COMB
GRAD
1" 100.0 100.0                || 85.0 15.0
1/2" 86.2 100.0                || 73.3 15.0
#4 39.2 99.0                  || 33.3 14.9
#8 25.3 93.0                  || 21.5 14.0
#30 13.7 42.0                 || 11.6 6.3
#200 8.6 .2                    || 7.3
=====
LABORATORY || 0= 2.441                MIX COMPOSITION
CHARACTERISTICS || d= 2.324                MIN.AGG. 95.0 %
AASHTO T-167 || STABIL= 568                ASPHALT CONTENT 5.0 %
=====
CALIBRATION NUMBER = MASTER GAUGE BACKGROUND COUNT = CURVE COEFFICIENTS - A1 = -
MASTER GAUGE SERIAL NO. = SAMPLE WEIGHT = - A2 =
=====
    
```

PROJECT=	RS-BRS-340(9)	ROUTE=	WV	COUNTY=	Boone-Callaway	DATE=	8/10/90
PRODUCT CODE / FACILITY CODE / PRODUCER-LOCATION	IDENT.	SP. GR	ABS	FORMATION	LEDGES	%	CHERT
100207ACLS / 3008800115 / City Qy., Columbia, MO	90- 2727	2.625	1.8	Burl. LS	1-3		
1002MSACMSLS / 3003000115 / Beck Materials, Holts Summit, MO	90- 3213	2.704		Callaway LS			
1002FAACFA / 3006400115 / Capital #1, Jefferson City, MO	90- 2725	2.643		Mo. River			
1002HLACHL / 3032400210 / Mississippi Lime, Ste. Genevieve, MO	90- 872	2.241		Hyd. Lime			

1015ACVG.. 0200 / 3014052924 / Elf Asphalt, Kansas City, KS	90- 1865	.997		AC-20			

MATERIAL	90	90	90	90	90	90	
IDENT.	2727	3213	2725	872	2727	3213	872

90253	PERCENT		67.0	17.0	15.0	1.0	

1"							
3/4"	100.0	100.0	100.0	100.0	67.0	17.0	15.0
1/2"	99.7	100.0	100.0	100.0	66.8	17.0	15.0
3/8"	78.5	100.0	100.0	100.0	52.6	17.0	15.0
#4	14.1	100.0	98.7	100.0	9.4	17.0	14.8
#8	4.2	73.4	90.1	100.0	2.8	12.5	13.5
#16	3.2	46.5	76.3	100.0	2.1	7.9	11.4
#30	2.6	29.9	58.1	100.0	1.7	5.1	8.7
#50	2.2	19.5	41.3	99.5	1.5	3.3	6.2
#100	1.9	12.1	8.0	98.5	1.3	2.1	1.2
#200	1.6	7.9	2.7	96.0	1.1	1.3	.4

LABORATORY	D=	2.469	% VOIDS=	5.75	FILM	MIX COMPOSITION	
CHARACTERISTICS	d=	2.327	V.M.A. =	15.36	THICK.=	9.9	MIN.AGG. 95.9 %
AASHTO T-167	STABIL=	497	% FILLED=	62.6	-200/AC=	0.9	ASPHALT CONTENT 4.1 %

CALIBRATION NUMBER	=		MASTER GAUGE BACKGROUND COUNT =		CURVE COEFFICIENTS - A1	=	
MASTER GAUGE SERIAL NO.	=		SAMPLE WEIGHT	=	- A2	=	

PROJECT=	IR-44-4(111)	ROUTE=	I-44	COUNTY=	St. Louis	DATE=	6/12/90
PRODUCT CODE / FACILITY CODE / PRODUCER-LOCATION	IDENT.		SP. GR	ABS	FORMATION	LEDGES	% CHERT
100210ACLS / 3005700316 / Bussen #3, Antire Qy., Eureka, MO	90-	3749	2.661	1.6	Plattin LS	15-19	
100207ACLS / 3005700316 / Bussen #3, Antire Qy., Eureka, MO	90-	3750	2.639	2.7	Plattin LS	15-19	
100204ACLS / 3005700316 / Bussen #3, Antire Qy., Eureka, MO	90-	3751	2.683	2.1	Plattin LS	15-19	
1002MSACNSSS / 3022100116 / International Mill #1, Granite City	90-	3752	3.385		Steel Slag		
1002FAACBN / 3005701316 / Bussen #13, Antire Sand, Eureka, MO	90-	3748	2.620		Bl. Miss. Ri.		
1002HLACHL / 3032400210 / Mississippi Lime, Ste. Genevieve, MO	90-	872	2.241		Hyd. Lime		
1015ACVG..0200 / 3001400126 / Apex Oil Co., St. Louis, MO	90-	840	1.036		AC-20		
MATERIAL	90	90	90	90	90	90	90
IDENT.	3749	3750	3751	3752	3748	872	872
90171	PERCENT		31.0	20.0	8.0	28.0	12.0
1"	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4"	93.3	100.0	100.0	100.0	100.0	100.0	97.9
1/2"	12.9	80.8	100.0	100.0	100.0	100.0	69.2
3/8"	4.3	36.9	100.0	100.0	100.0	100.0	57.7
#4	2.4	2.6	55.7	96.6	98.5	100.0	45.5
#8	2.0	1.7	11.0	64.8	95.1	100.0	32.3
#16	1.8	1.5	5.6	39.0	86.3	100.0	23.6
#30	1.8	1.5	4.5	24.0	60.3	100.0	16.2
#50	1.8	1.4	4.1	14.9	31.9	99.5	10.2
#100	1.7	1.4	3.7	9.3	12.7	98.5	6.2
#200	1.6	1.2	2.9	5.1	1.2	96.0	3.4
LABORATORY	D= 2.622		% VOIDS=	6.06	FILM	MIX COMPOSITION	
CHARACTERISTICS	d= 2.463		V.M.A. =	16.30	THICK.=	10.9	MIN.AGG. 95.7 %
AASHTO T-167	STABIL= 524		% FILLED=	62.8	-200/AC=	0.8	ASPHALT CONTENT 4.3 %
CALIBRATION NUMBER	=	MASTER GAUGE BACKGROUND COUNT	=		CURVE COEFFICIENTS	- A1	=-
MASTER GAUGE SERIAL NO.	=	SAMPLE WEIGHT	=		- A2		=

ASPHALTIC CONCRETE TYPE B

PROJECT= IR-44-4(111) ROUTE= 1-44 COUNTY= St. Louis DATE= 6/13/90

PRODUCT CODE / FACILITY CODE / PRODUCER-LOCATION	IDENT. SP. GR ABS	FORMATION / LEDGES / % CHERT
100210ACLS / 3005700316 / Bussen Antire Gy., Eureka, MO	90- 3749 2.661	1.6 Plattin / 15-19
100207ACLS / 3005700316 / Bussen Antire Gy., Eureka, MO	90- 3750 2.639	2.7 Plattin / 15-19
100204ACLS / 3005700316 / Bussen Antire Gy., Eureka, MO	90- 3751 2.683	2.1 Plattin / 15-19
1002MSACHSLS / 3022100116 / International Mill, Granite City, IL	90- 3752 3.365	Steel Slag
1002FAACBN / 3005701316 / Bussen Antire Gy., Eureka, MO	90- 3748 2.620	Miss. River
1002MFACHF / 3032400210 / Mississippi Lime., Ste. Genevieve, MO	90- 871 2.739	Min. Filler

1015ACVG..0200 / 3001400126 / Apex Oil, St. Louis, MO 90- 840 1.036 AC-20

MATERIAL	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90					
IDENT. 3749	3750	3751	3752	3748	871	3749	3750	3751	3752	3748	871	3749	3750	3751	3752	3748	871	3749	3750	3751	3752	3748	871	COMB
90203	PERCENT 28.0 19.0 12.0 28.0 12.0 28.0 12.0 1.0																				GRAD			
1"	100.0	100.0	100.0	100.0	100.0	28.0	19.0	12.0	28.0	12.0	1.0	28.0	19.0	12.0	28.0	12.0	1.0	28.0	19.0	12.0	28.0	12.0	1.0	100.0
3/4"	93.3	100.0	100.0	100.0	100.0	26.1	19.0	12.0	28.0	12.0	1.0	26.1	19.0	12.0	28.0	12.0	1.0	28.0	19.0	12.0	28.0	12.0	1.0	98.1
1/2"	12.9	80.8	100.0	100.0	100.0	3.6	15.4	12.0	28.0	12.0	1.0	3.6	15.4	12.0	28.0	12.0	1.0	28.0	15.4	12.0	28.0	12.0	1.0	72.0
3/8"	4.3	36.9	100.0	100.0	100.0	1.2	7.0	12.0	28.0	12.0	1.0	1.2	7.0	12.0	28.0	12.0	1.0	28.0	7.0	12.0	28.0	12.0	1.0	61.2
#4	2.4	2.6	55.7	96.6	98.5	.7	.5	6.7	27.0	11.8	1.0	.7	.5	6.7	27.0	11.8	1.0	27.0	.5	6.7	27.0	11.8	1.0	47.7
#8	2.0	1.7	11.0	64.8	95.1	.6	.3	1.3	18.1	11.4	1.0	.6	.3	1.3	18.1	11.4	1.0	18.1	.3	1.3	18.1	11.4	1.0	32.7
#16	1.8	1.5	5.6	39.0	86.3	.5	.3	.7	10.9	10.4	1.0	.5	.3	.7	10.9	10.4	1.0	10.9	.3	.7	10.9	10.4	1.0	23.8
#30	1.8	1.5	4.5	24.0	60.3	.5	.3	.5	6.7	7.2	1.0	.5	.3	.5	6.7	7.2	1.0	6.7	.3	.5	6.7	7.2	1.0	16.2
#50	1.8	1.4	4.1	14.9	31.9	.5	.3	.5	4.2	3.8	1.0	.5	.3	.5	4.2	3.8	1.0	4.2	.3	.5	4.2	3.8	1.0	10.3
#100	1.7	1.4	3.7	9.3	12.7	.5	.3	.4	2.6	1.5	1.0	.5	.3	.4	2.6	1.5	1.0	2.6	.3	.4	2.6	1.5	1.0	6.3
#200	1.6	1.2	2.9	5.1	1.2	.4	.2	.3	1.4	.1	.8	.4	.2	.3	1.4	.1	.8	1.4	.2	.3	1.4	.1	.8	3.2

LABORATORY || D= 2.609 X VOIDS= 5.48 FILM

CHARACTERISTICS || d= 2.466 V.M.A. = 16.82 THICK.= 12.6 MIN.AGG. 95.2 %

MAASHTO T-165 || STABIL= 461 X FILLED= 67.4 -200/AC= 0.6 ASPHALT CONTENT 4.8 %

CALIBRATION NUMBER = 00098 MASTER GAUGE BACKGROUND COUNT = 2247 CURVE COEFFICIENTS - A1 =- 6.782303

MASTER GAUGE SERIAL NO. = 770 SAMPLE WEIGHT = 7500 - A2 = 3.727116

PROJECT= IR-70-3(146)		ROUTE= I-70		COUNTY= Boone		DATE= 8/21/90	
PRODUCT CODE / FACILITY CODE / PRODUCER-LOCATION		IDENT. SP. GR ABS		FORMATION / LEDGES / % CHERT			
100207ACLS	/ 3008800115	/ City Qy., Columbia, MO	90- 1		Burl. LS	/ 1-3	
1002HSACHS	/ 3003000115	/ Beck Materials #1, Holts Summit, MO	90- 2		Callaway LS	/ 3-4	
1002FAACBN	/ 3006400115	/ Capital #1, Jefferson City, MO	90- 3		Bl. Mo. Rl.		

1015ACVG..0050 / 3042000226 / Shell Oil, Wood River, IL/ Rubber		90- 4	AC-5 w/Ground Rubber				

MATERIAL	90	90	90	90	90	90	
IDENT.	1	2	3	1	2	3	COMB

90172	PERCENT		67.0	23.0	10.0	GRAD	

1"							
3/4"	100.0	100.0	100.0	67.0	23.0	10.0	100.0
1/2"	99.5	100.0	100.0	66.7	23.0	10.0	99.7
3/8"	70.9	100.0	100.0	47.5	23.0	10.0	80.5
#4	10.9	99.8	99.4	7.3	23.0	9.9	40.2
#8	1.5	70.8	94.7	1.0	16.3	9.5	26.8
#16	1.0	46.5	76.3	.7	10.7	7.6	19.0
#30	1.0	25.7	67.5	.7	5.9	6.8	13.4
#50	.8	22.0	57.9	.5	5.1	5.8	11.4
#100	.8	12.1	8.0	.5	2.8	.8	4.1
#200	.7	6.7	1.8	.5	1.5	.2	2.2

LABORATORY	D=		% VOIDS= 2.8	FILM		MIX COMPOSITION	
CHARACTERISTICS	d= 2.313		V.M.A. =	THICK.=		MIN.AGG. 93.25 %	
AASHTO T-167	STABIL= 1800		% FILLED=	-200/AC=		ASPHALT CONTENT 6.75 %	

CALIBRATION NUMBER	=		MASTER GAUGE BACKGROUND COUNT =	CURVE COEFFICIENTS - A1		=	
MASTER GAUGE SERIAL NO.	=		SAMPLE WEIGHT	- A2		=	

F-71-1(32)
 PROJECT= HES-71-1(31)

ROUTE= 71 COUNTY= Jasper-Newton DATE= 8/15/90

PRODUCT CODE / FACILITY CODE / PRODUCER-LOCATION	IDENT.	SP. GR	ABS	FORMATION	LEDGES	% CHERT
100207ACLS / 3023600117 / Joplin Stone, Joplin, MO	90- 10337	2.608	1.1	Warsaw LS / 1-2		
1002MSACHSLS / 3009800218 / Conco #2, Willard, MO	90- 10336	2.674		Burl. LS / 2-3		
1002MSACHSCT / 3004000217 / Bingham #2, Picher, OK	90- 10338	2.649		Chat Sand		
1002HLACHL / 3001704018 / Ash Grove, Springfield, MO	90- 819	2.215		Hyd. Lime		
=====						
1015ACVG..0200 / 3044900127 / Sun Refining, Tulsa, OK	90- 4327	.999		AC-20		
=====						
MATERIAL 90 90 90 90	90 90 90 90					
IDENT. 10337 10336 10338 819	10337 10336 10338 819					
=====						
90311	PERCENT	66.0	25.0	8.0	1.0	GRAD
=====						
1"						100.0
3/4"	100.0	100.0	100.0	8.0	1.0	96.8
1/2"	95.1	100.0	100.0	8.0	1.0	82.8
3/8"	74.0	100.0	100.0	8.0	1.0	53.8
#4	30.0	100.0	99.7	8.0	1.0	37.2
#8	8.8	92.9	90.1	7.2	1.0	23.3
#16	3.1	60.5	64.5	5.2	1.0	14.8
#30	2.6	34.0	45.4	3.6	1.0	8.7
#50	2.4	16.0	26.2	2.1	1.0	5.8
#100	2.1	9.3	13.3	1.1	1.0	4.8
#200	1.9	7.4	7.4	.6	1.0	
=====						
LABORATORY	D= 2.455	% VOIDS= 6.19	FILM	MIX COMPOSITION		
CHARACTERISTICS	d= 2.303	V.M.A. = 15.90	THICK.= 8.7	MIN.AGG.	95.8 %	
AASHTO T-167	STABIL= 499	% FILLED= 61.1	-200/AC= 1.1	ASPHALT CONTENT	4.2 %	
=====						
CALIBRATION NUMBER	MASTER GAUGE BACKGROUND COUNT =		CURVE COEFFICIENTS - A1 =-			
MASTER GAUGE SERIAL NO.	SAMPLE WEIGHT =		- A2 =			

PROJECT=	IR-70-3(146)	ROUTE=	1-70	COUNTY=	Boone	DATE=	7/25/90
PRODUCT CODE / FACILITY CODE / PRODUCER-LOCATION	IDENT.	SP. GR	ABS	FORMATION	LEDGES	%	CHERT
100207ACLS / 3008800115 / City Oy., Columbia, MO	90- 2727A	2.625	1.8	Burl. LS	1-3		
1002MSACMSLS / 3003000115 / Beck Materials, Holts Summit, MO	90- 3213A	2.704		Callaway LS			
1002FAACFA / 3006400115 / Capital #1, Jefferson City, MO	90- 2725A	2.643		Mo. River			
1002HLACHL / 3032400210 / Mississippi Lime, Ste. Genevieve, MO	90- 872	2.241		Hyd. Lime			
1015ACVG..0200 / 3014052924 / Elf Asphalt, Kansas City, KS	90- 1865	.997		AC-20			
MATERIAL 90 90 90 90		90	90	90	90		
IDENT. 2727 3213 2725 872		2727	3213	2725	872		COMB
90253		PERCENT	67.0	17.0	15.0	1.0	GRAD
1"							
3/4"		100.0	100.0	100.0	100.0	1.0	100.0
1/2"		99.7	100.0	100.0	100.0	1.0	99.8
3/8"		78.5	100.0	100.0	100.0	1.0	85.6
#4		14.1	100.0	98.7	100.0	1.0	42.2
#8		4.2	73.4	90.1	100.0	1.0	29.8
#16		3.2	46.5	76.3	100.0	1.0	22.4
#30		2.6	29.9	58.1	100.0	1.0	16.5
#50		2.2	19.5	41.3	99.5	1.0	12.0
#100		1.9	12.1	8.0	98.5	1.0	5.6
#200		1.6	7.9	2.7	96.0	1.0	3.8
LABORATORY		D= 2.469	% VOIDS= 5.75	FILM			MIX COMPOSITION
CHARACTERISTICS		d= 2.327	V.M.A. = 15.36	THICK.= 9.9			MIN.AGG. 95.9 %
AASHTO T-167		STABIL= 497	%FILLED= 62.6	-200/AC= 0.9			ASPHALT CONTENT 4.1 %
CALIBRATION NUMBER	=	MASTER GAUGE BACKGROUND COUNT =					CURVE COEFFICIENTS - A1 =-
MASTER GAUGE SERIAL NO.	=	SAMPLE WEIGHT					- A2 =

PROJECT=	M-4936(605)	ROUTE=	366	COUNTY=	St. Louis	DATE=	7/18/90
PRODUCT CODE / FACILITY CODE / PRODUCER-LOCATION	IDENT. SP. GR ABS FORMATION / LEDGES / % CHERT						
100207ACLS / 3005700316 / Bussen #3, Antire Quarry	90-5223	2.662	1.7	Plattin LS / 15-19			
100207ACSS / 3022100116 / International Mill #1, Granite City	90-5224	3.286	3.0	Steel Slag			
100205ACSS / 3022100116 / International Mill #1, Granite City	90-5225	3.567	3.7	Steel Slag			
1002FAACBN / 3005701116 / Bussen #11, Koch Sand, St. Louis	90-5226	2.634		Blended Sand			
1002MFACMF / 3032400210 / Mississippi Lime, Ste. Genevieve, MO	90-6275	2.708		Mineral Filler			
=====							
1015ACVG..0200 / 3001400126 / Apex, St. Louis, MO (Clark Refinery)	90-5154	1.031		AC-20			
=====							
MATERIAL	90	90	90	90	90	90	90
IDENT.	5223	5224	5225	5226	5227	5228	5229
=====							
90115	PERCENT		23.0	30.0	31.0	15.0	1.0
=====							
1"							GRAD
3/4"	100.0	100.0	100.0	100.0	100.0	15.0	1.0
1/2"	78.4	98.4	100.0	100.0	100.0	15.0	1.0
3/8"	36.7	82.7	99.6	100.0	100.0	15.0	1.0
#4	2.5	12.2	82.5	99.2	100.0	14.9	1.0
#8	1.8	6.5	55.6	95.7	100.0	14.4	1.0
#16	1.6	4.9	34.9	85.5	100.0	12.8	1.0
#30	1.5	4.2	22.0	60.9	100.0	9.1	1.0
#50	1.4	3.4	12.6	32.0	100.0	4.8	1.0
#100	1.3	2.6	8.2	13.3	95.0	2.5	2.0
#200	1.2	1.6	4.2	1.2	79.0	1.3	.2
=====							
LABORATORY	D= 2.814		% VOIDS=	6.29	FILM	MIX COMPOSITION	
CHARACTERISTICS	d= 2.637		V.M.A. =	18.24	THICK.=	11.8	MIN.AGG. 95.3 %
AASHTO T-167	STABIL= 507		% FILLED=	65.5	-200/AC=	0.6	ASPHALT CONTENT 4.7 %
=====							
CALIBRATION NUMBER	=		MASTER GAUGE BACKGROUND COUNT	=	CURVE COEFFICIENTS		- A1 = -
MASTER GAUGE SERIAL NO.	=		SAMPLE WEIGHT	=	- A2 =		=

C026 RTRK

PROJECT= Highway Patrol Pursuit Facility ROUTE= COUNTY= DATE= 8/23/90

PRODUCT CODE / FACILITY CODE / PRODUCER-LOCATION IDENT. | SP. GR. | %ABS. | FORMATION / LEDGES / % CHERT
 10021088D0 / 3003000215 / Beck #2, Jefferson City, MO 90- 3911 2.687 4.3 J.C. Dolo / 1A, 1-2
 1002FAB8FA / 3006400115 / Capital #1, Jefferson City, MO 90- 3912 2.629 Mo. River

1015ACV6..0200 / 3014052924 / Elf Asphalt, Wolcott, KS 90- 6502 1.000 AC-20

90217

MATERIAL	90	90	90
IDENT.	3911	3912	3912
PERCENT			
1"	100.0	100.0	100.0
1/2"	73.0	100.0	77.1
#4	40.0	99.0	48.9
#8	29.0	91.0	38.4
#30	18.0	34.0	20.4
#200	9.2	7.8	7.8
GRAD			
	85.0	15.0	15.0
	85.0	15.0	15.0
	62.1	15.0	15.0
	34.0	14.9	14.9
	24.7	13.7	13.7
	15.3	5.1	5.1
	7.8		7.8

LABORATORY || D= 2.470 MIX COMPOSITION
 CHARACTERISTICS || d= 2.382 MIN. AGG. 95.0 %
 AASHTO T-167 || STABIL= 564 % FILLED= 77.1 ASPHALT CONTENT 5.0 %

CALIBRATION NUMBER = MASTER GAUGE BACKGROUND COUNT = CURVE COEFFICIENTS - A1 = -
 MASTER GAUGE SERIAL NO. = SAMPLE WEIGHT = - A2 =

C026 RTRK

PROJECT= Highway Patrol Pursuit Facility ROUTE= COUNTY=Cole DATE= 8/23/90

PRODUCT CODE / FACILITY CODE / PRODUCER-LOCATION IDENT. | SP.GR. | %ABS. | FORMATION / LEDGES

1002078PDO / 3003000215 / Beck Materials #2, Jefferson City, MO 90- 10334 2.706 J.C. Dolo. / 1A, 1-2

1002FABPFA / 3006400115 / Capital #1, Jefferson City, MO 90- 3088 2.606 Mo. River

1015ACVG..0200 / 3014052924 / Elf Asphalt, Kansas City, KS 90- 6502 1.000 AC-20

90073

MATERIAL 90 90 90 90
 IDENT. 10334 3088 10334 3088

PERCENT 80.0 20.0

3/4"	100.0	100.0	80.0	20.0	100.0
1/2"	85.0	100.0	68.0	20.0	88.0
#4	42.0	98.0	33.6	19.6	53.2
#8	27.0	92.0	21.6	18.4	40.0
#30	16.0	44.0	12.8	8.8	21.6
#200	8.8	7.0	7.0		7.0

LABORATORY || D= 2.468 % VOIDS= 3.57 MIX COMPOSITION
 CHARACTERISTICS || d= 2.380 V.M.A. = 15.98 MIN.AGG. 94.8 %
 AASHTO T-167 || STABIL= 545 % FILLED= 77.7 ASPHALT CONTENT 5.2 %

CALIBRATION NUMBER = MASTER GAUGE BACKGROUND COUNT = CURVE COEFFICIENTS - A1 = -
 MASTER GAUGE SERIAL NO. = SAMPLE WEIGHT = - A2 =

