

USING A NUCLEAR DENSITY GAUGE FOR FIELD  
TESTING OF CHEMICALLY PRESERVED WOOD

by  
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FINAL REPORT  
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Conducted by  
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for  
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The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Arkansas State Highway and Transportation Department or the Federal Highway Administration. This report does not constitute a standard, specification or regulation.

September, 1985

## ABSTRACT

This study determined that it is not feasible to use the Troxler Electronic Laboratories 3400 Series Surface Moisture-Density Gauge in its present configuration to make a fast analysis of the amount of wood preservative retained by wooden fence posts.



## IMPLEMENTATION STATEMENT

No implementable procedures are indicated by this study.

The Troxler Electronic Laboratories Model 3400 Surface Moisture-Density Gauge's standard reference block was milled to accommodate a core holder. Sample cores (0.20" x 1.5") were manufactured from untreated southern pine, vacuum dried for 12 hours at 30 C, soaked in different concentrations of pentachlorophenol for 1 hour and vacuum dried for 12 hours at 30 C. The weight changes produced by this treatment were proportional to the concentration of the soaking solution, thus, it was assumed that varying concentration of pentachlorophenol had been obtained. Testing these samples with the nuclear density gauge showed only a slight trend which was within the error limits of the device. It was decided that much of the radiation was passing around the core sample in this configuration. No significant difference could be determined by either holding samples under the probe (Fig. 1), the neutron source, or the detector.

A lead block was drilled to allow a window effect or a collimator parallel with the rays between the density source and the detector. Treated and untreated manufactured cores were placed perpendicularly through the window (Fig. 2 and Table A) and total

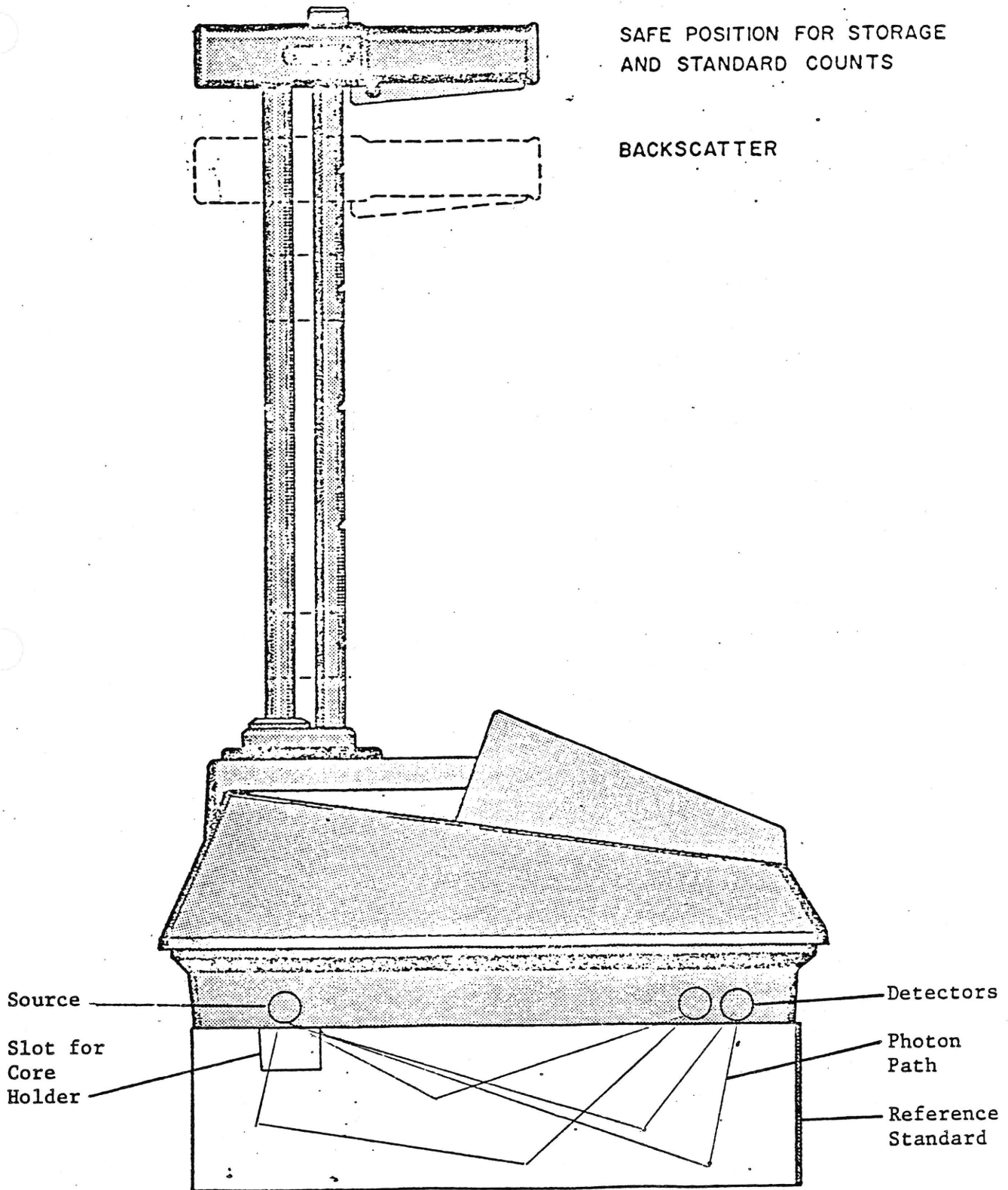


Figure 1 Troxler Moisture-Density Gauge in Backscatter Position with Reference Standard Slotted for Core Holder.

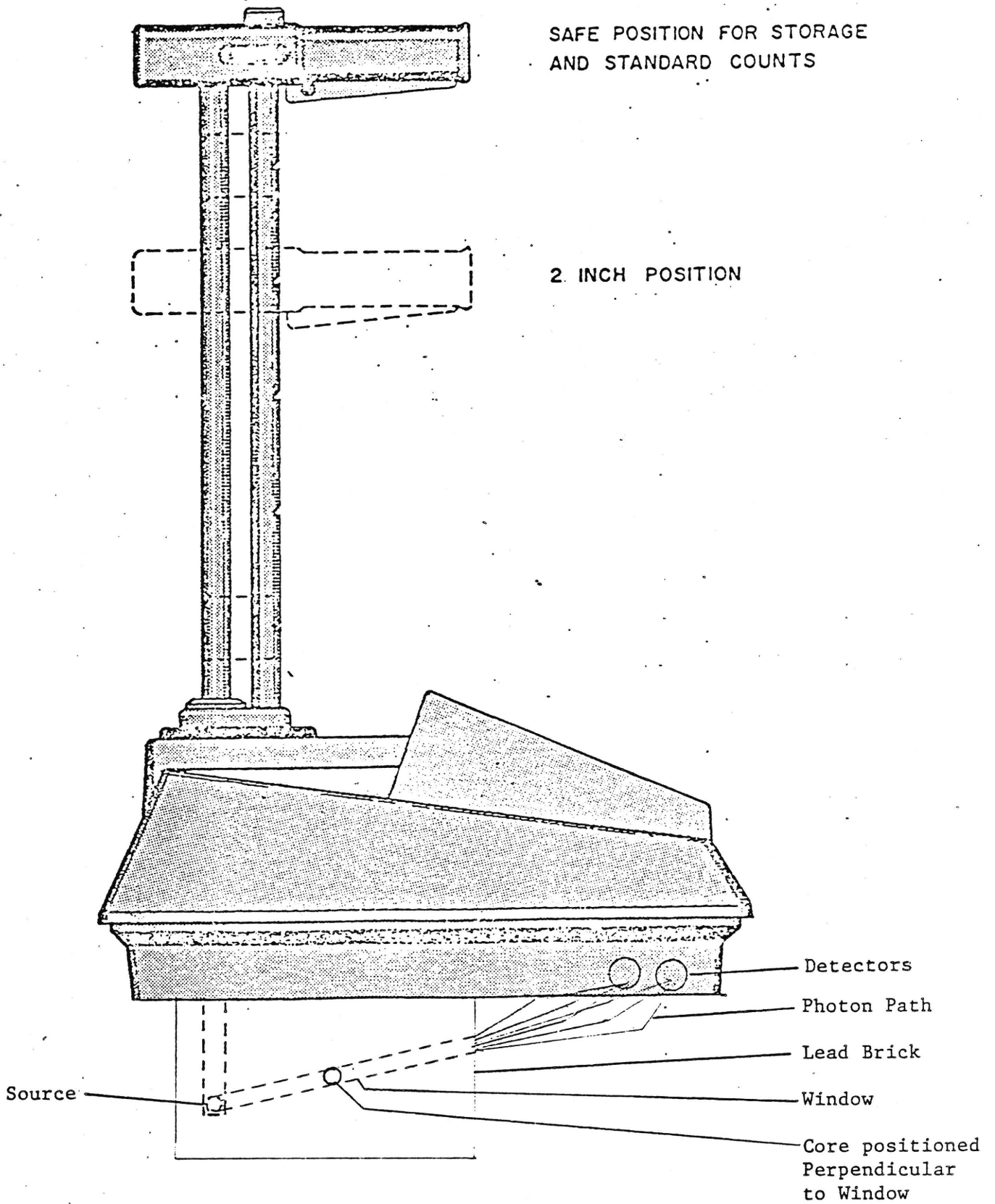


Figure 2 Troxler Moisture-Density Gauge in 2 inch Direct Transmission Position with Drilled Lead Brick to Collimate the Rays.

Table A

RESULTS OF MANUFACTURED CORES  
 Perpendicular placement of samples  
 10 replications of each

#	dose*	dc	sd	DS/dc	mc	sd	MS/mc
no sample		422	6	7.3	30	3	18.7
1	4.4	389	11	7.8	34	2	16.2
2	4.6	399	11	7.6	32	2	17.0
3	4.7	374	9	8.1	33	2	16.7
4	3.4	378	10	8.0	32	3	17.4
5	3.9	392	10	7.7	32	2	17.2
6	2.6	386	12	7.8	31	2	17.7
7	1.6	397	12	7.6	30	2	18.2
8	1.7	394	10	7.7	32	4	17.4
9	1.9	394	9	7.7	32	3	17.4
10	0.0	380	6	8.0	32	3	17.3
11	0.0	387	8	7.8	33	2	17.0
12	0.0	372	8	8.1	30	2	18.5
mean =		390		7.8	31.7		17.4
sigma =		13		0.2	1.1		0.7
95% low =		365		7.3	29.5		16.1
95% high =		415		8.2	34.0		18.8

# sample number  
 \* weight % of pentachlorophenol  
 dc density count  
 sd standard deviation  
 DS density standard count  
 mc moisture count  
 MS moisture standard count

cores were placed lengthwise in the window (Fig. 2 and Table B). A difference in absorption levels could not be determined even when two cores were placed end to end in the window (Table C).

Two groups of 1"x 6" southern pine blocks were treated with pentachlorophenol while equal groups of blocks were washed in only the solvent. These blocks were tested with the probe in 2" (Table D) and 4" (Table E) position at the end of the blocks. Various combinations of these treated and untreated blocks were tested. There appears to be more variation in the density of wood than difference in density of a block and that of blocks treated with pentachlorophenol. These 1" x 6" blocks were placed in such a manner that the neutron portion of the meter could be used to pick up chlorine in pentachlorophenol and MC test were made but again no meaningful differences could be determined.

Samples of untreated, laboratory pentachlorophenol treated, and commercially pentachlorophenol treated were drilled to allow the density probe to be inserted (Table F). No difference could be determined in the density count with the probe in the 2" position.

Commercially chromated copper sulfite (CCA) treated samples were tested in the backscatter position (Table G) and drilled to allow the insertion of the density probe. These were tested in the 2" position (Table H). There were at least 2 levels of CCA treatment and one untreated sample. Again, no consistent differences could be found.

Core samples of some of the commercially treated and laboratory treated samples were taken to the AHTD lab when the

Table B

RESULTS OF MANUFACTURED CORES  
 Parallel placement of single sample  
 10 replications of each

#	dose*	dc	sd	DS/dc	mc	sd	MS/mc
12	0.0	436	10	6.9	33	2	16.7
10	0.0	431	7	7.0	35	2	16.0
11	0.0	436	10	6.9	32	2	17.1
no sample		422	6	7.3	30	3	18.7
7	1.6	434	11	7.0	33	3	17.0
8	1.7	437	11	6.9	34	3	16.4
9	1.9	439	12	6.9	32	4	17.0
6	2.6	438	12	6.9	34	2	16.3
4	3.4	438	12	6.9	32	3	17.4
5	3.9	436	9	6.9	35	3	15.8
1	4.4	435	12	7.0	33	3	17.0
2	4.6	434	8	7.0	32	2	17.5
3	4.7	440	11	6.9	36	3	15.4
mean =		435		7.0	33.0		16.8
sigma =		4		0.1	1.5		0.8
95% low =		426		6.8	30.0		15.1
95% high		444		7.1	36.0		18.4

# sample number  
 \* weight % of pentachlorophenol  
 dc density count  
 sd standard deviation  
 DS density standard count  
 mc moisture count  
 MS moisture standard count

Table C

RESULTS OF MANUFACTURED CORES  
 Parallel placement of two cores  
 10 replications of each  
 legend

#	dose*	dc	sd	DS/dc	mc	sd	MS/mc
11,12	0.0	358	6	8.5	31	3	17.7
9,10	0.0	347	5	8.7	30	2	18.6
no sample		422	6	7.3	30	3	18.7
6,12	1.2	346	9	8.7	31	3	17.6
6,11	1.3	351	11	8.6	29	3	18.9
8,7	1.6	342	10	8.8	29	2	18.9
4,10	1.6	345	10	8.7	32	2	17.2
5,11	1.7	365	10	8.3	30	3	18.4
5,10	1.9	339	9	8.9	30	3	18.5
1,12	2.1	344	4	8.8	30	3	18.1
4,9	2.6	332	8	9.1	30	2	18.0
1,7	2.9	381	8	7.9	32	2	17.1
2,8	3.0	352	13	8.6	33	3	16.6
2,7	3.0	356	14	8.5	29	2	18.6
5,6	3.1	357	10	8.5	31	2	17.8
3,8	3.1	337	10	9.0	29	3	18.6
3,9	3.2	348	8	8.7	31	2	17.6
3,4	4.0	338	13	9.0	33	3	16.9
1,2	4.4	361	9	8.4	32	2	17.5
mean =		354		8.6	30.6		18.0
sigma =		20		0.4	1.2		0.7
95% low =		315		7.8	28.3		16.6
95% high =		393		9.4	32.9		19.3

# sample number  
 \* weight % of pentachlorophenol  
 dc density count  
 sd standard deviation  
 DS density standard count  
 mc moisture count  
 MS moisture standard count



Table D

RESULTS OF TREATED SOUTHERN PINE  
 Probe off end in 2" position  
 Six 1"x6" blocks in each sample  
 15 replications of each

#	*	mc	sd	MS/mc	dc	sd	dc/DS
1	0	123	5	4.5	8323	39	2.7
2	0	123	6	4.5	8185	38	2.7
3	0	119	5	4.6	8249	37	2.7
4	0	122	6	4.5	8322	42	2.7
5	0	121	7	4.6	8307	45	2.7
6	0	124	6	4.5	8349	40	2.7
7	0	122	7	4.5	8198	34	2.7
8	1	125	4	4.4	8256	50	2.7
9	1	129	6	4.3	8214	37	2.7
10	1	123	7	4.5	8228	26	2.7
11	1	122	5	4.6	8195	40	2.7
12	1	124	5	4.4	8272	36	2.7
13	1	124	6	4.4	8330	42	2.8
14	1	121	3	4.6	8221	34	2.7
15	1	122	5	4.6	8131	26	2.7
16	1	123	6	4.5	8233	43	2.7
17	1	127	4	4.3	8210	34	2.7
18	1	125	6	4.4	8226	42	2.7
19	1	121	5	4.6	8175	27	2.7
20	3	112	5	4.9	8450	30	2.8
21	3	124	3	4.5	8121	34	2.7
22	3	113	6	4.9	8431	50	2.8
23	3	114	6	4.8	8441	33	2.8
24	3	131	5	4.2	7999	42	2.6
25	3	110	5	5.0	8446	37	2.8
26	3	122	6	4.6	8215	38	2.7
27	3	106	4	5.2	8341	43	2.7
28	3	112	3	4.9	8374	42	2.8
29	3	118	2	4.7	8126	48	2.7
30	3	120	5	4.6	8132	47	2.7
31	3	139	6	3.9	8002	41	2.6
32	6	114	5	4.8	8105	46	2.7
33	6	112	4	4.9	8287	42	2.7
mean =		120.8		4.6	8245		2.7
sigma =		6.5		0.2	114		.0
95% low =		107.9		4.1	8017		2.6
95% high =		133.7		5.1	8474		2.8

\* number of pentachlorophenol treated blocks  
 sd standard deviation # sample number  
 DS density standard count dc density count  
 MS moisture standard count mc moisture count

able E

RESULTS OF TREATED SOUTHERN PINE  
 Probe off end in 4" position  
 Six 1"x6" blocks in each sample  
 15 replications of each

#	*	mc	sd	MS/mc	dc	sd	dc/DS
1	0	123	6	4.5	10018	37	3.3
2	0	115	4	4.8	10026	38	3.3
3	0	121	4	4.5	9986	42	3.3
4	0	123	6	4.5	10010	49	3.3
5	0	125	7	4.4	9924	43	3.3
6	0	124	6	4.4	10024	49	3.3
7	0	122	7	4.5	10071	49	3.3
8	1	124	6	4.4	10028	35	3.3
9	1	128	7	4.3	10101	43	3.3
10	1	115	6	4.8	10018	48	3.3
11	1	115	4	4.8	9931	33	3.2
12	1	125	6	4.4	10017	48	3.3
13	1	126	7	4.4	10046	52	3.3
14	1	115	4	4.8	10089	43	3.3
15	1	115	6	4.8	10014	46	3.3
16	1	115	5	4.8	10057	52	3.3
17	1	132	12	4.2	10026	27	3.3
18	1	131	5	4.2	10109	30	3.3
19	1	115	5	4.8	10009	57	3.3
20	3	111	5	5.0	10384	45	3.4
21	3	115	5	4.8	9937	40	3.3
22	3	114	5	4.8	10411	28	3.4
23	3	114	5	4.9	10389	44	3.4
24	3	131	6	4.2	9778	46	3.2
25	3	112	5	5.0	10390	47	3.4
26	3	115	5	4.8	10038	36	3.3
27	3	107	3	5.2	10313	40	3.4
28	3	113	4	4.9	10330	36	3.4
29	3	115	5	4.8	9960	49	3.3
30	3	115	6	4.8	10016	53	3.3
31	3	135	4	4.1	9763	32	3.2
32	6	115	4	4.8	9962	28	3.3
33	6	111	4	5.0	10062	35	3.3
mean =		111.7		4.3	9403		3.1
sigma =		29.3		1.1	2490		0.8
95% low =		53.1		2.1	4423		1.5
95% high =		170.4		6.6	14383		4.7

\* number of pentachlorophenol treated blocks  
 sd standard deviation # sample number  
 S density standard count dc density count  
 S moisture standard count mc moisture count

RESULTS OF PENTACHLOROPHENOL TREATED WOOD  
 Samples drilled and tested at 2" depth

#	DOSE*	SIZE	n	mc	sd	MS/mc	dc	sd	dc/DS
UT[A]	0	2(2"x6"x4')	5	84	2	6.6	8711	40	2.9
UT[B]	0	2(2"x6"x4')	6	84	5	6.6	8731	56	2.9
UT1	0	6(1"x6"x12")	10	66	4	8.0	8502	42	2.8
UT2	0	6(1"x6"x12")	10	82	6	6.7	9010	55	3.0
UT3	0	6(1"x6"x12")	10	65	3	8.2	8638	32	2.8
T1	?	6(1"x6"x12")	10	88	4	6.0	7764	28	2.6
T2	?	6(1"x6"x12")	10	102	3	5.2	8214	44	2.7
T3	?	6(1"x6"x12")	10	111	6	5.0	8223	39	2.7
D	?	4"x4"x6'rough	10	65	6	8.2	8545	35	2.8
D[1]	?	4"x4"x6'rough	5	67	3	8.2	8497	39	2.8
D[2]	?	4"x4"x6'rough	10	66	4	8.4	8647	31	2.9
E[1]	?	4"x4"x6'rough	5	92	4	5.9	8160	14	2.7
E[2]	?	4"x4"x6'rough	5	93	4	5.9	8406	27	2.8
D[3]	?	4"x4"x6'rough	5	67	4	8.1	8313	45	2.8
E	?	4"x4"x6'rough	10	88	5	6.1	9001	32	3.0
		mean =		81.3		6.9	8491		2.8
		sigma =		14.2		1.2	317		0.1
		95% low =		52.4		4.1	7750		2.6
		95% high =		115.3		9.3	9004		3.0

[ ] indicates different area of sample tested.  
 # sample number  
 \* weight % of pentachlorophenol  
 ? treated but level unspecified  
 n number of replications  
 dc density count  
 sd standard deviation  
 DS density standard count  
 mc moisture count  
 MS moisture standard count

Table G

RESULTS OF CCA SAMPLES

Commercially treated samples tested in the backscatter mode

#	DOSE*	SIZE	n	mc	sd	MS/mc	dc	sd	dc/DS
UT[B]	0	2(2"x6"x4')	5	78	2	0.0	3131	20	1.0
UT[A]	0	2(2"x6"x4')	5	88	4	6.3	3081	11	1.0
V[B]	.25	2(2"x4"x4')	5	70	2	7.8	3157	33	1.0
IV[A]	.25	2(2"x4"x4')	6	79	4	6.9	2988	30	1.0
V[A]	.25	2(2"x4"x4')	6	64	2	8.5	3143	26	1.0
IV[B]	.25	2(2"x4"x4')	5	81	3	6.7	2988	19	1.0
I[B]	.25	2(2"x6"x4')	5	158	6	3.5	2793	39	0.9
II[B]	.25	2(2"x6"x4')	6	134	5	4.1	2879	35	1.0
II[A]	.25	2(2"x6"x4')	5	118	5	4.7	2902	22	1.0
I[A]	.25	2(2"x6"x4')	6	158	3	3.5	2735	32	0.9
F[2]	?	4" dia x 15"	5	85	3	6.4	3014	37	1.0
VII[B]	.40	4"x4"x8'	5	63	3	8.6	3156	26	1.0
B[2]	?	4"x4"x8'	5	77	2	7.1	3179	12	1.1
VII[A]	.40	4"x4"x8'	7	73	2	7.4	3119	26	1.0
VII[C]	.40	4"x4"x8'	5	54	3	10.1	3208	13	1.1
C[2]	?	6" dia x 15"	5	112	7	4.9	2865	23	1.0
VI[A]	?	** 3"x5"x4'	5	107	4	5.1	2727	18	0.9
B[3]	?	** 3"x5"x4'	5	113	7	4.8	2855	16	0.9
mean =				93.5		6.4	3011		1.0
sigma =				29.8		1.8	154		0.1
95% low =				33.9		2.8	2702		0.9
95% high =				153.2		10.0	3320		1.1

- \*\* landscape timber
- [ ] indicates different area of sample tested.
- # sample number
- \* pounds per cubic foot of chromated copper arsenate
- ? treated but level unspecified
- n number of replications
- dc density count
- sd standard deviation
- DS density standard count
- mc moisture count
- MS moisture standard count

Table H

RESULTS OF CCA SAMPLES

Commercially treated samples drilled and test at 2" depth

#	Dose*	Size	n	mc	sd	MS/mc	dc	sd	dc/DS
UT[A]	0	2(2"x6"x4')	5	84	2	6.6	8711	40	2.9
UT[B]	0	2(2"x6"x4')	6	84	5	6.6	8731	56	2.9
VI[A]	?	** 3"x5"x4'	7	107	6	5.1	7667	51	2.5
VI[B]	?	** 3"x5"x4'	6	121	6	4.5	7391	26	2.4
IV[A]	.25	2(2"x4"x4')	5	70	2	7.7	7978	32	2.6
IV[B]	.25	2(2"x4"x4')	7	83	5	6.6	8169	69	2.7
V[B]	.25	2(2"x4"x4')	7	65	3	8.4	8230	25	2.7
V[A]	.25	2(2"x4"x4')	5	60	3	9.1	8234	42	2.7
I[A]	.25	2(2"x6"x4')	8	151	6	3.6	7948	50	2.6
II[B]	.25	2(2"x6"x4')	5	117	2	4.7	8685	41	2.9
II[A]	.25	2(2"x6"x4')	5	120	5	4.6	8454	29	2.8
I[B]	.25	2(2"x6"x4')	5	157	6	3.5	7994	29	2.6
F	?	15"x4"dia	10	68	5	7.9	7684	55	2.5
F[1]	?	15"x4"dia	5	93	3	5.8	7990	45	2.7
F[2]	?	15"x4"dia	5	94	4	5.8	8097	50	2.7
A[1]	?	4"x4"x15"	10	62	4	8.9	7989	40	2.6
A[2]	?	4"x4"x15"	10	71	4	7.6	8128	33	2.7
[ ]	?	4"x4"x8'	5	61	3	9.0	8465	23	2.8
V [ ]	.40	4"x4"x8'	5	70	4	7.7	8112	36	2.7
B[1]	?	4"x4"x8'	10	62	5	8.7	8478	29	2.8
VII[A]	.40	4"x4"x8'	5	66	2	8.3	8059	51	2.7
B[2]	?	4"x4"x8'	10	60	3	9.2	8414	34	2.8
VII[B]	.40	4"x4"x8'	5	63	3	8.7	8211	39	2.7
VII[B]	.40	4"x4"x8'	5	68	2	8.0	8390	43	2.8
B[3]	?	4"x4"x8'	5	79	3	6.9	7874	37	2.6
VII[A]	.40	4"x4"x8'	5	69	6	7.9	8104	46	2.7
C[3]	?	15"x6"dia	10	92	5	5.8	7917	33	2.6
C[2]	?	15"x6"dia	5	110	8	4.7	8129	29	2.7
C[1]	?	15"x6"dia	5	116	5	4.0	8231	29	2.7
C	?	15"x6"dia	10	139	5	6.7	8298	42	2.7
		mean =		89.0		6.8	8119		2.7
		sigma =		29.0		1.8	271		0.1
		95% low =		31.0		3.1	7577		2.5
		95% high =		146.9		10.4	8660		2.9

\*\* landscape timber  
 [ ] indicates different area of sample tested.  
 # sample number  
 \* pounds per cubic foot of chromated copper arsenate  
 dc density count  
 sd standard deviation  
 DS density standard count  
 mc moisture count  
 MS moisture standard count

gauge was returned. On considering the above results and the work load at the lab these were not analyzed.

This study determined that it is not feasible to use the Troxler Electronic Laboratories 3400 Series Surface Moisture-Density Gauge in the present configuration to make a fast analysis of the amount of wood preservative retained by wooden fence posts.