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Appendix 2

"For Information Only"

A PRELIMINARY EVALUATION OF COPPER NAPHTHENATE-TREATED POLES IN SERVICE [1]

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INTRODUCTION

Owing in large part to severe premature failures of poles treated with copper naphthenate, a taskforce was formed in 1996 in Subcommittee T-4 to investigate the performance of copper naphthenate-treated poles [CNTP] in service. This preliminary report is being provided in response to the data call made by the taskforce.

Thousands of poles treated with copper naphthenate [CN] are currently in service throughout the USA. Data have been presented on poles in five different locations and including at least two species, kiln-dried southern pine (*Pinus* spp.) and boultonized Douglas-fir (*Pseudotsuga menziesii*), and two carrier systems, AWPA P9 types A and B (Harp & Grove, 1993). In addition, the southern pine pole stubs from the original treatment trials conducted at Mississippi State University (Barnes & Hein, 1988) are showing excellent performance after over ten years in ground contact in Mississippi. These steam-conditioned stubs include several methods of post-treatment conditioning. Engdahl and Baileys (1992) reported on kiln-dried southern pine poles installed in 1988 at three locations in Ohio and one each in Virginia and West Virginia. The authors made no observations contraindicating adequate performance and suggested that the migration data developed was typical of oilborne preservative systems.

METHODS & MATERIALS

Test Poles--CNTP of different ages, sizes, and species from different geographical areas were identified and cooperation of the pole owners secured. Individual poles were numbered and a random number generator was used to identify which poles would be examined, depending on the wishes of the cooperating utility. If the physical location of a pre-chosen pole precluded its examination, the pole was replaced by the next number chosen.

Pole Inspection--All poles chosen for study were examined for signs of deterioration at one foot below groundline as well as aboveground by independent inspectors. Test poles were excavated to one foot below groundline, sounded from groundline to as high as the inspector could reach, examined for signs of external decay both above and below groundline, and bored three or four times near grade

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and once within one foot of the brand to determine internal decay and penetration. These cores were combined for assay as described below. Selected poles were bored above the brand in a spiral pattern in five-foot increments in order to more thoroughly assess the condition of the above-ground portion of the pole. These cores were assayed separately as a group. Cores were then placed in straws and shipped to the Mississippi Forest Products Laboratory (MFPL) where they were ground to pass a 30 mesh screen, and assayed using AWPA Standard A9-97 (AWPA, 1997). Each core was examined for signs of internal decay and the penetration of preservative was rechecked. A pictorial record for each pole sampled was made.

RESULTS

A total of 35 Group B Douglas-fir, 70 Group A southern pine, and 31 Group B southern pine CNTP were examined for this preliminary report. These poles represent five different utilities and four different treaters and include assessments for poles in deterioration zones 2, 3, 4, and 5. Douglas-fir data are summarized in Table 1. The data are summarized in Tables 2 and 3 for southern pine. The data for Douglas-fir show the following:

- Only two Douglas-fir failed to meet target assay, one being 67% of the desired target and the other 94% of desired target retention.
- Poles have been in service for six to eight years.
- No penetration problems were noted in any pole examined.
- No decay or insect attack were noted in any of the treated poles.
- Across all poles, retention averaged 0.16 pcf Cu, or 72% more than called for by the specified retention in the appropriate assay zone.

Considerably more variation was shown in the southern pine poles tested to date. Most non-conforming poles failed to meet the specified assay requirement. The two poles failing for penetration, also failed for assay. Only two seriously decayed poles have been found to date, and they were removed from service. One pole had a break below the bottom conductor in the decayed area. The other had a large decay pocket containing some preservative at groundline. Several southern pine poles are severely under-treated, with one being only 40% of the target retention specified. These poles are candidates for early failure. It was noted that some poles had bleached tops, but this observation did not correlate with under-treatment, decay, or other defects. The southern pine data show the following:

- For Group A poles, 53% of those assayed did not meet the desired target, 38% of the 0.08 pcf target and 62% of the 0.13 pcf target.
- Assays for non-conforming Group A poles averaged 80% for the 0.08 pcf specification and 76% of target for the 0.13 pcf specification.
- Group B southern pine poles were generally of better quality compared to Group A poles, with 26% not meeting the assay target.
- Non-conforming Group B poles represented 10% of the 0.08 pcf target poles and 55% of the 0.13 pcf target poles.
- Assays for non-conforming poles averaged 88% for the 0.13 pcf specification and 83% of target for the 0.08 pcf specification.
- The data suggest that treaters are having difficulty in meeting the 0.13 pcf retention regardless of pole class.
- The oldest poles in the southern pine survey group were installed in 1990.

Data comparing assays from pole tops (above brand) to those taken from the brand down are shown in Table 4. There was no consistent trend with respect to assay location with half of the poles having

a higher retention in the top portion and half with higher retentions in the bottom portion. All but two poles show bottom to top differences within ± 0.025 pcf Cu with the worst case pole showing a top retention equal to 37% of that found in the bottom. Based on the bottom assay, this particular pole was over-treated by a factor of 1.86. In two instances, the top assay did not meet the required target while the bottom did and in two instances the reverse was true. For the most part, these comparisons fall within what might be expected and do not seem to indicate differential treatment.

FUTURE PLANS

This study is continuing with data from at least two more utilities and two more treaters expected. With respect to failures, it is reasonable to ask '*Why does the survey to date indicate so few failures in light of widespread reports of early failures?*' Much of the other known performance data is the subject of litigation and hence unavailable for publication. The parties involved have not allowed inspection of poles that are part of the litigation.

In addition to the assay for copper, the naphthenic acid portion of the preservative is being analyzed following CuN extraction and cleaveage. Poles from additional utilities are scheduled for inspection. An attempt is being made to ascertain both the initial and final conditioning methods used on the poles. An additional study is being formulated to see if the theory put forward by Kamdem and colleagues (Kamdem *et al.*, 1998a, b; Zhang, *et al.*, 1997) has merit with respect to pole performance.

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Table 1. Data summary for Douglas-fir poles evaluated to date.

UTILITY	TREATER	BRAND MO	BRAND YR	BRAND CL	BRAND LGT (ft)	BRAND RTN	ZONE	ASSAY (pcf Cu)	CONFORMANCE TO STANDARDS: ASSAY (% of Target)	CONFORMANCE TO STANDARDS: PENETRATION
B	1		90	3	50	0.095	4	0.064	N 67%	OK
B	1		90	3	50	0.095	4	0.089	N 94%	OK
B	1		90	3	50	0.095	4	0.114		OK
A	1	7	92	H1	75	0.095	2	0.116		OK
A	1	8	92	H1	70	0.095	2	0.118		OK
B	1		90	3	50	0.095	4	0.122		OK
A	1	7	92	H1	75	0.095	2	0.127		OK
B	1		90	3	50	0.095	4	0.129		OK
B	1		90	3	50	0.095	4	0.129		OK
A	1	7	92	H1	75	0.095	2	0.130		OK
B	1		90	3	50	0.095	4	0.131		OK
B	1		90	3	50	0.095	4	0.134		OK
B	1		90	3	50	0.095	4	0.136		OK
A	1	8	92	H1	70	0.095	2	0.142		OK
B	1		90	3	50	0.095	4	0.143		OK
A	1	7	92	H1	75	0.095	2	0.144		OK
A	1	7	92	H1	70	0.095	2	0.155		OK
B	1		90	3	50	0.095	4	0.156		OK
A	1	8	92	H1	75	0.095	2	0.167		OK
A	1	8	92	H1	70	0.095	2	0.169		OK
B	1		90	3	50	0.095	4	0.171		OK
B	1		90	3	50	0.095	4	0.175		OK
B	1		90	3	50	0.095	4	0.179		OK
B	1		90	3	50	0.095	4	0.179		OK
A	1	8	92	H1	75	0.095	2	0.184		OK
B	1		90	3	50	0.095	4	0.193		OK
B	1		90	3	50	0.095	4	0.195		OK
B	1		90	3	50	0.095	4	0.209		OK
B	1		90	3	50	0.095	4	0.210		OK
B	1		90	3	50	0.095	4	0.215		OK
B	1		90	3	50	0.095	4	0.221		OK
B	1		90	3	50	0.095	4	0.226		OK
B	1		90	3	50	0.095	4	0.229		OK
B	1		90	3	50	0.095	4	0.231		OK
B	1		90	3	50	0.095	4	0.259		OK

	% of TOTAL	#	AVG
NON-CONFORMING [PENETRATION]		0	
NON-CONFORMING ASSAY	6%	2	0.077
CONFORMING ASSAY	94%	33	0.168
TOTAL		35	0.163

Table 2. Data summary for Group A southern pine poles evaluated to date.

UTILITY	TREATER	BRAND					ZONE	ASSAY (pcf Cu)	CONFORMANCE TO STANDARDS		
		MO	YR	CL	LGT (ft)	RTN			ASSAY (% of Target)		PENETRATION
C	2	5	91	5	40	0.08	3	ASSAY NOT POSSIBLE			OK
D	3	8	90	5	45	0.13	5	ASSAY NOT POSSIBLE			OK
C	2	5	91	5	40	0.08	3	0.043	N	54%	OK
E	2	10	95	5	35	0.13	5	0.052	N	40%	OK
C	2	5	91	5	40	0.08	3	0.054	N	68%	Decay pocket @ GL
E	4	5	94	5	35	0.13	5	0.057	N	44%	OK
A	2	5	93	5	30	0.08	2	0.061	N	76%	OK
A	2	3	93	5	35	0.08	2	0.062	N	78%	OK
C	2	5	91	5	40	0.08	3	0.063	N	79%	OK
A	2	5	93	5	35	0.08	2	0.064	N	80%	OK
A	2	9	93	4	40	0.08	2	0.070	N	88%	OK
A	2	6	93	4	40	0.08	2	0.070	N	88%	OK
C	2	5	91	5	40	0.08	3	0.075	N	94%	OK
C	2	5	91	5	40	0.08	3	0.076	N	95%	OK
E	2	7	96	5	35	0.13	5	0.077	N	59%	OK
A	2	5	93	4	40	0.08	2	0.080			OK
E	2	7	96	5	35	0.13	5	0.081	N	62%	OK
E	2	1	97	5	35	0.13	5	0.083	N	64%	OK
E	2	4	96	5	30	0.13	5	0.086	N	66%	OK
A	2	3	93	5	35	0.08	2	0.090			OK
A	2	9	93	4	40	0.08	2	0.092			OK
E	2	8	96	5	30	0.13	5	0.092	N	71%	OK
E	2	4	96	5	35	0.13	5	0.092	N	71%	OK
A	2	3	93	4	40	0.08	2	0.092			OK
C	2	5	91	5	40	0.08	3	0.093			OK
E	4	5	94	5	35	0.13	5	0.093	N	72%	OK
E	4	5	94	5	35	0.13	5	0.094	N	72%	OK
E	2	6	96	5	35	0.13	5	0.096	N	74%	OK
E	4	X	95	5	30	0.13	5	0.096	N	74%	OK
E	2	4	96	5	30	0.13	5	0.096	N	74%	OK
C	2	5	91	5	40	0.08	3	0.097			OK
C	2	5	91	5	40	0.08	3	0.098			OK
C	2	5	91	5	40	0.08	3	0.101			OK
D	3	8	90	5	45	0.13	5	0.103	N	79%	OK
A	2	5	93	4	40	0.08	2	0.104			OK
E	4	5	94	5	30	0.13	5	0.104	N	80%	OK
E	4	X	94	5	30	0.13	5	0.104	N	80%	65% SW
E	2	8	96	5	30	0.13	5	0.105	N	81%	OK
A	2	9	93	4	40	0.08	2	0.112			OK
E	2	10	96	5	30	0.13	5	0.112	N	86%	OK
E	2	6	96	5	35	0.13	5	0.113	N	87%	OK
E	4	3	94	5	30	0.13	5	0.115	N	88%	OK
E	4	6	95	4	35	0.13	5	0.118	N	91%	OK
D	3	8	90	5	45	0.13	5	0.120	N	92%	OK
E	4	5	95	5	30	0.13	5	0.120	N	92%	OK
E	2	6	96	5	35	0.13	5	0.121	N	93%	OK
A	2	9	93	5	35	0.08	2	0.122			OK
D	3	8	90	5	45	0.13	5	0.123	N	95%	OK
A	2	5	93	5	35	0.08	2	0.124			OK
C	2	5	91	5	40	0.08	3	0.125			OK
D	3	8	90	5	45	0.13	5	0.125	N	96%	OK
A	2	9	93	4	40	0.08	2	0.131			OK
E	4	5	94	5	35	0.13	5	0.132			OK

Table 2. Data summary for Group A southern pine poles evaluated to date.

UTILITY	TREATER	BRAND					ZONE	ASSAY (pcf Cu)	CONFORMANCE TO STANDARDS	
		MO	YR	CL	LGT (ft)	RTN			ASSAY (% of Target)	PENETRATION
D	3	8	90	5	45	0.13	5	0.135		OK
D	3	8	90	5	45	0.13	5	0.137		OK
E	2	10	97	5	30	0.13	5	0.139		OK
E	2	10	97	5	30	0.13	5	0.140		OK
D	3	8	90	5	40	0.13	5	0.141		OK
D	3	8	90	5	45	0.13	5	0.143		OK
D	3	8	90	5	45	0.13	5	0.145		OK
E	4	X	94	5	30	0.13	5	0.146		OK
D	3	8	90	5	45	0.13	5	0.146		OK
D	3	8	90	5	40	0.13	5	0.149		OK
C	2	5	91	5	40	0.08	3	0.149		OK
D	3	8	90	5	45	0.13	5	0.154		OK
E	2	1	96	5	30	0.13	5	0.154		OK
A	2	9	93	5	35	0.08	2	0.154		OK
D	3	8	90	5	45	0.13	5	0.163		OK
E	2	6	96	5	30	0.13	5	0.168		OK
D	3	8	90	5	45	0.13	5	0.173		OK

		#		AVG			
	TARGET	0.080	0.130	0.080	0.130		
NON-CONFORMING [PENETRATION]		1	1				
NON-CONFORMING ASSAY		10	26	0.064	0.099		
CONFORMING ASSAY		16	16	0.110	0.148		
NOT ASSAYED		1	1				
TOTAL		70					

Table 3. Data summary for Group B southern pine poles evaluated to date.

UTILITY	TREATER	BRAND					ZONE	ASSAY (pcf Cu)	CONFORMANCE TO STANDARDS	
		MO	YR	CL	LGT (ft)	RTN			ASSAY (% of Target)	PENETRATION
A	2	6	93	3	45	0.08	2	0.115		OK
A	2	7	93	3	45	0.08	2	0.100		OK
A	2	3	93	3	45	0.08	2	0.085		OK
C	2	5	91	3	45	0.08	3	0.086		OK
A	2	6	93	3	45	0.08	2	0.087		OK
A	2	4	93	3	45	0.08	2	0.090		OK
A	2	6	93	3	45	0.08	2	0.091		OK
A	2	4	93	3	45	0.08	2	0.093		OK
A	2	X	93	3	45	0.08	2	0.093		OK
A	2	7	93	3	45	0.08	2	0.094		OK
A	2	4	93	3	45	0.08	2	0.173		OK
C	2	5	91	3	45	0.08	3	0.095		OK
A	2	9	93	3	50	0.08	2	0.139		OK
A	2	3	93	3	45	0.08	2	0.105		OK
A	2	3	93	3	45	0.08	2	0.152		OK
A	2	6	93	3	45	0.08	2	0.111		OK
A	2	5	93	3	50	0.08	2	0.141		OK
A	2	6	93	3	45	0.08	2	0.119		OK
D	3	8	90	3	55	0.13	5	0.131		OK
D	3	8	90	3	55	0.13	5	0.137		OK
D	3	8	90	3	55	0.13	5	0.131		OK
D	3	8	90	3	55	0.13	5	0.130		OK
D	3	8	90	3	55	0.13	5	0.130		OK
A	2	6	93	3	45	0.08	2	0.069	N 86%	OK
C	2	5	91	3	45	0.08	4	0.062	N 78%	OK
D	3	8	90	3	55	0.13	5	0.120	N 92%	OK
D	3	8	90	3	55	0.13	5	0.117	N 90%	OK
D	3	8	90	3	55	0.13	5	0.116	N 89%	OK
D	3	8	90	3	55	0.13	5	0.106	N 82%	SPOTTY TOP[1]
D	3	8	90	3	55	0.13	5	0.094	N 72%	OK
D	3	8	90	3	55	0.13	5	0.128	N 98%	OK

	TARGET	#		AVG			
NON-CONFORMING [PENETRATION]			1				
NON-CONFORMING ASSAY		2	6	0.066	0.114		
CONFORMING ASSAY		18	5	0.109	0.132		
TOTAL		31					

[1] This pole had a break below the bottom conductor. It was removed from service and was subsequently shown to be seriously decayed in the break area.

Table 4. Comparison of southern pine pole tops (above brand) and bottoms (brand down).

UTILITY	TREATER	MO	YR	CL	LGT (ft)	RTN	ZONE	ASSAY (pcf Cu)		CONFORMANCE		RATIO [TOP: TARGET]	GRP	DIFF [BOT-TOP]
								BOTTOM	TOP	BOTTOM	TOP			
A	2	9	93	4	40	0.08	2	0.092	0.117			146%	A	-0.025
C	2	5	91	5	40	0.08	4	0.054	0.078	N	N	98%	A	-0.024
C	2	5	91	5	40	0.08	4	0.075	0.098	N		123%	A	-0.023
A	2	9	93	4	40	0.08	2	0.070	0.089	N		111%	A	-0.019
E	2	8	96	5	30	0.13	5	0.105	0.116	N	N	89%	A	-0.011
A	2	5	93	5	30	0.08	2	0.061	0.069	N	N	86%	A	-0.008
E	2	4	96	5	30	0.13	5	0.096	0.102	N	N	78%	A	-0.006
C	2	5	91	5	40	0.08	4	0.101	0.095			119%	A	0.006
A	2	6	93	3	45	0.08	2	0.119	0.112			140%	B	0.007
A	2	9	93	4	40	0.08	2	0.112	0.094			118%	A	0.018
E	4	3	94	5	30	0.13	5	0.115	0.095	N	N	73%	A	0.020
E	4	5	94	5	35	0.13	5	0.093	0.070	N	N	54%	A	0.023
C	2	5	91	5	40	0.08	4	0.098	0.063		N	79%	A	0.035
C	2	5	91	5	40	0.08	4	0.149	0.056		N	70%	A	0.093