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author: Thorndyke Roe, Jr.

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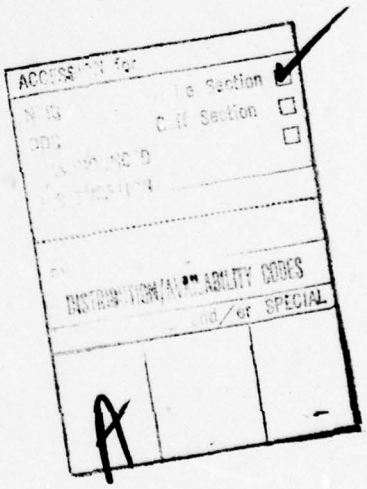

INTRODUCTION

In order to determine the effectiveness of any proposed preservative treatment for wood piling, it is necessary to expose full-sized piles impregnated with that treatment in marine borer infested waters. To decrease the time required to obtain meaningful data without imposing any artificial conditions upon the evaluation method, exposures are carried out in tropical locations where marine borers and the rate of their attack are much greater than in temperate waters.

PILING INSTALLATIONS AND INSPECTIONS

From 1963 to 1976, the Civil Engineering Laboratory (CEL) monitored two installations of experimentally treated piles. One installation (Ref 1) at Coco Solo Annex, Rodman Naval Station, Canal Zone, consisted of piles treated and supplied by the Cooperative Marine Piling Committee (an informal committee composed of representatives from the wood-treating industry, the Forest Products Laboratory, and the W. F. Clapp Laboratories). Monitoring of these piles was discontinued after the 1976 inspection. The second installation (Ref 2 through 6) at Waipio Peninsula, Pearl Harbor, Hawaii, consisted of Cooperative Marine Piling Committee piles plus four groups of CEL- and CEL/Industry-treated piles. Table 1 summarizes the original data on the piles driven at Pearl Harbor.

From the initial inspection through the 1974 inspection, the piles exposed at both sites were inspected visually from the surface of the water (Ref 7 through 14). One interruption in the exposure at Pearl Harbor occurred in August 1972 when 120 of the experimental piles were accidentally pulled and brought ashore by Harbor Cleanup Unit HCU-1. Those removed were 42 of the Cooperative Marine Piling Committee piles and the CEL piles driven in 1963 and the 78 CEL piles driven in 1965. Inspection revealed that many of these piles were either lost or were broken and could not be identified. Thus, only 51 of the original 120 piles removed were redriven: 4 of the 1963 piles (2 of the Cooperative Marine Piling Committee's and 2 CEL's), and 47 of the 1965 CEL piles (Ref 13).

Because of the difficulties encountered in trying to observe submerged pile surfaces, CEL let a contract to the Al Hanson Diving Service* to inspect the piles underwater in 1975. Similar contracts were let for the 1976, 1977, and 1978 inspections. Mr. Hanson reports the percentage

*Mr. Hanson has been the inspector of wood piles for the Port of Los Angeles for more than 25 years. Mrs. Hanson, who is both a licensed diver and diver tender, acts as his tender and records his data.

loss of cross-sectional area of each pile caused by borer attack as well as the extent and location of the attack (Ref 15, 16, 17). Splits, checks, and other defects or damage are also noted. The results of these inspections are shown in Tables 2 through 9.

FINDINGS

Cooperative Piles and CEL Creosoted Piles (Tables 2, 6)

After 14 years and 5 months of actual exposure, Douglas fir piles dual-treated with ammoniacal copper arsenite and creosote and southern pine piles dual-treated with chromated copper arsenate Type A and creosote had sustained attack in the 0% to 1% range. No other pile in this group, except for the cupro-nickel-jacketed creosoted southern pine pile, performed as well; creosoted piles had sustained from 2% to 5% attack.

CEL and CEL/Industry Piles (Tables 3, 4, 5, 7, 8, 9)

After 14 years of exposure, five of six southern pine piles treated with a moderate retention of creosote (17.4 pcf) containing 2% tributyltin oxide and 2% dieldrin were not attacked and the sixth has sustained only 2% attack. Four of six Douglas fir piles treated with a high retention (28.6 pcf) of creosote containing 5% chlordane were unattacked and two had sustained 1% to 3% attack; Douglas fir piles treated with high retentions (28.5 and 26.3 pcf) of creosote containing 2.5% or 1.25% chlordane had attack in the 0% to 3% range, except for one pile which sustained 4% attack in an area where a split or crack had occurred. Douglas fir piles treated with a high retention of creosote (32.9 pcf) had sustained 2% to 5% attack (Tables 3, 7).

After 13 years of exposure, most of the creosote-free treated Douglas fir piles were attacked. However, those treated with 5% chlordane and 2% tributyltin oxide had sustained 0% to 2% attack, and those treated with 5% chlordane and 1% tributyltin oxide had sustained 0% to 3% attack. Piles treated with 4% copper oxinate had sustained from 0% to 5% attack (Tables 4, 8).

After 12 years of exposure, one of six piles treated with basic zinc sulfate was unattacked, and five had sustained 2% to 3% attack. Five of six piles dual-treated with basic zinc sulfate and tributyltin oxide had sustained no attack, and the sixth showed 1% attack. Ammoniacal copper arsenite treated piles had sustained 1% to 4% attack, and ammoniacal copper arsenite-tributyltin oxide dual-treated piles had sustained no attack (three piles) and 1% to 3% attack (three piles). Ammoniacal copper arsenite-70/30 creosote-coal tar solution dual-treated piles had sustained no attack (four piles) and 1% attack (two piles). Chromated copper arsenate Type B plus tributyltin oxide dual-treated piles had sustained no attack (two piles) and 1% to 5% attack (four piles). The performance of piles treated with a high retention (31.7 pcf) of 70/30 creosote-coal tar solution was spotty: two were unattacked and the other four piles sustained 1%, 3%, 4%, and 15% attack (Tables 5, 9).

CONCLUSIONS

1. After exposure periods of from 12 to 14 years 5 months in Pearl Harbor, piles treated with high retentions of creosote or 70/30 creosote-coal tar solution showed good resistance to marine borer attack, but this resistance was improved by the addition of a toxic additive or additives to the creosote or creosote-coal tar solution.

2. After exposure periods of from 12 to 13 years, creosote-free single treatments such as 4% copper oxinate, ammoniacal copper arsenite, and basic zinc sulfate showed good resistance to marine borer attack, but treatment with a solution which contained two toxic compounds or treatment with a water soluble toxic compound followed by treatment with an oil-soluble toxic compound gave better resistance.

ACKNOWLEDGMENT

The author wishes to thank Mr. D. Kim, Maintenance Control Department, Public Works Center, Pearl Harbor, for his assistance.

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Table 1. Summary of Initial Data on Experimentally Treated Piles Driven at Pearl Harbor

Year Driven	Source of Piles[a]	Number of Treatments	Piles Per Treatment	Total Number of Piles	Summary of Treatments
1963	Coop	10	6	60	Inorganic salt followed by creosote (dual treatment); 70-30 creosote-coal tar solution; phenylmercuric oleate dissolved in 70-30 creosote-coal tar solution; 70-30 creosote-coal tar solution followed by sheathing with 90:10 cupro-nickel alloy
1963	CEL	1	6	6	Type III creosote
1964	CEL	9	6	54	Creosote solutions of specific organic compounds and/or metal organic compounds
1964	OWPC	1 1 1	4 5 6	15	Creosote solutions of specific organic and metal organic compounds
1965	CEL	13	6	78	Solutions of specific organic and metal organic compounds in xylene or creosote
1966	CEL	2	6	12	Dual treatment: copper sulfate followed by tributyltin oxide
1966	BCCWP	1	6	6	Chromated copper arsenate (Type B)

(continued)

Table 1. Continued

Year Driven	Source of Piles[a]	Number of Treatments	Piles Per Treatment	Total Number of Piles	Summary of Treatments
1966	AZLS	3	6	6	Basic zinc sulfate
1966	AZLS	3	6	18	Ammoniacal copper arsenite; 70-30 creosote-coal tar solution; dual treatment: ammoniacal copper arsenite followed by 70-30 creosote-coal tar solution
1966	AZLS/CEL	1	6	6	Dual treatment: basic zinc sulfate followed by tributyltin oxide
1966	BCCWP/CEL	1	6	6	Dual treatment: chromated copper arsenate (Type B) followed by tributyltin oxide
1966	JHB/CEL	1	6	6	Dual treatment: ammoniacal copper arsenite followed by tributyltin oxide

[a]Coop = Cooperative Marine Piling Committee.
CEL = Civil Engineering Laboratory.
OWPC = Osmose Wood Preserving Company of America.
BCCWP = British Columbia Clean Wood Preservers, Ltd.
AZLS = American Zinc, Lead, and Smelting Co.
JHB = J. H. Baxter and Co.

Table 2. Results of 1978 Inspection of Cooperative Piles at Pearl Harbor, Plus One Set of Piles Treated With Creosote by CEL (installed in 1963)

[Mart = Martesia; Lim = Limnoria; Ter = Teredo; ML = Mud Line; TA = Tide Area]

Treatment	Retentions (lb/ft^3)				Loss of Cross-Sectional Area (%) for --				
	Cooperative Assay		CEL Assay						
	Oil	Salt	Oil	Salt	Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5
Ammoniacal copper arsenite followed by creosote Douglas Fir	16.2	6.9	9.7	-	0	1: TA, dead Mart	0		
Chromated copper arsenate followed by creosote Douglas Fir	8.4	2.7	2.7	-	12: TA to ML, Lim, Mart	55: TA, Mart, Lim, Ter	2: ML, dormant Mart		
Southern Yellow Pine	23.2	2.7	17.3	-	Pile missing	1: TA, Lim	0		

(continued)

Table 2. Continued

Treatment	Retentions (lb/ft^3)				Loss of Cross-Sectional Area (%) for --				
	Cooperative Assay		CEL Assay						
	Oil	Salt	Oil	Salt	Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5
70-30 creosote-coal tar solution									
Douglas Fir	15.3	-	11.1	-	1: TA, Mart holes	7: ML, Lim	0		
Southern Yellow Pine	17.7	-	13.5	-	15: TA, Lim, large Mart holes	2: TA, Lim 10: ML, Lim			
70-30 creosote-coal tar solution containing 1% phenylmercuric oleate[a]									
Douglas Fir	20.7	-	18.5	-	13: TA, Lim	0	1: TA, Lim		
Southern Yellow Pine	24.1	-	18.5	-	3: TA, etching, Lim				

(continued)

Table 2. Continued

Treatment	Retentions (lb/ft^3)				Loss of Cross-Sectional Area (%) for --				
	Cooperative Assay		CEL Assay						
	Oil	Salt	Oil	Salt	Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5
70-30 creosote-coal tar solution containing 5% phenylmercuric oleate[a]									
Douglas Fir	13.0	-	10.0	-	2: TA attack dormant				
Southern Yellow Pine	27.5	-	22.1	-	12: TA to ML, Lim	3: ML, etching, Lim			
70-30 creosote-coal tar solution followed by sheathing with cupro-nickel alloy									
Southern Yellow Pine	-	-	-	-	0				

(continued)

Table 2. Continued

Treatment	Retentions (lb/ft^3)				Loss of Cross-Sectional Area (%) for --				
	Cooperative Assay		CEL Assay						
	Oil	Salt	Oil	Salt	Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5
CEL creosote Douglas Fir	-	-	17.2	-	4: TA tapers to 3: ML, Mart, Lim	2: TA, Lim	5: TA, Lim, Mart holes	3: TA, etching, Lim	4: TA, Lim, Mart 2: ML, Lim, Mart

[a]Nominal percentages. Analyses of core borings showed that the wood absorbed considerably less than the nominal percentage. No individual retention figures were reported (Ref. 1).

Table 3. Results of 1978 Inspection of CEL- and Industry-Treated Piles at Pearl Harbor (installed in 1964)

[Lim = Limnoria; Mart = Martesia; Ter = Teredo; TA = Tide Area; ML = Mud Line]

Group[a]	Creosote Additive	Creosote Retention (lb/ft^3)	Additive Retention (lb/ft^3)	Loss of Cross-Sectional Area (%) for –					
				Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5	Piling No. 6
1	None	32.9	0.00	3: TA, Lim	2: TA, Lim	2: TA, etching, Lim	5: TA, Lim 1: ML, Lim	5: TA, Lim, few Mart holes	3: TA hole, Lim, not active
2	5% chlordane	28.6	1.4	0	0	2: TA, Lim 0: ML	1: TA, etching	0	0
3	2.5% chlordane	28.5	0.7	1: Lim slight etching, no live Mart	0	3: TA, Lim	3: TA, very small Mart holes	1: TA, very slight etching, Lim	1: TA, slight etching, Lim
4	1.25% chlordane	26.3	0.3	1: TA, etching, Lim	0	0	2: high TA, Lim	1: Mart, dead	4: 16 in. crack or split, Lim
5	30% copper naphthenate	8.3	0.27[b]	2: TA, Lim	5: TA, Lim	3: TA, Lim, few Mart	7: TA to ML, Lim, Mart	5: TA, tapers to 3: ML, Lim, Mart	1: etching, Lim
6	15% copper naphthenate	9.4	0.15[b]	8: TA, very small Mart holes	0	42: TA, Lim, Mart 6: ML, Lim	3: TA, Lim, few very small Mart holes	18: TA, Lim, few Mart	92: TA, tapers to 6: ML, Lim, Mart
7	7.5% copper naphthenate	10.9	0.09[b]	97: TA, Lim, some Mart	0	73: 18 in. TA, Lim 4: ML, Lim	3: TA, etching, Lim	4: TA, Lim 2: ML, Lim	3–4: TA, Lim, few Mart holes

(continued)

Table 3. Continued

Group[a]	Creosote Additive	Creosote Retention (lb/ft^3)	Additive Retention (lb/ft^3)	Loss of Cross-Sectional Area (%) for –					
				Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5	Piling No. 6
8	14% copper naphthenate 1% tributyltin oxide	14.8	0.23[b] 0.15	78: TA, 12 in. hole, pile split, Lim, Mart 6–4: –12 in. to ML	8: TA, Lim, some small Mart holes	2: TA, Lim, dead Mart	28: TA, tapers to 2: ML, Lim	94: TA 1: ML, Lim, Ter	69: TA, Lim, some Mart 3–4: ML, Lim, some Mart
9	7% copper naphthenate 0.5% tributyltin oxide	8.6	0.07[b] 0.08	1: TA, etching, Lim	8: TA, Lim	1: TA, etching, Lim	7: TA, Lim, few Mart holes	77: TA 2: ML, Lim, some Mart	28: TA, tapers to 4: ML, Lim, Mart
10	None	18.6	0.00	33: TA, tapers to 14: ML, Lim, some Mart	29: TA, tapers to 4: ML, Lim, few Mart	77: TA, Lim 70: ML, Lim	30: TA to ML, Lim, very few Mart		
11	2% tributyltin oxide	13.9	0.28	18: TA, tapers to 3: ML, Lim	63: TA, Lim 4: ML, Lim	28: TA, Lim, few dead Mart 7: ML, Lim	94: TA, tapers to 6: ML, Lim	65: TA, Lim 4: ML, Lim	
12	2% tributyltin oxide 2% dieldrin	17.4	0.35 0.35	2: TA, Lim	0	0	0	0	0

[a]Treatment groups 1 through 9 had six Douglas fir piles each; groups 10, 11, and 12 had, respectively, four, five, and six pine piles each.

[b]As metallic copper.

Table 4. Results of 1978 Inspection of CEL-Treated Piles at Pearl Harbor (installed in 1965)[a]

[Lim = Limnoria; Mart = Martesia; Ter = Teredo; TA = Tide Area; ML = Mud Line]

Treatment[b]	Retention (lb/ft^3)	Loss of Cross-Sectional Area (%) for –					
		Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5	Piling No. 6
4% copper oxinate	0.87[c]	4: TA halfway to ML, Lim	1: TA, etching, Lim	1: TA, Lim	5: TA, Mart, Lim	3: flat spot in TA, Lim, Mart	0
2% copper oxinate	0.49[c]	2: TA, etching, Lim	4: piles split in TA, piece missing, attack in damaged area	20: TA, Lim, Mart, Ter 5: ML, Lim, Mart, Ter	0	4: TA, Lim	2: TA, Lim
2% copper oxinate 2% tributyltin oxide	0.25[c] 0.25	10: TA, Ter, Mart, Lim 20: ML, Ter, Mart, Lim	10: TA, Mart, Lim 12: ML, Mart, Lim	5: TA, Lim 3: ML, Lim	4: TA, Mart, Lim 4: ML, Lim	7: TA, Lim	6: TA to ML, Mart, Lim
3% copper oxinate 1% Victoria green base	0.69[c] 0.26	3: TA, Lim 2: ML, Lim	5: TA, Lim, Mart		2: ML, Lim	1: TA, Mart, Lim 2: ML, Mart, Lim	6: Lim, very few Mart 2: ML, Lim

(continued)

Table 4. Continued

Treatment[b]	Retention (lb/ft^3)	Loss of Cross-Sectional Area (%) for –					
		Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5	Piling No. 6
5% chlordane 1% tributyltin oxide	1.3 0.27	2: TA, etching, Lim	0	1: TA, dormant Mart	3: 3 ft above ML, Lim	0	0
5% chlordane 2% tributyltin oxide	1.5 0.62	0	1: TA, dead Mart	0	0	2: TA, etching, Lim	0
1.5% copper oxinate 0.5% Victoria green base 50% creosote	0.27[c] 0.09 9.2	6: ML, Lim	12: TA to ML, Mart, Lim, Ter	5: ML, Lim	5: TA to ML, Mart, Lim	7: TA, Mart, Lim 10: ML, Mart, Lim	8: TA, Mart, Lim 28: Lim, Mart
0.75% copper oxinate 0.25% Victoria green base 75% creosote	0.25[c] 0.08 24.7	0	6: pile split in TA, attack inside split	3: TA to ML, small areas of attack	0	6: TA to 5: ML, Lim, Mart	9: TA, Mart, Lim 4: ML, Mart, Lim

[a]These piles were accidentally pulled in August 1972 and redriven in May 1973.

[b]Solutions in xylene.

[c]As metallic copper.

Table 5. Results of 1978 Inspection of CEL- and Industry-Treated Piles at Pearl Harbor (installed in 1966)

Treatment	Retention (lb/ft^3)	Loss of Cross-Sectional Area (%) for					
		Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5	Piling No. 6
Chromated copper arsenate, Type B	0.50	100: TA, ML	100: top of pile missing 70: ML, Lim	6: TA, Mart, Lim	100: pile missing	100: TA, Ter, Mart, Lim 96: ML, Ter, Mart, Lim	3: TA, Mart 1: ML, Mart
Basic zinc sulfate	2.77[b]	2: TA, Lim, dead Mart	0	2: TA, Mart around knot hole	2: TA, Lim	3: TA, Mart, Lim	2: etching, Lim, Mart
Ammoniacal copper arsenite	0.51	1: TA, Mart holes	2: TA, Lim, Mart 3: ML, Lim, Mart	4: TA to ML, Lim	2: TA, very slight etching, Lim, Mart	4: TA, etching, Lim, Mart	4: TA, Mart, Lim
Chromated copper arsenate, Type B Tributyltin oxide	0.50 0.13	0	0	5: TA, Lim	1: etching, Lim, Mart	1: TA, etching, Lim, Mart	4: TA, etching, Lim
Basic zinc sulfate Tributyltin oxide	2.66[b] 0.09	0	0	0	0	0	1: very light etching, Lim

(continued)

Table 5. Continued

Treatment	Retention (lb/ft^3)	Loss of Cross-Sectional Area (%) for					
		Piling No. 1	Piling No. 2	Piling No. 3	Piling No. 4	Piling No. 5	Piling No. 6
Ammoniacal copper arsenite Tributyltin oxide	0.51 0.11	0	2: ML, etching	1: TA, Lim	0	0	3: TA, Lim 1: ML
70-30 creosote-coal tar	31.7	3: TA, Lim	15: TA, Lim, Mart	0	0	4: TA, etching, Lim	1: TA, very light etching
Ammoniacal copper arsenite 70-30 creosote-coal tar	0.51 19.6	0	1: TA, very light etching	0	1: Lim	0	0
Copper sulfate Tributyltin oxide	0.06[a] 0.19	18: TA, Lim, Mart	7: TA, Lim, Mart	7: TA, Lim, Mart 2: ML, Lim, Mart	3: TA, etching, Lim	2: etching, Lim, Mart	6: TA, Lim
Copper sulfate Tributyltin oxide	0.03[a] 0.20	3: ML, Lim, Mart 7: TA, Lim, Mart	5: TA etching, Lim	3: TA, Lim	98: TA, 26-in.-long hole 2: ML, Lim	1: TA, etching, Lim	90: TA, 18 in. split 2: ML

[a]As metallic copper.

[b]As metallic zinc.

Table 6. Summary of Inspection Results on Cooperative Piles at Pearl Harbor, Plus One Set of Piles[a] Treated With Creosote by CEL (installed in 1963)

Treatment (Number of Piles Redriven in May 1973)	Number of Piles Reported Attacked in --					
	1973	1974	1975	1976	1977	1978
Ammoniacal copper arsenite followed by creosote						
Douglas Fir (3)	0	0	0	0	0	1
Chromated copper arsenate Type A followed by creosote						
Douglas Fir (3)	2	0	1	3	3	3
Southern Yellow Pine (3)	0	0	0	0	0	1[b]
70-30 creosote-coal tar solution						
Douglas fir (3)	1	0	0	0	0	2
Southern Yellow Pine (2)	2	0	0	2	2	2
70-30 creosote-coal tar solution containing 1% phenylmercuric oleate[c]						
Douglas fir (3)	NR[d]	NR	0	2	2	2
Southern Yellow Pine (1)	NR	NR	0	0	0	1
70-30 creosote-coal tar solution containing 5% phenylmercuric oleate[c]						
Douglas Fir (1)	NR	NR	0	0	1	1
Southern Yellow Pine (2)	NR	NR	1	1	1	2
70-30 creosote-coal tar solution followed by sheathing with cupro-nickel alloy						
Southern Yellow Pine (1)	NR	NR	0	0	0	0
CEL creosote						
Douglas Fir (5)	NR	3	1	3	4	5

[a]These piles were accidentally pulled in August 1972 and redriven in May 1973.

[b]One pile in this series was reported missing in the 1978 inspection.

[c]Nominal percentages. Analyses of core borings showed that the wood absorbed considerably less than the nominal percentage (Ref. 11).

[d]NR = not reported.

Table 7. Summary of Inspection Results on CEL- and Industry-Treated Piles at Pearl Harbor (installed in 1964)

Group[a]	Creosote Additive	Creosote Retention (lb/ft^3)	Additive Retention (lb/ft^3)	Number of Piles Reported Attacked in --							
				1971	1972	1973	1974	1975	1976	1977	1978
1	None	32.9	0	1	1	1	0	4	5	6	6
2	5% chlordane	28.6	1.4	0	2	1	0	1	0	2	2
3	2.5% chlordane	28.5	0.7	0	1	2	0	2	2	4	5
4	1.25% chlordane	26.3	0.3	0	2	0	0	3	2	3	4
5	30% copper naphthenate	8.3	0.27[b]	0	2	1	0	2	4	4	6
6	15% copper naphthenate	9.4	0.15[b]	2	3	3	0	4	4	5	5
7	7.5% copper naphthenate	10.9	0.09[b]	1	2	2	1	3	5	5	5
8	14% copper naphthenate 1% tributyltin oxide	14.8	0.23[b] 0.15	1	2	5	0	5	5	6	6
9	7% copper naphthenate 0.5% tributyltin oxide	8.6	0.07[b] 0.08	0	2	2	0	4	4	6	6
10	None	18.6	0	0	1	4	3	4	4	4	4
11	2% tributyltin oxide	13.9	0.28	0	1	4	2	5	5	5	5
12	2% tributyltin oxide 2% dieldrin	17.4	0.35 0.35	0	0	0	0	0	0	0	1

[a]Treatment groups 1 through 9 had six Douglas fir piles each; groups 10, 11, and 12 had four, five, and six pine piles each, respectively.

[b]As metallic copper.

Table 8. Summary of Inspection Results on CEL-Treated Piles at Pearl Harbor (installed in 1965)[a]

Treatment[b]	Retention (lb/ft^3)	Number of Piles Reported Attacked in --					
		1973	1974	1975	1976	1977	1978
4% copper oxinate	0.87[c]	0	2	1	3	5	5
2% copper oxinate	0.49[c]	4	2	2	3	5	5
2% copper oxinate 2% tributyltin oxide	0.25[c] 0.25	4	0	0	4	6	6
3% copper oxinate 1% Victoria green base	0.69[c] 0.26	3	2	1	2	4	5[d]
5% chlordane 1% tributyltin oxide	1.3 0.27	0	2	0	0	2	3
5% chlordane 2% tributyltin oxide	1.5 0.62	0	2	1	1	1	2
1.5% copper oxinate 0.5% Victoria green base 50% creosote	0.27[c] 0.09 9.2	6	4	4	6	6	6
0.75% copper oxinate 0.25% Victoria green base 75% creosote	0.25[c] 0.08 24.7	4	4	1	3	3	4

[a]These piles were accidentally pulled in August 1972 and redriven in May 1973. Six piles in each group were redriven except where noted.

[b]Solution in xylene.

[c]As metallic copper.

[d]Five piles were redriven in May 1973.

Table 9. Summary of Inspection Results on CEL- and Industry-Treated Piles at Pearl Harbor (installed in 1966)

Treatment	Retention (lb/ft^3)	Number of Piles Reported Attacked in --							
		1971	1972	1973	1974	1975	1976	1977	1978
Chromated copper arsenate, Type B	0.50	3	3	3	5	4	6	6	6
Basic zinc sulfate	2.77[b]	0	0	3	2	0	2	5	5
Ammoniacal copper arsenite	0.51	0	0	3	2	1	4	6	6
Chromated copper arsenate, Type B Tributyltin oxide	0.50 0.13	0	0	0	2	1	2	3	4
Basic zinc sulfate Tributyltin oxide	2.66[b] 0.09	0	0	0	1	0	0	1	1
Ammoniacal copper arsenite Tributyltin oxide	0.51 0.11	0	0	0	0	0	0	1	3
70-30 creosote-coal tar	31.7	0	0	0	1	1	1	2	4
Ammoniacal copper arsenite 70-30 creosote-coal tar	0.51 19.6	1	0	1	0	0	0	1	2
Copper sulfate Tributyltin oxide	0.06[a] 0.19	2	4	3	1	2	5	6	6
Copper sulfate Tributyltin oxide	0.03[a] 0.20	0	1	0	2	3	5	6	6

[a] As metallic copper.

[b] As metallic zinc.

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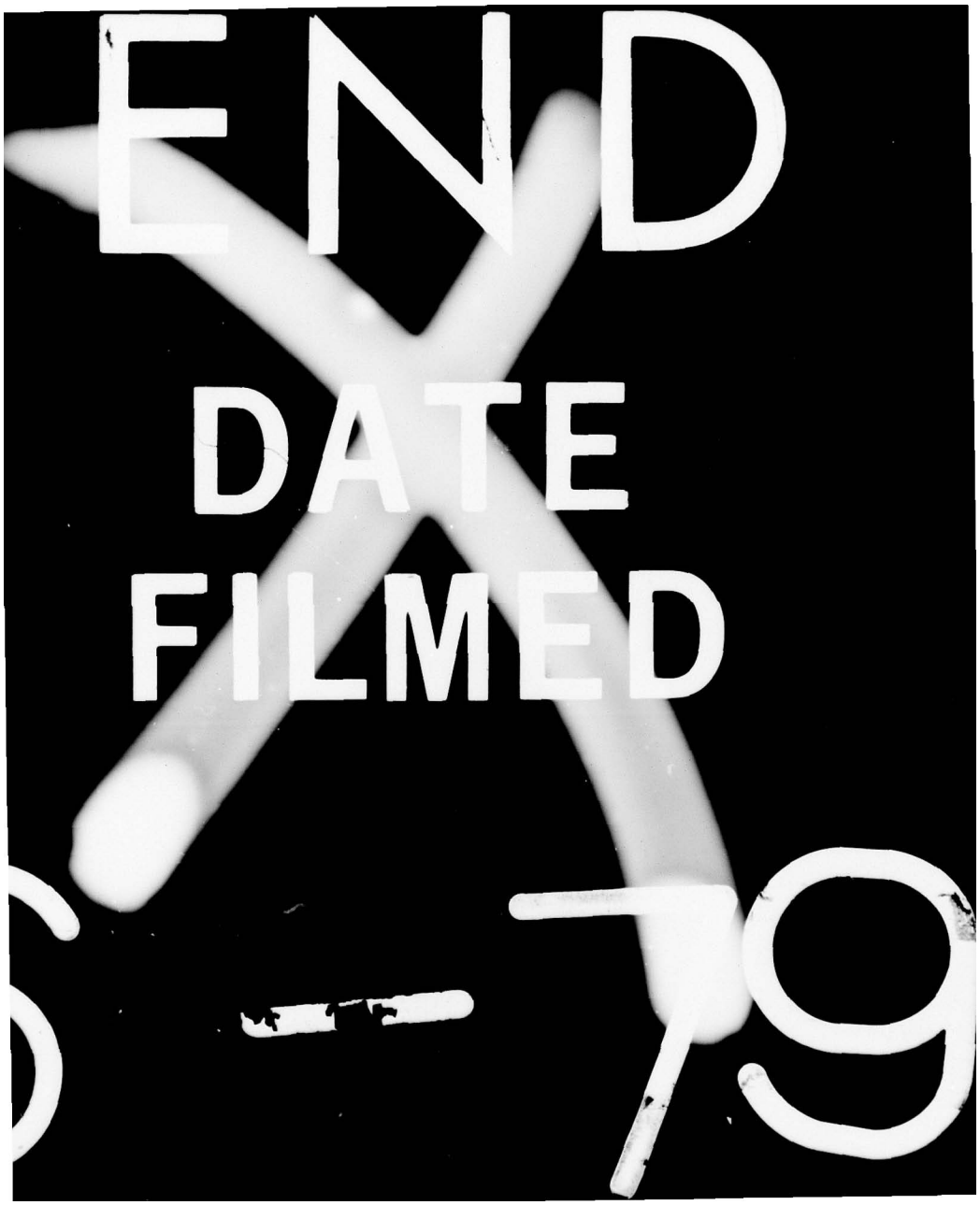
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1. Please make the following pen and ink corrections:

~~N-1505, Page 6: 2nd column, 1st entry should be JHB vice AZLS~~
~~Page 7: 3rd column, 1st entry should be 0.9 vice 6.9~~

AD-A066 225 N-1538, Page 6: 2nd column, 2nd entry should be JHB vice AZLS
Page 7: 3rd column, 1st entry should be 0.9 vice 6.9

PETER D. TRIEM
By direction