Designation: D 1758 – 02

Standard Test Method of Evaluating Wood Preservatives by Field Tests with Stakes[1]

This standard is issued under the fixed designation D 1758; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers accelerated procedures for determining the relative permanence and effectiveness of wood preservatives in stakes exposed in field plots.

1.2 The requirements for preparation of the material for testing and the test procedures appear in the following order:

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use*.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1413 Test Method for Wood Preservatives by Laboratory Soil-Block Cultures[2]

D 1625 Specification for Chromated Copper Arsenate[2]

3. Summary of Method

3.1 Wood stakes are impregnated with an appropriate series of retentions of a preservative, and then handled, prior to exposure in the field, according to specified procedures. The treated stakes are exposed in the ground to the action of wood-destroying fungi and termites in one or more selected field plots. An index of condition determined from grades assigned to the stakes for degree of decay and termite attack, in the course of periodic inspections, is used to express results periodically and at the termination of the test.

3.2 Two test procedures are outlined, employing two specimen types, ¾-in. square and nominal 2 by 4-in. stakes, designated hereafter respectively as Method A and Method B. Method A, using smaller and more numerous specimens, is preferred for possibly more rapid results, and Method B for longer term tests of a quasi service nature.

4. Test Plot

4.1 *General Requirements*—A warm humid climate is preferred. Select a natural area of fertile, fallow, level land of uniform soil character that is moist but well drained and large enough to permit expansion of future stake installations. The presence of wood-destroying fungi and active subterranean termites shall be proved by observation or experience and checked by exposure of suitable small specimens of untreated wood. No natural or artificial fertilizer or other chemicals shall be applied to the plot during its use as a test ground. Protection against fire, predators and pilferage shall be provided as far as practicable.

4.2 *Control of Vegetation*—As a general rule vegetation shall be controlled manually or by suitable mechanical means only, with minimum soil disturbance. No chemical controls shall be permitted. Weeding and cleaning the plot shall be uniform over any given test area.

4.3 *Reuse of Ground*—Stakes placed in ground that has been used previously for test purposes shall not be set closer than 6 in. (150 mm) to any earlier stake location.

5. Test Specimens

5.1 *Selection of Wood*—Sapwood of southern pine, with 6 to 10 rings per inch, shall be the preferred wood for comparative tests. It shall be free of knots, excessive cross-grain and resins or other obvious defects, and it shall show no visible evidence of infection by mold, stain, or decayed fungi. Whenever practicable, select straight-grained wood for the test stakes at the sawmill. Acceptable freshly cut lumber shall be kiln-dried in order to avoid fungus infection before and during shipment. The wood shall not have been treated with chemicals to prevent sapstain. The dried lumber shall be stored flat in a dry room where it can reach an equilibrium moisture content (oven-dry basis) of 12 % or less. Sapwood or heartwood of any species may be used for special investigations. In such cases the test stakes shall be all sapwood or all heartwood in any given

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[2] *Annual Book of ASTM Standards*, Vol 04.10.

comparative series. Individual stakes containing both sapwood and heartwood shall not be used.

5.2 *Cutting Test Blanks*—Test blanks may be sawed from the dry lumber in any convenient lengths, usually in multiples of the stake length.

5.3 *Test Stake Dimensions*—For Method A the test blanks shall be surfaced four sides as accurately as practicable to 19 by 19 mm (0.75 by 0.75 in.) and cut to a length of 457 mm (18 in.). For Method B the test blanks shall be surfaced four sides as accurately as practicable to 38 by 89 mm (1.5 by 3.5 in.), and cut to a length of 457 mm (18 in.). The average volume of the A stake is 165 cm^3 (10.1 $in.^3$) and of the B stake 1546 cm^3 (94.5 $in.^3$). The ratios of surface area to volume of the stakes are respectively 5.4 to 1.0 and 2.0 to 1.0.

5.4 *Storage of Test Blanks and Prepared Stakes*—Working stocks of test blanks or surfaced untreated stakes shall be stored flat under controlled humidity conditions.

6. Pretreatment Selection of Test Stakes

6.1 *Initial Weights*—Before impregnation the stakes shall be numbered and weighed to the nearest 1 g. Discard the upper and lower 2.5 % of the stakes. Any deviation from this procedure, such as grouping on a weight or ring count basis, shall be reported in detail (see 12.1.10). The initial untreated weights shall be coded T_1.

6.2 *Coding the Weight*—The system of *T* (tare) designations is as follows, with all weights recorded in grams:

T_1 = initial weight of the test stake before impregnation; and

T_2 = weight of the test stake after impregnation and after wiping to remove superficial liquid (equals T_1 plus grams of treating solution absorbed).

NOTE 1—The T_2 weight does not apply in certain cases, as in treatments employing liquefied petroleum gas (see Section 7.7).

7. Treatment Procedure

7.1 *Preferred Treatment Method*—The preferred treatment method is a full-cell process, simulating commercial practice as far as practicable with laboratory or pilot plant equipment. Use an initial vacuum, suitable temperature, and an appropriate pressure period determined by trial lots, but omit the final vacuum. (See 7.9 for method of obtaining gradient retentions by toluene dilutions.)

7.2 *Standard Reference Preservative*—The standard reference preservative shall be a freshly made aqueous solution of chromated copper arsenate (CCA-Type C; Specification D 1625; AWPA Standard P 5). Periodically treat not less than 20 stakes with this preservative by a full-cell process to retentions of 0.20, 0.40 and 0.60 lb/ft^3 (3.2, 6.4 and 9.6 kg/m^3). Randomize the stakes over the plot area on the same basis as the treated test stakes. Record their condition each inspection.

7.3 *Untreated Control Stakes*—Install not less than 20 untreated control stakes of each species of wood and of the same size used for preservative testing throughout the test area when the plot is first established and each time a new series of tests is installed. Installation shall be on the same random basis as the treated test stakes. Record the condition of the untreated control stakes at each inspection.

7.4 *Retention Populations*—The treatment retentions in any given group of treatments of a preservative shall represent as far as practicable a series running from low to high absorption in order to provide data on the effective protective retention level. The spread in the series shall be designed to straddle the expected or predetermined effective retention for outdoor stake tests. This retention may be based on experience, or on assumptions from the results of soil-block tests (Specification D 1413). The retention nearest the expected effective retention should be at or near the upper end of the series but lower than the highest retention selected. The lowest retention should be low enough to permit attack and provide proof of the presence of tolerant wood-destroying fungi, or termites, or both over the area of the test plot.

7.5 *Number of Stakes to Be Treated*—The number of stakes to be treated depends on available information and experience. In no case shall there be less than 10 stakes in a test. As a general policy, enough stakes should be treated to provide, within the graded retention population, extra stakes, or pilot stakes, that may be removed periodically in the early course of a test to determine the presence and progress of fungus or termite attack. Use such stakes where practicable to determine the identity of the attacking fungus and the depletion or change in character of the preservative tested. As examples, since the retentions in the stakes in a given charge will vary around the nominal retention for the charge, the above scheme may be accomplished by treating 20 stakes each in a series of nominal retention charges as follows:

Creosote: 80, 100, 130, 160, and 220 kg/m^3(5.0, 6.25, 8.13, 10.0, and 13.8 lb/ft^3).

Pentachlorophenol: 1.5, 3.0, 5.0, 8.0, and 11.0 kg/m^3(0.094, 0.19, 0.31, 0.5, and 0.69 lb/ft^3).

Chromated copper arsenate: 1.5, 3.0, 5.0, 8.0, and 11.0 kg/m^3(0.094, 0.19, 0.31, 0.5, and 0.69 lb/ft^3).

7.6 *Preservative Analysis*—Analyze each preservative or preservative solution prior to treatment. If there is reason to believe that a change in composition occurs during treatment, analyze after each treatment, and avoid extended use of the same solution.

7.7 *Treatment Retentions*—Determine the amount of preservative absorbed by the individual test stakes as accurately as possible in terms of kg/m^3 as soon as they have cooled to approximate room temperature (*a*) by weighing them on suitable scales, or (*b*) by assay of representative stakes by a method appropriate for the preservative concerned.

7.7.1 Preservative retentions in stakes treated with preservatives in highly volatile solvent carriers cannot be calculated from before and after treatment weights since the solvent is removed during the processing. Retentions must therefore be determined by an analysis of treated stakes. This may be accomplished by one of two methods:

7.7.1.1 *Method 1*—Several extra stakes (not less than 10) the same size, species, and density range shall be included in each retention charge. Cross sections of these stakes taken at a point between 100 and 125 mm (4 and 5 in.) from one end shall

be composited and analyzed. The resultant value shall be the retention for the entire charge.

7.7.1.2 *Method 2*—A sample shall be cut at a point between 100 and 125 mm (4 and 5 in.) from the tip end of each test stake representing half the cross section in 19 mm (¾-in.) stakes from a radial side as far as possible. Analyze each sample. The value determined shall be the retention for each stake. Coat surfaces exposed as a result of the sampling with a sealer such as a phenolic adhesive.

7.7.2 For the usual weight determination remove each stake individually from the treating chamber, wipe lightly to remove surface preservative or preservative solution, and weigh promptly to the nearest 1.0 g (Code T_2) (6.2).

7.8 *Calculation of Retentions*—Calculate the retention of preservative or preservative solution as follows:

7.8.1 For undiluted preservatives such as creosote, or pentachlorophenol petroleum systems for example:

$$\text{Retention, kg/m}^3 = 1000\,G/V \quad (1)$$

7.8.2 For diluted preservatives such as toluene solutions of creosote, pentachlorophenol in petroleum carriers, or preservative salts in water solution:

$$\text{Retention, kg/m}^3 = 1000\,GC/V \quad (2)$$

where:

G = $(T_2 - T_1)$ = grams of preservative or preservative solution absorbed by the stake,

C = grams of preservative or preservative solution system in 100 g of treating solution, as a decimal fraction, and

V = volume of stake, cm^3 : 0.000165 m^3 for Method A stakes, and 0.001546 m^3 for Method B stakes.

To convert kg/m^3 to lb/ft^3 divide by 16.

7.8.3 *Test Stake Identification*—After calculation of treatment retentions identify each test stake adequately with a tag of weather-resistant metal or plastic.

7.9 *Alternative Treatment Methods*—If it is necessary or desirable to establish the plot potential, for creosoted stakes, for example, with respect to fungus or termite hazard, or both, by installing standard reference stakes treated with both undiluted creosote and with diluted creosote, an alternative treatment method applicable to creosote only may be used.

7.9.1 The creosote shall be a Standard AWPA P1 creosote with the following distillation pattern by the AWPA Standard flask method:

to 235°C	5 to 10 weight %
to 270°C	20 to 30 weight %
to 315°C	45 to 60 weight %
to 355°C	78 to 81 weight %

7.9.2 The creosote should be diluted with toluene to obtain approximate average charge retentions as follows:

	%	
	Creosote	Toluene
For 80 kg/m^3(5.0 lb/ft^3)	17	83
For 100 kg/m^3(6.25 lb/ft^3)	21	79
For 130 kg/m^3(8.13 lb/ft^3)	27	73
For 160 kg/m^3(10.0 lb/ft^3)	33	67
For 220 kg/m^3(13.8 lb/ft^3)	46	54

7.9.3 Treat the stakes by a full-cell process, and proceed as outlined under 7.1.

7.10 *Empty-Cell Treatments*—For comparative purposes empty-cell treatment processes may be used for creosote and for pentachlorophenol-petroleum solutions or for preservatives in volatile carriers, at the discretion of the operator.

8. After Treatment Handling of Test Stakes

8.1 *Stakes Treated with Water Solution*—Dry stakes treated with water-borne preservatives by air-seasoning, kiln-drying, or a combination of both. Stack the stakes so that air can circulate freely between them until their average moisture content is less than 12 %, oven-dry weight basis, or dry them in an oven or kiln at a temperature not to exceed 140°F until their average moisture content is less than 30 %. If other types of conditioning before installation are employed, report the method of after-treatment handling fully. In all cases the drying period shall be long enough, not less than 15 days, for the salt preservatives to set thoroughly.

8.2 *Stakes Treated with Diluted Oil-Type Preservatives or with Preservatives Dissolved in Highly Volatile Solvents*—Cross-pile stakes treated with volatile solvent solutions, such as creosote in toluene, or pentachlorophenol in light petroleum solvents or in liquefied petroleum gas, horizontally over a flat base or other suitable support, or stack in a space rack frame, in such a manner as to permit free air circulation to all faces of the stakes and to facilitate removal of individual stakes for periodic weighing. Continue the exposure until the average loss in weight is equivalent to at least 90 % but not more than 95 % of the amount of solvent or diluent is absorbed.

8.3 *Stakes Treated with Undiluted Preservatives*—Stack stakes treated with undiluted preservatives such as creosote or pentachlorophenol-petroleum solutions for drying as prescribed for air-seasoning under 8.1 for a period of not less than 15 days to permit drying of any superficial or bleeding liquid.

8.4 *Individual Stake Condition*—It is essential to maintain the integrity of the individual test specimens before installation as far as practicable. At the end of any drying or evaporation period, bundle or wrap only those stakes with treatment retentions within the limits of the coded retention cells together for storage. If there is any likelihood that oil-type preservatives may be transferred from one stake to another when bundled together wrap the test stakes individually in heavy aluminum foil.

8.5 *Storage of Treated Test Stakes*—Store the wrapped test stakes in a cool room until shipment for installation.

9. Installation of Stakes

9.1 *Time Lapse Between Treatment and Installation*—As a general rule the treated stakes should be installed in the test plot as soon as practicable after treatment (see 12.1.9).

9.2 *Spacing of Stakes in Test Plot*—For Method A, space the test stakes not less than 300 mm (1 ft) between specimens and not less than 600 mm (2 ft) between rows. For Method B space the test stakes not less than 600 mm (2 ft) between specimens and not less than 900 mm (3 ft) between rows.

9.3 *Depth of Installation*—Install the stakes, with all tags oriented in the same direction in the row, at a depth of 229 to 250 mm (9 to 10 in.) to a legible groundline mark. Compact the soil around each stake at the appropriate groundline.

9.4 *Randomization*—Randomize the test stake, reference stake, and control stake settings in an appropriate manner within the selected test plot area.

9.5 *Mapping the Plot*—Map the plot and the position of each installed stake to facilitate inspection and records.

10. Inspection of Specimens

10.1 *Inspection General*—Whenever practicable inspect the test stakes, reference stakes, and control stakes in the fall after fungus activity slows down. The frequency of inspection depends on the indications of fungus or termite attack revealed by plot stakes or selected stakes from the series of low to high retention specimens. In exploratory tests, make inspection annually. With preservatives of known effectiveness, present in sufficient concentrations, the first inspections as well as the intervals in subsequent inspections may be delayed at the discretion of the operator.

10.1.1 As a general principle leave test stakes in place at the original groundline setting as long as possible in order to avoid disturbing the soil-fungus-wood complex and acceleration of decay in any exposed area. Examine any stakes that have worked up out of the soil or that are no longer at the original depth of setting at any given inspection carefully for the amount of change at the groundline. If the amount of heaving is less than 6.4 mm (0.25 in.) reset the stakes as nearly as practicable to the original groundline mark. Use any convenient depth gage. If the heaving exceeds the above limit set the stakes as nearly as practicable to the current groundline. Raise depressed stakes to the original groundline. At each inspection compact the soil against the stake.

10.2 *Inspection Procedure*—Remove the stakes from the ground carefully by a straight upward pull, disturbing the soil as little as possible, using any appropriate leverage tool if the stakes are firmly fixed in the earth. Avoid rocking the stakes and enlargement of the stake holes as far as possible. Use a dull instrument, such as a putty knife or a dull knife blade, to scrape adhering soil from the wood surface. Avoid unnecessary probing, picking, and gouging of the wood. Test the soundness of the stake by use of the dull instrument. A light tap may be used with caution to test the groundline area for loss of impact strength. Some preservatives do not indicate loss in cross-section area or visible decay, but for all practical purposes preservative failure occurs if the strength of the wood is lost. Take special care in ratings made when the stakes are very wet, because softening due to high moisture content can be mistaken for decay.

10.3 *Grading System (for Below-Ground Condition)*—In general, the grading system is based on the percent loss of cross section due to the attacking organism. The grading system is as follows:

Decay Grades

Grade No.	Description of Condition
10	no decay; trace attack permitted
9	trace attack to 3 % of cross-section
8	decay 3 to 10 % of cross-section
7	decay 10 to 30 % of cross-section
6	decay 30 to 50 % of cross-section
4	decay 50 to 75 % of cross-section
0	failure

Termite Grades

Grade No.	Description of Condition
10	no attack; 1 to 2 small nibbles permitted
9	nibbles to 3 % of cross-section
8	penetration 3 to 10 % of cross-section
7	penetration 10 to 30 % of cross-section
6	penetration 30 to 50 % of cross-section
4	penetration 50 to 75 % of cross-section
0	failure

A combined grade, for example, of a decay grade of 9 and a termite grade of 7 would be coded 9-7. In applying these grades, a sound stake shall be a stake in which the wood at groundline and below is firm and the corners still square. For example, the general condition of sound stake may have trace of decay and shallow termite nibbles. Apply a grade of 9 to a test stake that shows slight attack up to approximately 3 % loss of cross-section or nibbles and up to 3 % loss of cross-section in the case of termites. A grade of 8 means that decay or termite attack has become firmly established with 3 to 10 % of the cross-section lost due to the attack. If a stake in the category of 4 can be broken easily by flexing or light tapping, the grade shall be reduced to zero. It is important that the bottom of all stakes be inspected carefully for possible attack. If attack is found, the amount of wood loss shall be taken into account when considering the percent loss of cross-section. The quality of the grading system is established by periodic comparison of the recorded grades in subsequent inspections.

10.4 *Post Mortem*—Assay representative stakes for determination of the characteristics and amount of preservative residual. Select sound stakes and stakes just beginning to show evidence of incipient decay to determine the effective preservative residual that is presenting fungus attack at any given inspection time. Whenever practicable identify the principal fungi causing the decay.

11. Evaluation of Results

11.1 *Periodic Calculation of the Index of Condition*—Maintain a running record covering any given preservative population, identifying each test stake by number, grade, and date of inspection, preferably arranged in ascending order of retention or in a card record system that permits such an arrangement. Group the stakes with adjacent retentions in appropriate cells for creosote, for example. Calculate weighted averages for retention and grade within each cell. A sample calculation is shown in Table 1, where the weighted average retention for the 80 to 94.4 kg/m^3 (5.0 to 5.9) cell for low-residue creosoted stakes, 9 years in test, is shown as 85 kg/m^3 (5.3 lb/ft^3) and the average grade, or index of condition, is shown as 7.4.

11.1.1 *Alternative Methods for Summarizing the Periodic Inspection Data*—The results of the tests may be summarized in two ways, designated respectively “Depreciation Method” and “Dosage Response Method.”

NOTE 2—The former is the traditional method yielding data for depreciation curves; the latter is a refinement in procedure designed not only to reveal automatically a best estimate of the effective preservative retention level under the conditions of the test, but also to provide data for drawing the traditional depreciation curves.

11.1.1.1 *Depreciation Method (Optional)*—Arrange the grading data in a format that will permit the selection of points for the drawing of depreciation curves, with a time scale in

TABLE 1 Example of Calculation of Index of Condition in a 80 to 94.4 kg/m³ (5.0–5.9 lb/ft³) Cell; Coal Tar Creosote, 9 Years in Test

Grade and Number								Summation		
kg/m³	lb/ft³	10	9	7	4	0	*n*	kg/m³	lb/ft³	Grade
82	5.1	...	3	7	...	...	10	816	51.0	76
83	5.2	...	1	1	1	...	3	250	15.6	20
88	5.5	...	1	1	1	...	3	264	16.5	20
93	5.8	...	1	1	...	...	2	186	11.6	16
94	5.9	1	...	1	...	...	2	189	11.8	17
						Total	20	1704	106.5	149
						$\bar{x}$		8.5	5.3	7.4

TABLE 2 Average Ratings, Low Residue Coal Tar Creosote, ¾ in. Southern Pine Stakes, 1, 3, 5, 7, and 9 Years in Test; n = 40; 128 kg/m³ (8 lb/ft³) and 64 lkg/m³ (4) Empty-Cell Groups

Years	Average Ratings	
	128 kg/m³ (8 lb/ft²)	64 kg/m³ (4 lb/ft³)
1	10.0	10.0
3	9.8	9.3
5	9.1	6.7
7	7.4	4.6
9	5.5	...

years as the abscissa and average rating as the ordinate. The method is illustrated in Table 2 and Fig. 1. The curves in Fig. 1 are drawn on a semilog scale to facilitate comparison with Fig. 2 and Fig. 3.

11.1.1.2 *Dosage-Response Method (Optional*)—Enter the pertinent data for each cell group in ascending order of retention in an appropriate table, to provide summary data on the relation of retention to grade rating for the whole preservative population at a given inspection period. An example of one format for such a table is shown in Table 3. The three right-hand columns in the table illustrate a process for smoothing the average retention and grade data by use of 3-point moving averages.

11.1.1.2.1 Using a retention scale on the abscissa and 3-point moving average grades on the ordinate, plot average rating against average retention, for example, such values as appear in the last two columns of Table 3. Draw best approximation curves through the plotted points. Examples of such curves for coal tar creosote, 7, 9, and 11½ years in test, are shown in Fig. 2. These curves reveal the approximate effective protection level of a retention, at any given inspection period, under the conditions of the test, for the ground-contact zone of the stakes.

11.1.1.3 *Depreciation Curves Derived from Dosage-Response Data*—Depreciation curves may be drawn by reading from a series of periodic dosage-response curves for comparison with traditional depreciation curve data from other stake tests. Illustrative data appear in Table 4, derived from Fig. 2. Examples of depreciation curves drawn from the data in Table 4 are shown in Fig. 3.

11.2 *Short-Cut Method*—In preliminary explorative or reconnaissance tests, or if the variation within a group retention cell can be considered insignificant, calculate the index of condition by the method illustrated in Table 5.

11.3 *Percent Index of Condition*—If the accuracy of results warrants it, the index of condition for any retention group may be expressed as percent index of condition by multiplying the calculated index of condition by 10.

11.4 *Termination of Test*—Since the index of condition of a given preservative population varies with the length of the exposure period, the test may be terminated at the discretion of the operator at whatever time observation, experience, or periodic dosage-response curves (see Fig. 2) indicate that the approximate protective retention level has been defined by the behavior of the treated stakes.

12. Reports

12.1 Reports of test results shall include as a minimum concise information on the following essential phases of the test:

12.1.1 Location of plot.

12.1.2 Weather data, including average rainfall and average temperature per month, average minimum and maximum temperature per month, and total annual rainfall.

12.1.3 Character of soil, including values for pH and moisture-holding capacity (see Method D 1413) of the upper 2 in. (51 mm).

12.1.4 Species of wood and size of test stakes; number of test stakes per group or charge.

12.1.5 *Preservatives*—Name and chemical description of both preservatives and preservative carriers, if any, sufficient to identify them fully.

12.1.6 Treating method, full cell, toluene dilutions, empty cell; average retention per group, lot or charge, including CCA controls, and range of retention or standard deviation. Information on method of determining retentions. If the preservative is in a solution of organic solvent remaining in the wood, show the retention of solvent and the concentration of preservative in the solution.

12.1.7 Average indexes of condition per charge or retention group of test stakes in periodic reports and at the time the test is terminated, with supporting tabular data and illustrative behavior curves. Comparative data on indexes of control CCA stakes and untreated stakes.

12.1.8 Time in test (11.5) (years to termination) for test stakes and treated reference stakes, if any.

12.1.9 Holding period between time of treatment and time of installation, details of after-treatment handling and storage conditions during interim.

12.1.10 Deviation, if any, from standard procedure.

13. Precision and Bias

13.1 This test method is dependent upon the physiological action of living organisms. Therefore, the results may not be

TABLE 3 Example of Summary and Analysis of Retention VS Grade Ratings; Low Residue Coal Tar Creosote, Empty-Cell Treatment, 11½ Years in Test

Cell Range kg/m³	Rating, Grade and Number								3-Point Moving Average		
	n	$\bar{X}$ kg/mg³	10	9	7	4	0	*X*	*n*	$\bar{X}$ kg/m³	$\bar{X}$ Grade
51 to 62	17	59	...	...	5	2	10	2.5	(17)	(59)	(2.5)
66 to 78	18	72	...	1	10	4	3	5.3	51	72	5.0
82 to 94	16	85	...	2	14	...	...	7.2	46	85	6.4
101 to 110	12	106	...	3	8	...	1	6.9	40	101	7.4
117 to 125	12	118	3	2	7	...	...	8.1	36	118	8.1
130 to 136	12	131	7	3	2	...	...	9.2	28	128	9.1
146 to 149	4	147	2	2	...	...	...	9.5	24	147	9.3
168 to 173	8	171	5	2	1	...	...	9.4	18	171	9.6
184 to 189	6	186	6	...	...	...	...	10.0	22	183	9.7
192 to 200	8	192	6	2	...	...	...	9.8	20	200	9.9
222 to 224	6	223	6	...	...	...	...	10.0	(6)	(223)	(10.0)
Total	119		35	17	47	6	14				
Percent			29.4	14.3	39.5	5.0	11.8				

TABLE 4 Examples of Depreciation Curve Data Read From Dosage-Response Curves; Low Residue Coal Tar Creosote

Retention		Years in Test		
		7	9	11½
lb/ft³	kg/m³	Average Grade		
5.0	80	8.8	6.7	6.0
7.0	112	9.7	8.7	8.0
9.0	144	9.9	9.6	9.2
11.0	176	10.0	9.9	9.7
13.0	208	10.0	10.0	9.9

TABLE 5 Short-cut Calculation Index of Condition

Nominal Retention, lb/ft³	No. of Stakes in Group	Decay Grade, *Y*	No. of Stakes, *f*	Weighted Grades, *f Y*
8	20	10	1	10
		9	2	18
		7	6	42
		4	8	32
		0	3	0
			20	102

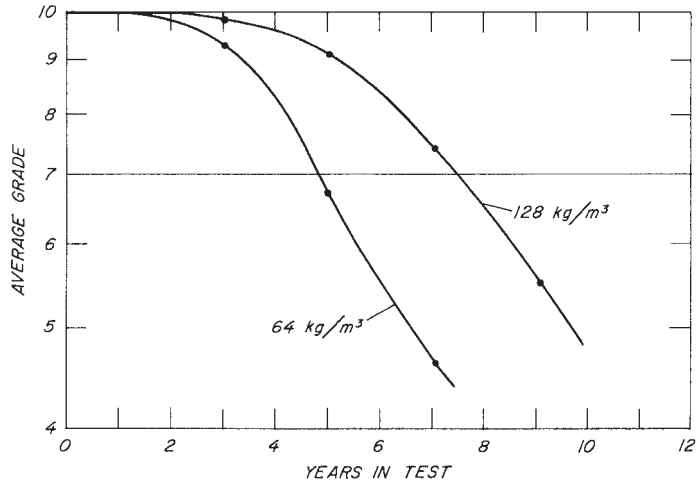
$$I = \Sigma f Y/\Sigma f = 102/20 = 5.1$$

where:
I = average index of condition for the group,
f = number of stakes in each grade, and
Y = decay grade.

repeatable or reproducible. While the relative efficacy between experimental levels within each individual test group is obtainable, repeatability and reproducibility cannot be applied to make any inference of relative performance between different test groups.

14. Keywords

14.1 field tests; preservatives



NOTE 1—In Figures 1, 2 & 3 convert the g/cm^3 to kg/m^3 by multiplying by 1000.

FIG. 1 Depreciation Curves; Low Residue Creosote; ¾-in Stakes 1, 3, 5, 7, and 9 Years in Test; Average Rating, 64 and 128 kg/m^3 (8 and 4 lb/ft^3) Groups; *n* = 40

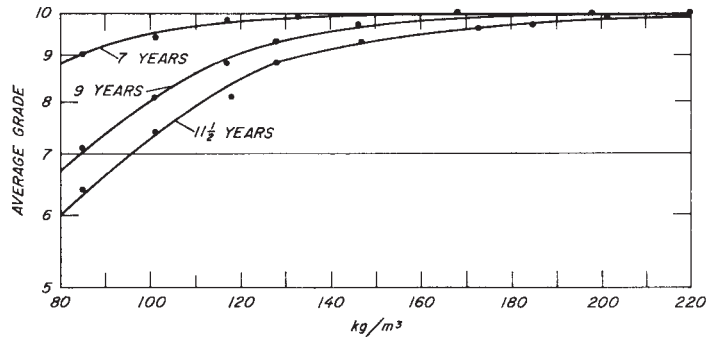


FIG. 2 Retention versus Grade; Dosage-Response Curves: Low Residue Coal Tar Creosote, Empty-Cell Treatment, 7, 9, and 11½ Years in Test

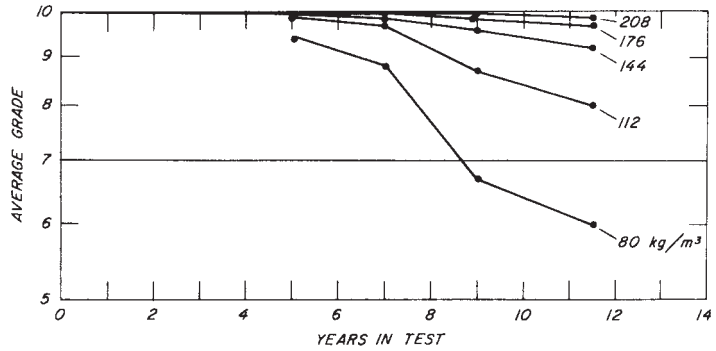


FIG. 3 Example of Depreciation Curves: Low-Residue Creosote 80, 112, 144, 176, and 208 kg/m^3