IEEE Standards

IEEE Std 1217-2001

IEEE Guide for Preservative Treatment of Wood Distribution and Transmission Line Structures

IEEE Power Engineering Society

Sponsored by the
Transmission and Distribution Committee

IEEE

Published by
The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

22 October 2001

Print: SH94943
PDF: SS94943

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IEEE Std 1217-2001

IEEE Guide for Preservative Treatment of Wood Distribution and Transmission Line Structures

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Transmission and Distribution Committee
of the
IEEE Power Engineering Society

Approved 14 June 2001
IEEE-SA Standards Board

Approved 25 October 2001
American National Standards Institute

Abstract: *This guide discusses the preservative treatment of both distribution and transmission wood poles. The guide includes definitions, descriptions of equipment, methods of treatment, information about preservatives, and preparation and specifications for treatment.*
Keywords: *overhead distribution lines, overhead transmission lines, preservative treatment, wood distribution structures, wood transmission structures*

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

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Print: *ISBN 0-7381-2932-1* *SH94943*
PDF: *ISBN 0-7381-2933-X* *SS94943*

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Introduction

(This introduction is not part of IEEE Std 1217-2001, IEEE Guide for Preservative Treatment of Wood Distribution and Transmission Line Structures.)

The most common material used for the construction of distribution and transmission lines, especially in the 69kV through 345 kV range, is wood. In order to protect wood from decay and insects, it must be treated with preservatives. There are several different types of preservatives and different methods of treatment. This guide provides the engineer with technical information on preservatives and how to properly specify them when purchasing preservative treated wood poles and crossarms.

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IEEE Guide for Preservative Treatment of Wood Distribution and Transmission Line Structures

1. Overview

Wood is one of the most common structural materials used in the U.S. for distribution and high-voltage transmission structures. To date, there has been limited guidance to the design engineer on preservative systems and treatment methods used for wood structures.

Wood can be protected from the attack of decay fungi, harmful insects, or marine borers by proper application of selected wood preservatives. Obtaining prolonged service life of treated wood utility products requires careful control of all aspects of the conditioning and treating process. Effective treatment will significantly increase the service life of wood structures.

1.1 Scope

This guide is intended to provide practical information to be used in conjunction with technical information provided in the AWPA 2001 Book of Standards,[1] ANSI 05.1-1992 (for wood poles), ANSI 05.2-1989 (for wood products such as structural glued laminated timber for utility structures), and ANSI 05.3-1989 (for wood products such as solid sawn wood crossarms and braces). These voluntary product standards are used worldwide and are modified as necessary by users for their specific needs.

1.2 Purpose

The purpose of this guide is to provide the design engineer with information on treatment of wood poles and crossarms for distribution and overhead transmission lines.

2. References

This guide shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply.

[1] Information on references can be found in Clause 2.

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American Wood-Preservers' Association (AWPA) Book of Standards, 2001.[2]

ANSI 05.1-1992, American National Standard Specifications and Dimensions for Wood Poles.[3]

ANSI 05.2-1989, American National Standard Specifications for Structural Glued Laminated Timber for Utility Structures.

ANSI 05.3-1989, American National Standard for Solid Sawn Wood Crossarms and Braces—Specifications and Dimensions.

Federal Specification TT-W-571 (1977), Wood Preservation Treating Practices 1997.[4]

Rural Utilities Service (RUS) Bulletin 1728F-700, RUS Specification for Wood Poles, Stubs and Anchor Logs, September 1993.[5]

3. Definitions

For the purposes of this guide, the following terms and definitions apply. The *IEEE 100, The Authoritative Dictionary of IEEE Standards Terms,* Seventh Edition [B5] should be referenced for terms not defined in this clause.

3.1 carrier: Medium that is used to carry the preservative into the wood.

3.2 empty-cell process: Treating process where air pressure is used to force excess preservative out of the wood at the end of the process.

3.3 full-cell process: Treating process where preservative is forced by pressure into the wood.

3.4 fungi: Organisms that can decay wood.

3.5 Lowry: A specific type of empty-cell treating process.

3.6 oilborne: Dissolved in oil.

3.7 pressure treatment: Preservative treatment where wood is placed in a pressure vessel and preservative is forced into the wood.

3.8 seasoned: Term used for wood that has the moisture content reduced enough to receive preservative treatment.

3.9 thermal treatment: Preservative treatment in open tanks where temperature differential causes preservative movement into wood.

3.10 treating cylinder: Cylindrical pressure vessel used in the treating process, ranging in length to over 36 m.[6]

3.11 waterborne: Dissolved in water.

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[2]AWPA publications are available from the American Wood-Preservers' Association, P.O. Box 5690, Granbury, TX 76049, USA (http://www.awpa.com).

[3]ANSI publications are available from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (http://www.ansi.org/).

[4]Federal Specification TT-W-571 has been superceded by the AWPA 2001 Book of Standards, however, copies can be obtained from Global Engineering, 15 Inverness Way East, Englewood, CO 80112-5704, USA, tel. (303) 792-2181 (http://global.ihs.com/).

[5]Rural Utilities Service (RUS) publications are available from the U.S. Deptartment of Agriculture (http://www.usda.gov/rus/regs.shtml).

[6]36 m ≈ 120 ft.

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4. Wood preservation by pressure process and thermal process

The two methods used by manufacturers to treat utility products are the pressure process and the nonpressure process, also known as the thermal process.

4.1 Pressure process

Pressure treatment is generally the most effective method of protecting wood against decay, fungi, and insects. Uniform penetration of a preservative can be achieved and the retention of a preservative can be closely controlled.

4.1.1 Equipment

Pressure treatment is performed in steel cylinders, ranging in size from 1.2 m to 3 m in diameter and up to 46 m in length, capable of withstanding pressure up to 1380 kPa. The layout of each treating plant is unique, consisting of various vacuum pumps, storage tank areas, piping, and air compressors needed to achieve the required results.[7]

A boiler plant is necessary to provide steam for heating and processing. Treating cylinders are also equipped with instruments and gauges to measure and record temperatures, vacuums, and pressures.

Poles intended for treatment are loaded on to small cars called trams, which run on steel tracks into the cylinder. Removable tracks bridge the entrance into the cylinder. When a charge, the collective term for the entire amount of material to be treated, is loaded onto the trams, they are pushed into the cylinder. The short rails connecting the stationary track with the track in the cylinder are removed, and a round, hinged door is closed and bolted in place. The charge is now ready to be treated.

4.1.2 Methods of pressure treatment

There are three processes by which poles are pressure treated. They are the empty-cell, full-cell, and modified full-cell processes. The method used is usually determined by the type of carrier used—oil or water.

4.1.2.1 Empty-cell process

The objective of empty-cell treatment is to obtain adequate penetration with a relatively low net retention of preservative. For treatment with oil preservatives, the empty-cell process should always be used if it will provide the desired retention. Two empty-cell processes, the Rueping and Lowry, are commonly employed.

The Rueping empty-cell process has been widely used for many years in both Europe and the US. The following general procedure is employed:

a) Air under pressure is forced into the treating cylinder, which contains the charge of poles. The air penetrates some species easily, requiring only a few minutes application of pressure. In the treatment of the more resistant species, a common practice is to maintain air pressure from 1/2 h to 1 h before admitting the preservative, but the necessity for long air-pressure periods does not seem fully established. The gauge air pressures employed generally range between 170 kPa and 700 kPa, depending on the net retention of the preservative desired and the resistance of the wood.[8]

b) After the period of preliminary air pressure, the preservative is forced into the cylinder. As the preservative is pumped in, the air escapes from the treating cylinder into an equalizing or Rueping

[7] 1.2 m to 3 m is equal to 4 ft to 10 ft; 46 m is equal to 150 ft; 1380 kPa is equal to 200 lbf/in^2

[8] 170 kPa and 700 kPa are equal to 25 lbf/in^2 and 100 lbf/in^2

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tank, at a rate that keeps the pressure constant within the cylinder. When the treating cylinder is filled with the preservative, the treating pressure is raised above that of the initial air and is maintained until the wood will take no more of the preservative, or until enough has been absorbed to leave the required retention of the preservative in the wood after the treatment.

c) At the end of the pressure period, the pressure is reduced to atmospheric, the preservative is drained from the cylinder, and surplus preservative is removed from the wood with a final vacuum. The amount recovered may be from 20% to 60% of the gross amount injected.

The Lowry process is often called the empty-cell process without initial air pressure. Preservative is admitted to the cylinder without either an initial air pressure or a vacuum, and the air originally in the wood at atmospheric pressure is imprisoned during the filling period. After the cylinder is filled with the preservative, pressure is applied, and the remainder of the treatment is the same as described for the Rueping treatment.

The Lowry process has the advantage that equipment for the full-cell process can be used without other accessories; the Rueping process usually requires additional equipment, such as an air compressor and an extra cylinder or Rueping tank for the preservative, or a suitable pump to force the preservative into the cylinder against the air pressure. Both processes, however, have advantages, and both are widely and successfully used.

The purpose of both processes is to load the wood cells with compressed air so that when the pressure is released at the end of the treatment cycle, the air will expand and force out some of the preservative.

4.1.2.2 Full-cell process

The full-cell process is used when high net retentions are desired. It is a standard procedure for material to be treated using the full-cell process with creosote when protection against marine borers is required. Waterborne preservatives are generally applied by the full-cell process, and control over preservative retention is obtained by regulating the concentration of the treating solution.

Steps in the full-cell process are essentially as follows:

a) The charge of conditioned poles are sealed in the treating cylinder, and a preliminary vacuum is applied for 1/2 h or more. The vacuum removes most of the air from the cylinder and as much as possible from the wood.

b) Maintaining the vacuum, the preservative is admitted to the cylinder.

c) After the cylinder is filled, pressure is applied to force the preservative into poles until the required retention of the preservative is obtained or until refusal.

d) When the pressure period is completed, the pressure is released, and the preservative is then withdrawn from the cylinder.

e) A short final vacuum may be applied to free the charge from the dripping preservative.

4.1.2.3 Modified full-cell process

The modified full-cell process is basically the same as the full-cell process except for the amount of initial vacuum. The modified full-cell process uses lower levels of vacuum, the actual amount being determined by the species and the final retention desired. This process is used only on material 5.08 cm or less in thickness.[9]

[9]5.08 cm is equal to 2 in

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4.2 Thermal process

Although most wood species are treated by the pressure process, some thin sapwood species, such as lodgepole pine and western red cedar, are treated by the nonpressure method called the thermal process. The principal advantage of thermal treatment is that it can be performed with relatively simple equipment. The butt-treating thermal process only treats the surface of a pole where it makes contact with the ground.

To be full-length treated by the thermal process, seasoned poles are laid in horizontal, open-top tanks and secured to prevent floating. Hot preservative, generally at temperatures from about 93 °C to 110 °C, is pumped into the tank until the poles are completely immersed in the preservative solution.[10] The preservative's temperature is maintained for a period of 6 h or more, after which it is pumped from the treating tank to a storage tank.

Immediately, the tank is flooded with preservative considered cold, approximately 38 °C, and allowed to remain there for a few hours, or a cooling cycle may be used where the hot preservative is left in the tank and allowed to cool.[11] This temperature differential causes hot air in the wood cells to contract, creating a partial vacuum. This results in movement of the preservative into the treatable portion of the wood.

For butt treatment, the same process is used except the poles are treated vertically with only the butts immersed in the treating tank.

Butt-treated poles perform well in arid states that have a low decay hazard or northern climates with low decay rates.

Full-length, thermal-treated western red cedar poles perform well in any environment.

4.3 Wood preservatives

Wood preservatives fall into the following two general classes:

1) Oilborne preservatives such as creosote and petroleum solutions of pentachlorophenol and copper naphthenate (CuN)
2) Waterborne preservatives such as inorganic arsenicals that are applied as water solutions

Wood may swell slightly from preservative oils, but will shrink as it loses moisture during the treating process. Creosote and solutions with heavier, less volatile petroleum oils often help protect wood from weathering, but may adversely influence its cleanliness, odor, color, and paintability.

4.3.1 Coal-tar creosote

Coal-tar creosote is a black or brownish oil made by distilling coal tar. Its advantages are as follows:

— High toxicity to wood-destroying organisms
— Relative insolubility in water and low volatility, which impart to it a degree of permanence under the most varied-use conditions
— Ease of application
— Ease with which its depth of penetration can be determined
— General availability
— Long record of satisfactory use
— Recommended for marine applications

[10]93 °C to 110 °C is equal to 200 °F to 230 °F
[11]38 °C is equal to 100 °F

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The character of the tar used, the method of distillation, and the temperature range in which the creosote fraction is collected all influence the composition of the creosote. The composition of the various coal-tar creosotes available, therefore, may vary to a considerable extent. Small differences in composition, however, do not prevent creosotes from giving good service; satisfactory results in preventing decay may generally be expected from any coal-tar creosote that complies with the requirements of standard specifications.

Although coal-tar creosote or creosote-coal-tar solutions are well suited for general outdoor service in structural timbers, they have properties that are disadvantageous for some purposes.

The color of creosote and the fact that creosote-treated wood cannot be painted satisfactorily make this preservative unsuitable where appearance and paintability are important.

The odor of creosoted wood may be unpleasant to some persons. Also, creosote vapors are harmful to growing plants, and foodstuffs that are sensitive to odors should not be stored where creosote odors are present. Workmen sometimes object to creosoted wood because it soils their clothes and, in some individuals, may irritate the skin on the face and hands. With precautions to avoid direct skin contact with creosote, there appears to be no danger to the health of workers handling or working near the treated wood.

Freshly creosoted timber can be ignited and may burn readily, producing a dense smoke. However, after the timber has seasoned for some months, the more volatile parts of the oil disappear from near the surface, making it harder to ignite. Until this volatile oil has evaporated, ordinary precautions should be taken to prevent fires. On the other hand, poles that have been kept sound by creosote treatment are harder to ignite than untreated wood that has started to decay.

Standard P1 in the AWPA 2001 Book of Standards covers the technical requirements for creosote. *Clean creosote* refers to a type of creosote that has entered the marketplace recently. Clean creosote meets the technical requirements of Standard P1 in the AWPA 2001 Book of Standards, but increased filtering of the preservative causes the treated product to be dry to the touch and lighter in color.

4.3.2 Pentachlorophenol solutions

Water-repellent solutions containing chlorinated phenols, principally pentachlorophenol, in solvents of the mineral spirits type, were first used in commercial treatment of wood by the millwork industry in about 1931. Commercial pressure treatment with pentachlorophenol in heavy petroleum oils started on poles in about 1941, and considerable quantities of various products were soon pressure treated. Standard P8 in the AWPA 2001 Book of Standards and Federal Specification TT-W-570 define the properties of pentachlorophenol, and Standard P9 in the AWPA 2001 Book of Standards covers solvents for oilborne preservatives. A commercial process using pentachlorophenol dissolved in liquid petroleum gas was introduced in 1961, however, it is no longer in production today.

Pentachlorophenol solutions for wood preservation generally contain 5–7% (by weight) of this chemical, although solutions with volatile solvents may contain lower or higher concentrations. The performance of pentachlorophenol and the properties of the treated wood are influenced by the properties of the solvent used. The heavy petroleum solvent included in Standard P9 type A in the AWPA 2001 Book of Standards is preferable for maximum protection, particularly where the wood treated with pentachlorophenol is used in contact with the ground.

The heavy oils remain in the wood for a long time and do not usually provide a clean or paintable surface. Because of the toxicity of pentachlorophenol, care is necessary to avoid excessive personal contact with the solution or vapor in handling and using it. This treatment is not recommended for use in the marine environment.

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The results of pole service and field tests on wood treated with pentachlorophenol in a heavy petroleum oil are similar to those with coal-tar creosote. This similarity has been recognized in the preservation retention requirements of treatment specifications.

4.3.3 Waterborne preservatives

Standard wood preservatives used in waterborne solutions include ammoniacal copper zinc arsenate (ACZA) and chromated copper arsenate (CCA) (types A, B, and C). These preservatives are often employed when cleanliness and paintability of the treated wood are required. Several formulations involving combinations of copper, chromium, and arsenic have shown high resistance to leaching and very good service performance. Both ACZA and CCA are included in many product specifications for materials such as building foundations, building poles, utility poles, marine piles, and piles for land and fresh-water use. Treatment usually takes place at ambient temperature. Douglas fir poles should not be treated with CCA because of nonuniform penetration.

Waterborne preservatives leave the wood surface comparatively clean, paintable, and free from objectionable odor. In the retentions normally specified for wood preservation, waterborne preservatives decrease the danger of ignition and rapid spread of flames. However, once ignited, poles treated with copper and chromium tend to smolder for a prolonged period. This is known as the afterglow effect.

There has been some objection to the surface hardness of southern yellow pine treated with CCA, causing difficulty in climbing. Additives have been developed that aid in keeping the pole surface climbable.

4.3.3.1 Ammoniacal copper zinc arsenate

According to Standard P5 in the AWPA 2001 Book of Standards, ACZA (chemonite) should contain approximately 50.0% copper oxide, 25.0% arsenic pentoxic, and 25.0% zinc oxide. The net retention of the preservative is calculated as weight of copper oxide plus arsenic pentoxide and zinc oxide per volume of wood treated within the proportions in the specification.

Service records on structures treated with ACZA show that this preservative provides very good protection against decay and termites. High retentions of preservative will provide extended service life to wood exposed to the marine environment.

4.3.3.2 Chromated copper arsenate

Types A, B, and C of CCA are covered in Standard P5 in the AWPA 2001 Book of Standards. The compositions of the three types are given in Table 1.

CCA Type A. Service data on treated poles, posts, and stakes installed in the U.S. since 1938 has shown excellent protection by CCA Type A against decay fungi and termites.

CCA Type B. This type has been used commercially in Sweden since 1950 and now throughout the world. It was included in stake tests in the U.S. in 1949 and gives excellent protection. Commercial use of this preservative in the U.S. started in 1964.

CCA Type C. Composition of CCA Type C was arrived at by AWPA technical committees in encouraging a single standard for CCA preservatives. Commercial preservatives of similar composition have been tested and used in England since 1954, and more recently in Australia, New Zealand, Malaysia, and in various countries of Africa and Central Europe, and are performing very well. Type C is the most commonly used formulation of CCA for utility poles because of low conductivity and because it is less corrosive than the other formulations.

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Table 1—Composition of the three types of CCA

Component	Percent by weight		
	Type A	Type B	Type C
Chromium trioxide	65.5	35.3	47.5
Copper oxide	18.1	19.6	18.5
Arsenic pentoxide	16.4	45.1	34.0

4.3.4 Copper naphthenate

CuN is a commercially available preservative treatment for utility structures that is classified as a nonrestricted-use pesticide by the Environmental Protection Agency (EPA).

This preservative should meet the requirements of Standard P8 in Standard P9 Type A, heavy oil, in the AWPA 2001 Book of Standards. Concentrate used to prepare wood-preserving solutions should contain not less than 6% nor more than 8% copper in the form of CuN.

The physical characteristics of CuN are similar to those of pentachlorophenol in heavy oil because they use the same carrier. CuN was first used to treat poles during the mid-1940s when, because of the limited availability of creosote, CuN was mixed 50/50 with creosote. It was used for only a limited time because of economic reasons.

5. Preparation for treatment

For satisfactory treatment and good performance thereafter, poles should be sound and suitably prepared. Poles should be peeled and properly conditioned prior to treatment. It is also highly desirable that all framing be completed before treatment.

5.1 Peeling

Peeling poles is necessary to enable the wood to dry quickly enough to avoid decay and insect damage, and to permit the preservative to penetrate satisfactorily. In order for the preservative to be evenly distributed into the pole, all inner and outer bark have to be removed from the pole. Where patches of bark remain, the preservative will not obtain proper penetration, thus offering a potential avenue of attack for decay or insects.

5.2 Incising and boring

For thin sapwood species, such as douglas fir, that are resistant to penetration by preservatives, aids to penetration are recommended. With incising, poles and crossarms are run through a machine that inserts teeth into the pole to a predetermined depth in a diamond pattern. As a minimum, transmission poles are usually penetrated to a depth of 6.4 cm in the area, 0.6 m above, and 1.2 m below the designated groundline.[12] Crossarms are usually penetrated to a depth of approximately 6 mm.[13]

[12]6.4 cm is equal to 2.5 in; 0.6 m is equal to 2 ft; 1.2 m is equal to 4 ft
[13]6 mm is equal to 1/4 in

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Alternatives to incising are radial drilling and through drilling. In radial drilling, 8 mm diameter holes are drilled in the same pattern and depth as incising.[14] Through drilling utilizes holes bored through the pole in the groundline area. Hole sizes from 8 mm to 11 mm are used.[15]

Drilling holes in the groundline section of a pole may decrease the pole strength by up to 10% at the groundline. For transmission-sized poles, the maximum stress point does not occur at groundline, so this loss of strength should not decrease the allowable spans.

5.3 Conditioning prior to treatment

Conditioning before treatment opens up the checks before the preservative is applied, thus increasing penetration, and reduces the risk of exposing untreated wood when checks open after treatment. The most commonly used methods for conditioning are air seasoning, steaming, kiln drying, and Boulton drying. The species of wood, region of the country, and time of the year determine what precautions must be taken to avoid serious damage from fungi in poles before treatment. For treatment with waterborne preservatives by certain diffusion methods, high moisture content may be permitted. For treatment by other methods, however, drying before treatment is essential.

5.3.1 Air seasoning process

In fairly low humidity areas such as the northwestern US, where the predominate species are douglas fir and western red cedar, poles once peeled can be stickered and stacked outdoors to air dry for up to 24 months using proper drying techniques. Using this method, the poles are exposed to open air and gradually dried until they come into approximate equilibrium with the average relative humidity of the air. In order to sterilize air-seasoned poles, they should be conditioned in the cylinder so that the pitch center of the pole is heated for at least 2 h at a temperature of not less than 65.5 °C.[16]

5.3.2 Kiln drying process

Kiln drying uses the application of temperature and humidity along with proper air circulation to greatly increase the drying rate. Average moisture content can be reduced to any desired value. Specific kiln schedules are used to control the temperature and humidity in order to obtain the final moisture content. Care must be exercised to ensure that the cycle does not cause drying defects. Kiln drying is the most common method of conditioning southern yellow pine poles for treatment.

5.3.3 Steaming

In the steaming process, green wood is steamed in the treating cylinder from 4 h to 20 h, usually at a maximum temperature of 118.3 °C, depending on wood species.[17] When the steaming is completed, a vacuum is immediately applied. During the steaming period, the sapwood is heated to a temperature approaching that of the steam; the subsequent vacuum lowers the boiling point so that part of the water is evaporated or is forced out of the wood by the steam produced when the vacuum is applied.

5.3.4 Boulton drying process

Boulton drying is a process that takes place in both full- and empty-cell, oil-type preservative treatments. Moisture is removed from the wood during the treating cycle. After the initial vacuum, the cylinder is filled

[14] 8 mm is equal to 5/16 in
[15] 8 mm to 11 mm is equal to 5/16 in to 7/16 in
[16] 65.5 °C is equal to 150 °F
[17] 118.3 °C is equal to 245 °F

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with hot preservative (82 °C to 104 °C) while under vacuum.[18] This is commonly known as boiling in oil and can last for up to 72 h, depending on the initial wood-moisture content. This process will lower the boiling point of water, and as the wood heats up, the moisture contained in the wood will turn to water vapor. This vapor is pulled off by vacuum and then goes to a condenser which turns the vapor to condensate.

The condensate is collected in "hot wells" and calculations are made to measure the rate of drying and the moisture content of the wood. The treating engineer uses these measurements to best determine when the wood will be most receptive to preservative impregnation by pressure treatment.

6. Specifications for treatment

When purchasing treated material, purchase orders should contain the following information:

- Species
- Quality of material before treatment
- Size and framing requirements
- Surface preparation limitations
- Special conditioning requirements
- Preservative
- Preservative retention and penetration
- Method of retention and penetration determination

Standard M1 in the AWPA 2001 Book of Standards provides general information for the purchaser who is unfamiliar with wood preservatives and wood preservation procedures. Standards C4 and C25 in the AWPA 2001 Book of Standards specify the actual physical steps and limitation of treatment, such as steaming time, vacuum pressures, required depth of penetration, number of borings to be taken to check retention, and penetration. These standards should be referenced when purchasing material. In the AWPA standards, when more than one retention of a preservative is shown for a given species, the proper retention and corresponding penetration requirements should be dependent upon the location within the U.S. The minimum retention values shown should be avoided due to the uncertainty of where treated poles may ultimately be installed.

With a view toward current environmental concerns, a variety of new formulations for wood treatment are being developed and proposed to AWPA. The use of new preservatives should be conditional unless sufficient data is available to ensure that the desired retention levels will provide satisfactory service performance.

Table 2 illustrates typical retentions, assay zones, and penetrations for various species of poles. These are minimum requirements and each user should analyze their service area and current service life of poles to decide if higher retentions or other modifications are warranted.

Table 3 lists typical preservative retentions used for crossarms. The minimum recommended retention in the outer 1.6 cm assay zone should not be less than the values shown in Table 3.[19]

Table 4 shows the AWPA standards that should be used to analyze preservatives and treated material for retention and penetration.

[18] 82 °C to 104 °C is equal to 180 to 220 °F
[19] 1.6 cm is equal to 5/8 in

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Table 2—Treatment and results of treatment Bulletin 1728F-700 Exhibit H[a]

Species	Preservative treatment minimum retention (pounds/cubic foot)					Assay zone (inches from surface)	
	Area use[b]	Creosote[c]	Penta[d]	Waterborne[e]	CuN[f]	Inches from surface	Penetration % of sapwood (inches)
	Pressure process—full length treatment						
Southern pine	1	9.0	0.45	0.60	0.080	0.5–2.0	3.5 or 90
Southern pine	2	7.5	0.38	—	0.060	0.5–2.0	3.0 or 90
Douglas fir[g,h]	1	12.0	0.60	0.60	0.095	0.25– 1.0	0.75 and 85
Douglas fir[g,h]	2	9.0	0.45	—	0.075	0.25–1.0	0.75 and 85
Ponderosa pine[g]	1	9.0	0.45	0.60	—	0.5– 2.0	3.5 or 90
Ponderosa pine[g]	2	7.5	0.38	—	—	0.5–2.0	3.0 or 90
Red pine	2	10.5	0.53	0.60	—	0.10– 1.6	2.5 or 85
Jack pine	2	12.0	0.60	0.60	---	0.10– 0.75	1.5 or 85
	Pressure and thermal process—full length treatment						
Western larch	2	15.0	0.75	0.60	—	0.1– 0.6	0.5 and 100
Lodgepole pine[h]	2	12.0	0.60	0.60	—	0.1–0.75	0.75 and 85
Alaska yellow	2	16.0	0.80	0.60	—	0.0– 0.50	0.5 or 100
Western red cedar	2	16.0	0.80	0.60	0.120	0.0– 0.50	0.5 or 100
Northern white	2	16.0	0.80	0.60	—	0.0– 0.50	0.5 or 100

[a]Table 2 is reprinted from the Rural Utilities Service (RUS) Bulletin 1728F-700, RUS Specification for Wood Poles, Stubs and Anchor Logs, 1993 [B6].

[b]Use Area 1—South of the 40th parallel of north latitude and east of the 95th meridian of west longitude, including the Gulf Coast of Texas. Use Area 2—Elsewhere than as defined for Use Area 1.

[c]Test by toluene extraction.

[d]This retention is for lime ignition or X-ray spectroscopy method. Copper pyridine method, which equals 90% of lime ignition results is required when poles may have been in contact with salt water and for all species native to the Pacific Region, unless it specifically states on the raw material invoice that the material has been in contact with salt water or shown by analysis that there are no additional chlorides present in the wood before treating.

[e]Pressure treatment only.

[f]In Decay Zone 5, shown in RUS Bulletin 1730-B121, minimum retentions are 0.130 lb/ft^3 for southern pine and 0.150 lb/ft^3 for Douglas Fir, for all poles within 80 km (50 miles) of coastal waters.

[g]Species native to the Pacific Coast region as per Agriculture Handbook 541 (1979) [B1].

[h] Coast type.

Table 3—Typical preservative retentions for crossarms

Preservative	Retention	
	(kg/m^3)	lb/ft^3
Credsote	128.14	(8)
Pentachlorophenol	6.41	(0.4)
CCA or ACZA	6.41	(0.4)
Copper Naphthenate	0.064	(0.04)

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Table 4—AWPA standards to be used

Preservative	Preservative analysis	Retention	Penetration
Creosote	A1	A6	A3
Pentachlorophenol	A5 or A9	A5 or A9	A3
CCA or ACZA	A2	A2, A7, A9, or A11	A3
Copper Naphthenate	A5	A5, A9, or A11	A3

7. Inspection and quality control

Wood, because it is a naturally grown material, has inherent variability from tree to tree. This variability necessitates the inspection of products at various phases of production to ensure that accepted limits are met.

The most important step a purchaser can take is to make sure that the treating plant from which they purchase poles has an ongoing plant quality control program. This should consist of one individual or a supervisor of a team of individuals who inspects each pole before and after treatment at the plant in accordance with Standard M2 in the AWPA 2001 Book of Standards. It is also recommended that the purchaser enlist the services of an unbiased inspection agency or that a monitoring program be present at the plant and inspect poles on the purchaser's behalf to ensure conformance. Purchasers should also be familiar enough with treated wood products and the specification to give each shipment a visual examination upon receipt. If questions arise concerning quality of products from the treating plant, a third party arbitrator may be required.

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Annex A

(informative)

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[B6] Rural Utilities Service (RUS) Bulletin 1728F-700, RUS Specification for Wood Poles, Stubs and Anchor Logs, 1993. U.S. Regulatory Guides are available from the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20013-7082, USA.

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