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Designation: D 1760 – 96



Standard Specification for Pressure Treatment of Timber Products¹

This standard is issued under the fixed designation D 1760; 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 This specification is under the jurisdiction of ASTM Committee ~~D-7~~ D07 on Wood and is the direct responsibility of Subcommittee D07.06 on Treatments for Wood Products.

Current edition approved ~~June~~ April 10, 1996; 2001. Published ~~August~~ June 2001. Originally published as D 1760 – 60. Last previous edition D 1760 – 95a6. Some requirements in this specification are similar to those in the Commodities Standards of the American Wood-Preservers' Association for treatment of timber products by pressure processes in closed vessels with preservative materials and solutions. Acknowledgment is made to the American Wood-Preservers' Association for its development of subject matter used in this specification.

1. Scope

1.1 This specification covers treatment of timber products by pressure processes in closed vessels with preservative materials and solutions.

1.2 This specification is divided into two general sections. Sections 1-9 cover requirements relating to all species and commodities, while Tables 1-7 show requirements relating to specific species and commodities. The purchaser should note that these individual requirements vary widely and, consequently, great care must be used in applying them in specific instances.

1.3 The values stated in inch-pound units are to be considered as standard.

2. Referenced Documents

2.1 ASTM Standards:

D 347 Tables for Volume and Specific Gravity Correction for Creosote and Coal Tar²

D 390 Specification for Coal-Tar Creosote for the Preservative Treatment of Piles, Poles, and Timbers for Marine, Land, and Fresh Water Use²

D 391 Specification for Creosote-Coal Tar Solution²

~~D 1034 Specification for Fluor-Chrome-Arsenate-Phenol²~~

~~D 1035 Test Methods for Chemical Analysis of Fluor-Chrome-Arsenate-Phenol²~~

~~D 1272 Specification~~ 1272 Specification for Pentachlorophenol²

D 1325 Specification for Ammoniacal Copper Arsenate and Ammoniacal Copper Zinc Arsenate²

D 1326 Methods for Chemical Analysis of Ammoniacal Copper Arsenate and Ammoniacal Copper Zinc Arsenate²

D 1624 Specification for Acid Copper Chromate²

D 1625 Specification for Chromated Copper Arsenate²

D 1627 Methods for Chemical Analysis of Acid Copper Chromate²

D 1628 Test Methods for Chemical Analysis of Chromated Copper Arsenate²

D 1858 Specification for Creosote-Petroleum Solution²

D 1860 Test Method for Moisture and Creosote-Type Preservative in Wood²

D 2085 Test Method for Determining Chloride Used in Calculating Pentachlorophenol in Solutions or Wood (Lime Ignition Method)²

D 2604 Specification for High-Boiling Hydrocarbon Solvent for Preparing Oil-Borne Preservative Solutions²

D 2605 Specification for Volatile Petroleum Solvent (LPG) for Preparing Pentachlorophenol Solutions²

D 3225 Specification for Low-Boiling Hydrocarbon Solvent for Oil-Borne Preservatives²

D 5584 Test Methods for Chemical Analysis of Ammoniacal Copper Quat Type B (ACQ-B)²

D 5653 Specification for Copper bis (Dimethyldithiocarbamate)²

D 5654 Specification for Ammoniacal Copper Quat Type B (ACQ-B)²

D 5655 Test Method for Analysis of Copper Dimethyldithiocarbamate (CDDC) Treated Wood by Colorimetry²

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

² Annual Book of ASTM Standards, Vol 04.10.

3.1.1 *preservative materials and solutions*—materials that when injected into wood protect it from the destructive action of fungi, insects, and marine borers.

3.1.2 *timber products*—include round, sawn, and otherwise fabricated materials of various species. Examples are utility poles, piles, posts, crossies, lumber, timbers, glued laminated timbers, plywood, and so forth.

ALL TIMBER PRODUCTS

4. General Requirements

4.1 The following requirements, except as modified, or supplemented by Tables 1-7, for the various species and types of material, apply to each of the treating processes and to all species and types of material. If these requirements are to be otherwise modified to meet special conditions, complete detailed instructions shall be given by the purchaser or specifier.

4.1.1 Maximum time duration (total elapsed time of a treating phase), maximum temperature, and maximum pressure limits shall not be exceeded. A phase shall begin when a change in conditions within the cylinder is initiated and shall end when either new conditions are imposed, or the cylinder is emptied of preservative.

TABLE 1 Treatment of Lumber, Timbers, Bridge Ties, and Mine Ties by Pressure Processes

	Southern Pine and Ponderosa Pine			Hemfir, ^A Pacific Coast Douglas Fir, ^B Western Hemlock and Western Larch ^C		
Conditioning	air seasoning, kiln drying, Boulton drying, heating in preservative or a combination			air seasoning, kiln drying, Boulton drying, steaming (water-borne treatments only), heating in preservative or a combination		
Steaming: ^D						
Temperature, max, °F (°C)	245 (120)			240 (117)		
Duration, max, h	17			6		
Vacuum, min, in. (mm) at sea level	22 (558.8)			22 (558.8)		
Heating in preservative:						
Temperature, max, °F (°C)	220 (104)			210 (99)		
Duration, max, h	optional			6 if seasoned, optional if green		
Incising	not required			required		
Treatment:						
Pressure, psig (kPa)						
min	75 (517)			50 (345)		
max	200 (1379)			150 (1034)		
Expansion bath: temperature, max, °F (°C)	220 (104)			220 (104)		
Final steaming:						
Temperature, max, °F (°C)	240 (117) (not permitted for service in coastal waters)			240 (117) (not permitted for service in coastal waters)		
Duration, max, h	2			2		
	<i>Above Ground</i>	<i>Ground Contact</i>	<i>Coastal Waters</i>	<i>Above Ground</i>	<i>Ground Contact</i>	<i>Coastal Waters</i>
Results of treatment:						
Retention, min, lb/ft ³ (kg/m ³): (sampling zone for assay 0 to 0.60 in. (0 to 15.2 mm) from surface):						
Creosote and creosote solutions—by assay:						
Creosote	6 (96)	8 (128)	20 (320) full cell	8 (128)	10 (160)	20 (320) full cell
Creosote-coal tar solution	6 (96)	8 (128)	20 (320) full cell	8 (128)	10 (160)	20 (320) full cell
Creosote-petroleum solution	6 (96)	8 (128)	not recommended	8 (128)	10 (160)	not recommended
Oil-borne preservatives—by assay						
Pentachlorophenol using Specifications D 2604, D 2605, or D 3225 solvents	0.30 (4.81)	0.40 (6.4)	not recommended	0.40 (6.4)	0.50 (8.0)	not recommended
Water-borne preservatives—by assay:						
ACC	0.25 (4.0)	0.50 (8.0)	not recommended	0.25 (4.0)	0.50 (8.0)	not recommended
ACA and ACZA	0.25 (4.0)	0.40 (6.4)	2.50 (40.0)	0.25 (4.0)	0.40 (6.4)	2.50 (40.0) ^E
CCA, Types A and G	0.25 (4.0)	0.40 (6.4)	2.50 (40.0)	0.25 (4.0)	0.40 (6.4)	not recommended
ACQ-Type B	0.25 (4.0)	0.40 (6.4)	not recommended	0.25 (4.0)	0.40 (6.4)	not recommended
CCA, Types A and C	0.45 (7.2)	not recommended	not recommended	0.45 (7.2)	not recommended	not recommended
CDDC ^H (as copper metal)	0.25 (4.0)	0.40 (6.4)	2.50 (40.0)	0.25 (4.0)	0.40 (6.4)	not recommended
	0.10 (1.6)	0.20 (3.2)	not recommended			—FCAP 0.25 (4.0) not rec
Penetration	2.5 in. (64 mm) unless 85 % of sapwood			0.40 in. (10.2 mm) and 90 % of sapwood less than 5 in. (127 mm) in thickness, 0.50 in. (12.7 mm) and 90 % of sapwood thicker than 5 in. and for coastal waters service		
Determination of penetration	^F			A borer core shall be taken from the incised faces of 20 pieces in each charge. If 80 % of the borings meet the penetration requirements the charge shall be accepted. Borings not meeting the penetration requirements shall show evidence of preservative penetration.		
Jack Pine, Lodgepole Pine, and Red Pine						
Conditioning	air seasoning, kiln drying, Boulton drying, steaming (water-borne treatments or ice-coated or frozen materials with oil treatments only), heating in the preservative or a combination					
Steaming: ^G						
Temperature, max, °F (°C)	240 (117)					
Duration, max, h	6					
Vacuum, min, in. (mm) at sea level	22 (558.8)					
Heating in preservative:						
Temperature, max, °F (°C)	210 (99)					
Duration, max, h	6 h seasoned, green optional					
Incising	required					
Treatment:						

TABLE 1 Continued

Jack Pine, Lodgepole Pine, and Red Pine	
Pressure, psig (kPa):	
min	75 (517)
max	175 (1207)
Expansion bath: temperature, max,	
°F (°C)	220 (104)
Final steaming ^C :	
Temperature, max, °F (°C)	240 (117) (not permitted for service in coastal waters)
Duration, max, h	2

	Jack Pine, Lodgepole Pine, and Red Pine		
	Above Ground	Ground Contact	Coastal Waters
Results of treatment:			
Retention, min, lb/ft ³ (kg/m ³) (sampling zone for assay 0 to 0.60 in. (0 to 15.2 mm) from surface):			
Creosote and creosote solutions—by assay:			
Creosote	6 (96)	8 (128)	refusal
Creosote-coal tar solution	6 (96)	8 (128)	refusal
Creosote-petroleum solution	6 (96)	8 (128)	not recommended
Oil-borne preservatives—by assay:			
Pentachlorophenol using Specifications D 2604, D 2605, or D 3225 solvents	0.30 (4.81)	0.40 (6.4)	not recommended
Water-borne preservatives—by assay:			
ACC	0.25 (4.0)	0.50 (8.0)	not recommended
ACA and ACZA	0.25 (4.0)	0.40 (6.4)	not recommended
CCA, Types A and C	0.25 (4.0)	0.40 (6.4)	not recommended
—FGAP	0.45 (7.2)	not recommended	not recommended
	0.25 (4.0)	not recommended	not recommended
Penetration	Less than 5 in. (127 mm) thick, 0.40 (10.2 mm), and 90 % of sapwood. 5 in. thick and thicker and coastal water service, 0.50 in. (12.7 mm) and 90 % of sapwood.		
Determination of penetration	A borer core shall be taken from each of 20 pieces in each charge. If 80 % of the borings meet the penetration requirement the charge shall be accepted.		

	Northern White Pine, Sugar Pine, and Western White Pine			Redwood		
	Above Ground	Ground Contact	Coastal Waters	Above Ground	Ground Contact	Coastal Waters
Conditioning	air seasoning, kiln drying, Boulton drying, steaming (water-borne treatments and ice-coated or frozen material with oil treatments only), heating in preservative or a combination			air seasoning, kiln drying, Boulton drying, steaming (water-borne treatments or ice-coated or frozen material with oil-type treatments only), heating in preservative or a combination		
Steaming: ^D						
Temperature, max, °F (°C)	240 (117)			240 (117)		
Duration, max, h	6			4.5		
Vacuum, min, in. (mm) at sea level	22 (558.8)			22 (558.8)		
Heating in preservative:						
Temperature, max, °F (°C)	210 (99)			210 (99)		
Duration, max, h	6 h seasoned, green optional required			6 h seasoned, green optional required		
Incising						
Treatment:						
Pressure, psig (kPa):						
min	50 (345)			50 (345)		
max	150 (1034)			125 (861)		
Expansion bath: temperature, max, °F (°C)	220 (104)			220 (104)		
Final steaming:						
Temperature, max, °F (°C)	240 (117) (not permitted for service in coastal waters)			240 (117) (not permitted for service in coastal waters)		
Duration, max, h	1			1		

Results of treatment:
Retention, min, lb/ft³ (kg.m³)
(sampling zone for assay 0 to 0.60 in. (0 to 15.2 mm) from surface):

TABLE 1 *Continued*

	<i>Above Ground</i>	<i>Ground Contact</i>	<i>Coastal Waters</i>	<i>Above Ground</i>	<i>Ground Contact</i>	<i>Coastal Waters</i>
Creosote and creosote solutions—by assay:						
Creosote	6 (96)	8 (128)	refusal	8 (128)	10 (160)	20 (320) full cell
Creosote-coal tar solution	6 (96)	8 (128)	refusal	8 (128)	10 (160)	20 (320) full cell
Creosote-petroleum solution	6 (96)	8 (128)	not recommended	8 (128)	10 (160)	not recommended
Northern White Pine, Sugar Pine, and Western White Pine						
	<i>Above Ground</i>	<i>Ground Contact</i>	<i>Coastal Waters</i>	<i>Above Ground</i>	<i>Ground Contact</i>	<i>Coastal Waters</i>
Oil-borne preservatives—by assay:						
Pentachlorophenol using Specifications D 2604, D 2605, or D 3225 solvents	0.30 (4.81)	0.40 (6.4)	not recommended	0.60 (9.6)	0.50 (8.0)	not recommended
Water-borne preservatives—by assay:						
ACC	0.25 (4.0)	0.50 (8.0)	not recommended	0.25 (4.0)	0.50 (8.0)	not recommended
ACA and ACZA	0.25 (4.0)	0.40 (6.4)	not recommended	0.25 (4.0)	0.40 (6.4)	not recommended
CCA, Types A and C	0.25 (4.0)	0.40 (6.4)	not recommended	0.25 (4.0)	0.40 (6.4)	not recommended
FCAP	0.45 (7.2)	not recommended	not recommended	0.45 (7.2)	not recommended	not recommended
	0.25 (4.0)	not recommended	not recommended	0.25 (4.0)	not recommended	not recommended
Penetration	Less than 5 in. (127 mm) thick, 0.40 (6.4 mm) and 90 % of sapwood. 5 in. and thicker and for service in coastal waters, 0.50 in. (8.0 mm) and 90 % of sapwood			Less than 5 in. (127 mm) thick, 0.40 (6.4 mm), and 90 % sapwood. 5 in. and thicker and coastal waters service, 0.50 (8.0 mm) and 90 % of sapwood		
Determination of penetration	^F			A borer core shall be taken from each of 20 pieces in each charge. If 80 % of the borings meet the penetration requirement, the charge shall be accepted. Borings not meeting the penetration requirements shall show evidence of preservative penetration.		
Black Gum and Red Gum						
	<i>Above Ground</i>	<i>Ground Contact</i>	<i>Coastal Waters</i>	<i>Above Ground</i>	<i>Ground Contact</i>	<i>Coastal Waters</i>
Conditioning	air seasoning, kiln drying, Boulton drying, steaming, heating in preservative or a combination			air seasoning, kiln drying, Boulton drying, heating in preservative or a combination		
Steaming: ^D				not permitted		
Temperature, max, °F (°C)	240 (117)					
Duration, max, h	6					
Vacuum, min, in. (mm) at sea level	22 (558.8)					
Heating in preservative:						
Temperature, max, °F (°C)	220 (104)			220 (104)		
Duration, max, h	optional			optional		
Incising						
Treatment:						
Pressure, psig (kPa):						
min	125 (861)			125 (861)		
max	200 (1379)			250 (1724)		
Expansion bath: temperature, max, °F (°C)	220 (104)			220 (104)		
Final steaming:						
Temperature, max, °F (°C)	240 (117) (not permitted for service in coastal waters)			240 (117) (not permitted for service in coastal waters)		
Duration, max, h	1			1		
Oak						
	<i>Above Ground</i>	<i>Ground Contact</i>	<i>Coastal Waters</i>	<i>Above Ground</i>	<i>Ground Contact</i>	<i>Coastal Waters</i>
Results of treatment:						
Retention, min, lb/ft ³ (kg/m ³) (by gage):				^E		
Creosote and creosote solutions:						
Creosote	6 (96)	8 (128)	refusal	6 (96)	7 (112)	refusal min 10 (160)
Creosote-coal tar solution	6 (96)	8 (128)	12 (192) minimum	6 (96)	7 (112)	refusal min 10 (160)
Creosote-petroleum solution	6 (96)	8 (128)	not recommended	6 (96)	7 (112)	not recommended

TABLE 1 *Continued*

Oil-borne preservatives:						
Pentachlorophenol using Specifications D 2604, D 2605, or D 3225 solvents	0.30 (4.81)	0.40 (6.4)	not recommended	0.30 (4.81)	0.40 (6.4)	not recommended
Water-borne preservatives:						
ACC	0.25 (4.0)	0.50 (8.0)	not recommended	0.25 (4.0)	0.50 (8.0)	not recommended
ACA and ACZA	0.25 (4.0)	0.40 (6.4)	not recommended	0.25 (4.0)	0.40 (6.4)	not recommended
CCA, Types A and C	0.25 (4.0)	0.40 (6.4)	not recommended	0.25 (4.0)	0.40 (6.4)	not recommended (refusal) —FCAP
	0.25 (4.0)	not recommended	not recommended	0.25 (4.0)	not recommended	not recommended
Penetration	1.5 in. (38 mm) unless 85 % of sapwood		White oaks, 90 % of sapwood. Red oaks, 65 % of annual rings to center of cross section. Charges of recalcitrant wood with less penetration may be accepted if the wood is properly conditioned before treatment and if treatment is continued to refusal.			
Determination of penetration	<i>A,B,C,D,E,F,G,H,I</i>		<i>F</i>			

^A The species grouping, Hemfir, includes Western hemlock (*Tsuga heterophylla*), California red fir (*Abies magnifica*), grand fir (*Abies grandis*), noble fir (*Abies procera*), Pacific silver fir (*Abies amabilis*), and white fir (*Abies concolor*).

^B Pacific Coast Douglas fir includes Douglas fir from west of the crest of the Cascade Mountains in Oregon, Washington, and Northern California and west of the crest of the Sierra Nevada Mountains in the rest of California. Interior Douglas fir is Douglas fir grown anywhere else.

^C Interior Douglas fir and Western larch are not suitable species to be used for lumber or timbers in coastal waters.

^D Steam-conditioning southern pine, ponderosa pine, red pine, or black or red gum lumber before treatment with ACC or CCA preservatives is prohibited except when the lumber is ice-coated or frozen.

^E Retentions apply to red oak only. White oak of all sizes shall be treated to refusal.

^F A borer core shall be taken from each of 20 pieces in the charge. If 80 % of the cores meet the penetration requirements, the charge shall be accepted. Borings not meeting the penetration requirements shall show evidence of preservative penetration.

^G This retention applies to Pacific Coast Douglas Fir and is not recommended for Hemfir, Western Hemlock, or Western Larch.

^H Treatment of Pacific Coast Douglas fir and Western larch with CCA, Type A or C, shall only be valid when the material is chosen from permeable wood selected by treatment trials.

^I Southern pine only.

TABLE 2 Treatment of Land and Fresh-Water Piles and Foundation Piles by Pressure Processes

	Southern Pine and Ponderosa Pine	Pacific Coast Douglas Fir ^{B,C}	Oak	Lodgepole Pine
Conditioning	air seasoning, kiln drying, steaming, heating in preservative, or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, or a combination thereof	air seasoning, kiln drying, heating in preservative, or a combination thereof	air seasoning, kiln drying, steaming (for ice-coated or frozen piles only) Boulton drying, heating in preservative, or a combination thereof
Steaming:				
Temperature, max, °F (°C)	245 (120)	not permitted	not permitted	240 (117)
Duration, max, h	southern pine: 15 ^A ponderosa pine: 6			6
Vacuum, min, in. (mm) at sea level	22 (558.8)			22 (558.8)
Heating in preservative:				
Temperature, max, °F (°C)	220 (104)	seasoned 210°F (99 °C) and 6 h	220 (104)	220 (104)
Duration, max, h	optional	green or partially seasoned 220°F (104° C) and optional	optional	optional
Treatment:				
Pressure, psig (kPa)				
min	125 (861)	75 (517)	150 (1034)	100 (689)
max	200 (1379)	150 (1034)	200 (1379)	150 (1034)
Expansion bath: temperature, max, °F (°C)	220 (104)	220 (104)	not permitted	220 (104)
Final steaming:				
Temperature, max, °F (°C)	245 (120)	240 (117)	not permitted	24 (117)
Duration, max, h	3	3		3
Results of treatment:				
Number of borings per charge	20	20	20	20
Retention, min, lb/ft ³ (kg/m ³) (sampling zone for assay, in. (mm) from surface)	0 to 3.0 (0 to 76.2)	0 to 1.00 (0 to 25.4)	0 to 2.00 (0 to 50.8)	0 to 1.00 (0 to 25.4)
Creosote and creosote solutions:				
Creosote	12 (192)	17 (272)	6 (96)	17 (272)
Creosote-coal tar solution	12 (192)	17 (272)	6 (96)	17 (272)

TABLE 2 *Continued*

Creosote-petroleum solution	12 (192)	17 (272)	6 (96)	17 (272)
Oil-borne preservatives: Pentachlorophenol using Specification D 2604 solvent	0.60 (9.6)	0.85 (13.6)	0.30 (4.81)	0.85 (13.6)
Water-borne preservatives: ACA and ACZA	0.80 (12.8)	1.00 (16.0)	not recommended	1.00 (16.0)
CCA, Types A and C	0.80 (12.8)	1.00 (16.0)	not recommended	1.00 (16.0)
Penetration	3.5 in. (89 mm) unless 90 % of sapwood ^D	0.75 in. (19 mm) and 85 % of sapwood unless 1.60 in. (41 mm) ^D	100 % of sapwood	0.75 (19 mm) and 85 % of sapwood unless 1.60 in. (41 mm)
	Southern Pine and Ponderosa Pine	Pacific Coast Douglas Fir ^{B,C}	Oak	Lodgepole Pine
Determination of penetration	A borer core shall be taken midway between the butt and the top of each pile in the charge. Only the piles that meet the penetration requirements shall be accepted.	A borer core shall be taken midway between the butt and the top of each pile in the charge. Only the piles that meet the penetration requirement shall be accepted.	A borer core shall be taken midway between the butt and the top of each pile in the charge. Only the piles that meet the penetration requirement shall be accepted.	A borer core shall be taken midway between the butt and the top of each pile in the charge. Only the piles that meet the penetration requirement shall be accepted.
	Red Pine	Western Larch	Jack Pine	
Conditioning	air seasoning, kiln drying, steaming (ice-coated or frozen piles only), heating in preservative, or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, or a combination thereof	air seasoning, kiln drying, steaming (ice-coated or frozen piles only), heating in preservative, or a combination thereof	
Steaming:				
Temperature, max, °F (°C)	240 (117)	not permitted	240 (117)	
Duration, max, h	6		6	
Vacuum: min, in. (mm) at sea level	22 (558.8)		22 (558.8)	
Heating in preservative:				
Temperature, max, °F (°C)	220 (104)	seasoned 210°F (99 °C) and 6 h partially seasoned or green 220°F (104 °C) and optional	220 (104)	
Duration, max, h	optional		optional	
Treatment:				
Pressure, psig (kPa)				
min	100 (689)	75 (517)	100 (689)	
max	150 (1034)	150 (1034)	150 (1034)	
Expansion bath: temperature, max, °F (°C)	220 (104)	220 (104)	220 (104)	
Final steaming:				
Temperature, max, °F (°C)	240 (117)	240 (117)	240 (117)	
Duration, max, h	3	0.5	3	
Results of treatment:				
Number of borings per charge	20 0 to 2.00 (0 to 50.8)	20 0 to 1.00 (0 to 25.4)	20 0 to 2.00 (0 to 50.8)	
Retention, min, lb/ft ³ (kg/m ³) (sampling zone for assay, in. (mm) from surface)				
Creosote and creosote solutions—by assay:				
Creosote	12 (192)	17 (272)	12 (192)	
Creosote-coal tar solution	12 (192)	17 (272)	12 (192)	
Creosote-petroleum solution	12 (192)	17 (272)	12 (192)	
Oil-borne preservatives—by assay:				
Pentachlorophenol using Specification D 2604 solvent	0.60 (9.6)	0.85 (13.6)	0.60 (9.6)	
Water-borne preservatives—by assay:				
ACA and ACZA	0.80 (12.8)	1.00 (16.0)	0.80 (12.8)	
CCA, Types A and C	0.80 (12.8)	1.00 (16.0)	0.80 (12.8)	
Penetration	2.5 (64 mm) in. unless 85 % of sapwood	0.75 (19 mm) and 85 % of sapwood unless 1.60 in. (41 mm)	1.50 (38 mm) in. unless 85 % of sapwood	
Determination of penetration	A borer core shall be taken midway between the butt and top of each pile in the charge. Only the piles that meet the penetration requirements shall be accepted.	^{A,B,C,D,E}	^E	

^A Piles shall be steamed at 240 to 245°F for not more than 1 h/in. of the average midpoint diameter of the piles in the charge. Total steam conditioning time shall include all steaming time during which the temperature exceeds 200°F.

^B Pacific Coast Douglas fir is Douglas fir grown west of the crest of the Cascade Mountains in Oregon, Washington, and Northern California and west of the crest of the Sierra Nevada Mountains in the rest of California. Interior Douglas fir is Douglas fir grown elsewhere.

^C Treatment of Pacific Coast Douglas fir and Western larch with CCA, Type A or C, shall only be valid when the material is chosen from permeable wood selected by treatment trials.

^D Effective penetration must be continuous with both earlywood and latewood in each ring penetrated. Certain grain configurations or defects may make it difficult to determine actual depth of penetration in a core and shall be excluded from constituting a skip. These defects include but are not limited to pitch, pitch pockets, ingrown bark, and knots. A core of this type shall be disregarded and a new core taken from another location on the same member.

^E A borer core shall be taken midway between the butt and the top from each pile in the charge. Only the piles that meet the penetration requirement shall be accepted.

TABLE 3 Treatment of Poles by Pressure Processes

	Southern Pine ^A	Ponderosa Pine ^A	Red Pine ^A
Conditioning	air seasoning, kiln drying, Boulton drying, steaming, or heating in preservative, or a combination thereof.	air seasoning, kiln drying, Boulton drying, steaming, heating in preservative, or a combination thereof.	air seasoning, kiln drying, Boulton drying, or a combination of air seasoning and steam conditioning.
Steaming: ^B			
Temperature, max, °F (°C)	245 (120)	240 (117)	240 (117)
Duration, max, h	Group A—17, Group B—20	6	4
Vacuum, min, in. (mm) at sea level	22 (559)	22 (559)	22 (559)
Heating in preservative:			
Temperature, max, °F (°C)	220 (104)	220 (104)	220 (104)
Duration, max, h	optional	optional	optional
Treatment:			
Pressure, max, psig (kPa)	200 (1379)	200 (1379)	150 (1034)
Expansion bath: temperature, max, °F (°C)	220 (104)	220 (104)	220 (104)
Final steaming:			
Temperature, max, °F (°C)	240 (117)	240 (117)	240 (117)
Duration, max, h	3	3	3
Results of treatment:			
Number of borings per charge	20	20	20
Retention, min, ^E lb/ft ³ (kg/m ³) (sampling zone for assay, in. (mm) from surface)	0.50 to 2.00 (12.7 to 50.8)	0.50 to 2.00 (12.7 to 50.8)	0.10 to 1.60 (2.54 to 40.6)
Creosote and creosote solutions—by assay:			
Creosote	6 (96), 7.5 (120), 9 (144)	6.0 (96), 7.5 (120), 9.0 (144)	8 (128), 10.5 (168), 13.5 (216)
Creosote-coal tar solution	not recommended	not recommended	8 (128), 10.5 (168), 13.5 (216)
Creosote-petroleum solution	not recommended	not recommended	not recommended
Oil-borne preservatives—by assay:			
Pentachlorophenol using Specifications D 2604, D 2605, or D3225 solvents	0.30 (4.8), 0.38 (6.1), 0.45 (7.2)	0.30 (4.8), 0.38 (6.1), 0.45 (7.2)	0.40(6.4), 0.53 (8.5), 0.68 (10.9)
Water-borne preservatives ^C —by assay:			
ACA and ACZA	0.60 (9.6)	0.60 (9.6)	0.60 (9.6)
CCA, Types A and C	0.60 (9.6)	0.60 (9.6)	0.60 (9.6)
Penetration	2.5 in. (64 mm), 3.0 in. (76 mm), or 3.5 in. (89 mm) unless 85 %, 90 %, or 90 % of sapwood. ^H Deeper penetrations are for higher retentions above. For water-borne treatments 3.5 in. (89 mm), unless 90 % of sapwood	2.5 in. (64 mm), 3.0 in. (76 mm), or 3.5 in. (89 mm) unless 85 %, 90 %, or 90 % of sapwood. Deeper penetrations are for higher retentions above. For water-borne treatments 3.5 in. (89 mm), unless 90 % of sapwood	2.5 in. (64 mm), 3.0 in. (76 mm), or 3.5 in. (89 mm) unless 85 %, 90 %, or 90 % of sapwood. Deeper penetrations are for higher retentions above. For water-borne treatments 3.5 in. (89 mm), unless 90 % of sapwood
Determination of penetration ^D	<i>Group A Poles</i> —Take one boring from midway between the butt and tip from each of 20 poles in each charge. If the penetration in 18 or more of the borings meet the penetration requirement, accept all of the Group A poles in the charge except for any poles in the sample from which nonconforming borings were taken. If 16 or 17 of the borings from Group A in the sample meet the penetration requirement, bore each Group A pole in the charge and accept only the poles that furnish conforming borings. If less than 16 of the borings from Group A poles in the sample meet the penetration requirement do not accept any of the Group A poles in the charge.	<i>Group A Poles</i> —Take one boring from midway between the butt and tip from each of 20 poles in each charge. If the penetration in 18 or more of the borings meet the penetration requirement, accept all of the Group A poles in the charge except for any poles in the sample from which nonconforming borings were taken. If 16 or 17 of the borings from Group A in the sample meet the penetration requirement, bore each Group A pole in the charge and accept only the poles that furnish conforming borings. If less than 16 of the borings from Group A poles in the sample meet the penetration requirement do not accept any of the Group A poles in the charge.	<i>Group A Poles</i> —Take one boring from midway between the butt and tip from each of 20 poles in each charge. If the penetration in 18 or more of the borings meet the penetration requirement, accept all of the Group A poles in the charge except for any poles in the sample from which nonconforming borings were taken. If 16 or 17 of the borings from Group A in the sample meet the penetration requirement, bore each Group A pole in the charge and accept only the poles that furnish conforming borings. If less than 16 of the borings from Group A poles in the sample meet the penetration requirement do not accept any of the Group A poles in the charge.

TABLE 3 *Continued*

	Southern Pine ^A	Ponderosa Pine ^A	Red Pine ^A
	<i>Group B Poles</i> —From each 45-ft long and shorter pole, take one boring midway between the butt and tip of each pole and accept any pole only if the boring from that pole meets the penetration requirement. From each 50-ft long and longer pole, take two borings 90° apart midway between the butt and tip of each pole around the pole and accept any pole only if both borings from that pole meet the penetration requirement.	<i>Group B Poles</i> —From each 45-ft long and shorter pole, take one boring midway between the butt and tip of each pole and accept any pole only if the boring from that pole meets the penetration requirement. From each 50-ft long and longer pole, take two borings 90° apart midway between the butt and tip of each pole around the pole and accept any pole only if both borings from that pole meet the penetration requirement.	<i>Group B Poles</i> —From each 45-ft long and shorter pole, take one boring midway between the butt and tip of each pole and accept any pole only if the boring from that pole meets the penetration requirement. From each 50-ft long and longer pole, take two borings 90° apart midway between the butt and tip of each pole around the pole and accept any pole only if both borings from that pole meet the penetration requirement.
			requirement.
	Pacific Coast Douglas Fir ^{A,E,F}	Jack Pine ^A	Western Larch ^{A,F}
Conditioning	air seasoning, kiln drying, Boulton drying, heating in preservative, steaming (for water-borne treatments only), or a combination thereof.	air seasoning, kiln drying, Boulton drying, heating in preservative, steaming (for water-borne treatments of ice-coated or frozen poles for oil treatments only), or a combination thereof.	air seasoning, kiln drying, Boulton drying, or steaming (for water-borne treatments only).
Steaming: ^B			
Temperature, max, °F (°C)	240 (117)	240 (117)	240 (117)
Duration, max, h	6	4	6
Vacuum, min, in. (mm) at sea level	22 (559)	22 (559)	22 (559)
Heating in preservative:			
Temperature, max, °F (°C)	seasoned, partly seasoned, or green: 220°F (104°C) and optional	220	seasoned, partly seasoned, or green: 220°F (104°C) and optional
Duration, max, h		optional	
Treatment:			
Pressure, max, psig (kPa)	150 (1034)	150 (1034)	150 (1034)
Expansion bath: temperature, max, °F (°C)	220 (104)	220 (104)	220 (104)
Final steaming:			
Temperature, max, °F (°C)	240 (117)	240 (117)	240 (117)
Duration, max, h	4	3	3
Results of treatment:			
Number of borings per charge	20	30	30
Retention, min, ^B lb/ft ³ (kg/m ³) (sampling zone for assay, in. (mm) from surface)	0.25 to 1.00 (6.35 to 25.4)	0.10 to 0.75 (2.54 to 19.1)	0.10 to 0.60 (2.54 to 15.2)
Creosote and creosote solutions—by assay:			
Creosote	9 (144), 12 (192)	12 (192), 16 (256)	16 (256)
Creosote-coal tar solution	not recommended	not recommended	not recommended
Creosote-petroleum solution	9 (144), 12 (192)	not recommended	16 (256)
Oil-borne preservatives—by assay:			
Pentachlorophenol using Specifications D 2604, D2605, or D3225 solvents	0.45 (7.2), 0.60 (9.6)	0.60 (9.6), 0.80 (12.8)	0.80 (12.8)
Water-borne preservatives ^E —by assay:			
ACA and ACZA	0.60 (9.6)	0.60 (9.6)	0.60 (9.6)
CCA, Types A and C	0.60 (9.6)	0.60 (9.6)	0.60 (9.6)
Penetration	0.75 in. (19 mm) and 85 % of sapwood unless 1.6 in. (41 mm) ^H	1.50 in. (38 mm) unless 85 % of sapwood	0.50 in. (12.7 mm) and 100 % of sapwood unless 0.75 in. (19 mm)
Determination of penetration ^D	<i>Group A Poles</i> —Take one boring from midway between the butt and tip from each of 20 poles in each charge. If the penetration in 18 or more of the borings meet the penetration requirement, accept all of the Group A poles in the charge except for any poles in the sample from which nonconforming borings were taken. If 16 or 17 of the borings from Group A in the sample meet the penetration requirement, bore each Group A pole in the charge and accept only the poles that furnish conforming borings. If less than 16 of the borings from Group A poles in the sample meet the penetration requirement do not accept any of the Group A poles in the charge.	<i>Group A Poles</i> —Take one boring from midway between the butt and tip from each of 20 poles in each charge. If the penetration in 18 or more of the borings meet the penetration requirement, accept all of the Group A poles in the charge except for any poles in the sample from which nonconforming borings were taken. If 16 or 17 of the borings from Group A in the sample meet the penetration requirement, bore each Group A pole in the charge and accept only the poles that furnish conforming borings. If less than 16 of the borings from Group A poles in the sample meet the penetration requirement do not accept any of the Group A poles in the charge.	<i>Group A Poles</i> —Take one boring from midway between the butt and tip from each of 20 poles in each charge. If the penetration in 18 or more of the borings meet the penetration requirement, accept all of the Group A poles in the charge except for any poles in the sample from which nonconforming borings were taken. If 16 or 17 of the borings from Group A in the sample meet the penetration requirement, bore each Group A pole in the charge and accept only the poles that furnish conforming borings. If less than 16 of the borings from Group A poles in the sample meet the penetration requirement do not accept any of the Group A poles in the charge.

TABLE 3 *Continued*

Group B Poles—From each 45-ft long and shorter pole, take one boring midway between the butt and tip of each pole and accept any pole only if the boring from that pole meets the penetration requirement. From each 50-ft long and longer pole, take two borings 90° apart midway between the butt and tip of each pole around the pole and accept any pole only if both borings from that pole meet the penetration requirement.

Group B Poles—From each 45-ft long and shorter pole, take one boring midway between the butt and tip of each pole and accept any pole only if the boring from that pole meets the penetration requirement. From each 50-ft long and longer pole, take two borings 90° apart midway between the butt and tip of each pole around the pole and accept any pole only if both borings from that pole meet the penetration requirement.

Group B Poles—From each 45-ft long and shorter pole, take one boring midway between the butt and tip of each pole and accept any pole only if the boring from that pole meets the penetration requirement. From each 50-ft long and longer pole, take two borings 90° apart midway between the butt and tip of each pole around the pole and accept any pole only if both borings from that pole meet the penetration requirement.

TABLE 3 Continued

	Lodgepole Pine ^A	Western Red Cedar ^A
Conditioning	air seasoning, kiln drying, Boulton drying, or a combination of air seasoning and steam conditioning or by treating in preservative	air seasoning, kiln drying, Boulton drying, steaming or heating in preservative, or a combination thereof
Steaming: ^B		
Temperature, max, °F (°C)	240 (117)	240 (117)
Duration, max, h	4	4
Vacuum, min, in. (mm) at sea level	22 (559)	22 (559)
Heating in preservative:		
Temperature, max, °F (°C)	220 (104)	220 (104)
Duration, max, h	optional	optional
Treatment:		
Pressure, max, psig (kPa)	150 (1034)	100 (1034)
Expansion bath: temperature, max, °F (°C)	220 (104)	220 (104)
Final steaming: ^C		
Temperature, max, °F (°C)	240 (117)	240 (117)
Duration, max, h	3	3
Results of treatment:		
Number of borings per charge	30	30
Retention, min, ^{D,E} lb/ft ³ (kg/m ³) (sampling zone for assay, in. (mm) from surface):	0.10 to 0.75 (25.4 to 19.1)	0.10 to 0.6 (2.54 to 15.2)
Creosote and creosote solutions—by assay:		
Creosote	12 (192), 16 (256)	16 (256)
Creosote-coal tar solution	not recommended	not recommended
Creosote-petroleum solution	not recommended	not recommended
Oil-borne preservatives—by assay:		
Pentachlorophenol using Specifications D 2604, D 2605, or D 3225 solvents	0.80 (12.8)	0.80 (12.8)
Water-borne preservatives—by assay:		
ACA and ACZA	0.60 (9.6)	0.60 (9.6)
CCA, Types A and C	0.60 (9.6)	0.60 (9.6)
Penetration	0.75 in. (19 mm) and 85 % of sapwood	0.50 in. (12.7 mm) unless 100 % of sapwood
Determination of penetration ^{F,G,H}	<p><i>Group A Poles</i>—Take one boring from midway between the butt and tip from each of 20 poles in each charge. If the penetration in 18 or more of the borings meet the penetration requirement, accept all of the Group A poles in the charge except for any poles in the sample from which nonconforming borings were taken. If 16 or 17 of the borings from Group A in the sample meet the penetration requirement, bore each Group A pole in the charge and accept only the poles that furnish conforming borings. If less than 16 of the borings from Group A poles in the sample meet the penetration requirement, do not accept any of the Group A poles in the charge.</p> <p><i>Group B Poles</i>—From each 45-ft long and shorter pole, take one boring midway between the butt and tip of each pole and accept any pole only if the boring from that pole meets the penetration requirement. From each 50-ft long and longer pole, take two borings 90° apart midway between the butt and tip of each pole around the pole and accept any pole only if both borings from that pole meet the penetration requirement.</p>	<p><i>Group A Poles</i>—Take one boring from 2 ft below the standard groundline from each of 20 poles in each charge. If the penetration in 18 or more of the borings meet the penetration requirement, accept all of the Group A poles in the charge except any poles in the sample from which nonconforming borings were taken. If 16 or 17 of the borings from Group A in the sample meet the penetration requirement, bore each Group A pole in the charge and accept only the poles that furnish conforming borings. If less than 16 of the borings from Group A poles in the sample meet the penetration requirement, do not accept any of the Group A poles in the charge.</p> <p><i>Group B Poles</i>—From each 45-ft long and shorter pole, take one boring 2 ft below the standard groundline of each pole and accept any pole only if the boring from that pole meets the penetration requirement. From each 50-ft long and longer pole, take two borings 90° apart midway between the butt and tip of each pole around the pole and accept any pole only if both borings from that pole meet the penetration requirement.</p>

^A Poles treated with ACA formulation may be steamed up to a maximum temperature of 240°F (117°C). Steam 6 h for air-seasoned and kiln-dried Southern Pine, Pacific Coast Douglas fir, and Western larch and 4 h for all other species. Poles to be treated with CCA formulations may be steamed only to remove ice or thaw frozen material in accordance with 4.3.1, Specification D 1760.

^B When climatic conditions are unfavorable or delivery will be delayed because of conditioning requirements stated above, the material may be steamed for a total of not more than 4 h at a maximum temperature of 240°F (117°C). Ponderosa pine may be steamed for a total of 6 h at 240°F (117°C), provided that the moisture content at 2½ in. (64 mm) from the surface is not over 25 %.

^C The high retentions and corresponding penetration requirements are recommended for large poles or severe service conditions.

^D Water-borne preservatives used to treat utility poles shall not use as constituents copper sulfate, sodium arsenate, or pyro-arsenate, potassium or sodium dichromate or other constituents that will form water-soluble electrolytes in utility poles. This shall not exclude technical-grade materials within the limits of the individual specifications.

^E *Group A*—Poles whose 6 ft from the butt circumference is less than 37.5 in. (952 mm) (Western red cedar 40 in. (1016 mm)). *Group B*—Poles whose 6 ft from the butt circumference is at least 37.5 in. (952 mm) (Western red cedar 40 in. (1016 mm)).

^F Pacific Coast Douglas fir includes Douglas fir from west of the crest of the Cascade Mountains in Oregon, Washington, and Northern California and west of the crest of the Sierra Nevada Mountains in the rest of California. Interior Douglas fir is Douglas fir grown anywhere else.

^G Treatment of Pacific Coast Douglas fir and Western larch with CCA, Type A or C, shall only be valid when the material is chosen from permeable wood selected by treatment trials.

^H Effective penetration must be continuous with both earlywood and latewood in each ring penetrated. Certain grain configurations or defects may make it difficult to determine actual depth of penetration in a core and shall be excluded from constituting a skip. These defects include but are not limited to pitch, pitch pockets, ingrown bark, and knots. A core of this type shall be disregarded, and a new core taken from another location on the same member.

TABLE 4 Treatment of Cross ties and Switch Ties

	Southern and Ponderosa Pine	Black and Red Gum	Pacific Coast Douglas Fir, ^A Western Hemlock and Western Larch	Interior Douglas Fir ^A	Ash, Black Locust, Honey Locust, Hickory and Black Walnut Ties	Jack Pine, Lodgepole Pine, and Red Pine	Beech, Birch and Maple	Oak	
Conditioning	air seasoning, kiln drying, Boulton drying, steaming, heating in preservative, or a combination thereof	air seasoning, kiln drying, Boulton drying, steaming, heating in preservative, or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, steaming (for ice-coated or frozen material only), or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, or a combination thereof
Steaming:									
Temperature, max, °F (°C)	245 (120)	240 (117)				240 (117)			
Duration, max, h	18	6	not permitted	not permitted	not permitted	3	not permitted	not permitted	
Vacuum, min, in. (mm) at sea level	22 (559)	22 (559)				22 (559)			
Heating in preservative:									
Temperature, max, °F (°C)	220 (104)	220 (104)	210°F (99°C) seasoned 6 h	210°F (99°C) seasoned 6 h	220 (104)	210°F (99°C) seasoned 6 h	220 (104)	220 (104)	
Duration, max, h	optional	optional	partly seasoned or green: optional	partly seasoned or green: optional	optional	partly seasoned or green: optional	optional	optional	
Incising	not required	not required	required	required		required			
								Red Oak	White Oak
Treatment:									
Pressure, psig (kPa)									
min	optional	optional	optional	optional	optional	optional	optional	optional	150 (1034)
max	200 (1379)	200 (1379)	150 (1034)	150 (1034)	200 (1379)	175 (1207)	200 (1379)	250 (1724)	250 (1724)
Expansion bath:									
Temperature, max, °F (°C)	220 (104)	not permitted	220 (104)	220 (104)	not permitted	220 (104)	not permitted	not permitted	not permitted
Results of treatment:									
Retention, min, lb/ft ³ (kg/m ³), by gage									
Creosote and creosote solutions									
Creosote	8 (128)	10 (160)	8 (128)	refusal	refusal	6 (96)	7 (112)	6 (96)	refusal
Creosote-coal tar solution	8 (128)	10 (160)	8 (128)	refusal	refusal	7 (112)	7 (112)	6 (96)	refusal
Creosote-petroleum solution	8 (128)	10 (160)	8 (128)	refusal	refusal	7 (112)	7 (112)	6 (96)	refusal
Penetration	2.5 in. (64 mm), unless 85 % of sapwood	1.5 in. (38 mm), unless 75 % of sapwood	0.50 in. (38 mm) and 90 % of sapwood	90 % of sapwood	95 % of sapwood	0.50 in. (12.7 mm) and 90 % of sapwood	85 % of sapwood	65 % of annual rings; charges of recalcitrant wood with less penetration may be accepted if the wood is properly conditioned before treatment and the treatment continued to refusal	95 % of sapwood

TABLE 4 *Continued*

	Southern and Ponderosa Pine	Black and Red Gum	Pacific Coast Douglas Fir, ^A Western Hemlock and Western Larch	Interior Douglas Fir ^A	Ash, Black Locust, Honey Lo- cust, Hickory and Black Walnut Ties	Jack Pine, Lodgepole Pine, and Red Pine	Beech, Birch and Maple	Oak
Determination of penetration	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	A borer core shall be taken from each of 20 pieces in the charge. If the average penetration of the 20 borings meets the penetration requirement the charge shall be accepted. Borings not meeting the penetration requirements shall show evidence of preservative penetration.	<i>B</i>	A borer core shall be taken from the center of 20 ties in each charge. If 80 % of the borings meet the penetration requirement the charge shall be accepted. Borings not meeting the penetration requirements shall show evidence of preservative penetration.	A borer core shall be taken from each of 20 pieces in the charge. If the average penetration of the 20 borings meets the penetration requirement, the charge shall be accepted. Borings not meeting the penetration requirements shall show evidence of preservative penetration.

^A Pacific Coast Douglas fir includes Douglas fir from west of the crest of the Cascade Mountains in Oregon, Washington, and Northern California and west of the crest of the Sierra Nevada Mountains in the rest of California. Interior Douglas fir is Douglas fir grown anywhere else.

^B A borer core shall be taken from the center of 20 ties in each charge. If 80 % of the borings meet the penetration requirement, the charge shall be accepted. Borings not meeting the penetration requirements shall show evidence of preservative penetration.

4.1.2 For example, the period of steaming shall begin when the temperature in the cylinder reaches 200°F and shall end when the steam is shut off in the cylinder and the cylinder is vented. After steam is introduced into the cylinder the total time permitted to reach 200°F shall not exceed 2 h.

4.1.3 The minimum time duration, when stipulated for a phase, shall be the period of time after the minimum condition has been attained and until the end of that phase.

4.2 *Plant Equipment*—Treating plants shall be equipped with the thermometers and gages necessary to indicate and record accurately the conditions at all stages of treatment, and all equipment shall be maintained in acceptable, proper working condition. The apparatus and chemicals necessary for making the analyses and tests required by the purchaser shall also be provided by plant operators and kept in condition for use at all times.

4.3 *Conditioning:*

4.3.1 The material shall be conditioned by air seasoning, by kiln drying, by steaming, by heating in the preservative at atmospheric pressure or under vacuum, or by a combination thereof, as agreed upon, in such a manner as will not cause damage for the use intended. Ice-coated or frozen material may be steamed prior to conditioning or treatment for a total period not to exceed 2 h; the temperature shall not exceed 240°F (120°C).

4.3.2 When steam conditioning is used, the material shall be steamed in the cylinder at the temperature specified for the individual type of material or species, but in any case the maximum temperature specified shall not be reached in less than 1 h. The cylinder shall be provided with vents to relieve it of air and ensure proper distribution of the steam. Two types of steam sources are allowable, steam directly from the boiler (live steam) and steam generated within the cylinder by the use of water over the heating coils (closed steam). With live steam, the cylinder shall be drained continuously or frequently enough during the steaming to prevent condensate from accumulating in sufficient quantity to reach the wood. With closed steam, the water level shall be limited to covering the heating coils and no venting is needed after maximum temperature levels are reached. After steaming is completed, a vacuum as specified for the individual type of material or species may be drawn. Before the preservative is introduced into the retort, the cylinder shall be drained of condensate.

4.3.3 In order to avoid sludging, material that is to be treated with ACC or CCA solutions shall be cooled to below 120°F (49°C) before the preservative solution is introduced into the report.

4.3.4 When conditioning by heating in the preservative is used, the preservative shall cover material in the cylinder. The temperature of the preservative during the conditioning period shall not exceed the maximum specified for the individual type of material or species. If a vacuum is drawn during the conditioning period, it shall be of sufficient intensity to evaporate water from the material at the temperature of the preservative. The intensity of the vacuum or the temperature of the preservative, or both, shall be adjusted so as to regulate the evaporation of the water satisfactorily. The conditioning shall continue until the material is

sufficiently heated and enough water removed to permit proper penetration. The preservative shall be removed from the cylinder and air admitted before an empty-cell process is applied.

4.3.5 Water-borne preservative solutions shall not be used for conditioning material by heating in preservative.

4.3.6 *Sterilization*—Suppliers of treated Southern pine, Ponderosa pine, Douglas-fir, Lodgepole pine, Red pine, Western larch, and Jack pine poles and piles shall provide the purchaser with certification that sterilization of poles and piles treated with oil-borne preservatives has occurred during either the conditioning or treatment process, or both. Heating times and temperatures during drying or treatment, or both, of poles and piles shall be sufficient to obtain a temperature of at least 150°F at the center of the entire pole or pile for at least 1 h, to ensure sterilization.

4.4 *Sorting and Spacing*—Material in any charge shall consist of pieces of the same species similar in form and size, moisture content, and receptivity to treatment, and so separated as to ensure contact of treating medium with all surfaces.

4.5 *Machining*—All cutting, such as adzing, boring, chamfering, framing, gaining, surfacing, trimming, and so forth, should be done prior to treatment. In the event that cutting becomes absolutely necessary after treatment, cut surfaces should be treated by brushing or swabbing with several coats of preservative.

4.6 *Incising*—Woods that are difficult to penetrate should be incised. When required in Tables 1-7, material shall be incised prior to treatment by a method that will provide at least the minimum penetration specified without damage and with the least loss in strength, with the exception that incising shall be waived when it will make the material unfit for the use intended.

4.7 *Painting*—If treated material is to be painted or otherwise finished following treatment, the processor should be advised and the painting shall be done in accordance with the recommendations of the processor, the paint manufacturer, or the painting contractor.

5. Treatment

5.1 *Manner of Treatment*—The material shall be impregnated with preservative by a combination of such processes and under such conditions as will produce a satisfactory product for the use intended.

5.2 *Oil Treatment*—Following the conditioning period, the material shall be treated by an empty-cell process, unless otherwise specified, to obtain as deep and uniform penetration as possible with the retention of preservative stipulated. Material shall be treated by the full-cell process only when the maximum net retention is desired and where pressure is held to refusal, or when the stipulated retention is greater than can be obtained by the use of an empty-cell process.

5.3 *Water-Borne Preservative Treatment*—Following the conditioning period, the material shall be treated by an empty-cell process or by the full-cell process.

5.4 *Standard Processes:*

5.4.1 For empty-cell treatment the material shall be subject to atmospheric (Lowry process) or to higher air pressures (Rueping process) of the required intensity and duration. For full-cell treatment, the material shall be subjected to a vacuum of not less than 22 in. Hg (74 kPa below 1 atm) at sea level for not less than 30 min either before the cylinder is filled or during the period of heating in preservative. These initial conditions shall be applied prior to filling and shall be maintained while the cylinder is being filled with preservatives.

5.4.2 When refusal treatment is specified, the material shall be treated by the full-cell process; the pressure and temperature during the pressure period shall be maintained constant or increased within a range consistent with good practice for the material being treated until the quantity of preservative absorbed during each of the two consecutive ½-h periods is not more than 2 % of the amount already injected.

5.4.3 *Impregnation Pressure*—The pressure during any impregnation period shall not exceed the maximum specified for the individual species and shall reach at least the minimum specified. Pressure shall be reduced to atmospheric either before or while the cylinder is being emptied of preservative. A vacuum of not less than 22 in. Hg (74 kPa below 1 atm) at sea level shall be created and maintained until the wood is removed free of dripping preservative, except that a vacuum is not required to be used after a full-cell or refusal treatment when the maximum possible retention is required.

5.4.4 *Temperature of Preservative*—The temperature of the preservative during the entire pressure period shall not exceed the maximum temperatures specified as follows:

	°F	Maximum Temperature	°C
Creosote or creosote solutions:			
Western red cedar	200		93
All other species	210		99
Oil-borne preservatives:			
Western red cedar	200		93
All other species	210		98
Water-borne preservatives:			
Acid copper chromate (ACC)	120		49
Ammoniacal copper arsenate (ACA)	150		66
Ammoniacal copper zinc arsenate (ACZA)	150		66
ACQ-Type B	150		66
Chromated copper arsenate (CCA, Types A and C)	120		49

5.4.5 *Expansion Bath*—When permitted by the requirements of Tables 1-7, an expansion bath may be applied after pressure of oil treatment is completed and before removal of preservative from the cylinder by quickly reheating the oil surrounding the material to the maximum temperature permitted by the individual species specification, either at atmospheric pressure or under vacuum, the steam to be turned off the heating coils as soon as the maximum temperature is reached. The cylinder shall then be emptied speedily of preservative and a vacuum of not less than 22 in. Hg (74 kPa below 1 atm) at sea level created promptly and maintained until the wood is removed from the cylinder free of dripping preservative.

5.4.6 *Final Steaming*—At the completion of an oil treatment, the material may be cleaned by final steaming as specified for the individual type of material or species.

6. Results of Treatment

6.1 Retention of Preservative:

6.1.1 *General*—The minimum retention as listed in Tables 1-7 shall be determined by assay or gage as specified in the appropriate table. When retention by gage is specified, the amount of preservative retained shall be determined by reading of working tank gages or scales, or from weights of the charge or parts of the charge before and after treatment. If retention is determined from readings of working tank gages the retention of preservative shall be calculated after correcting the volume to 100°F (38°C). Correction tables shall be agreed on. Volume and Specific Gravity Correction Tables D 347 can be used for this purpose. When the retention of preservative is determined by before- and after-treatment weights of the charge, correction shall be made for changes in moisture content. When retention by assay is specified, the preservative content of a specified zone of the treated material shall be determined by extraction or by chemical analysis. The sample zone and the number of borings making up the standard sample are listed in the tables. When the retention in material treated with water-borne preservatives is to be determined by assay, the retention shall be not less than as shown in Table 8 for any individual component or for the sum of all components.

6.1.2 *Creosote and Creosote Solutions*—The retention of creosote or creosote solutions shall be based on pounds of preservative as defined in Section 7.

6.1.3 *Oil-Borne Preservatives*—The retention of oil-borne preservatives shall be based on pounds of the preservative as defined in Section 7. If retention by gage is specified, the concentration of pentachlorophenol in the solution shall be between 4.5 and 5.5 weight %. The solvent used shall meet the requirements of Specifications D 2604, D 2605, or other ASTM specifications for pentachlorophenol solvents.

6.1.4 *Water-Borne Preservatives*—The retention of water-borne preservatives shall be based on pounds of the preservative as defined in Section 7. Concentration of preservative in solution shall be determined by analysis. The retention of water-borne preservatives set by analysis of the treated wood shall be not less than as shown in Table 8 for any individual component or for the sum of all components. There are, presently, no methods for determining sodium fluoride or dinitrophenol in wood so retention by assay for preservatives composed partly of these materials shall be based on the sum of the remaining constituents of the preservative found in the wood.

6.1.4.1 The sample for analysis shall consist of a sufficient number of borings of a single diameter from the stipulated zone to provide a sample large enough for analysis, but in no case shall there be less than 20 borings or, in the case of lumber, less than one boring for each 1000-ft (2.360-m³) board measure in the lot.

6.2 *Penetration*—The penetration shall be specified by the purchaser in accordance with use requirements, but shall not be less than that specified for the individual type of material or species. Penetration shall be determined by boring a representative number of pieces that are well distributed throughout each charge as specified for the individual type of material and species.

6.2.1 Penetration specified in Tables 1-7 are in inches (millimetres) and percent of sapwood penetrated.

6.3 *Plugging Holes*—Holes made during inspection for measuring penetration or for samples for analysis shall be plugged with tight-fitting treated cylindrical plugs.

6.4 *Condition of Material*—When minimum retentions are specified for creosote, creosote solutions, or oil-borne preservatives, the material shall be supplied free of exudate and surface deposits. Such surface conditions are not required for heavier retentions of these preservatives. Material treated with water-borne preservatives shall be supplied free from chemical dust. All material shall be processed in such a manner as to minimize damage and degrade.

7. Preservatives

7.1 The preservatives used shall be whichever of the following specifications is stipulated:

TABLE 5 Piles for Marine Service Treatment with Creosote, Creosote-Coal Tar Solution, or Water-Borne Preservatives

	Southern Pine	Pacific Coast Douglas Fir	Oak
Conditioning	air seasoning, kiln drying, steaming, heating in preservative, or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, or a combination thereof	air seasoning, kiln drying, heating in the preservative, or a combination thereof ^A
Steaming:			
Temperature, max, °F (°C)	240 (117)	not permitted	not permitted
Duration, max, h	20		
Vacuum, min, in. (mm) at sea level	22 (558.8)		
Heating in preservative:			
Temperature, max, ° F (°C)	220 (104)	seasoned 210°F (99°C) and 6 h green or partially seasoned: 220°F (104°C) and optional	220 (104)
Duration, max, h	optional		optional
Treatment:			
Pressure, psig (kPa)			
min	125 (861)	75 (517)	150 (1034)
max	200 (1379)	150 (1034)	200 (1379)
Expansion bath:			
Temperature, max, °F (°C)	220 (104)	220 (104)	220 (104)
Final streaming:			
Temperature, max, °F (°C)	not permitted	not permitted	not permitted
Duration, max, h			
Results of treatment:			
Retention, min, lb/ft ³ (kg/m ³) (sampling zone for assay in. (mm) from surface)	0 to 3.00 (0 to 76.2)	0 to 2.00 (0 to 50.8)	0 to 2.00 (0 to 50.8)
Number of borings per charge	20	20	20
Creosote and creosote solutions ^B —			
by assay:			
Creosote	20 (320)	20 (320)	10 (160)
Creosote-coal tar solution	20 (320)	20 (320)	10 (160)
Water-borne preservatives—by assay:			
Sampling zone for assay, in. (mm) from surface	0.10 to 0.50 (2.5 to 12.7) (Zone 1) 0.50 to 2.0 (12.7 to 51) (Zone 2)	0 to 1.00 (0 to 25)	
Number of borings per zone	<u>20</u>	<u>20</u>	<u>20</u>
Number of borings per zone	20	20	20
ACA and ACZA	2.50 (64) (Zone 1)	2.50 (64)	not recommended
ACA, ACZA	<u>2.50 (64) (Zone 1)</u>	<u>2.50 (64)</u>	<u>not recommended</u>
ACQ-Type B,	<u>1.50 (38) (Zone 2)</u>		
CCA, Type A or C	1.50 (38) (Zone 2)		
GGA, Types A and G			
Penetration	4.0 in. (102 mm) unless 90 % of sapwood ^C	If sapwood is 2.0 in. (51 mm) or less, 1.0 in. (25 mm) and 85 % of sapwood. If sapwood is over 2.0 in. (51 mm), 1.75 in. (44 mm) penetration in each charge must average 1.40 in. (36 mm) ^C	100 % of sapwood
Determination of penetration	A borer core shall be taken midway between the butt and the top of each pile. Only the piles that meet the penetration requirement shall be accepted	^{D,E}	^F

^A Pacific Coast Douglas fir is Douglas fir grown west of the crest of the Cascade mountains in Oregon, Washington, and Northern California and west of the crest of the Sierra Nevada Mountains in the rest of California. Interior Douglas fir is grown elsewhere.

^B Creosote and creosote-coal tar solution used should be marine grades.

^C Effective penetration must be continuous with both earlywood and latewood in each ring penetrated. Certain grain configurations or defects may make it difficult to determine actual depth of penetration in a core and shall be excluded from constituting a skip. These defects include but are not limited to pitch, pitch pockets, ingrown bark, and knots. A core of this type shall be disregarded and a new core taken from another location on the same member.

^D Effective penetration must be continuous with both spring wood and summer wood in each ring penetrated.

^E A borer core shall be taken midway between the butt and top of each pile in the charge. Only the piles that meet the penetration requirement shall be accepted.

^F A borer core shall be taken between the butt and the top of each pile. Only the piles that meet the penetration requirement shall be accepted.

**TABLE 6 Treatment of Piles for Marine Service by Pressure Processes
Dual Treatment, Treatment With Water Borne Preservative- and Creosote or Creosote, Coal Tar Solution**

First Treatment	Southern Pine	Pacific Coast Douglas Fir ^A
Conditioning	air-seasoning, kiln drying, steaming, or a combination thereof	air-seasoning, kiln drying, or a combination thereof
Steaming:		
Temperature, max, °F (°C)	245 (120)	not permitted
Duration, max, h	6	
Vacuum min, in. (mm) at sea level	22 (559)	
Treatment:		
Pressure, psig (kPa)		
min	125 (861)	75 (517)
max	200 (1379)	150 (1034)
Expansion bath:		
Temperature, max, °F (°C)	220 (104)	220 (104)
Final steaming:		
Temperature, max, °F (°C)		
Duration, max, h	not permitted	not permitted
Results of treatment:		
Retention, min, lb/ft ³ (kg/m ³) (sampling zone for assay in. (mm) from surface)	0 to 1.00 (0 to 25.4)	0 to 1.00 (0 to 25.4)
Number of borings per charge	20	20
ACA and ACZA—by assay	1.00 (16.0)	1.00 (16.0)
CCA, Types A and C—by assay	1.00 (16.0)	1.00 (16.0)
Penetration, min, in. (mm)	1.00 (25)	1.00 (25)
Determination of penetration	a borer core shall be taken midway between the top and the butt of each pile in each charge. Only those piles meeting the penetration requirements shall be accepted	
Second Treatment	Southern Pine	Pacific Coast Douglas Fir ^A
Conditioning	air seasoning, steaming, heating in preservative, or a combination thereof	air seasoning, Boulton drying, heating in preservative, or a combination thereof
Heating in preservative:		
Temperature, max, °F (°C)	220 (104)	seasoned 210°F (99°C)
Duration, max, h	optional	green: not permitted
Treatment:		
Pressure, psig (kPa)		
min	150 (1034)	75 (517)
max	200 (1379)	150 (1034)
Expansion bath:		
Temperature, max, °F (°C)	220 (104)	220 (104)
Final steaming:		
Temperature, max, °F (°C)		
Duration, max h	not permitted	not permitted
Results of treatment:		
Retention, min, lb/ft ³ (kg/m ³) (sampling zone for assay in. (mm) from surface)	0 to 1.00 (0 to 16.0)	0 to 1.00 (0 to 16.0)
Number of borings per charge	20	20
Creosote and creosote solutions ^B —by assay		
Creosote	20 (320)	20 (320)
Creosote-coal tar solution	20 (320)	20 (320)
Penetration	4.0 in. (102 mm) unless 90 % of sapwood	2 in. (51 mm) or less sapwood, 1.00 in. (25 mm) and 85 % sapwood. Over 2 in. (51 mm) of sapwood, 1.75 in. (44 mm). Penetration in each charge must average 1.40 in. (36 mm)
Determination of penetration	<i>C</i>	<i>D, C</i>

^A Treatment of Pacific Coast Douglas fir and Western larch with CCA, Type A or C, shall only be valid when the material is chosen from permeable wood selected by treatment trials.

^B Creosote and creosote-coal tar solutions shall be in accordance with Specifications D 390 and D 391.

^C A borer core shall be taken midway between the butt and top of each pile in the charge. Only the piles that meet the penetration requirements shall be accepted.

^D Effective penetration must be continuous with both spring wood and summer wood in each ring penetrated.

TABLE 7 Treatment of Posts by Pressure Processes

	Southern and Ponderosa Pine	Jack Pine	Lodgepole Pine	Red Pine	Douglas Fir, Western Hemlock, and Western Larch ^{A,B}
Conditioning	air seasoning, kiln drying, Boulton drying, steaming, heating in preservative, or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, steaming (water-borne treatments or ice-coated or frozen material only), or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, steaming (water-borne treatments or ice-coated or frozen material only), or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, steaming (water-borne treatments or ice-coated or frozen material only), or a combination thereof	air seasoning, kiln drying, Boulton drying, heating in preservative, steaming (water-borne treatments or ice-coated or frozen material only) or a combination
Steaming:					
Temperature, max, °F (°C)	245 (120)	240 (117)	240 (117)	240 (117)	240 (117)
Duration, max, h	10	3	3	3	6
Vacuum, min, in. (mm) at sea level	22 (559)	22 (559)	22 (559)	22 (559)	22 (559)
Heating in preservative:					
Temperature, max, °F (°C)	220 (104)	220 (104)	220 (104)	220 (104)	seasoned: 210°F (99°C) and 6 h
Duration, max, h	optional	optional	optional	optional	partly seasoned or green: 220°F (104°C) and optional
Treatment:					
Pressure, psig (kPa)					
min	75 (517)	75 (517)	75 (517)	75 (517)	75 (517)
max	200 (1379)	150 (1034)	150 (1034)	150 (1034)	150 (1034)
Expansion bath:					
Temperature, max, °F (°C)	220 (104)	220 (104)	220 (104)	220 (104)	220 (104)
Final steaming:					
Temperature, max, °F (°C)	245 (120)	245 (120)	245 (120)	245 (120)	240 (117)
Duration, max, h	3	3	3	3	3
Results of treatment:					
Number of borings per charge	30	30	30	30	30
Retention, min, lb/ft ³ (kg/m ³) (sampling zone for assay, in. (mm) from surface)	0 to 1.0 (0 to 25.4)	0 to 1.0 (0 to 25.4)	0 to 1.0 (0 to 25.4)	0 to 1.0 (0 to 25.4)	0 to 1.0 (0 to 25.4)
Creosote and creosote solutions—by assay:					
Creosote	6 (96)	6 (96)	6 (96)	6 (96)	6 (96)
Creosote-coal tar solution	6 (96)	6 (96)	6 (96)	6 (96)	not recommended
Creosote-petroleum solution	7 (112)	6 (96)	7 (112)	7 (112)	7 (112)
Oil-borne preservatives—by assay					
Pentachlorophenol using Specifications D 2604, D 2605, or D 3225 solvents	0.30 (4.81)	0.30 (4.81)	0.30 (4.81)	0.30 (4.81)	0.30 (4.81)
Water-borne preservatives—by assay:					
ACC	0.50 (8.0)	0.50 (8.0)	0.50 (8.0)	0.50 (8.0)	0.50 (8.0)
ACA and ACZA	0.40 (6.4)	0.40 (6.4)	0.40 (6.4)	0.40 (6.4)	0.40 (6.4)
ACA and ACZA	0.40 (6.4)	0.40 (6.4)	0.40 (6.4)	0.40 (6.4)	0.40 (6.4)
CCA, Types A and C	0.40 (6.4)	0.40 (6.4)	0.40 (6.4)	0.40 (6.4)	0.40 (6.4)
Penetration	2.0 in. (51 mm), unless 85 % of sapwood	1.5 in. (38 mm), unless 85 % of sapwood	1.25 in. (31 mm), unless 85 % of sapwood	2.0 in. (51 mm), unless 85 % of sapwood	3/8 and 100 unless 1.0
Determination of penetration	<i>c,D</i>	<i>D</i>	<i>D</i>	<i>D</i>	<i>D</i>

^A Pacific Coast Douglas fir includes Douglas fir from west of the crest of the Cascade Mountains in Oregon, Washington, and Northern California and west of the crest of the Sierra Nevada Mountains in the rest of California. Interior Douglas fir is Douglas fir grown anywhere else.

^B Round posts only.

^C Treatment of Pacific Coast Douglas fir and Western larch with CCA, Type A or C, shall only be valid when the material is chosen from permeable wood selected by treatment trials.

^D A borer core shall be taken from each of 20 pieces in the charge. If 80 % of the borings meet the penetration requirement the charge shall be accepted. Borings not meeting the penetration requirements shall show evidence of preservative penetration.

TABLE 8 Retention of Water-Borne Preservatives

Retention Specified in Tables 1 to 7	lb/ft ³ (kg/m ³)	Minimum Retention of Individual Components, lb/ft ³ (kg/m ³)					Minimum Sum of Retentions of Individual Components As- sayed
		Copper as CuO	Chromium as CrO ₃	Arsenic as As ₂ O ₅	Quat (as DDAC)	Zinc as ZnO	
ACC	0.25 (4.0)	0.064 (1.03)	0.136 (2.18)	...	...	...	0.25 (4.0)
	0.50 (8.0)	0.127 (2.03)	0.273 (4.37)	...	...	...	0.50 (8.0)
ACA and ACZA	0.25 (4.0)	0.10 (1.6)	...	0.10 (1.60)	...	...	0.25 (4.0)
	0.40 (6.4)	0.16 (2.56)	...	0.16 (2.56)	...	...	0.40 (6.4)
	0.60 (9.6)	0.24 (3.84)	...	0.24 (3.84)	...	...	0.60 (9.6)
	1.00 (16.0)	0.40 (6.4)	...	0.40 (6.4)	...	...	1.00 (16.0)
	2.50 (40.0)	1.00 (16.0)	...	1.00 (16.0)	...	...	2.50 (40.0)
CCA	0.25 (4.0)	<u>0.13 (2.08)</u>	...	...	<u>0.07 (1.12)</u>	...	<u>0.25 (4.0)</u>
	0.40 (6.4)	<u>0.21 (3.36)</u>	...	...	<u>0.11 (1.76)</u>	...	<u>0.40 (6.4)</u>
	<u>0.60 (9.6)</u>	<u>0.32 (5.12)</u>	...	...	<u>0.16 (2.56)</u>	...	<u>0.60 (9.6)</u>
CCA A	0.25 (4.0)	0.040 (0.64)	0.148 (2.37)	0.037 (0.59)	...	...	0.25 (4.0)
	0.40 (6.4)	0.065 (1.04)	0.236 (3.78)	0.059 (0.95)	...	...	0.40 (6.4)
	0.60 (9.6)	0.098 (1.57)	0.354 (5.56)	0.089 (1.43)	...	...	0.60 (9.6)
	1.00 (16.0)	0.163 (2.61)	0.590 (9.4)	0.150 (2.40)	...	...	1.00 (16.0)
	2.50 (40.0)	0.41 (6.56)	1.48 (23.7)	0.38 (6.1)	...	...	2.50 (40.0)
CCA C	0.25 (4.0)	0.041 (0.66)	0.106 (1.70)	0.076 (1.22)	...	...	0.25 (4.0)
	0.40 (6.4)	0.067 (1.07)	0.171 (2.74)	0.122 (2.03)	...	...	0.40 (6.4)
	0.60 (9.6)	0.100 (1.60)	0.257 (4.12)	0.184 (2.95)	...	...	0.60 (9.6)
	1.00 (16.0)	0.167 (2.68)	0.428 (6.85)	0.306 (4.90)	...	...	1.00 (16.0)
	2.50 (40.0)	0.42 (6.72)	1.07 (17.1)	0.76 (12.2)	...	...	2.50 (40.0)
FCAP	0.25 (4.0)	...	0.083 (1.33)	0.057 (0.91)	...	0.155 (2.5)	
FCAP			0.083 (1.33)	0.057 (0.91)	...	0.155 (2.5)	

Preservative	ASTM Specifica- tion	Quantita- tive Ana- lytical Method
Copper dimethyldithiocarbamate (CDDC)	D 5653	D 5655
Creosote and creosote solutions:		
Creosote	D 390	D 1860
Creosote-coal tar solutions	D 391	D 1860
Creosote-petroleum solutions	D 1858	D 1860
Oil-borne preservatives:		
Pentachlorophenol	D 1272	D 2085
Water-borne preservatives:		
Acid copper chromate (ACC)	D 1624	D 1627
Ammoniacal copper arsenate (ACA)	D 1325	D 1326
Ammoniacal copper zinc arsenate (ACZA)	D 1325	D 1326
Chromated copper arsenate (CCA)	D 1625	D 1628 — Fluor- chrome- arsenate-phenol (FCAP)

8. Retreatment

8.1 Material not conforming to the stipulated minimum requirements shall be retreated and may be reoffered for acceptance under the following conditions:

8.1.1 Material shall not be retreated more than twice.

8.1.2 The limits on pressure and temperature for conditioning and treatment stipulated in this specification shall not be exceeded during treatment.

8.1.3 When steam conditioning is used, the total duration, starting from the time steam is introduced into the cylinder, for the original treatment and for retreatment combined shall not exceed the maximum duration permitted for the original treatment. The duration of final steaming is included in the above total.

8.1.4 When material is retreated in a charge with untreated material, the volume of the material to be retreated shall not exceed 10 % of the total volume of the charge, and all of the material in the charge shall be considered as untreated: (1) with respect to the maximum duration of steaming time permitted, and (2) when computing the minimum required net retention of preservative, if specified by gage.

8.1.5 When a charge as a whole is retreated, the total retention as a result of all treatments shall be sufficient to satisfy the specified requirements for both net retention and penetration.

8.1.6 When a charge made up of pieces rejected for insufficient penetration only is retreated, the amount of preservative injected during retreatment shall be sufficient to produce the required penetration.

8.1.7 Piles that have been in storage for longer than one year shall be reassayed before shipment. When the assay results are less than the minimum in this specification, the piles shall be retreated.

9. Post-Treatment Drying of Waterborne Preservatives

9.1 *Air Drying After Treatment*—Conditions that lead to leaching of preservatives shall be minimized.

9.2 *Kiln Drying After Treatment*—During kiln drying after treatment, the dry-bulb temperature of the kiln shall not exceed 160°F (74°C). At no time shall the override exceed 165°F (74°C).

9.3 *Dual Treatment*—For dual-treated poles in Table 6 where the first treatment is CCA, Types A or C, kiln drying shall not be permitted until 20 days after treatment.

SPECIFIC REQUIREMENTS

10. Tables of Requirements

10.1 Specific requirements are given in the following tables:

10.1.1 *Table 1*—Treatment of lumber, timbers, bridge ties, and mine ties by pressure processes.

10.1.2 *Table 2*—Treatment of piles by pressure processes.

10.1.3 *Tables 5 and 6*—Treatment of piles for marine service by pressure processes.

10.1.4 *Table 3*—Treatment of poles by pressure processes.

10.1.5 *Table 4*—Treatment of crossties and switchties by pressure processes.

10.1.6 *Table 7*—Treatment of posts by pressure processes.

10.1.7 *Table 8*—Component retention requirements for Tables 1-8 for water-borne preservatives.

10.1.8 *Appendix*—SI units corresponding to inch-pound units in Tables 1-8, inclusive.

11. Keywords

11.1 lumber; poles; piles; posts; preservative; pressure treatment; specification; timber; treatment

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