

UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Electrification Administration

BULLETIN 1728H-702

SUBJECT: REA Specification for Quality Control and Inspection
of Timber Products

TO: All Borrowers

EFFECTIVE DATE: September 2, 1993.

EXPIRATION DATE: Date of change of §1728.202 by rulemaking.

OFFICE OF PRIMARY INTEREST: Transmission Branch, Electric Staff
Division

PREVIOUS INSTRUCTIONS: This Bulletin replaces Bulletin 50-24,
REA Specification for Quality Control and Inspection of Timber
Products, issued June 2, 1987.

FILING INSTRUCTIONS: Discard Bulletin 50-24 dated June 2, 1987,
and replace with this bulletin. File with 7 CFR part 1728 and on
REANET.

PURPOSE: This bulletin describes the responsibilities and
procedures pertaining to quality control by the producers and
responsibilities for inspection of timber products produced in
accordance with REA timber specifications.

This bulletin is a "user friendly" reformat of the text codified
in 7 CFR 1728.202 published at 58 FR 41394, dated August 3, 1993.
Every effort has been made to ensure that accuracy of this
document. However, in case of discrepancies, the regulation at
7 CFR 1728 section 1728.202 is the authorized source.

John H. Arnesen

Administrator

08/13/93

Date

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ABBREVIATIONS

AITC American Institute of Timber Construction
ALSC American Lumber Standards Committee
ANSI American National Standards Institute
APA American Plywood Association
AWPA American Wood-Preservers' Association
REA Rural Electrification Administration

DEFINITIONS

Arm refers to structural wood member used to support electrical conductors.

Certificate of Compliance shall consist of a certification over the signature of an authorized employee of the producer that the material shipped meets the requirements of this specification and any supplementary requirements cited in a contract or order under which it was purchased.

Crossarm is a term used interchangeably with arm.

Independent Inspection relates to examination of material by an independent inspector employed by a commercial agency.

Inspection means an examination of material in sufficient detail to insure conformity to all phases of the specification under which it was purchased.

Lot is a quantity of crossarms of like size, conditioning and fabrication usually making up one treating charge.

Producer is used to describe the party who manufactures and treats crossarms.

Purchaser refers to either the REA borrower or contractors acting as the borrower's agent, except where a part of the specification specifically refers to only the borrower or the contractor.

Quality control designee refers to an individual designated by the producer to be responsible for quality control.

Reserve treated stock consists of timber products treated in accordance with this specification, prior to and in anticipation of the receipt of specific orders, and held in storage ready for immediate shipment.

Supplier is a term used interchangeably with producer or in some cases, may be distributor selling crossarms to the borrower.

Treating Plant is the organization that applies the preservative treatment to the crossarms.

Bulletin 1728H-702 to 7 CFR 1728.202 CROSS-REFERENCE

<u>Bulletin</u> <u>1728H-702</u>	<u>7 CFR</u> <u>1728.202</u>	<u>Bulletin</u> <u>1728H-702</u>	<u>7 CFR</u> <u>1728.202</u>
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1. SCOPE: This specification describes the responsibilities and procedures pertaining to the quality control by producers and pertaining to inspection of timber products produced in accordance with the following REA specifications:

Poles, pole stubs, anchor logs - REA Bulletin 1728F-700,
REA Specification for Wood Poles, Stubs and Anchor Logs

Wood crossarms - REA Bulletin 1728H-701, REA
Specifications for Wood Crossarms

This specification also describes and designates responsibilities of REA borrowers in regard to their purchases under the above referenced specifications.

2. GENERAL STIPULATIONS

2.1 Each REA borrower is responsible for obtaining assurance through its selected purchase plan (as provided in the above referenced specifications) that the treated material which it purchases and the manufacturing and treating plant capability, plant quality control, plant yard conditions and storage yard conditions are in compliance with REA specifications. Each REA electric borrower shall submit to the Director, Electric Staff Division, Rural Electrification Administration, Room 1250-S, 14th & Independence Avenue, SW., Washington, D.C. 20250-1500 in January of each year a list of plants from which it obtained poles or crossarms during the preceding calendar year.

2.2 Plants furnishing laminated timber products shall be qualified to produce in accordance with American Institute of Timber Construction (AITC) standards and shall be able to so certify.

2.3 Ultimate quality control is the responsibility of the producer's management; however, a member of the producer's staff shall be designated quality control designee and charged with the responsibility for the exercise of proper quality control procedures.

2.3.1 Other requirements in American Wood-Preservers' Association (AWPA) Standard M3, covering records, adequate laboratory, plant gauges and other plant facilities including proper storage, shall be followed.

2.4 The methods of inspection described herein shall be used no matter which plan timber products are purchased under, i.e., Independent Inspection Plan or Quality Assurance Plans. The number of poles and crossarms actually inspected by monitors for quality control under a Quality Assurance Plan may vary from the number of poles and crossarms inspected under the Independent Inspection Plan. Under the Independent Inspection Plan, each pole and a sample number of crossarms shall be inspected.

2.5 Under the Independent Inspection Plan, the REA borrower should designate in the purchase order which inspection agency it has selected. Unless the REA borrower contracts for inspection as a separate transaction, the treating company shall obtain the services of the REA borrower's designated inspection agency. For reserve treated stock for purchase under the Independent Inspection Plan, the treating company shall obtain the services of an inspection agency. Selection of and changes in inspection agencies for reserve treated stock shall be promptly reported to Rural Electrification Administration, Washington, D.C. 20250-1500, per REA Bulletin 1728F-700 and REA Bulletin 1728H-701.

2.6 Individual inspectors in the employ of Independent Inspection Agencies must be experienced, competent. The inspector shall perform all phases of the inspection personally and in the proper sequence. The primary responsibility of the inspector is to determine, for the borrower, by careful inspection and verification, that the timber products, preservative and treatment meet the requirements of REA specifications and that the methods, storage facilities and production equipment conform to applicable REA specifications. For details of the inspector's qualifications see Appendix A of this bulletin.

2.7 All producers of laminated material for use on REA borrower systems shall follow manufacturing and quality control requirements as stated in ANSI 05.2 - 1983, American National Standard for Wood Products Structural Glued Laminated Timber for Utility Structures, and ANSI/AITC A190.1-1983, American National Standard for Wood Products - Structural Glued Laminated Timber. The product shall be so marked and certified.

2.7.1 Inspection of laminated material shall be by a qualified inspection and testing agency under the standards and provisions of the American Lumber Standards Committee (ALSC) and the American Institute of Timber Construction (AITC), or American Plywood Association (APA).

2.7.2 Quality control of material shall be performed to determine conformance with REA Bulletin 1728H-701 and AITC 200-83, Inspection Manual.

3. QUALITY CONTROL AND INSPECTION PROCEDURES FOR PRODUCT ACCEPTANCE: It is the responsibility of the plant quality control designee to perform the following procedures to ensure that a particular lot of material conforms to the requirements of the applicable REA specification prior to treatment. After the plant quality control designee has performed these procedures, a particular lot of material will be released to the inspector for verification of conformance.

3.1 Poles can be purchased under any of the three purchase plans. These plans are Insured Warranty Plan, Independent Inspection Plan or an REA approved Quality Assurance Plan. Under the Independent Inspection Plan, all poles in a lot shall be inspected in accordance with the methods described below. Under Insured Warranty and an REA approved Quality Assurance Plan, the number of poles in a lot actually inspected may be less than every pole, depending on the terms of the plans.

3.1.1 Ample space and assistance shall be provided for handling and turning to ensure that the surfaces of all items can be adequately inspected.

3.1.2 Under the Independent Inspection Plan, all poles shall be inspected for conformance to the requirements of REA Bulletin 1728F-700 and applicable drawings. If a pole is rejected and the cause of rejection is corrected, the rejected pole may be offered again for inspection as new material.

3.1.3 Dimensions, length and circumference shall be measured by a standard steel pole tape to determine that they are in agreement with the details for class and length in the brand and butt stamp. If it is obvious by visual comparison with a measured pole that the brand information is correct, individual poles need not be measured. Pole circumference dimensions made prior to treatment shall govern acceptance. Reduction in dimension due to treatment and shipping shall be not more than 2 percent below the minimum for the pole class.

3.1.4 If 15 percent of the poles in a lot offered for inspection are defective, the inspector shall terminate the inspection. Re-examination of an entire lot by plant quality control shall be required when the number of rejected poles exceeds 15 percent of the lot inspected. All defective or nonconforming poles shall be either removed from the lot or marked out.

3.1.5 Poles in a lot inspected for decay shall be of the same seasoning condition. If there is a suspicion that decay has occurred, a slice should be cut from both ends for closer examination. If 5 percent of the inspected poles in a lot shows evidence of decay, the entire lot shall be unconditionally rejected without further sorting.

3.1.6 Moisture content, when limited by the purchaser, as stated on the purchase order, shall be measured by calibrated electric moisture meter unless specifically required by the purchaser to be determined otherwise. Calibration of the meter shall include not only the zero settings for the X and Y readings, but also two resistance standards for 12 and 22 percent moisture content.

3.1.7 Material failing to conform for moisture content may be retested upon request after a recalibration of the instrument.

The results of the second test shall govern disposition of the lot.

3.1.8 Re-examination for any mechanical damage or deterioration and for original acceptance shall be conducted on timber products not treated within 10 days after inspection.

3.2 Crossarms can be purchased under either of two purchase plans: the Independent Inspection Plan or an REA approved Quality Assurance Plan. Under the Independent Inspection Plan, crossarms are to be inspected prior to manufacture, during manufacture and after treatment. Under a Quality Assurance Plan, crossarms are monitored according to the terms of the quality assurance program as approved by REA.

3.2.1 Inspection prior to treatment shall be as follows:

3.2.1.1 Surface inspection of the ends of the arms should be made of all arms. This is usually done on the stacks of arms prior to manufacture. Particular attention shall be paid to defects commonly found in the ends, such as compression wood, red heart and other forms of decay, shakes, splits, through checks, scantiness, honeycomb and low density determined by rings per inch and percent of summerwood. Whenever the number of nonconforming arms is found to exceed 0.5 percent of the lot or one arm, whichever is greater, the entire lot shall be rejected for excess number of defective ends. After the producer has removed or marked out the defective material, the arms may be resubmitted.

3.2.1.2 Surface inspection of the lengthwise side shall be performed on a random representative sample. The sample size shall equal 20 percent of a lot size or 200 arms, whichever is smaller. The inspector shall examine side surfaces as it is slowly rotated. When necessary, the rotation may be stopped for closer inspection. Whenever the number of nonconforming arms is found to exceed 2 percent of the sample size, the entire lot shall be rejected. After the producer has removed or marked out the defective material, the arms may be resubmitted.

3.2.1.3 Moisture content of the random sample shall be checked by a calibrated moisture meter.

3.2.1.4 Crossarm dimensions of the random sample shall be measured after surfacing.

3.2.2 Inspection during manufacture will consist of the following:

3.2.2.1. Bolt and insulator pin holes shall be squarely bored completely through the arm without excessive splintering.

3.2.2.2 Marking brands shall be checked for completeness, location and legibility, but not so deep as to impair strength of an arm, e.g., 1/16 inch.

3.2.2.3 Any arm in the lot which is found to be nonconforming shall be rejected.

3.2.3 Under the Independent Inspection Plan, there shall be a final inspection during and after treatment for preservative retention and penetration and for damage.

3.3 Structural glued laminated timber shall be tested and inspected in accordance with AITC 200-83 Inspection Manual. Grade of lumber shall be inspected by a qualified grader in accordance with grading rules of the American Lumber Standards for specified quality and so marked. Adhesives used for all structural arms shall meet requirements of ANSI 05.2-83, paragraph 5.2. Melamine urea adhesives shall not be used. End joint spacings and limitations shall be in accordance with ANSI 05.2-83.

4. PRESERVATIVES: All preservatives shall meet the requirements for the specified preservative when analyzed in accordance with applicable AWWA Standards or ASTM Standards.

4.1 Creosote shall conform to AWWA Standard P1 and be analyzed by AWWA Standard A1, sections 2, 3, 4, either 5 or 9, and 6 as follows:

4.1.1 Each occasional charge.

4.1.2 First charge and one of every five charges randomly selected in consecutive charges.

4.2 Results of analyses and tests for penta, hydrocarbon solvents, Copper Naphthenate, and chemicals used in waterborne treatments provided by the supplier of the preservatives will be accepted and copies of the analysis shall accompany each charge.

4.3. Solutions of waterborne preservatives shall be analyzed for components in accordance with AWWA Standards A2, A9, or A11, and shall meet the requirements of P5 for composition. AWWA A2 shall be used as a referee method.

4.4 Pentachlorophenol shall contain not less than 95 percent chlorinated phenols and conform to AWWA Standard P8 in hydrocarbon solvent AWWA P9 Type A.

4.5 Copper Naphthenate in hydrocarbon solvent (AWWA P9 Type A) shall contain not less than 6 percent nor more than 8 percent copper in the form of Copper Naphthenate and shall conform to

AWPA Standard P8 when analyzed in accordance with AWPA
Standard A5.

5. PLANT FACILITIES AND INSPECTION DURING TREATMENT:

5.1 Manufacturing and treating plant facilities shall be in accordance with AWPA Standard M3, paragraph 3. Pressure plants shall be equipped with recording instruments to register time, pressure, temperature and vacuum during each cycle of treatment, and with indicating thermometers and pressure and vacuum gauges to check the accuracy of the recorders. Work tanks shall be equipped with a thermometer. Thermal treating vats shall be equipped with a time and temperature recorder and with an indicating thermometer. Temperature recording devices are not mandatory for plants treating exclusively with waterborne preservatives.

5.2 Under the Independent Inspection Plan, the inspector shall be present during the treatment procedure, except at times when it may be impractical, such as during late night or early morning treatments. At such times, temperature, pressure and vacuum data shall be taken from the recording charts. (AWPA Standard M2.)

5.3 Recording instruments shall be checked with indicating gauges and thermometers. Inaccuracies shall be referred to the treating company for prompt correction. In the event of an inaccuracy, indicating possible damage to the material, the inspector shall reject the charge.

6. RESULTS OF TREATMENT:

6.1 Poles shall be tested for retention and penetration by means of a calibrated increment borer 0.2 inch (± 0.02 inch) in diameter in accordance with procedures in AWPA Standard M2, paragraph 5.22. Under the Independent Inspection Plan, all treating charges shall be tested for retention and penetration. Plant quality control and independent inspection shall do their analysis separately. Under Quality Assurance Plans the frequency of testing retention and penetration may vary according to the approved plan. When testing, the sampling shall be as follows:

Western red and northern white cedars and western larch poles shall be bored at any point of the periphery approximately 6-12 inches above ground line and all other species approximately 1 foot above or below the brand.

Penetration shall be determined in accordance with AWPA Standard A3. Chrome Azurol S and Penta-Check shall be used to determine penetration of copper containing preservatives and penta, respectively.

6.1.1 Retention sampling shall be as follows:

6.1.1.1. When there are 20 or more poles in the treating charge, the retention sample for creosote shall consist of 20 assay zones

from southern pine and Douglas-fir poles as shown in Table 10 of REA Bulletin 1728F-700. All poles in charges with fewer than 20 poles shall be bored once. Charges with less than 15 poles shall be bored once and bored again on a random basis to obtain a minimum of 15 assay zones.

6.1.1.2. Retention sample shall be taken from 20 poles in charges of 20 or more poles.

6.1.1.3 Retention sample for Alaska yellow, western red and northern white cedars shall be comprised of a minimum of 30 assay zones for creosote and waterborne preservatives. For penta charges of fewer than 30 poles, the sample shall contain the assay zone from each pole in the lot.

6.1.1.4 Retention samples shall be comprised of borings, representative of pole volumes for each class/length in the charge. Further selection and marking of poles of mixed seasoning, volume and location on the tram shall be made as illustrated in the following table:

<u>Number</u>	<u>Class/Length</u>	<u>Vol. in cu. ft.</u>	<u>Total Volume</u>	<u>Number of Borings</u>
27	7/30	232	15	3
26	4/35	447	29	6
11	5/35	163	10	2
55*	6/35	704	46	9
		Total 1,546		

*If a portion of these poles were green and some partially seasoned, then the number of borings should reflect the approximate percentage of each.

When a lot of material consists of fewer pieces than the designated minimum number of samples for assay, additional borings shall be taken so as to make up at least the minimum sample, and in such manner that the sample is representative of the lot of material with respect to any variations in size, seasoning condition or other features that might affect the results of treatment.

6.1.2 Analyses for preservative retention shall be in accordance with applicable AWPA standards as follows:

6.1.2.1 Creosote by AWPA Standard A6.

6.1.2.2 Penta by AWPA Standard A5 or A9. Copper pyridine method, is required when timber may have been in contact with salt water and for all species native to the Pacific Coast region unless it specifically states on the raw material invoice that the material has not been in contact with salt water or shown by

analysis that there are not additional chlorides present in the wood before treating.

6.1.2.3 Copper Naphthenate by tests in accordance with recognized standard in AWP Standards A5 or A9.

6.1.2.4 Waterborne preservatives by tests in accordance with the recognized standard methods for chromium, copper, zinc and arsenic ions listed in AWP Standards A2, A7, A9, or A11.

6.1.2.5 Prior to unloading a tram, the inspector may take samples and analyze them concurrently with the quality control designee, but each shall work independently and quality control data must be presented before acceptance of the charge.

6.1.3 Penetration Sampling of poles shall be as follows:

6.1.3.1 Group A - Poles with a circumference of 37.5 inches or less at 6 feet from butt.

- a. Bore 20 poles or 20 percent of the poles, whichever is greater; accept if 100 percent of the sample conform, otherwise bore all poles.
- b. Retreat the charge if more than 15 percent of the borings are found to be nonconforming.
- c. Retreat all nonconforming poles if 15 percent or less fail the requirement.

6.1.3.2 Group B - Poles with circumference greater than 37.5 inches at 6 feet from the butt.

- a. Fifty feet and shorter, bore each pole and retreat only those found to be nonconforming unless more than 15 percent fail in which case retreat the entire lot.
- b. Longer than 50 feet, bore each pole twice at 90° apart around the pole and accept only those poles conforming to the penetration requirement in both borings. All nonconforming poles may be retreated only twice.

6.1.4 All holes (nominal 0.2 inch diam. bit) shall be promptly filled with treated, tight-fitting wood plugs.

6.2 Under the Independent Inspection Plan all treating charges of crossarms shall be tested for retention and penetration. Plant quality control and Independent Inspection shall do their analysis separately. Under the Quality Assurance Plans the frequency of testing retention and penetration may vary according to the approved plan. When testing, the sampling shall be as follows:

6.2.1 The penetration and retention sample shall consist of 20 (48 for creosote) outer 0.6 inch for Douglas-fir and 1 inch for Southern Yellow Pine zones from borings taken from any face except the top face at a location as close to the end as possible being at least 3 inches from the end of the arm and no closer than 3 inches from the edge of any holes. For laminated material, borings shall be taken from laminates on a random basis.

6.2.2 Penetration shall be tested by taking not less than 20 borings from 20 crossarms in each charge and determined in accordance with AWWA Standard A3. Chrome Azurol S and Penta-Check shall be used to determine penetration of copper containing preservatives and penta, respectively.

6.3 Laminated material shall be checked for any evidence of delamination due to treatment and for the identifying quality stamp of AITC or APA.

6.4 When x-ray fluorescence (XRF) instruments are used to analyze preservative or retention, Periodic Instrument Checks (PIC) shall be made by the treating plant and any outside inspection agency using the treating plant's instrument or their own, in accordance with the procedure outlined in Appendix B.

At a minimum, treating plants shall perform the PIC weekly and record the results in the instrument's log, which shall be stored with the instrument. Independent inspection agencies shall use their own samples to perform the PIC on treater's instrument once per visit, not to exceed one PIC per week. Inspection agencies shall record their results in the instrument's log and state the date of his/her latest PIC on all treating reports.

XRF instruments shall be accurate and reliable, and they shall generate reproducible results. Instruments shall have thorough instructions which should include recommendations on drying techniques, equipment, and density calculations. These drying recommendations shall be followed when using these instruments.

7. PRODUCT ACCEPTANCE: Under the Independent Inspection Plan, the inspector shall signify acceptance by marking each piece of accepted material with a clear, legible hammer stamp in one end prior to treatment and in the other end after treatment. The inspector shall personally mark each piece, and shall not delegate this responsibility to another person.

8. CHARGE INSPECTION REPORTS

8.1 Inspection Reports shall cover the following matters:

8.1.1 Total pieces in the lot, number of and causes for rejection.

8.1.2 Conditioning of the material prior to treatment.

8.1.3 Analyses of preservative identified by the analyst's signature or certification.

8.1.4 Details of treatment.

8.1.5 Results of treatment including:

- a. Depth of penetration for retention sample and a summary of all poles rejected for insufficient penetration.
- b. Worksheets for retention analyses each identified by quality control designee and independent inspector.
- c. Number of pieces offered and rejected together with the cause(s) for rejection.
- d. Date of latest Periodic Instrument Check.

8.2 On each inspection report the independent inspector and the plant quality control designee shall certify, in writing, that the material listed on the report has been inspected before, during, and after treatment, and that the preservative used was analyzed in accordance with the requirements of this section.

8.3 Each inspector or inspection agency shall retain for a period of 1 year, a copy or transcript of each report of inspection, together with laboratory worksheets covering retention by assay and preservative analyses for the purchaser, and on request shall furnish a copy or transcript of any of these reports to the Director, Electric Staff Division, Rural Electrification Administration, Washington, D.C. 20250-1500.

9. CHARGE NUMBERS ON RETREAT POLES: The letter "R" shall be added to the original charge number in the butts of all poles that are retreated for insufficient penetration or retention of preservative. All poles that fail to meet treatment requirements after two retreatments shall be permanently rejected.

10. SAFETY PROVISIONS: Poles intended for REA borrowers shall not be inspected when, in the opinion of the inspector, unsafe conditions are present.

APPENDIX AINSPECTORS' QUALIFICATIONS

Inspection agencies should see that inspectors assigned to the inspection of timber products and treatment for REA borrowers are competent and experienced.

In general, any of the following examples are to be considered as minimum qualifying experience before assignment of a new inspector to inspection for REA borrowers:

- a. Three years experience as an inspector of timber and the preservative treatment of timber.
- b. Three years experience in timber treating plant quality control work.
- c. Under the direct supervision of an experienced, well qualified inspector, he/she shall have performed the following:
 1. Inspected at least 2,500 poles and/or crossarms "in the white."
 2. Checked preservative penetration results on at least 500 poles and/or crossarms.
 3. Made at least 35 wood assays for preservative retention.
 4. Made at least 25 analyses of each type preservative used of material he/she is assigned to inspect.
- d. In both a and b above, the experience shall be not less than that required in c.1, 2, 3, and 4.

Inspectors experienced in the inspections of one product, such as poles, should not be qualified to inspect another product, such as crossarms, until the above experience is gained.

The inspector should be especially well informed in wood preservation and the operation of a timber treating plant, and be competent in preservative analysis and other laboratory work.

In all cases, an inspector shall be thoroughly instructed in the application of REA specifications and standards pertaining thereto before independent assignment to inspection of timber products and treatment for REA borrowers. Knowledge of these specifications and standards as well as the inspector's proficiency may be checked by members of the REA staff.

APPENDIX BPERIODIC INSTRUMENT CHECK
X-ray Fluorescence

The following sample calibration standards and procedures may be used in lieu of comparison with analysis by wet ash or lime ignition methods.

Penta

Until such time as AWWA approves calibration standards for penta, the following method shall be used to run a salt water solution to measure Cl (chloride).

1. Standard Solution

Dry approximately 15 grams of reagent grade NaCl at 105°C for 1 hour. Weigh 10.00 grams into a tared beaker. Add distilled water until the total weight is 100.00 grams. Stir until completely dissolved. This will give a 10 percent weight-to-weight solution of NaCl.

2. Baseline Check

- a. Insure that the instrument is in good agreement with lime ignition.
- b. Record any user correction factors.
- c. Stabilize and standardize the instrument.
- d. Run the salt solution five times using the PENTA-OIL calibration mode.
- e. Record the average and standard deviation of the values for percent penta. The average value will now be considered the nominal value.

3. Periodic Instrument Check

Run the salt solution two times and average the results. If the value is more than ± 5 percent of the nominal value, the instrument needs further calibration, following manufacturer's recommendation.

Waterborne Preservatives

Treaters and inspection agencies shall purchase AWWA Committee

P-5 Standard Reference Materials to analyze on their instruments. Reference materials should be in the retention range of the material being produced at the plants.

If the value is more than ± 5 percent of the nominal value, the instrument needs further calibration.

AWPA Committee P-5 Standard Reference Materials may be purchased from:

American Wood-Preservers' Association
P.O. Box 286
Woodstock, Maryland 21163-0286

Phone: (410) 465-3169

APPENDIX C**METRIC CONVERSION FACTORS**

TO CONVERT FROM	TO	MULTIPLY BY
foot (ft)	meter (m)	0.3048
inch (in)	centimeter	2.54
pound per cubic foot (pcf) (lb/ft ³)	kilogram per cubic meter (kg/m ³)	1.601846
pound per square inch (psi) (lb/in ²)	kilogram per square meter (kg/m ²)	703.0696
degrees Fahrenheit (X°F)	degrees Celsius (°C)	5/9(X-32)