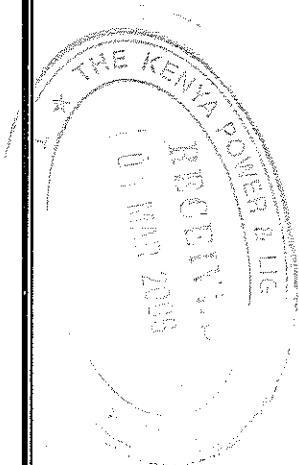


KENYA STANDARD

KS 02-94: 1985
UDC 674.04

Specification for preservation of timber



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KENYA BUREAU OF STANDARDS (KEBS)

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**KS 02-94: 1985
UDC 764.04**

Specification for preservation of timber

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P R E F A C E

This Kenya Standard was prepared by the Preservation of Timber Technical Committee under the guidance of the Building and Construction Industry Standards Committee, and is in accordance with established procedures of the Bureau.

It is general experience that the satisfactory performance of a wood preservative depends not only on the efficiency of the preservative itself but also on the method of its application to the timber, the treatability of the timber and the environment in which the treated timber is to be used. It is hoped that this standard will create an awareness and a better understanding of the many factors involved in timber preservation.

This standard specifies the chemical compositions of the most commonly used locally available preservatives, the most common methods of application and average retention of preservative levels for various species of timber in a variety of environmental conditions.

The standard is as comprehensive as practically possible. It will be revised to include additional preservatives and preservation processes after they become established in Kenya.

In the preparation of this standard, reference was made to the following publications:

- | | |
|----------------|---|
| AS 1604 - 1980 | Preservative treatment for sawn timber, veneer and plywood. |
| BS 1282 | Guide to the choice, use and application of wood preservatives. |
| BS 4072 | Specification for wood preservation by means of water-borne copper/chrome/arsenic compositions. |

Acknowledgement is hereby made for the assistance derived from these sources.

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KENYA STANDARD
SPECIFICATION FOR PRESERVATION OF TIMBER

1. SCOPE

This Standard specifies requirements for preservative treatment of timber. The preservatives, methods of application and suggested average retention levels have all been specified with the object of achieving long service life.

2. APPLICATION

In order to comply with this standard, treated timber shall satisfy the requirements for preservative, preservative penetration and average retention levels specified herein.

3. DEFINITIONS

For the purpose of this standard the definitions given in KS 02-93* shall apply, except where otherwise defined as follows:

- 3.1 *CHARGE RETENTION* — The net absorption of preservative by wood as calculated from the charge sheet excluding the solution leakage and dripping losses.
- 3.2 *PENETRATION* — The depth of wood from the surface which has been impregnated with preservative.
- 3.3 *RETENTION ZONE* — The area of the cross section which contains a specific amount of preservative.
- 3.4 *SAMPLE* — The timber chosen, on which process quality control measurements are made for the purpose of checking conformance with this standard.
- 3.5 *TREATED TIMBER* — Timber purporting to comply with the requirements of this standard.

4. PRESERVATIVES

4.1 *COPPER - CHROME - ARSONIC SALTS (CCA) SOLUBLE IN WATER*

- 4.1.1 These preservatives are a water soluble mixture of chrome, copper and arsenic salts or oxides of these metals. They are supplied ready-mixed in either powder or paste form, or as individual parcels of the dry ingredients in a large container.

4.1.2 *Specification for CCA*

- (i) The treatment solution shall be of a concentration containing not less than 3 per cent mass of dry salts per volume of the solution.

*Glossary of terms used in timber.

- (ii) The CCA preservative shall be in a form which shall dissolve in water to give a solution containing the active elements copper, chromium (hexavalent), and arsenic in the proportions specified in Table 1.
- (iii) On dissolving in water and stirring, but keeping the solution temperature below 40°C, insoluble matter shall not exceed 0.5 per cent of the solid preservative formulation.

TABLE 1. PROPORTIONS OF ACTIVE ELEMENTS IN CCA PRESERVATIVE

ELEMENT	PROPORTION, PER CENT	
	Minimum	Maximum
Copper	30	40
Chromium	35	50
Arsenic	18	32

4.1.3 The desired formulations can be obtained from various water soluble compounds of hexavalent chromium, bivalent copper, and pentavalent arsenic, e.g. potassium or sodium dichromate ($\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$), copper sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) and arsenic pentoxide ($\text{As}_2\text{O}_5 \cdot 2\text{H}_2\text{O}$).

4.1.4 A three per cent aqueous solution of correctly formulated preservative shall have a p^{H} of 2.0 to 2.8.

NOTE: Timber treated with CCA preservative must be retained at the treatment plant for 48 hours to allow the preservative to become fixed in the timber.

4.2 COAL TAR CREOSOTE OR CREOSOTE SOLUTION

4.2.1 *Creosote* — A coal tar distillate shall have the following properties:

- (i) *Density* — Specific gravity at 38°C shall not be less than 1.003.
- (ii) *Liquidity* — The creosote shall become completely liquid on being slowly warmed to 38°C with stirring. On cooling it shall remain liquid after standing for two hours at 32°C.
- (iii) *Water content* — The creosote shall contain not more than 1.5 per cent by volume water.
- (iv) *Toluene insoluble matter* — The creosote shall yield not more than 0.5 per cent by mass residue insoluble in toluene.
- (v) *Distillation range* — On distillation of water-free and previously liquified creosote the distillates shall be within limits specified in Table 2.

4.2.2. *Creosote Oil Solution* — This shall be a blend of creosote as specified in Clause 4.2.1 and a heavy petroleum oil. Other additives may be included provided that the resulting preservative solution shall contain by mass not less than 60 per cent creosote.

TABLE 2. DISTILLATION LIMITS OF COAL TAR
CREOSOTE

TEMPERATURE °C	CUMULATIVE DISTILLATE, PER CENT MASS	
	Minimum	Maximum
205	-	5
230	-	30
315	40	78
355	65	-

4.3 PENTACHLOROPHENOL (PCP) IN ORGANIC SOLVENT

This preservative shall be dissolved in organic solvent. The organic solvent may be a light petroleum distillate such as white spirit or a heavy petroleum oil of properties listed in Table 3.

TABLE 3. HEAVY PETROLEUM OIL SOLVENT FOR PCP SOLUTION

PROPERTY DESCRIPTION	LIMIT
Specific gravity at 25°C	-0.85 min.
Water and sediment, by mass	0.5% max.
Flashpoint	66°C min.
Cumulative distillates at 310°C, by volume	75% min.
PCP solvency at 25°C, by mass	10% min.
Initial boiling point	180°C min.
Viscosity (centistokes scaled at 38°C)	40 mm ² /s min. 120 mm ² /s max.

PCP in light oil is usually for low hazard situations and where a clean paintable surface is required. PCP in heavy oil is usually used as a substitute for creosote in ground contact situations.

This preservative is sometimes used in conjunction with one or more active insecticides.

- 4.3.2 (i) The solution shall contain not less than 5 per cent PCP by mass.
- (ii) *Chlorinated phenol* — Dry PCP solid shall contain not less than 95 per cent chlorinated phenol calculated as C₆Cl₅OH.
- (iii) *Alkali insoluble matter* — The matter insoluble in 4 per cent aqueous sodium hydroxide solution at 60°C shall not be more than one per cent.

5. PRESERVATION PROCESSES

In this standard four processes are specified, namely vacuum pressure

process, diffusion process, hot and cold open tank process and sap displacement process.

5.1 *GENERAL* — It is desirable that all timber should be cut and dried prior to treatment; where this is not possible cut surface shall be liberally brushed with preservative solution. The aim is to maintain an outer envelope of treated timber.

5.2 *VACUUM PRESSURE IMPREGNATED METHOD* — This method is suitable for treatment of timber with all types of preservative solutions. When properly controlled the method allows most reliable and consistent results. This method is described in Appendix A(i).

5.2.1 In general, control shall be exercised over the following:

- (i) *Moisture content* — The average moisture content shall not be more than 20 per cent for softwood and 25 per cent for hardwood.
- (ii) The concentration and volume of preservative solution.
- (iii) The levels and duration of the vacuum and pressure cycles.
- (iv) *Impregnation solution temperature* — The treatment solution shall be 85°C to 100°C at the time of impregnation in the case of creosote preservatives. The temperature of CCA solutions shall not be higher than 40°C.

5.3 *DIFFUSION PROCESS* — This process is suitable for use with boron salts. The wood to be preserved by diffusion shall be green, straight off the saw. The process is not suitable for preserving wood milled from dead trees, since this is generally too dry for diffusion to occur; conversely, timber which is wet with rain water should not be preserved by diffusion as the rain water can dilute the chemicals too much. The process is described in Appendix A(ii).

5.4 *HOT AND COLD OPEN TANK PROCESS* — This process is suitable for creosote and PCP oil solutions. It is not for use with waterborne preservatives. It does not allow for close control directly as is the case with pressure impregnation methods, but the treatment is adequate, sometimes even being excessive. The process is described in Appendix A(iii).

5.5 *SAP DISPLACEMENT PROCESS* — This is a process of treating small round timbers such as fence posts with CCA preservatives. This process is described in Appendix A(iv).

NOTE: In general, for methods in Clauses 5.2 to 5.5 control must be exercised over the volume and species of the charge. Only timber of one species shall be included in a charge, otherwise if a charge is made up of different types of timber, the treatment shall be controlled so as to ensure adequate treatment of the species most resistant to treatment.

5.6 *TIMBER PRETREATMENT*

5.6.1 *Surface Condition* — The surface of the wood shall be free from inner and outer bark, dirt or any other surface covering.

5.6.2 *Decay and Insect Damage* — The wood shall be free from fungal or insect attack, other than sapstain and negligible pinhole bores

subject to acceptance by the purchaser.

5.6.3 *Prefabrication* — As far as possible all manufacturing involving wood cutting, such as cross-cutting and rebating, shall be carried out before preservation treatment.

5.7 *ENVIRONMENTAL AND OCCUPATIONAL HEALTH*

5.7.1 *Environmental Health* — The treatment plant shall be designed to prevent contamination of water supplies, drainage systems, rivers, lakes and streams; discharge into these shall not be allowed. Leaks and spillages shall be contained by an effective bund wall around the treatment plant, and these solutions, plus drippings from treated wood, shall be run off into a suitable sump and returned, if suitable, into the working solution.

Sludge and other liquid waste shall be neutralized with lime and mixed with sawdust before disposal by burial in an approved pit.

5.7.2 *Personal Health Precautions* — When handling preservatives and freshly treated timber avoid skin contact and avoid inhalation of dust and vapours. Wear waterproof aprons/overalls, PVC gloves or gauntlets. Wear breathing masks when handling powders and eye protection goggles when handling solutions.

Washing facilities with running water and soap and also skin barrier creams shall be available at treatment plants.

After handling the chemicals, and before eating food, wash hands and face with soap and clean water. Smoking or eating shall not be permitted whilst handling preservatives.

6. *PRESERVATIVE RETENTION AND PENETRATION*

The degree of preservation is expressed in two ways; Retention and Penetration.

6.1 *RETENTION*

6.1.1 Retention is expressed as the weight of preservative chemical contained in one cubic metre of wood. Retention gives no indication of distribution of the chemicals in the wood; it may be uniformly distributed across the sections of contained in a thin skin on the surface.

6.1.2 Treated timber shall contain the suggested minimum amounts of preservative as required in Table 4, either as the certified average of a charge or on analysis of sufficient samples.

6.1.3 Analysis of CCA preservative treatment shall be based on chemical or physical analysis as per Appendix D.

6.1.4 Analysis of oil preservative treatment shall be based on extraction of moisture-free preservative solution from specimens of accurately measured volume (*see* Clause C2).

TABLE 4. RECOMMENDED AVERAGE RETENTION LEVELS FOR COMMON APPLICATIONS OF IMPREGNATED TIMBER

CLASS	SERVICE CONDITIONS	EXAMPLE	PCP IN LIGHT OIL; DRY PCP RETENTION Kg/m ³	PCP IN HEAVY OIL; SOLUTION RETENTION Kg/m ³	CCA DRY SALTS RETENTION Kg/m ³	CREOSOTE OR CREOSOTE OIL SOLUTION RETENTION Kg/m ³
1	Interior timbers not in contact with the ground, not exposed to the weather and not in a drywood termite area	Interior timbers used in roofs, interior joinery timbers, etc.	Not recommended	Not recommended	6.0	Not recommended
2	Exterior timbers (above damp proof course) - Not in contact with the ground but exposed to weather, and all interior and exterior timbers in a drywood termite area	Exterior building timbers, cladding, bargeboards, doors, window and door frames, stadium seating, decking, refrigerator linings, railway wagons.	8.0	100.0	8.0	100.0
3	Timbers in contact with, or buried in, the ground, exposed to weather, but excluding power transmission and telegraph poles	Posts and groundline timbers in buildings, railway sleepers, bridge timbers, fence posts, rails, gates, farm buildings, posts for highway crash barriers	12.0	Gum poles 80.0 Pine/Podo 160.0	12.0	Gum poles 80.0 Pine/Podo 160.0
4	Timbers frequently or permanently immersed in fresh water or subjected to very high humidities and condensation, including power transmission and telegraph poles	Building timbers in wet industries, roofs, flumes, land drains, cooling towers, revetments, power transmission and telegraph poles	Not recommended	Gum poles 80.0 Pine/Podo 160.0	Gum poles 16.0 Pine/Podo 16.0	Gum poles 80.0 Pine/Podo 160.0
5	Timbers frequently or permanently immersed in sea water	Marine timbers such as groynes, jetties, dolphins	Not recommended	Not recommended	Pine/Podo 24.0	Pine/Podo 240.0

- NOTES: 1. At the time of producing this standard the drywood termite areas are those areas which are within 50 kilometres of the coasts of the Indian Ocean and lake Victoria.
2. For the higher hazard classes it is important to use a treatable timber that can be penetrated to a sufficient depth so as to provide a complete envelope of impregnated timber.
For example, gum poles have treatable sapwood. So, when used in the round form the treated sapwood provides the complete envelope of impregnated timber.
Pine and Podo have treatable sapwood and treatable heartwood, i.e. full penetration is possible and both timbers are suitable for high hazard situations.
3. Cypress has moderately treatable sapwood but heartwood that is resistant to treatment; heartwood penetration is unlikely to exceed 6 mm to 10 mm and as such is not a suitable timber for high hazard situations.
4. Of the less common species of timber some are more resistant to treatment than others. Specific advice from the Forestry Department should be sought in individual cases.

6.2 PENETRATION

- 6.2.1 Penetration is the depth of wood from the surface which has been impregnated with preservative.
- 6.2.2 Penetration shall be measured on a cross-section cut at least 50 cm from the end of the timber or in the case of treated poles or baulks on a boring made right through the section with a hollow core increment borer. Its determination is described in Appendix B.
- 6.2.3 *Requirements* — A complete envelope of treated timber and, if possible, complete sapwood penetration.

NOTE: The sapwood of most species is perishable but usually treatable and complete penetration is desirable, especially for high hazard situations.

7. SAMPLING

7.1 PRESERVATIVES

- 7.1.1 The sampling shall be made on batches delivered to treatment plants and a composite sample of about one litre or one kilogram is generally adequate.

The same safety precautions necessary in treating timber shall be taken while sampling and handling the sample. Gloves of PVC, or preferably of polychloroprene, goggles or a face shield, and an apron need to be worn while handling powder preservatives (see Clause 5.6).

- 7.1.2 *Solid Preservatives* — A special instrument known as a 'thief sampler' is needed to take several samples from each container. The samples shall then be thoroughly mixed by heaping into cores

followed by flattening several times, quartering the heaps, and repeating the mixing and subdivision to leave a sample of approximate size for analysis. Great care is necessary to avoid contamination or changes of moisture content during the sampling process.

- 7.1.3 *Paste or Liquid Preservative* — A sampling container shall be used to draw samples after thorough mechanical mixing of the preservative to as much homogeneity as possible. From each container samples are drawn from near the top, mid-depth and base of the container. These are then thoroughly mixed and subsampled as necessary.

Oil preservatives are similarly sampled and where solid deposits form at low temperature the oil shall be warmed to complete liquidity before taking samples.

- 7.1.4 *Solution* — The container shall be clean and have a tight sealing lid, about 10 per cent air space should be left. About 10 g is needed for a physical analysis or 300 ml for a chemical analysis.

7.2 *TREATED TIMBER*

- 7.2.1 Lengths of timber shall always be selected by random sampling from consignments or charges. Test samples for preservative analysis shall be obtained from not closer than 500 mm from the end grain surface, and not within 3 days of treatment.

- 7.2.2 Generally the most appropriate test specimens shall be complete cross-sections for converted timber and increment cores for round poles and baulks. The increment cores shall pass right through the pole or fitting plugs of treated timber so as to make the timber fit for use.

Test specimens shall invariably consist of sound wood. Wood with, or close to, growth defects such as knots and mechanical defects should be avoided.

8. MARKING

- 8.1 Timber preserved by pressure impregnation or diffusion process shall be legibly and indelibly marked with the following particulars:

- (i) The name of the preservation plant.
- (ii) The hazard class.
- (iii) The year of treatment.
- (iv) The number of this standard.

9. CERTIFICATE OF TREATMENT

- 9.1 The purchaser of pressure impregnated timber shall be supplied with a certificate of treatment and charge sheet details.
- 9.2 Treatment firms shall retain for a period of at least 5 years records of treatment and results of any tests made to determine penetration and retention.

A P P E N D I X A

(i) VACUUM PRESSURE PROCESS

A(i)1. GENERAL

This method is usually used with CCA salts or creosote oil solutions or PCP oil solutions.

A(i)2. APPARATUS

The essential equipment shall be an airtight pressure cylinder in which timber completely immersed in solution shall be subjected to hydraulic pressure to mechanically force the solution into the wood cells. Associated equipment shall consist of pumps, preservative mixing and storage tanks, piping and various gauges. Where the preservative solution is a heavy oil auxiliary, heating equipment shall form an integral part of the preservation plant.

A(i)3. PROCEDURE

A(i)3.1 Inspect timber to be treated, for suitability of species or defects, for example:

- (a) Decay.
- (b) Insect infestation.
- (c) High moisture content.

A(i)3.2 Timber dried to below 20 per cent moisture content for softwoods and to below 25 per cent moisture content for hardwoods and prepared for a treatment charge shall be placed in the pressure cylinder which shall then be sealed airtight. There are variations of the impregnation process which follow as detailed below:

A(i)3.2.1 *Full Cell (or Bethell) Process* — Before admission of the treatment solution into the pressure cylinder, a vacuum of more than 500 mm mercury shall be applied for a period of about 30 minutes. With vacuum still on, the solution, at appropriate temperature, shall be added to fill the cylinder completely. Then a maximum pressure of up to 1.5 MPa, depending on the type of timber, shall be applied for a period of 1 hour to 6 hours until it is seen that the required amount of preservative has been absorbed. The cylinder shall then be emptied of the solution and a final vacuum similar to the initial vacuum may be applied. The initial vacuum empties all the cavities of air to leave space for the treatment solution on application of pressure. The final vacuum serves to minimize subsequent bleeding and leave the wood surface dry for clean handling.A(i)3.2.2 *Empty Cell Process* — With timbers which readily absorb preservative solutions and to avoid too much retention the initial vacuum shall be omitted. The cylinder shall be filled with the treatment solution while at atmospheric pressure (Lowry process). A small initial pressure is sometimes applied in the cylinder and filling with solution takes place at this pressure (Rueping process). After filling the cylinder details of treatment which shall be followed are the same as in the full cell process.

The pressure period allows the interior of wood to be filled with the treatment solution. When the pressure is released the resulting expansion of the compressed air in the cell cavities forces out some of the absorbed solution. More solution is recovered on application of a final vacuum.

By adjusting the amount and duration of pressure, the quantity of solution absorbed by the timber in the charge can directly be controlled to the desired levels.

(ii) DIFFUSION PROCESS

A(ii)1. GENERAL

This method is usually used with boron salts; it is not suitable for CCA, creosote oil solutions, or PCP in oil solutions.

A(ii)2. APPARATUS

Mixing tank, circulating pump, fine mesh hard strainer, pipes, reinforced plastic covers, etc.

A(ii)3. PROCEDURE

Estimate the volume of solution required for the day's run. Fill the mix tank up with clean water to 85 per cent of the solution. Calculate the weight of salt required and the concentration. Add the salt to the mix tank, stirring thoroughly and running the circulating pump, until all salt is dissolved. Top up with water to the required volume. The timber to be treated shall be cut the same day from green logs free from decay or blue stain. It shall not be wet with rain. Dip or spray the timber, maintaining the temperature. At the end of the day's operations clean out all saw dust with a fine mesh hard strainer and dilute the remaining solution to about 50 per cent of the average working volume.

The timber shall be completely submerged or sprayed. Immediately after dipping or spraying, the timber shall be built into square ended block stacks 100 mm clear of smooth level ground. Every effort should be made to shake free as little as possible of the solution off the timber.

When the stacks are complete they shall be covered on top sides and ends with tightly fitting impermeable cover to exclude all outside air. Laps in the cover shall be a minimum 0.5 m. The covers shall extend over the ground 0.5 m and shall be firmly held down with weights, stones or timber.

(iii) HOT AND COLD OPEN TANK PROCESS

A(iii)1. GENERAL

This method is usually used for creosote oil solution, or PCP in heavy oil.

A(iii)2. APPARATUS

A strong open tank of any convenient size and shape with provision for heating the treatment solution.

A(iii)3. PROCEDURE

Suitably dried timber shall be immersed in the preservative solution which is heated to 90°C to 100°C and maintained at that temperature for a period of about 3 hours to 4 hours. With the timber still immersed, the tank shall be cooled to allow absorption of the solution due to contraction of the residual air in the wood cell cavities. Alternatively the wood is quickly transferred to a tank with cold preservative solution. The appropriate duration of heating timber at the maximum treatment temperature and the cooling period of the hot bath, or the period of immersion in cold bath, are adjusted to suit the specified penetration and retention.

A(iii)4. PRECAUTION

There exists risk of fire breaking out if the solution spills over the tank. Therefore the solution shall not be heated above the specified temperature as there is likelihood of the solution frothing and spilling over. For the same reason, indirect heating by steam is preferable to direct fire. The tanks shall be kept covered to avoid solution contamination with dust and moisture.

(iv) SAP DISPLACEMENT PROCESS

A(iv)1. GENERAL

A method of treating small round timbers such as fence posts with waterborne preservatives.

A(iv)2. PREPARATION OF POSTS

The posts and droppers shall be barked and placed in the treatment solution within 24 hours of felling the tree. Building posts and fence posts should be treated in the lengths in which they are to be sold. Droppers should be treated in 4 m lengths.

Bamboos should be treated with their leaves and branches left on within 24 hours of cutting.

A(iv)3. SOLUTION STRENGTH

For most purposes a 6 per cent solution is adequate, but should a larger or a smaller retention than normal be required, then, a more concentrated or less concentrated solution can be used. To make up a 6 per cent solution 8 kg of a copper/chrome/arsenic salt are dissolved in 135 litres of water. (This volume of water is suitable for treatment in a 200 litres drum).

A(iv)4. TREATMENT

Drums should be placed in as hot and sunny a place as possible, preferably where there is a wind. Optimum results are obtained where the drying rate is highest. Posts and bamboos should be placed in the drums and left for four to six days whereas droppers

can be removed after three days. Long posts or bamboos require to be rested against some kind of frame or support to prevent them overturning the drums.

Wet weather, high humidity or cold weather slow down treatment so that treatments need to be adjusted from the 4 days to 6 days average to suit varying conditions. It is strongly recommended that anyone intending to use this treatment should calculate the volumes of a few trial batches and treat them until an overall retention of 12 Kg/m^3 is obtained so as to give them an idea of the length of treatment required to suit the particular conditions.

The posts should be kept for one week after treatment before being used to allow the preservative to become fixed in the timber. It is strongly recommended that after 3 days in the solution, fence posts should be reversed for the last day so as to treat the top of the post better. If this is done, adequate treatment is obtained in 4 days.

A P P E N D I X B

METHOD FOR DETERMINATION OF PRESERVATIVE PENETRATION

B1. TEST SPECIMENS

Penetration is best measured on a freshly prepared end grain surface, alternatively the measurements can be taken on increment cores. The end grain surface shall be cut at least 500 mm from the end of the treated timber because penetration along the grain is easy and good penetration is always achieved near the ends of preserved timber.

B2. MEASUREMENT OF PENETRATION

B2.1 *OIL PRESERVATIVES* — The depth of penetration is easily seen on the end grain surface. If the sample has been recently treated, the saw or the core bores may smudge the oil over unpenetrated parts of the timber.

B2.2 *WATERBORNE PRESERVATIVES* — Sometimes the depth of penetration is not apparent, in which case it is necessary to treat the surface with a chemical indicator which changes colour in the presence of the preservative. Best results are achieved when the end grain surface is made smooth by planing or sandpapering and the chemical indicator applied sparingly, ideally by spray but a rag moistened with the chemical indicator is better than wetting the test specimen with indicator.

B3. COPPER

B3.1 *CHROME AZUROL S TEST*

Reagent: A solution containing 0.5 per cent chromo azurol S dye and 5 per cent sodium acetate in distilled water.

Application: Light spray gives a strong royal blue colour in wood with copper, persistent for several weeks. Untreated wood becomes orange coloured.

B3.2 RUBEANIC ACID TEST

Reagents: A 5 per cent ammonium solution made by diluting 1 part ammonia (0.880) with 6 parts water by volume - Solution A.

A 0.5 per cent rubeanic acid made by dissolving 0.5 g rubeanic acid (dithio-oxamide) in 100 ml ethanol or methylated spirit - Solution B.

Application: Spray with solution A followed by solution B produces a greenish black to almost black colouration indicating presence of copper, untreated areas retaining natural wood colour. The colouration is persistent for a period of years.

B4. ARSENIC

B4.1 MOLYBDATE TEST

Reagents: Solution A made by mixing 22 ml concentrated hydrochloric acid and 88 ml distilled water then dissolving in this solution 10 g sodium molybdate.

Solution B made by dissolving 5 g stannous chloride in a mixture of 22 ml concentrated hydrochloric acid and 88 ml distilled water. Alternatively 5 g ascorbic acid is dissolved in 100 ml distilled water. The solution does not keep long and that of the last alternative shall be prepared fresh each day of test.

Application: Spray with solution A followed after soaking in by spray with Solution B produces a royal blue colour in wood containing arsenic.

B5. PENTACHLOROPHENOL IN OIL SOLUTION

B5.1 CUPRIN ACETATE TEST

Reagent: Cupric acetate and 0.5 g wetting agent (such as shell 'Nonident P40') in 100 ml water.

Silver nitrate solution made by dissolving 0.4 g silver nitrate in 100 ml water. The solution is light sensitive and shall be stored in dark brown glass bottles.

Application: A mixture of equal quantities of the two solutions (shelf life about one month) applied to a freshly cut surface produces a deep red-brown colour in wood containing PCP.

A P P E N D I X C

METHODS FOR DETERMINATION OF PRESERVATIVE RETENTION

C1. GENERAL

The cheapest and simplest way of measuring preservative retention is by measuring the quantity of preservative before and after treatment of a charge and the volume of timber in the charge.

These measurements shall be routine in any treatment operation. This method assumes that the difference in the volumes of the treatment solution is entirely due to absorption by the treated wood, which is not strictly true because some solution losses take place by leakage, spilling and dripping from both the treatment equipment and the treated timber. Additional analytical tests may be required to confirm treatment to the required specification. (see Clauses C2 and C3.)

C2. OIL PRESERVATIVES

The charge retention shall also be measured by weighing a number of sample pieces, or even all the timber in a charge before and after treatment. It may also be checked as in Clause C1.

C2.1 RETENTION MEASUREMENTS BY ANALYSIS

C2.1.1 *Analytical Sample* — Test specimens preferably consist of increment cores, or other geometrically uniform pieces, the volume of which can be calculated from their linear dimensions.

The volume of irregularly shaped pieces shall be determined by water displacement.

C2.1.2 *Apparatus* — The apparatus assembly shown in Figure 1 consisting of an extraction flask, soxhlet extractor, water trap and a reflux condenser or cold-finger shall be used to extract the preservative solution from the wood sample. The same equipment shall be employed for determination of moisture content of treated wood.

The water trap shall be chemically clean so that the shape of the meniscus at the end of the extraction is the same as at the beginning. It may be coated from time to time with a silicone resin to give a uniform meniscus. A thin rod of material to which water does not adhere, such as polytetrafluoroethylene, may be used to transfer water condensed elsewhere to the water layer in the trap.

C2.1.3 *Procedure* — Sufficient toluene shall be placed in the extraction flask to fill the water trap and soxhlet extractor and to maintain a reservoir in the extraction flask. About 0.5 ml distilled water shall be added. The apparatus shall be assembled, heat applied and refluxed for about 30 minutes. The contents of the water trap shall be allowed to cool to room temperature, then any water adhering to the walls of the condenser and water trap shall be transferred to the water layer in the trap. The volume of water in the trap shall be noted to the nearest 0.01 ml.

The weighed test specimens shall then be placed in the soxhlet extractor and sufficient heat is applied to the extraction flask to reflux the toluene at the base of the condenser or cold-finger so as to operate the soxhlet siphon at least once every 12 minutes. The refluxing shall be continued for 5 hours to 16 hours or until no more colour is extracted from the sample, whichever is the greater.

The contents of the trap shall then be allowed to cool to room temperature before transferring any water adhering to the walls of condenser and water trap to the layer in the trap. The volume of water shall again be read to the nearest 0.01 ml.

The extracted specimens shall be reweighed after drying to constant weight in a ventilated oven at $103 \pm 2^\circ\text{C}$.

C2.1.4 *Calculation*

$$\text{Preservative retention} = \frac{w_1 - w_2 - m \text{ kgm}^{-3}}{v}$$

$$\text{Moisture content} = \frac{100 m}{w_2} \text{ per cent}$$

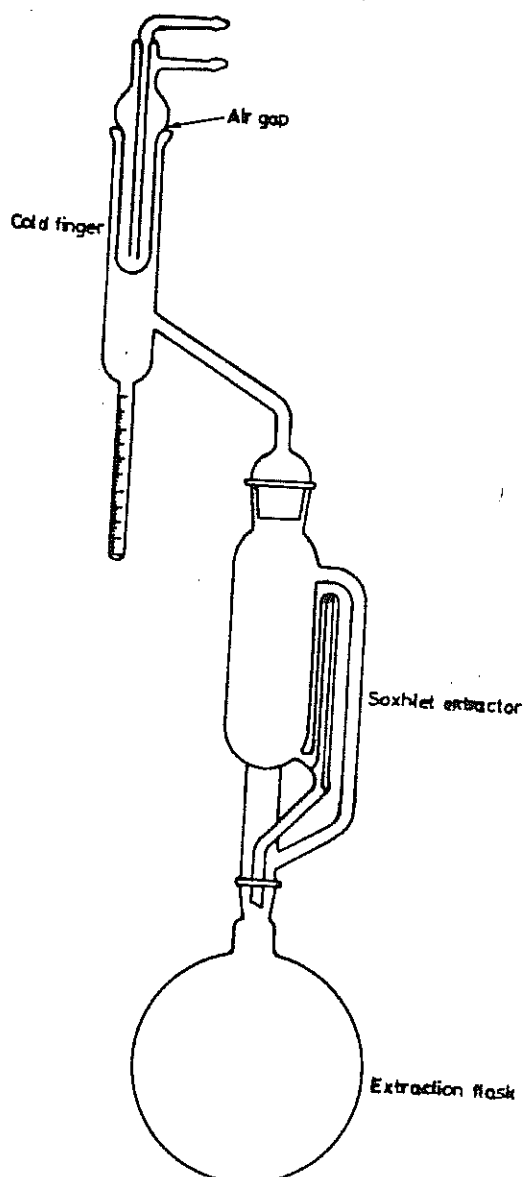
where,

w_1 = mass of wood pieces in g before extraction,

w_2 = oven dry mass in g of extracted wood pieces,

m = volume in ml of water extracted, and

v = volume of the wood pieces in cm^3 .



*Reflux condenser may be substituted.

FIG. 1. - APPARATUS FOR OIL RETENTION ANALYSIS

C3. WATERBORNE PRESERVATIVES

- C3.1 *ANALYTICAL SAMPLE* — Test specimens in form of increment cores or cross-sections shall be sampled further into thin shavings or dust from which the preservative can be extracted by leaching. Appropriate reagents shall be reacted with the small wood particles to transfer the preservative into solution. The quantities of individual ingredients in the solution are determined most conveniently spectrophotometrically and retention then calculated by adjusting for wood density and moisture content.

The reagents employed differ according to the preservative, the element to be determined, and the specific method of instrument used to measure concentration in the solution after leaching. Appendix D explains the procedure for analysis of copper-chrome-arsenic preservative treated wood by atomic absorption spectrophotometer but any other suitable chemical method of analysis may be used.

A P P E N D I X D

METHOD FOR DETERMINATION OF COPPER, CHROMIUM AND ARSENIC IN PRESERVATIVE TREATED TIMBER

D1. APPLICATION

The method is suitable for wood samples weighing up to 8 g, containing not less than 0.000 2 per cent of copper and chromium and 0.000 5 per cent arsenic. It is suitable for determination of the elements in sawdust, woodflour and thin shavings. There is no inter-elemental interference during the determination and the procedure is specific for arsenic in the presence of phosphorus compounds.

D2. REAGENTS

All reagents including water shall be of analytical reagent quality.

- D2.1 *SULPHURIC ACID 2.5 M* — Made by cautiously adding, with stirring and cooling, 280 ml concentrated sulphuric acid to 1 600 ml of water and diluting to 2 litres with water.
- D2.2 *HYDROGEN PEROXIDE SOLUTION* — 100-volume
- D2.3 *SODIUM SULPHATE SOLUTION* — 3 per cent made by dissolving 30 g sodium sulphate in water and diluting to one litre.
- D2.4 *SULPHURIC ACID/SODIUM SULPHATE SOLUTION* — Made by diluting 200 ml of the 2.5 M sulphuric acid plus 100 ml of the 3 per cent sodium sulphate solution with water to one litre.
- D2.5 *STANDARD SOLUTION* — Copper pentahydrate 0.198 5 g shall be dissolved in water and the solution transferred to a 100 ml volumetric flask. Anhydrous potassium dichromate 0.288 g shall be dissolved in water and 10 ml of 2.5 M sulphuric acid and 2 ml of 100-volume hydrogen peroxide added, boiled, cooled and the mixture transferred to the volumetric flask. Arsenic trioxide 0.132 0 g, after drying at 103°C - 110°C for 1 hour to 2 hours, shall be dissolved by boiling in a solution consisting of 10 ml of 2.5 M sulphuric acid, 2 ml

of 100-volume hydrogen peroxide and 10 ml of water, cooled and also transferred to the volumetric flask. Then 10 ml of 31 per cent sodium sulphate solution shall be added to the flask and diluted to the mark with water. One ml of the standard solution is equivalent to 500, 1 000 and 1 000 micrograms of copper chromium and arsenic respectively.

D2.5.1 *Calibration Solutions* — Aliquots of the standard solution shall be transferred by pipette or burette to 100 ml volumetric flasks and mixed after diluting to the mark with the sulphuric acid-sodium sulphate solution.

D2.5.2 *Atomic Absorption Spectrophotometer Operating Conditions* — With small differences necessary with instruments of different manufacture, the instrument shall be set to conditions listed in Table 5.

TABLE 5.

INSTRUMENT CONTROL	COPPER	CHROMIUM	ARSENIC
Wavelength, mm	324.8	357.9 or 429.0	193.7 or 197.2
Slit width, mm	0.08	0.06 or 0.10	0.30
Lamp current, mA	4	8	7
Scale expansion	up to X10	up to X10	up to X10
Burner	100 mm acetylene	100 mm acetylene	100 mm propane
Burner height, mm	10	5	14
Acetylene flow rate, $\text{cm}^3 \text{ min.}^{-1}$ at a pressure of 0.7 bar	1 000	1 800	-
Air-flow rate, $\text{cm}^3 \text{ min.}^{-1}$ at a pressure of 2.1 bar	5 000	5 000	-
Hydrogen flow rate, $\text{cm}^3 \text{ min.}^{-1}$ at a pressure of 0.7 bar	-	-	1 800
Argon flow rate, $\text{cm}^3 \text{ min.}^{-1}$ at a pressure of 2.1 bar	-	-	5 000

D2.5.3 *Flame Ignition Procedure for the Argon (Entrained Air)/ Hydrogen Flame* — If argon and hydrogen are introduced together great difficulty will be experienced in igniting the mixture. The argon cylinder shall be connected, via a reducing valve, to the air inlet.

Similarly the hydrogen supply shall be connected to the fuel inlet. Gas lines, especially the hydrogen line, shall be ascertained as free from leaks and the spray chamber flushed with hydrogen. The hydrogen flow shall be adjusted to 1 500 cm³ min.⁻¹ and flame ignited. Argon is then turned on and the flow adjusted to 500 cm³ min.⁻¹.

D3. PROCEDURE

Ground sample shall be weighed and transferred to a 250 ml calibrated flask, 50 ml of 2.5 M Sulphuric acid and 10 ml of a 100-volume hydrogen peroxide added, and heated in a water bath at 75°C for 20 minutes with occasional swirling to mix the contents of the flask. The flask shall be removed from the water bath, 150 ml of water and 2 ml of the 3 per cent sodium sulphate solution added, swirled to mix, cooled to room temperature, diluted to the mark with water, and mixed again. Mixing shall be repeated twice at 5-minute intervals. The leach solution shall be filtered through a dry 90-mm Whatman No.44 filter paper, the first 5 ml filtrate being discarded.

Using the instrument operating conditions listed in Table 5, the sulphuric acid/sodium sulphate solution shall be aspirated to obtain the blank absorbance, then a suitable range of calibration solutions followed by the filtrate from the sample solution. After the last sample has been run the calibration solutions shall be checked. From calibration graphs of the concentration of copper, chromium and arsenic against absorbance, concentration in the sample solution shall be determined by comparing the test solution absorbance with the calibration graphs.

This procedure is suitable for samples in the weight range of 3 g to 8 g. For smaller samples of 100 ml, 50 ml or 25 ml, calibrated flasks and corresponding volume of reagents shall be used. A corresponding sample shall be dried in an oven for moisture content determination.

D4. CALCULATION

$$\text{Element retention} = \frac{av(100 + m)}{w} \text{ per cent of oven-dry wood}$$

where,

- a = equivalent absorbance in g/ml of the element in the leach solution,
- v = volume in ml of the leach solution,
- m = moisture content in percentage of the wood sample, and
- w = mass of the test wood sample.

A P P E N D I X E

METHODS FOR DETERMINATION OF MOISTURE CONTENT OF WOOD

E1. SAMPLE SELECTION

For average moisture content, test specimens consisting of full cross sections 15 mm to 20 mm thick shall be cut, not closer than 500 mm

from the end of the timber piece sampled. Alternatively, borings, perpendicular to the timber surface may be taken. The test specimens shall be weighed immediately after extraction or put in airtight containers for later weighing.

E2. PROCEDURE

The weighed specimen shall be dried to constant weight in an oven at $103 \pm 2^\circ\text{C}$ and then reweighed. From the two weighings moisture content in percentage shall be calculated from the formula:

$$\text{Moisture content} = \frac{100(W_1 - W_2)}{W_2}$$

where,

W_1 = original mass of the wood sample on extraction,

W_2 = oven-dry mass of the wood sample.

E3. OTHER METHODS

E3.1 *LIQUID EXTRACTION* — For wood treated with preservative oils the appropriate method is described in Clause C2.

E3.2 *DIRECT MEASUREMENT WITH MOISTURE METER* — Moisture content can approximately be measured directly with an electric moisture meter. The method is useful as a preliminary indication for wood at a moisture content below fibre saturation point but cannot generally be relied on alone.

A P P E N D I X F

DURABILITY OF WOOD POLES AND POSTS

F1. MEANING OF WOOD DURABILITY

It is common practice in describing characteristics of individual timber to include its durability, which is an indication of its relative resistance to natural destructive agents. Being organic material, wood is destined for climatic and bio-degradation but the period of time taken for completion of the degradation process or its advancement to a specific degree depends on many factors, the most important of which are the species of wood, the destructive agents involved, and the particular environmental location of the material.

While any wood can last indefinitely in a dry sheltered location, the same wood is sure to be destroyed soon or later in most service situations. The most common natural agents of wood destruction are decay fungi and insects. Quicker destruction takes place where these agents abound, which means in an environment as does exist in soil. Those timbers therefore which persist for a relatively long period while exposed to weather in contact with ground are classified as durable. Natural durability of different timbers varies from a few months for some species to several decades for the most durable species. Experience has shown that adequately preservative treated

timber can exceed durability of the most naturally durable timber species.

F2. NATURALLY DURABLE TIMBERS

There are not many Kenya grown timbers sufficiently naturally durable for use in situations with high decay hazards. Certainly, apart from cedar, *Juniperus Procera*, NONE can be said to have ever been readily available commercially.

If available however, the heartwood of the timbers listed in Table 6 is sufficiently durable to be used without treatment.

The point must be stressed that only the heartwood is durable and in using naturally durable poles or posts all sapwood should preferably be trimmed off.

F3. SUITABLE TIMBERS FOR TREATED POLES

Unfortunately, some timbers are not easily treatable. Like natural durability, treatability of wood differs over a very wide range. There are also differences between heartwood and sapwood of the same timber, the sapwood generally being more easily treated. Thus timbers like tallow wood and iron bark combine natural durability of heartwood and easily treatable sapwood while a timber like cypress has heartwood of only moderate natural durability and sapwood fairly resistant to preservative treatment. It is important therefore in selecting timber for preservative treatment to ascertain that the timber is treatable.

Among locally grown common timbers, pine, eucalypts, and casuarina are recommended as suitable for preservative treatment in their natural round form.

TABLE 6. SOME EXAMPLES OF TIMBERS WITH DURABLE HEARTWOOD

STANDARD NAME	BOTANICAL NAME
Muiri	<i>Prunus africana</i>
Muhuhu	<i>Brachylaena huillensis</i>
Cedar	<i>Juniperus procera</i>
Mbambakofi	<i>Azalia quanzensis</i>
Iron bark	<i>Eucalyptus paniculata</i>
Tallow wood	<i>Eucalyptus microcorys</i>

F4. DURABILITY AND SERVICE LIFE

Because of the many variables determining service life of timber, it is impossible to state definitely the period timber in use will last. However, if naturally durable timbers are estimated to last under severe decay hazard situations for an average life of thirty years, timber conforming to this standard should last equally as long.