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The selection and treatment of wood poles as used in electric distribution

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THE SELECTION AND TREATMENT OF WOOD POLES AS USED IN ELECTRIC DISTRIBUTION.

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Purpose of the Thesis

The purpose of this thesis is to assemble in a compact form all desirable information on the subject of wood poles as used for Overhead supports in the electrical distribution industry. This thesis is in reality a handbook of facts as gathered by actual experience and by a rather thorough research into the subject.

INTRODUCTION INTO THE PROBLEM.

The Use of Wood Poles.

Wood poles have been used as a means of supporting wires for electric service since the construction of our first overhead telegraph line between Washington and Baltimore in 1844. It is reasonable to assume that the use of wood poles as support for overhead conductors will continue as long as there is a supply of suitable pole timber available.

The property requirements of poles used for the above mentioned purpose are strength, comparative lightness in weight, durability, straightness, a gradual and well defined taper, and an abundant and accessible supply.

The wood poles in their native condition are excellent supports for overhead conductors but the weakness of these poles is their lack of durability. This failing is corrected to a great degree by various kinds of treatments designed to increase their lives. By the proper use of wood treatments the United States Department of Agriculture estimates that a saving of at least twenty-two million dollars per year could be effected.

Origin of Various Kinds of Wood Poles.

Western Red Cedar: (Thuya Plicata) is found in the Rocky Mountain regions of Idaho, Washington and British Columbia and in the coast mountains of Washington and Oregon.

Northern White Cedar: (Thuya Occidentalis) is found in Michigan, Wisconsin and Minnesota.

Chestnut: The present source of supply for poles is Virginia, Tennessee, West Virginia, North Carolina, and other Southern states.

South Yellow Pine: A goodly supply is given from most of the Southern states.

Several other species of trees such as Douglas fir, cypress, Western yellow pine, etc. but the use of these trees is limited for the most part to the section where they are grown and the amount used for poles is very small.

Development of the Art of Wood Preserving.

While the modern practice of wood treatment is a highly developed art, yet the science of wood preserving has been practiced since the days of the early Romans and Egyptians, who were the first to make practical use of the art. During the intervening years innumerable preservatives and processes have been used and experimented with in all parts of the world.

Among the earlier investigators on the subject of wood preservation may be mentioned Johann Glouber, the famous chemist of Carlstadt, Germany, who in 1657 experimented with vegetable tar and pyroligneous acid, the wood having first been carbonized by the action of fire, then covered with a tar coating and immersed in pyroligneous acid. Since this period many processes have been tried, but most failed, either due to the cost of material or to difficulties in their application. Since 1657, up to 1846, no less than forty-seven different processes adopted for the preservation of wood are recorded, besides other of more recent date (Rome - Preservation of Wood pp 99 - 100). Of the

many processes discovered probably a great proportion of them would prove to some degree successful provided they could be carefully and economically applied.

The Importance of the Problem as Viewed by the National Electric Light Association.

The importance of the question is shown by statement of the Overhead Systems Committee of the National Electric Light Association, in their report T-3-21 submitted to the 44th Annual Convention. An extract from the report is as follows: "The fact is particularly emphasized that pole users are now in a position to adopt one form or another of reliable treatment, and the Committee feels it a duty to do what educational work it can in persuading member companies to treat their poles. It is hoped that within a reasonable time practically all of the poles used in this country will be treated. The proper treatment of poles has many advantages, but the principal ones are the economic saving through added life, the reduction in pole replacement work, and the great aggregate saving that can be made in conserving the timber resources of the country. The Committee would especially deal with a phase of the treating not previously well understood, namely the facilities now offered by commercial treating companies so that pole purchases may secure their poles already treated, and, if they so elect, in accordance with their own specifications. Many pole purchasers have been aware that such facilities are available and that treated poles can be secured as conveniently as untreated poles. Right here it should be stated that what the consumer is really paying for is results.

The desired results are a certain penetration of the creosote oil, using the proper kind of oil, with uniform impregnation at the part of the pole intended to be treated".

Painting Poles as a Bad Practice.

Painting poles or any solid timber does not preserve it against decay.

Moisture finds its way into the wood through the checks. The coating of paint prevents evaporation, thus producing conditions favorable to decay.

The smooth surface of painted poles piled horizontally permits rain to carry rot spores into the checks, thus producing a concentrated source of infection, where due to the retention of moisture, conditions most favorable for decay are brought about.

In the case of the unpainted pole, the rot spores usually attach themselves to the rougher, outer surface. Most of them soon dry up and blow away.

The damage caused as a result of painting is not as great to poles set in the line as to poles in storage because the water drains out of the checks more rapidly.

When painting is desirable, to conform with city ordinances or for appearance, it is recommended that painting be done only so far ahead of construction work as to permit the paint to dry before hauling the poles for setting. In St. Louis the city ordinances require that poles be painted. At the present time a great many pressure treated yellow pine poles are set in St. Louis, Missouri. These poles

present a very pleasing appearance as the pressure treatment has left the pole with a beautiful brown color and in such cases painting is not required in order to comply with the St. Louis City ordinances.

Storage of Poles.

Deterioration of poles held in storage can be avoided by proper care and piling.

Skids should always be used. These skids should be elevated or blocked up to provide a clear space of from eighteen inches to two feet from the ground to the bottom of the pole pile.

The ground under and around the pile should be kept clean of vegetation. The storage yard should not contain rotten pole butts or rotting wood of any kind, because any piece of decayed wood is a constant source of infection.

The point of contact between the poles and the skid produces a water pocket which is an ideal location for the propagation and growth of fungus, which causes decay. To prevent this decay, skid timbers should be given a liberal application of creosote. This application can be given with a broom or brush. Any rotten spots on the skid timbers should be very carefully cut away so that the skid timbers will not be a source of infection.

It is a good rule to re-roll any poles which have been stored in piles for more than twelve months. This changes points of contact between poles. At the time of rolling any spots of decay appearing on the poles should be shaven clean, followed by a heavy application of creosote on the area thus treated.

Preservatives.

Two general classes of preservatives are available for the treatment of timber. Both of these classes of preservatives have toxic properties that destroy fungous growth or make the timber immune to the destruction of the plant. These two classes of preservatives are salts and creosote.

Salts: Poisonous metallic salts, such as zinc chloride, mercuric chloride, copper sulphate, sodium fluoride, and various arsenic compounds have been employed in the treatment of various kinds of wood. These salts true enough have the necessary toxic properties to render them a suitable preservative but these salts are also soluble in water and thus the effectiveness of the treatment is lost due to the rains and other moisture to which poles are exposed. This latter failing renders the metallic salts practically useless as a preservative substance for poles.

Creosote: Creosote is most widely used as a preservative for wood in the United States. It penetrates easily and has excellent toxic properties. Creosote is obtained in the destructive distillation of tar; either coal tars, oil tars or wood tars. The composition of creosote varies greatly due to the tar from which it is distilled, the temperature at which it is distilled and other factors. Thus "creosote" has no fixed chemical composition but applies to all liquid distillates, heavier than water which are obtained in the distillation of tar. The

important creosotes for use in the treatment of woods are coal tar creosote, water gas tar creosote, wood creosote and low temperature tar creosote.

Decay of Timber.

Wood in its natural state contains food for a lower class of plant life known as fungi and unless some treatment is given the natural wood the above plant life tends to destroy such material.

Fungi are propagated by spores which correspond to seeds of more highly developed plants. These spores are very minute, and are carried about by the wind. These spores settle on wood and if the proper conditions exist, the spores take root. These roots are known as mycelia and tend to break up the original composition of the wood, absorbing the food elements and changing the entire structure of the wood. These mycelia are the body of the fungous plant which, like other plants produces a fruit. The fruit of the fungi is commonly known as toadstool, bracket or couch. The latter growths appear on the outside of the wood being attacked, and holds the spores which it broadcasts to the wind for distribution.

Favorable conditions must exist in order for the fungous spore to thrive after it is deposited on the wood by the wind. The conditions favorable to the growth of the fungus are air, mdsture, heat and food supply. To prove the fact that the fungus will not thrive without air, one need only mention the fact that wood submerged in water will not be attacked by the growth. To show that moisture is necessary to the prosperity of the fungus I shall mention the fact

that wood which is not subjected to the weather is generally well preserved. In the requirement of the fungus for a certain amount of heat in order that it might thrive, I merely cite a typical characteristic of all plant life. It is also quite natural that the fungi, being a living organism, cannot exist without a food supply. To make impossible the destruction of wood by a fungus we need only see that the growth is denied one of its vital requirements: air, moisture, heat or food supply.

Wooden poles as used in the electric lighting industry hold forth excellent conditions to the fungous growth for a hearty existance. The poles are especially susceptible to the growth at the ground line as the four requirements, air, moisture, heat and food supply all requirements at this point on a pole. As the poles are exposed to all sorts of weather no practicable means have been found to exclude the air, the moisture, or the heat from the surface, but it has been found practicable as well as highly profitable to treat the pole by various methods in such a manner that the wood, which is the food for the fungus, is rendered unfit as food for the destructive plant.

STANDARD METHODS OF TREATING POLES AS GENERALLY ACCEPTED BY UTILITY COMPANIES.

Five Standard Ways of Treating Poles are Used by Various Utilities Throughout the United States.

1) Brush treatment at individual pole yards.

2) AA treatment in open tanks (15 minutes hot creosote)

3) A treatment with open tanks (15 minutes hot carbolineum)

4) B " " " " (4 hours hot - 2 hours cold) creosote.

5) Pressure treatment throughout the entire length of the pole.

If the best material and workmanship is used any one of these methods is beneficial but varies in degree of success with the grade of material and workmanship. The first four methods can be used profitably only with seasoned poles. Authorities agree that penetration and oil stability are essential to lasting results. Any method selected insures greater line life if pure distillate of coal tar is used. The purity of the distillate is of great importance.

Ground Line and Minimum Length of Treated Section on Butt Treated Poles.

Length of Pole (Feet)	Distance of Ground Line Above-Butt	Minimum Length of Treated Section Measured from Butt of Pole (Feet)
20 or less	4	5½
25	5	6
30	5½	6½
35	6	7
40	6	7½
45	6½	7½
50	7	8
55	7½	8½
60	8	9
65	8½	9½
70	9	10

Brush Treatment

The brush treatment of poles consists in applying hot creosote to the surface of a pole with a brush. This method is not in general use among pole dealers, but is used by operating companies for local treatment.

For effective brush treatment the highest boiling point coal tar distillate obtainable is essential. High boiling creosote oils penetrate the wood readily. They are free from black and sticky tars that do not penetrate but concentrate on the outer wood cells.

The above treatment is more in use where native poles are used (regardless of kind of wood) and a very economical means of construction desired.

"AA" Treatment.

Provides for an immersion of poles butts in hot creosote oil for a minimum duration of fifteen minutes.

The penetration is usually one-sixteenth to one-quarter of an inch. This treatment is especially well adapted for lines where a few years service in addition to the natural life of the untreated pole is desired.

"A" Treatment.

Provides for an immersion of pole butts in hot carbolineum for a minimum duration of fifteen minutes.

Satisfactory results justifying the additional outlay for treating under this process are obtained.

"B" Treatment.

This treatment is sometimes called "hot and cold process", provides for the continuous submersion of the butts of the poles in hot creosote oil, for a minimum duration of four hours, followed by the immersion in cold creosote oil for an additional period of two hours. The theory is that subjecting the pole to the hot bath expels the moisture and expands the air in the cells of the sap wood. The cold bath which follows contracts the air, forming a partial vacuum which draws the preservative into the wood.

"B" treatment is without question the most satisfactory of the process treatments. No minimum penetration is guaranteed, but results are usually quite satisfactory, and often excellent. In treating a full carload of poles it is not unusual to find that 50% of the material has a full sap penetration. The remainder of the poles will show varied depths of penetration ranging from one to three-eighths of an inch.

The results in "B", as well as other process treatments, are controlled by two factors: the degree to which the poles have been seasoned, and the texture of the sap wood. As an average figure most companies expect a life of twenty years from poles treated by this process.

Pressure Treatment.

Pressure treatment is not required for the preservation of the more durable species of wood commonly used for poles, such as chestnut , northern white cedar and western red cedar, as these are subject to

rapid decay only at the ground line. Pressure treatment is necessary, however, for the different species of southern pine, as they decay rapidly even in the sections of the pole above the ground line.

International Rueping (Empty Cell Process) 8 Pounds Creosote, Final Retention.

General.

The following specification is intended to obtain an empty cell treatment of the poles; and if the material to be treated is in a different condition as to moisture and seasoning, material for each retort charge shall be selected as to condition of moisture so that there will be no great difference in degree of seasoning in any one charge. Only perfectly sound poles shall be treated. The treating plant shall be equipped with indicating and recording gauges and other necessary apparatus for accurately observing and recording the treating process. Above the level of the creosoting cylinder shall be an overhead drum for the purpose of determining when the cylinder is completely filled with the preservative and free from air, there shall also be a sap drum below the level of the cylinder for the purpose of assuring the complete removal of condensation. The treating plant must have all the necessary chemicals, a laboratory and laboratory apparatus to enable the quality of preservative to be determined.

Air-Seasoning.

In air-seasoning, the poles shall be stacked in such a manner as to provide free air circulation and minimum contact between individual

pieces in each stack. These stacks shall be placed on treated or otherwise permanent skids at least six inches above the ground on a well drained storage yard free from vegetation and decaying wood. Alleys between the stacks shall be continuous and straight. The material shall remain on the seasoning yard until it is sufficiently seasoned to obtain maximum benefit from the treatment.

Seasoning by Steam.

When time for air-seasoning is not available, steam seasoning shall be used. Live, saturated steam shall be admitted to the treating cylinder, taking care that all air is forced from the cylinder before the outlet valve is closed. Pressure shall then be raised gradually to the maximum temperature desired, which should not be less than 259°F. The duration of the steaming process is dependent upon the degree of seasoning of the poles in the cylinder charge, but shall in no case be carried to such an extent as to injure the timber.

Vacuum.

After the steaming process has been completed, the steam is blown off and the treating cylinder exhausted as quickly as possible to a vacuum of at least twenty-two inches at sea level, or proportionately less at higher altitudes. This vacuum shall be maintained for at least one hour, or for whatever longer period is necessary, so that the wood may be as dry and free from air as practicable. During the exhaustion process, the temperature within the treating cylinder shall be maintained by the introduction of steam into closed coils within the cylinder.

Initial Air Pressure.

The seasoned poles shall be subjected to an air pressure of sufficient intensity and duration (Generally 40 to 70 pounds) to provide, after the release of oil pressure, the ejection of preservative necessary to insure the required final retention.

Treatment.

The creosote oil shall be introduced, the air pressure being maintained constant, until the cylinder is filled to overflowing with oil at a temperature of not less than 175°F., nor more than 200°F. The oil must flow from the overhead drum on top of the treating cylinder, thus assuring that the cylinder is completely filled with the preservative. The pressure shall then be applied gradually and maintained at a sufficient intensity for a period of time necessary to obtain not only the largest practical volumetric injection that can be reduced to the required final retention (i.e. 8 pounds per cubic foot of wood), but also the maximum penetration which can be secured with the final retention of 8 pounds of creosote oil per cubic foot of timber. During this pressure period the temperature of the oil shall be maintained between 170°F. and 200°F.

Final Vacuum.

After the oil has been forced from the treating cylinder, a quick vacuum shall be drawn so as to remove surface oil, so leaving the poles clean.

International Bethel (Full Cell Process) 12 pound creosote, Final Retention.

General.

The following specification is intended to obtain a full cell treatment of the poles. The material to be treated in any one charge shall be of approximately the same degree of seasoning. Green and seasoned poles shall not be treated in the same charge. Only perfectly sound poles shall be treated. The treating plant shall be equipped with indicating and recording gauges and other necessary apparatus for accurately observing and recording the treating process. Above the level of the creosoting cylinder shall be an overhead drum for the purpose of determining when the cylinder is completely filled with the preservative and free from air; there shall also be a sap drum below the level of the cylinder for the purpose of assuring the complete removal of condensation. The treating plant must have all the necessary chemicals, a laboratory and laboratory apparatus to enable the quality of the preservative to be determined.

Air Seasoning.

In air-seasoning, the poles shall be stacked in such a manner as to provide free air circulation and minimum contact between individual pieces in each stack. These stacks shall be placed on treated or otherwise permanent skids at least six inches above the ground on a well drained storage yard free from vegetation and decaying wood. Alleys between the stacks shall be continuous and straight. The material shall remain on the seasoning yard until it is sufficiently seasoned to obtain maximum benefit from the treatment.

Seasoning by Steam.

When time for air-seasoning is not available, steam seasoning shall be used. Live, saturated steam shall be admitted to the treating cylinder, taking care that all air is forced from the cylinder before the outlet value is closed. Pressure shall then be raised gradually to the maximum temperature desired, which should not be less than 259°F. The duration of the steaming process is dependent upon the degree of seasoning of the poles in the cylinder charge, but shall in no case be carried to such an extent as to injure the timber.

Vacuum.

After the steaming process has been completed, the steam is blown off and the treating cylinder exhausted as quickly as possible to a vacuum of at least twenty-two inches at sea level, or proportionately less at higher altitudes. This vacuum shall be maintained for at least one hour, or for whatever longer period is necessary, so that the wood may be as dry and free from air as practicable. During the exhaustion process, the temperature within the treating cylinder shall be maintained by the introduction of steam into closed coils within the cylinder.

Treatment.

The creosote oil shall be introduced, without breaking the vacuum, at a temperature not less than 180°F., and not more than 200°F., until the cylinder is filled to overflowing. The oil must flow from the overhead drum on top of the treating cylinder, thus assuring that the cylinder is completely filled with the preservative. The pressure shall then be applied gradually until such an amount of oil has been injected into the poles as to provide a final retention of 12 pounds of creosote

oil per cubic foot of timber. After the pressure is completed and the cylinder emptied of oil a quick vacuum shall be drawn so as to remove surface oil, so leaving the poles clean.

SPECIFICATIONS FOR ANALYSIS OF CREOSOTE.

These specifications describe methods for the analysis of dead oil of coal tar or coal tar creosote. They shall be followed in determining the properties of oil furnished under any specifications in which reference is made to this text for methods of analysis.

These methods include all direction necessary for ascertaining whether the material submitted has the particular properties required by the specifications for dead oil or creosote, but it is not intended to describe herein all the methods of analysis which may be employed to determine whether the material is an unadulterated derivative of gas tar prepared by the processes of manufacture permitted by the specifications for dead oil or creosote.

A form for reporting the results and a list of apparatus and materials required in making the analysis are included in these specifications.

Sample: About one (1) quart of oil will be required for a complete analysis. The sample shall not be taken from the tank, can or other receptacle until the oil has been completely liquefied and well mixed. Before analyzing, the sample shall be thoroughly liquefied and well mixed by shaking and stirring. One-half shall be analyzed, as given below, and the other half held in reserve for a check test should such be desired.

Specific Gravity: The specific gravity of the oil shall be obtained by nearly filling the hydrometer cylinder with the liquefied oil and placing the cylinder in water which shall then be heated until the temperature of the oil is several degrees higher than that at which the specific gravity is to be taken. The water shall then be allowed to cool until the oil has

reached the temperature specified for the determination of the specific gravity.

The oil shall then be thoroughly stirred, the hydrometer placed in the cylinder, and the reading carefully observed. Care must be taken that the hydrometer does not touch the bottom or sides of the cylinder when the reading is made.

Fluidity: The fluidity of the oil shall be determined by heating about one hundred (100) cubic centimeters of oil in a beaker, to a temperature at least seven degrees Centigrade (7°C.) above the limiting temperature specified for the separation of solid particles. The oil shall then be allowed to cool gradually. When the limiting temperature of the specifications is reached, the oil shall be carefully examined, using a glass stirring rod. No solid crystalline particles should appear on the rod when withdrawn from the oil.

Distillation: The apparatus for the distillation of the oil shall be arranged as shown on drawing No. 92-E-20 or No. 88-E-95. The retort shall conform in all respects to drawing No. 126-B-17.

Before attaching the retort to the ring stand, it shall be accurately weighed on the pan balance. Then without removing the retort from the balance pour exactly one hundred (100) grams of thoroughly liquefied oil into the retort. This can readily be done by using a glass dropper to add the last drops.

Before the distillation is begun, the thermometer shall be so fitted through the stopper in the neck of the retort that the bulb is one-half (1/2) of an inch above the surface of the oil. The thermometer shall not be moved during the distillation. The retort shall rest on a wire gauze sheet

having twelve meshes to the linear inch and shall be protected by an asbestos shield as shown in drawing No. 92-E-20 or No. 88-E-95.

The heat applied to the retort shall be so regulated that the distillate passes over at the rate of about sixty drops per minute, i.e., one drop per second.

It is to be understood that the distillation has commenced as soon as the first drop of the distillate appears in the delivery tube of the retort and ended when a temperature of three hundred and sixty degrees Centigrade (360°C) is reached.

The distillation of some samples of oil may be accompanied, especially during the first few moments, by a violent spattering of the liquid and small quantities may go over into the receivers (small Erlenmeyer flasks or test tubes.) This can usually be avoided by gently shaking or moving the ring stand and retort so that the oil is kept in motion.

Distillate: The fractions of the distillate shall be separated at the temperature given in the table below and collected in separate receivers. The weights of the receivers shall be accurately determined before the distillation.

Receiver	Temperature	Fraction
#1	to 170°C.	Water, hydrocarbons and phenols.
#2	170°C. - 205°C.	Phenols and cresols.
#3	205°C. - 210°C.	Naphthalene and phenols.
#4	210°C. - 235°C.	"
#5	235°C. - 245°C.	" and anthracene oil.
#6	245°C. - 270°C.	Anthracene oil.
#7	270°C. - 300°C.	" " and anthracene.
#8	300°C. - 315°C.	" " " "
#9	315°C. - 360°C.	" " " "
#10	360°C. - and above	Residue in retort.

After the completion of the distillation, the receivers and the retort with their contents shall be accurately weighed and the percentage of the various fractions computed.

The sum of the per cents obtained in all the fractions shall be ascertained and its difference from one hundred per cent. recorded as the loss per cent. The loss should not exceed one-half of one per cent. (0.5%) except when there is a considerable amount of water present. If the loss is found to be large when a sample containing little water or other low boiling constituents is distilled, the distillation shall be repeated after the computations have been checked in order to ensure their freedom from error.

Computations based on the results of fractionations which have been carried out with satisfactory freedom from loss shall be made to cover all percentage limits specified for distillation.

Water: To determine the amount of water in the oil, transfer the contents of receiver No. 1 to a small separatory funnel. If the separation of the water from the other constituents in the funnel is well defined, draw off the water into a small Erlenmeyer flask or a test tube and determine its weight.

Should the separation not be well defined, pour a small amount of ether into the funnel and shake. Allow the contents to settle and then draw off the water from the ethereal solution. Weigh the water and compute the per cent. present.

The ethereal solution shall then be warmed, to expel the ether, and the oil or remainder reserved for the tar acids test.

The ether used for this purpose should be free from alcohol and may be prepared in the following manner. Shake a convenient quantity of commer-

cial sulphuric ether in a separatory funnel with one-half of its volume of distilled water and then let the water run out. Repeat the washing of the ether twice with fresh lots of water. Let the moist alcohol-free ether thus obtained stand over about one-half its weight of dry calcium chloride in a stoppered flask or bottle for at least two hours and filter through paper before using.

Sulphonation Residue: This test should be made on fractions No. 8 and No. 9. Heat these two fractions until they are liquid and mix thoroughly. Place ten (10) grams of the mixed fractions, accurately weighed, in a Babcock milk test bottle. Add to this thirty cubic centimeters (30 cc.) of thirty-seven (37) times normal sulphuric acid in three equal portions. Shake the bottle and contents for two (2) minutes after each addition of acid. After all the acid has been added, keep the bottle at a constant temperature of from ninety-eight (98) to one hundred (100) degrees Centigrade for an hour, shaking vigorously every ten (10) minutes. At the end of the hour remove the bottle from the hot bath and fill to the top of the graduation with a Babcock separator. Measure the unsulphonated residue which should now be collected in the graduated neck of the bottle, and record its volume in cubic centimeters. The bottles are graduated to fifths of a cc. and readings should be estimated to the nearest quarter of a subdivision. The cc. observed multiplied by ten (10) represents the per cent. residue.*

For heating during the sulphonation a steam-jacketed oven may be used, or if this is not available the bottles may be suspended in a dish of boiling water.

Acid of the required strength is made of mixing two hundred and sixty-nine (269) parts, by weight, of fuming acid (84.56% sulphur trioxide) with four hundred and forty-nine (449) parts of sulphuric acid (sp. gr. 1.84).

Since the sulphur trioxide content of the fuming acid varies somewhat, it is best in field inspections to have this mixture made in the laboratory and shipped to place of use.

Tar Acids: The volume of tar acids in the oil shall be determined in the following manner. The fractions from No. 1 to No. 7 inclusive shall be collected in a beaker of about three hundred cubic centimeters capacity and thoroughly mixed by stirring. Thirty (30) cubic centimeters of caustic soda solution (specific gravity 1.20) shall be added to the oil and the whole shall be heated gently for two (2) minutes with frequent stirring. The oil and soda solution shall then be transferred to a large separatory funnel and shaken vigorously for at least one (1) minute. The mixture shall then be allowed to settle and the soda solution, which forms the lower layer of liquid, drawn off and saved.

This operation shall be repeated a second and a third time using twenty (20) cubic centimeters of the soda solution each time.

* In reading the quantity of sulphonation residue, it is to be noted that with the standard Babcock milk test bottle,
5 full divisions = 1 cc. and are equivalent to 10% residue
1 " " = 0.2 cc. and is equivalent to 2% residue
1 subdivision = .04 cc. and is equivalent to 0.4% residue
1/4 " .01 cc. and is equivalent to 0.1% residue

The three soda solutions shall now be mixed together, boiled vigorously for five (5) minutes and allowed to cool. Dilute sulphuric acid (one (1) part of acid (sp. gr. 1.84) added to three (3) parts of water) is then added until the solution begins to change litmus paper from a blue to a red color. About thirty-five (35) cubic centimeters of acid will be required and care must be taken that the solution is kept cool while adding the acid.

The entire solution shall now be transferred to a separatory funnel and allowed to stand until the tar acids are well separated.

The volume of the tar acids shall then be measured in a vessel graduated in cubic centimeters and the percentage computed by dividing this value by the volume of the oil taken for distillation; viz. original weight of oil divided by the specific gravity.

Flashing Point: Place an evaporation dish about four inches (4") or four and one-half inches (4-1/3") in diameter on an asbestos diaphragm of sufficient size to extend several inches beyond the dish. A hole about one-half the maximum diameter of the dish should be cut in the center of the diaphragm and the dish set therein. Cover the bottom of the dish with dry sand to a depth of about one-quarter of an inch (1/4") and place a deep form evaporation dish, about three inches (3") in diameter, on the sand. Fill the remaining space between the two dishes with sand until it reaches nearly to the rim of the inner dish. A thermometer should be arranged so that the bulb is inside and about one-quarter of an inch (1/4") above the bottom of the inner dish. Pour some of the liquefied oil into the dish until it is about three-quarters full. Care should be taken that the bulb of the thermometer is completely covered by the oil. Place a low flame beneath the sand bath, with a suitable guard to protect it from draughts, which should be carefully excluded from the vicinity of the testing apparatus. Heat so that the temperature of the oil will increase about three degrees (3°) per minute. Apply a small flame to the surface of the oil for every two degrees (2°) rise of temperature until the flame flashes across the surface of the oil. The temperature of the oil when this occurs is the

flashing point.

Burning Point: Continue the heating and the application of the testing flame until the oil ignites and burns for five seconds or more. The temperature, when this occurs, is the burning point.

Benzol Test: To determine the per cent. insoluble in benzol weigh a ten (10) gram sample of the dead oil into a small beaker (about 100 to 150 cubic centimeters capacity); add twenty (20) cubic centimeters of benzol and filter, using a weighed Alundum crucible to receive the insoluble material. Wash thoroughly with benzol, either hot or cold; dry at 110° Centigrade; weigh and compute the per cent. of insoluble material.

Suction may be used as an aid in filtering and washing or the final washing may be carried out in the vapors of hot benzol. In this latter case the crucible should be covered by an inverted watch-glass, and the washing continued until the drippings from the crucible are perfectly clear. (Three to six hours may be necessary for this.) As convenient for this purpose we recommend either the Wiley glass extraction apparatus or the extractor known as the Underwriters' Laboratories extraction apparatus, arranged as shown in the drawing hereinafter referred to. If the washing is carried out by filtration alone, it should be continued until 10 cc. of the washings show no more color than 10 cc. of a standard solution when compared in test tubes under similar conditions of light and quantity. The standard solution is made up by adding one drop of dead oil to 200 cc. of benzol.

If the oil contains a very large amount of pitchy material, it is permissible to use a smaller sample to facilitate the washing.

Acetic Acid for Acetates: If the oil is to be used for the treatment of duct, the following method shall be employed to determine whether it contains acids of the acetic series or their salts.

Weigh a one hundred (100) gram sample into a one-liter round bottom flask. Add five (5) grams of glacial phosphoric acid dissolved in 15-20 cc. of water. Distill with steam using a condenser fitted with a glass rod to be used as a ram for removing solid napthalene in case of clogging. Collect at least two hundred (200) cc. of distillate. Add five (5) grams of powdered chemically pure calcium carbonate. Heat in an Erlenmeyer flask, using a reflux condenser, for 5 to 10 minutes. Cool and filter. Evaporate the filtrate to dryness and ignite at a temperature sufficient to burn off all organic matter. Cool and dissolve the residue in a slight excess of tenth normal ($\frac{n}{10}$) nitric acid, using phenolphthalein as in indicator. Note the quantity of acid added. Boil to expel carbon dioxide, cool and titrate with a ten normal ($\frac{n}{10}$) solution of sodium hydrate to determine excess of acid. Compute the number of cc. of acid required for reaction with the residue. If the quantity of acid used exceeds five (5) cc. report that the test shows the presence of acids of the acetic series of their salts.

Computations and Report: The results of the analysis of the oil shall be calculated on the basis of the water-free oil if more than 2% of water is present. If less than 2% of water is present, allowance shall not be made for it in computing the results. The results shall be recorded in the following form.

Analysis of Dead Oil of Coal Tar

Sample No.:
Manufactured by:
Purchased from: Date 191

A. Specific Gravity at *° C.:

B. Condition at *°C.:

C. Distillation of 100 grams:

(1) Oil distilling below *° C.: Per cent.

(2) Oil not distilling below *°C. "

(3) Water: "

(4) Tar Acids: "

(5) Sulphonation residue: "

D. Insoluble in Benzol: "

* Insert specification temperature limit or limits.

**E. Acetic Acid or Acetates:

Fractionation.

Weight of Retort

" " " plus sample

Fraction Number	Temperature	Per Cent.	Weight of Vessel	Weight of Vessel and Contents	Weight of Contents
1.	to 170°C.				
2.	170°C. to 205°C.				
3.	205°C. to 210°C.				

** This feature to be reported only when oil may be used for treatment of duct.

4.	210°C. to 235°C.				
5.	235°C. to 245°C.				
6.	245°C. to 270°C.				
7.	270°C. to 300°C.				
8.	300°C. to 315°C.				

9. 315°C. to 360°C.

10. Residue (in retort)

Total per cents found:

Loss per cent.

Cleaning Apparatus: The retort, flasks or test tubes, beakers, etc., should be thoroughly cleaned after each analysis. To remove the residue from the retort, add some oil and heat until residue is all dissolved. Pour out the oil and wash with hot water and sapolio.

Drawings: The following drawings form a part of these specifications:

Drawing No. 92-E-20 or No. 88-E-95) Arrangement of Apparatus for Distillation Test.

" No. 126-B-17 - Standard Retort.

" No. 92-E-19 - Use of Extractor in Benzol Test.

Note A. The following apparatus and chemicals will be required for the test of oil in accordance with these specifications:

Apparatus

6 - 8 ounce glass retorts(as per drawing No. 126-B-17)

2 - Distilling flasks (25 cc.)

(36 - 50 cc. Erlenmeyer flasks or

(36 - 7 inch test tubes.

12 -6 inch test tubes.

2 - Nitrogen bulb thermometers (-30° to 400° Centigrade).
Length of scale 12-7/8" (Standardized)

1 - Hydrometer - specific gravity = 1.00 to 1.20

2 - Glass hydrometer cylinders.

2 - Large glass funnels.

2 - Small glass funnels.

1 - Copper water bath.

1 - Iron ring stand with clamps and rings.

1 - Berzelius alcohol lamp (replaced by Bunsen burner if gas can be had)

1 - Two bottle milk testing centrifuge.

8 - Babcock milk test bottles graduated to 10 per cent. in 1/5 per cent.

2 - 10 cc. Pipettes.

1 - Tin can large enough to hold hydrometer cylinder.

2 - Agate ware dippers (about one (1) quart capacity).

2 - Agate ware dippers (about one (1) pint capacity).

1 - Pan Balance (sensibility 2 mgs.) and weights (300 gm. to 1 mg.)

12 - Cork stoppers (fitted for retorts.)

3 - Triangular files.

3 - Rat-tail files.

4 - Test tube cleaners.

2 - Flask cleaners.

2 - Test tube racks.

1 - Glass separatory funnel (about 125 cc. capacity)

1 - Glass separatory funnel (about 250 cc. capacity)

1 - Glass separatory funnel (about 50 cc. capacity)

Asbestos paper - 1/16" in thickness and flexible(to be used for making shield to protect retort during distillation.)

Asbestos board - 1/8" in thickness (for supporting sand bath in flash point test.)

1 - Graduated cylinder (10 cc. capacity - graduated in fifth of a cc.)

1 - Graduated cylinder (50 cc. capacity)

1 - Graduated cylinder (500 cc. capacity)

2 - Alundum crucibles (25 cc. capacity)

1 - Box gummed labels.

12 - Test tube holders.

1 - Pair pincers for handling weights.

1 - Box sapolio.

1 - Glass medicine dropper.

1 - Gasolene heater (if gas cannot be had.) Barthel's gasoline burner is recommended.

1 - Kettle for hot water.

Wire gauze for retort support (should have 12 meshes to linear inch.)

Glass beakers (150,400 and 600 cc. capacity - 2 of each.)

Glass stirring rods.

Blue litmus paper.

1 - Iron tripod (if gas can be had.)

2 - Bunsen burners (if gas can be had.)

Rubber tubing to fit gas burners.

3 - Porcelain evaporating dishes about 3" in diameter (deep form.)

2 - Iron or enamel ware evaporating dishes about 4" to 4 1/2" in diameter.

Small blow pipe for flask test.

2 - Extractors (if desired for benzol test.)

(If suction is available and will be used in benzol test filtration)

1 - Spencer's glass funnel with rubber ring for use with Alundum crucible.

1 - Side neck filtering flask, Erlenmeyer shape. 500 cc. capacity.

3 - One-hole rubber stoppers, to fit filtering flask.

1 - Medium sized filter pump.

Rubber tubing to connect up pump.

(Additional apparatus required if test for "Acetic Acid or Acetates." is to be made).

2 - 25 cc. Buretts (graduated in 20ths of a cc.)

3 - No. 2 Porcelain crucibles (50 cc. capacity)

1 - 12 inch Allihm's condenser.

3 - 500 cc. Erlenmeyer flasks.

2 - 250 cc. Erlenmeyer flasks.

1 - 1 liter round bottom flask.

10 - feet No. 4 glass tubing.

Rubber tubing to fit.

Chemicals.

1 - Pound C.P. caustic soda (purified by alcohol.)

1/2 - Pound Calcium chloride (dry).

1 - Bottle C.P. sulphuric acid (sp. gr. 1.84)

1 - Bottle C.P. hydrochloric acid (sp. gr. 1.20)

1 - Bottle C.P. nitric acid (sp. gr. 1.42)

1 - Pound ether.

1 - Pound Benzol (Merck's Reagent.)

1 - Bottle standard acid for sulphonation test (37 times normal sulphuric acid).

2 - Quarts alcohol (if gas cannot be had.)

1 - Gallon Gasoline (if gas cannot be had.)

(Additional chemicals required if test for "Acetic Acid or Acetates" is to be made.)

1 - Pound C.P. glacial phosphoric acid.

1 - Pound C.P. calcium carbonate.

Phenolphthalein solution.

CREOSOTE OIL SPECIFICATIONS.

General.

The material desired under these specifications is that known as dead oil of coal tar or coal tar creosote, obtained through the distillation of gas tar produced by the destructive distillation of bituminous coal either in the manufacture of coal gas or in the manufacture of coke by the by-product process. It shall be without adulteration. Information shall be furnished on request as to the origin of the oil and the names of the parties through whose hands it may have passed. A copy of any analysis of the oil that may have been made prior to its use shall also be furnished.

The right is reserved to take representative samples of the oil and test the same wherever desired.

Requirements.

All dead oil of coal tar furnished under these specifications shall conform to the following requirements:

1st: The oil shall have a specific gravity of at least one and three hundredths (1.03) at thirty-eight degrees Centigrade (38°C).

2nd: The oil shall be thoroughly liquid at a temperature of thirty-eight degrees Centigrade (38°C.)

3rd: When one hundred grams of the oil are distilled in accordance with the requirements of the specifications for the analysis of dead oil of coal tar or coal tar creosote hereinafter referred to -

(a) Not more than five (5) per cent. shall distill off up to 205°C.

(b) Not more than forty (40) per cent. shall distill off up to 235°C.

(c) Not more than eighty (80) per cent. shall distill off up to 315°C.

(d) The oil shall not contain more than *two (2) percent. of water.

*Note: When unseasoned timber is being treated for the telephone company by the cylinder pressure process using steam for seasoning the oil may contain not more than five (5) per cent. of water. But in case more than two (2) per cent. of water is present in the oil, the quantity of the preservative added to the timber shall be increased by an amount sufficient to ensure that the required amount of oil computed on a water-free basis has been taken up by the timber.

(e) The quantity of tar acids present in the fractions distilling below 300°C. shall not exceed ten (10) per cent. (measured by volume) of the total sample distilled.

(f) The sulphonation residue from the fraction distilling between 300°C. and 360°C. shall not exceed two (2) per cent. (measured by volume) of the said fraction.

4th: The constituents of the oil insoluble in benzol shall not exceed one (1.0) per cent. by weight.

5th: When oil is intended for use in the treatment of wood duct it shall be free from acids of the acetic series and their salts.

Analysis.

The oil shall be analyzed in accordance with the methods outlined in the specifications for the Analysis of Dead Oil of Coal Tar of Coal Tar Creosote.

Subsidiary Specifications.

The following specifications form a part of these specifications:

Specifications for the Analysis of Dead Oil of Coal Tar or Coal Creosote.

POLE SPECIFICATIONS.

NATIONAL ELECTRIC LIGHT ASSOCIATION

SPECIFICATIONS FOR

CHESTNUT POLES.

Specifications for chestnut poles as per the 1923 report of the Overhead Systems Committee of the National Electric Light Association.

Material.

The poles shall be of chestnut (Castansa Dentata), well proportioned from butt to top. All poles shall be thoroughly sound, straight and free from defects, except as hereinafter set forth.

Blighted Poles.

Poles injured or killed by the chestnut blight fungus shall not be furnished under this specification.

Fire Killed Poles.

Fire killed poles, when furnished under this specification, shall have been cut within one year after the killing; all sapwood shall be free from char and rot, and the pole shall in all respects satisfy the requirements of this specification without any exceptions as to checking and splitting.

Condition of Wood.

Poles having dead streaks or brashy wood appearing over more than one-quarter of their surface shall not be furnished under this specification. Poles having dead streaks covering less than one-quarter of their surface shall have a circumference sufficiently greater than that hereinafter required for their length and class to afford a cross-sectional area of sound wood equivalent to that of sound poles of the same class and length.

Decay.

Poles shall be free from sap rot and all other forms of decay or rot which attack the cut timber, and from all signs or evidences of the

presence of fungus growth.

Insect Damage.

The scaring or channeling of the pole surface by insects working under bark shall not be classed as insect damage. Pin worm holes or larger insect holes entering the body of the pole by insects, worms, or grubs, shall be considered insect damage. All poles furnished under this specification shall be free from insect damage.

Grain.

No poles shall have more than one complete twist of grain in any 20 feet of length.

Large Checks.

All poles shall be free from large or injurious checks.

Knots.

Sound knots will be permitted in any section of the pole. Knots showing evidence of past decay to a depth not exceeding 1/2 inch will be permitted in any section of the pole except the section between the butt and a point 2 feet above the ground line. The diameter of any single knot shall not, however, exceed one-third the diameter of the pole at that point, and the sum of the diameters of all knots in any 2 foot section shall not exceed one-half the diameter of the pole at that section. In all cases the diameter of the knot shall be considered to be its least diameter. Loose knots or knots showing signs of past decay to a depth greater than 1 inch or active decay, or of insect damage shall not be present in any part of the pole.

Scars.

Scars or catfaces will not be permitted between the butt and a

point 2 feet above the ground line. Poles having scars or catfaces whose distance from the top of the pole is less than the distance given for its length class in the following table shall be rejected. Catfaces will be permitted in the body of the pole, providing the cross-section of the pole is not materially reduced.

Length of Pole	Distance from top
16 ft.	2 ft.
18 "	2 "
20 "	3 "
25 "	3 "
30 "	5 "
35 "	7 "
40 "	9 "
45 "	11 "
50 "	13 "
55 "	17 "
60 "	21 "
65 "	25 "

Defective Butts.

No poles shall split butts. All pole butts shall be free from butt rot, ring rot, or other hollowing except in the central portion, where hollow heart, butt rot or ring rot is permitted, provided that the distance from the pith center is not more than one-third of the distance from the pith center to the edge of the butt surface and that the depth of any ring rot measured from the butt sur-

face is not more than 2 feet.

Partial or complete circular shakes (sometimes termed "cup-shakes") may be permitted on the butt surface only, provided that the diameter of the ring which they follow is not more than one-third of the diameter of the butt. Checks radiating from the pith center of the butt (sometimes called "star-shakes") are permitted provided that they do not extend outward from the pith center to the pole surface in such a way as to split off a section of the butt.

Defective Poles.

All poles shall be free from split, shakey, hollow or decayed tops.

Miscellaneous Defects.

No poles shall contain woodpecker holes, or plugged holes, and no shaved poles or bracked poles shall be furnished under these specifications.

Dimensions, Shape and Finish.

Length.

Poles under 50 feet in length shall not be over 3 inches shorter or 6 inches longer than the length specified in the order. Poles 50 feet or more in length shall not be over 6 inches shorter or 12 inches longer than the length specified in the order.

Circumference.

Poles shall be classified with respect to their circumference at 6 feet above the butt end of their top in accordance with the table set forth below. This table gives minimum allowable circumference at

6 feet above the butt and at the top for poles of each class, and shall not preclude the acceptance of poles having greater circumference at these points of measurement than those given in the table.

Shape and Finish.

Poles shall be free from all deviations from straightness except sweep in one plane only. The amount of sweep between the top and butt of these poles shall be such that a straight line connecting the points in the butt and top circumferences lying the plane of the sweep, shall not deport from the surface of the pole more than 1 inch for each 5 feet of length. All poles shall have the outer bark completely peeled, and all knots and limbs closely trimmed. All poles shall be neatly sawed square at the butt and top.

Marking.

All poles shall have the length and class stenciled or branded on the butt, together with the name or symbol of the company selling the poles. All marks interfering with the legibility of the required markings shall be removed. All poles shall be scored with a cross at a point ten feet from the butt.

Storage.

Poles accepted under these specifications which are not at that time or immediately thereafter placed for setting or which are not to be loaded in cars within two weeks, shall be stored on skids in such a manner as to be sustained at all points at least 1 foot above the surface of the ground. No decayed or decaying wood shall be permitted to remain underneath stored poles. Any material under the poles not a part of the skids and any vegetation growing under the poles shall be considered a part of the ground. See Table A following for minimum circumference of poles (chestnut).

NATIONAL ELECTRIC LIGHT ASSOCIATION

SPECIFICATIONS FOR

NORTHERN WHITE CEDAR POLES.

National Electric Light Association Specifications for Northern White Cedar Poles.

The material desired under these specifications consists of poles of the best quality of either seasoned or live green cedar of the dimensions hereinafter specified. Seasoned poles shall have preference over green poles provided they have not been held for seasoning long enough to have developed any of the timber defects hereinafter referred to. All poles shall be reasonally straight, well proportioned from butt to top, shall have both ends squared, the bark peeled and all knots and limbs closely trimmed.

Dimensions.

The dimensions of the poles shall be in accordance with the following table, the "top" measurement being the circumference at the top of the pole and the "butt" measurement the circumference six (6) feet from the butt.

Minimum Dimensions of Poles in Inches (Circumference)

Length of poles Feet	Classes					
	A		B		C	
	Top	6' from Butt	Top	6' from Butt	Top	6' from Butt
25	-	-	22	32	18.75	30
30	24	40	22	36	18.75	33
35	24	43	22	38	18.75	36
40	24	47	22	43	18.75	40
45	24	50	22	47	18.75	43
50	24	53	22	50	18.75	46
55	24	56	22	53	18.75	49
60	24	59	22	56	-	-

When the dimension at the butt is not given the poles shall be reasonably well proportioned throughout their entire length.

The dimension requirement of the six (6) foot mark shall be rigidly followed in all cases. Class A, B and C poles may have top circumference

not more than one half (1/2) inch less than those shown in the preceding table. No pole shall be over six (6) inches longer or three (3) inches shorter than the length for which it is accepted; if any pole be more than six inches longer than is required it shall be cut back.

Quality of Timber.

Dead Poles. The wood of a dead pole is grayish in color. The presence of a black line on the presence of sap wood "as seen on the butt" also shows that a pole is dead. No dead poles, and no poles having dead streaks covering more than one-quarter of their surface shall be accepted under these specifications. Poles having dead streaks covering less than one quarter of their surface shall have a circumference greater than otherwise required. The increase in the circumference shall be sufficient to afford a cross-sectional area of sound wood equivalent to that of sound poles of the same class.

Fire Killed or River Poles. No dark red or copper colored poles, which when scraped do not show good live timber shall be accepted under these specifications.

Twisted, Checked or Cracked Poles. No poles having more than one complete twist for every twenty (20) feet in length, no cracked poles containing large season checks shall be accepted under these specifications.

Shaved Poles. No shaved poles shall be accepted under these specifications.

Miscellaneous Defects. No poles containing sap rot, evidence of internal rot as disclosed by a careful examination of all black knots,

hollow knots, woodpecker holes, or plugged holes; and no poles showing evidence of having been attacked by ants, worms or grubs shall be accepted under these specifications, except that poles containing worm or grub marks below the six (6) foot mark will be accepted.

Crooked Poles. No poles having a short crook or bend, a crook or bend in two planes or a reverse curve shall be accepted under these specifications. The amount of sweep, measured between the six foot mark and the top of the pole, that may be present in poles acceptable under these specifications, is shown in the following table:

35	foot	poles	shall	not	have	a	sweep	over $10\frac{1}{2}$ inches
40	"	"	"	"	"	"	12	"
45	"	"	"	"	"	"	9	"
50	"	"	"	"	"	"	10	"
55	"	"	"	"	"	"	11	"
60	"	"	"	"	"	"	12	"

Defective Tops. Poles having tops of the required dimensions must have sound taps. Poles having tops one (1) inch or more above the requirements in circumference may have one (1) pipe rot not more than one-half (1/2) inch in diameter. Poles with double tops or double hearts shall be free from rot where the two parts or hearts join.

Defective Butts. No poles containing ring rot (rot in the form of a complete or partial ring) shall be accepted under these specifications.

Poles having hollow hearts may be accepted under the conditions shown in the following table:

Ave. Diameter of Rot	Add to Pole Requirements: Of 25 and 30 foot poles	Of 35, 40 and 45 foot poles	Of 50, 55, 60, and 65 foot poles
2"	Nothing	Nothing	Nothing
3"	1"	"	"
4"	2"	"	"
5"	3"	1"	"
6"	4"	2"	1"
7"	Reject	4"	2"
8"	"	6"	3"
9"	"	Reject	4"
10"	"	"	5"
11"	"	"	7"
12"	"	"	9"
13"	"	"	Reject

Scattered rot, unless it is near the outside of the pole may be estimated as being the same as heart rot of equal area.

"Wind Shakes". Poles with cup shakes (checks in the form of rings) which also have heart or star checks may be considered as equal to poles having hollow hearts of the average diameter of the cup shakes.

Inspection. All poles shall be subject to inspection by the purchaser's representative, either in the woods where the trees are felled, or at any point of shipment, or destination. Each pole thus inspected shall be marked according to its length and class with a marking hammer, by the purchaser's representative. All poles failing to meet specifications shall be rejected.

NATIONAL ELECTRIC LIGHT ASSOCIATION

SPECIFICATIONS FOR

WESTERN RED CEDAR POLES

National Electric Light Association

Specification for

Western Red Cedar Poles.

The material desired under these specifications consists of poles and guy stubs of the best quality of either seasoned or live green cedar of the dimensions hereinafter specified. The poles covered by these specifications are of Western Red Cedar. Seasoned poles shall have preference over green poles, provided they have not been held for seasoning long enough to have developed any of the timber defects hereinafter referred to. All poles shall be reasonably straight, well proportioned from butt to top, shall have both ends squared, sound tops, the bark peeled, and all knots and limbs closely trimmed.

The dimensions of the poles shall be in accordance with the following table, the "top" measurement being the circumference at the top of the pole, and the "butt" measurement, the circumference six feet from the butt. The dimensions given are the minimum allowable circumferences at the point specificed for measurement and not intended to preclude the acceptance of poles of larger dimensions.

When the dimension at the butt is not given, the poles shall be reasonably well proportioned throughout their entire length. No pole shall be over six inches longer, or three inches shorter than the length of which it is accepted. If any pole is more than six inches longer than is, required, it shall be cut back.

Minimum Dimensions of Poles In Inches.

Length of Poles	Class A Minimum Circumference	Class B Top 6 feet from butt.	Class C Circumference	Class D	Class E	Class F
	28"	25"	22"	18½"	15"	12"
20'	30"	28"	26"	24"	No	No
22'	32	30	27	25	Butt	Butt
25'	34	31	28	26	Require-	Re-
30'	37	34	30	28	ments	quire- ments
35'	40	36	32	30		
40'	43	38	34	32		
45'	45	40	36	34		
50'	47	42	38	36		
55'	49	44	40	38		
60'	52	46	41	39		
65'	54	48	43			

Quality of Timber.

Dead Poles. No dead poles and no poles having dead streaks covering more than one quarter of their surface shall be accepted under these specifications. Poles having dead streaks covering less than one quarter of their surface shall be accepted under these specifications. Poles having dead streaks covering less than one quarter of their surface shall have a circumference greater than otherwise required. The increase in the circumference shall be sufficient to afford a cross-sectional area of

sound wood equivalent to that of sound poles of the same class.

Twisted, Checked or Cracked Poles.

No poles having more than one complete twist for every twenty feet in length, no cracked poles and no poles containing large season checks shall be accepted under these specifications.

Crooked Poles.

No poles having a short crook or bend, a crook or bend in two planes or a reverse crook or bend shall be accepted under these specifications. The amount of sweep measured between the six foot mark and the top of the pole, shall not exceed one inch to every six feet in length.

"Cat Faces."

No poles having "cat faces" unless they are small and perfectly sound and the poles have an increased diameter at the "cat faces", and no poles having "cat faces" near the six foot mark or within ten feet of their tops shall be accepted under these specifications.

Shaved Poles.

No shaved poles shall be accepted under these specifications.

Wind Shakes.

No poles shall have cup shakes (checks in the form of rings) containing heart or star shakes, which enclose more than ten per cent of the area of the butt.

Butt Rot.

No poles shall have butt rot covering in excess of ten per cent of the total area of the butt. The butt rot, if present, must be located close to the center in order that the pole may be accepted.

Knots.

Large knots, if sound and trimmed close shall not be considered a defect. No poles shall contain hollow or rotten knots.

Miscellaneous Defects.

No poles containing sap rot, woodpeckers' holes or plugged holes, and no poles showing evidence of having been eaten by ants, worms or grubs, shall be accepted under these specifications.

Marking.

Every pole shall be scored with a cross at a point ten feet from the butt.

SPECIFICATIONS FOR

CREOSOTED YELLOW PINE POLES

These specifications cover poles of southern yellow pine meeting the requirements specified herein, divided into classes with respect to dimensions, and treated with preservative as hereinafter described. Orders for poles under these specifications should state the desired length and circumference class. If framing different from that hereinafter specified is desired, the order should also include full details.

GENERAL

Poles shall be of southern yellow pine (long leaf, short leaf, Cuban or loblolly), well proportioned from butt to top, sound, straight, and free from defects, except as hereinafter set forth.

QUALITY OF TIMBER

General

All poles shall be free from decay, rot, dote, red heart, dead streaks, brashy wood, cracks, and bird holes. Poles shall be free from all other defects exceeding in amount the allowances hereinafter specified. (See requirements below in reference to knots and holes).

Timber

All poles shall be cut from live timber. Poles may be cut from trees which have been worked for turpentine, but no part of any section of the tree which has been exposed in this operation shall extend above a plane three (3) feet below the ground line as hereinafter set forth in the table entitled "Minimum Dimensions of Poles in Inches - Circumference."

Insect Damage

The scoring or channeling of the pole surface by insects working under the bark shall not be classed as insect damage. Holes or tunneling entering the body of the poles and indicating attack by ants, worms, grubs or other insects, shall be considered insect damage. Insect damage is permitted to the following extent: Pin-holes, circular in outline, less than one sixteenth (1/16) inch in diameter, not greater in number than fifteen (15) per four (4) square inches shall be permitted in unseasoned poles. Similar holes in seasoned poles shall also be permitted in case their depth does not exceed one (1) inch.

Grain

No pole shall have more than one complete twist of grain in any twenty (20) feet of length.

Shakes and Checks (Before Treatment)

The tops of poles shall be free from shakes. Shakes in the butt surface not over one (1) foot in depth and extending over not more than one-quarter (1/4) of the circumference are permitted, provided they are at least one (1) inch distant from the edge of the butt. Shakes over one (1) foot in depth or shakes extending over more than one-quarter (1/4) of the circumference shall be permitted only when they fall inside a circle whose center is the pith center of the piece, and whose diameter is one-half (1/2) the diameter of the butt. Checks starting from the pith center of the butt shall not extend to the edge of the butt surface. The top and side surfaces of the pole shall be free from large or injurious checks.

Scars

No pole shall have had a catface or other form of scar located within two (2) feet of the ground line. The distance of the ground line from the butt shall be as hereinafter set forth under the heading "Table of Dimension." Scars located in other sections of the pole shall be smoothly trimmed so as to remove all bark and all surrounding or overhanging wood not completely intergrown with the wood of the body of the pole. Such trimming shall not result in abrupt changes in the contour of the pole surface or have a depth of more than one (1) inch, except that where the diameter of the pole at the location of the scar is more than ten (10) inches, the depth may be one-tenth (1/10) of the diameter.

The distance to the axis of the pole from trimmed surfaces located between two (2) feet below the ground line and the butt shall not be less than the radius of the pole at a point two (2) feet above the ground line.

Knots and Holes.

Knots over one (1) inch in diameter, showing discoloration or softness of fibre, indicating possible decay, shall be neatly gouged to a depth of not more than one-fifth (1/5) of the diameter of the pole at the point where the knot is located to permit determination of the character and extent of decay. Sound wood shall not be unnecessarily removed. The gouging should be done in such a manner as to insure drainage of water from the hole when the pole is set. Where such gouging reveals the presence of "heart rot" or "punk" rot, the pole shall be rejected. Knots under one (1) inch in diameter need not be gouged. Knots showing hollow pith centers shall be reamed to a diameter of three-eights (3/8) inch and plugged with the creosoted wooden plugs shown in

the drawing appended to these specifications. All poles shall be free from nails, spikes and other metal. Holes over one (1) inch deep left by the withdrawal of nails or spikes, which will not drain water, shall be completely filled with the creosoted wooden plugs shown in the drawing.

Butts and Tops

The tops of poles shall be free from pith holes. Pith holes shall be permitted in the butts of poles. Butt slivering due to felling shall be permitted if the distance from the outside circumference is not less than one-quarter (1/4) of the butt diameter and the height is not more than one (1) foot.

PREPARATION FOR TREATMENT

Bark

Outer bark shall be completely removed from the surface of all poles. No patch of inner bark left on the pole surface shall be more than one quarter (1/4) inch wide or four (4) inches long. No two patches of inner bark shall be separated from each other by less than six (6) inches.

Trimming and Sewing.

All knots shall be trimmed close. Completely overgrown knots, where the covering wood does not rise more than one (1) inch above the main surface of the pole, need not be trimmed. All poles shall be neatly sawed at the butt along a plane which shall not be out of square with the axis of the pole by more than two (2) inches per foot of butt diameter. Bevelling at the edge of the sawn butt surface not over one-twelfth (1/12) of the diameter in width of an equivalent area, if un-

symmetrically located, shall be permitted.

Framing

Before the poles are subjected to the creosoting process, they shall be framed, unless otherwise ordered, in the following manner, and as shown in the appended drawing.

The tops of all poles shall be roffed at an angle of approximately 120°. The number of gains for poles of the various classes and lengths shall be as follows:

	Class of Poles				
	A	B	C	D	E
Required Number of Gains.					
9	35 ft. or over	-	-	-	-
8	30 ft.	-	-	-	-
6	25 ft.	-	-	-	-
5	22 ft.	22 ft. or over			
4	-	20 ft.	20 ft. or over		
3	-	-	18 ft.	18 ft. or over	-
2	-	-	-	16 ft.	16 ft. or over

Each gain shall be of the dimensions shown in the drawing appended hereto. The distance between gains and the distance between the uppermost gain and the ridge of the roof shall be as shown in this drawing. A tenty-one thirty-second (21/32) inch hole shall be bored through the pole at the center of each gain. This hole shall be perpendicular to the face of the gain. The removal of wood between the upper edge of the top gain and the roof is permitted, provided the surface is at no point below the level of the face of the top gain.

Differences in level between gains on the same pole shall be such that if straight edges thirty (30) inches long are placed on the faces of the finished gains so as to extend fifteen (15) inches on either side from the center line of the pole and are sighted in the direction of the length of the pole, the straight edges in any two gains will not depart from parallelism by more than one-sixteenth (1/16) inch at their ends.

The gains on poles showing sweep or curvature shall be located on the concave side of the pole. In case the pole shows sweep or curvature in more than one direction, the concave side with the greatest curvature be gained.

DIMENSIONS AND SHAPE

Dimensions - Length

Poles under fifty (50) feet in length shall not be over three (3) inches shorter or six (6) inches longer than their nominal length. Poles fifty (50) feet or over in length shall not be over six (6) inches shorter or twelve (12) inches longer than their nominal length.

Circumference

Poles shall be classified with respect to their circumference at six (6) feet from the butt and at their top in accordance with the table set forth below. This table gives the minimum allowable circumference at (6) feet above the butt and at the top for poles of each class and length listed and shall not preclude the acceptance of poles having greater circumferences at these points of measurements than those given in the table. The top dimensional requirement shall be understood to apply at a point corresponding to the minimum length permitted for the pole.

(See next page for table)

MINIMUM DIMENSIONS OF POLES IN INCHES - CIRCUMFERENCE.

Length of Poles (Feet)	Distance of Ground Line from Butt (Feet)	Class A 6 ft. from Top	Class A 6 ft. from Butt	Class B 6 ft. from Top	Class B 6 ft. from Butt	Class C 6 ft. from Top	Class C 6 ft. from Butt	Class D 6 ft. from Top	Class D 6 ft. from Butt	Class E 6 ft. from Top	Class E 6 ft. from Butt
16	4							16	22	14	19
18	4					18	25	16	23	14	20
20	4	22	29½	20	27	18	26	16	24	14	21
22	4½	22	30½	20	28	18	27	16	25	14	22
25	5	22	32½	20	29½	18	28½	16	26	14	23
30	5½	22	35	20	32	18	30½	16	28½	14	24½
35	6	22	38	20	34	18	32½	16	30	14	26
40	6	22	40	20	36	18	34½	16	32	14	27½
45	6½	24	42½	22	38	20	36	18	33½		
50	7	24	44½	22	40	20	38	18	35		
55	7½	24	47	22	42½	20	40				
60	8	24	49	22	44½	20	42				
65	8½	24	51	22	47						
70	9	24	53	22	49						
75	9½	24	55	22	51						
80	10	24	57								
85	10½	24	59								
90	11	24	61								

Shape

Poles shall be free from short crooks.

Poles may have sweep in two planes or sweep in two directions in one plane provided that a straight line connecting the center of the butt with the center of the top does not at any intermediate point pass through the external surface of the pole. When sweep is in one plane and one direction only, the amount between the top and the butt shall not be greater than that specified for the length of the pole in the following table.

Length of Pole (Feet)	Maximum Sweep (Inches)	Length of Pole (Feet)	Maximum Sweep (Inches)	Length of Pole (Feet)	Maximum Sweep (Inches)
16 & 18	3 1/2	40	8		
20	4	45	9	70	14
22	4 1/2	50	10	75	15
25	5	55	11	85	16
30	6	60	12	85	17
35	7	65	13	90	18

TREATMENT

All poles before being treated shall satisfy all requirements set forth above applying to poles "in the White".

Unless otherwise ordered, poles shall be impregnated with not less than twelve (12) pounds of dead oil of coal tar per cubic foot of wood or its equivalent, in accordance with the requirements of the specifications for creosoting timber hereinafter referred to.

HANDLING AND STORAGE

Handling

The prevention of decay is dependent upon the continuity of the external treated layer of wood. Care shall be taken in handling poles to preserve the continuity of the treated layer. Pole tongs, cant-hooks and other pointed tools capable of producing indentations of more than one (1) inch in depth shall not be used on poles treated under these specifications. Pole tongs shall be so handled as to preclude their tearing away from any pole. Treated poles shall not be dragged along the ground.

Storage

When poles treated under these specifications have for any reason to be held in storage they shall be stacked in close piles (either parallel or crosswise) on treated or other non-decaying skids. The skids shall be of such dimensions and so arranged as to support the poles without producing noticeable distoration of any of them. The skids shall be so placed that no part of any pole shall be in permanent water, or in contact with the underlying soil.

Shipment of Poles

It is desired that poles be shipped on flat cars. Gondola cars or other cars having fixed sides shall not be used for shipment except when flat cars are not available for shipping within the time limit in an order. When a shipping time limit is not given in an order, shipment in other than flat cars shall only be made when permission to do so has been obtained from the purchaser of the poles.

Poles shall be secured in position when loaded by stakes of adequate strength placed in the sockets on the side of the flat car and by wiring from the stakes on one side of the car to stakes on the other side, in accordance with the rules and specifications of the Railroad Association of the district in which the shipment originates or in the absence of such rules and specifications, in accordance with the rules and specifications of the railroad initially receiving the shipment.

SUBSIDIARY SPECIFICATIONS AND DRAWINGS

The following specifications, drawings and appendix form a part of these specifications:

Specifications for Creosoting Timber.

Drawing No. 46-M-30, "Framing of Creosoted Yellow Pine Poles."

Drawing No. 46-L-78, "Creosoted Wooden Plug."

Appendix A "Definition."

DEFINITIONS

To words and terms used in

Pole Specifications.

DEFINITIONS.

The following terms are defined for the purpose of these specifications and the definition given for each term shall apply wherever the term is used.

Live Timber and Dead Streaks.

Live timber is that cut from trees which were standing and living at the time of cutting. Dead streaks start from the butt and are portions of the sap wood in which the life processes had ended prior to the cutting of the tree, differing therein from wounds, such as catfaces, scars and turpentine cuttings where the growth of new wood and the accumulation of resin show that life processes are still acting to repair the injured part.

Shakes

Shakes are splits or openings which cause a separation of the wood between annual rings.

Checks

Checks are splits or openings which cause a separation of the wood in a radial direction.

Cracks.

Cracks are breaks or fractures in the grain of the wood.

Catfaces or Scars

Catfaces or scars are surface depressions in the body of the pole, generally elliptical in shape, resulting from tree wounds, where healing has not reestablished the normal cross-section of the pole.

Sweep

Sweep is the deviation of a pole from straightness. Sweep shall be measured as indicated in Diagram No. 1 of the appended drawing.

Short Crooks

Short crooks are localized deviations from straightness which within any section of five (5) feet or less in length reach an amount of more than five (5) inches. See Diagram No. 2 of the appended drawing.

Knot Diameter

The diameter of a knot is its diameter measured at the surface of the pole in a direction at right angles to the lengthwise axis of the pole.

Ground Section

The ground section of the pole is that part lying between its butt and the plane perpendicular to its longitudinal axis at a point two (2) feet above the ground line.

Above-Ground Section

The above-ground section of a pole is the part lying between its top and the upper end of the ground section.

Brashy Wood

Wood fibre is brashy when it has become brittle and lifeless through weathering or decay or is deficient in density through peculiarity of tree growth.

Water Drainage

Hole, hollows and notches required to drain water shall be so shaped that they will not retain water when the pole is set.

Distance from Butt

Where distance from butt is specified, the measurements shall be made from the average level of the sawn butt surface.

Distance from Top

Where distance from top is specified, the measurements shall be made from a plane whose distance from the butt is equal to the nominal length of the pole.

Sapwood

The wood of a tree next to the bark. It is in this portion of a tree that the sap travels. This portion of a tree consists of wood softer than the interior and less durable.

Red Heart

A disease which attacks the heart of a tree causing the wood to take on a red color which ultimately leads into rot.

"In the White"

Timber before being treated with a preservative.

Results of study which would tend to show the lives of butt treated poles by various processes as compared to untreated poles.

Among the literature on the subject of the preservation of wood which would show the life in years of untreated poles as compared with poles treated by various methods is a paper by Kohlman in Archive. fur Post und Telegraphie: M. 5, Berlin, 1890, under the title, "The Different Processes of Protecting Wood Against Decay With Special Reference to the Conditions Which are Involved in the Treatment of Telegraph Poles".

This paper gives a rather detailed description of the various methods of treatment practiced at the time the paper was written. The paper also states that fir (Kieferne) poles of the usual dimensions have lives approximately as follows:

Untreated poles	4 to 5 years
Poles treated with copper sulphate	10 to14 "
" " " zinc chloride	8 to 12 "
" " " dead oil of coal tar	15 to 20 "
" " " corrosive sublimate	9 to 10 "

However in the above paper the necessary figures to substantiate the above decisions are lacking and I will not try to use the above figures in a final conclusion of the problem but merely mentioned them as a matter worthy of notice.

Probably the most valuable information available on the subject of pole treatments which would tend to show the lives of poles treated by various methods is the "Report of German Government - Telegraph Department on The Relative Life and Value of Wooden Poles" by Geh. Ober - Postrat Christiani in Archive fur Post und Telegraphie: M. 16 Berlin, August 1905.

The study in the above paper deals with years between Jan. 1852 and Dec. 1903. Thus a long study of 52 years is available during which time 4,659,816 telegraph poles were under observation. Such a long period of observation and such an unusual large number of observations would seem to varify the results of the study. (See Table I).

Geh. Ober. Postrot Christiani in his paper of the above reference states that "The restriction to a single line or to a shorter period of observation would afford no guarantee for the reliability of the average figures. For, on the one hand, the life of poles depends, for the same kind of treatment, to a large degree on the dimensions as well as on the species, on the age and on the conditions of growth of the tree from which poles are obtained; on the other hand, on the character of the soil in which they are set and on the climatic influences to which they are exposed. This diversity of conditions could not but make itself felt in a small series of observations; it however is compensated if we can give the inquiry as broad a scope as was at our command for the calculations in question."

TABLE I

Total Number of Poles Under Observation.

	Poles Standing in the line at the end of 1903	Number of Poles which have been removed between 1852 - 1903			Total # of poles under Observation
		On account of Decay	From Other Causes	All together	
Copper Sulphate	2,560,412	663,069	536,955	1,200,024	3,760,436
Zinc Chloride	11,689	172,822	33,388	206,210	217,899
Dead Oil Coal Tar	86,818	83,630	92,049	175,679	262,497
Corrosive Sublimate	156,818	113,577	23,516	137,093	293,911
Other treatments	2,108	-	-	-	2,108
Untreated	30,895	76,813	15,257	92,070	122,965
Total	2,848,740	1,109,911	701,165	1,811,076	4,659,816

Table "A"

Minimum Circumference of Chestnut Poles (inches)

Length Feet	Distance from Ground Line Butt Feet	AAA Top	AAA Butt	AA Top	AA Butt	A Top	A Butt	B Top	B Butt	C Top	C Butt	D Top	D Butt	E Top	E Butt
20	4	28	36	26	35	24	33	22	31	20	29	18	27	16	24
25	5	28	39	26	37	24	36	22	33	20	32	18	29	16	27
30	5½	28	41	26	40	24	38	22	36	20	34	18	32	16	29
35	6	28	44	26	42	24	40	22	38	20	35	18	34	16	32
40	6	28	46	26	44	24	42	22	40	20	38	18	36	16	34
45	6½	28	49	26	46	24	44	22	42	20	40	18	38	16	36
50	7	28	52	26	49	24	46	22	44	20	42	18	40	16	38
55	7½	28	54	26	52	24	49	22	46	20	44	-	-	-	-
60	8	28	57	26	54	24	52	22	49	20	45	-	-	-	-
65	8½	28	60	26	57	24	54	22	52	20	49	-	-	-	-

TABLE 111.

Tabulation of the poles removed from the lines between 1852 and 1882 on account of decay, and their length of life.

Life of the Poles Removed (Years)	Poles Treated with: Copper Sulphate — Number Removed	Copper Sulphate — Total Life Pole Years	Zinc Chloride — Number Removed	Zinc Chloride — Total Life Pole Years	Dead Oil of Coal Tar — Number Removed	Dead Oil of Coal Tar — Total Life Pole Years	Corrosive Sublimate — Number Removed	Corrosive Sublimate — Total Life Pole Years	Untreated Poles — Number Removed	Untreated Poles — Total Life Pole Years
1	392	392	637	637	106	106	7	7	6	6
2	2,067	4,126	1,802	3,604	220	440	85	170	53	106
3	5,248	15,744	4,699	14,097	435	1,305	187	561	123	369
4	6,327	25,308	5,988	23,952	823	3,292	435	1,740	393	572
5	6,366	31,830	7,854	39,270	1,024	5,120	707	3,535	682	3,410
6	5,591	33,546	9,042	54,252	1,705	10,230	1,141	6,846	732	4,392
7	4,913	34,391	9,851	68,957	1,833	12,831	1,487	10,409	927	6,489
8	5,147	41,176	9,911	79,288	2,184	17,472	1,094	8,752	924	7,392
9	4,759	42,831	11,337	102,033	2,889	26,001	1,425	12,825	499	4,491
10	4,629	46,290	10,871	108,710	3,114	31,140	1,094	10,940	171	1,710
11	4,676	51,436	11,586	127,446	3,100	34,100	978	10,758	424	4,664
12	3,895	46,740	7,848	94,176	2,861	34,332	736	8,832	114	1,368
13	3,561	46,293	7,433	96,629	2,721	35,373	492	6,396	30	390
14	4,522	63,308	6,788	95,032	2,177	30,478	292	4,088	-	-
15	3,207	48,105	4,438	66,570	1,933	28,995	165	2,475	21	315
16	3,122	49,952	4,007	64,112	1,131	18,096	130	2,080	144	2,304
17	2,821	47,957	3,752	63,784	905	15,385	151	2,567	30	510
18	2,620	47,160	3,349	60,282	550	9,900	174	3,132	225	4,050
19	2,085	39,615	1,955	37,145	151	2,869	190	3,610	210	3,990
20	862	17,240	796	15,920	35	700	105	2,100	-	-
21	524	11,004	241	5,061	41	861	9	189	-	-
22	146	3,212	105	2,310	62	1,364	-	-	-	-
23	83	1,909	10	230	9	207	-	-	-	-
24	47	1,128	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-
Total	77,006	750,693	124,300	1,223,497	30,009	320,597	11,084	102,012	5,708	47,528

TABLE II

CHANGE IN THE NUMBER OF TELEGRAPH POLES FROM 1852 TO 1903

At the close of official year.	Poles were standing in the lines Treated with				
	Copper Sulphate	Zinc Chloride	Dead Oil of Coal-Tar	Corrosive Sublimate	Untreated
1852	-	1,983	-	-	-
1854	-	1,990	-	-	-
1856	-	5,751	-	-	942
1857	-	6,723	2	-	942
1858	562	8,185	2	105	952
1859	3,241	12,318	93	105	952
1860	12,136	18,783	566	105	960
1861	25,048	28,323	2,501	379	1,041
1862	46,246	44,983	3,270	2,072	1,420
1863	65,619	31,973	7,661	2,353	1,462
1864	76,926	50,233	13,268	2,636	2,263
1865	81,702	57,810	20,864	2,893	2,891
1866	80,811	64,005	29,028	2,893	3,574
1867	79,378	71,654	41,117	3,008	6,877
1868	77,306	75,447	70,224	3,425	9,943
1869	75,820	78,847	86,204	4,390	13,165
1870	72,828	81,125	97,704	5,854	15,510
1871	70,545	82,574	116,427	10,924	19,321
1872	69,940	85,089	135,630	12,884	23,535
1873	75,878	92,663	155,073	15,411	28,393
1874	96,767	107,074	159,368	18,803	28,638
1875	137,149	100,411	160,678	26,437	30,930
1876	188,615	88,668	160,016	31,283	29,811
1877	258,221	90,828	163,857	41,995	29,044
1878	350,202	77,679	156,044	67,474	
1879	429,834	68,357	148,323	77,571	Data
1880	482,878	56,941	138,683	81,111	Missing
1881	522,572	49,519	134,792	81,849	
1882	566,906	42,551	129,897	80,321	
1883	605,504	37,318	128,582	81,616	21,404
1884	613,604	32,317	124,603	85,272	19,277
1885	739,160	27,342	123,976	88,047	16,049
1886	803,493	23,671	119,093	91,393	12,730
1887	888,636	19,560	113,419	94,718	9,957
1888	943,348	17,121	110,678	97,131	7,779
1889	1,018,529	16,723	107,747	95,751	6,259
1890	1,105,656	15,642	103,999	92,278	5,436
1891	1,134,151	14,429	100,326	88,407	4,698
1892	1,268,842	16,791	96,684	83,845	4,156
1893	1,331,683	16,643	92,099	78,580	16,421
1894	1,439,379	17,296	89,332	74,330	21,962
1895	1,515,234	17,599	85,577	66,957	31,161
1896	1,585,001	17,851	83,640	59,298	42,652
1897	1,670,985	16,949	82,209	52,967	51,300
1898	1,784,312	16,579	81,306	47,392	55,257
1899	1,917,166	15,816	84,505	56,652	60,914
1900	2,111,952	15,089	90,338	74,770	57,332
1901	2,278,021	13,965	88,963	91,035	49,015
1902	2,428,930	13,469	88,254	125,196	39,830
1903	2,560,412	11,689	86,818	156,818	30,895

TABLE IV.

Tabulation of the poles removed from the lines between 1882 and 1903 on account of decay, and their length of life.

	Pole treated with														
	Copper Sulphate			Zinc Chloride			Dead Oil of Coal Tar			Corrosive Sublimate			Untreated Poles		
Year	No. removed	Average Life Per Pole	Total Life Pole Years	No. removed	Average Life Per Pole	Total Life Pole Years	No. removed	Average Life Per Pole	Total Life Pole Years	No. removed	Average Life Per Pole	Total Life Pole Years	No. removed	Average Life Per Pole	Total Life Pole Years
1883	8420	9.4	79,148	5168	14.0	72,352	2774	14.9	41,433	2286	9.5	21,717	4658	8.0	37,264
1884	11117	9.1	101,165	4799	14.6	70,075	3230	15.1	78,773	2914	9.3	27,100	5065	8.9	45,078
1885	13252	9.4	124,569	4419	14.6	64,517	3358	14.4	48,355	4107	9.1	37,373	4528	9.2	41,657
1886	14306	9.0	128,754	3521	15.3	53,871	3172	16.3	51,703	4512	9.7	43,766	3448	9.7	33,445
1887	18329	9.0	164,961	3657	15.6	57,049	3395	16.7	56,687	5001	10.0	50,010	2670	9.2	24,564
1888	20373	9.3	189,469	2916	14.4	41,990	3281	17.2	56,533	5122	10.2	52,224	2169	9.5	20,605
1889	21698	9.3	260,376	2790	16.6	46,314	2860	17.6	50,536	5424	11.4	61,833	1557	11.0	17,127
1890	23294	9.9	230,611	2053	16.2	33,259	2631	18.2	47,884	4871	12.0	58,452	1010	11.3	11,413
1891	24531	10.2	250,216	1754	16.8	29,467	3322	18.8	62,453	5549	12.3	68,252	766	11.7	8,962
1892	25562	10.7	273,513	1513	17.4	26,326	2801	18.9	52,938	5625	12.8	71,000	808	8.9	7,191
1893	25161	10.8	271,738	1216	18.0	21,888	2754	18.9	52,050	5538	12.9	71,437	460	8.6	3,956
1894	24006	10.4	353,662	1495	17.0	24,415	2609	19.3	50,353	5772	13.7	79,076	581	9.5	5,519
1895	34756	10.7	371,869	1128	17.6	19,852	2220	19.4	43,068	7026	14.0	98,364	332	9.9	3,287
1896	39221	11.1	435,353	1099	16.3	17,914	2340	18.9	44,226	7718	14.6	112,682	1172	8.7	10,196
1897	34970	11.4	389,566	1213	16.3	19,772	1828	19.3	35,280	6078	14.8	89,954	1867	6.9	12,882
1898	35524	12.0	426,288	1382	16.5	22,803	1570	19.3	30,301	5277	15.4	81,265	3367	7.8	26,263
1899	28169	12.0	338,028	1095	18.0	19,710	1303	18.4	23,975	3946	15.9	62,741	3603	4.9	17,654
1900	34433	12.0	413,196	1654	16.6	27,456	1525	18.6	28,365	4245	15.9	67,495	6177	5.5	33,973
1901	40488	12.7	514,198	1723	17.4	29,980	1776	18.1	32,145	3846	16.5	63,460	8091	6.1	49,355
1902	47045	13.4	630,403	1788	17.9	32,005	2071	19.5	40,384	4092	16.7	68,336	9012	6.6	59,479
1903	50808	13.9	706,231	2139	15.2	32,513	2801	19.8	55,459	3544	16.8	59,539	9764	6.7	65,418
	585,463		6,653,334	48,522		764,528	53,621		952,801	102,493		1,346,096	71,105		535,288

TABLE V

(Supplementary to Table IV)

Poles in Service 20 years and over, Removed on Account of Decay.

	Poles treated with									
	Copper Sulphate		Zinc Chloride		Dead Oil		Corrosive Sublimate		Untreated Poles	
Year	# Removed	Pole Yrs. to be Added Assuming 25 yr. Pole Life	# Removed	Pole Yrs. to be Added Assuming 25 yr. Pole Life	# Removed	Pole Yrs. to be Added Assuming 35 yr. Pole Life	# Removed	Pole Yrs. to be Added Assuming 28 yr. Pole Life	# Removed	Pole Yrs. to be Added Assuming 25 yr. Pole Life
1883	1308	-	918	-	154	-	97	-	69	-
1884	1616	-	1362	-	488	-	83	-	213	-
1885	2102	-	1082	-	498	-	11	-	125	-
1886	1514	-	1044	-	778	-	13	-	89	-
1887	1445	-	953	-	945	-	116	-	63	-
1888	1341	-	677	-	1290	-	97	-	56	-
1889	1034	-	596	-	1243	-	111	-	202	-
1890	953	-	388	-	1328	-	172	-	62	-
1891	1321	-	558	-	1936	-	128	-	62	-
1892	930	-	488	-	1890	-	131	-	54	-
1893	1095	-	607	-	2068	-	144	-	24	-
1894	2114	-	858	-	2165	-	344	-	69	-
1895	2768	-	631	-	1889	-	791	-	57	-
1896	4237	-	424	-	1971	-	1151	-	35	-
1897	4569	-	485	-	1619	-	1089	-	11	-
1898	5905	-	532	-	1418	-	1903	-	6	-
1899	5199	-	437	-	1046	-	1513	-	8	-
1900	6679	-	650	-	1274	-	1502	-	15	-
1901	8281	-	713	-	1250	-	1564	-	21	-
1902	10986	-	942	-	1849	-	1506	-	19	-
1903	11938	-	1003	-	2654	-	1432	-	70	-
Total	77335	385,675	15348	76,740	29753	446,295	13898	111,184	1320	6,600

TABLE VI.

Average Life of Different Kinds of Poles

Summary of	Treated With: Copper Sulphate		Zinc Chloride		Dead Oil of Coal Tar		Corrosive Sublimate		Untreated Poles	
	Removed on Account of Decay Poles	Total Life in Pole Years	Removed on Account of Decay Poles	Total Life in Pole Years	Removed on Account of Decay Poles	Total Life in Pole Years	Removed on Account of Decay Poles	Total Life in Pole Years	Removed on Account of Decay Poles	Total Life in Pole Years
Table III	77,606	750,693	124,300	1,223,497	30,009	320,599	11,084	102,012	5,708	47,528
Table IV	585,463	6,653,334	48,522	764,528	53,621	952,801	102,493	1,346,096	71,105	535,288
Table V	-	386,675	-	76,740	-	446,295	-	111,184	-	6,600
Total	663,069	7,790,702	172,822	2,064,765	83,630	1,719,693	113,577	1,559,292	76,813	589,416
Resultant Average Life		11.7 yrs.		11.9 yrs.		20.6 yrs.		13.7 yrs.		7.7 yrs.

CONCLUSION.

As a conclusion to the problem it has been determined that the lives of butt treated poles by the various processes are as follows:

1)	Copper sulphate treatment	11.7 years
2)	Zinc chloride treatment	11.9 years
3)	Dead oil of coal tar	20.6 years
4)	Corrosive sublimate	13.7 years
5)	Untreated poles	7.7 years

The figures are self convincing as to the advisability of using creosote treated poles. In the early part of this report I have given the standard requirements of various kinds of pole such as red cedar, white cedar etc. in order that the report should cover a wider field as of course utility companies doing business in various parts of the country will find it economical to use the kind of wood which can be best obtained due to the geographical location.

I have given no comparative figures which would show the lives of pressure treated yellow pine poles. No actual figures can be shown on this type of treatment as its origin has been of late years and no decay has occurred on poles of such treatments. I will however add that all authorities on the utility business agree that pressure treated yellow pine poles should under ordinary conditions last from forty to fifty years.

At a location in St. Louis County a utility company had occasion to remove a line of pressure treated yellow pine poles which

had been in service approximately twenty years. These poles were in excellent condition and should easily last twenty-five to thirty years additional.

I might add that practically all utility companies who operate on a scientific basis are at present using either some kind of butt treated poles or eight or twelve pound retention creosoted yellow pine poles. The cause of using such poles is purely an economical reason on the part of the companies using same. This saving of timber is of course in line with the ideas advanced by the United States Bureau of Forestry in order to curtail the destruction of our gradual diminishing supply of timber.