PN-AAL-109

POWER POLE
survey report

APRIL 12, 1972

PN-AAB-067

WOOD POLE SURVEY
(April 12, 1972)

Contract No. AID/ead-200, entered into on January 10, 1972, provided that Mr. Bescher would determine whether present pole production facilities of the Philippines are capable of meeting all or a portion of the projected needs of the electric power program. Specific emphasis was to be directed to the projected $100 million program of the National Electrification Administration.

Mr. Bescher was to coordinate his efforts with structural concrete and wood pole production and treatment experts in the Philippines and a report was to be prepared that summarizes the current state of the Philippine pole industry and recommends a practical plan of action for NEA and other Government agencies. Specifications for producing wood and/or concrete poles were to be included. The report is submitted herewith.

POLE REPORT

This report covers a survey of the availability of concrete and pressure treated wood poles for rural electrification of the Philippines. Mr. Bescher prepared the report for wood poles and Mr. Rustico C. Manipol of Adrian Wilson International Associates contributed the report for concrete poles.

Availability of Poles in the Philippines

Problem

The Government of the Philippines' proposed rural electrification program being administered by the National Electrification Administration (NEA) will require approximately 216,000 poles during the next three to five years. These poles will be used in thirty-six rural districts widely scattered throughout the Archipelago.

The plan of NEA is to start two rural electric cooperatives each month. Each system will require approximately six thousand poles. Construction time will be a minimum of eighteen months, therefore, if the projects stay on schedule the need for poles will average six thousand per month.

The actual theoretical rate will build up to 12,000 at the 18-month point and then drop to zero at the 36th month as follows:

Month	Cooperatives Started	Poles	Month	Poles
1	2	667	19	11,333
2	4	1,333	20	10,667
3	6	2,000	21	10,000
4	8	2,667	22	9,333
5	10	3,333	23	8,667
6	12	4,000	24	8,000
7	14	4,667	25	7,333
8	16	5,333	26	6,667
9	18	6,000	27	6,000
10	20	6,667	28	5,333
11	22	7,333	29	4,667
12	24	8,000	30	4,000
13	26	8,667	31	3,333
14	28	9,333	32	2,667
15	30	10,000	33	2,000
16	32	10,667	34	1,333
17	34	11,333	35	667
18	36	12,000	36	0

REPORT ON WOOD POLES FOR RURAL ELECTRIFICATION PROJECTS

Poles Used for Demonstration Projects

Two demonstration rural electrification projects have been built on Negros Island in the Visayas (VRESCO) and in northern Mindanao (MORESCO).

The poles used for the construction of these demonstration projects were purchased in the United States. They are insured warranty pentachlorophenol pressure treated southern yellow pine produced in the State of Georgia. The quantity of poles supplied was approximately 15,000. The majority of the poles were in class size "7" and 30 and 35 feet long. This is a large quantity of poles in a limited number of sizes and lengths. Philippine treating industry was not sufficiently organized to supply this number of poles within the time limit prescribed.

To obtain this quantity of poles in the United States was relatively easy since the United States produces four million to five million poles annually.

Present Treated Pole Supply in the Philippines

Philippine public and private operating utilities that were contacted advised uniformly that poles are in short supply and are expensive. Cost estimates indicate that Philippine poles cost up to fifty percent more than the poles purchased in the United States and delivered in the Philippines. The Manila Electric

Company (Meralco) is currently purchasing six hundred large poles from the United States because of availability and price.

The National Power Corporation last year produced 1,880 poles and is presently producing six thousand poles for its own use. These poles are being produced from lands that it controls and where it has free rights to cut the poles. The poles are first cut by contractors hired by the National Power Corporation. NPC then contracts with one of the treating companies to transport the poles from the production area to the treating plant, treat the poles, and transport them to the point of use. In this manner NPC feels procurement is simplified and costs are reduced because treated poles in the Philippines are available in only limited quantities and on a custom basis.

The total production of wood poles in the Philippines at present is not known, but it is probably in the range of 800 to 1,600 poles per month. The major use of poles from foreign and domestic sources is in the greater Manila area -- possibly half of all the poles used in the islands is in this area.

Availability of Pole Stumpage

As a result of several personal field trips throughout many of the provinces and from many discussions with knowledgeable people regarding the forestry industry of the Philippines, it is concluded that there is an ample supply of poles size trees

available at locations throughout the Philippines in the sizes needed for the rural electrification program. There is poles stumpage available on all of the islands with almost unlimited supply on the Island of Palawan. This island is almost completely covered by clear stands of the preferred pole species Apitong.

The total need for poles in the Philippines including the greatly increased requirements for rural electrification is a small percentage of the volume of wood being cut annually for export and domestic needs.

The total annual cut of Philippine timber is estimated at 11.6 million cu.m. The total quantity of the poles required for the 36 projects is only approximately 25 thousand cu.m./year for 3 years.

One company, the Bislig Bay Lumber Company, cuts the equivalent of all the poles needed for the whole planned thirty-six cooperatives in a little over one month for use in its lumber and wood pulp operations. The same Bislig Bay Lumber Co. is recognized in the country as being a progressive leader in good forest management, is cutting its timber on a sustained yield basis, and is practicing reforestation. Annually the company discards a fair portion of the poles that could be used for the electrification projects because they are unsuitable for its operations. Some of the land contains up to 30 to 40% Apitong,

which is a preferred species for poles, but which is not acceptable for manufacturing veneers, plywood, fine lumber, or for making pulp and paper. This wood is usable only for such purposes as rough construction lumber, poles and piles. The trees that could be used for rural electrification poles are too small to be economically sawed into lumber.

The natural growth rate of the trees in the Bislig land area is too slow to maintain the present plywood, lumber, and pulp and paper operations on a sustained yield basis without reforestation with preferred species. Therefore, this company is practicing clear cutting for three hundred meters on each side of its logging roads and the small trees that otherwise are suitable for poles are being cut and allowed to lay in the woods to decay.

Problem of Logging Poles

The logging operations at Bislig, as in most of the Philippines, are performed by use of a spar tree or a spar mounted on a truck, and a high line to drag the logs to the road. This is a relatively expensive and slow means of removing logs from the forest, and the cost goes up as the size of the log becomes smaller. The size of the full length logs required to produce poles of the classes and lengths predominantly used by a cooperative contain only one-fourth to one-third of a cubic meter of wood. If poles are logged in this manner the cost is certain to be high.

The logging problem is further complicated by the fact that only a percentage of the small trees in a natural forest are useful as poles. Most of the trees are not the precise size and length needed, they are too crooked, have bad knots, or exhibit some other defect. A pole must be a near perfect tree of the correct size. The pole availability can be increased by using that section of the tree that produces the right size and discarding the balance, although sometimes it is possible to get two poles from one tree in a virgin forest where they grow with little taper. Most of the poles that will be produced in the Philippines will probably be several sizes oversize at the top because of the small taper. Since the rural electrification project will require a large number of poles but in only a few sizes and since no appreciable market exists in the country for poles of other sizes, the production of poles for the rural electrification program will be difficult and will probably have to be obtained over a wide area of the country.

Legal Restraints

The logging is further complicated by the Bureau of Forestry requirement which prohibits the cutting of trees as small as are needed for rural electrification poles. Regulations state that this size tree can only be cut where the land is being cleared for a road or for agriculture or development uses and the treating companies must obtain a signed Government Certificate stating that

these poles were legally cut. The cost of these certificates is not known.

The Bureau of Forestry permits any logging operation to destroy a reasonable number of the residual trees which otherwise would be left for future growth, by providing that if they are damaged and there is an economical use for them they may be removed from the forest. This figure is usually 40% of the small sized trees. However, these trees are generally not removed from the forest because of the unprofitable logging cost. Also, they would not be suitable for utility poles because it is an unsafe risk for a lineman to use a tree that might have been damaged in logging. If these small available trees are to be used for poles they would have to be removed from the woods, before they are damaged.

A change in the Bureau of Forestry regulations regarding cutting small trees would be most helpful, since the regulation serves to increase the cost and restrict the supply of poles.

While the legal problem of obtaining the few poles now produced in the Philippines has apparently not been too great, it is anticipated that it would become much more serious when the volume is increased by ten to fifteen fold to meet the projected schedule of the rural electrification program.

Cost of Poles

The cost of stumpage for poles in the Philippines is very inexpensive. The Government tax or fee for the tree on public lands is 3.5 pesos per cubic meter of wood. This is equal to one or two pesos per pole of the sizes primarily needed.

The cost of charter or contract water transportation from any one port in the Philippines to any other port in the islands is approximately the same. In lots of one thousand poles, a fair estimate of the cost of transportation is twelve pesos per pole. If poles are produced on one island and transported to a second island where a treating plant is located, and then back to the first island or to a third island, the cost of transportation is doubled. Therefore, a treating plant located on the island of the source of the poles will have an advantage of at least one water transportation cost plus double the saving if the use is at the same location.

Treating Plants

The four largest treating plants are located in Manila. It is estimated that any one of the four treating plants could treat poles at a rate greater than called for by the NEA program if the plant worked around the clock six or seven days a week. This is a normal work week for treating plants in the United States, since operating at full capacity materially lowers the cost.

The meager occupany of Philippine treating companies contributes to the high cost of treated poles.

Outside Manila there are more treating plants that are capable of treating additional poles. For example, there is a plant in Baguio, Benguet Consolidated, Inc., which has a tree length logging operation primarily for cutting timber for gold mining operations. Because of the cultural requirements of the Benguet Pine the land must be clear cut, except for a specified number of seed trees. The smaller trees are now used to cut only one six by six from a tree that could well be used as a pole. The slabs and top are sold for pulpwood. This company could easily select suitable trees for poles at its log deck and run them through its treating plant.

A creosoting plant is being built in Catanduanes and should be operating by September, 1972. The contractor is the AG&P Company which is an expert in both construction and operation of treating plants. A third plant is operated by the Davao Treating Company - which is currently treating poles for the Davao Light and Power Company. The Fil-Eastern Wood Industries, Inc. has constructed a plant at Barton, Palawan, but it has never operated although it has unlimited source of supply. There are additional plants available in the Islands.

The Treating Plant

A treating plant large enough to treat the majority of the poles needed by each rural electric cooperative system can be bought for approximately U.S. $30,000.00. If only six thousand (6,000) poles were treated in one of these plants and the plant then abandoned, the cost of a pole would increase a little over thirty (30) pesos per pole. The cost of a turnkey treating plant can be obtained from Hickson Company, England; Koppers Co., U.S.A.; and the AG&P Co. in the Philippines. All three of these companies will not only provide the plant, but will also provide technical and operating services.

A pole is a primary product. It is in reality a tree that has had limbs and bark removed. To make a pole from a satisfactory tree requires the simplest of tools and relatively unskilled labor. Treating plant equipment is simple, consisting of a closed pressure cylinder and an open storage tank and pumps to move the solution from the storage tank to the cylinder and return it. Poles of the size needed for the rural electrification program can be man-handled with the use of skids. With the abundance of labor in the Philippines, and the low labor cost of about one peso per hour, poles should be quite economical. In fact, they could be a potential export item for the Philippines supplying particularly timber-poor countries such as Taiwan, Japan, and Korea.

With the large quantity of pole timber available only the more desirable species need be used -- Apitong, Bagtikan, and Benguet Pine. Of these three species Apitong is most readily available in the larger export sizes and is well accepted in the outside world.

How to Increase Pole Supply

With all the favorable factors present in the Philippines for the production and sale of poles why is there a shortage, and what needs to be done to establish a viable pole treating industry? First, restraints on cutting pole size trees must be removed. The Philippine Government might support with laws and administrative action the establishment of a wood pole industry that is free of undue interference both operational and legal. This can be done without desecration of the land. Second, the method of production of poles must be changed. The poles can most economically be produced in conjunction with veneer and saw logs and pulp logs. To obtain these products, forest access roads must be built. To obtain adequate production of poles along with the other forest products, it is necessary that the poles be removed from the forest first. This can best be done by having a forester, or an adequately trained man go into the area as it is opened up with a logging road. With a paint marking gun he can mark those trees of the size and length needed for poles. A contractor would then follow with a small crew which would cut the trees, limb them, debark them, and drag them to the logging road. The

dragging operation can be carried out with a winch on the back of a truck, a small tractor, or a carabao. Once the logs have been dragged to the logging road there are adequate facilities in the Philippines to transport them to the treating plant. The contractor should be paid for each pole delivered to the road, and he should be paid every day or at least every week for poles delivered. The amount of timber removed from the woods can be tallied by the painted stumps remaining in the forest, and the ownership and contractor can be tallied by colored paints used on the peeled pole. Many variations of this basic idea can be used -- for example -- the treating company can arrange with the limber company to obtain the poles and then hire his own contractors, thus minimizing interference with the normal operations of the large lumber companies. The volume of wood being removed by the pole contractor is too small to be of interest to most large lumber companies, yet it will give them a small return for wood not otherwise saleable. It will also provide stumpage tax to the Government. Another satisfactory way of producing poles is to obtain them from a lumber company which clear cuts and logs in tree lengths, similar to the way Pine is produced in northern Luzon. A contractor can also produce poles by cutting trees on private farm land. In general it is necessary to produce poles in such a manner that their removal from the woods does not interfere with the much larger and more profitable harvesting of matured trees.

Pole Standards

A third problem in developing a wood pole industry in the Philippines is the lack of pole standards. Each user of poles in the Philippines has its own requirements for poles. Three general classifications - standard, light and flyweight - are common descriptions but poles are not standardized. The description of satisfactory poles has never been spelled out, so that the buyer and seller of white stock (untreated poles) have difficulty agreeing on the definition of a "pole". The result is that the Philippines is not making use of the full strength of the wood in the poles. Likewise, the treating specifications and quality control are only a request by the purchaser of what he wants without any method of counting what he buys. In the United States poles are divided into nine classes with full specifications for treatment and quality control which results in efficient use of the timber and at the same time protection to the purchaser.

Specifications for Wood Pole Procurement

To provide assistance with the pole procurement problem, a complete specification for treated wood poles is attached to this report. The specification follows very closely the two-part standards used in the United States with the American Standards Association covering the white stock and strength, and the American Wood Preservers Association Standards covering treatment and quality control. The specifications are identical with those used by the

U.S. Rural Electrification Administration, except for changes required to accommodate the Philippine wood species. The specification for the white pole is considered a minimum to protect the ultimate user yet permitting the maximum number of trees growing in the woods to be utilized for poles. The treating specifications are minimal to give the fullest range of opportunities to the treating plant to produce economical utility poles.

The quality control and inspection for final acceptance is placed in the hands of the buyer and is applied at destination. This method of controlling the quality and quantity of treatment motivates the producer to produce materials uniformly and fully up to the specifications, to avoid rejections. The quality control method is straight-forward and reproducible. The producer can include in the treatment as big a factor of safety in meeting the specifications as desired.

The specifications also call for branding or labeling the pole. Every good product contains the manufacturer's name, and for a pole to be of acceptable quality it likewise should contain the name of the producer along with the other information requested on the brand. The brand should be located at a specific distance from the butt to simplify inspection for the depth of set of the pole.

The specifications do not permit artificial seasoning in the treating cylinder. They call for sufficient air drying to permit the poles to be treated to meet the specification requirements for both penetration and retention. It is desirable to have as many "season checks" (cracks) develop in the poles prior to treatment as is possible. Those that develop after treatment reduce the quality of the pole.

Rigid enforcement of the specifications will encourage the treatment plant operator to practice quality control at the plant to make sure the poles meet the requirements and thus avoid rejection at the destination.

The inspection of the poles at destination should not be difficult. A trained person first examines the poles to see that they meet the physical requirements, then he bores all the poles to see that they meet the penetration requirement of one and one-half inches or 85% of the sapwood, whichever is greater. If the poles are acceptable thus far, twenty representative poles are selected and bored for assay determination. The borings as they are taken from the poles are cut in a jig to exactly one and one-half inches, and the portion of the core nearest the center of the pole is thrown away. These samples are then placed in a glass or plastic vial, given a code mark, and forwarded to the Analytical Laboratory that will run the Assay. The Forest Products Research & Industries Development Commission of

Los Baños is presently fully equipped and knowledgeable in these technical procedures.

The specifications permit three types of preservative treatment, (1) 70-30 Creosote-Petroleum, (2) Penta-chlorophenol in approximately number three fuel oil, and (3) three similar types of Chromated Copper Arsenate water-borne salts.

Creosote is very toxic to decay and insects, and when hot is easy to impregnate into wood. The wood does not need to have too low a moisture content at time of treatment. The Creosote is slowly lost from the poles by evaporation. The 30% Petroleum is added to reduce the evaporation rate. The first sign of loss of preservative will be a thin layer of "soft rot" on the surface of the poles below the groundline, although at this stage the pole will still have many years of life. The pole usually is not removed from service until the loss of surface wood reduces the strength of the pole 25%.

Creosote gives pole protection from weathering, i.e., reduces the development of checks and cracks.

Pentachlorophenol performs the same as Creosote and is a full alternate.

The three Chromated Copper Arsenate salt preservatives are very permanent but they have a smaller factor of safety on toxicity to decay and wood

destroying insects. They give no weather protection. The water soluble solution of salts are impregnated into the wood by the full cell method. Therefore, the poles after treatment are full of water and are very heavy.

The chemicals Chromium Copper and Arsenic react with the water soluble wood constituents in a pole to make the salt water insoluble. If the poles contain free water or liquid sap at the time of impregnation the reaction takes place too rapidly, the concentration of insoluble salts are deposited in the outer portions of the sapwood and the inner portions may not contain enough chemicals to protect against decay and insect attack. This is true even if the pole is tested for penetration, since the chemicals used to give the color reaction are very sensitive.

The air seasoning of poles to be treated with water-borne salts must be drier than poles to be treated with creosote or pentachlorophenol. The moisture content at the depth of penetration requirement, 1-1/2 inches, should be below the fiber saturation point (30%). If this value is not reached the distribution of the salt will not be flat enough to provide full protection to the center of the poles. This point is covered in the specifications which state that a minimum of .3#/cu.ft. in the 3rd 1/2 inch from the surface of the pole. Salt treated poles will most likely start to fail by center rotting.

Salt treated poles are more difficult to pressure treat, but if they are properly treated to meet these specifications they will give long life.

Poles processed with creosote and pentachlorophenol treatments may be promptly retreated if they do not meet the penetration and/or the retention requirements. Salt treated poles, because of the treatment process, are completely full of water solution and have no room for more treatment and therefore, must be fully air dried before retreatment.

All three of the types of preservatives (70-30 creosote-petroleum, pentachlorophenol and salts) when impregnated into the poles, so as to meet all the requirements of the specifications, will give long life to the product. To the buyer they are equal. Even though treated poles have been used since before 1920, the service life has not yet been fully established becuase enough poles have not failed to arrive at an average life. But it is safe to estimate that the properly treated pole will have a life greater than 50 years. Obsolescence generally causes removal in half this time. All three types of treatment are about the same cost.

Lead Time in Buying Poles

Since air seasoning of a pole is important for the best quality of treatment, time must be allowed for the seasoning to take place. It is estimated that 3 to 4 months will probably be required to adequately dry the poles. The treating

companies may also have to provide roofing over the drying poles during the wet season, and some spray fungicides may be needed.

The procurement of a good treated pole requires the inclusion of time for obtaining the poles from the woods, the transportation of the poles to the seasoning yards, the seasoning of the poles, the scheduling of the treatment through the treating plant and the final transportation to the construction site.

One of the major reasons poles are not readily available in the Philippines is because of the long lead time needed to supply an order. Six months is about the minimum time. If to this is added delays inherent in supplying the low volume requirements for certain sizes, the time required to clear accounts receivable and thus provide working capital, and the lack of incentives to maintain large inventories, as much as 12 months supply time develops. This slow turnover of working capital accounts for at least a part of the high prices charged for poles.

It is estimated that the long lead time increases the cost of the poles at least thirty percent (30%) primarily because money in the Philippines is expensive. The National Electrification Administration has essentially direct control over when poles are needed and therefore can make great contributions to both the availability of poles and the lowering of their price. Besides the

obvious advantages of good scheduling and prompt payment, NEA could also promote payment for the white pole at the time it is received at the treating plant and encourage final payment for the poles promptly on delivery and final destination inspection.

The National Power Corporation is currently active at all stages in the production of its poles. NPC contracts to have the poles cut on land which it controls (no legal restraints) and pays the contractor promptly each thirty (30) days. After the poles are produced, the treating company processes the poles and delivers them to the point of use. Again the invoice is promptly paid. On a lot of 1,880 poles, mostly 55 feet in length but ranging from 35 to 85 feet, NPC estimates it saved ₱467,000.00 compared with bid prices. These poles cost them ₱667,000.00 including internal charges for engineering supervision and general administration amounting to 25%.

Summary

There is no viable pole treating industry in the Philippines at the present time capable of meeting the quantity and production rates needed for the rural electrification program. If NEA tries to buy the poles on a competitive basis, the price will be unreasonably high and it will be difficult to assure the meeting of the proposed construction schedules. If the treating industry is

forced to take the full risk of the production and delivery of poles, including the increase in the cost of money that may develop due to late payment, a class 7, 35-foot pole will cost an estimated ₱270.00. The NEA could produce the pole for considerably less if it provides low-cost money, obtains relief from the legal restraints and develops capability for selection of proper timber size and quality. The pole supply industry is in reality a procurement and service business, with the industrial manufacturing operation playing a minor role. The cost of a treated pole is the sum of the cost of (1) the untreated pole; (2) the preservative; (3) handling; and (4) transportation. Very little cost is incurred from the action of putting the preservative into the pole. The cost is greatly affected by the slow turnover of inventory and delay in clearing the accounts receivable. Therefore, to have a successful pole treating industry there must be an economical procurement and delivery operation and adequate low-cost working capital.

The Philippines has adequate quantities of poles in the forest. It has adequate treating capacity. It has only limited production of poles, and very few people that know how to select the poles from the woods. The Philippines' large timber corporations are not interested in producing poles and will consider this operation as a nuisance and interference with their business, unless it is carefully integrated.

The National Power Corporation has set up its own procurement operation, consisting of buying the poles and buying the treatment separately to improve its pole procurement program. NEA can follow suit or at least be of material influence in developing a total pole treating industry in the Philippines by recognizing each requirement in the pole production process, although NEA will have the additional problem of rights to the timber which is not a problem for NPC. If NEA would attempt to provide its own pole procurement operation, it would require people that are knowledgeable in the methods of procuring poles from the forest, in proper treating and seasoning of wood, in the operation of treating plants and in measuring the quality of the treated product. It is not likely that economical poles can be purchased on the desired schedule without substantial support to the present Philippine pole industry or the development of a whole new industry. It is suggested that rather than just asking for bids that NEA enter into negotiated contracts with groups of entrepreneurs who are interested in establishing a pole treating industry. Before entering into such contracts NEA procurement people must be fully knowledgeable in this field. It is entirely possible that limited production can be obtained by direct quotations from three or four treating companies in the Philippines. But too much reliance should not be placed upon simple promise of delivery without critically looking into all phases of the pole industry, and above all, providing lead time of at least nine months to a year, with constant

checking during this period to see that each step of the procurement process is on schedule.

Suggested Alternatives

These suggestions are made without regard to any political or financial restraints that may have been placed on the rural electrification projects. The suggested alternatives provide ways to accomplish the objective of obtaining poles on a relatively short time schedule.

1. NEA purchase insured warranty treated southern yellow or ponderosa pine poles in U.S. c.i.f. Philippine ports. Poles from U.S. can be supplied in 3 to 4 months, they will be of good quality -- probably lowest cost.

2. NEA follow the lead of NPC and staff itself with a few people that are dedicated, capable, honest and knowledgeable in treated pole production. Open up pole concentration yards and buy white poles from encouraged local contractors. Stock the poles for seasoning and enter into contracts with an established treating company to treat and deliver the poles to the job site. NEA would have to obtain control over the legal right to cut pole size trees. NEA supply the working capital by having money or bank drafts to pay for the poles as delivered to the yards. NEA might obtain the personnel from NPC.

3. NEA start a cottage industry for treating poles through one or more of the cooperatives. Purchase a turnkey CX40-foot package salt treating plant with operating and technical service provided by seller. Produce the poles locally by contractors and obtain legal cutting right. The plant would help the community during the construction period and afterwards by supplying treated wood for bridges, farm and home buildings, etc.

4. NEA follow the lead of the Philippine local utilities and obtain bids from the 3 or 4 pole treating companies. The awarding of contracts will probably be on a delivery time basis rather than a price. Negotiated contracts on a company by company basis will probably result in the lowest prices. Consider concrete pole companies as suppliers. Their delivery will be good and prices of poles delivered will not be much higher than wood. Evaluate construction and delivery cost of concrete poles.

5. A combination of several of the suggested methods of obtaining poles will probably be the best solution to the cost and delivery of poles. NEA follow schedule of supplier to assure delivery.

REPORT ON CONCRETE POLES FOR RURAL ELECTRIFICATION PROJECTS

Present Use of Concrete Poles

At the beginning of the post war era, the use of concrete poles in the Philippines was limited to distribution systems in small towns. These poles were mostly twenty-five feet in length with square cross-section, and with ordinary reinforcing steel bars. They were cast in wooden forms usually by the utility company themselves. Even today, the smaller utility companies with distribution systems situated far from Manila still use concrete poles as they are more readily available compared with creosoted poles which they have to buy in Manila.

Spun concrete poles came into use when a local wood treatment plant, PACWOOD, Inc. introduced it into the market. Spun concrete poles were used in urban housing development areas because of its neater appearance. But higher cost and the more exacting requirements for transportation and handling limited their use to within Manila and its suburbs only.

Prestressed concrete poles were introduced here by Philippine Prestressed Concrete Company, Inc. (Philstress), and by Constress Philippine, Inc. Poles were of the square and the H cross-section with four (4) high tensile strength steel prestressing strands. These poles are now being used in distribution systems located even in remote areas such as Bislig, Surigao del Sur.

Comparison with Wood Poles

Prestressed concrete poles can be made with strength similar to that of wood poles, although concrete poles will weigh more than wood poles for the same length and strength. The ratio is about 3 to 1.

Philstress tested two sample concrete poles last March 24th. Both poles were 35-footers. The first had a 10" x 10" butt and a 6" x 6" tip while the second had a 9" x 9" butt and a 5" x 5" tip. The bigger pole weighed 2400 lbs; had four 1/2 high tensile strength pre-tensioning cables in a square cross section and used 5,000 psi concrete mix. At the time of the tests, the pole was 3 days from the time of casting. It was loaded gradually to 3100 lbs at a point 2 ft. from the tip and the deflection of the tip reached 64 inches. The pole failed at 3100 lbs. load after deflecting 64 inches at the tip. This pole would then be classified as Class 3. The smaller pole weighed 990 lbs., had four 3/8" high tensile strength pre-tensioning cables and concrete mix of 5000 psi. A gradually increasing load up to 2,200 lbs was applied 2 ft. from the tip and a maximum deflection at the tip of 86" was measured. The test facilities set up at Philstress could not pull up the tip to beyond 86" and the test was stopped with the pole not reaching the breaking point. This pole would then be classified as Class 4. When the load on the smaller pole was released, the pole went back to its original form. The tests also showed that the poles

have considerable flexibility. This flexibility is helpful in the distribution of load among several poles in case heavy winds or in case there is the breaking of one or more poles.

Facilities for Fabrication

Both Philstress and Constress have prestressed pole casting plants in the Manila area. Philstress has also a prestressed concrete pile and pole plant in Bislig, Surigao del Sur. Mobile plants consisting of the prestressing beds and a portable boiler for steam curing of the poles can be set up in about 3 months at a new site. This can turn out about 10,000 poles in eight months.

The approximate total pole requirement for 36 electric cooperatives at an estimated 6,000 poles per cooperative, is 216,000 poles. If these are all concrete poles, and taking the 35-foot pole as average, a total of about 820,000 bags of cement will be needed for this total pole requirement. This is about 273,000 bags of cement per year. The requirement for reinforcing wire for pre-tensioning will be about 5,270 miles.

Specifications for NEA Concrete Poles

1. Aggregates

Concrete aggregates shall conform to American Concrete Institute National Building Code Standard No. 26-4-67. Concrete aggregates failing to meet

the requirements of the aforementioned standard may be used, provided special tests prove that the aggregate used will produce concrete of equal strength as required. In no case shall the maximum size of aggregate be greater than 3/4".

2. High Tensile Strands

Prestressing steel to be used shall be stress-relieved cold drawn high tensile wire .276" ø stressed to 9,800 lbs or seven wire strand 3/8" ø or 1/2" ø stressed to 14,700 lbs or 25,200 lbs respectively. Coils of wire or strands shall be as large as practicable to insure that straight wires are furnished preventing initial bending stresses. Minimum ultimate strength shall be 250,000 psi.

Prestressing steel shall be clean and free of excessive rust, scale and pitting. Welding operations shall be done carefully so that prestressing steel shall not be subjected to excessive temperatures, welding sparks or ground current.

3. Design Criteria

a) Design Load - breaking load as specified by NEA applied two (2) feet from top of the pole shall be used.

b) Design Stresses

Minimum concrete strength = 5,400 psi @ 28 days

Minimum concrete strength = 4,000 psi @ transfer

Minimum concrete strength at transport = 5,000 psi

Prestressing steel = 250,000 psi (fs)

Mild steel = 33,000 psi (fs)

4. Others

Ultimate strength method as per ACI 318-63 code shall be used only to predict the breaking load. Any acceptable test to determine the breaking load should supplement the design.

5. Production

Forms for prestressed concrete poles shall be clean steel moulds coated with approved bond breaker to minimize resistance to the shortening of the member.

Prestressing steel shall be threaded through bearing plates designed for its purpose providing 2-1/2" clearance from the molds as minimum concrete cover.

Deposition of concrete from mixer to final position in the moulds shall be as nearly as practicable to avoid segregation due to handling and flowing.

Concrete shall be thoroughly consolidated by means of approved vibrators during placement and shall be thoroughly worked around reinforcements and corners of forms.

Curing shall be by means of gradual application of steam after the initial set has been found out, maintaining the temperature at not less than 180°F for at least fourteen (14) hours. Shorter curing time may be used provided the requirement of concrete strength could be attained.

6. Testing of Materials

Testing of aggregates, cement, prestressing steel and mild steel shall conform to the requirements of American Society for Testing Materials.

Such tests shall be conducted by U.P. Industrial Research Center Testing Laboratory or by the Bureau of Public Highways Testing Laboratory.

Service Life

Prestressed concrete poles have only been introduced in the Philippines for a few years and no substantial record of service life is available. The greatest factor in the early failure of any concrete pole is the corrosion of its steel reinforcement due to the entrance of moisture through cracks. For prestressed concrete poles, cracks due to stresses on the pole are again closed when the

stressing load is relieved, showing no signs of cracks in the concrete. For this reasons, prestressed concrete poles will have a longer service life than ordinary reinforced concrete poles.

Comparison of Costs

Philstress made studies on its costs of producing these concrete poles and the company indicates it can produce concrete poles at the cost equivalent to wood poles. Hence, only the additional cost of transporting and handling by the line contractor will add to the cost of a system using concrete poles. Philstress further indicates that prestressed concrete poles can be handled like wood poles. This pole can be dropped from a trailer without breaking, and can be erected by dropping it butt first into the pole hole, using handlines to control the sway. Pole pikes cannot be used, however. But the best means of erecting the poles seems to be through the use of gin poles.

Problem Related to Use

No special handling and transporting equipment is required for prestressed concrete poles although the use of line trucks with booms is recommended. Other than its heavier weight, handling is much the same as wood poles.

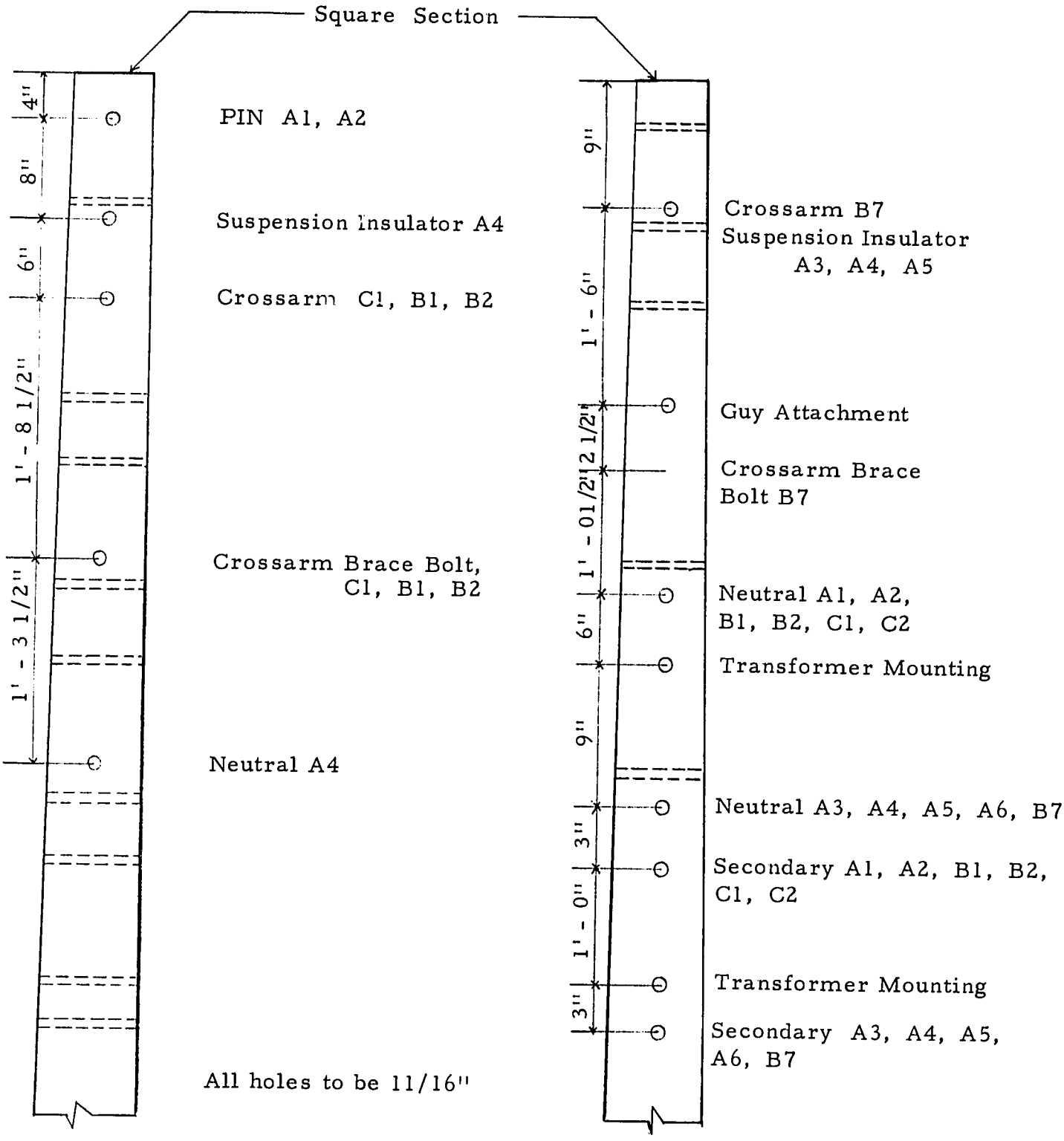
For climbing concrete poles, removable step bolts are used, and step bolt holes will be pre-bored during casting.

As shown on the attached drawings of concrete pole framing M20A and M20B, pre-bored holes will be used for attaching the pole line hardware, including the installation of the more common single phase transformer.

Conclusion

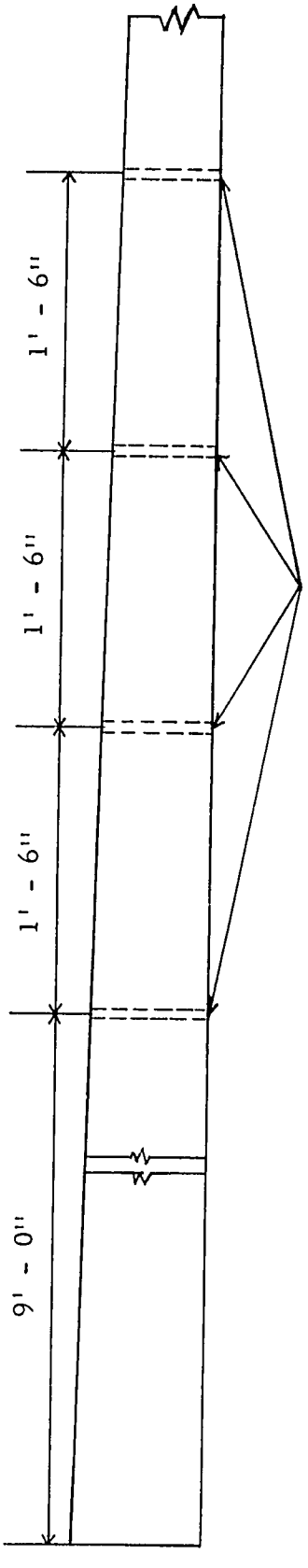
The biggest factor in favor of the use of concrete poles in the rural electrification projects is that their schedule of deliveries can be assured. The prestressed concrete manufacturers can mobilize and set up concrete pole plants in three months. The quantity of cement required for even a total shift to concrete poles will not affect the cement industry, unlike, for example, the concreting of highways, and therefore, there will be no effect on the country's construction program.

With several rural electric cooperatives being constructed at the same time, the pole requirement will exceed the normal output of all the local wood treating plants. Under this situation, use of concrete poles as a supplement to wood poles should be resorted to.



CONCRETE POLE FRAMING FOR TYPES A1, A2, A3, A4, A5, A6, B1, B2, C1, C2, C7.

M 20A



11/16" HOLES FOR STEP BOLTS SPACED 1'-6" FROM POINT 9' - 0" FROM BUTT TO WITHIN 7' - 0" FROM THE TOP

HOLES FOR REMOVABLE STEP BOLTS FOR CONCRETE POLES

M 20B

36

Specification Pressure Treated Wood Poles

Standard Specifications and Dimensions for Pressure Treated Wood Poles for Rural Electric Lines

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I. Scope

This specification describes the minimum acceptable quality of wood poles and anchor logs purchased by or for NEA borrowers. Where there is conflict between this specification and any other specification referred to herein, this specification shall govern. This specification is designed to be complete in itself.

II. General Stipulations

Poles shall be warranted to conform to this specification. If any pole shall be found defective or non-conforming under this specification in any detail except preservative retention, within one year from date of shipment it shall be replaced as promptly as possible by the producer.

Preservative retention (See Table XX) shall meet specification as a minimum at time of shipment. A reduction of no more than 10 percent will be acceptable within 30 days from date of delivery.

Poles will be inspected by NEA or their agents at time of delivery at destination for Penetration and Retention. Poles not meeting requirement set for in this specification will be rejected.

III. Material Requirements:

A. Species of Timber.

Poles and stubs furnished under this specification may be made of the species of timber. Apitong (Diptero carpus), Bagtikan (Parashorea plicata), Benguet Pine (Pinus insolaris).

B. Prohibited Defects - See Definitions

1. Cross breaks.

2. Decay, except as permitted in paragraph III, C, 1, and paragraph III, D, 6.

3. Dead streaks.

4. Holes, open or plugged, except holes for test purposes, which shall be plugged.

5. Hollow butts or tops, except as permitted in paragraph III, C, 2, and paragraph III, D, 3.

6. Marine borer damage.

7. Nails, spikes and other metal not specifically authorized by the purchaser.

C. Permitted Defects - See Definitions

1. Firm Red Heart. Firm red heart not accompanied by softening or other disintegration (decay) of the wood.

2. Hollow Pith Centers. Hollow pith centers in the tops or butts are permitted.

3. Sap Stain. Sap stain that is not accompanied by softening or other disintegration (decay) of the wood.

D. Limited Defects - See Definitions

1. Bark Inclusions. Depressions containing bark inclusions shall be not more than two inches in depth as measured from the surface of the pole.

2. Compression Wood. The outer one inch of all poles shall be free from compression wood visible on either end.

3. Defective Butts. Hollowing in the butt caused by "splinter pulling" in felling the tree is permitted provided that the area of such a hollow is less than ten percent of the butt area.

4. Insect Damage. Insect damage consisting of holes 1/16 inch or less in diameter, or surface scoring or channeling is permitted. All other forms of insect damage are prohibited.

5. Knots. The diameter of any single knot when measured at right angle to the length of the pole shall not exceed 1/3 of the diameter of the pole at the section where it occurs. Knot clusters shall not be permitted.

6. Dead Knots. Sound dead knots are permitted. Decay is permitted in dead knots provided it is not associated with heart rot.

7. Scars. No pole shall have a scar, pitch streak or a turpentine face (pine) located within two feet of the groundline. Turpentine scars shall be trimmed as necessary to examine for evidence of fungus infection and insect damage. Other sound scars are permitted elsewhere on the pole surface, provided they are smoothly trimmed and do not interfere with the cutting of any gain and provided:

   a. That the circumference at any point on trimmed surfaces located between the butt and two feet below the groundline is not less than the minimum circumference specified at six feet from the butt for the class and length of the pole.

   b. That the depth of a scar is not more than two inches if the diameter at the location of the scar is ten inches or less, or more than one-fifth of the pole diameter at the location of the scar if the diameter is more than ten inches.

8. Shakes. Shakes in the butt surface are permitted provided that they are more than two inches from the side surface of the pole and do not extend to the groundline. Shakes in the top are prohibited.

9. **Shape.** Poles shall be free from short crooks. A pole may have sweep subject to the following limitations:

a. For poles 50 feet and shorter of all species, having sweep in one plane and one direction only, a straight line joining the surface of the pole at the groundline and the edge of the pole at the top shall not be distant from the surface of the pole at any point by more than one inch for each ten feet of length between these points in 90 percent or more of an inspection lot; in the remainder of the inspection lot (ten percent), the poles may have a deviation of one inch for each six feet of length when measured as above.

Poles 55 feet and longer shall meet the one inch in ten-feet requirements in 75 percent of the lot (25 percent), the poles may have a deviation of one inch for each six feet of length when measured as above. (See Diagram 1 of subsidiary drawing entitled "Measurement of Sweep and Short Crook in Poles".)

b. Where sweep is in two planes (double sweep), or in two directions in one plane (reverse sweep), a straight line connecting the midpoint at the groundline with the midpoint at the top shall not at any intermediate point pass through the surface of the pole.

(See Diagram 2 of subsidiary drawing entitled "Measurement of Sweep and Short Crook in Poles".)

11. Spiral Grain. Spiral grain (twist grain) is permitted as follows:

Length of Pole	Maximum Twist of Grain Permitted
30 feet and shorter	1 complete twist in any 10 feet
35 feet to 45 feet inclusive	1 complete twist in any 16 feet
50 feet and longer	1 complete twist in any 20 feet

12. Splits and Checks.

a. In the Top. A split or a combination of two single checks (each check terminating at the pith center and separated at the surface of the pole by not less than one-sixth of the circumference) and having one or both checks located in a vertical plane within 30 degrees of the top bolt hole shall not extend downward along the pole more than six inches. All other combination of checks or a split shall not extend downward along the pole more than 12 inches.

b. In the Butt. A split or a combination of two single checks shall not extend upward along the pole more than two feet.

IV. Dimensions: For dimensions (circumference) of poles, see Tables 1 and 2.

A. Length.

Poles less than 50 feet in length shall be not more than three inches shorter or six inches longer than nominal length. Poles 50 feet or more in length shall be not more than six inches shorter or 12 inches longer than nominal length.

Length shall be measured between the extreme ends of the pole.

B. Circumference.

The minimum circumference at six feet from the butt and at the top for each length and class of pole are listed in the tables of dimensions. The circumference at six feet from the butt of any pole shall be not more than seven inches or 20 percent larger than the specified minimum, whichever is greater.

The top dimensional requirement shall apply at a point corresponding to the minimum length permitted for the pole.

C. Classification.

The true circumference class shall be determined as follows: Measure the circumference at six feet from the butt. This dimension will determine the true class of the pole, provided

that its top (measured at the minimum length point) is large enough. Otherwise, the circumference at the top will determine the true class, provided that the circumference at six feet from the butt does not exceed the specified minimum by more than seven inches, or 20 percent, whichever is greater.

V. Manufacturing Requirements:

A. Bark Removal.

Outer bark shall be completely removed from all poles.

On all poles, no patch of inner bark more than one-inch wide and more than six-inches long shall be left on the pole surface between the top and two feet below the groundline.

B. Sawing.

All poles shall be neatly sawed at the top and at the butt along a plane which shall not be out of square with the axis of the pole by more than two inches per foot of diameter of the sawed surface. Beveling at the edge of the sawed butt surface not more than one-twelfth of the butt diameter in width, or an equivalent area unsymmetrically located, is permitted.

C. Trimming.

Completely overgrown knots rising more than one inch above the pole surface, branch stubs, and partially overgrown knots shall be trimmed close. Completely overgrown knots less than one inch high need not be trimmed. Trimming may be done by hand or shaving machine.

D. Framing.

All poles shall be bored, gained and cut to length prior to final treatment, and in accordance with the attached drawings or with any drawing which accompanies an order or contract. When gains are required on one side only, they shall be cut on the face of the pole; and the gained surfaces shall be in approximately parallel planes.

E. Marking.

Each pole shall be legibly burn-branded or tagged on the face of the piece at such location that the bottom of the brand or tag is within one inch above or below a point at ten feet from the butt end on poles 20 to 50 feet long, inclusive; at 14 feet from the butt end on poles longer than 50 feet, and each piece shall be marked (burn or hammer branded) in the butt surface.

In lieu of the burn-brand, the tag shall be a disk made of 20

to 24 gauge-sheet aluminum. The disk shall be embedded in a bored recess, approximately one-quarter inch deep and of such size that the disk will lock firmly when pressed into place. An aluminum nail driven through the center of the disk shall be used for additional security of attachment.

1. The following details shall be included in the brand or disk on the face of the pole or stub:
   a. The supplier's code or trade-mark.
   b. The plant location and month and year of treatment.
   c. Code letters denoting the pole species and preservative used.
   d. The true circumference class numeral and numerals indicating length of the pole.
2. The marking on the butt end need include only the class and length numerals on poles.
3. All poles shipped to an NEA borrower shall have a suitable tag bearing the charge number in which it was treated securely attached to the butt-end surface. In lieu of the tag, the charge number may be hammer branded in the butt surface after treatment.
4. The arrangement of the required several details in the brand shall be in the sequence (top to bottom) as listed above.

5. Code letters shall be, for pole species:

Apitong	Ap
Bagtikan	Ba
Pine	P

Code letters for preservatives and retention:

Creosote	C-12
Pentachlorophenol-Petroleum	P-6
Chromated Copper Arsenate Salts	SA.8
	SB.8
	SC.8
Oxide Basis	

Code numeral for class and length:

Class - 1 to 10
Length - 20, 25, 30, etc.

Code letters and numerals shall not be less than 5/8-inch high, if burn branded; and not less than 1/8-inch high if embossed or stamped on a metal disk.

Poles shall not be dragged along the ground. Cant hooks, pole tongs, or other pointed tools shall not be applied to the groundline section of any treated pole.

VI. Definition of Terms:

The following definitions shall apply in these specifications:

A. Check. A lengthwise separation of the wood that usually extends across the rings of annual growth and commonly results from stresses set up in wood during seasoning.

B. Compression Wood. Abnormal wood formed on the lower side of branches and inclined trunks of softwood trees. Compression wood is identified by its relatively wide annual rings, usually eccentric, relatively large amount of summerwood, sometimes more than 50 percent of the width of the annual rings in which it occurs, and its lack of demarcation between springwood and summerwood in the same annual rings. Compression wood shrinks excessively lengthwise, as compared with normal wood.

C. Cross Break. A separation of the wood cells across the grain. Such breaks may be due to internal strains resulting from unequal longitudinal shrinkage or to external forces.

D. A dead knot is a knot left by a branch that dies before the tree was cut. Dead knots may contain soft fibers (decay) that do not extend deeper than an inch or two from the pole surface.

E. Dead Streak. A dead streak is an area, devoid of bark, resulting from progressive destruction of the growth cells of wood and bark at the edge of the streak. On a pole, a dead streak is characterized by a discolored weathered appearance and by lack of evidence of overgrowth along the edges of the deadened surface.

F. Decay. The decomposition of wood substance by fungi.

1. Advanced (or typical) decay. The older stage of decay in which the destruction is readily recognized because the wood has become punky, soft and spongy, stringy, ring-shaked, pitted, crumbly, or which is in a "soggy" condition occurring in poles not stored or rafted in water. Decided discoloration or bleaching of the rotted wood is often apparent.

2. Incipient decay. The early stage of decay that has not proceeded far enough to soften or otherwise perceptibly impair the hardness of the wood. It is usually accompanied by a slight discoloration or bleaching of the wood.

G. Face of Pole. The face of a pole is the concave side of the poles with sweep in one plane and one direction, or the side of greatest curvature in poles having reverse or double sweep between the groundline and the top.

H. Groundline Section. The groundline section is that portion of a pole between one foot above and two feet below the groundline as defined in the pole dimension tables.

I. Hollow Heart. A hollow heart is a void in the heartwood caused by decay or insect attack.

J. Hollow Pith Center. A hollow pith center is a small hole at the pith center of the trunk or of a knot, caused by disintegration of the pith (small soft core occurring in the structural center of a tree or branch).

K. Insect Damage. Insect damage is the result of boring in the pole by insects or insect larvae. Scoring or channeling of the pole surface is not classed as insect damage.

L. Knot Diameter. A knot diameter is its diameter on the surface of the pole measured in a direction at right angles to the lengthwise axis of the pole. The sapwood as well as the heartwood portion of a knot shall be included in the measurement.

M. Red Heart. Red heart is caused by a fungus, *Fomes pini*, that occurs in the living tree. It is characterized in the early stages of infection by a reddish or brownish color in the heartwood. This is known as "firm red heart". Later, the wood in the case of a living tree disintegrates (decays) in small, usually distinct, areas that develop into white-lined pockets.

N. Sap Stain. Sap stain is a discoloration of the sapwood caused by the action of certain molds and fungi that is not accompanied by softening or other disintegration of the wood.

O. Scar (Cat Face). A scar is a depression in the surface of the pole resulting from a wound where healing has not re-established the normal cross-section of the pole.

P. Shake. A separation along the grain, the greater part of which occurs between annual growth rings.

Q. Short Crook. A localized deviation from straightness which, within any section five feet in length, is more than one-half the mean diameter of the crooked section. (See figure 1, diagram 3).

R. Spiral-grained (twisted-grained) Wood. Wood in which the fibers take a spiral course about the trunk of a tree instead of a vertical course. The spiral may extend in a right-handed or a left-handed direction around the tree trunk. Spiral grain is a form of cross grain.

S. Split. A lengthwise separation of the wood due to tearing apart of the wood cells. A split differs from a check (paragraph VI, A) in that a check extends from the surface toward the pith center of the pole.

T. Sweep. Deviation of a pole from straightness (See figure 1, diagrams 2 and 3).

VII. Preservatives:

A. The preservative shall be one of the following, whichever is specified in the purchase order. Substitution of another preservative for the one ordered shall not be made except by authorization from the purchaser. These preservatives are considered equivalent.

Creosote (AWPA P-1)

Pentachlorophenol-Petroleum Solution containing not less than 5 percent pentachlorophenol by weight of the solution. (AWPA P-8, P-9)

Chromated Copper Arsenate Salts (AWPA-5)

1 Creosote-Petroleum Solution 70-30. (AWPA P-1, P-3, P-4)

The Creosote-Petroleum shall contain not less than 70 percent by Volume of Creosote and Balance Heavy Bunker C Petroleum.

The preservative may be tested for quantity of creosote by pressing preservative from a section cut from the butt of a pole by Published AWPA Method.

1. Creosote. The creosote shall be a distillate derived entirely from bituminous coal tar and shall conform to the following details as determined by standard analytical methods. (AWPA Standard A1).

	Creosote in Use	
	Not more than	Not less than
Water, %	3.0	---
Benzol insoluble, %	1.5	---
Specific Gravity at 38°C compared with water at 15.5 C	---	1.05
Distillation (water free basis)		
2-210°C	2	---
2-235°C	12	2
0-270°C	40	20
0-315°C	65	45
0-355°C	82	73
Specific Gravity of fractions distilling between		
235°C - 315°C	---	1.027
315°C - 355°C	---	1.095

Petroleum (AWPA P-4) Bunker C Heavy.

2. Pentachlorophenol (AWPA P-8). The pentachlorophenol shall contain not less than 95 percent of chlorinated phenols as determined by titration of hydroxyl and calculated as pentachlorophenol.

Matter insoluble in N/1 aqueous sodium hydroxide solution, not more than 1 percent. Freezing point, not less than 174°C.

3. Petroleum for Penta-Petroleum Solutions (AWPA P-9). The petroleum shall conform to the following:

Specific gravity at 60°60°F, not less than 0.85
Water and sediment, not more than 0.5 percent

Distillation
Below 500°F, not more than 50 percent by volume
Below 600°F, not more than 90 percent by volume

Viscosity
At 100°F, not more than 70 Saybolt Universal Seconds

Solvency for pentachlorophenol, at least 10 percent by weight.

4. Salts Chromated Copper Arsenate, Types A, B and C (AWPA P-5).

a. Chromated copper arsenate, Type A, shall have the following composition:

Hexavalent chromium, as CrO_3	65.5%
Copper, as CuO	18.1%
Arsenic, as As_2O_5	16.4%

subject to the following tolerances:

b. The composition of the solid preservative or of the preservative present in a treating solution may vary within the following limits:

	Min.,%	Max.,%
Hexavalent chromium, as CrO_3 -----	59.4	69.3
Copper, as CuO ----------	16.0	20.9
Arsenic, as As_2O_5 ----------	14.7	19.7

c. The solid preservative or treating solution shall be made up of water soluble compounds selected from the following groups each in excess of 95 percent purity on an anhydrous basis:

Hexavalent chromium -- e.g., potassium or sodium dichromate, chromium trioxide
Bivalent copper -- e.g., copper sulfate, basic copper carbonate, cupric oxide or hydroxide
Pentavalent arsenic -- e.g., arsenic pentoxide, arsenic acid, sodium arsenate or pyroarsenate

The commercial preservative shall be labeled as to its total content of active ingredients listed in the first paragraph.

d. Tests to establish conformity with the foregoing requirements shall be made in accordance with the standard methods of the American Wood-Preservers' Association. (See Standard A2.)

5. <u>Chromated Copper Arsenate, Type B (CCA - Type B).</u>

a. Chromated copper arsenate, Type B, shall have the following composition:

Hexavalent chromium, as CrO_3 ----------	35.3%
Copper, as CuO ----------	19.6%
Arsenic, as As_2O_5 ----------	45.1%

subject to the following tolerances:

b. The composition of the solid preservative or of the preservative present in a treating solution may vary within the following limits:

	Min., %	Max., %
Hexavalent chromium, as CrO_3 ------	33.0	38.0
Copper, as CuO ----------	18.0	22.0
Arsenic, as As_2O_5 ----------	42.0	48.0

c. The solid preservative or treating solution shall be made up of water soluble compounds selected from the following groups each in excess of 95 percent purity on an anhydrous basis:

Hexavalent chromium -- e.g., potassium or sodium dichromate, chromium trioxide
Bivalent copper -- e.g., copper sulfate, basic copper carbonate, cupric oxide or hydroxide
Pentavalent arsenic -- e.g., arsenic pentoxide, arsenic acid, sodium arsenate or pyroarsenate

The commercial preservative shall be labeled as to its total content of active ingredients listed in the first paragraph.

d. Tests to establish conformity with the foregoing requirements shall be made in accordance with the standard methods of the American Wood-Preservers' Association.(See Standard A2.)

6. Chromated Copper Arsenate (CCA - Type C).

a. The active ingredients in chromated copper arsenate shall have the following composition:

Hexavalent chromium, as CrO_3	47.5%
Copper, as CuO	18.5%
Arsenic, as As_2O_5	34.0%

b. The analytical composition of the active ingredients in the solid preservative or treating solution shall lie between the following limits:

	Min., %	Max., %
Hexavalent chromium, as CrO_3	44.5	50.5
Copper, as CuO	17.0	21.0
Arsenic, as As_2O_5	30.0	38.0

c. The solid preservative or treating solution shall be made up of water soluble compounds selected from the following groups each in excess of 95 percent purity on an anhydrous basis:

Hexavalent chromium --e.g., potassium or sodium dichromate, chromium trioxide
Bivalent copper --e.g., copper sulfate, basic copper carbonate, cupric oxide or hydroxide
Pentavalent arsenic --e.g., arsenic pentoxide, arsenic acid, sodium arsenate or pyroarsenate

The commercial preservative shall be labeled as to its total content of active ingredients listed in the first paragraph.

d. The pH of the treating solution shall be between 1.6 and 3.2.

e. Tests to establish conformity with the foregoing requirements shall be made in accordance with the standard methods of the American Wood-Preservers' Association. (See Standard A2.)

VIII. Preservative Treatment:

A. Conditioning Prior to Treatment.

Poles are to be air seasoned enough to permit pressure treatment to meet penetration and retention requirements without the use of Boulton or Steaming Processes, the maximum pressure not greater than 200# /sq. in. and temperature not greater than 200°F.

B. Results of Treatment.

1. Penetration and retention of preservative shall be tested on borings taken at approximately:

   a. In a plane approximately one foot below the brand on all poles.

2. Penetration shall be measured between the outer end of a boring and the innermost annual growth ring in which preservative is visible, provided there is no intermediate untreated growth ring within the measured distance. Penetration shall be measured on all poles. Poles treated with Water-Borne Salts shall have penetration determined using Test Solutions given in AWPA A-3.

3. Depth of penetration shall be not less than 1-1/2 inches, or 85 percent of Sapwood whichever is greater.

4. Retention of preservative shall be by Assay and not less than the amount specified in following Table XX.

	Sample Zone for Assay inches from Surface	Numbered Borings	Retention by Assay Pounds per cu. ft.
Creosote Petroleum 70 - 30	0 - 1.5	20	12
Pentachloro-phenol	0 - 1.5	20	0.6
Chromated Copper Arsenate	0 - 1.5	20	0.8* 1/

*Note Oxide Value.

Assay Retention shall be determined by:

a. Toluene extraction for creosote shall be used when the preservative is creosote-petroleum solution AWPA Method A-6.

b. Lime fusion test or Copper pyridine test for pentachlorophenol shall be used when the preservative is a penta-petroleum solution AWPA Method A-5.

c. Analysis for Chromium, Copper and Arsenic shall be used when the preservative is Chromated Copper Arsenate AWPA Method A-2.

1/ In addition to Specified Retention the distribution must be uniform enough to give .3 #/cu.ft. Assay in the 3rd 1/2 inch.

In computing retentions, use a dry wood weight of 32 pfc for both Benguet Pine and Bagtikan and 38.0 pfc for Apitong.

In Chromated Copper Arsenate the Assay Retention is the sum of the three Oxides determined in the chemical analysis provided they are within the limits of Maximum and Minimum specified in Section VII, A, 4 for the type called for on the purchase order. Any excess of any one or two of the three oxides is not to be included in the Assay Retention.

IX. Drawings:

The attached drawings show in detail the framing (gains and bolt holes) for poles ordered under this specification. Poles should be ordered by Drawing Number, and should include any desired detail not shown on these drawings.

Drawings 801, M-20, TM-4A, TM-5, TM-5A, TM-4.

X. Related Specifications:

The following listed specifications may be considered as pertinent to this specification subject to the restriction in the paragraph under Scope.

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AWPA C1	Standard for Preservative Treatment by Pressure Processes - All timber products.
AWPA C4	Standard for the Preservative Treatment of Poles by Pressure Processes.
AWPA M1	Standard for the Purchase and Preservation of Forest Products.
AWPA M2	Standard Instruction for the Inspection of Preservative Treatment of Wood.
AWPA A1	Standard Methods for Analysis of Creosote and Oil-Type Preservatives.
AWPA A5	Standard Methods for Analysis of Oil-Borne Preservatives.
AWPA A6	Method for the Determination of Water and Oil-Type Preservatives in Wood.

May be purchased from:

American Wood-Preservers' Association (AWPA)
1012 Fourteenth Street, N.W.
Washington, D. C. 20005

Tables one through six are ASA 05.1 - 1963. Part of the "scope" of this standard is:

> "The poles described herein are considered as simple cantilever members subject to transverse loads only, under which conditions the maximum stress is at the groundline. Modifications of the requirements may be necessary for other types of construction."

P1	Standard for Creosote
P3	Standard for Creosote-Petroleum Oil Solution

P4 Standard for Petroleum Oil for Blending with Creosote

P5 Standard for Water-Borne Preservatives

P8 Standard for Oil-Borne Preservatives

P9 Standard for Hydrocarbon Solvents for Oil-Borne Preservatives

A2 Standard Method for Analysis of Water-Borne Preservatives and Fire-Retardant Formulations

A3 Standard Method for Determining Penetration of Preservatives

A8 Standard Method for Qualitative Recovery of Creosote or Creosote-Coal Tar Solution from Freshly Treated Piles, Poles, or Timber (Squeeze Method)

TABLE 1

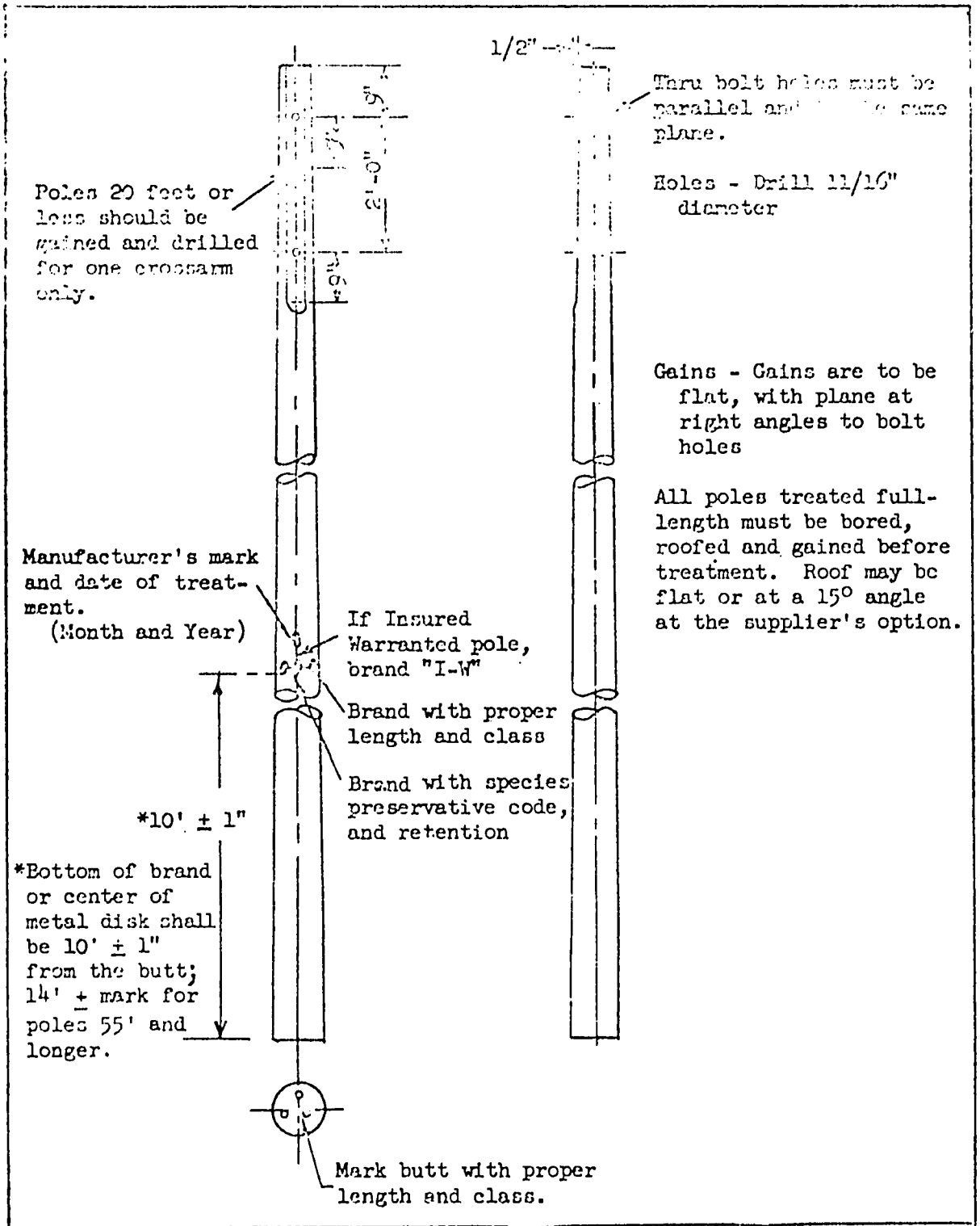
Dimensions of Apitong and Bagtikan
(Based on a Fiber Stress of 9100 psi)

CLASS		1	2	3	4	5	6	7	9	10
Minimum Circumference at top (Inches)		27	25	23	21	19	17	15	15	12
Breaking Load (pounds)		4500	3700	3000	2400	1900	1500	1200		
Length of (feet)	Groundline Distance from Butt (feet)	Minimum Circumference at 5 Feet from Butt (Inches)								
25	5	32	30	28	26	24	22.5	20.5	18	14
30	5½	34.5	32.5	30	28	26	24	22.5	19	
35	6	37	34.5	32.5	30	27.5	26	24		
40	6	39	36.5	34	31.5	29	27	25.5		
45	6½	41	38.5	36	33	30.5	28			
50	7	43	40	37.5	34.5	32	29.5			
55	7½	44.5	41.5	39	36	33.5				
60	8	46	43	40	37.5	34.5				
65	8½	47	45	41.5	38.5					
70	9	48.5	46	43	40					
75	9½	50	46.5	44						
80	10	51	48	45						

TABLE 2

Dimensions of Benguet Pine Poles
(Based on a Fiber Stress of 7600 psi)

CLASS		1	2	3	4	5	6	7	9	10
Minimum Circumference at top (Inches)		27	25	23	21	19	17	15	15	12
Breaking Load (pounds)		4500	3700	3000	2400	1900	1500	1200		
Length of Pole (feet)	Groundline Distance from Butt (feet)	Minimum Circumference at 5 Feet from Butt (Inches)								
25	5	34.0	32.0	30.0	27.5	25.5	24.0	21.5	19.0	15.0
30	5½	36.5	34.5	32.0	30.0	27.5	25.5	24.0	20.0	
35	6	39.5	36.5	34.0	32.0	29.5	27.5	25.5		
40	6	41.5	39.0	36.0	33.5	31.0	29.0	27.0		
45	6½	43.5	41.0	38.5	35.0	32.5	30.0	28.0		
50	7	45.5	42.5	40.0	36.5	34.0	31.5	29.5		
55	7½	47.0	44.0	41.5	38.5	35.5	32.5			
60	8	48.5	45.5	42.5	40.0	36.5	34.0			
65	8½	50.0	47.5	44.0	41.0	38.0				
70	9	51.5	48.5	45.5	42.5	39.5				
75	9½	53.0	49.5	46.5	43.5					
80	10	54.5	51.0	47.5	44.5					



RURAL TELEPHONE CONSTRUCTION PRACTICES

POLE FRAMING

Scale: NTS

September 6, 1960

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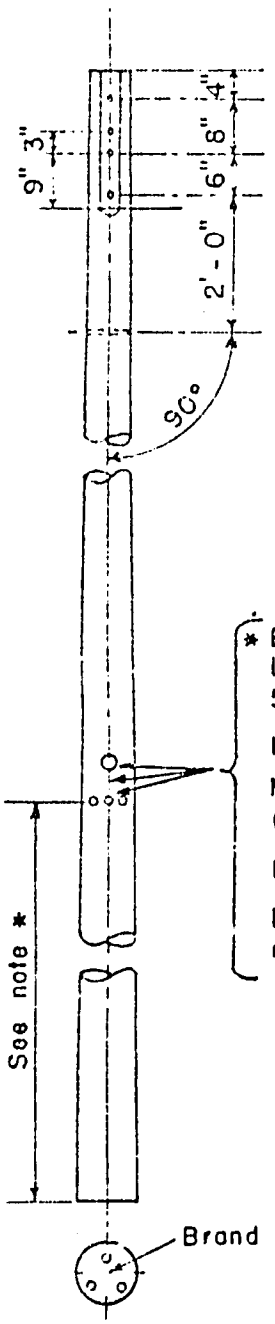
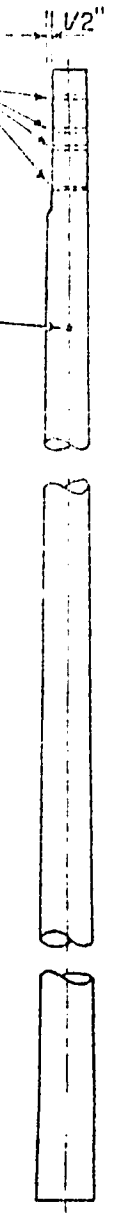




Through-bolt holes must be parallel and in the same same plane.

HOLES: Drill 11/16" diameter.

GAINS: Gains are to be flat wi. at right angles to bolt hole.

Neutral bolt hole must be at 90° angle with through-bolt holes.

All poles treated full-length must be bored, roofed and gained before treatment, except that Class 7 and smaller poles need not be gained unless requested by purchaser. Roofs may be flat or at a 15° angle at the producer's option.

* Bottom of brand or center of metal disk shall be 10' ± 1" from pole butt; 14' ± 1" mark for poles 55' and longer.

If insured warranted pole, Brand "IW".

Manufacturer's Mark and Date of Treatment, (Month and Year).

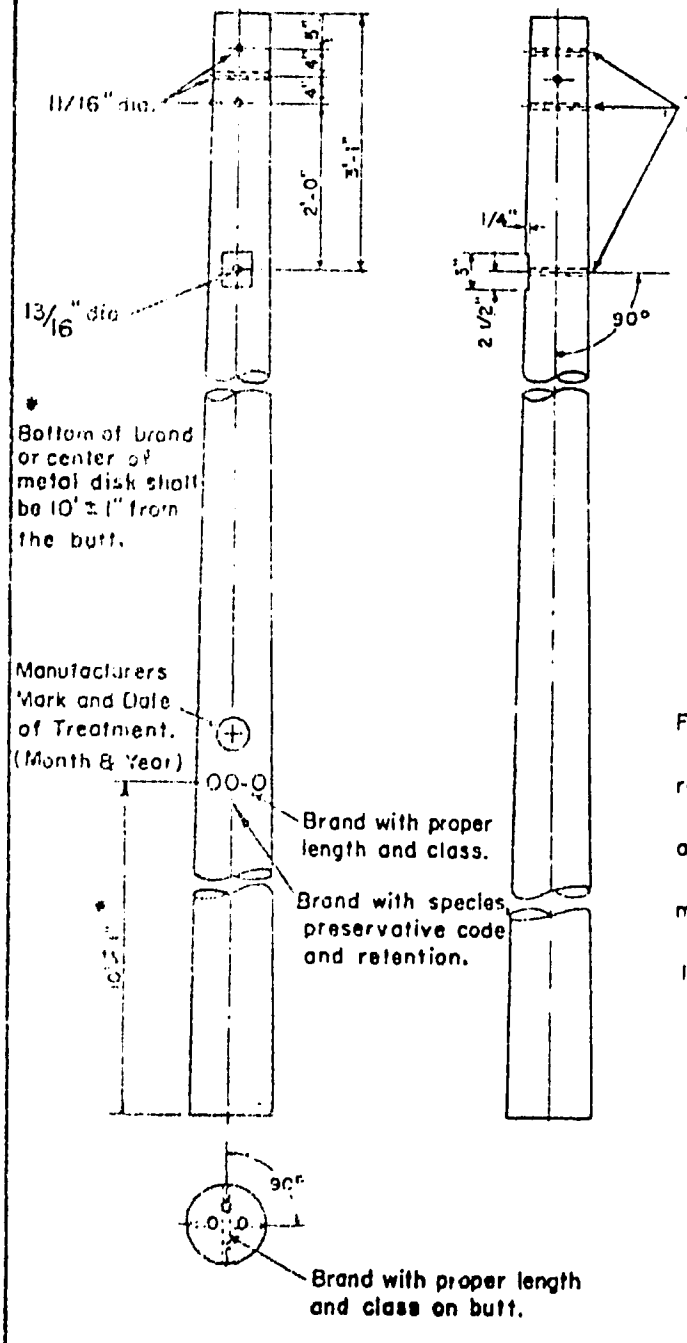
Brand with proper length and class.

Brand with species, preservative code and retention.

Brand butt with proper length and class.

POLE FRAMING GUIDE

Jan. 1, 1962		M20



FRAMING

All poles treated full length must be bored, roofed, and gained before treatment.

Gains are to be flat with plane at right angles to bolt hole.

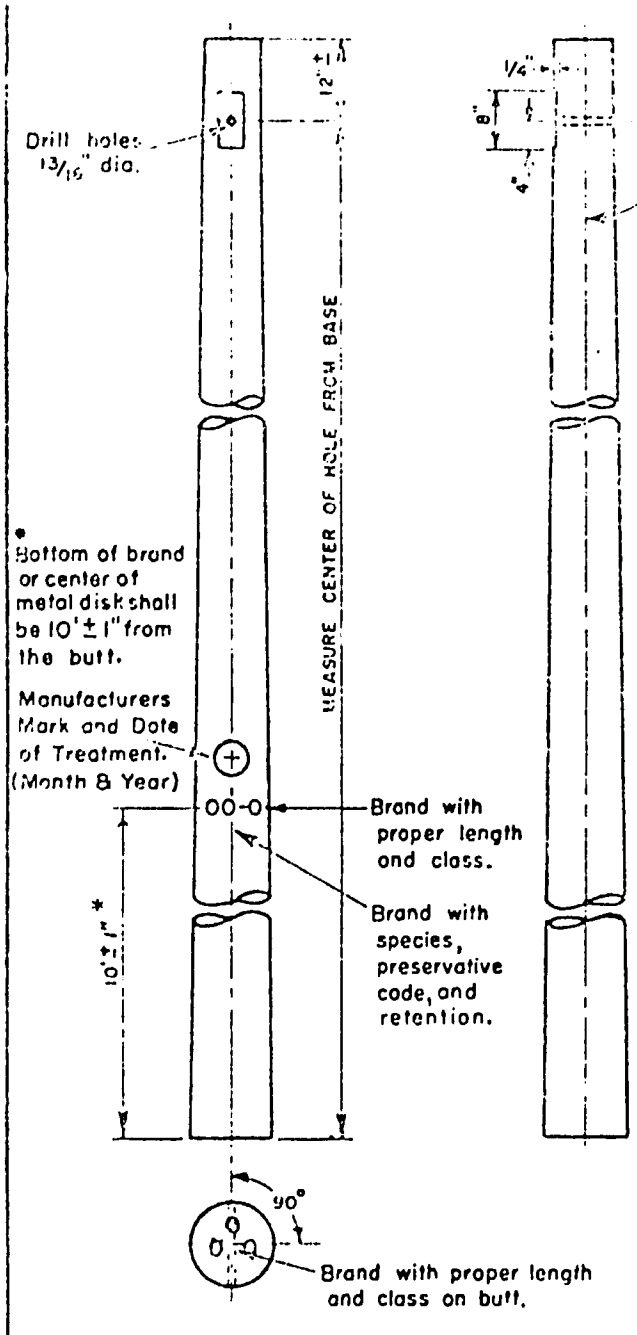
For field gains on full length treated poles metal gains are preferred.

Roots may be flat or at an angle of 15°, at the supplier's option.

(1)* Note: 14' ± 1" mark for poles 55 feet and longer.

TRANSMISSION LINE POLE FRAMING
FOR STRUCTURE TP-1

NO	REVISION	DATE	Scale: 1/2"=1'-0"		Date: 11-49
1	Reissued	1-60			TM-4



FRAMING

All poles treated full length must be bored, roofed, and gained before treatment.

Gains are to be flat with plane at right angles to bolt holes.

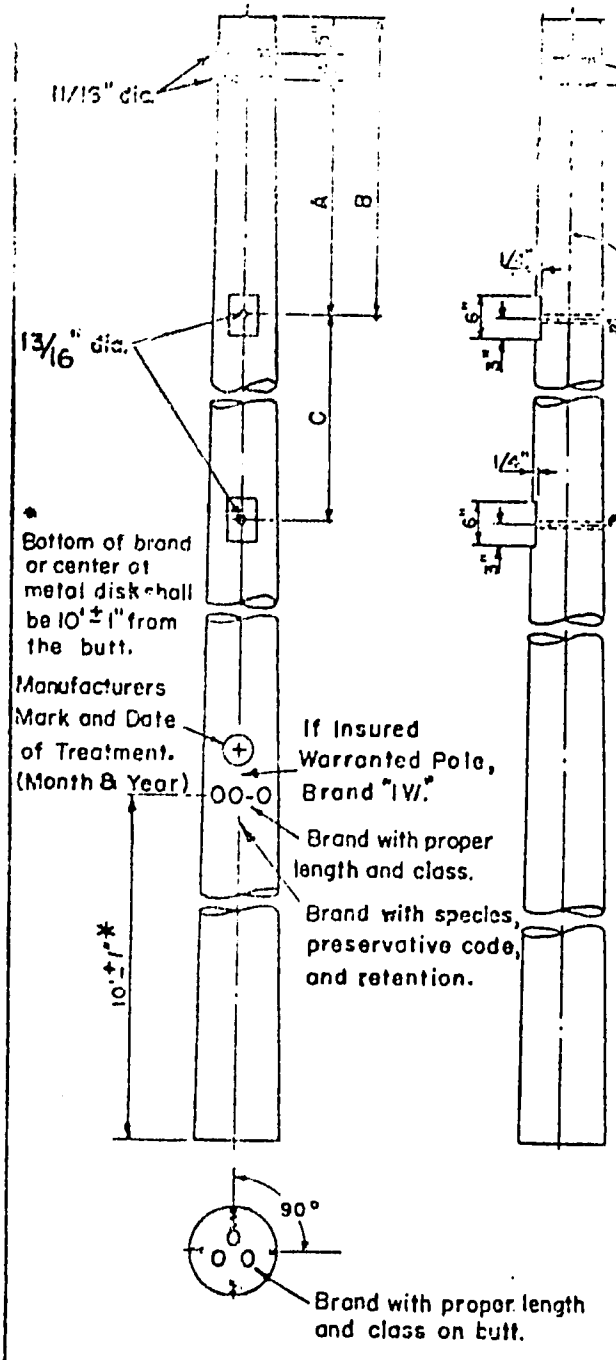
For field gains on full length treated poles metal gains are preferred.

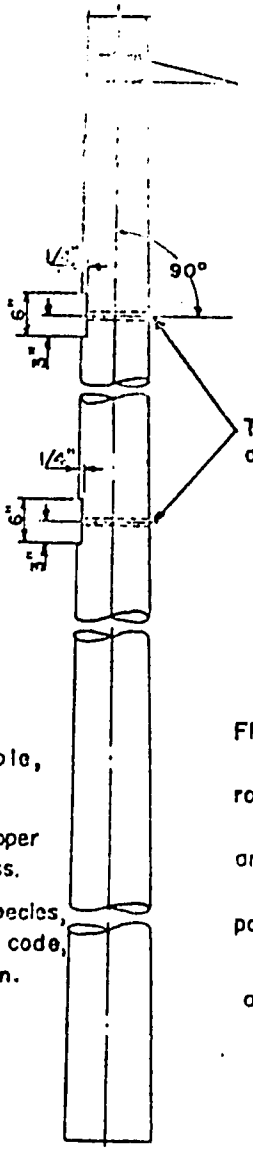
Roofs may be flat or at an angle of 15°, at the supplier's option.

(1) *Note: 14' ± 1" mark for poles 55 feet and longer.

TRANSMISSION LINE POLE FRAMING
FOR STRUCTURE TH-1

NO.	REVISION	DATE			
1	Reissued	1-60	Scale: 1/2"=1'-0"		Date: 11-42
					TM-4A





FRAMING

All poles treated full length must be bored, roofed, and gained before treatment.

Gains are to be flat with plane at right angles to bolt hole.

For field gains on full length treated poles metal gains are preferred.

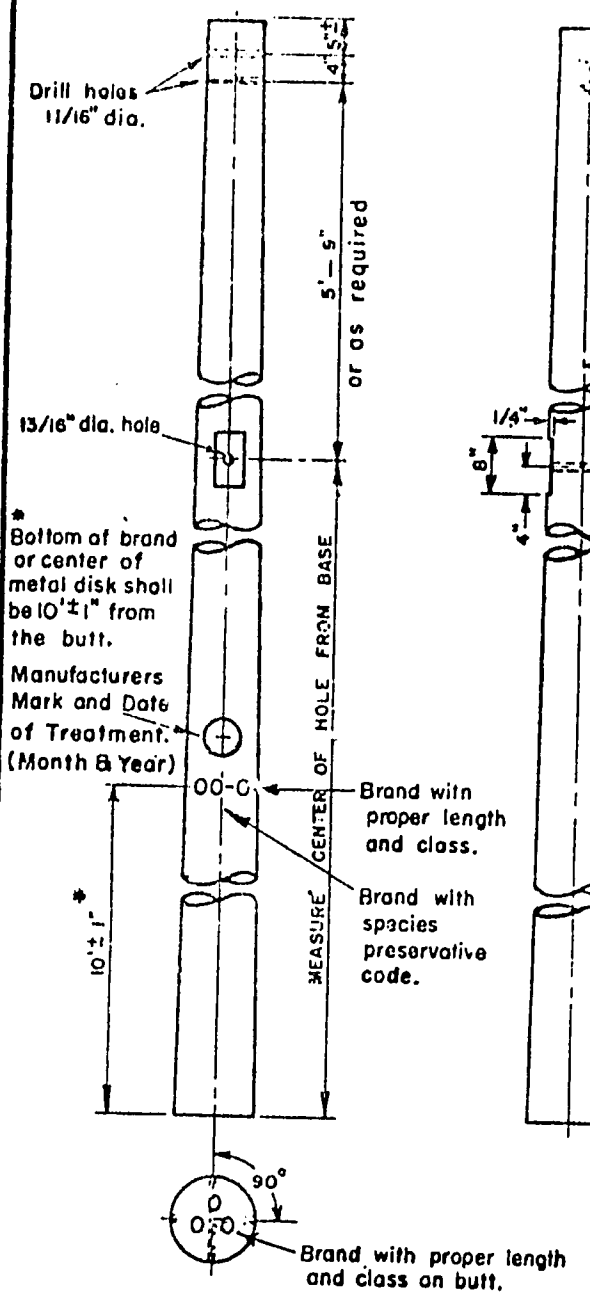
Roofs may be flat or at an angle of 15°, at the supplier's option.

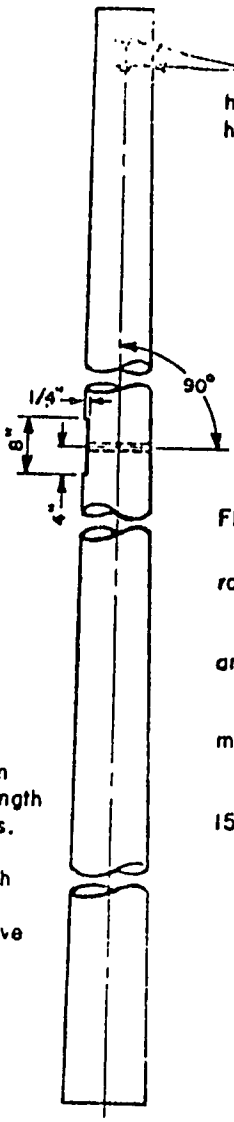
DRG. NO.	DIMENSIONS		
	A	B	C
TM-5	2'-9"	3'-6"	6'-0"
TM-5X	3'-9"	4'-6"	7'-0"

(1) Note: 14'±1" mark for poles 55 feet and longer.

TRANSMISSION LINE POLE FRAMING
FOR STRUCTURES TS-I AND TS-IX

NO.	REVISION	DATE			Date: 11-49
1	Revised	4-20			TM-5, TM-5X





FRAMING

All poles treated full length must be bored, roofed, and gained before treatment.

Gains are to be flat with plane at right angles to bolt holes.

For field gains on full length treated poles metal gains are preferred.

Roofs may be flat or at an angle of 15°, at the supplier's option.

(1) *Note: 14' ± 1" mark for poles 55 feet and longer.

TRANSMISSION LINE POLE FRAMING
FOR STRUCTURES TH-1G AND TH-1A

NO.	REVISION	Date			
1	Reissued	1-60	Scale: 1/2"=1'-0"		Date: 11-4-9
					TM-5A

Fig. 1

Measurement of Sweep and Short Crook in Poles

DIAGRAM 1 — MEASUREMENT OF SWEEP IN ONE PLANE AND ONE DIRECTION

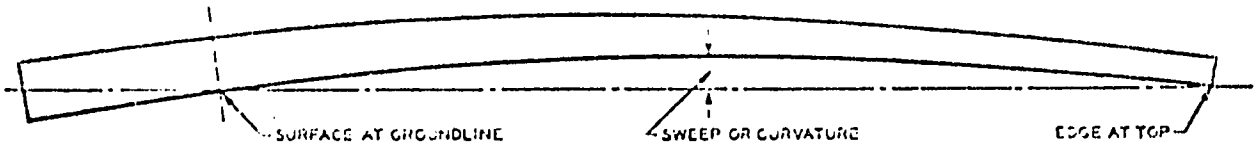


DIAGRAM 2 — MEASUREMENT OF SWEEP IN TWO PLANES (DOUBLE SWEEP) OR IN TWO DIRECTIONS IN ONE PLANE (REVERSE SWEEP)

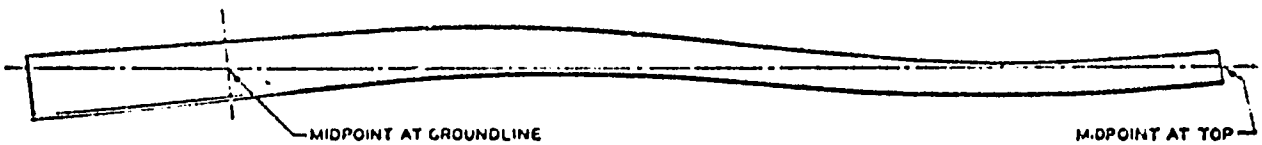
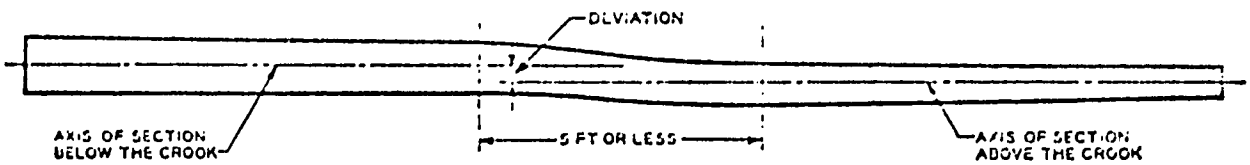
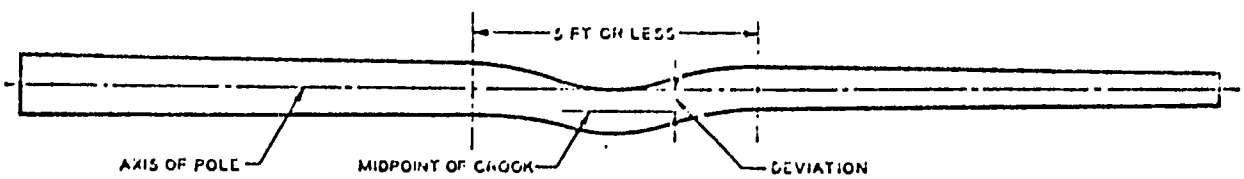


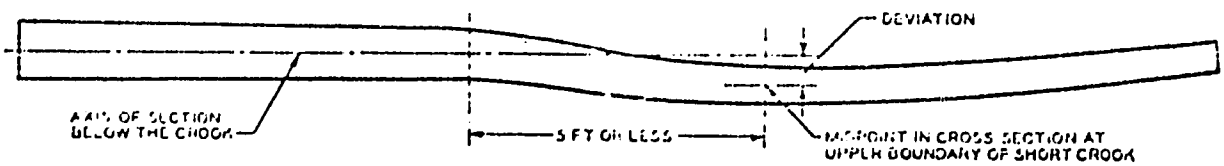
DIAGRAM 3 — MEASUREMENT OF SHORT CROOK (THREE CASES SHOWN)



CASE 1: WHERE THE REFERENCE AXES ARE APPROXIMATELY PARALLEL



CASE 2: WHERE AXES OF SECTIONS ABOVE AND BELOW THE CROOK COINCIDE OR ARE PRACTICALLY COINCIDENT



CASE 3: WHERE AXIS OF SECTION ABOVE SHORT CROOK IS NOT PARALLEL OR COINCIDENT WITH AXIS BELOW THE CROOK

NOTE: The three cases shown under Diagram 3 are typical and are intended to establish the principle of measuring short crooks. There may be other cases not exactly like those illustrated.