UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Utilities Service

RUS BULLETIN 1730B-121

SUBJECT: **Wood Pole Inspection and Maintenance**

TO: All Electric Borrowers

EFFECTIVE DATE: Date of Approval.

OFFICE OF PRIMARY INTEREST: Transmission Branch, Electric Staff Division.

FILING INSTRUCTIONS: This bulletin replaces RUS Bulletin 1730B-121, "Pole Inspection and Maintenance," issued April 15, 1996.

PURPOSE: To furnish information and guidance in establishing a continuing program of pole maintenance.

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Date

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ABBREVIATIONS

ACA - Ammoniacal copper arsenate
ACZA - Ammoniacal copper zinc arsenate
ANSI - American National Standards Institute
AWPA - American Wood Protection Association
CCA - Chromated copper arsenate
EPA - Environmental Protection Agency
NaMDC - N-methyldithiocarbamate
NESC - National Electrical Safety Code
MITC - Methylisothiocyanate
pcf - pounds per cubic foot
RUS - Rural Utilities Service

1 PURPOSE

To furnish information and guidance to electric cooperatives in establishing a continuing program of pole maintenance and to operating personnel in performing inspection and maintenance of standing poles. Included in this bulletin are methods and procedures for determining the minimum permissible groundline circumferences of distribution and transmission poles.

2 GENERAL DISCUSSION OF POLE DECAY

Pole Decay. Decay of treated poles is usually a gradual deterioration caused by fungi and other low forms of plant life. Damage by insect attack (termites, ants and wood borers) is usually considered jointly with decay because preservative treatment of wood protects against both fungi and insects. In most cases, the decay of creosote and penta-treated poles will be just below the groundline where the conditions of moisture, temperature and air are most favorable for growth of the fungi. Factors affecting pole life, such as species of wood, type and thoroughness of treatment, geographical location, and soil conditions are discussed below.

a Pole Species. Of the millions of poles on RUS financed systems, about 85 percent are the thick sapwood southern pines. Untreated, the sapwood is especially vulnerable to attack by wood destroying fungi, termites, and carpenter ants. In the Gulf States, where temperature and moisture are most favorable for growth of these major wood-destroying organisms, the time to pole failure of an untreated pole would be 2 to 3 years. In areas of lower rainfall and few frost-free days, the time to pole failure would increase to 5 to 10 years.

The bulk of the remaining pole population is classified as the western species, comprised of Douglas-fir, western red cedar, red pine, lodgepole pine, ponderosa pine and a small amount of jack pine.

Adequate preservative treatment protects the pole sapwood and the underlying heartwood. Heartwood of these pole species varies not only in decay resistance, but is difficult to treat with preservatives. The heartwood decay resistance for the major pole species is as follows:

Durable - Western red cedar heartwood.

Moderately Durable - Douglas-fir and most of the pines.

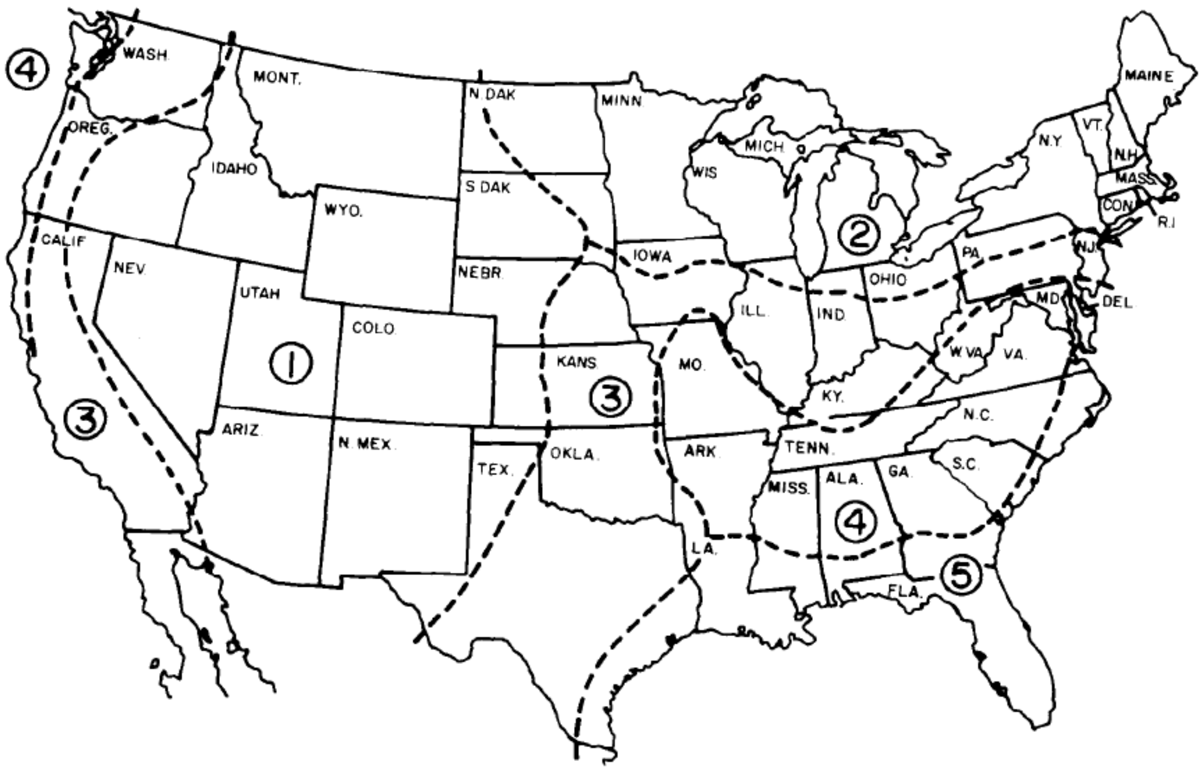
Least Durable - Lodgepole pine. (The use of this species has been limited primarily to the Mountain States areas.)

b Preservative Treatments. There are two general classes of preservative treatment, oilborne (creosote, penta in petroleum, and Copper Naphthenate) and waterborne (arsenates of copper). Creosote was the only preservative for poles on rural systems until 1947, when post-war shortages prompted the introduction of pentachlorophenol (penta) and Copper Naphthenate. Both of these preservatives were dissolved in fuel oils from petroleum or mixtures with creosote.

For many years, penta has been the most widely used preservative for poles. With the increase in cost of petroleum-based products, penta-in-oil treated pole costs have also increased. Presently, both penta and waterborne preservatives are widely used with both preservatives having performed satisfactorily. Where problems have occurred with penta treated poles, the decay can be tied to poor conditioning of the poles, to the loss of solvent carrier due to migration and bleeding or to loss of dissolved penta to retentions below the effective preservative threshold. To overcome these losses, treatments and quality control have been improved.

Standard wood preservatives used in waterborne solutions include ammoniacal copper zinc arsenate (ACZA), and chromated copper arsenate (CCA) (types A, B, and C). These preservatives are often employed when cleanliness and paintability of the treated wood are required. Several formulations involving combinations of copper, chromium, and arsenic have shown high resistance to leaching and very good performance in service. Both ACZA and CCA are included in many product specifications for materials such as building foundations, building poles, utility poles, marine piles, and piles for land and fresh water use. Treatment usually takes place at ambient temperature. Care needs to be taken during treatment to ensure heat sterilization of the pole when treating Douglas-fir with ACZA.

c Decay Zones. The following Decay Severity Zones on a map of the United States was originally based on summer humidity and temperature information and later on a pole performance study conducted by RUS. Decay severity ranges from least severe in Zone 1 to most severe in Zone 5. Service life records and individual experience or a planned sample inspection will indicate if the decay hazard for a system is typical of the zone in which the system is located.



Decay severity zones for wood utility poles as defined by the USDA Rural Utilities Service. Decay is least severe in zone 1, most severe in zone 5.

d Types of Decay. Internal decay may be found in southern pine poles that were not properly conditioned or in which penetration or the amount (retention) of preservative is inadequate. Internal decay of the western species usually involves the heartwood in butt-treated western red cedar, lodgepole pine, and Douglas-fir which have been improperly seasoned prior to treatment. After installation, decay organisms invade the heartwood through the poorly treated sapwood zone checks, or woodpecker holes. Internal decay may also occur in field framed poles when supplementary treatment is neglected.

Insufficient treatment or migration of oil-type preservatives is the principal cause of external decay in southern pine poles. This decay is generally the result of improper seasoning or treatment. Inspection methods should be directed toward discovery of this type of defect and maintenance efforts to supplement the treatment with additional chemicals.

External decay above ground, or better known as "shellrot", may occur in butt-treated western red cedars after 12-15 years of service.

3 PLANNED INSPECTION AND MAINTENANCE PROGRAM

Purpose. The purpose of a planned inspection program is to reveal danger poles and poles which are in early stages of decay so that corrective action can be taken to prolong the service life of the pole. The end result of the inspection program is the establishment of a continuing maintenance program for extending the average service life of all poles on the system. The steps in developing a planned pole inspection and maintenance program are outlined below.

a Spot Checking. Spot checking is the initial step in developing a planned pole inspection and maintenance program. Spot checking is a method of sampling representative groups of poles on a system to determine the extent of pole decay and to establish the priority for a pole maintenance program. A general recommendation is to inspect a 1,000 pole sample made up of continuous pole line groupings of 50 or 100 poles in several areas of the system. The sample should be representative of the poles in place. For instance, all the poles on a line or a map section should be inspected as a unit and not just the poles of a certain age group. The inspection of the sample should be complete, consisting of hammer sounding, boring, and excavation as described in Section 4. Field data should be collected on the sample as to age, supplier, extent of decay, etc.

After the data has been collected, it should be analyzed to determine the areas having the most severe decay conditions and to establish priorities of a pole-by-pole inspection of the entire system. It may be desirable to take additional samples on other portions or areas of the system to determine if the severity of decay is significantly different to warrant the establishment of an accelerated pole inspection and maintenance program for that portion of the system. The results of the spot check will aid in scheduling a continuous pole inspection and maintenance program at a rate commensurate with the incidence of decay.

b Scheduling the Inspection and Maintenance Program. The results of the spot check will aid in determining when the planned program should be started. The suggested timing for initial pole-by-pole inspection and subsequent re-inspection, when supplementary treatment is applied after each inspection, is as follows:

Decay Zone	Initial Inspection	Subsequent Re-inspection	Percent of Total Poles Inspected Each Year
1	12 – 15 Years	12 Years	8.3
2 and 3	10 – 12 Years	10 Years	10
4 and 5	8 - 10 Years	8 Years	12.5

The vulnerability of poles to decay is generally proportionate to the decay zone in which they are located. As a general recommendation, the initial pole-by-pole inspection program should be inaugurated at a yearly rate of 10 percent of the poles on the entire system when the average age of the poles reaches 10 years. If a spot check indicates that decay is advanced in 1 percent of the pole sample, the inspection and maintenance program should be accelerated so that a higher percentage of poles are inspected and treated sooner than the figures shown above. If the decay rate is low for a particular decay zone or area of the system, the pole-by-pole inspection can be postponed accordingly. Historical inspection data indicates that the ratio between the decaying/serviceable poles to reject poles in the 10-15 year age group is about six or more to one. In a 30-year age group, it is about one to one or less. In the latter group, the survivors have more than sufficient residual preservative to protect them indefinitely. The poorly treated poles in the 30-year old group have already decayed and been replaced.

The greatest economic benefit from regular inspection is in locating the decaying/serviceable group. Treatment of poles in this group can extend pole life, thereby saving the cost of emergency replacement. Inspection and proper maintenance can more than pay dividends by extending the serviceable life of the poles. With the costs of replacing poles rising, the economics of extending the service life are more favorable.

c Establishing the Program. The pole-by-pole inspection and maintenance work may be done by system employees or by contracting with an organization specializing in this type of work. The choice should be made on the basis of the amount of work to be done, the trained employees available, and a comparison of the costs. Developing the necessary skills in the system's own crews may require considerable time and be contingent upon the availability of an experienced inspector to train system employees. Therefore, qualified contract crews may be preferable for this work in many instances. An inspector to be qualified should have inspected, as a minimum, 5,000 poles in conjunction with a qualified inspector and another 5,000 on his own, but under close supervision. The inspector's work should be checked every week or two by the system's representative and the inspector's supervisor. To check an inspector’s work select at random about 10 poles, inspected in the previous few weeks, re-excavate, take off paper and treatment, and re-inspect. Check for hollow sounds, take a boring, check soft surface wood, especially adjacent to shaved areas or along checks, re-measure the pole, recheck the calculations, then retreat and backfill. If any serious errors are discovered, all the work between these spot checks should be re-inspected.

The pole inspection and maintenance program may result in a large number of replacements. If the reject rate is high, the system's crews may not be able to replace rejected poles in a reasonable time because of other work. The temporary addition of skilled personnel for inspection or pole replacement may be required. It is generally necessary to use at least one crew full time to keep up with the pole inspector. An average pole inspector can check 150-200 poles per week or 800 poles per month. It is desirable to have one person responsible for supervision and coordination.

d Re-inspections. Information obtained during the first pole-by-pole inspection can serve as the basis for scheduling subsequent inspections. As a guide, it is recommended that a re-inspection be made every 8 to 12 years as shown in paragraph 3c of this Section, according to the decay zone and severity of decay. The recommended re-inspection intervals are based on treating poles during the previous inspection cycle. Shorter re-inspection intervals are recommended if poles were not treated. These recommendations may be modified by experience, but the intervals should not be extended by more than 3 years. It is advisable to recheck some poles which have been groundline treated. At the completion of the inspection of a pole, a small, weatherproof tag should be attached to the pole indicating the organization that performed the inspection and the date of the inspection.

4 INSPECTION METHODS

Inspection Types. There are varying types of inspection, each with a different level of accuracy and cost. Inspection methods with low accuracy require more frequent re-inspection than methods which are detailed and more accurate.

a Visual Inspection. Visual inspection should be considered the first step to inspecting poles but has the lowest accuracy. Since most decay is underground or internal, this method will not detect the majority of defective poles. Obvious data can be collected on each specific structure, such as the condition of the pole above ground, crossarm, and hardware. This method is not recommended for detecting decay.

b Sound and Bore. This method involves striking a pole with a hammer from groundline to as high as the inspector can reach and detecting voids by the hollow sound. An experienced inspector can obtain significant information about a pole by listening to the sounds and noticing the feel of the hammer. The hammer rebounds more from a solid pole than when hitting a section that has an internal decay pocket. The internal pocket also causes a sound that is dull compared to the crisp sound of a solid pole section.

Some contracts require all poles to be bored, while others require boring only when decay is suspected. Boring is usually done with either an incremental borer or power drill with a 3/8" bit. An experienced inspector will notice a change in resistance against the drill when it contacts decayed wood. The shavings or the borings can be examined to determine the condition of the wood, and the borings can be analyzed for preservative penetration and retention.

When voids are discovered a shell thickness indicator can be used to measure them. This information can be used to evaluate the reduction strength by the void.

The effectiveness of the sound and bore method varies by species. For southern yellow pine poles, which represent a majority of the poles in North America, decay normally is established first on the outside shell below ground. The decay moves inward and then upward to sections above ground. By the time sound and bore inspection can detect internal decay pockets above ground, the pole is likely to have extensive deterioration below ground.

Sound and bore method is more effective with Douglas-fir and western red cedar. Decay on these poles is likely to begin internally near the groundline, or in the case of Douglas-fir, above the groundline. Therefore, sounding and boring can identify at least some decay at a stage before the groundline section is severely damaged. All borings should be plugged with a treated wood plug which is properly sized for the respective hole.

c Excavation. The effectiveness of the sound and bore inspection is greatly increased when excavation is added to the process. Excavation exposes the most susceptible section of the pole for inspection. For southern yellow pine this is particularly true, since decay begins externally and below ground.

Poles should be excavated to a depth of 18 inches in most locations. Deep excavation may be required in dry climates. After excavation the exposed pole surface should be scraped clean to detect early surface decay.

Shell rot and external decay pockets should be removed from the pole using a specially designed chipper. Axes or hatchets should not be used for this application. The remaining pole should be measured to determine if the pole has sufficient strength with the reduced circumference. Tables 2, 3, and 4 assist in adjusting circumferences for various size voids.

After complete inspection and application of preservative treatment, the pole is backfilled. The dirt should be tamped firm every 6 to 8 inches. The backfill should mound up around the pole to allow for future settling and drainage away from the pole.

5 ADDITIONAL INSPECTION TOOLS AND METHODS

Additional Methods. Over the past several years there has been a considerable amount of research work done by companies to develop additional products that can be incorporated into the in-line pole inspection process. These products, involving many diverse technologies, are intended to improve both the accuracy and reliability of the in-line inspection programs used by utilities, as well as decrease the time necessary to carry out the inspection process. In developing comprehensive inspection programs, cooperatives are encouraged to examine all potential inspection tools and processes to determine the best system for their particular needs. The data from these testing devices does not always correlate exactly with the actual bending strength determined by full scale testing and, as a result, should be used to establish trends showing changes in strength.

6 RESULTS OF WOOD POLE INSPECTION

a Inspection Results. Inspection results should be used to update pole plant records, evaluate pole condition, plan future inspection and maintenance programs, and provide information for map revisions. The inspection process will result in identifying the condition of each individual distribution or transmission pole.

In general the National Electric Safety Code (NESC) requires that if structure strength deteriorates to the level of the strength reduction factor required at replacement, the structure shall be replaced or rehabilitated. The inspection results should indicate if a pole is "serviceable" or a "reject".

b Serviceable. The characteristics of "serviceable" are based on the following conditions:

(1) Large portion of completely sound wood.

(2) Early stages of decay which have not reduced the pole strength below code requirements.

(3) Pole condition as stated above but a defect in equipment may exist, such as a broken ground or loose guy wire. Equipment defects should be subsequently repaired.

c Rejects. Any poles that do not meet the above conditions should be classified as "rejects". Their characteristics are:

(1) Decay, insect or mechanical damage has reduced pole strength at the groundline below code requirement.

(2) Severe woodpecker hole damage has weakened the pole below safety standards.

(3) Hazardous conditions exist above ground, such as split top.

d Reinforce or Replace. Rejected poles may be classified further depending on the severity of the deterioration and whether they are reinforceable.

(1) A “reinforceable reject” is any reject which is suitable for restoration of the groundline bending capacity with a method of reinforcement.

(2) A “replacement” candidate would be a rejected pole which is not suitable for the necessary rehabilitation.

7 REMEDIAL TREATMENT

Purpose. The purpose of remedial treatment of standing poles is to interrupt the degradation by the addition of chemicals, such as pesticides, insecticides and fungicides, thereby extending the useful life of the structure. Treatment may be external groundline treatment or internal treatment.

a Regulations and Licensing. The majority of states require that applicators or the job supervisor obtain a pesticide applicator license. Testing for this license includes a "basic skills test" to show knowledge of the rules and regulations governing pesticides. Some states also give a "category test" which is specific to wood poles and wood preservation. The uses of every pesticide are classified by the U.S. Environmental Protection Agency (EPA) as either "general" or "restricted".

(1) A "general use" pesticide is not likely to harm humans or the environment when used as directed on the label. These preservatives may be purchased and applied without a pesticide applicator license. However, a manufacturer may choose not to make a product available for purchase by the general public.

(2) A "restricted use" pesticide could cause human injury or environmental damage unless it is applied by competent personnel (certified applicators) who have shown their ability to use these pesticides safely and effectively. These wood preservatives can only be purchased and applied by someone who has a pesticide applicator license or whose immediate supervisor has a pesticide applicator license.

b Groundline Treatment. All treated poles eventually lose resistance to decay. Groundline treatment with effective preservatives provides an economical extension of their physical life. Experience has shown that a well designed and implemented groundline inspection and maintenance program can significantly increase the service life of many poles. Groundline external treatment is recommended under the following conditions:

(1) Whenever a pole is excavated during an inspection, and the pole is sound or decay is not so far advanced that the pole must be replaced or rehabilitated.

(2) Whenever a pole over 5 years old is set.

(3) Whenever a used pole is installed as a replacement.

External preservatives used for groundline treatment typically contain active ingredients that are either water soluble, oil soluble or practically insoluble.

Before application of external preservatives, decayed wood should be stripped from the pole and removed from the excavation. The preservative paste is most commonly brushed onto the pole following label directions. A polyethylene backed paper is then wrapped around the treatment and stapled to the pole. The paper aids the migration of the preservative into the critical outer shell.

c Internal Treatment. The three basic types of preservatives used for internal treatment are liquids, fumigants, and solids.

(1) Liquid Internal Preservative: Liquid internal preservatives should be applied by pressurized injection through a series of borings that lead to internal decay pockets or voids. Adequately saturating the pocket and surrounding wood should arrest existing decay or insect attack and prevent further degradation for an extended time.

Liquid internal preservatives contain water soluble or oil soluble active ingredients. Sodium fluoride, boron and various forms of copper solutions are the principle active ingredients used today. Moisture that is present in the pole will help facilitate diffusion of the active ingredients into the wood beyond a decay pocket.

Oil based internal preservatives most often incorporate Copper Naphthenate as an active ingredient with fuel oil or mineral spirits as the solvents. Since oil-based Copper Naphthenate is not soluble in water, it is likely to migrate into the surrounding wood only as far as the oil will travel.

(2) Fumigants: Most of the fumigants in use for wood poles today were originally developed for agricultural purposes. Applying fumigants to soil will effectively sterilize the ground. Due to high levels of microorganisms and chemical activity in soil, the fumigants will degrade fairly rapidly and dissipate so that new crops can be planted in a short time.

These same fumigants do not degrade rapidly in wood and will remain affixed to sound wood cell structure for many years. Fumigants have also been found to migrate longitudinally in wood, several feet away from the point of application. This helps control decay in a large section of the pole. When the vapors migrate into a decay void, however, they may dissipate through associated checks and cracks. This reduces the long term efficacy and requires more frequent application.

Registered pole fumigants include Sodium N-methyldithiocarbamate (NaMDC), Methylisothiocyanate (MITC),tetrahydro-3,5-dimethyl-2H-1,3,5-thiadiazine-2-thione (Dazomet) and Chloropicrin. Chloropicrin is a very effective wood fumigant. However, the liquid must be applied from pressurized cylinders, and the applicator must wear a full-face air respirator.

MITC, NaMDC and Dazomet are the most widely used wood pole fumigants. Pure MITC is a solid below 94°F and contains 97 percent active ingredient. Solid MITC sublimes directly into fumigant vapors. Avoiding the liquid stage helps to minimize loss of fumigant during application through checks and cracks. MITC is packaged in aluminum tubes to facilitate installation. Just before placing the tube into a treatment hole, the cap is removed. As with any fumigant, application holes should be plugged with pressure treated wooden or plastic plugs.

NaMDC is soluble in water to a maximum amount of 32.7 percent. Treatment holes drilled in a wood pole are filled with the aqueous solution so the appropriate dosage is applied. Recommended dosages vary according to pole size. The NaMDC solution decomposes and generates MITC as the main fungi-toxic ingredient. The maximum theoretical amount of resultant MITC at ideal conditions is 18.5 percent by weight. After decomposition the MITC vapors then migrate up and down the pole to help control decay.

Dazomet is a very fine granular material that is 98-99% active ingredient. Treatment holes drilled in a wood pole are filled with the granular material so the appropriate dosage is applied. Like NaMDC, Dazomet decomposes and generates MITC as the main fungi-toxic ingredient. The maximum theoretical amount of resultant MITC at ideal conditions is 45.0 percent by weight. The MITC vapors then migrate up and down the pole to help control decay.

(3) Solids: Currently there are several solid diffusible rods available as a supplemental preservative treatment for wood poles. Active ingredients used in these rods include Sodium Fluoride, Boron and Copper. The migration of these ingredients through the wood to control or prevent internal fungal decay is aided by the moisture content present. The zone of effective treatment is determined by the distance the active ingredients move from the point of application at fungi-toxic levels. Studies have shown wood moisture content in excess of the fiber saturation point (approximately 30%) are necessary for significant migration to occur. However, at wood moisture levels typically found at groundline in the internal regions of in-service utility poles, adequate diffusion can be achieved with an appropriate drill pattern in the treatment zone. Active ingredients from rods will tend to move slower than fumigants. Preservative rods should be applied according to the label directions. The rods are typically applied through a pattern of downward angled holes beginning at groundline or below with application rates varying with pole

circumference. Diffusible rods can also be used to sterilize inspection holes and to control or prevent pole top decay.

d Woodpecker Damage. Woodpecker damage is an on-going issue that must be continually addressed. Many preventative methods are available but each typically has a varying degree of success.

It is difficult to predict which poles woodpeckers may select. Frequently the first hole invites further attack by other woodpeckers. For these reasons, it is good maintenance practice to seal up the smaller holes. Various materials are available for plugging the holes, and a wire mesh can be used to cover the plugged hole as well as large areas of a pole. In addition, as a preventative measure, wire mesh can be applied to poles in areas where woodpecker activity is expected. Some of these repairs restore varying degrees of strength to the pole, while others simply plug the hole.

e Pole Reinforcement. Various methods are available to reinforce a deteriorated pole at the ground line. A determination must be made as to whether or not a sufficient cross section of sound wood remains at the ground line if pole reinforcement is to be used. When considering reinforcement options, consult with the pole reinforcement system supplier for design and installation support.

Even though reinforcement may not be economically justified, other factors may need to be considered such as difficulty of access to the pole for replacement or system critical load which would prevent the line from being taken out of service at the time when the pole may be in danger of failing.

8 DETERMINING THE SERVICEABILITY OF DECAYED POLES

Serviceability. The decision to treat or replace a decayed pole depends upon the remaining strength or serviceability of the pole. The permissible reduced circumference of a pole is a good measure of serviceability. The following procedure may be used to assist in determining if a pole should be replaced or reinforced.

a Decay Classifications. Decay at the groundline should be classified as:

(1) General external decay
(2) External pocket
(3) Hollow heart, or
(4) Enclosed pocket.

b Permissible Reduced Circumference. The 2012 edition of the National Electric Safety Code (NESC) requires that wood structures shall be replaced or rehabilitated when deterioration reduces the structure strength to 2/3 of that required when installed for NESC District loading. The NESC 2012 also requires that wood structures shall be replaced or rehabilitated when deterioration reduces the structure strength to 3/4 of that required when installed for NESC extreme wind or extreme ice with concurrent wind loadings.

Computer programs are available that can calculate the remaining capacity of the pole by taking the voids into account when determining the effective remaining section of the pole.

Tables 1 through 4 will assist in determining when replacement or rehabilitation is necessary. If the reduced circumference indicates a pole at or below the minimum reduced circumference, the pole should be replaced, splinted, stubbed immediately, or otherwise rehabilitated.

c General Procedure for Using Table 1, 2, 3 and 4

(1) General External Decay. After removing all the decayed wood, measure the circumference above and below the decayed section to determine the original circumference. Then measure the reduced circumference at the decayed section. Enter Table 1, Column 1, with the original pole circumference. After determining the acceptable level of deterioration as described in paragraph 8c, find the minimum acceptable reduced circumference from the appropriate column - Column 2 for 2/3 of the original circumference, or Column 3 for 3/4 of the original circumference - on the same line as the original circumference. If the actual reduced circumference is larger than the acceptable calculated minimum, from Column 2 or 3, replacement or rehabilitation is not required yet.

(2) External Pockets. Remove decayed wood and take measurements of the depth and width of the pocket. Measure the pole for the original circumference. Refer to Table 2 to determine the circumference reduction. Use the procedure from paragraph 8d(1) to determine the minimum acceptable reduced circumference. If the actual reduced circumference, i.e. the original circumference minus the circumference reduction from Table 2, is larger than the acceptable calculated minimum from Table 1, Column 2 or 3, replacement or rehabilitation is not required yet.

(3) Hollow Heart (Heart Rot). If hollow heart is found, determine the shell thickness and measure the original circumference of the pole. Refer to Table 3 to determine the circumference reduction. Use the procedure from paragraph 8d(1) to determine the minimum acceptable reduced circumference. If the actual reduced circumference, i.e. the original circumference minus the circumference reduction from Table 3, is larger than the acceptable calculated minimum from Column 2 or 3, replacement or rehabilitation is not required yet.

To determine the shell thickness, bore three holes (preferably of 1/4- or 3/8-inch diameter), 120° apart; measure the shell thickness at each hole, add the measurements, and divide by 3. Treat and plug holes with tightly fitting cylindrical wood plugs that have been treated with preservative once shell thickness is determined. A transmission pole with a shell thickness less than 3 inches should be removed from service.

(4) Enclosed Pocket. An enclosed pocket is an off-center void as shown in Table 4 and its diameter should be measured by boring holes as described in paragraph 8d(3). Using the minimum thickness of the shell, refer to Table 4 for the reduction in circumference. Measure the original circumference. Use the procedure from paragraph 8d(1) to determine the minimum acceptable reduced circumference. If the actual reduced circumference, the original circumference minus the circumference reduction from Table 4, is larger than the acceptable calculated minimum from Column 2 or 3, replacement or rehabilitation is not required yet.

Table 1

Reduced circumferences for NESC Rules 250B, 250C, and 250D

	Rule 250B – Combined ice and wind district loading	Rule 250C - Extreme wind and Rule 250D - Extreme ice and concurrent wind
Original Circumference (in)	Minimum Reduced Circumference (in) (Based on 2/3 initial strength)	Minimum Reduced Circumference (in) (Based on 3/4 of initial strength)
30	26.2	27.3
31	27.1	28.2
32	28.0	29.1
33	28.8	30.0
34	29.7	30.9
35	30.6	31.8
36	31.5	32.7
37	32.3	33.6
38	33.2	34.5
39	34.1	35.4
40	35.0	36.3
41	35.8	37.3
42	36.7	38.2
43	37.6	39.1
44	38.4	40.0
45	39.3	40.9
46	40.2	41.8
47	41.1	42.7
48	41.9	43.6
49	42.8	44.5
50	43.7	45.4
51	44.5	46.3
52	45.4	47.3
53	46.3	48.2
54	47.2	49.1
55	48.1	50.0
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57	49.8	51.8
58	50.7	52.7
59	51.5	53.6
60	52.4	54.5

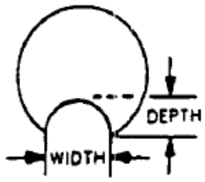

Table 2
Reduction in Measured Circumferences to Compensate for External Pockets

Pocket Width (in)	1					2					3					4					5					6				
Pocket Depth (in)	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Measured Circumference of Pole (in)	Reduction in Circumferences (in)																													
20 to 30	1	1	2	-	-	2	2	3	-	-	2	3	4	-	-	3	4	5	-	-	4	6	8	-	-	6	8	-	-	-
30 to 40	1	1	1	2	-	1	2	2	3	3	2	3	4	4	4	2	4	5	5	6	3	5	6	7	8	5	7	8	9	-
40 to 50	1	1	1	2	2	1	2	2	3	3	2	3	3	4	4	2	3	4	5	6	3	4	5	6	7	3	5	6	7	8
50 to 60	1	1	1	2	2	1	2	2	3	3	2	3	3	4	4	2	3	3	4	5	3	4	4	5	6	3	4	5	6	7

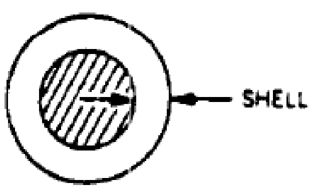

Table 3
Reduction in Measured Circumferences to Compensate For Hollow Heart

Measured Circumference Of Pole (ins)	Minimum Thickness of Shell (ins)					
	2	2.5	3	3.5	4	4.5
20 to 25	1	-	-	-	-	-
25 to 30	2	1	-	-	-	-
30 to 35	3	2	1	-	-	-
35 to 40	4	3	2	1	-	-
40 to 35	5	4	3	2	1	-
40 to 45	7	5	4	3	2	1

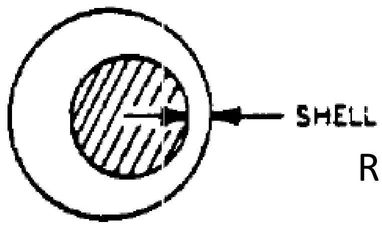

Table 4
Reduction in Measured Circumferences to Compensate
For Enclosed Pockets

Diameter of Pocket (in)	3			4			5		
Shell Thickness (in)	1	2	3	1	2	3	1	2	3
Measured Circumferences Of Poles (in)	Reduction in Circumferences (in)								
20 to 30	2	1	-	3	1	-	4	2	-
30 to 40	2	1	1	3	1	1	4	2	1
40 to 50	2	1	1	3	2	1	4	3	1

METRIC CONVERSION FACTORS

To Convert From	To	Multiply by
Foot (ft.)	Meter (m)	0.3048
Inch (in)	Centimeter (cm)	2.54
Degrees Fahrenheit (X°F)	Degrees Celsius (°C)	5/9 (X° - 32)