# Remedial Treatment:
# Economic Benefits, Justification, and Auditing Techniques

**By**

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Abstract

Wooden utility poles provide safe, economic, easily obtainable means of delivering power, communications, and cable television to the masses of industrial and residential locations throughout the world. Wood, however, is a biological commodity that can undergo deterioration by insects, decay fungi, termites, and mechanical destruction. In many ways wood poles, can outlast materials constructed of synthetic materials like concrete, fiberglass, steel and aluminum if well maintained and cared for in a consistent and timely manner.

This paper reviews several mathematical model options to justify a remedial treatment program on wood poles. Several models are shown to illustrate the cost-benefit of maintaining a wooden pole system and uses simple measures to help utility line maintenance engineers with the means to help justify maintaining their wood pole plant with periodic maintenance. Also, included in this paper is one method of auditing your groundline/remedial treatment contractors' service to ensure that you are getting proper treatment and value for monies expended on such a program.

Keywords: Remedial treatment, groundline, wood poles, decay, supplemental preservative, utility poles, and external treatment

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Background on Remedial Treatments and Justification

Or why………..Groundline Treatment Can Pay For Itself…And More

The poles, wires, transformers and insulators of a utility system represent a sizable economic investment. To help protect that investment and the personnel, who maintain it, special attention should be directed to a vulnerable spot-- the groundline. A periodic pole inspection program, coupled with maintenance using a good, quality source of years of historical tested remedial treatment products, reduce outages, eliminate some emergency replacements, improve customer relations and provide a safer system. This is why remedial treatment is becoming so common-- it can save money and prevent problems. Many electric utilities have found that it more than pays for itself.

Throughout the world, hundreds of millions (greater than 140 million at last count in the US alone) of wood poles carry electric power from power stations to substations and on to eventual power users. A pressure process has treated most of these wood poles with one of several preservatives, although non-pressure processes including thermal treatment and butt treatment have effectively treated some species. Pressure treatment, butt treatment, and thermal treatment has been extremely effective in adding many years to the useful life of wood poles.
However, when a pole has been in service for a substantial numbers of years, its failure becomes more likely. The principal cause of pole failure is decay, and the most common area for decay to occur is that portion of the pole from approximately 2 inches above groundline to approximately 18 inches below. It is in those three necessary ingredients for decay -- oxygen, moisture and food in the form of the wood-- are readily available for decay organisms to thrive. By eliminating or decay, a utility's pole system will experience a longer average pole life, a decrease in pole failures, less line outage and money savings.
A regular program of inspection and treatment with a quality, tested and proven pole preservative from a quality producer can maximize the service life of wood pole investment. Without preventative maintenance, the average pressure- treated wood pole will provide service of 25 to 35 years.
By utilizing an effective pole line inspection program and a groundline pole preservative as needed, utilities have found they can extend the life of a pole 10 years or more. These results, when multiplied across a whole system, can raise the average expected life of the system and save tremendously on replacement costs.

HOW TO REDUCE OPERATING COST BY $2 Million Dollars EACH YEAR

The cost reduction possible with a groundline treatment program is so great, it may seem unbelievable. Even using very conservative estimates, the example below indicates a huge benefit.
The commonly accepted average life pole under typical conditions is 30 years. Presently, the cost to purchase, install and wire a replacement pole is approximately $1,200. Therefore, over the life of a pole, its average cost is $ 1,200 /30 years or $40.00.

Suppose that pole is on a system with a groundline treatment program. Laboratory analysis has shown that the preservative in a remedial pole treatment remains effect for 10 years or more. Based on field studies, utilities and contractors have stated that a quality treatment product will extend the life of the pole by 10 years with one proper application. For this example, however, let us suppose that the pole is treated twice-- once 15 years after installation and again at 25 years -- and that the average pole so treated last only 5 years longer than its neglected counterpart. The number of applications used and added service life is well within reported results of actual experience.

The installation cost, as was the case with the earlier pole remains $1,200. Current cost for groundline treatment, depending on various factors, is $15 to $25 per pole for materials and labor. Thus the lifetime cost of this pole, including two remedial treatments at the estimate of $20, is 1,240. If this results in a pole that lasts 35 years, only 5 years longer than a pole that is not maintained, its average cost is $1,240/35 or $35.43.

The average annual cost of the second poles $4.57 less than the first, even using conservative numbers. Multiplying the figure by the number of poles in your system will show you the tremendous cost reduction possible with a groundline treatment program. If your system comprises 500,000 poles, 2,285,000 would reduce your average operating cost annually. The following table summarizes this incredible reduction.

Example of Cost Reduction
Possible by Use of a Remedial Treatment Program

| Pole maintenan ce | Installed Cost per pole | Remedial Cost Per Pole | Lifetime Cost Per Pole | Estimated Pole lIfe(Years) | Annual Cost Per pole | Number of Poles in Service | Annual Cost of System |
|---|---|---|---|---|---|---|---|
| NO Remedial Treatment | $1200 | $0.00 | $1200 | 30 | $40.00 | 500,000 | $20,000,000 |
| Remedial Treatment | $1200 | $40.00 | $1240 | 35 | $35.43 | 500,000 | $17,710,000 |

Annual Savings to Utility

Using Remedial Treatment $2,290,000

Adopted from a paper by W.S. Laidlaw, we find an additional method for the cost benefit analysis of performing a routinely scheduled remedial treatment program on wood poles( ) .

Method

Compare costs of maintenance, including replacement, for groups of poles using the Present Worth of estimated future expenditures for the alternative scenarios.

What is Present Worth?

If $100 is to be spent one year from now how much money needs to be in pocket now? If the interest rate is 5% and $95 is invested, the interest will be $4.75. About $95 would be needed if only the interest rate is considered. Say inflation is 2%, because of decreased buying power to take care of inflation, an extra $2 would be needed. Total requirement is $95 + $2 = $97. The present worth factor is 0.97. If the expenditure was made in 32 years with a discount rate of 3% the present worth of that dollar is 38.8¢.

Formula: $$PW = \frac{1}{(\text{ 1+ interest rate discounted for inflation})^{n}}$$

The interest rate discounted for inflation (interest rate - inflation rate) is sometimes called the discount rate. “n” is the number of years between now and the expenditure. The historical discount rate is quite stable - in the 3% to 4% range.

Examples: Discount rate

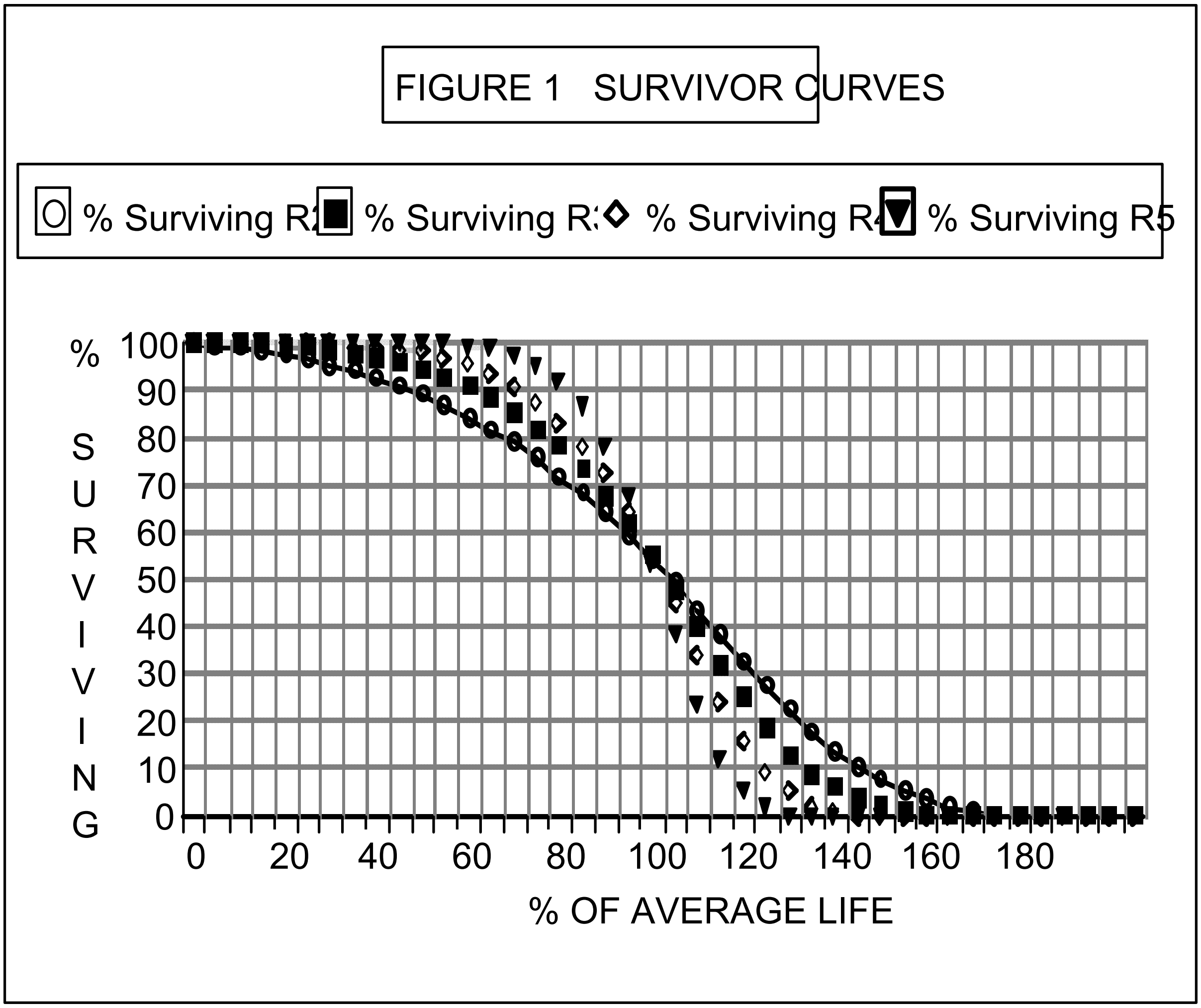
| years = n | 3% PW factor | 4% PW factor |
|---|---|---|
| 1 | .9708 | . 9615 |
| 2 | .942 | .924 |
| 4 | .888 | .854 |
| 8 | .789 | .730 |
| 16 | .632 | .533 |
| 32 | .388 | .285 |

**What are the Variables?**

Case 1 / Case 2

- Interest rate discounted for inflation (usually 3% to 4%) _______________
- Average cost of one maintenance treatment (usually $20 - $40) _______________
- Average cost of a pole replacement (usually $1000 - $3000) _______________
- Average age of poles at first maintenance treatment (usually 14 - 20 years) _______________
- Years between maintenance treatments (Treatment cycle, usually 5 - 15 years) _______________

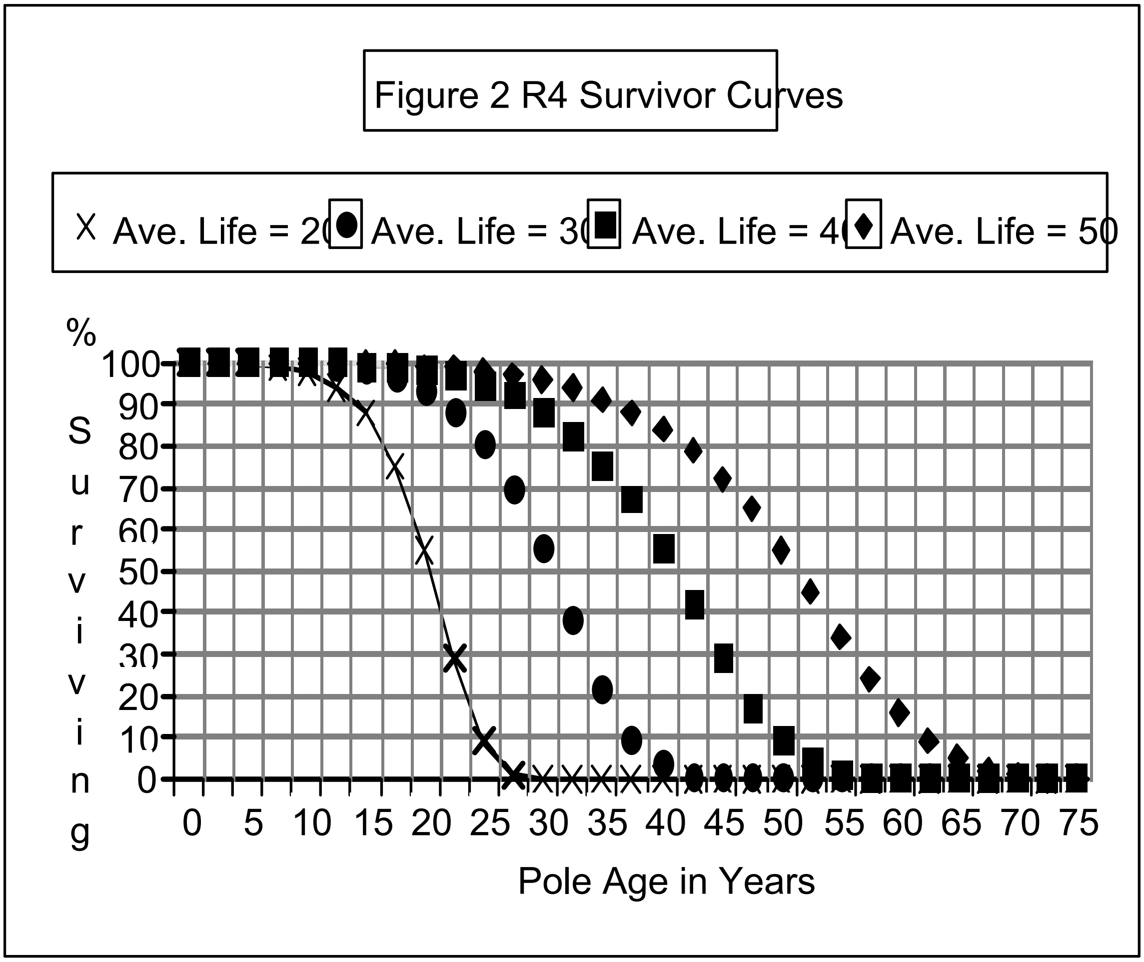
Average pole life for the group under consideration. Survivor curves are of help in determining average pole life. _______________




Notes to Figure:

The rate of pole replacement due to variables other than pole deterioration is effected by:

- motor vehicle accidents
- road realignments
- storm damage
- changes in pole height requirements
- additional strength requirements e.g. transformer additions




This is the R4 survivor curve from Figure 1 modified to relate
% surviving to pole age in years

Notes:

The rate of pole replacement due to variables other than pole deterioration is effected by:

- motor vehicle accidents
- road realignments
- storm damage
- changes in pole height requirements
- additional strength requirements e.g. transformer additions

These items usually effect distribution lines to a greater extent than transmission lines.

An R3 curve might be applicable for a distribution system in a particular geographical area while an R5 curve might be applicable to transmission lines in the same area.

**Example**

Present Worth of Alternatives - Maintenance vs. No Maintenance

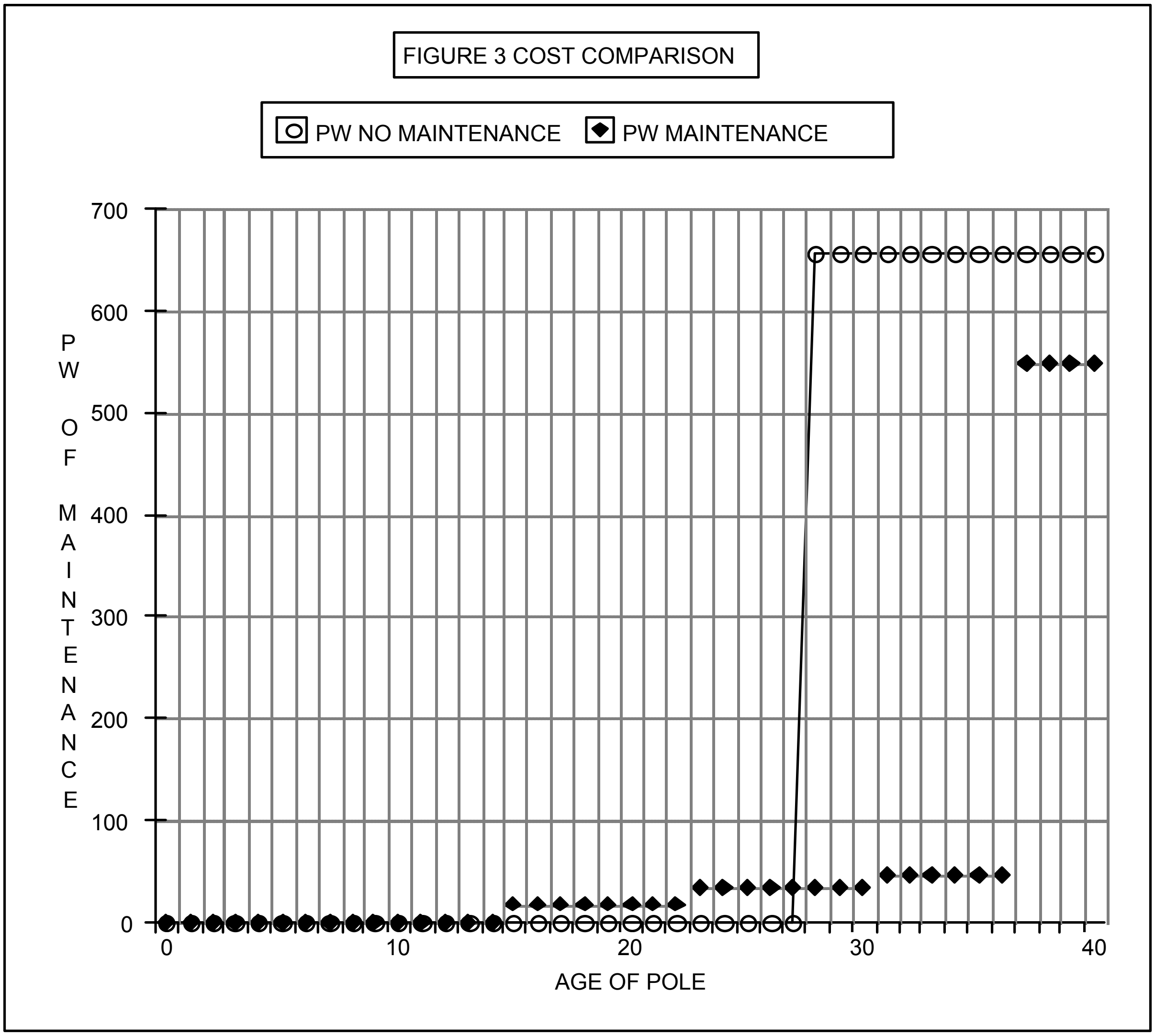
Assign values for the variables:

| | |
|---|---|
| - interest rate | 5% |
| - inflation rate | 2% |
| - cost of maintenance treatment | $30 |
| - cost of pole replacement | $1500 |
| - average age when poles are first eligible for treatment | Age 15 |
| - years between treatments (treatment cycle) | 8 years |
| - average life of poles eligible for treatment | |
| no maintenance | 28 years |
| maintenance | 37 years |

Calculate the present worth of the alternatives.

The calculation is most easily done using a spreadsheet format.

Graphical Representation of Results - See Figure 3. on the next page.




Present worth of maintenance over the life of these poles:

No maintenance $655 over 28 years or $23.41/pole /year
Maintenance $549 over 37 years or $14.84/pole/year
Difference $8.57/pole/year

If this Utility owns 1,000,000 poles with treatment starting at age 15 and ending at age 37 when the pole is replaced, the number of poles in the treatment program will be (37-15)/37x 100 = 59%

Annual saving 1,000,000 x 59% x 8.57/pole = $5,056,300

**Next Example**

Present Worth of Alternatives - Maintenance vs. Delay Maintenance 1 Year

Assign values for the variables:

| | |
|---|---|
| - interest rate | 5% |
| - inflation rate | 2% |
| - cost of maintenance treatment | $30 |
| - cost of pole replacement | $1500 |
| - average age when poles are first eligible for treatment | Age 15 &16 |
| - years between treatments (treatment cycle) | 8 years |
| - average life of poles eligible for treatment | |
| maintenance | 37 years |
| delay maintenance 1 year | 36 years |

Calculate the present worth of the alternatives.

| | |
|---|---|
| delay maintenance 1 year average expenditure = | $15.63 |
| maintenance: average expenditure = | $14.84 |
| difference | $ 0.79 |

Cost due to delay = 0.79 x number of poles involved in the one year delay.

**Graphical Representation of How Values Assigned to Variables Effect Results**

These results do not reflect public liability considerations or the cost of administering a test and treat program. Provision for these costs should be made when comparing the alternatives for a particular group of poles.

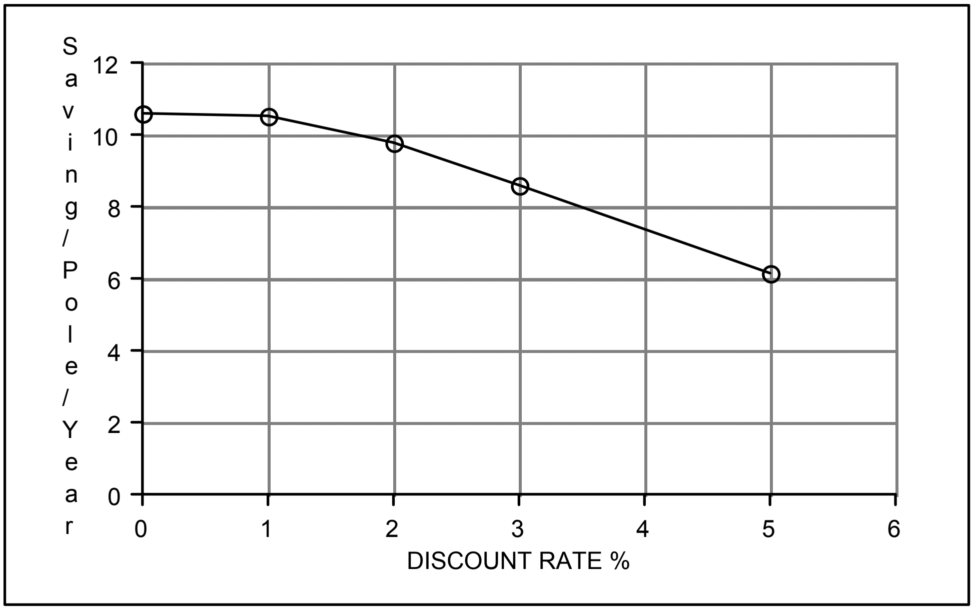
Base line values chosen for these comparisons are the same as indicated in Example 1:

| | |
|---|---|
| Commercially Treated Pine Poles (Distribution) | |
| Discount rate | 3% |
| Age of pole when treatments start | 15 |
| Average pole life | |
| No test & treat program | 28 years |
| Test & treat program | 37 years |
| Treatment cycle | 8 years |
| Treatment cost | $30 |
| Pole replacement cost | $1500 |

| | |
|---|---|
| Present Worth (PW) of maintenance over the life of the average pole | |
| No maintenance - Average cost per year over 28 years | $23.41 |
| Maintenance - Average cost per year over 37 years | $14.84 |
| Difference | $8.57 |

A. Vary Discount Rate (interest rate - minus inflation rate)

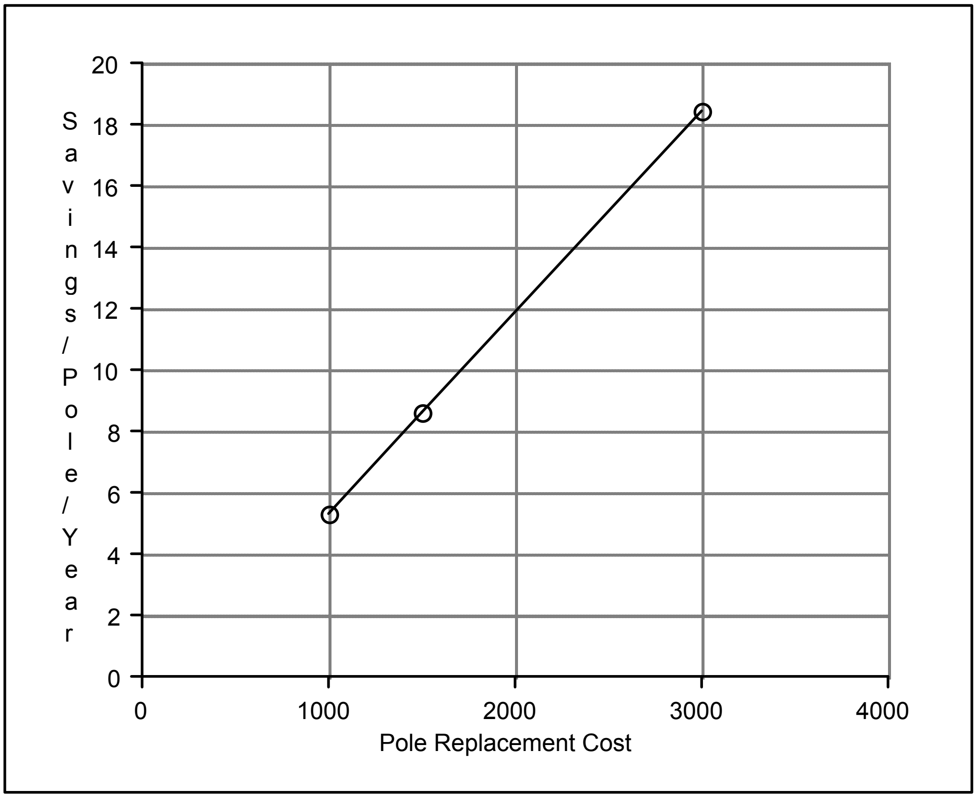
| | A | B |
|---|---|---|
| 1 | Discount Rate | Saving/Pole/Year |
| 2 | 0 | 10.6 |
| 3 | 1 | 10.55 |
| 4 | 2 | 9.78 |
| 5 | 3 | 8.57 |
| 6 | 5 | 6.17 |




Discount rate is usually quite stable at about 3% to 4%

B. Varying the Wood Pole Replacement Cost

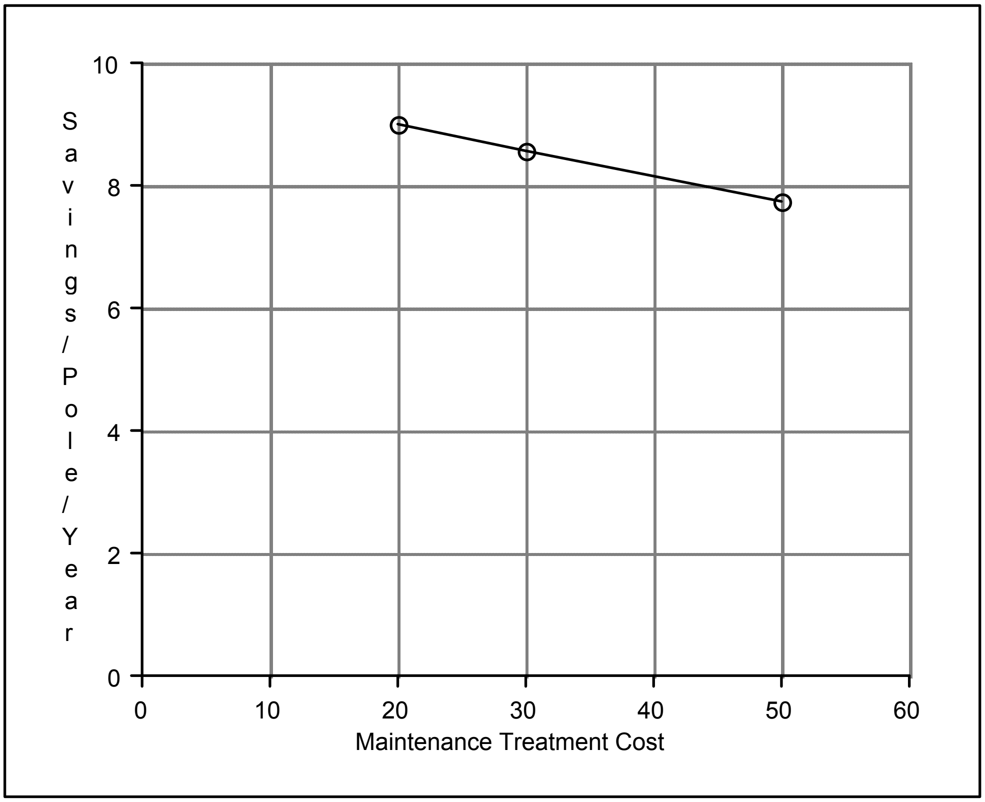
| | A | B |
|---|---|---|
| 1 | Pole Replacement Cost | Saving/Pole/Year |
| 2 | 1000 | 5.32 |
| 3 | 1500 | 8.57 |
| 4 | 3000 | 18.41 |




Pole replacement costs should include the cost of disposing of the old pole

C. Varying the  Cost of a Wood Pole Maintenance Treatment

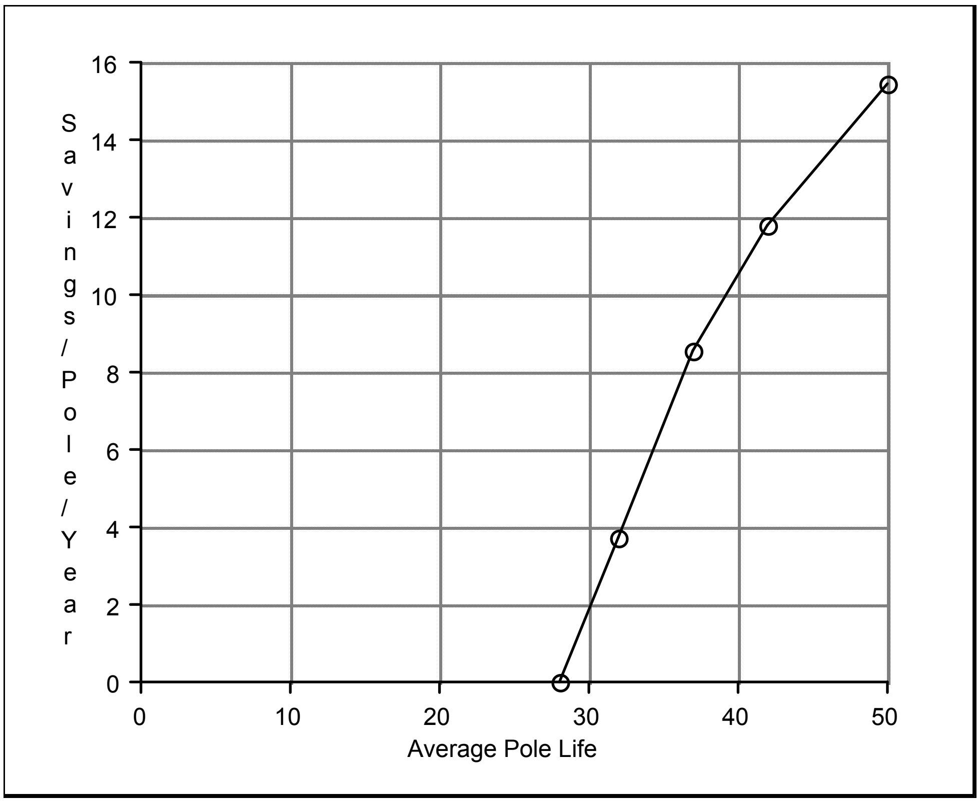
| | A | B |
|---|---|---|
| 1 | Treatment Cost | Savings/Pole/Year |
| 2 | 20 | 8.99 |
| 3 | 30 | 8.57 |
| 4 | 50 | 7.74 |




This graph is only valid if pole life does not increase with increased maintenance treatment costs, probably an invalid assumption

D. Vary Average Pole Life

| | A | B |
|---|---|---|
| 1 | Average Life | Savings/Year |
| 2 | 28 | 0 |
| 3 | 32 | 3.75 |
| 4 | 37 | 8.57 |
| 5 | 42 | 11.76 |
| 6 | 50 | 15.45 |




For this set of variables:

Average life of poles with no test and treat program - 28 years

A test and treat program that would increase average pole life to 37 years for example, will result in a cost saving of $8.57/pole/year

Using examples from the Paper by Gene Cline, the following section supports the use of this method for justifying the use of remedial treatment and inspection. Groundline treatment of in-place wood poles is a program which can be used to extend pole life. In general, groundline treatment consists of the following:

1.) Excavation around the base of a pole to a depth of approximately 1 foot-6 inches.
2.) Removal of all decayed wood.
3.) Application of a preservative to the base of the pole from slightly above groundline to the depth of the excavation.
4.) Wrapping the area treated in (3) above with some type of non-porous material in order to retain the preservative around the pole.
5.) Back-filling of the excavated area.

Groundline treatment is done primarily for one reason - - to lengthen the life of the pole involved. The treatment itself will generally protect against further decay for a period approximating 6-12 years with the actual time dependent upon a number of factors including the type(s) of preservative used. The environment around the pole and the geographical location of the pole. The pole should be groundline treated for the second time about the time the effectiveness of the initial groundline treatment wears off and periodic treatment should be continued until eventual replacement of the pole.

Several obvious questions arise when one considers a groundline treating program. The most common of these questions generally include the following.

1.) Should existing wood distribution poles be groundline treated?
2.) Can it be justified economically?
3.) What is the optimum frequency for subsequent treatments?
4.) How can savings be maximized?
5.) How should these answers be determined?

Based on recent economic studies and data gathered during the last 20-plus years, LP&L answers the first two of these questions as follows:

Yes, we should groundline treat existing wood distribution poles.
Yes, we can afford to. Better put, we can’t afford not to.

With reference to the first three of these five questions, the rest of this paper is devoted to describing a method which can be used to answer them. This method was recently used to determine the economics of groundline treating vs. not groundline treating in typical areas served by a typical power company and it is felt that the same basic approach will apply to other cases.

# METHOD OF EVALUATION USED
# (INCLUDING FACTS AND ASSUMPTIONS)

Start with two basic alternatives:
1.) No treatment.
2.) Periodic treatment.

With these two alternatives in mind, determine the cost over a period of time of each of the alternatives then select the one with the lower present worth cost.

Much basic data needs to be developed - - inflation rate, present worth factor, installation costs, replacement costs, rejection rates, etc.

If real statistics are not available on pole life characteristics, as was the situation in our case, assumptions must be made.

Data used in the sample calculation are as follows:

FACTS AND ASSUMPTIONS
(IN 1980 DOLLARS)

A. FACTS:

| | |
|---|---|
| 1. Cost to Treat Pole (TC) | $ 10.65 |
| 2. Average Cost to Replace Pole (RC) | $ 450.00 |
| a. Maintenance Cost (MC) | $ 180.00 |
| b. Capitalize Expenditure | $ 270.00 |
| 3. Cost of Money (CM) | 14%/Yr. |
| 4. Levelized Fixed Charges (LFC) | 19%/Yr. |

5. Study covers 45 year period, 1974 thru 2019 and all initial pole installations took place in 1974.
6. The annual cost of capitalized expenditures is 19%. ie., levelized fixed charges.
7. Maintenance expenses are paid from internally generated funds and do not have an associated annual cost.
8. All future expenditures will be present worthed to 2002 using a cost of money of 14%/Yr.

B. ASSUMPTIONS:

| | |
|---|---|
| 1. Inflation (I) | 12%/Yr. |
| 2. Average life expectancy of pole, no groundline treating (with the effect on money requirements due to failure of poles less than 25 years old being offset by poles which last longer than 25 years.) | 25 Yrs. |
| 3. Average life expectancy of pole, with groundline treating. | 45 Yrs. |

4. Rejection Rate (Dependent on Treating Cycle)

| Treating Cycle | Rejection Rate |
|---|---|
| 6 Yrs. | 1%/Yr. |
| 8 Yrs. | 1.5%/Yr. |
| 10 Yrs. | 2.5%/Yr. |
| 12 Yrs. | 4.0%/Yr. |
| 14 Yrs. | 6.5%/Yr. |
| 16 Yrs. | 10.5%/Yr. |

The facts used can generally be obtained from pole treating contractors and persons who deal with money matters. In all likelihood, your facts will differ from these examples.

The assumptions are, like all assumptions, based on data of varying amounts and degrees of accuracy, educated guesses, etc. These assumptions concerning average life expectancies of poles and rejection rates for various treating cycles are opinion of LP&L's actual operating experiences and may or may not be suitable for your use.

For what its worth, the author have varied average life expectancies and rejection rates and for reasonable variations the overall answer is the same - - it is economical to groundline treated poles. Varying the assumptions does alter the amount of savings realized along with the time frame to maximize savings thus it is recommended that assumptions be as accurate as possible (Examples of results obtained using different assumptions from those listed are included as appropriate on the following pages.)

# CALCULATIONS

## COST OF NOT TREATING

As stated earlier, one of the two alternatives under consideration is no groundline treatment and it is necessary to determine the cost of this alternative over a specified period of time. This was accomplished using the following procedure.

The pole in question was originally installed in 1974 and has an expected life of 25 years. Consequently, the pole will be replaced in 1999, 19 years from now, and the cost to replace said pole in terms of 1980 dollars can be determined as follows:

$$RC = MC + CE$$

$$= (1980MC)\ (1+I)^{19}\ (PWF\ Yr.\ 19)$$

$$+ (1980CE)\ (1+I)^{19}\ (LFC)\ (\Sigma\ PWF\ Yr.\ 20\ thru\ Yr.\ 45)$$

$$= (180)\ (1.12)^{19}\ \frac{1}{(1+14)^{19}}$$

$$+ (270)\ (1.12)^{19}\ (.19)\ \frac{1-(1.14)^{-45}}{.14} - \frac{1-(1.14)^{-19}}{.14}$$

$$= \$381.67$$

Where PWF means Present Worth Factor.

A pole installed in year 1999 will not be 25 years old until 2024 and the end of the study period is 2019, 39 years from now. The pole installed in 1999 still has 5 years of expected life in 2019 and the value, in 1980 dollars, of this remaining pole life has to be subtracted from the replacement cost to determine actual cost during the 45 year time period under study. This value can be approximated as follows:

PW Value = PW of dollars saved between 2019 and 2024

-- PW of dollars spent between 2019 and 2024

= (\$270) $(1.12)^{39}$ (.19) ($\sum$ PWF Yr. 40 thru Yr. 45)

+ (180) $(1.12)^{39}$ $\left(\frac{1}{(1+14)}\right)^{39}$

-- (270) $(1.12)^{19}$ (.19) ($\sum$ PWF Yr. 40 thru Yr. 45) = \$180.04

The cost of not treating is \$381.67 - \$180.04 or \$201.63 in terms of 2002 dollars and for the duration of the time period under study. Using the assumption previously stated that the initial installation of poles for all treating cycles occurred in 1974, the cost of \$201.63 for not treating will apply to all cases. One of the reasons for selecting the same period 1974 thru 2019 for all treating cycles was to make this cost remain constant.

COST TO TREAT

The second of the two alternatives under consideration is periodic treatment of poles. As with the first alternative of not treating, the cost of this alternative needs to be determined. Additionally, this alternative contains a number of alternatives, one each for each different treating cycle, and several need to be evaluated to determine the most economical treating cycle.

Although the most economical treating cycle is unknown, it is expected to be somewhere in the range of 8-12 years. It cannot be determined without making cost studies for a number of different cycles and in actual practice cost studies were made for 6, 8, 10, 12, 14 and in 16-year cycles. Since the procedures used were the same for each cycle, only a portion of the calculations, for the 10-year cycle, are included. The results only of cycles other than 10 years will be provided.

Assuming that the pole in question was initially installed in 1974, it would be groundline treated for the first time in 1984 with additional groundline treatments occurring in 1994, 2004 and 2014. The pole would become 45 years old in 2019 so no treatments would occur after 2014. Money would be spent in each of the years when treatment took place with this money being spent for the two reasons as follows:

1. The cost of the groundline treatment.

2. The cost of replacing a percentage of the pole with this percentage being based upon the assumed rejection rate for the treatment cycle involved.

(It is recognized that "a percentage of the pole" cannot be replaced, however, the end result of replacing "a percentage of the pole" for a per-pole study is the same as replacing a number of poles for a study based on a large number of poles.)

The cost of groundline treating and pole replacement in terms of 1980 dollars associated with a 10-year treating cycle and a 2.5% rejection rate is determined as follows:

YEAR – 1984 (4 Years From Now)

Treatment Cost = (1980 TC) $(1+I)^4$ (PWF Yr. 4)

$$= (10.65)\,(1.12)^4\,\frac{1}{(1.14)^4}$$

$$= \$9.94$$

Replacement cost

Maint. Cost = $(Rej.Rate)(MC)(1+I)^4(PWF\ Yr.\ 4)$

$= (.025)(\$180)(1.12)^4 \frac{1}{(1.14)^4}$

$= \$4.19$

Capt. Cost $= (PWF\ Yr.5\ thru\ 45)(LFC)(Rej.Rat)(CE)(1.12)^4$

$= (7.1232 - 2.9137)(.19)(.025)(\$270)(1.12)^4$

$= \$8.49$

Cost 1984 = \$9.92 + \$4.19 + 8.49 = \$22.60

YEAR – 1994 (14 Years From Now)

Treatment Cost = $(1980\ TC)\ (1+I)^{14}\ (PWF\ Yr.\ 14)$

$= (10.65)\ (1.12)^{14} \frac{1}{(1.14)^{14}}$

$= \$8.31$

Replacement cost

Maint. Cost = $(Rej.Rate)(MC)(1+I)^{14}(PWF\ Yr.\ 14)$

$= (.025)(\$180)(1.12)^{14} \frac{1}{(1.14)^{14}}$

$= \$3.51$

Capt. Cost $= (PWF\ Yr.15\ thru\ 45)(LFC)(Rej.Rat)(CE)(1.12)^{14}$

$= (7.1232 – 6.0021)(.19)(.025)(\$270)(1.12)^{14}$

$= \$7.03$

Cost 1994 = \$8.31 + \$3.51 + \$7.03 = \$18.85

Cost 2004 (Determined in same way as 1984 & 1994) = \$15.51

Cost 2014 (Determined in same way as 1984 & 1994) = \$12.13

Total cost for treatment and replacement, 10-year cycle and 2.5% rejection rate =
1984 cost + 1994 cost + 2004 cost + 2014 cost
= \$22.60 + \$18.85 + \$15.51 + \$12.13 = \$69.09

Using the same procedure, the total cost for treatment and replacement for other cycles and rejection rate is:

| | | | |
|---|---|---|---|
| 6 Year Cycle, | 1% Rejection Rate | - | $82.68 |
| 8 Year Cycle, | 1.5% Rejection Rate | - | $68.71 |
| 12 Year Cycle, | 4.0% Rejection Rate | - | $70.38 |
| 14 Year Cycle, | 6.5% Rejection Rate | - | $90.94 |
| 16 Year Cycle, | 10.5% Rejection Rate | - | $97.57 |
| | And as determined earlier | | |
| 10 Year Cycle, | 2.5% Rejection Rate | - | $69.09 |

Using the previously stated facts and assumptions, an 8-year treating cycle is the least expensive with the cost of 10-year and 12-year cycles very close. In general, a shorter treating cycle would be more economical assuming a higher rejection rate and a longer treating cycle would be the more economical for a lower rejection rate.

For example, if the rejection rate is assumed to be one-half that previously stated, the total cost for treatment and replacement is:

| | | | |
|---|---|---|---|
| 6 Year Cycle, | 0.5% Rejection Rate | - | $69.07 |
| 8 Year Cycle, | 0.75% Rejection Rate | - | $54.10 |
| 10 Year Cycle, | 1.25% Rejection Rate | - | $50.06 |
| 12 Year Cycle, | 2.0% Rejection Rate | - | $46.99 |
| 14 Year Cycle, | 3.25% Rejection Rate | - | $56.51 |
| 16 Year Cycle, | 5.25% Rejection Rate | - | $56.60 |

Based on these assumptions, a 12-year treating cycle is the least expensive.

## BOTTOM LINE – TO TREAT OR NOT TO TREAT

Recapping, the economic evaluation is based on two simple alternatives - - the cost to treat and the cost not to treat. We determined the cost not to treat, in 1980 dollars and for a study period of 45 years, 1974 thru 2019, to be $201.63 per pole. For the same period of time and in 1980 dollars, we determined that the 8-year treating cycle was the most economical with all associated costs being $68.71.

These figures tell us that we cannot afford not to groundline treat poles. We can save $132.92 per pole ($201.63 – 68.71) over a year period by groundline treating.

## QUALIFICATIONS TO The CLINE MODEL

The savings noted above justify a groundline treating program if they are actually realized and the obvious question at this time is - - what is the confidence level of achieving such a savings?

I can't give you a direct answer to this question because the study as made was dependent upon several assumptions with unknown degrees of accuracy. I can, however, vary these assumptions within reasonable extremes (or unreasonable if desired) to see how they alter the answer.

Consider the following 2 examples noted as Case 1 and Case 2:

1. Case 1 Assumptions:
   - A. Average life expectancy of pole, no groundline treating. - 30 years
   - B. Average life expectancy of pole, with groundline treating. - 40 years
2. Case 2 Assumptions:
   - A. Average life expectancy of pole, no groundline treating. - 20 years
   - B. Average life expectancy of pole, with groundline treating. - 50 years

Using the same procedure as previously outlined to evaluate the economics of groundline treating with Case 1 and Case 2 assumptions, the savings are determined to be $48.59 and $435.83 respectively.  We how have 3 values of savings for 3 sets of assumptions as follows:

| AVERAGE LIFE EXP. NO GROUNDLINE TREATING | AVERAGE LIFE EXP. WITH GROUNDLINE TREATING | SAVINGS IN 1980 DOLLARS FOR LIFE OF STUDY |
|---|---|---|
| 20 | 50 | $ 433.83 |
| 25 | 45 | $ 132.92 |
| 30 | 40 | $  48.59 |

Assuming that the life expectancies above cover the extremes which occur, the actual savings lies somewhere between $48.59 and $435.83. Based on the initially stated assumptions, the savings are $132.92 per pole and it is felt that this is reasonably close. In any case, groundline treating is an economical venture.

Facts in place of assumptions are required to determine an answer in which a high degree of confidence can be placed and your assistance in obtaining a high degree of confidence is requested. You can assist in this by providing statistics on mortality rates, average life expectancies of poles, reasons for pole retirements and the percent and age of poles retired for these reasons, rejection rates for poles which have and have not been groundline treated, etc. The data would be most appropriately presented in distribution curves. Please let me know if you have any statistical data of this nature which you would be willing to share.

## REVIEW OF ACTUAL TREATING RECORDS

We have been groundline treating poles for over 20 years and have accumulated a large amount of data dealing with such items as:

1. Average age of rejects, initial treating.
2. Percent of rejects, initial treating.
3. Average age of rejects, poles previously treated.
4. Percent of rejects, poles previously treated.

While this data is not adequate to allow us to build the statistical model required to replace assumptions with facts, a summary of this data is quite interesting and tends to agree with the economic evaluation just described. For example, treating reports on 55,640 poles being treated for the first time tell us that their average age was 17.1 years and the rejection rate was 10.2%. Treating reports on 39,903 poles previously treated tell us that their average age was 25.7 years with a rejection rate of 3.7%. Another way of saying this is that poles which are groundline treated and average 25.7 years old have one-third the rejection rate of 17.1 year old poles which are not treated.

This information coupled with logic strongly implies that groundline treatment can reduce your costs by extending the life of poles. We are convinced that this is true.

### Auditing Techniques

Auditing techniques vary with many utilities and with the many treatments. For sake of simplicity, I will outline one very effective audit technique I have used for determining if a groundline contractor has been applying the bandage, wrap, paste or grease at the recommended level on the label, and if that material have the amount of active ingredients prescribed by the government approved regulatory label( PMRA for Canada, and US EPA for the United States.

One such audit technique to use is the grab sample, and total gravimetric analysis technique. This technique is applicable to pastes, gels, greases, pads and diffusibles. First, one must purchase a standard surface sampling punch of the type used by sawmills to test the surface of treated wood to see if the correct amount of surface fungicide has been used and applied to give adequate surface stain and mold control on fresh-cut green lumber. One source of these punches is Orion Engineering in Vancouver, BC, Canada. In lieu of using such a punch, samples can be taken using a standard1 inch wide wood chisel if care is maintained.

First excavate an area below the groundline where the treatment was to have taken place earlier (if testing for diffusibles, you should sample within 90 days of treatment, making sure to remove at least 1/2 inch of wood during the sample extraction.). Remove a one square inch sample including wood to a depth of at least 1/2 inch of wood, and carefully extract the entire sample from the chisels or from the sample punch. Helpful hint is to rinse the tool with once a water wash and then later a solvent wash to ensure all water – soluble and organic soluble fractions have been adequately removed, taking care to save and reserve all the fractions into a common contain per individual sample inspection.

Using the proper wet chemical techniques, which are applicable to the elements or the compounds you are trying to quantify, perform a total gravimetric analysis on the sample. (Example: if you are trying to quantify that a 1/8 inch of creosote from a paste was used to treat a previously treated penta pole, perform a total creosote extraction and quantification per AWPA Standard methods or if testing to see if the correct amount of CuNap has been used from a paste, gel, or bandage, completely degrade the sample in acid media per AWPAS instructions, and assay for total copper if a gravimetric plating analyzer is not available.

Using the raw data, like density of the product from the product technical bulletin or MSDS, you can easily calculate the amount of total active ingredient that is supposed to be in a one square inch sample that is supposed to be applied at a certain thickness, and easily compare this result with that of the analytical outcome. Such auditing techniques will quickly show if you as the utility are getting the product and service your have paid your contractor to provide.

Summary and Conclusions

Three specific methods to justify the expenditures for having a remedial treatment program in place were reviewed and documented in detail. It should now be obvious, that regardless of initial preservative treatment, an effective inspection and remedial treatment program should be in-place foir all utilities( IOU's, municipals, REA's?RUS's), cable companies, and phone carriers. Although slight and sometimes significant levels on financial contribution to the entire pole plenat relies on the ability of wood utility poles to effectively carry and distribute energy and communications needs, remedial treatment and inspection should always be performed on wooden structures.

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