WOOD POLE PURCHASING, INSPECTION, AND MAINTENANCE: A SURVEY OF UTILITY PRACTICES

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ABSTRACT

Deregulation and consolidations have changed the operating environment for electric utilities in the United States. One important aspect of this change that may be overlooked is how utilities manage one of their most important assets: the wood poles that support their electric transmission and distribution system. The purchasing, inspection, and maintenance practices related to wood pole use by 261 North American utilities were surveyed. The results were compared with a similar, but less intensive survey performed in 1983. The survey showed that most utility practices were unchanged from those found in 1983, but that many utilities were exploring alternative pole materials. Utilities also appeared to have some misconceptions concerning pole service life; a factor that could influence the selection of alternative materials. The survey also showed that those charged with specifying and maintaining wood poles come to their jobs with little formal training in wood as a material. These results suggest the need for more continuing education offerings to better educate utilities concerning how to best manage their wood pole systems for maximum value.

Wood poles have a long history of providing excellent service for supporting overhead electrical and telecommunication lines. These lines represent up to 40 percent of the net value of some utilities. More importantly, failures of these lines can interrupt service, reducing sales and resulting in costly emergency repairs.

In recognition of these risks, the National Electric Safety Code (NESC) requires that utilities regularly inspect and maintain the poles in their systems and that they replace structures in which strength has declined below 66 percent of the original design value. Most utilities meet NESC requirements through regular inspection and remedial treatment programs that have evolved to address individual utility needs.

A 1983 survey showed that most utilities had some type of inspection program, although the frequency of inspections, the procedures employed, and the treatments applied to arrest decay varied widely (Goodell and Graham 1983). This survey was performed in an era when utilities were more tightly regulated. Recent moves to deregulate utilities, coupled with substantial downsizing and a trend toward consolidation, have sharply altered the utility operating environment. Despite these major changes, utilities must still reliably deliver power to their customers using overhead lines that are primarily supported by wood poles. Thus, the conflict between the need to be more profitable, while maintaining reliability, may cause utilities to alter their inspection programs. In order to explore that potential, the following study was performed.

The objectives of this survey were to assess 1) material preferences for utility poles; 2) inspection practices; 3) remedial treatment practices; and 4) perceptions concerning remedial treatment efficacy and safety.

MATERIALS AND METHODS

A questionnaire was developed for this study based upon previous work by Goodell and Graham (1983). A number of additions were made in order to gain additional insights concerning material preferences, remedial treatment perceptions, and inspection practices. The survey sought information on location,
type, and ownership of the utility; character- istics of wood poles in the system (number, wood species, and initial pre- servative treatment); the number of pole failures purchased in 1997; whether the respondent used any treatment-em- ploying processes for Douglas-fir poles (such as boring or radial drill- ing); whether the utility inspected new poles; and what service life expectations they had for a given species. We also surveyed maintenance practices to de- terminate whether utilities contracted in- spection, and if so, whether they audited the contractor. We then inquired about the inspection frequency for each wood pole species and what tools were used. Utilities were asked about levels of car- penter ant and woodpecker attack in their systems and what treatments they currently use; they were then asked to assess each treatment on the basis of performance and safety. Utilities were also asked whether they had used wood substitutes in the past 5 years. Finally, the respondents were asked to provide their original field of trading.

The survey was pretested on five utilities (one public, four investor-owned) located in five different states. The ques- tionnaire was then modified based upon feedback from these respondents. The survey was initially mailed to 1,100 utility engineers, purchasing agents, and specifiers across the United States. This mailing was followed by a reminder postcard 2 weeks later. The population of interest consisted of rural electric cooperatives, public utilities, municipal utilities, and investor-owned utilities located across the United States (excluding Alaska and Hawaii). The ini- tial mailing and reminder postcard rep- orted responses in 173 usable surveys, while an- other 70 surveys were undeliverable. A subsequent mailing 6 months later to non-respondents produced an additional 88 responses (12.2% total response rate).

The results were tabulated on an over- all basis for all questions except the pole material preferences question. In this case, the results were tabulated on the basis of utility ownership (investor or public); region of the country; and num- ber of poles in the system to determine whether these characteristics affected their pole purchasing practices. Non-response bias was assessed by comparing 27 respondents to the initial survey with 27 respondents to the sec- ond mailing from the same states and systems. The re- sponses from these utilities concerning pole material preferences and for the questions concerning incidence of carp- enter ants and woodpeckers were com- pared using Tukey's Studentized Range test to see if there was a signif- icant difference between the two groups (SAS 1999).

Results and discussion

Two hundred sixty-one responses were received from the two mailings. Often, however, the respondents lacked information to respond to one or more questions. Wherever possible, a follow- up telephone call was made to try to col- lect that missing information, but this was only possible when the respondent was identified. Non-response bias tests showed that there was no significant dif- ference between early and late responses concerning pole material preferences, carpenter ant attack levels, woodpecker attack levels, or amount spent each year for woodpecker repairs (t = 0.05).

Utility sizes

The majority of respondents main- tain similar-sized utilities. The re- sponses from these utilities concerning pole material preferences and for the questions concerning incidence of carp- enter ants and woodpeckers were com- pared using Tukey's Studentized Range test to see if there was a signif- icant difference between the two groups (SAS 1999).

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Most respondents were located with chro- mated copper arsenate (CCA) (16%), creosote (16%), copper naphthenate (3%) and ammonium copper arsenite/ acryl- azide (AA) (16%) (Fig. 2). Olehine chemi- cals continue to dominate system size, with CCA-treated southern pine poles are increasingly more frequent in the southern United States.

New pole purchases

Most utilities purchased fewer than 500 poles per year, a finding that re- forces a survey of utilities in the western United States showing that pole replace- ment rates at many utilities ranged be- tween 0.5 and 0.7 percent per year (Morrell 1999).

Although wood poles continue to comprise the majority of poles supporting lower voltage lines, many utilities have employed "autoclave pole materials" within the last 5 years (Fig. 3). Such materials were the most frequently used substitute, while concrete, fiberglass, or laminated wood poles had been employed by 48 to 60 respondents. These responses indi- cate that utilities are exploring alterna- tive materials, although our survey did not allow us to collect data on the extent of the substitution.

A majority of respondents were also interested in confirming pole quality, as evidenced by the nearly 200 respondents

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that used either an in-house program or
4th-party agent to inspect new poles. This
suggests that utilities remain con-
scious about the quality of trench in-
spection programs. These practices are
a sharp contrast to other material pur-
cases, where the manufacturer is ex-
pected to provide quality materials with-
out significant purchaser oversight.

A final question under the new pole
purchase section concerns the test-
treatment procedures to improve the depth
of initial treatment. These practices in-
cluded radial drilling, through-boring,
and deep incising that are primarily ap-
p lied to Douglas-fir, a species with a thin
sapwood band surrounding a difficult-
to-treat heartwood core (Graham 1983).
A majority of respondents (140 utilities)
did not use Douglas-fir in their systems,
reflecting the appearance of smaller pub-
lic utilities east of the Rocky Mountains.
These utilities typically do not have
large numbers of transmission lines
where Douglas-fir would be used. Of the
remaining 120 respondents, 110 em-
ployed one of the 3 groundline pretreat-
ment practices on their Douglas-fir
poles. Most utilities claimed to use deep
incising on their poles, a somewhat sur-
prising finding, given the limited num-
ber of treaters that can apply this
method. We suspect that some respon-
dents confused conventional incising
(which uses 12- to 19-mm-long teeth on
rollers to improve sapwood penetration)
with deep incising (which drives 60- to
75-mm-long teeth into the wood). As a
result, the incising response must be
viewed cautiously. The 60 utilities that
incorporated radial drilling or through-
boring into their specifications reflect a
growing trend among Douglas-fir users
to improve treatment in the critical
groundline zone. These trends should
markedly improve pole service life and
alter the manner in which these utilities
inspect their poles (Graham 1983).

EXPECTED SERVICE LIFE

Utility consolidations and increasing
drivers for higher investment returns
have encouraged many utilities to evalu-
ate the service lives they obtain from a
variety of materials, including wood. At
the same time, alternative materials have
made service life claims that are, at best,
difficult to confirm. For many years,
most utilities have used 30 to 40 years as
the estimated service life for wood
poles. The survey responses reflected
these figures for southern pine, ponder-
osa pine, lodgepole pine, and Douglas-
fig (Fig. 4). However, most western
redecor users estimated service life of
this species to be between 51 and 70
years. Numerous lower-voltage cedar
transmission lines across North Amer-
ica that were installed in the 1950s
clearly attest to the excellent perfor-
mance of this species. The tendency for
utilities to continue to perceive lower
service lives for other species is per-
plexing in light of advances in inspec-
tion and maintenance practices over the
past three decades. Western surveys
suggesting replacement rates of 0.5 to
0.7 percent per year would place aver-
age service life at 70 to 100 years (Mit-
rell 1999). Recent reports on pole ser-
vice life at several Midwest utilities
support these estimates (Nelson 1999,
Stewart 1996). Although these results
remain promising, it is clear that utilities
continue to use outdated information
when comparing wood pole service life
with that of other materials.
This misconception may also influence future utility purchasing decisions. Of the respondents, 48 had used laminated poles, 116 used steel poles, 57 used fiberglass, and 62 used concrete within their systems within the last 5 years. While the survey did not ask what percentage of total purchases were alternative materials, results imply a diversification of pole usage patterns. Utility engineers explore the performance properties of wood alternatives.

### Maintenance Practices

**Inspection Cycles.** As expected, there was a wide disparity in inspection frequency among respondents. This disparity was greatest in the distribution systems, where many utilities reported that they had no inspection program for these poles. Transmission poles were inspected every 7.2 years, while distribution poles were inspected every 8.1 years. It is important to remember that this cycle could range from a cursory visual inspection to a complete excavation, sounding, and boring.

The vast majority of utilities reported using combinations of visual inspection, sounding with a hammer, and boring with a drill (Fig. 5). These figures differ little from those in the 1983 survey (Goodell and Graham 1983) and reflect a long-term preference for these techniques (Inwards and Graham 1980, REA 1974, Eslyn 1968, Mothershead and Graham 1962). Most of utilities who responded to the current survey bored both above and below groundline, although the number that inspected below the ground was somewhat lower, possibly reflecting the decay risk in many locations. It is common knowledge among utilities in many areas in Zone 1 that decay tends to occur 300 to 450 nun below the ground where moisture conditions are more suitable for fungal growth. Excavation is essential for detecting decay in poles exposed in these regions.

While sounding and boring formed the basis for most pole inspections, some respondents, used alternative inspection devices (Fig. 5). Seven respondents reported using a moisture meter for pole inspection. While this device will detect wet wood that could be at risk of decay, it does not detect decay. It is possible that these respondents used the moisture meter to assess conformance to post-treatment moisture levels in newly purchased poles rather than for in-service poles. Twelve utilities used the Shigometer for pole inspection. This device measures resistance drops as a twisted wire probe is inserted into a predrilled hole in the pole. The resistance drops signify areas of possible decay. The Shigometer was originally developed for detecting decay in living trees, and has seen only limited application to wood products (Shiga 1980, Shortle et al. 1978). A number of evaluators have concluded that this device is best operated by trained inspectors who can interpret the resulting output (Zabel et al. 1982, Graham and Corden 1980).

Forty-one respondents reported using the sonic device, Potensc3, in their inspection process, with a majority (76%) using the device on Douglas-fir or western redcedar. Although sonic devices have attributed considerable utility interest, it appears that few respondents have incorporated this technology into their
systems. Twenty-one respondents reportedly used other inspection tools in their programs, but did not specify the nature of those devices.

The past decade has witnessed the introduction of a number of microdrilling or sonic devices that seek to provide supplemental information to the inspector. Despite these efforts, however, it appears that most utilities are unwilling to change their inspection procedures to incorporate such devices. It is unclear whether the delayed adoption of new technology represents the conservative nature of the industry or dissatisfaction with the results these devices provide.

Carpenter-ants. — Carpenter ants can be an important problem in some regions of the United States, particularly where utility-right-of-ways pass through forested areas. Unlike termites, which can usually be controlled by void treatments into their galleries, carpenter ants are more mobile and therefore capable of moving out of the remedially treated zone to attack other portions of the pole. Approximately 1.4 percent of poles in the responding utilities experienced carpenter-ant attack. The damage, however, was often concentrated among utilities that had extensive territories in more heavily forested areas. Most utilities (61% of respondents) reported that they had no treatment in their specifications for carpenter-ant control (Fig. 6). Presumably, utilities that reported carpenter-ant attack replace poles once the damage exceeds the utility's replace- ment criteria. The remaining respondents used a variety of treatments including Hollowtear, "Fume", Dursban, sodium fluoride rods, copper naph- thanate, and Patox. While carpenter ants do not appear to be a nationwide utility issue, it is clear that they are locally important. It is unclear, however, if the level of damage is sufficient to support specialized practices for preventing attack by these insects.

Woodpeckers. — Like carpenter ants, woodpecker damage appears to be more closely related to the proximity of line to a forested area. However, even a small grove of trees can serve as potential woodpecker habitat that could increase the likelihood of pole attack. Woodpeckers attack wood poles for a variety of reasons, including nesting, feeding, and nesting, and not all species attack poles. Woodpeckers damaged an estimated 5.75 percent of poles in the responding utilities, a figure suggesting that the estimated cost of this damage ($5,572,200 yr) seems relatively low. Many respondents (102/206 or 49.5%) used pre-drill fillers to control woodpecker attack, while 56/206 (27%) used hardware cloth to prevent damage (Fig. 6). A limited number of utilities used fiberglass wraps (6.3%), while 35 respondents used "other" methods, but did not identify those methods.

REMEDIAL TREATMENTS

Respondents were asked to identify all of the remedial treatments used in their systems (Fig. 7) and then assess their level of satisfaction with each chemical (Figs. 8 and 9). These treatments can be divided into external systems for controlling soft-rot attack and internal systems for controlling internal decay. Over 40 percent of the respondents used Osmophoric for external decay control, while nearly 30 percent used one of three copper napthenate-based formulations (Fig. 8). Although the contents of Osmophoric have changed in the intervening 17 years, the percentage of respondents using this system has changed little from the 37 percent in 1983 (Goodell and Graham 1983). Nearly 20 percent of respondents used Patox, which we presumed to be Patox II, a sodium fluoride-based system. The results indicated that most utilities have largely shifted from using penta-chlorophenol-based external treatments as a result of changes in licensing requirements for the use of penta-based materials.

While chemical usage patterns have changed, it is also clear that the respondents were generally satisfied with the performance of these systems. Most utilities perceived the performance of the currently specified systems to be acceptable or better. Interestingly, Osmophoric received the most excellent responses of any chemical evaluated (nearly 30% rated this chemical as an excellent performer). Similarly, utility perceptions about safety mirrored performance perceptions. Most importantly, few respondents viewed the chemicals as being unsafe.

Utilities rated their perceptions on five internal remedial treatments: methan sodium, chloropirin, mTC-Fume, sodium fluoride rods, and fixed boron rods (Fig. 9). Comparisons between the new
data and that generated in 1993 were not possible because the original survey lumped all fumigants together and neither boron nor fluoride rods were available at that time. A majority of respondents in the current survey used one of the three fumigants. Interestingly, however, MITC-Fume was the most commonly used treatment followed by methyl sodium and chloropicrin. Until the introduction of MITC-Fume in the early 1993, methyl sodium was the dominant fumigant used for internal decay control. Chloropicrin was traditionally used in overland transmission lines away from inhabited areas owing to its difficulties in handling. It would appear that MITC-Fume, which is a solid at room temperature and is encapsulated in aluminum tubes for safe handling, has taken market share from both methyl sodium and chloropicrin. Boron and fluoride rods are both relatively recent entries into the U.S. utility market, although both have been commercially used in other countries. Both systems are water soluble and easily handled. They have relatively mild language on their labels that does not require that the applicator license for installation. These chemicals, however, work more slowly than fumigants. It would appear that utilities are incorporating diffusible rods into their systems, but the pace of product adoption is relatively slow. The slow rate of adoption may reflect perceptions about performance and safety. Most utilities felt that MITC-Fume, methyl sodium, and chloropicrin provided good-to-excellent performance, and a high percentage of these respondents felt that MITC-Fume and chloropicrin provided excellent protection. Conversely, few respondents felt that either boron or fluoride rods provided excellent performance. These perceptions are reversed when safety is the primary concern. Most respondents rated the rods as excellent in terms of safety, while few perceived that either methyl sodium or chloropicrin were in the excellent category. It is interesting to note that MITC-Fume proved to be intermediate in these categories, with many utilities rating both safety and performance favorably. This presumably accounts for the high number of utilities that currently specify this chemical to stand the nature of the materials and the characteristics of the chemicals. A majority of respondents used electrical ca-

**Figure 6.** Frequency of utilities using various remedial systems for: A) carpenter ant infestation or B) woodsucker attack of wood poles (242 respondents).

**Figure 7.** Frequency of usage of various remedial treatments among 260 responding utilities.

**Training.** An inspection and maintenance program is only as effective as the degree to which the personnel under-
ginnering as their primary field of training (124/260) suggesting that they came to their jobs with little in the way of formal training in wood as a material or the treatments used to protect wood (Fig. 10). Only 76/260 respondents had for-

entry training and only 4/9 of these were trained in forest products, an astounding low level of initial training given the economic importance of wood in most utility systems. The low initial knowledge level that many utility personnel bring to the job implies a need for training and information to educate personnel on wood-related issues.

One concern that did not emerge from the survey was that utilities were becoming increasing isolated in the ways they sought to maximize their internal knowledge, while minimizing transfer of this knowledge to other utilities who might eventually compete for business. This may reflect the relatively early stage of deregulation in many states. We may expect to see less interaction between utilities as these companies increasingly compete for customers.

**CONCLUSIONS**

The results suggest that many utility practices remain relatively unchanged from those found 17 years ago. Utilities clearly see wood as an important component in their systems, although their perceptions on service life of wood deserve some reconsideration. Most utilities have regular inspection programs and appear to be satisfied with the chemicals they use to arrest decay. The study also suggested a need for supplemental training to assist engineers who lack initial training in wood as a material.

**LITERATURE CITED**


Figure 10. — Primary field of training for respondents (261 respondents).


