

# WOOD POLE TOPS:

## PROBLEMS AND SOLUTIONS

This article examines the issue of wood pole top problems in the utility industry, specifically describing the causes of checking and splitting and end grain deterioration, the resulting safety, maintenance and functional problems and the available corrective measures currently in broad use. Proven technology designed to solve these problems in a cost effective manner is described along with actual utility field experience with these devices. Widespread use of these low cost devices as preventative measures can minimize rejection and replacement of potentially defective poles, improve safety and lower field maintenance expenses and prolong the life of the wood utility pole.

## **PREFACE**

A subject vitally important to all of us in the treated wood industry is the extension of “life cycle” for treated wood utility poles. There has been a fairly recent ground swell of interest in life cycle costs due to the incursion of alternate materials to produce utility poles. This concerns everyone connected with the forestry, production and treatment of wood poles. Claims of extended life (80 plus years) by producers of steel, fiberglass and concrete poles have put wood producers at a competitive disadvantage. Utility users typically compute their costs based on initial cost, maintenance costs and the perceived life of their pole plants, 33-40 years. This is of utmost importance to utilities as an average sized utility pole plant represents approximately 25% of the gross plant with a replacement cost of 1.35 billion dollars. A typical pole plant of this size would have approximately 800,000 + wood poles in the system -25% transmission and 75% distribution.

Recent meetings and wood pole conferences have indicated that “the market for wood poles is sharply dropping off as alternative materials seize a larger market share.” To combat this trend, principal utility engineers advocate that the wood pole industry must take “an immediate proactive stance” or expect market share to continue to decline. A leading northeastern utility with an active wood pole maintenance program states that approximately 15% of their pole rejects are due to problems encountered at the pole top. One half of those pole top rejects are due to splits and the other half due to decay. Strong points have been made by utility users that pole producers need to be more receptive to requests for additional pole enhancements (e.g. incising, through-boring, star, etc) to extend pole life. Producers need to furnish utility users with a quality product that will have minimal maintenance problems and a simplified inspection program.

Several well-known wood research experts have advocated immediate upgrading of treated wood poles through proper initial specifications, quality control of production as well as follow on inspection and maintenance programs. An important point to be considered at this juncture is that while our accepted ANSI and AWP standards produce a high quality utility pole, these are minimum standards. Many utilities have utilized options contained in these specifications to fit their special needs for climate or environmental concerns (e.g. wood specie, moisture content, seasoning temperatures, etc.) Each utility should use the ANSI/AWPA standards as a guide, adapting special options to assure the maximum life of their individual pole plant. Once again, the basic level of national standards are adequate for most applications when combined with a positive inspection and follow on maintenance program. When properly specified and produced, our treated wood poles are superior to alternative materials in quality and life cycle cost.

Dr. Jeff Morrell of Oregon State University speaking at an EPRI workshop in JULY 1996 says, “there is an increasing body of evidence that average service lives may extend to 80-150 years where poles are properly specified and maintained.”

A highly respected wood scientist presented a paper to the International Pole Conference in March 1996 at Colorado State University that reviewed the current status of treated wood poles, their current perceived life cycle and a case study of wood pole lines that have been subjected to a program of regularly scheduled inspection and maintenance. His study indicated that utility experience “of properly produced and maintained wood poles is significantly longer than perceived—certainly approaching 75 or more years of service.” He further states the “based on the premise that wood pole life is significantly longer than the generally accepted value (33 years), it is likely that degradation mechanisms, in addition to ground line decay, will become limiting factors in determining pole life.” The mechanisms that need to be addressed to ensure that extended lives are achieved include:

***Pole top decay (stove piping)***

***Decay at connections***

***Splitting of pole tops***

***Excessive weathering***

A speaker at the October 1996 Northeastern Pole Conference made a point of the cost, performance and liability associated with unexpected failures and the cost of emergency replacements, when inspection programs would probably identify these defective poles. He further states that “the cost of leaving a bad pole in the system is both difficult to estimate or quantify because its cost is associated with the interruption of service and the liability of an accident occurring.” He also says “typical maintenance and inspection deals with near ground line zone of the pole....whereas less emphasis is placed on above ground line zone of the pole which is usually subject to decay at field drilled holes and pole tops,” and that “as wood poles age they degrade due to environmental conditions that promote decay.”

During 1994, a survey was conducted of Edison Electric Institute members asking for the objectives of a pole inspection program. The responses reflect the most significant objectives of participating utilities are detection of hazardous poles and prevention of outages. The top three responses were:

Prevention of injuries by detection of hazardously decayed poles—22%

Prevention of outages due to pole failures—19%

Selection of poles to receive remedial treatment—14.8%

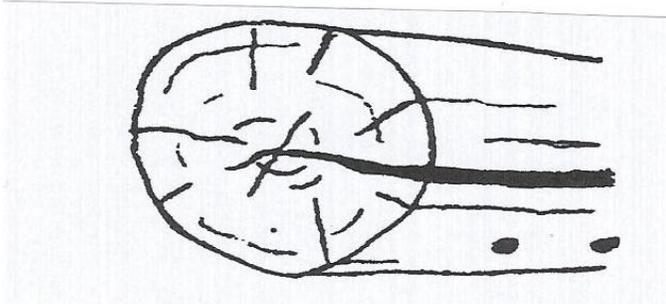
As we are now able to extend the service life of wood poles through cost effective specifications, inspection and maintenance programs, we must now extend those programs to the upper half of the wood pole to gain our maximum life cycle.

These are specific problems that we address. Three of the four major problems cited above can be mitigated today and extended pole lives of 15-20 years can be expected. Further, these remedies are cost effective, costing less than half of one percent of the installed unit cost.

## INTRODUCTION

The twin wood pole top problems of 1) checking and splitting and 2) deterioration and rotting of end grain wood have long been a neglected area. Wood utility poles have historically been well protected at the ground line and below by a variety of preservative methods. However, research and development of methods and techniques to protect the top of the wood pole during the 1970's have only recently been more widely utilized by the utility industry.

The top of the wood pole is as critical to successful field performance as proper ground line preservation. The top of the pole must provide a solid base for pole top mounting of cross arms, transformers and other transmission hardware. In addition to bearing the weight of transmission equipment, the pole top must be safe enough for linemen to climb and conduct needed maintenance and repairs. When the top of a wood utility pole splits in a critical sector or loses significant strength due to end grain and heartwood rotting, the entire pole must be replaced at a considerable expense.



## CHECKING & SPLITTING

Wood utility poles have a natural tendency to check and split through the tops due to their fiber construction and round shape. The phenomena is directly attributable to the shrinking and swelling of wood cells due to moisture changes. The severity and degree of checking is related to several factors, the most significant being changes in ambient moisture levels or installation in areas where frequent alternating wet/dry cycles occur.

Checking patterns vary somewhat in different wood species due to unique wood cell structure and different methods of harvest and treatment. The basic underlying problem, however, of wood in the round shrinking and expanding with moisture change, results in tearing of the wood fiber with checks and subsequent splits occurring to relieve stress. This will happen over

time regardless of wood species or initial differences in pole top appearance due to artificial versus natural pole seasoning.

Stress relieving checks will generally follow the path of least resistance from the pole perimeter to the center of the top, resulting in one or two wide, major tears of the fiber. Checks and splits in pole tops do not necessarily reduce the overall strength of poles; however they can create significant problems with pole top attachments such as insulators, cross arms and transformers. These problems are compounded after installation when checks and splits develop through the same plane as bolt holes. This can undermine the secure attachment of equipment, jeopardizing function and safety. Severe checks can also expose untreated heart wood which is very susceptible to decay.

A check/split defect in a wood pole may or may not cause rejection for power line use. The American National Standards Institute (ANSI) specification 05.1 defines the severity and specific locations of permitted checks for power line construction. It is important to remember however, that checks and splits will continue to develop as a natural process throughout the life of the pole. Checks may develop in critical areas after inspection and installation in the field. Although all species of pole tops are subject to the same stresses related to moisture change, the development of problems follow different time lines dependent upon species, harvest and treatment methods.

## END GRAIN DETERIORATION

Another significant wood pole problem is that of pole top deterioration. The top of the pole is composed entirely of end grain wood which has no natural resistance to moisture absorption nor to the accumulation of debris that initiates decay in end grain wood. This debris includes dirt, organic matter and decay fungus of many types. A major contributor to end grain decay are the droppings of rooting birds. Full length treatment of poles helps slow this inherent deterioration of end grain wood. The difficulty in maintaining decay free pole tops is that most treatments tend to migrate downwards and decay producing debris is constantly renewed at the pole top. This debris, often renewed on a daily basis, provides the perfect environment for fungus growth- moisture, food and light. Rotting end grain wood is the result.

## **CORRECTIVE ACTION**

The standard industry remedy for defective split pole tops has been “split bolts” placed at right angles to the hardware mounting bolts. These bolts are sometimes installed by utilities prior to line erection; however due to the uncertainty of the future severity and location of checks, a special maintenance procedure involving linemen, trucks, etc is often required. This remedy, used after a problem has occurred, and requiring a line crew dispatch is expensive and time consuming, with no assurance that all problem poles are corrected prior to failure.

Various remedies to limit the moisture changes in and debris collection on pole tops have been used over the years, with minimal success. Several products including round rubber tops, plastic tops and homemade sheets of meal crudely cut to fit have been used.

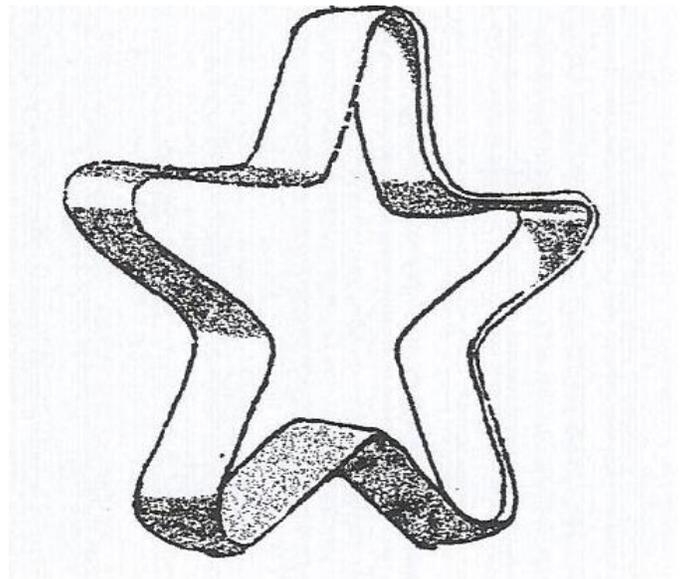
Unfortunately the available rubber and plastic tops tended to fit tightly and thus aggravate pole top deterioration by trapping moisture on the end grain wood and effectively functioning as a “wick” to draw additional moisture.

## **SOLUTIONS**

The Bayne Company has developed a pole top protection system to effectively protect the pole top from the serious problems of checking/splitting and deterioration. This system has been tested under controlled conditions and has been proven in the field by major industry partners including New York State Electric & Gas, Pacific Gas & Electric, Trans Alta Utilities, Wisconsin Power & Light and many other utilities across North America.

## **CHECKING & SPLITTING SOLVED**

An effective solution to the problem of wood in the round checking and splitting will prevent and control the negative results of this natural process. The Star-Lock was designed with this objective in mind. The first practical device for truly reinforcing wood pole tops, the Star-Lock is made of 14 gauge steel, formed in a unique 360 degree design to change the stress pattern that occurs when wood fiber shrinks and expands.



The design, a rounded five point star, completely encloses the center of the pole top, crossing internal growth rings at a gradual angle, pulling the rings into a compact whole. This compression of the core actually encourages smaller checks to develop outside the perimeter of the device and effectively prevents severe through checks from developing at the top of the pole. The inside beveled edge of the device, 30 degrees, serves two functions. First, it permits ease of installation with a simple hammer device and secondly it forces the Star-Lock to spring slightly as it is installed, forming an internal stressed band of protection that cannot be removed or loosened through natural expansion. This effectively eliminates through checks in pole tops and forces stress relief to move around the perimeter of the pole top. Extensive testing of pole tops, initiated in 1979 and monitored on a quarterly basis for two years, confirmed the efficacy of the device’s construction and design.

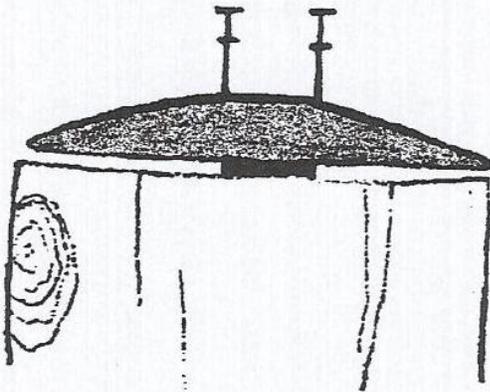
Since the introduction of the Star-Lock to the industry in 1982, annual usage has dramatically increased from 1100 units to over 50,000 units. A ten year review of the original test poles was accomplished in 1992 and the results clearly showed the Star-Lock to be a proven problem solver. Test poles had not developed any through checks and the integrity of the pole tops was intact. Best estimates at present put the installed base of Star-Locks in use at over one million units throughout the United States and Canada.

## **END GRAIN DETERIORATION SOLVED**

To address problems inherent in past pole top cover products, a new device was developed based on the

results of over two years of research and development. The ProTop was made available to the market in late 1994 and addresses many of the shortcomings of previous pole top cover devices.

The choice of material, a basic ABS (Acrylonitrile Butadiene Styrene ) plastic was selected for utility, strength and cost effectiveness. The one piece molded construction resulted in a simple device, easily fastened to the pole top with commonly available spiral nails or screws fitted with rubber grommets to further seal out moisture. The unique structure of the device permits 1/8" of air flow between the protective lid and the pole top to minimize fluctuations in moisture content. The natural air flow will rapidly aid in evaporation of any excess moisture.



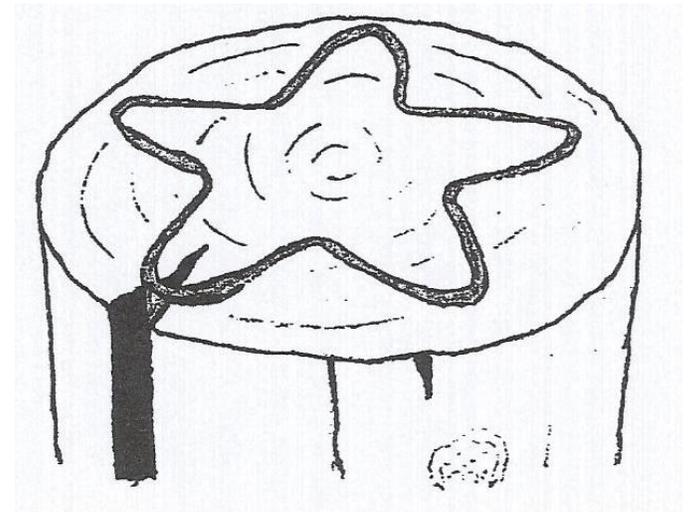
The cover device was designed with a cavity in the bottom that fits snugly against the top of the pole end grain wood. This cavity is a standard 2" diameter on all sizes of the device and is designed for the slow release of a moisture activated follow-on wood preservation, if desired. The cavity will only allow downward diffusion of the preservative into the end grain pole top. Both pole top protection devices come in three standard sizes to accommodate ANSI pole tops. The Star-Lock is manufactured in 4", 5" and 6" diameters, while the ProTop is produces in 7", 9" and 11" diameters.

## FIELD EXPERIENCE

Positive field experience with the Star-Lock and ProTop has been widespread geographically and functionally in utility applications. With over a million units installed on lines throughout the world, on both transmission and distribution systems, acceptance and expanded usage continues to grow.

During 1995, New York State Electric & Gas (NYSEG) initiated a pole top protection program consisting of the use of a Star-Lock and ProTop on each installed pole. This program was implemented after several years of requiring Star-Locks in all transmission poles and observing the excellent results.

This program is expected to assure the integrity of both the distribution and transmission systems against split pole tops requiring intervention and dramatically slow the deterioration of exposed end grain wood on pole tops. The expected cost savings of eliminating in-house repair and maintenance, as well as a significant reduction of in-line failures, will result in increased reliability and safety at a minimal initial expense. NYSEG has the Star-Locks for west coast species (Douglas Fir and Western Red Cedar) installed by the pole contractors, while ProTops and Star-Locks for the eastern pole species (Southern Yellow Pine) are installed at each NYSEG warehouse prior to use. This forward looking program at NYSEG is a prototype for utilities interested in using the latest and best technology available for assuring maximum performance of a high cost wood pole, while realizing a cost savings on future maintenance, reliability and replacement needs.



Utilities in the southwestern United States, led by Pacific Gas & Electric, Southern California Edison, Arizona Public Service and Tucson Electric have specified Star-locks in their poles for several years. The transition of moisture sensitive wood fiber from the wood pole producing areas of the Pacific Northwest and Southeastern US to the extremely arid, harsh conditions encountered in the desert areas of the Southwest cause

immediate and dramatic shrinking and checking of round wood poles, particularly the exposed end grain tops.

Star-Locks are currently installed by many pole contractors in order to reduce the chance of a rejected pole unit due to a split top in excess of ANSI criteria. Pole contractors also install the device at the direction of a utility or independent inspector to meet the requirements of an individual pole specification. The low cost of installation of a Star-Lock is minimal when the cost of replacement or rejection on receipt is considered. More importantly, the utility has purchased a pole with the latest available pole top protection system, assuring trouble free use for many years to come.

The American Wood Preservers Association (AWPA) has long recognized the need for pole top reinforcement by inclusion of the Star-Lock in specification C1 as a recommended option "to control checking on pole" (Rev 1987) The Rural Electric Administration has confirmed the efficacy of the Star-Lock by a letter from the Technical Standards Committee "A", Electric Staff Division, in 1989, allowing use of the device on poles purchased for cooperatives.

Many other individual utilities throughout the United States and Canada have specified the installation of Star-Locks in new poles purchase, e.g. Bonneville Power, or at the discretion of inspectors, while other utilities, such as Trans Alta Utilities have stocked them in warehouses for in-house use. The gradual inclusion

of ProTops in pole specifications, working with the Star-Lock as complete system, will provide utilities with a safe, reliable and maintenance free wood pole top.

## **CONCLUSION**

The combination of a Star-Lock for positive reinforcement and the ProTop for protection from moisture and decay together from the best available wood pole top insurance. These devices, used in combination, provide longer pole life, improved safety and cost savings. The system also allows the utilization of poles that develop checks between harvest and treatment and those that become defective once installed in line. Both devices can be installed at any stage of pole life, from immediately prior to treatment to installed structures, with the same positive results. Minimizing rejection and replacement of potentially defective poles reduces the overall cost of wood poles, adds to an ongoing growing inventory and helps conserve a valuable natural resource.

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