



## STEEL DISTRIBUTION POLE CASE STUDY

### Tucson Electric Power

There are approximately 185 million utility poles in North America that deliver electricity to homes and businesses across the country. Approximately two million to four million poles are installed annually due to new construction, poles reaching the end of their useful service life, damage from severe weather, and various other reasons.

Over the last decade, many electric utility companies have started to convert wood distribution poles to steel. Steel distribution poles are strong and durable, while subject to potential corrosion are impervious to insects and rot, and are almost entirely recyclable at the end of a long service life.



Today, more than 600 electric utility companies in the U.S. are using steel distribution poles, with some converting the majority of their distribution system poles to steel. Tucson Electric Power (TEP) in Tucson, Arizona is a leader in this transition. Over the last eight years, the company has gradually converted most of its warehouse inventory from wood to steel based on total cost of ownership (TOC) benefits, all the while improving field education, maintenance practices and wildlife protection.

### Company History

Founded in 1892, Tucson Electric Power (TEP) is the principal subsidiary of UniSource Energy Corporation. The electric utility has more than 2,200 megawatts of generating capacity and 20,000-plus miles of power lines to serve more than 400,000 customers in a southern Arizona service territory that spans 1,155 square miles. TEP is investing significant resources in upgrading its generation, transmission and distribution systems as well as the computer technology and other business operations that support them.

The utility is recognized as a worldwide leader in renewable energy, due in part to a giant 4.6-MW solar array it has built near the Springerville Generating Station in eastern Arizona.

## Pioneering New Directions

As part of its maintenance and upgrade program, TEP replaces between 700 and 900 of its 125,000 distribution poles every year. Like most U.S. electric utilities, the utility had used wood poles for more than 90% of its transmission and distribution needs while regularly evaluating alternative pole products, including concrete, fiberglass and steel poles. TEP used its first steel pole in the late 1960s on a 138kV line, and later moved into using steel on the transmission side. Yet for the most part the utility continued to rely on wood poles for much of its distribution system – until 2000.

Ron Runion, T & D Construction Group Lead for TEP, recalled, “We started using steel poles as stopper poles in the 1990’s in emergency replacement situations along our transmission lines. We soon realized that steel poles minimize the potential cascading effects of sudden failure during a storm or a microburst.”

A subsequent cost benefit, lifecycle analysis of steel versus wood brought to light some other advantages. An internal TEP comprehensive study showed that while the cost of steel was higher than wood, the life expectancy of a steel pole at 60 years or more was twice that of a wood pole, which is typically 30 years.

The following table compares the relative life cycle cost of steel versus wood for the three most commonly used TEP distribution steel poles:

Steel	Wood	Cost of Steel*
45 S3	45 C4	83%
45 S1	45 C2	96%
50 S1	50 C2	100%

\* As a percentage of wood.

Within this life cycle study, the cost of placing one steel pole versus 2 wood poles is equivalent, although the initial material cost of steel is higher.

David Parpart, Senior Distribution engineer for TEP, adds, “The study also found that a steel pole offered better reliability in a consistent engineered product. In terms of construction, the steel was lighter than a comparable wood pole.”

TEP’s distribution steel pole team – made up of Engineering, Standards, Construction, Environmental, Safety and Purchasing – did encounter some internal resistance and skepticism to this change. Once engineers and linemen realized the installation, life span and reliability benefits that steel had to offer, acceptance was increased.

## Looking to the Future with Steel

In 2000, after observing steel 46/138kV poles' superior performance in storms, TEP made the decision to go to steel distribution poles.

Runion says, "Our original plan was to replace every fifth pole in our transmission system with a steel pole. However, after reviewing the magnitude of that project, we realized that we had set our goals out of reach considering the workload and resources available."



After a resurvey of existing conditions, TEP realized that they were replacing poles on a regular basis and that if they could replace these poles with steel poles during these times, they could achieve similar results.

The majority of steel distribution poles in use today are galvanized but some utilities prefer the aesthetics of a "brown" weathering steel pole. Maintenance and aesthetics are the primary reasons TEP uses primarily weathering steel poles in its system.

## The Installation Process at TEP

Steel distribution poles are fabricated with uniform dimensions from steel conforming to ASTM specifications and tolerances, and have the flexibility to be designed as direct wood pole replacements, or can be engineered to meet any specific loading criteria. They are light in weight and easy to install.

TEP has specific training for handling and use of steel and wood poles. The company also equips linemen and trucks to support both products.

As the TEP crews have become more confident working with steel poles, the speed of installation has increased. On average, a TEP four-man crew can set a steel pole in a little over an hour, just slightly longer than what it used to take to install a comparable wood pole.

Runion emphasizes, "Upfront training is important with any new product and this was true with steel. I recommend getting construction involved early in the process; they will play a key part in your success. Spend time with other companies that have successfully changed to steel. You don't need to reinvent everything. Learn from others."

## A Consistent Use of Best Practices

Throughout TEP's transition to steel poles, the utility has developed some best practices.

In terms of special precautions, TEP has changed its center phase insulator to a bolt top design to eliminate the need to spin a preformed tie wire near the steel pole. Short pole guards are used with rubber blankets to cover the pole when transferring phases. TEP does not mount wood x-arms on steel poles, believing that the use of manufactured products together in a unit makes more economic sense over the life span of the unit. They also don't climb steel poles. Therefore, steel poles are not used in areas with limited access.



TEP uses greater mil thickness than the industry designed standards on the embedded portion of the pole, taking special care to understand the geotechnical aspects of the soils in order to avoid corrosion over the lifetime of the pole.

Roger Hall, Standards Group Supervisor for TEP, says, "When we first started using steel poles, we thought the weathering steel would not corrode at greater depths in the ground. So we'd leave the bottom four feet of pole untreated to provide a better earth ground. That seemed to make sense until we saw some unexpected corrosion of the unprotected portion of the pole butt."

After advice from the coating manufacturer and some extensive testing on poles with and without coatings, TEP found that 40-mils of coating 18" above the ground line fully coated in the embedded portion is optimal.

"Coating is such a small price to pay to enhance the long term durability of a pole. It's also worth it to us to spend the extra money on a thicker coating to safeguard against chipping during the delivery and installation," says Hall.

TEP, like other utilities in the southwest, is concerned with electrocution of protected species of birds and has modified distribution configurations, whether wood or steel pole-based, to minimize the threat to wildlife. Typically, this modification on 3-phase construction consists of applying raptor hoods over the center phase conductor. TEP also uses cover up on the equipment attached to the pole and 1000 volt wire is used to provide protection for wildlife.

Finally, TEP looked closely at the sustainability of weathering steel poles.

Ken Wright, Lead Superintendant of Transmission Maintenance with TEP says, “Steel poles are entirely recyclable. Wood poles on the other hand have been treated with preservatives and therefore must be handled per disposal guidelines. Even though they’re a natural material, there are certain restrictions and costs associated with disposal.

### Hardening the Line



Since moving to steel poles almost exclusively, TEP has noted improvement of system reliability. Wind is the most severe natural power system problem on our system.

Majid Farahani, Superintendant of Civil/Transmission Engineering with TEP explains, “It is very common for us to see a micro-burst or a concentrated gust of wind that happens during monsoon storms. Sometimes we will see house roofs blown off on one side of a street and on the other side of the street trash cans will not even be tipped over. When a microburst occurs at a pole line, and the pole breaks, our goal is minimize the subsequent cascading effect that could bring down the rest of the line.”

Farahani explains that in, theory, a wood pole of equivalent strength should function the same as a steel pole. “In reality, you can’t maintain such consistency in wood as you would with steel. Therefore, wood poles require higher strength factors as specified by the NESC.”

Wood poles also face loss of strength due to aging and can be weakened by natural causes such as infestation, leading to sudden failures, Farahani said. “Steel is a ductile material and therefore its mode of failure is much more forgiving,” he said.

Hall adds, "We have also had cases where a vehicle slams into a pole. Even in these extreme cases we see the failure mode of steel is better. It basically bends like a kinked soda straw instead of breaking into pieces or pulling other poles down with it." In most cases the pole, though damaged, is still holding up the wires.

Presently 95% of TEP's new distribution poles in inventory are made of steel. Overall, the conversion from wood to steel poles combined with other engineering advancements has helped the utility create a more reliable, durable, safer and sustainable distribution system.

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***For more information about steel distribution poles, contact Dan Snyder, Manager Business Development, AISI's Steel Market Development Institute, (202) 452-7100, or visit <http://lineman.steel.org>. Roger Hall of TEP can be reached at (520) 918-8235 or email him at [rhall@tep.com](mailto:rhall@tep.com).***

