North American Wood Pole Coalition

TECHNICAL BULLETIN

Pressure-Treated Wooden Utility Poles and Our Environment

by Dr. Kenneth Brooks

OVERVIEW

From the concerned homeowner to national environmental groups, questions are sometimes directed at utilities regarding the safety and environmental impact of treated wood utility poles.

Just how much risk is there? To help people understand the issues, the North American Wood Pole Coalition asked internationally recognized environmental toxicologist, Dr. Kenneth Brooks of Aquatic Environmental Sciences, to summarize the science and risks associated with the common wood preservative systems used to treat wood utility poles.

It is estimated that over 100 million pressure treated wooden utility poles are in service in the United States and Canada. The necessity and benefits of this power and communication infrastructure to society goes without question. However, during their decades of service, a portion of the preservative protecting the wood pole, whether it has been treated with pentachlorophenol, creosote, copper naphthenate, CCA, ACQ or ACZA, will move from the pole to the environment. With the environmental awakening of our society, there has been increased focus on understanding and evaluating the human and environmental risks, as well as the benefits, associated with all types of materials and products. This has included pesticides and it is appropriate to ask the question: *What environmental risks are associated with the use of pressure treated utility poles?*

The first line of protection for society is the registration of chemicals, in this case wood preservatives, by the U.S. Environmental Protection Agency or Health Canada. These agencies conduct extensive reviews of the risks and benefits of wood preservatives with heavy emphasis on human and environmental health effects. The wood preservatives in use have all been through this screening, and classified as *general use* (copper naphthenate and ACQ) or *restricted use* pesticides (pentachlorophenol, ACZA, CCA) with specific requirements and regulatory controls for the handling and use of the chemicals; and guidance, through the approval of *Consumer Information Sheets* for the use of the products treated with the preservatives and Material Safety Data Sheets (MSDS) for the products.

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What are the active ingredients used in wood preservatives?

Many of the biocides used in wood preservatives are natural components of the earth's crust and

> "...pressure treated wood utility poles pose no greater risk to the environment than growing the wheat used to bake your next loaf of bread, and present far less personal risk than driving to your local grocery store to purchase that bread."

biosphere. For example, creosote, which has been used to protect wood for nearly 200 years is a mixture of naturally occurring polycyclic aromatic hydrocarbons (PAH) derived from coal. These same PAH are produced by the combustion of organic material associated with forest fires, volcanoes, automobiles, your home's fireplace or barbecue grill and asphalt paving. These PAH have been found in 2,000 year old glacial ice in Sweden. Typically, naturally occurring background levels of PAH are low, in the neighborhood of 10 to 100 parts per billion (by weight) in soils and sediments (Eisler, 1987). Copper Naphthenate is prepared from naphthenic acid which occurs naturally in petroleum products (Brient et al.). Copper Naphthenate is used to preserve new poles and for field treating field cuts and drill holes.

Pentachlorophenol (Penta) has been in use for over 60 years for treating utility poles. It is produced by the catalyzed direct chlorination of phenol. Extensive scientific study has shown that Penta does not persist in most environmental settings as both aerobic and anaerobic organisms, as well as sunlight, effectively degrade the product in soils and water (Brooks, 1998a).

Waterborne preservatives rely on common metals to deter molds, fungi and insects that would consume untreated wood. The relative abundance in the earth's crust of copper, chromium, arsenic and zinc used in waterborne wood preservatives is provided in Table 1. Also included are natural

Table 1. Natural background levels of wood preservative components. All of the concentrations given are in milligrams of metal per kilogram of soil or water (parts per million). The metals are listed by relative abundance in the earths crust, with the ranking shown in parentheses.

Metal	Mean for earth's crust	Range in soil concentration	Range in water concentration
Chromium (21st)	100	5-2,000	0.003-0.084
Zinc (23rd)	132	5-2,000	0.005-0.650
Copper (25th)	70	1-300	0.001-0.105
Arsenic (47th)	5	2-200	0.001-0.200

background levels typically found in undisturbed environments for these metals.

Obviously, these metals are everywhere. Chromium, zinc and copper are essential trace elements for the proper functioning of our bodies. The same may be true for arsenic. We also know that these same chemicals, while helpful or benign at normal exposure levels, can be poisonous to plants or animals at high concentrations. We cannot, and need not, eliminate these chemicals from our environment. What we do need to do is manage the increases caused by human activity so that they don't reach toxic levels for man or the biological community.

What are safe levels of wood preservatives in soil and water? The answer to this question could be applied to any of the multitude of products that contain these same metals, PAH, or chlorinated phenols. Because these materials are so widely used, they have been well studied and regulatory agencies have defined benchmarks describing safe levels. A range of soil quality and drinking water benchmarks developed by various government jurisdictions from around the world are provided in Table 2.

Table 2. Soil and drinking water guidelines. All values are expressed in mg/kg or mg/L (parts per million).

Environment	Arsenic	Chromium^{III}	Copper	Zinc	Total for 13 PAH	Penta
Residential	0.38-100	600-7,500	130-26,000	2,200	0.90-2,260	2.4-11.0
Commercial/ Industrial	3.00-300	190,000	660,000	56,000	26.00-38,752	12.0-610
Drinking Water	0.025-0.050	37.00	1.30	5.00	0.20-0.30	0.001-0.003

How much preservative is lost from utility poles? Pressure treated utility poles can be preserved with creosote, pentachlorophenol, copper naphthenate, CCA-C, ACZA or ACQ-B. Small amounts of preservative do leach or migrate from each of these types of treated wood. The exact amount of preservative lost depends on how well the wood was treated, how old it is, and the environment around the pole.

Most of the metal losses from CCA-C, ACZA and/or ACQ-B occur during rain events. While each of these preservatives behaves somewhat differently, the environmental risks are similar and the following discussion focuses on CCA-C, because that is the most well studied waterborne preservative. A typical CCA-C treated utility pole will be 40 feet tall and will average 10 inches in diameter. For each hour that this pole is completely wetted by rainfall, it will lose an average of 0.000141 grams of arsenic, 0.000077 grams of copper and 0.000020 grams of chromium (Lebow et al., 1999). ACZA behaves very similarly to CCA-C in terms of metal losses (Brooks, 1997b). ACQ-B does not contain arsenic or chromium but loses more copper than the other preservatives

(Brooks, 1998b).

To put these numbers into better perspective, a CCA-C treated utility pole that is continually wetted will lose an average of 1.44 grams of copper each year during its lifetime. A penny contains 2.5 grams of copper and each pole contributes about a penny's worth of copper to the environment every two years. Utility poles are not continually immersed in water and the actual losses are likely far lower—perhaps the equivalent of a penny's worth of copper for every 20 poles each year.

Preservative losses from pentachlorophenol and creosote treated poles are a little more difficult to predict. Losses associated with rainfall are very low at 7.75 x 10^{8} grams per utility pole per hour of rainfall for pentachlorophenol and 0.06 grams of PAH per creosote treated utility pole per hour of rainfall (Brooks, 1997a). However, because these preservatives remain in a more liquid state within the wood cells, movement of preservative down the pole can be anticipated as a result of gravity. This will sometimes result in an accumulation and darkening of the soil around the base of the pole. The rate of these losses depends on the temperature. However, as will be seen, the preservative remains within a few inches of the pole.

What are the environmental concentrations of wood preservatives found around utility poles and do these concentrations pose significant risks? Utility poles are generally located in upland areas. Numerous studies have described the concentration of preservative in soils around these poles. Subtle differences in the distribution of preservative concentrations are associated with soil type (clay, silt, loam, sand, etc.), pH of the rainfall, amount of sun exposure, etc. The following discussions describe typically observed soil concentrations of metals from CCA-C as representative of waterborne treatments and from pentachlorophenol treated poles as representative of the oil type treatments.

Waterborne treatments (CCA-C, ACQ-B and ACZA). Cooper and Ung (1997) described the distribution of metals around CCA-C treated utility poles that had been in service for seven years. Figure 1 indicates that highest metal levels were observed immediately adjacent to the pole (0.0 inches). These levels declined sharply and were near background levels at 9.75 inches. There is no evidence of elevated metals at 19.5 inches. Note that even immediately next to the pole, arsenic concentrations are less than the upper government benchmark given in Table 2. In fact,

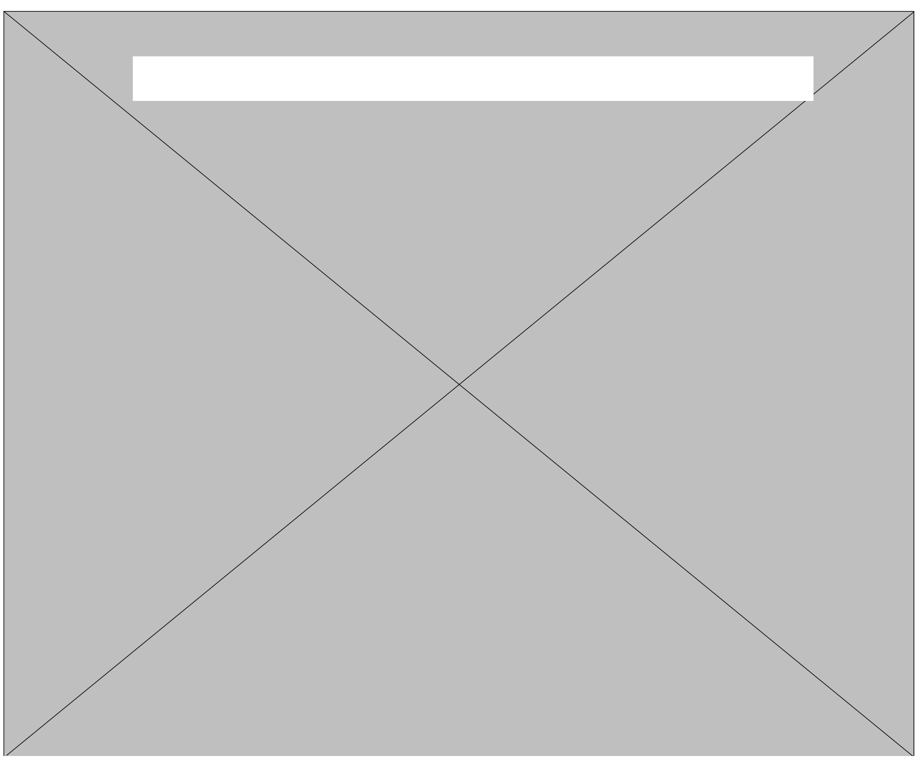

Figure 1.
Soil concentrations of copper, chromium and arsenic in the upper 6 inches of soils adjacent to CCA-C treated red and jack pine utility poles (Cooper and Ung, 1997).

the arsenic content in the upper six inches of soil immediately adjacent to this series of poles was 82.5 mg/kg, just over twice the maximum arsenic concentrations found in crab meat (38 to 40 mg/kg) by several authors.

Arsenic can be fatal in humans at doses as low as 75 to 150 mg per person. To reach this level would require a person to eat one to two kilograms (two to four pounds) of dirt scraped from the area within less than half an inch from these CCA-C treated utility poles. Also note that copper is the only metal that exceeds its benchmark for residential soils and that occurs only immediately adjacent to the pole. Metals are immobilized in most soils and the higher concentrations next to the pole provide an extra measure of protection for the pole. This immobilization also means that there is little likelihood that copper, chromium or arsenic will migrate through the soil into adjacent streams or downward into groundwater. This statement is supported by the findings of Cooper and Ung (1997) who observed that most of the metal was found in the upper six inches of the soil and at horizontal distances less than 9.75" from the perimeter of the pole. If metals were not bound to the soil they would have been found further away from the pole and at greater depths.

Pentachlorophenol and creosote treated utility poles. The Electric Power Research Institute (EPRI, 1997) examined 180 penta-preserved poles to determine the distribution of pentachlorophenol in soils around the poles on the surface and at several depths. The mean pentachlorophenol values represented by the lower line in Figure 2 provide a good assessment of environmental exposure. The graph suggests that mean penta concentrations are greater than the residential benchmark within 3 inches of the pole but not at a distance of 8 inches. Significantly elevated mean levels of pentachlorophenol were not detected beyond 8" in this study. Mean concentrations of penta did not exceed the high Industrial Benchmark at any distance. The pentachlorophenol concentrations rarely exceeded either the Residential or Industrial Benchmarks in this study. Only three of the 153 samples collected at 48" were greater than the 10 mg/kg residential benchmark and approximately 90% of all samples were less than 1.0 mg/kg at distances greater than 3 inches from the pole. Lower penta levels were observed in a similar study conducted by EPRI (1995) in New York State.

Preservative lost from creosote treated wooden poles behaved very much like the pentachlorophenol poles with nearly all of the PAH found at distances

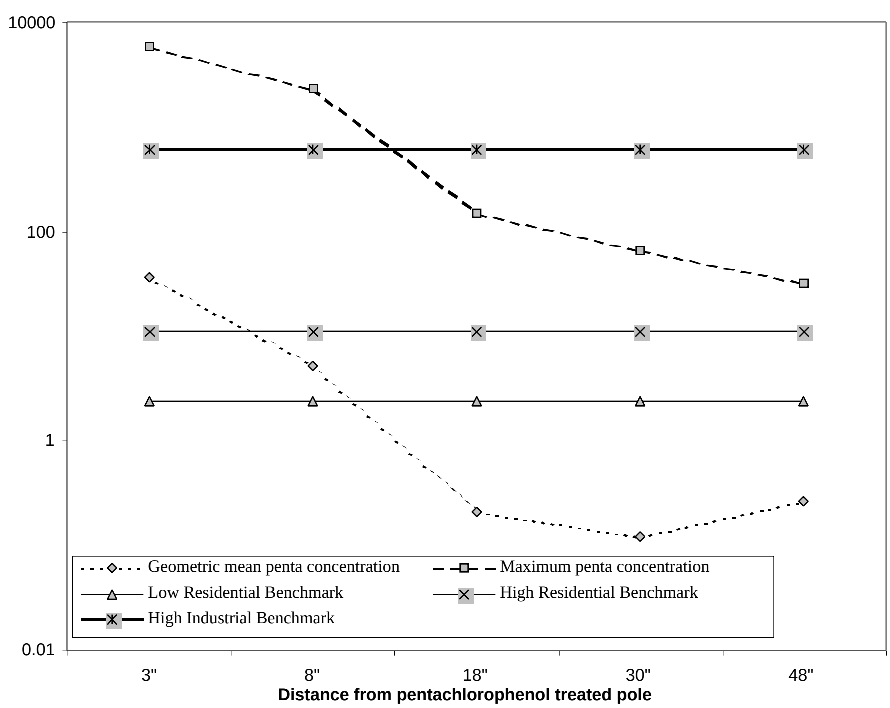

Figure 2. Pentachlorophenol concentrations in soils adjacent to pressure treated utility poles. Concentrations are in milligrams of pentachlorophenol per kilogram of soil.

≤ 8" from the perimeter of the poles. Creosote concentrations in soil did not decline as quickly with depth however, as was observed for pentachlorophenol. Both these organic based preservatives will biodegrade and, over time, will decompose to undetectable concentrations.

Use of wooden utility poles in aquatic environments. Streams, rivers and wetlands are considered our most sensitive environments and as such have been the subject of extensive study in regard to appropriate use of treated wood. State and Federal sediment and water quality standards necessary to protect these environments are actually lower (i.e. more restrictive) than the human exposure based standards in Table 2. Extensive scientific studies have documented that when treated wood structures (piles, poles, docks, boardwalks, bridges, etc.) are placed in water flowing at even very slow speeds, the small amount of preservative lost from pressure treated wood is diluted and/or degraded so quickly as to pose no threat to aquatic organisms. Research also indicates that special care should be taken when significant numbers of poles are placed in sensitive wildlife habitats where the water is stagnant. Risk Assessment Models have been developed to evaluate such situations and can be obtained by contacting WWPI.

Conclusions. There are environmental risks associated with everything we do and with all of the materials used to construct utility structures. For instance, Morris (1998) documented the leaching of zinc from steel utility poles and found concentrations around two of five poles that exceeded the Canadian Council of Ministers of the Environment (CCME, 1997) benchmark of 200 mg zinc/kg soil for residential and agricultural use.

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It is a basic truth that essentially every human activity — from the soil erosion associated with growing the wheat for a loaf of bread to producing the power that runs our appliances — has an associated environmental cost and risk associated with it. As environmental management matures in North America, we will better understand that, lacking an ability to eliminate risk, well educated societies everywhere will turn from the polemics of risk aversion to the more proactive and fruitful task of risk management.

Automobile travel is certainly *Risky Business*. We manage those risks with stop signs, speed limits, air bags and a host of rules that, if followed, can make any journey much safer — but not risk free. Appropriate rules are also required to manage the environmental risks associated with our utility infrastructure. Years of research and experience have developed a strong basis of science supporting a conclusion that properly produced and used utility poles pose minimal and totally manageable environmental risks.

- The Utility industry can assure worker safety and environmentally appropriate use by carefully adhering to the guidelines in the *Consumer Information Sheet* and the MSDS for the treated wood product provided by the producers.
- Utility poles removed from service can appropriately be reused for landscaping and other non-structural applications by the public. Utilities should ensure proper transfer of ownership and should supply a *Consumer Information Sheet* to the new owner.
- Computer risk assessment guides are available for evaluating uses in especially sensitive aquatic environments where the treated wood utility poles need to be carefully managed.

Following these simple guidelines can insure that the long history of safe pressure treated wood use continues into the future. Properly produced and used, pressure treated wood utility poles pose no greater risk to the environment than growing the wheat used to bake your next loaf of bread, and present far less personal risk than driving to your local grocery store to purchase that bread.

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About the Author:

Dr. Kenneth Brooks is President of Aquatic Environmental Sciences in Port Townsend, Washington. Dr. Brooks is recognized internationally for his research, publications and expertise in evaluating the environmental risks associated with the use of treated wood products in aquatic and sensitive environments. He has been a principal researcher in major treated wood environmental evaluation research programs conducted for the U.S. Forest Products Laboratory, the Bureau of Land Management, Environment Canada and private industry. He provides consulting services to the various federal and state agencies such as EPA, National Park Service and California Department of Health as well as local governments, industry and project proponents. Dr. Brooks holds doctorate degrees in Physics and Marine Biology and is a retired Navy combat pilot.

North American Wood Pole Coalition

American Wood Preservers Institute
703-204-0500

Canadian Institute of Treated Wood
613-737-4337

Southern Pressure Treaters Association
703-204-0500

Western Red Cedar Pole Association
800-410-1917

Western Wood Preservers Institute
800-729-9663