

Exponential Corrosion Principle

THE DANGERS OF ELECTRICAL CORROSION

Four Corrosion Phases

Four phases of transmission tower corrosion exist:

Phase I

- Coffee stain rust-cosmetic, not structural;
- 5 percent rust
- Rust appears on edges and bolts
- Approximately 1-2 mils of galvanization remains

Phase II

- Abrasive rust
- Rust appears on bolts, edges and horizontal flat areas
- Rust falls off on touch

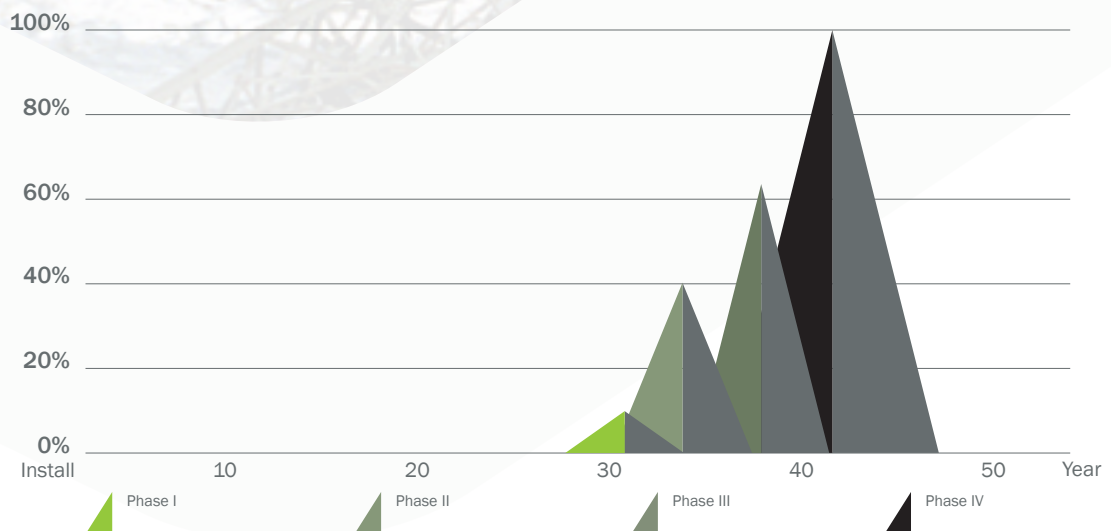
Phase III

- Extensive, abrasive rust

Phase IV

- The tower falls

Corrosion Rate



BOTTOM LINE

SAVINGS THROUGH

ACTIVE MAINTENANCE



Transmission towers and poles are among an electric utility's largest and most important commercial assets. Unfortunately, as the need to generate profits and shareholder dividends has intensified, regular investment in tower and pole maintenance has often been reduced or eliminated to cut costs. Ironically, such cost-saving measures have the potential to double or triple long-term maintenance costs while increasing the risk for power outages and public safety problems.

Exponential Corrosion Principle

More than 3,200 electric utilities operate hundreds of thousands of transmission towers in the U.S. These poles and lattice works of galvanized steel typically range from 50 to 180 feet in height, but can reach 900 feet or more. In the U.S., most of these structures were built between 1960 and 1990, which means they have had or will soon need maintenance and repairs.


Depending on where they are situated, galvanized transmission towers and poles can function for 20 to 35 years before showing the first signs of corrosion. While galvanized steel in rural or desert

settings may remain rust-free for up to 50 years, coatings in salty coastal air or heavy industrial environments may only do so for 15 years or less.

Once a galvanized transmission tower or pole begins to corrode, the corrosion advances exponentially. As the figure on this page indicates, a tower or pole with less than 5 percent rust at age 30 can oxidize to the point of failure within 10 years. More critically, as the tower or pole corrosion accelerates, so can the repair time and labor and materials cost.

LONG-TER

MANAGING AND



Once Phase IV is reached, repairs are impossible and replacement is necessary.

When electrical utilities were deregulated in the late 1980s, many immediately and dramatically dropped resources directed to transmission tower maintenance. Although utilities often owned or maintained thousands of transmission towers and poles, for many the goal shifted from delivering power to maximizing return on investment. As a consequence, many of today's transmission towers and poles need significant repair.

PHASE	TOWER CONDITION	REPAIR REGIMEN	COST PER TOWER
Phase I	Coffee stain rust (cosmetic) 5% rust 1-2 mils of galvanization remain	Minimal Cleaning (5%) One coat of paint One summit of tower	\$2,750
Phase II	Abrasive rust Rust appears on bolts, edges and horizontal flat areas Rust falls off on touch	Cleaning (up to 50 percent) Spot or full primer as needed One coat of paint Two summits of tower	\$5,555
Phase III	Extensive abraasive rust	Cleaning (75 to 100 percent) One full coat of primer One coat of paint Three summits of tower	\$8,883
Phase IV	Tower Falls	Full Replacement Potential environment damage from fires and tower debris	Catastrophic

M COST SAVINGS

BUDGETING FOR REPAIRS



Prioritizing Repairs

As the previous Table illustrates, repairs for Phase III damages can be up to 70 percent more than Phase I repairs. The most effective way to minimize maintenance expenditures is to fix towers closest to transitioning to the next phase.



Long-term Cost Savings

Although utilities maintain thousands of transmission towers, for many the goal shifted from delivering power to maximizing return on investment. Consequently, many of today's transmission towers need significant repair.



Tower Maintenance

In addition to saving millions of dollars, an active maintenance program delivers the benefits of increased employee and public safety, lower risks for black-outs and community approval for towers that are clean and attractive.

Managing and Budgeting for Repairs

When corrosion begins to consume a transmission tower or pole, the key to managing repair costs is to arrest its progress before the unit transitions from one phase of corrosion to the next. For electric utilities, the optimal solution is to repair the entire inventory of towers and poles as early as possible in Phase I, when it is less costly. Unfortunately, that is not possible for most utility companies because of budget constraints and the varied ages of the towers and poles in their inventory.

TRANSMISSION TOWER MAINTENANCE PLAN

Precision Fluid Systems offers a comprehensive maintenance program designed to eliminate the movement of transmission towers and poles from one phase of corrosion to the next.

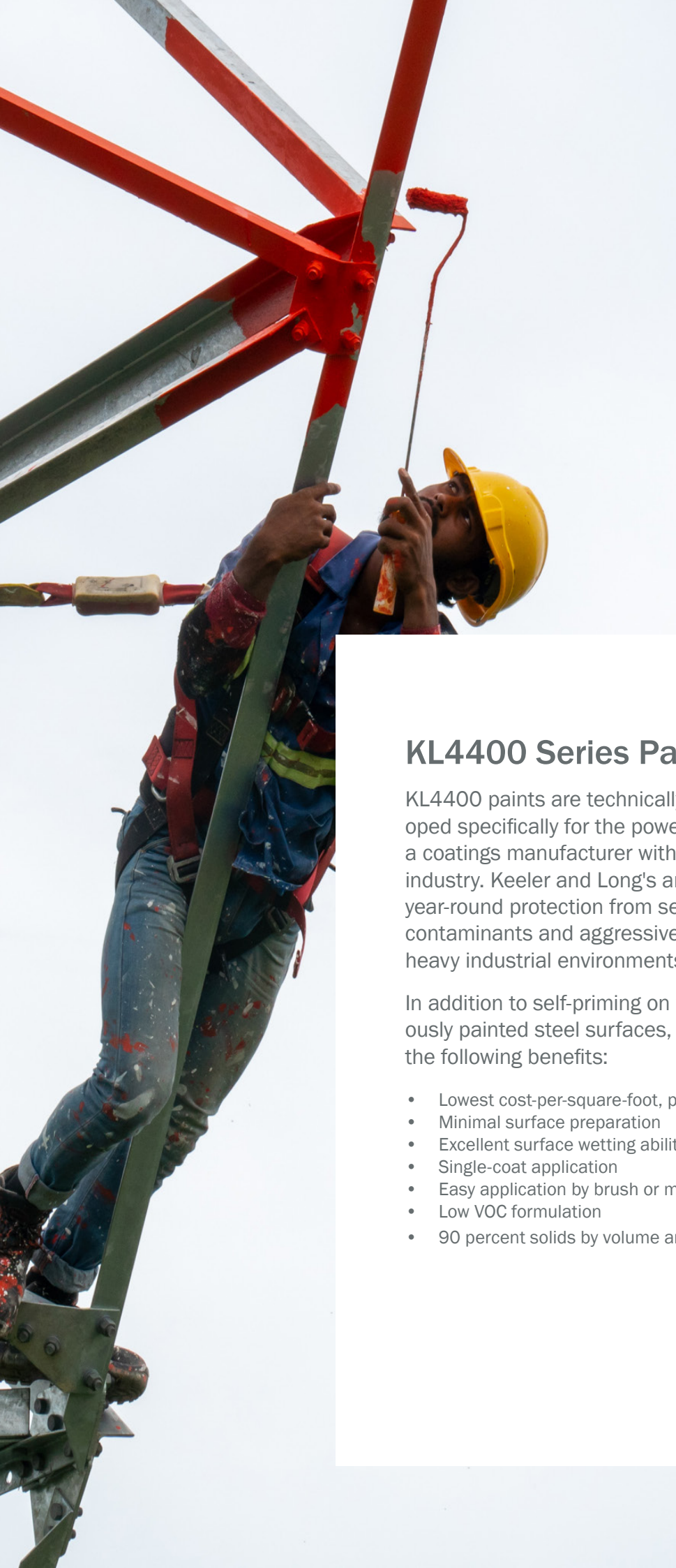
Elements of the program include the following:

- Application of Keeler and Long's KL4400 Series paint, an anodic, self-priming PPG paint engineered specifically for use on electrical transmission towers, bridges and substation structures;
- Free structural grid evaluations, including on-site surveys by trained and experienced PPG personnel;
- Recommendations of trusted and qualified repair contractors;
- Development of maintenance plans, including prioritization of repairs;
- Paint specification proposals;
- Application consultation; and
- Proposed budgets.

Below Ground Inspections

Precision Fluid Systems 's "Eliminate the Movement" program includes thorough underground transmission tower and pole evaluations. Underground sections deteriorate faster than visible sections due to constant exposure to sub-surface moisture, alkalis and other hazards.





KL4400 Series Paint

KL4400 paints are technically advanced coatings developed specifically for the power industry by Keeler & Long, a coatings manufacturer with experience in the power industry. Keeler and Long's anti-corrosive coatings provide year-round protection from severe weather as well as the contaminants and aggressive exposure associated with heavy industrial environments.

In addition to self-priming on weathered galvanized or previously painted steel surfaces, KL4400 Series paints offer the following benefits:

- Lowest cost-per-square-foot, per-year protection
- Minimal surface preparation
- Excellent surface wetting ability
- Single-coat application
- Easy application by brush or mitt
- Low VOC formulation
- 90 percent solids by volume and Single-component.

CORROSION IN ELECTRICAL PANELS

Corrosion at interior components of an electrical panel creates several safety problems





Anti-oxidant paste is required to be applied over exposed aluminum wire at connection lugs in a panel. But, if that is not done or excessive moisture attacks the aluminum, the wiring can overheat and start a fire.

1

Circuit breakers are mechanical devices and, like any mechanical device, corrosion can cause it to freeze up and not trip when too much current is flowing in the circuit. This will overheat the wires and possibly start a fire.

2

Aluminum corrodes into a crystalline white powder and, although aluminum is an excellent conductor, aluminum oxide is an insulator. An example of corrosion forming at aluminum bus bars, along with rust stains

3

Many panels with severe corrosion have a defect that allows water to drip down through the panel box. Rust at the bottom of the interior is a sure sign of water intrusion, and the water draining through the panel box can also cause an electrical short and fire.

Eventually, corrosion will completely destroy the panel box





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