Upgrade Transformer Protection with Optimal Paint Specifications

by **Maria Lamorey**

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Transformer manufacturers are facing many challenges—the looming winter storm season, supply chain challenges, labor shortages and more. While many factors are beyond their control, identifying paints and coatings that offer next-level protection for important metal components is within their purview.

Considering their exposure to extreme weather conditions, outdated and substandard coatings systems can—and do—lead to impairments and disruptions in power services.

The right coating system that offers durability and resilience at every layer of protection can extend the service life of transformers and reduce the risk of coatings-related failures, a move that helps to protect their business and their brand.

It all starts with a detailed and up-to-date paint specification.

Strong Defense Against Corrosion

When it comes to the metal components of a transformer, corrosion is public enemy number one and prevention is the top line of defense.

Metal electrical equipment parts corrode for any number of reasons. Some factors include the intersection of two metals with different corrosion thresholds, or continuous or repeated exposure to high temperatures and humidity from decades in the field, damaging pH (acid) levels, electrolytes, chemicals, and ultraviolet rays from sunlight.

Coatings Specification: The Building Block of Better Protection

If the goal of an electrical equipment manufacturer is to build next-generation components that exceed performance mandates while protecting its brand reputation, paint specifications should be reviewed and updated regularly.

Selecting the right coating system and supplier that utilizes advanced formulations will help transformer, switchgear and other electrical equipment manufacturers outperform competitors, extend the lifecycles of their products, and reduce warranty claims.

On average, finished electrical components are composed of about 70% metal and 30% non-metal substrates. Yet most electrical equipment manufacturers view painting metal as beyond their core competency, despite the importance of high quality protective coatings on the durability and performance of their goods.

written by IEEE, UL, CSA and ASTM when painting and protecting new equipment.

Coatings manufacturers can contribute to the problem by relying on standards dictated by their customer or taking the path of least resistance by continuing with existing solutions instead of exploring more

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While most electrical equipment holds a minimum life expectancy of 20 years, many components are expected to survive 50 years or more. Harsh elements can accelerate corrosion and leave sensitive instrumentation vulnerable during storms and compromise its reliability.

Unfortunately, many manufacturers still combine old "cut-and-paste" specifications that date back 20 to 30 years with current industry-standard regulatory requirements

advanced technologies that are proven to perform better in the field.

The building block of any great coatings system starts with the right specifications. Here are some important factors to consider when specifying products.

Coating type—Coating manufacturers offer a variety of resin chemistries to improve resistance to corrosion and UV exposure, including epoxies, polyesters, urethanes and acrylics, as well as hybrid coatings, which incorporate a combination of resin chemistries. Each have their strengths and weaknesses.

For instance, epoxies are ideal for chemical resistance and mechanical properties, but are lacking in UV resistance and weatherability. Polyesters, urethanes and acrylics all offer exceptional weathering characteristics, but each offers a different benefit, such as great physical properties for polyesters; chip, scuff and mar resistance for urethanes; and exceptional surface appearance for acrylics.

Product codes—Electrical equipment producers should avoid using a specific paint manufacturer's product code. Codes can be ambiguous or difficult to find, as they often change or may be unique to a specific customer. Instead, detail the specific coatings technology the equipment demands (pretreatment, liquid, powder or electrocoat); then detail the resin chemistry of the desired coating.

Color – Establishing and maintaining a standard color can be challenging. It is important to detail an acceptable range of color variation and use a proven and consistent method for determining that the color of a painted parts falls within specification.

- Pantone, RAL, Munsell, and ANSI are color-cataloging systems commonly used for these purposes, although some equipment manufacturers choose to create their own in-house standards. Maintaining color standards is a whole separate topic, so it is best to work with a reputable paint manufacturer to understand the intricacies of creating a color standard and how to detail its parameters in the specification.

The building block of any great coatings system starts with the right specifications. Coating type, product codes, color, gloss, texture, product handling and storage, and performance are some important factors to consider when specifying products.

Gloss – Like the color spec, the gloss range specification can have a big impact on a product's finished appearance. It is important to provide a specific gloss range in a paint specification, as variations in gloss can cause the same color on a piece

of equipment to appear as different shades.

Texture –In the electrical industry, some orange peel (minor paint dimpling) in the finish is considered preferable, as it tends to hide flaws and wear well over time. Regardless, standards for texture types and variation should be written into the paint specification.

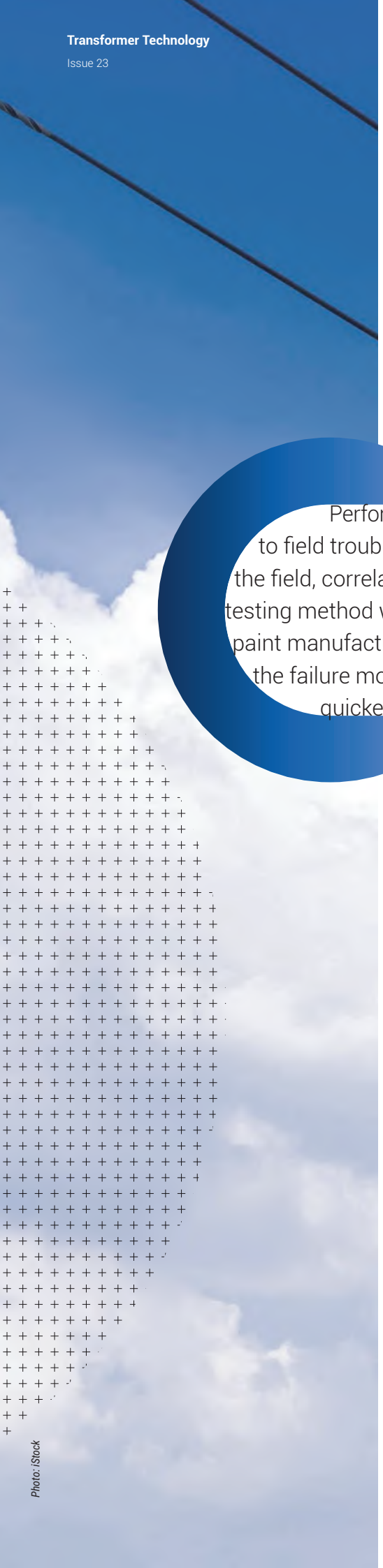
Product handling and storage – Manufacturers suggest specific rules for handling and storage in their product data sheets, including an acceptable range of temperature exposures and fixed expiration dates to ensure inventory is properly rotated.

Performance – Regulatory standards such as UL or IEEE should be detailed in the paint specification. These standards are written to include a range of acceptable results for products undergoing laboratory-based performance tests, which have been agreed upon by the industry for their ability to mimic real-world performance environments.

It is strongly recommended that manufacturers include performance tests that most accurately reflect a product's ability to fulfill a warranty or expected service life into the paint specification.

The Role of Performance Testing

While many coatings systems are robust enough to pass industry-accepted performance tests, they can fail in the field because the real-world conditions can be much more demanding.



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It is strongly recommended that manufacturers include the tests that most accurately reflect a product's ability to fulfill a warranty or expected service life into the paint specification. For example, does a specific impact test predict the likelihood of paint chipping once installed in the field? Or does it depict real-world color fade or coating breakdown with an accelerated weathering test?

Performance testing must correspond to field troubleshooting. If a coating fails in the field, correlating the failure to a specific testing method will enable the equipment and paint manufacturers to identify the reason for the failure more quickly, which can lead to quicker corrective action.

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Some of the most common performance tests written into electrical equipment paint specifications include:

- Salt Spray – This is the most specified test in the electrical industry. UL1332 requires 600 hours of salt-spray exposure for electrical enclosures and switchgear. Many transformers require between 1,000 and 2,000 hours of exposure.

- Ultraviolet Accelerated Weather Testing (QUV) – In this test, coated panels are exposed to ultraviolet (UV) light of varying types, resulting in "maintain X% specific gloss level after X number of hours" rules as detailed in a specification. These tests are designed to predict how a coating will fade outdoors over time.

- Simulated Corrosive Atmospheric Breakdown (SCAB) – In this test protocol, painted panels are scribed, then cycled through exposure conditions produced in the following environments: an oven, a freezer, immersion in an NaCl solution, room temperature, high humidity. The IEEE test for SCAB required 15 total cycles with prescribed times in each area. This testing is designed to predict how well a coating will maintain its integrity when subjected to a succession of regular and extreme performance environments.

- Humidity Testing – During this test, painted panels are typically placed in a chamber for 1,000 hours, then examined for evidence of blistering or softening. This testing is designed to predict how well a coating resists water.

- Impact Resistance – For this test, panels are exposed to an array of impact hazards, measured according to pounds. Transformers are typically tested at 80 pounds of impact. This testing is designed to predict how well a coating will resist force from an object, such as a tool or machine. It also may predict a coating's resistance to chipping when a bolt or other fastener is tightened onto its surface.

- Cross Hatch Adhesion – In this test, a tool is used to cut a lattice pattern into a metal substrate. A quick pass/fail rating is assessed to the full coating system to gauge its ability to adhere to a substrate.

- Gravelometer – Road gravel is air-blasted into coated panels, which are then placed into a salt-spray chamber to assess the corrosion resistance of the exposed parts. This test is designed to predict a coating's ability to withstand road gravel and chip resistance.

Other tests that are occasionally used and built into specifications for electrical equipment include:

- Pencil hardness – During this test, a pencil is pressed through the surface of a coating to measure its adhesive strength.
- Adhesion testing – This test method involves applying tape across a painted surface in a cross-cut method, then removing it to determine how effectively the paint sticks to the surface.

There are also many types of chemical tests, including an insulating fluids test to determine a coating system's ability to resist exposure to certain types of chemicals.

> The different coating technologies include liquid, powder, electrocoat or combination. Selecting the right protective coating helps products look better and last longer, improves application efficiencies and can lower operating costs.

Consider the Optimal Coating Technology: Liquid, Powder, Electrocoat or Combination

Selecting the right protective coating helps products look better and last longer, improves application efficiencies and can lower operating costs. But manufacturers need to consider important factors to determine the best-fit solution for the application:

A complete review of mechanical and chemical pretreatment options, the foundation of every coating system, followed by the pros and cons of electrocoat, powder and liquid solutions. By working closely with the paint supplier, manufacturers can get a clearer understanding of which coating is best, based on performance needs, application ease, environmental considerations and cost.

Liquid coatings use solvents or water and are applied to pretreated metal with electrostatic spray, dipping and other conventional methods before being air-dried or force-cured. When used as part of an integrated primer, pretreatment and topcoat system, liquid coatings offer exceptional resistance to corrosion and chemicals, excellent sag resistance and strong adhesion. Newer product offerings in waterborne liquid technologies offer a more sustainable option as part of an integrated coating layer.

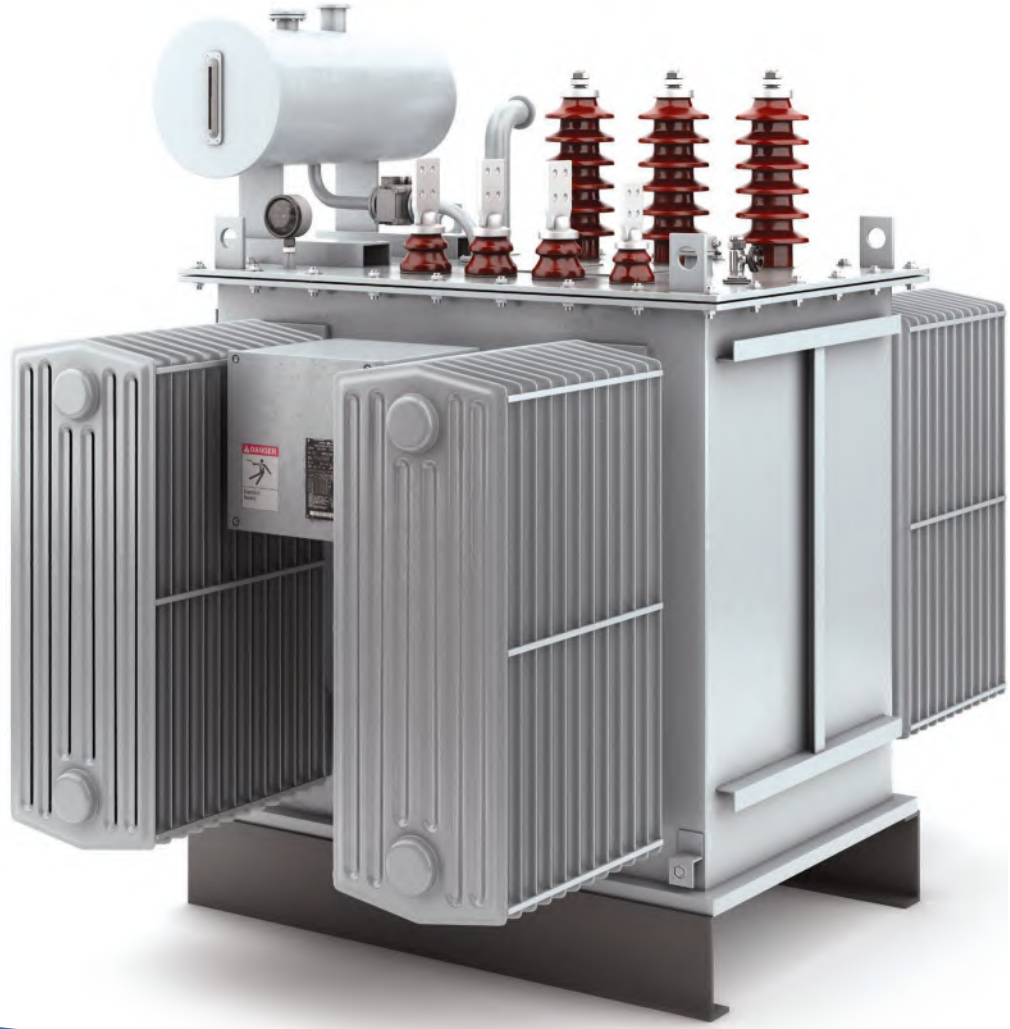
Manufacturers are also increasingly turning to powder coatings for its performance, aesthetic and sustainability advantages. In fact, powder coating is the fastest growing technology due to its performance, aesthetic and sustainability advantages.

Powder coatings are formulated for applications that require the ultimate combination of corrosion resistance, weathering performance and operational attributes. These coatings are typically formulated with specific resins combined to provide excellent corrosion and chemical resistance, as well as all-around application versatility.

Since powder coatings are made without solvents, they generate virtually no volatile organic compound (VOC) emissions, which can help to achieve environmental compliance and reduce material usage, energy consumption and maintenance costs thanks to a first-pass transfer rate of up to 85%.

Newer coatings systems offer an additional layer of protection by combining a liquid primer with a powder topcoat.

Layering is the key to more robust corrosion protection for all the coil coated metal parts on a transformer. Optimal coverage for manufacturers in this space include a two-coat system that features a primer coat for improved corrosion resistance and a top coat for durability and color.



> Equipment manufacturers should involve paint and pretreatment suppliers in the design process as early as possible, preferably with a proven coatings company that can offer both pretreatment and paint capabilities as an integrated package.

Scientists recently developed a **Coil Primer Powder Topcoat (CPPT)** system that replaces the standard DTM process with the addition of a durable liquid primer basecoat.

Coatings Suppliers Make Valuable Partners

Equipment manufacturers should involve paint and pretreatment suppliers in the design process as early as possible, preferably with a proven coatings company that can offer both pretreatment and paint capabilities as an integrated package.

Integrated, full-service coatings suppliers typically have a deep understanding of the entire coatings process, along with a wide range of products and resin chemistries that have been tested according to standard industry criteria.

Coatings suppliers can be valuable partners by helping to identify potential vulnerabilities to corrosion and recommending protect solutions to prevent it.

Most integrated coatings suppliers have a global presence and partnerships that span a wide range of industries. This broad expertise, along with dedicated lab resources, can be invaluable to manufacturers in helping them to identify the best test methodologies to measure a product's potential service life, quickly correct coatings failures and troubleshoot general coatings-related production problems.

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