



UL PERFORMANCE MATERIALS

**ELECTRICAL INSULATION
SYSTEMS AND MATERIALS**

AT THE CENTER OF ELECTRICAL INSULATION SYSTEMS

High reliability and performance are the foundation of a quality product. To achieve this, it is imperative that high-quality electrical insulation systems (EIS) are used when building magnetic devices, including motors, transformers, generators, and solenoids. In general, quality electrical insulation materials that work properly together as a “system” are at the center of magnetic devices.

An EIS is comprised of a combination of closely packed insulating materials that operate at or below the indicated system class temperature. It is important to note that the combination of materials is unique and there is no interchange of components between different systems. The materials used in the design of any EIS must have high resistance to current flow and remain safe during use. As a result, the integrity of insulation components is critical for end-product reliability.

UL focuses on the science, innovation, and success of your designs while following the rigorous EIS safety requirements that must be met during testing and certification. We work to stay aware of the changing market and we use UL, IEEE, and IEC standards to test these types of electrical components.

We designed this testing and certification catalog to better serve EIS manufacturers by providing guidance on the service portfolio UL offers. Involving UL from day one helps guarantee a smooth process from design to material selection to production.





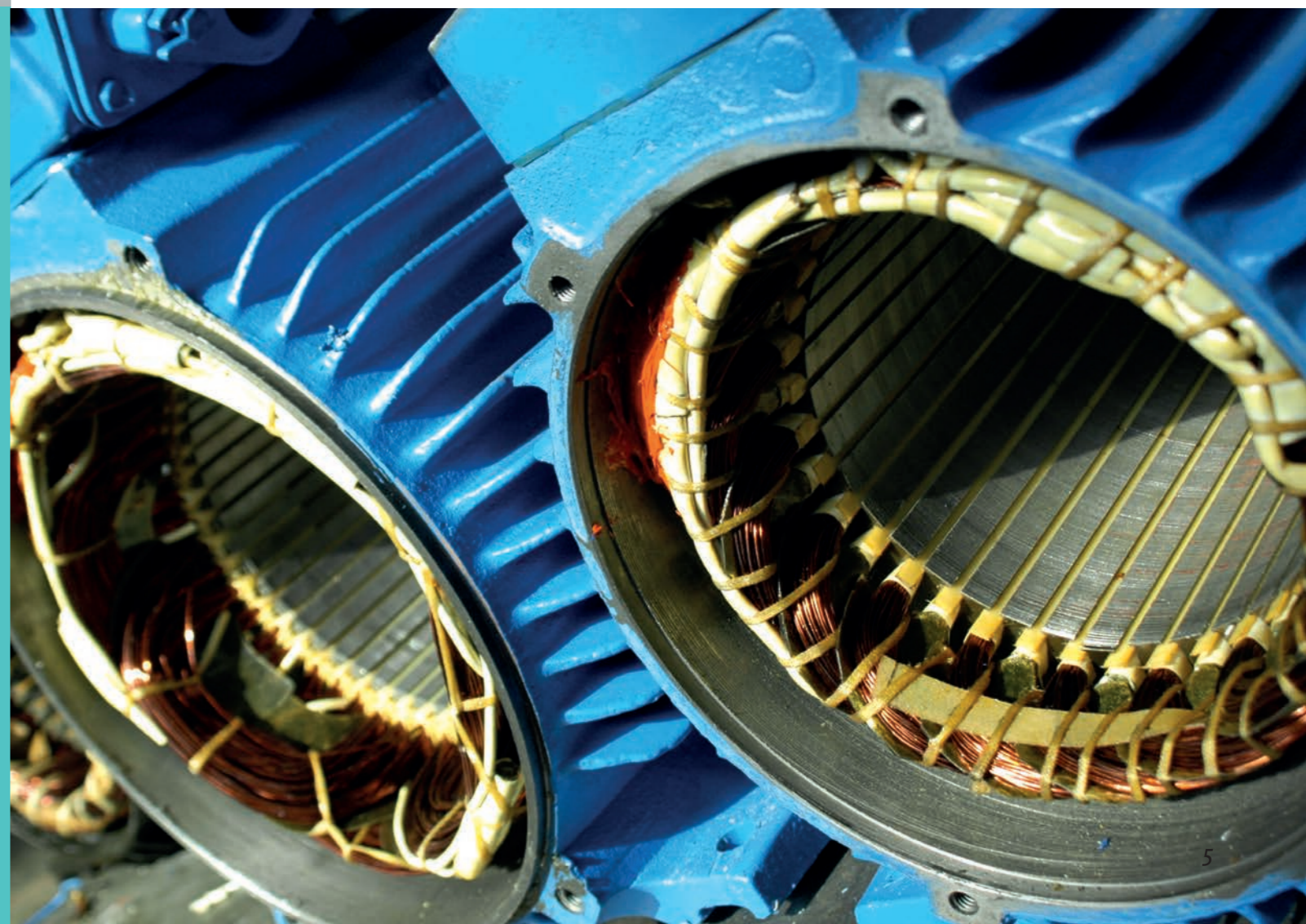
At UL, we test and certify electrical insulation materials (EIM) and electrical insulation systems (EIS) in an effort to help system builders create better final components for end products that function as planned. In this industry, the complete EIS continues to be the primary focus, but understanding EIM certifications can help you understand the material certification process while allowing you to make better decisions for your products.

UL created testing and certification offerings for both EIM and EIS. The offerings are sometimes referred to as “category code numbers” or simply “CCN.” Every alphanumeric CCN describes a specific component category for a specific product and serve as UL’s product category identifier. The CCN for each applicable test offering is included in this catalog.



UL SERVICES PORTFOLIO FOR THE EIS MARKET

An evaluated EIS provides long-term performance reliability and safety protection from electrical shock and fire hazards. The purpose of a thermal rating in all EIS systems is to establish how high the temperature can be in the device before the insulation materials begin to fail prematurely. Additionally, these ratings show how well the materials will hold up under these high temperature stresses for the life of the device.



EIM TESTING AND CERTIFICATION

High-quality materials are required for a safe, high-performing EIS. UL understands the importance of these materials and, as a result, offers testing and certification so that you can select materials with confidence.

MAGNET WIRE COMPONENT TESTING; OBMW

UL's magnet wire component testing covers the use of a specific wire in applications where the wire alone is being relied upon as turn insulation in magnetic devices including motors, transformers and coils. These wires are evaluated using methods outlined in ASTM D2307 and ANSI NEMA MW 1000 Standards.

This category is intended to establish the interchangeability of magnet wire with similar film coatings and equal or higher thermal ratings in Recognized EIS that have been investigated under the thermal aging programs of UL.

MAGNET WIRE COATINGS; OBNT

Safety is critical when copper or aluminum wire is coated with a very thin layer of insulation for use in EIS. When magnet wire is used in the construction of transformers, inductors, motors, electromagnets, and other applications that require tight coils of wire, the wire is classified by temperature class, insulation

class, diameter or area. In most cases, these areas of concern define the selection and specification of the magnet wire to be used in the product.

UL tests magnet wire coatings to evaluate them with respect to their chemical composition and temperature index. The purpose of this category is to demonstrate that magnet wire produced with these coatings meets specific requirements for OBWM certification and allows for a reduction in the testing necessary to establish the certification.

PLASTICS; QMFZ

UL evaluates plastics for electrical tracking, ignition characteristics from various thermal and electrical sources, flammability, and other electrical, physical and mechanical characteristics. In addition, the effects of long-term exposure to elevated temperature (air-oven aging), water, ultraviolet light, cold, etc., on property retention may be investigated. This information can be used to help determine how a plastic material may perform under various independent conditions.

VARNISH COMPONENTS; OBOR

When using a varnish for EIS applications it's important to select a varnish that safely meets the specified requirements.

UL is a leader in testing EIS and can help you ensure that the correct varnish is tested for the correct application. Varnish manufacturers can use to this category to get their products certified and tested for use in EIS applications.

LAMINATE CONSTRUCTION DETAILS FOR INSULATION SYSTEMS – COMPONENT; OBFQ

This category covers the material traceability of fabricated laminated sheet insulations for use as major components in a Recognized Component EIS when these materials can only be identified at the manufacturer's location. Materials covered under this category are intended to eliminate the uncertainty of the polymeric material identity and its construction details in the end-use product. In addition, this recognition provides the opportunity for laminate material representation and a possible reduction in the testing required to add these laminates to an EIS.

SINGLE- AND MULTI-LAYER INSULATED WINDING WIRE – COMPONENT; OBJT

This category covers insulated wire intended for use in transformers that do not normally have interleaved turn or interwinding insulation. When evaluated in an EIS thermal aging test, these insulated wires do not require additional Ground or Interwinding Insulation. In addition, the insulation provides basic, supplementary or reinforced insulation in wound components in Class A, E, B, F and H insulation systems using round winding wire when evaluated as wound components in ANSI/UL 60950-1 Annex U, "Information Technology Equipment – Safety – Part 1: General Requirements," and UL 60601-1, "Medical Electrical Equipment, Part 1: General Requirements for Safety."

EIS TESTING AND CERTIFICATION

The individual materials in a successful EIS must perform well, but for a truly successful EIS all the materials must perform well together. Full EIS testing and certification at UL is the only way to guarantee that performance, safety, and overall product longevity will meet expectations.

ELECTRICAL INSULATION SYSTEM; OBJY

When testing is required for the user of magnetic electrical insulation systems – including motors, transformers, and solenoid coils – UL offers certification services. This certification is applicable for UL Recognized insulation systems used in facilities where coil is produced. These systems are either evaluated for the product manufacturers (OBJY) or adopted from an insulation system component supplier (OBJS).

System components for electrical insulation systems that are available for adoption by motor, transformer or coil manufacturers can be quickly identified in UL's online EIS database.

DID YOU KNOW?

Certification under OBJY makes it possible to extend certification to **IEC 60085** without additional testing under UL's ODCA category. This certification is possible because the **UL 1446** thermal aging test method is from the **IEC 61857** standard.

ELECTRICAL INSULATION SYSTEM COMPONENTS; OBJS

When a completed EIS is submitted for investigation to UL, all components must be evaluated. This is the insulation system category for the supplier of a material that will be used in the construction of an electrical insulation system.

It is important to note that these components are deemed incomplete in certain constructional features or restricted in performance capabilities but are intended for use as components of complete equipment submitted for investigation. In other words, these insulation systems are intended for use by end-product insulation system manufacturers in constructing equipment with complete electrical insulation systems that will be submitted to UL for Recognition under Systems, Electrical Insulation (OBJY).



STANDARDS UTILIZED FOR LOW TO HIGH VOLTAGE EIS



LOW-VOLTAGE EIS

- **UL 1446 Standard** For Systems Of Insulating Materials – General

UL 1446 evaluates random wound, low-voltage applications commonly used in motors, solenoids, etc. This test is conducted by aging motorettes, or general-purpose models, at three or more elevated temperature cycles with intermittent dielectric proof testing. After each cycle, samples are also subjected to a repeated series of environmental exposures such as cold shock, mechanical stress and humidity. Reduced test programs of one- or two-temperature thermal aging's or sealed tube testing may be done to evaluate modifications to an existing EIS.



MEDIUM- AND HIGH-VOLTAGE EIS

- **IEC 60085**, Electrical Insulation – Thermal Classification.

- **IEC 61857** (All Parts), Electrical Insulation Systems – Procedures for Thermal Evaluation

- **IEC 60034-18-31** Functional evaluation of insulation systems – Test procedures for form-wound windings – Thermal evaluation and classification of insulation systems used in rotating machines

- **IEEE 1776 – IEEE** Recommended Practice for Thermal Evaluation of Unsealed or Sealed Insulation Systems for AC Electric Machinery Employing Form-Wound Pre-Insulated Stator Coils for Machines Rated 15,000 V and Below.

IEEE 1776 and IEC 60034 evaluates EIS that use form-wound windings and are commonly used in high-horsepower motors and wind turbine generators. Testing involves the use of representative models referred to as “formettes.” These formettes hold small-scale, form-wound coils. Thermal heat cycling, mechanical stress and humidification exposure are followed by dielectric proof voltage tests in order to detect the breakdown of the insulation materials.

- **IEEE C57.12.60 – IEEE** Standard Test Procedure for Thermal Evaluation of Insulation Systems for Dry-Type Power and Distribution Transformers, Including Open-Wound, Solid-Cast, and Resin-Encapsulated Transformers.

IEEE C57.12.60 evaluates the EIS for use in power and distribution transformers. Testing involves thermal heat cycling, cold shock, and humidification exposure followed by a 1.2x50µs positive full-wave impulse test and an induced potential test in order to detect the breakdown of the insulation materials. Tests are conducted on actual transformer coil or a representative model of transformer coil.

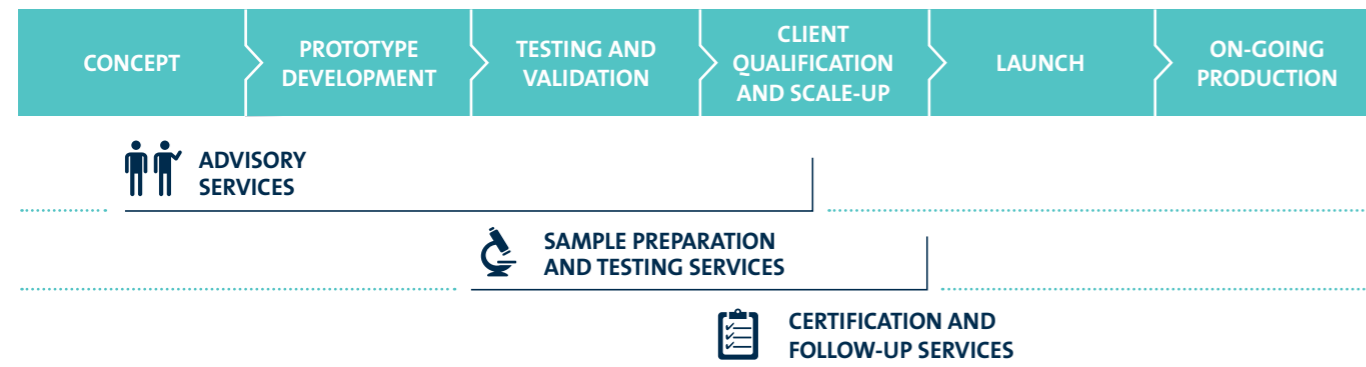
HOW TO GET STARTED

UL certification is a critical market access requirement for product innovation and introduction in North America and globally. UL understands the complexities that exist in this process and, with over 120 years of industry experience and knowledge, we're able to offer services that ease the process of product introduction and help bring your products to market as quickly as possible.

From advisory services to follow-up services, UL enables ease of collaboration every step of the way. UL's complete range of services is modular, allowing you to take advantage of what

works best for your needs. And with this complete array of services in one place, working with UL greatly enhances speed to market, coordinated communication and risk reduction while providing the familiar UL peace of mind. Whether you're ready for certification or you're not quite sure where to begin, calling upon UL provides the knowledge and expertise to help you navigate growing complexities across the supply chain from compliance and regulatory issues to trade challenges and market access.

PRODUCT DEVELOPMENT CYCLE



SERVICES PORTFOLIO

ADVISORY SERVICES

Several decisions must be made when pursuing certification and, with UL, you'll find that navigating this process saves you time and money. UL understands that customers faced with these challenging decisions have unique needs and interests and we make everything before certification easier than ever by offering complete advisory services to guide you every step of the way.

UL's high tough consultative advisory service offerings provides:

- Market Insights
- Market Entry Training
- Product Differentiation Planning
- Platform Review
- Program Assessment

DELIVERABLES

REPORT TRAINING ADVISORY

SAMPLE PREPARATION AND TESTING SERVICES

UL's global network of dedicated testing facilities and laboratories allows us to deliver innovative, customized solutions that streamline sample preparation and testing for customers accessing markets around the world. UL's sample preparation and testing services offer a complete portfolio of functional and engineering evaluations of raw materials and finished products. Testing is designed to provide measurable performance data and, if needed, actionable business intelligence to help with screening, performance data, and on-going quality verification.

UL's performance testing includes the following:

- Motterette sample preparation and assembly
- Plastics compounding and test specimen production
- Physical material testing (mechanical, impact)
- Electrical and flammability material testing
- Analytical testing
- Testing to failure
- Benchmark and comparison testing
- Root cause failure analysis
- Predictive modeling
- New test method development/recommendations

DELIVERABLES

REPORT

CERTIFICATION AND FOLLOW-UP SERVICES

To establish certification, samples of a product submitted by manufacturers for certification are evaluated at UL. If UL determines the product fulfills all applicable requirements, it authorizes the manufacturer to apply a certification mark to production of the samples submitted, or issues a certificate or notification that the product is now certified by UL. A report of the evaluation is provided to the manufacturer. Before the manufacturer releases products with a certification mark, the manufacturer must agree with UL's Follow-up Service procedure.

UL's Follow-Up Services distinguishes UL from other certification service providers and is fundamental to the integrity of the UL Mark that appears on 21 billion products annually. For a product to bear a UL Certification Mark, it must not only comply with the applicable requirements when initially evaluated but also maintain compliance with safety requirements as it is being produced on an ongoing basis. Throughout the lifetime of a product's UL certification, it must undergo regular inspections and/or sample selection at manufacturing facilities to verify continued compliance with requirements. Manufacturers and UL share the common goal of seeing only those products fully complying with applicable safety requirements are produced and carry the UL Mark.

Certified products are added to UL's Online Certification Database (ul.com/database) or iQ for Electrical Insulation Systems database (iq.ul.com/systems). UL's databases brings immediate visibility to your certified products as thousands of designers, engineers, and suppliers search and utilize our databases monthly to verify important safety critical features. In addition, UL product certification is a valuable marketing tool allowing you to show that your product or company has successfully met stringent standards for product safety.

DELIVERABLES

CERTIFICATE CERTIFICATION MARKS DATABASE

DID YOU KNOW?

Certification under OBJS includes placement in the UL iQ™ EIS database, a robust, easily searchable database of certified EIS systems. (iq.ul.com)

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