



SMMA 2009 Fall Technical Conference

– UL and Motors – What, Why, Where and Who –

This paper will focus on answering these 4 classic questions in the context of Underwriters Laboratories and the Motor industry today.

**What** – What UL has done in the technical evaluation, testing and certification of motors since our last presentation at SMMA in 2006? And what do we have in the pipeline?

- As promised, we wrote, balloted, published and implemented five new Motor Standards.

These are:

UL 1004-1, Rotating Electrical Machines - General Requirements


UL 1004-2, Impedance Protected Motors

UL 1004-3, Thermally Protected Motors

UL 1004-4, Electric Generators

UL 1004-5, Fire Pump Motors

- As promised, these new Standards provide many new compliance alternatives in motor design and construction. For example:
  1. The elimination of fixed requirements for spacings. Now, you no longer need to comply with fixed spacing requirements. We've provided performance-based alternatives.
    - a. For example, instead of fixed clearances, you can alternatively evaluate adequacy either through a dielectric test or an impulse test.
    - b. Instead of fixed creepage requirements:
      - i. You can use materials with better CTI ratings,
      - ii. You can provide better motor sealing to realize a lower degree of pollution and/or
      - iii. You can get credit for components providing a guarantee of reduced likelihood of overvoltage, i.e., MOV's
  2. Elimination of 18-day locked-rotor cycling test for evaluation of NMFP in most motor constructions. Now, the requirements consider the overtemperature protection provided in the motor design to eliminate costly and time-consuming 18-day locked rotor tests.
  3. Replacement of wire gauge and number of turns with wire gauge and DC resistance for follow-up purposes. While it was previously the practice to require periodic repeat of locked rotor testing by UL's Field Inspectors, we now more specifically document the motor design. If the design hasn't changed, we don't retest. This eliminates costly and time consuming quarterly locked rotor tests.

4. Change in motor capacitor requirements to reflect current capacitor technology. Our new requirements now accept dry metallized polypropylene film capacitors rated less than 330 volts without requiring a minimum available fault current (AFC) rating. Additionally, we've reduced the required minimum AFC for all capacitors to credit the current limiting provided by the impedance of the motor winding.
5. Enabling the evaluation of oil coiled motors. We've incorporated a test program that allows the evaluation of the compatibility of insulating system materials with the oil used in oil-cooled motors.
6. Reduction in dielectric test potential for low-voltage motors. Low-voltage motors (those below 42.4 volts peak or 60 volts DC) are now only required to undergo a 500 volt dielectric test instead of the previous  $2V + 1000$ . This potentially translates into smaller, more efficient low-voltage motors.
7. Ability to provide NEMA or IP enclosure ratings for motors. Now you can have your motor evaluated and the enclosure evaluated for NEMA or IP enclosure ratings as part of the same evaluation.
8. As promised, a completely new motor certification program – Listed Motors. For the past 100+ years, UL has never before Listed ordinary purpose motors. For local inspectors and Authorities Having Jurisdiction (AHJ's) this lead to constant questions – is this motor suitable for this use? For Listed motors, this is no longer an issue – Simply Look for the Mark. 
9. As promised, 3 new additional Standards were written, positively balloted (unanimous) and are now imminent to publication. These are:
  - a. UL 1004-6, Servo and Stepper Motors
  - b. UL 1004-7, Electronically Protected Motors
  - c. UL 1004-8, Inverter duty Motors

Let's take these one at a time:

#### **UL 1004-6, Servo and Stepper Motors**

This Standard provides consistent criteria for the evaluation of normal operation. Servos are tested (rating and normal temperature tests) at maximum torque, zero speed and at maximum speed, maximum torque (two operating points). Steppers are tested at holding torque and at maximum speed at pullout torque (again, two operating points).

#### **UL 1004-7, Electronically Protected Motors**

Let's spend some considerable time with this one. This Standard was written to provide clarity, consistency and the most streamlined evaluation of electronically protected motors that is consistent with a high level of safety.

UL's Motor safety Standards are designed to ensure that the motor will provide service reasonably free from the risk of fire, electric

shock or injury to persons over its useful life. Overtemperature protection provided for a motor relies upon the ability of the motor itself, or some external or integral means, to limit motor winding temperatures to a level consistent with the proven ability of the insulating system materials to function effectively over their useful life without premature degradation caused by the effects of excessive heat. Where previously, electromechanical devices were relied upon to provide motor overtemperature protection, increasingly, this function is provided by electronic circuitry. Where this is the case, it is consistent with responsible safety engineering that these circuits are tested and evaluated to ensure that this protective functionality is provided **safely, reliably and consistently** by the circuit through all normal and reasonably anticipated abnormal events over the reasonably anticipated life of the motor and circuit.

The first step in the process of evaluating (or even determining if it is necessary to evaluate) an electronic control that provides safety functionality is to clearly understand the safety functionality required by the end product Standard. Obviously, there is no need to evaluate or verify safety functionality that is not required.

Though there are some common denominators, required safety functionality is generally unique to the end product Standard. One example is:

Washing machines – UL 2157 requires (in part) that the machine, “Stop the movement of all accessible moving parts within 7 seconds”. Generally, this means that when the washing machine lid or door is opened, the drum comes to rest within 7 seconds. Naturally, there are other alternatives:

- a. Some machines lock the door or lid so that it cannot be opened.
- b. Machines may simply, through guarding or other means prevent access when the lid or door is opened.
- c. A simple switch may be used to short the motor windings effectively braking the motor to a stop within 7 seconds.

If however, an electronic control is used to provide this functionality, then this becomes a required or critical safety function for the control.

UL 1004-7 provides a roadmap or blueprint for how electronic motor protection is evaluated. So, as a customer, what can you expect from the evaluation of an electronically protected motor evaluation:

1. First and foremost, you can expect us to work together with you in partnership. Consider us as a part of your design team.

2. Though we are well aware of our responsibility, as a safety organization, to thoroughly and consistently evaluate product safety to our published requirements, we have an equal responsibility to not impede the industries and markets that we serve by evaluating or testing features or functionality unnecessarily; that is, where other product features provide the required safety functionality. While it is very common that products provide several levels of redundant safety features, we will work together with you on two levels:
  - a. First we will discuss what is the required safety functionality for your product, and
  - b. Second, we will discuss together what safety features are already designed into your product so that together, we can determine the most time and cost-effective way to meet the requirements. In short, if we can rely upon a simple switch to provide required safety functionality that is far preferable to engaging in a lengthy and costly evaluation of a microprocessor based control if the two provide an equivalent level of safety.
3. As a world renowned product safety organization, we have wealth of experienced and knowledgeable technical staff in areas of product safety that address every component and sub assembly that make up your product. You can expect that we will draw on these resources as necessary to evaluate your product. What you can also expect is that we will do this in the form of a comprehensive project plan.

For products having electronic controls of some complexity, it is very common that the project will involve project handlers, Reviewers and lab technicians from the motor categories, the control categories and the end product categories; perhaps 9 or more UL technical staff working on your project simultaneously. Such a project will have an owner and the rest are then classified as “subcontractors” to that project owner.

To the greatest extent possible, the “owner” is the point of contact between your company and the UL “subcontractors”. While there will undoubtedly be 3 (or more) test programs and evaluations going on, they will be driven by a single cohesive project plan.

The owner of the project is most naturally the end product project handler and Reviewer. As noted, it is the end product requirements that determine the required safety functionality and it is then the end product team that must determine, through intelligent engineering and collaboration with you and your staff, what will provide that

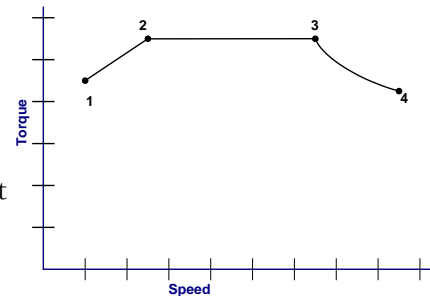
functionality – you are an important part of that decision. Once that has been determined, the end product team owner can develop the comprehensive project plan in conjunction with the UL subcontractors who will in turn, evaluate and test their respective pieces in conformance with the plan.

In short, we will work with you and your staff to ensure the most positive product safety certification process experience that is consistent with our mission: “To be the fastest, highest quality and most customer friendly third party conformity assessment company in the world.”

### UL 1004-8, Inverter duty Motors

This Standard provides consistent criteria for the safety evaluation of Inverter Duty Motors at 4 defined operating points:

- 1 = Torque at minimum declared speed
- 2 = Lowest speed of the constant torque range
- 3 = Highest speed of the constant torque range
- 4 = Maximum declared speed based on constant horsepower and any mechanical limitation on rotational speed



10. We delivered, 32 revisions to the new Standards that are intended to provide **even greater** compliance alternatives Some of the most significant examples include:
  - a. We defined the terms protective control and operating control. This is very powerful. Protective controls are relied upon to provide required safety functionality. Where that required safety functionality is provided by some other means, the control is considered an operating control and the evaluation of an operating control is typically far less costly and time consuming.
  - b. We defined small parts as having a maximum volume of 2cc and a maximum dimension no greater than 3cm. We’ve provided an exception that reads:

Small parts and adhesives need not be investigated if they are:

    - a. not relied upon to maintain the proper functioning of the device with regard to the likelihood of electric shock, fire, and injury to persons, and/or
    - b. not relied upon to maintain separation between uninsulated live parts of opposite polarity, live parts and accessible metal parts and/or uninsulated live parts and earth ground.

This means that small motor parts that have no required safety function but may simply be provided for ease of manufacturing assembly, are not required to be evaluated.

- c. We've allowed a dust test as an alternative to reduce required CTI for materials. If your motor enclosure is dust tight, we recognize that the likelihood of surface tracking of insulating materials is greatly reduced.
  - d. Thermal motor protector (TMP) insulators are no longer required to be part of the motor insulating system. Where our original concern was that incompatibility of the TMP insulator and the insulating system materials could lead to premature insulating function failure, we now recognize that:
    - i. The area of contact is small and thus the likelihood of failure is equally small
    - ii. Typically, such a small localized failure would simply represent a small turn-to-turn failure, not a catastrophic one and
    - iii. If such a failure did occur, the TMP would respond to the localized heating and shut down (fail-safe).
  - e. A non-metallic functional part (NMFP) that has successfully undergone the Locked Rotor Endurance test (LRET), is not required to be further evaluated.
- We're not done yet. We're **committed** to ensuring that our new family of motor Standards continues to be technically current and consistent with current motor design technology. With this in mind, we are proposing 10 new revisions to the just published 5 motor Standards. Some of these we developed internally and others were as a result of our collaborative STP process, they came from motor manufacturer's recommendations. The more significant of these include:
- a. We will formally define the risk of fire and electric shock in Rotating Machinery. Why is this significant? This simple concept is very powerful indeed.
    - i. If your motor (or some part of your motor) is only exposed to voltages less than 42.4 volts peak or 60 volts DC, then none of the requirements and tests related to electric shock will apply to that motor or motor part!
    - ii. Similarly, if your motor or some part of your motor is only exposed to maximum available energy less than 15 watts, then none of the requirements and tests related to the potential for fire hazard will apply to that motor or motor part!

This is extraordinarily powerful and has significant implications for the safety evaluation of motors.

- b. We will propose a requirement that states, “If the motor winding does not exceed normal temperature during the Locked Rotor Temperature Test, then the Locked Rotor Endurance Test is not required. Today’s motors are designed to be more efficient and to run cooler. This requirement gives recognition to the reduced likelihood of premature insulating material failure experienced by cooler running, more efficient motors by eliminating an 18-day test.
- c. We are proposing requirements that provided greater alternatives for compliance of motor splices.
- d. We are defining requirements for linear motors.

**So now that we’ve talked about the What, lets talk about the other classic questions.**

So **Why** UL?

**Our Mission** – Working for a Safer World Since 1894

**Our Vision** – To be the Fastest, Highest Quality, most Customer Friendly Certification Organization in the World! By embracing the concepts of LEAN, DMAIC, Kaizen and Gage R & R, we are moving closer to realizing that vision each and every day.

**Our Standards Development** – “We write the songs that make the whole world sing” – We are not just a test and certification organization, we research, develop and write the Standards that are used and held as models worldwide. Sure there are other test and certification organizations. In the US, we generally write the Standards that they test to. Who would understand them better than the guys (and gals) that wrote them? In the international test and certification arena, UL participates on many, many of the Standards development committees and panels. We have 2 of our technical experts on each and every panel that are responsible for writing the US National Electric Code (NEC).

**Global Market Access** – We provide testing, evaluation and certification services to international Standards (in addition to our own) that provide global market access in 17 major countries

**Where** – Where is UL located?

In short, anywhere that you or your customers are, and then some

We are located in 27 different countries and can service you and your customers in each of those countries in their and your native language and we understand each of those countries rules, laws, cultures and customs.

**Who** – Who do you call? (Hint: Not Ghostbusters)

UL – for technical consultation – UL has Principal Engineers (typically with over 35 years or more in the product safety business) in virtually all product safety categories

UL – for Global Market Access – UL’s team of GMA professionals are standing by to advise you to help you gain market entry abroad.

UL – for training needs – UL University provides a stunning array of in-house training services. Would you rather test defects out and redesign or design safety in from the outset? We can help show you how to do that.

UL – for EMC services. We have extensive state of the art EMC facilities located at various geographies.

UL – for hazardous location services. We provide evaluation, test and certification of hazardous location (explosion-proof) motors.

UL – for Multiple Listing services. Are you an OEM manufacturer? We can help not only with the initial test, evaluation and certification but also with setting up the documents and agreements to ensure that no matter who you partner with to sell your products and no matter what brand name your products will ultimately bear, your customers will know that your product has been certified by UL.

UL – for anti-counterfeiting services. We maintain a significant Department that partners with US Customs to ensure that counterfeit products bearing the UL Mark never make it to the marketplace. Working collaboratively with law enforcement, we have been responsible for the seizure and destruction of hundreds of millions of dollars of counterfeit products. Our policing of our Mark ensures a fair marketplace for your products.

UL – for contract testing for product development, quality assurance, materials testing, etc. We're not just safety. We provide testing and evaluation services whether quality control or incoming inspection to your requirements. Let us work with you.

UL for RoHS programs. We understand RoHS. Let us be part of your RoHS solution.



**Working for a Safer World Since 1894**

**...and striving every day,**

**“To be the Fastest, Highest Quality, most Customer Friendly Certification Organization in the World!”**