[6450-01-P]

DEPARTMENT OF ENERGY

Office of Energy Efficiency and Renewable Energy

[Docket No. EERE-BT-2013-DET-0017]

Energy Efficiency Program for Industrial Equipment: Petition of UL Verification Services Inc. for Classification as a Nationally Recognized Certification Program for Small Electric Motors

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Notice of petition and request for public comments.

SUMMARY: This notice announces receipt of a petition from UL Verification Services (UL) for classification by the U.S. Department of Energy (DOE) as a nationally recognized certification program under 10 CFR 431.447 and 431.448. In its petition, which appears at the end of this notice, UL provides documentation to help substantiate its position that its certification program for small electric motors satisfies the evaluation criteria for classification as a nationally recognized certification program that are specified in 10 CFR 431.447(b). This notice summarizes the substantive aspects of these documents and requests public comments on the merits of UL's petition.

DATES: DOE will accept comments, data, and information with respect to the UL Petition until **[INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**.

ADDRESSES: You may submit comments, identified by docket number "EERE-BT-2013-DET-0017," by any of the following methods:

- Federal eRulemaking Portal: http://www.regulations.gov. Follow the instructions for submitting comments.
- E-mail: CertProgSmElecMotors2013DET0017@ee.doe.gov Include the docket number EERE-BT-2013-DET-0017 in the subject line of the message.
- Mail: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE-2J/1000 Independence Avenue, SW, Washington, DC 20585-0121. Telephone: (202) 586-2945. Please submit one signed original paper copy.
- Hand Delivery/Courier: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 950 L'Enfant Plaza SW, Suite 600, Washington, DC 20024. Please submit one signed original paper copy.

Docket: For access to the docket to review the background documents relevant to this matter, you may visit the U.S. Department of Energy, 950 L'Enfant Plaza SW, Washington, DC, 20024; (202) 586-2945, between 9:00 a.m. and 4:00 p.m., Monday through Friday, except Federal holidays. Please call Ms. Brenda Edwards at the above telephone number for additional information.

FOR FURTHER INFORMATION CONTACT: Mr. Lucas Adin, U.S. Department of Energy, Building Technologies Program, Mail Stop EE-2J, Forrestal Building, 1000 Independence Avenue, SW., Washington, DC 20585-0121. Telephone: (202) 287-1317. E-mail: Lucas.Adin@ee.doe.gov.

Mr. Michael Kido, U.S. Department of Energy, Office of the General Counsel, Mail Stop GC-71, Forrestal Building, 1000 Independence Avenue, SW., Washington, DC 20585-0103. Telephone: (202) 586-8145. E-mail: Michael.Kido@hq.doe.gov.

SUPPLEMENTARY INFORMATION:

I. Background and Authority

Part C of Title III of the Energy Policy and Conservation Act contains energy conservation requirements for, among other things, electric motors and small electric motors, including test procedures, energy efficiency standards, and compliance certification requirements. 42 U.S.C. 6311-6316.[1] Section 345(c) of EPCA directs the Secretary of Energy to require manufacturers of electric motors ``to certify through an independent testing or certification program nationally recognized in the United States, that [each electric motor subject to EPCA efficiency standards] meets the applicable standard." 42 U.S.C. 6316(c).

[1] For editorial reasons, upon codification in the U.S. Code, Part C was re-designated Part A-1.

Regulations to implement this statutory directive are codified in Title 10 of the Code of Federal Regulations Part 431 (10 CFR Part 431) at sections 431.36, Compliance Certification, 431.20, Department of Energy recognition of nationally recognized certification programs, and 431.21, Procedures for recognition and withdrawal of recognition of accreditation bodies and certification programs. Sections 431.20 and 431.21 set forth the criteria and procedures for national recognition of an energy efficiency certification program for electric motors by theDOE. With the support of a variety of interests, including industry and energy efficiency advocacy groups, DOE published a final rule on May 4, 2012, that established requirements for small electric motors that are essentially identical to the criteria and procedures for national recognition of an energy efficiency certification program for electric motors. See 77 FR 26608, 26629 (codifying parallel provisions for small electric motors at 10 CFR 431.447 and 431.448).

For a certification program to be classified by the DOE as being nationally recognized in the United States for the testing and certification of small electric motors, the organization operating the program must submit a petition to the Department requesting such classification, in accordance with sections 431.447 and 431.448. In sum, for the Department to grant such a petition, the certification program must: (1) have satisfactory standards and procedures for conducting and administering a certification system, and for granting a certificate of conformity; (2) be independent of small electric motor manufacturers, importers, distributors, private labelers or vendors; (3) be qualified to operate a certification system in a highly competent manner; and (4) be expert in the

test procedures and methodologies in IEEE Standard 112-2004 Test Methods A and B, IEEE Standard 114-2010, CSA Standard C390-10, and CSA C747 or similar procedures and methodologies for determining the energy efficiency of small electric motors, and have satisfactory criteria and procedures for selecting and sampling small electric motors for energy efficiency testing. 10 CFR 431.447(b).

Each petition requesting classification as a nationally recognized certification program must contain a narrative statement as to why the organization meets the above criteria, be accompanied by documentation that supports the narrative statement, and signed by an authorized representative. 10 CFR 431.447(c).

II. Discussion

Pursuant to sections 431.447 and 431.448, on February 20, 2013, UL submitted to the Department a Petition for "Classification in Accordance with 10 CFR Part 431.447 and 431.448" ("Petition" or "UL Petition"). The Petition was accompanied by a cover letter from UL to the Department, containing five separate sections that included narrative statements for each -- (1) Overview, (2) Standards and Procedures, (3) Independent Status, (4) Qualification of UL LCC and UL Verification Services, Inc. to Operate a Certification System, and (5) Expertise in Small Motor Test Procedures. The petition included supporting documentation on these subjects. Through its cover letter, UL initially asserted that certain portions of its petition were confidential – namely, the Overview, Appendices A, B, and C, and UL's discussion of its qualifications (Item (4) noted above). The Department is required to publish in the Federal Register such

petitions for public notice and solicitation of comments, data and information as to whether the Petition should be granted. 10 CFR 431.448(b). After having reviewed UL's claim for confidential treatment and the materials at issue, DOE has rejected UL's claim and is making the entirety of its submission publicly available to enable the public to comment effectively on UL's petition. A copy of UL's petition and accompanying cover letter have been placed in the docket.

The Department hereby solicits comments, data and information on whether it should grant the UL Petition. 10 CFR 431.448(b). Any person submitting written comments to DOE with respect to the UL Petition must also, at the same time, send a copy of such comments to UL. As provided under section 431.448(c), UL may submit to the Department a written response to any such comments. After receiving any such comments and responses, the Department will issue an interim and then a final determination on the UL Petition, in accordance with sections 431.448(d) and (e) of 10 CFR part 431.

In particular, the Department is interested in obtaining comments, data, and information respecting the following evaluation criteria:

(1) Whether UL has satisfactory standards and procedures for conducting and administering a certification system, including periodic follow up activities to assure that basic models of small electric motors continue to conform to the efficiency levels for which they were certified, and for granting a certificate of conformity.

DOE is also interested in obtaining comments as to how rigorously UL operates its certification system under the guidelines contained in ISO/IEC Guide 65, General requirements for bodies operating product certification systems.

(2) Whether UL is independent of small electric motor manufacturers, importers, distributors, private labelers or vendors. To meet this requirement it cannot be affiliated with, have financial ties with, be controlled by, or be under common control with any such entity.

(3) Whether UL is expert in the content and application of the test procedures and methodologies in IEEE Std 112-2004 Test Methods A and B, IEEE Std 114-2010, CSA C390-10, and CSA C747 (incorporated by reference, see § 431.443) or similar procedures and methodologies for determining the energy efficiency of small electric motors. DOE is also interested in receiving comments on whether UL's criteria and procedures for the selection and sampling of electric motors tested for energy efficiency are technically appropriate and statistically rigorous.

Issued in Washington, DC on May 10, 2013.

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Kathleen B. Hogan
Deputy Assistant Secretary for Energy Efficiency
Energy Efficiency and Renewable Energy

Petition for Recognition

Energy Efficiency Evaluation of Electric Motors to

United States Department of Energy

Requirements as Documented in

10 CFR Part 431 –

Subpart B and Subpart X

State of TEXAS

SS: County of COLLIN

Before me, the undersigned notary public, this day, personally, appeared Michael Shows to me known, who being duly sworn according to law, deposes the following:

On Behalf of UL Verification Services

/s/ Michael Shows

Michael Shows

Director – Global Technical Research

UL Verification Services

Subscribed and sworn to before me this 20 day of February, 2013.

/s/ Terri T. Thomas, Notary Public

My Commission Expires: 2-10-2014

[To view the signed copy of this document, see Docket No. EERE-2013-BT-DET-0017, UL Petition, No. 01, p. 1]

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OVERVIEW –

UL is a global independent safety science company with more than a century of expertise innovating safety solutions from the public adoption of electricity to new breakthroughs in sustainability, renewable energy and nanotechnology. Dedicated to promoting safe living and

working environments, UL helps safeguard people, products and places in important ways, facilitating trade and providing peace of mind.

UL certifies, validates, tests, inspects, audits, and advises and trains. We provide the knowledge and expertise to help customers navigate growing complexities across the supply chain from compliance and regulatory issues to trade challenges and market access. In this way, we facilitate global trade and deliver peace of mind.

In 2011:

- 22.4 Billion UL Marks appeared on products
- 19,909 Different types of products were evaluated by UL
- 563,862 Follow Up inspections were conducted by UL
- 67,798 Manufacturers produced UL certified products
- 104 Countries were home to UL customers
- 3.1 Billion consumers in Europe, Asia and North America were reached with safety messages
- 6,461 Products were certified for Energy Star
- 86.972 Product evaluations were conducted by UL
- 95 Laboratory, testing and certification facilities in the countries within which we operate
- 1,464 Currently published UL Safety Standards
- 46 Countries with UL employees

Today, globally UL is made up of over 11,800 staff of which approximately 2,700 are engineers.

UL today is comprised of five businesses, Product Safety, Verification Services, Life & Health, Knowledge Services and Environment.

Energy efficiency testing is a portion of what UL provides as part of its Verification Services business. UL's verification services provides testing and evaluation such as a full range of photometric testing, illuminating engineering research and development, and lighting test equipment, meeting key mandates for ENERGY STAR®, Natural Resources Canada(NRCan), Zhaga, U.S. Department of Energy (DOE) and DesignLights™ Consortium (DLC) criteria.

Our appliance testing capabilities apply to a wide variety of standards, including ENERGY STAR®, NRCan, Zhaga, DOE and Consumer Electronics Control (CEC) requirements to help manufacturers validate performance claims and compliance with government regulations. Specifically, with regard to electric motors, UL provides testing to:

- US Department of Energy (USDOE) requirements
- Natural Resources Canada (NRCan) requirements
- International Electrotechnical Commission (IEC) requirements
- Certification of motor energy efficiency at a manufacturer's request

This work is conducted in the same facilities, using the same equipment and staff as is UL's product safety work.

UL's product safety certification program is an ISO Guide 65 compliant program as corroborated by ANSI accreditation. An ANSI letter of confirmation/accreditation is provided as part of Attachment 3.

The certification of motors under UL's Energy Verification Service is based upon the satisfactory evaluation and testing to the requirements of the applicable standard. Continued certification is judged through continued surveillance of products at the manufacturing location. The following is a description of the major elements of UL's Energy Verification Service used for qualifying manufacturers' motors.

Application Process

The customer requests energy verification certification of their motors. UL will collect information and provide applications to the customer. Upon receipt of applications UL will assign a qualified UL staff member to be responsible for handling the investigation.

Initial Product Evaluation Criteria

General — The following information is obtained prior to and during the initial visit to the manufacturer's facilities:

(a) Identification of the products being submitted by type, brand name, model designations and, if available, rated yearly energy consumption (kWh/yr.) and any other pertinent information specific to these products.

(b) A summary of test data and information on energy consumption, and product capacity for the products being submitted, obtained in accordance with the applicable Standard.

(c) Information on the test facilities used in obtaining the test data and to be used in verifying the test data—a list of instruments used in making the necessary measurements such as temperature,

electrical, time and power supply, information on calibration and other applicable information on the test room such as the location, source of supply and environmental controls.
(d) Information on the products' design and construction, including the critical product features which would affect the product performance with respect to energy efficiency which must be controlled by the manufacturer in order to maintain a consistent product performance with respect to energy efficiency.

NOTE: All motors accepted for evaluation for energy efficiency must also be evaluated and tested for compliance to UL's applicable Motor Safety Standard(s). This is to ensure not only safety but to ensure the integrity of the efficiency performance.

Test Facility Evaluation

Due to the volume of testing, and the need to demonstrate that products manufactured after the initial evaluation remain in compliance with requirements, UL's Energy Verification Service is designed to make use of manufacturers' test facilities whenever possible. A client may utilize the UL Client Test Data Program or the UL Witness Test Data program as detailed in the UL Client Interactive Manual.

The Witness Test data program includes a review of the test facilities, equipment and competence of personnel conducting the testing. All tests are witnessed by UL staff to confirm the results of the tests.

The UL Client Test Data programs require initial and annual assessments of the clients testing capabilities which includes: the laboratory quality system, physical resources, test equipment, personnel, procedures and documentation of data.

Sample Selection

Representative samples from the manufacturer's production are selected by UL's engineering staff. Representative samples are those that, when reviewed as a group, can adequately represent a line of similar models that use the same major energy consuming components. The objective in selecting representative samples is to obtain sufficient confidence that the series of motors verified meet the applicable energy efficiency standard and regulation while at the same time minimizing the number of tests the manufacturer is required to perform. For a series of motors, samples are selected to represent the entire range of motors. The data collected in the representative samples is reviewed to verify the samples can completely represent the model line. Additional sampling may be necessary to completely represent the model line.

Product Construction Evaluation

The manufacturer's product construction is evaluated to identify the critical construction features that would affect the product capacity and performance with respect to energy efficiency. In addition, the manufacturer's existing quality assurance procedures for controlling critical construction features, as well as the manufacturer's procedures for ongoing production testing, are evaluated to determine that adequate controls are in place to provide consistent energy efficiency.

On-Going Production Testing

Manufacturers test samples of their products as part of their ongoing production procedures to determine continued compliance with the energy efficiency requirements. The number of samples to be tested and the frequency of testing varies for each product type and is dependent on the applicable standard, government regulation, industry practices and number of units manufactured. The manufacturer is required to document the test results, which UL audits as part of each followup visit.

Follow-Up Visits and Testing

UL representatives conduct unannounced inspections at each authorized manufacturing location. Typically, two visits to each manufacturing facility are carried out each year to examine samples of the product and monitor the manufacturers' production and control measures and use of the Energy Verification marking. Whenever possible, the follow-up visits are combined with ongoing safety certification Follow-Up visits. During each visit, samples are selected by the UL representative and tested by the manufacturer at its own or other qualified facility. The test results are compared to the documented test results for the selected products to verify continuing compliance. The number of samples to be tested varies for each product and is dependent on variables similar to those used to determine the number of tests to be performed.

Non-Conformance

For non-conforming test results found during follow-up testing at the manufacturer's own or other qualified test facilities, the manufacturer is required to either remove the UL Energy

Verification markings from non-conforming products or determine the cause of non-conformance and implement one of the following:

(a) Cull the lot to segregate non-conforming products;

(b) Rework the lot to correct the nonconformance; or

(c) Determine that no other sample will exhibit non-conformance.

Certification

After determination that the motors meet the applicable standard and regulation, the applicant is formally notified that they are authorized to apply the UL Energy Verification Mark. A Follow-Up Procedure report is issued that contains identification of the motors found in compliance, electrical and efficiency ratings, critical construction features, test results and Follow-Up testing requirements. A directory listing all the products verified for energy efficiency is published and available to the general public.

Follow-Up Service (FUS) Agreement

In compliance with ISO Guide 65 Clause 13.2 and as a means of control of UL's Energy Verification Mark, the applicant and manufacturer must enter into contract ''FUS Agreement'' with UL Inc. This FUS Agreement defines the conditions for maintaining certification such as access to manufacturing sites, records, follow-up inspections and product re-testing. A client may only apply UL's mark to products that comply with the UL Follow-Up Procedure, described above.

STANDARDS AND PROCEDURES –

FORWARD

General

All staff involved in the evaluation and determination of compliance for electric motor energy efficiency shall be qualified and authorized by the Primary Designated Engineer for Motor Efficiency.

PURPOSE

This guide outlines the criteria used to evaluate electric motor energy efficiency in accordance with the energy efficiency regulations in effect in the United States. This guide is to be used in combination with the EVS Manual for conducting evaluations in accordance with UL's energy verification service and the Federal Register 10 CFR Part 431, subparts B and X.

Links:

Link to eCFR website:

http://www.ecfr.gov

Link to 10 CFR page:

http://www.ecfr.gov/cgi-bin/textidx?

SID=d4b2930b9ca4e669ea7425942886a1b4&tpl=/ecfrbrowse/Title10/10tab_02.tpl

Link to 10 CFR Part 431 page:

http://www.ecfr.gov/cgi-bin/textidx?

c=ecfr&SID=d4b2930b9ca4e669ea7425942886a1b4&rgn=div5&view=text&node=10:3.0.1.4.19&idno=10

SCOPE

Subtype I:

General purpose electric motor that is:

1. Is a single-speed, induction motor;

2. is rated for continuous duty (MG1) operation or for duty type S1 (IEC);

3. contains a squirrel-cage (MG1) or cage (IEC) rotor;

4. has foot-mounting that may include foot-mounting with flanges or detachable feet;

5. is built in accordance with NEMA T-frame dimensions or their IEC metric equivalents, including a frame size that is between two consecutive NEMA frame sizes or their IEC metric equivalents;

6. has performance in accordance with NEMA Design A (MG1) or B (MG1) characteristics or equivalent designs such as IEC Design N (IEC);

7. operates on polyphase alternating current 60-hertz sinusoidal power, and:

a. Is rated at 230 or 460 volts (or both) including motors rated at multiple voltages that include 230 or 460 volts (or both), or

b. Can be operated on 230 or 460 volts (or both); and

8. includes, but is not limited to, explosion-proof construction.

Subtype II:

General purpose electric motor that incorporates design elements of a general purpose electric motor (subtype I) but, has one or more of the following characteristics:

1. Is built in accordance with NEMA U-frame dimensions as described in NEMA MG1-1967 (incorporated by reference, see § 431.15) or in accordance with the IEC metric equivalents,

including a frame size that is between two consecutive NEMA frame sizes or their IEC metric equivalents;

2. has performance in accordance with NEMA Design C characteristics as described in MG1 or an equivalent IEC design(s) such as IEC Design H;

3. is a close-coupled pump motor;

4. is a footless motor;

5. is a vertical solid shaft normal thrust motor (as tested in a horizontal configuration) built and designed in a manner consistent with MG1;

6. is an eight-pole motor (900 rpm); or

7. is a polyphase motor with a voltage rating of not more than 600 volts, is not rated at 230 or 460 volts (or both), and cannot be operated on 230 or 460 volts (or both).

NEMA Design B

A squirrel-cage motor that is:

1. Designed to withstand full-voltage starting;

2. develops locked-rotor, breakdown, and pull-up torques adequate for general application as specified in sections 12.38, 12.39 and 12.40 of NEMA MG1-2009 (incorporated by reference, see§ 431.15);

3. draws locked-rotor current not to exceed the values shown in section 12.35.1 for 60 hertz and 12.35.2 for 50 hertz of NEMA MG1-2009; and

4. has a slip at rated load of less than 5 percent for motors with fewer than 10 poles.

Fire Pump Electric Motor

An electric motor, including any IEC-equivalent, that meets the requirements of section 9.5 of NFPA 20.

Small Electric Motor

A NEMA general purpose alternating current single-speed induction motor, built in a two-digit frame number series in accordance with NEMA Standards Publication MG1-1987, including IEC metric equivalent motors.

NOTE: Terms used are as defined in 10CFR431.12 and 10CFR431.442 in the case of any inadvertent discrepancy, the language of the CFR shall prevail

DEFINITIONS

For a complete list of definitions see http://www.ecfr.gov, 10 CFR 431, Subpart B, Sec. 431.12, and Subpart X, Sec. 431.442.

In addition, the following additional terms may be useful:

Core and Iron Losses – The hysteresis and eddy current losses in the iron

Hysteresis – When a core is subjected to a magnetic field, there is a small residual magnetization that remains on the laminations. When the field reverses, energy is required to overcome this residual magnetic alignment, which then leaves the core charged in the opposite polarity. The energy required to overcome the previous field change is the hysteresis losses. Silicon is typically added to the laminations alloy to reduce this effect.

Stator Losses – The losses in the stator winding

Rotor losses – The losses in the rotor winding

Friction and windage losses – The mechanical losses due to bearing friction and windage

Stray load losses – The additional fundamental and high frequency losses in the iron, strand and circulating-current losses in the stator winding, and harmonic losses in the rotor conductors under load. These losses are assumed to be proportional to the rotor current squared.

Total losses – The difference between the input and output

Input – The electrical power measured at the terminals of the motor

Output – The mechanical power measured at the shaft of the motor

Basic Motor Characteristics:

Synchronous Speed by number of Poles:

Poles	60 Hz	50 Hz (for reference)
2	3600	3000
4	1800	1500
6	1200	1000
8 (subtype II only)	900	750

Basic formula to calculate: $RPM = \frac{(120 \times Frequency)}{} Number\ of\ poles$

BASIC OPERATING PRINCIPLES OF ELECTRIC MOTORS

Electric motors function on the principle of magnetism. In an induction motor, the magnetic field (created in the windings of the stator) induces a current in the rotor. This rotor current causes a secondary magnetic field to be generated in the rotor and the interaction of those two fields cause the rotor to turn.

The rotor is constructed of layers of sheet steel, stacked upon one another. Metal bars are placed within the end rings in a cylindrical pattern. The end rings connect the metal bars, forming a complete circuit within the rotor.

In a standard AC induction motor, alternating current flows into the stator, causing the polarity to alternate between positive and negative. If the rotor is spinning, the bars break the stator lines of force. This creates current flow within the rotor bars, which, in turn, creates magnetic forces operating in circular motion around the rotor bars. These forces move in the same direction as the stator forces, which add to the magnetic field and cause the rotor to continue turning.

Three phase motors

Three phase motors create the rotating field in a manner slightly different than when only a single phase is present. Instead of having one voltage which oscillates, the AC power is comprised of three independent voltages. Each voltage is 120 degrees out of phase from the others (i.e., when the first voltage (V1) is at zero, the second (V2) is near the maximum (in the positive direction) and the third source (V3) is near the maximum (in the negative direction).

The phases change from positive to negative and back again as the AC power cycles. If each phase is connected to an electrically isolated winding of a motor, a rotating magnetic field is generated.

In the United States, AC power oscillates at 60 cycles per second (Hz) between positive and negative (60 Hz). This causes a change in the stator magnetic field, followed by a change in the rotor magnetic field. The change in the rotor lags the change in the stator by 60 degrees. This lag creates a pull on the rotor to move in the direction of the shift, causing rotation.

INTERNAL FACTORS AFFECTING MOTOR EFFICIENCY

Motor efficiency is defined as the ratio between the total usable output power and the total input power, where the input power consists of output power, plus losses.

Heat and friction cause much of the losses in a motor. Motor losses are typically divided into five categories:

1. Core or Iron losses,
2. Stator losses,
3. Rotor losses,
4. Friction and Windage losses, and
5. Stray Load losses (see Fig 1 at UL Petition, No. 01, p. 14).

When all the losses from these five effects are combined, the total power loss of a motor can be calculated.

Power losses are usually observed as heat, which is dissipated from the motor frame. By cooling the motor, a reduction in losses is seen. Motor design modifications that reduce any of the loss in

one of the five categories results in a more efficient motor. In other words, minimizing losses equals maximizing efficiency.

Core (or Iron) Losses

Core or iron losses consist of two components: the energy required to magnetize the steel lamination of the core, and the current losses (I2R) from the (magnetically induced) eddy currents within the core. Core losses account for approximately 25% of all losses.

Core losses can be minimized by using higher grades of steel with lower core loss characteristics or using thinner laminations. Reductions in losses will result from minimizing eddy current losses. Designing motors with longer cores reduces the operating flux density, similarly resulting in greater efficiency.

Stator Losses

Stator losses are caused by the heating of the motor from current flow through the windings (I2R). Stator losses vary directly with the square of the current multiplied by the winding resistance in ohms. Thus, the higher the current flow in the stator, the higher the corresponding power losses. Stator losses are the primary source of inefficiency for motors, typically making up over 33% of all losses generated.

Rotor Losses

Rotor losses are caused by the heating of the motor from current flow through rotor bars and end rings (I2R). Rotor losses, like stator losses vary directly with the square of the current multiplied by the winding resistance in ohms.

Rotor losses can be reduced by minimizing the resistance of the rotor bars and end rings. Using copper conductor bars and end rings can significantly increase motor efficiency (10-20% reduction in losses). This is a relatively unused option since it usually requires manufacturing parts by hand and special dies to cast the parts.

Friction and Windage Losses

Friction and windage losses are comprised of bearing friction, wind friction within the motor, load created from the motor's cooling fan load (if provided) and any other sources of friction or wind in the motor. These losses typically account for less than 5% of all losses measured. Friction and windage losses are not a primary source of loss within a motor. However, use of high quality bearings and long lasting lubricants can help ensure losses from friction are kept to a minimum. Efficient fan designs also reduce loading, thereby reducing losses.

Stray Load Losses

Stray load losses consist of all other losses within a motor. They include leakage created by load currents, manufacturing variations, harmonics, and imperfections in the design of the motor. Stray load losses account for approximately 10% of the total losses generated.

Strict quality control (to maintain consistent and reliable construction) and optimized motor design (use of updated motor design software) can minimize the amount of stray load loss.

EXTERNAL FACTORS AFFECTING MOTOR EFFICIENCY

The first sections related to motor and motor design. There are four additional major factors which influence the motor efficiency once the motor is selected: loading and proper sizing, voltage balance, maintenance and electronic variable speed (variable frequency) drives (VSDs).

Loading and proper sizing

Motors are usually most efficient at or near their designed rating. By selecting the proper sized motor for the application (75-100% of motor load rating), efficiency can be maximized.
You can see in Figure 2 that the efficiency drops off significantly below 50% of rated load and that maximum efficiency does not always occur exactly at 100% of full load.
(See FIG. 2 in UL Petition, No. 01, p. 16)

In addition to proper sizing, choosing the proper type of motor can reduce motor losses. The National Associate of Electrical Manufacturers (NEMA) has guides to help users select design types which maximize efficiency.

Voltage Balance

Voltage balance is another consideration when trying to reduce losses. If the voltage supply is unbalanced, all aspects of motor performance are affected (i.e. current, speed, temperature, etc.).

By ensuring that voltages are balanced, the effectiveness and thus efficiency of the motor will be maximized.

Maintenance

Performing regular maintenance on the motor can help reduce losses from friction (direct bearings, insufficient lubrication, etc.) and windage (broken or dirty fans).

Variable Speed Drives (VSDs)

Lastly, the use of VSDs can offer significant energy savings over using traditional methods of motor/load coupling/matching such as belts, pulleys, clutches and the like. Since the motor is controlled electronically, no moving parts are required. This all but eliminates any losses caused by friction, which can be significant, especially when using pulleys or belts.

In addition, VSDs can control several motors simultaneously, thereby ensuring each motor is operating at an optimized speed or output.

ENERGY EFFICIENCY AND MOTOR SIZE

Typically larger horsepower motors are inherently more efficient; however, it is important to note that the total energy loss can still be significant. In Fig. 3, you see that the total losses for a 300 Hp motor (which is more than 96% efficient) are roughly equal to the total energy input for an 8kW (~10 Hp motor). (See Fig. 3 in UL Petition, No. 01, p. 18)

TESTING PROCEDURE

Data obtained shall be entered into the most current datasheets. For integral horsepower motors, when using the CSA C390 test method, the most current datasheets are:
C390_calculation_sheet (UL)V1.1.1.XLSM

If using the IEEE 112 test method, use the datasheet included as part of the standard. For fractional horsepower motors, when using the CSA C747 test method, use:
C747_calculation_sheet (UL)V1.2.0.XLSM

If using the IEEE 114 test method, use the datasheet included as part of the standard.

Copies of C390_calculation_sheet (UL)V1.1.1.XLSM and C747_calculation_sheet (UL)V1.2.0.XLSM can be obtained from ePublisher or by downloading directly from the UL global documents library. Copies of the datasheets are also included in Appendix A of this document.

If you obtain a correlation factor below 0.90, the test shall repeated. Prior to reconducting the test, the source of error(s) shall be investigated.

SAMPLE SELECTION

The motor manufacturer shall provide test data that is developed using the sample requirements contained in 10 CFR Part 431, Section 431.17(a)(b).

Based upon the data provided, samples will be randomly selected by UL staff consisting of production units. These samples shall represent the range of motors submitted to verify the initial and ongoing compliance. As part of the data analysis, the following factors shall be utilized in determining the number and range of samples to be selected for the verification testing. A minimum of 20% of the manufacturer's initial product submittal shall be audited at the manufacturer's facility, or, if the manufacturer is employing an AEDM, 5 samples of 5 motors (25 motors total) shall be tested and compared with the AEDM predicted results.

Factors to be considered in the selection of samples include (in order of *general* importance), but are not limited to:

1) Volume of production*

2) Margin of compliance (any data that shows nominal efficiency results close to the minimum should be considered)

3) Electrical Ratings (number of poles, voltage, horsepower, - a cross section of samples, but not necessarily the maximum and minimum, shall be considered)

4) Variations in construction (when both open and enclosed motors are submitted, obtaining samples of both are recommended, especially when employing AEDMs)

* - If more than two general types are submitted, a minimum of two of the samples audited shall be the highest unit volumes of production (from the basic types being submitted for review) by the manufacturer in the prior year.

Additional samples for testing may be required if the verification testing shows variations from the manufacturer generated data.

Note: 3 samples of each motor type selected shall be used for verification testing.

ASSESSMENT OF CLIENT FACILITY

During the investigation of a client facility, the following aspects of the manufacturer's testing lab will be reviewed:

Quality System – ISO 9001 or 9002 registered or similar quality assurance program in place

Qualified Personnel – Each technician conducting tests shall be assessed for competency and tests reviewed by an authorized signatory.

Lab Environment – Stable, draft free environment between 10-40°C

Equipment – Proper equipment ± 0.2% full scale accuracy for voltage, current, power and output torque meters, ± 3% for instrument transformers. Instruments for measuring speed shall be accurate within ± 1 rpm.

Calibration – All equipment must be annually calibrated by a body that can provide traceability to a national standard of measurement

Standards – In strict accordance with DOE test procedure 10 CFR Part 431, Section 431.16.

PROJECT COMPLETION

Following the testing of the motors, review of test data and assessment of the client facility, the project handler shall complete the additional steps outlined in the Energy Verification Services (EVS) manual, Chapter 3, Project Completion.

In addition, following the completion of the project, a certificate of compliance shall be sent to the manufacturer indicating compliance with the appropriate standards (i.e., IEEE 112 or CSA C390-10).

APPENDIX A

[Appendix A contains example data recording sheets for UL's Laboratory Data Package for electric motors. See UL Petition, No. XX, pp. 24-37]

APPENDIX B

[Appendix B contains example data recording sheets for UL's Laboratory Data Package for small electric motors. See UL Petition, No. XX, pp. 38-52]

INDEPENDENT STATUS –

UL does not have or maintain any relationship, direct or indirect, with an electric motor manufacturer, importer, distributor, private labeler, vendor, trade association or other such entity, that it believes might appear to create a conflict of interest for the certification program in operating a certification system for determining the compliance of small electric motors with the applicable energy efficiency standards of the US Department of Energy

See Appendix C – Signed and notarized, Statement of Independence.

APPENDIX C

Statement of Independence

UL's (defined for the purposes of this document as the UL family of companies inclusive) work to test and evaluate electric motors to the requirements of the United States Department of Energy requirements as described in 10 CFR Part 431 is handled by UL Verification Services Inc.

To put that in context:

Prior to 1 January 2012, conformity assessment services in the UL family of companies were the responsibility of and used assets and staff of Underwriters Laboratories Inc. This legal entity was founded in 1894 by William Henry Merrill and has operated for over 118 years as an independent testing and certification laboratory for all types of electrical and mechanical equipment. On 1 January 2012 Underwriters Laboratories Inc. transferred the bulk of its assets, staff and intellectual property related to US conformity assessment services to a newly formed, wholly owned subsidiary, UL LLC. Some staff were also transferred to UL Verification Services Inc., in turn, a wholly owned subsidiary of UL LLC. The employees of UL Verification Services Inc. are responsible for US conformity assessment services related to energy efficiency in general and of energy efficiency services for electric motors specifically and of energy efficiency services for compliance to US DOE requirements most specifically. UL Verification Services utilizes technical staff and laboratories of its own and of its parent (UL LLC) in the delivery of these energy efficiency services.

In the interest of full and complete transparency and disclosure, entities within the UL family of companies and indeed divisions of UL Verification Services do engage in advisory and/or consulting services. However, UL has a very strict and documented policy which governs these engagements and that governance is administered at the highest levels of the UL organization. That policy, SOP 00-TC-S0026, Consulting Project Approval SOP, is attached for reference.

UL operates its motor energy efficiency business in strict compliance with the provisions of ISO/IEC Guide 65, which states, in part:
The Certification Body shall ensure that activities of related bodies do not affect the confidentiality, objectivity and impartiality of its certifications and it shall not:
1. Supply or design products of the type it certifies,
2. Give advice or provide consultancy services to the applicant as to methods of dealing with matters which are barriers to the certification requested,
3. Provide any other products or services, which could compromise the confidentiality, objectivity or impartiality of its certification process and decision.

In addition, though, in the conduct of its business, UL is frequently called upon to write and present technical papers and other presentations to industry and/or trade organizations of the electric motor industry, neither UL nor any of its staff engaged in the work of energy efficiency testing to US Department of Energy requirements is a member of any such organization, receives compensation from any such organization except for that compensation directly related to the test, evaluation and certification of electric motors nor does UL or any of its staff engaged in the work of energy efficiency testing to US Department of Energy requirements have or maintain

any relationship, direct or indirect, with an electric motor manufacturer, importer, distributor, private labeler, vendor, trade association or other such entity, or have or maintain any other relationship that it believes might appear to create a conflict of interest for the certification program in operating a certification system for determining the compliance of small electric motors with the applicable energy efficiency standards.

State of TEXAS

SS: County of COLLIN

Before me, the undersigned notary public, this day, personally, appeared Michael Shows to me known, who being duly sworn according to law, deposes the following:

(Affiant's Statement)

/s/ Michael Shows

Michael Shows

Director – Global Technical Research

UL Verification Services

Subscribed and sworn to before me this 20th day of February, 2013.

/s/ Terri T. Thomas, Notary Public

My Commission Expires: 2-10-2014

[To view the signed copy of this document, see UL Petition, No. 01, pp. 54-55]

QUALIFICATION OF UL LLC AND UL VERIFICATION SERVICES INC. TO OPERATE A CERTIFICATION SYSTEM

1. Prior to 1 January 2012, conformity assessment services in the UL family of companies were the responsibility of and used assets and staff of Underwriters Laboratories Inc. This legal entity was founded in 1894 by William Henry Merrill and has operated for over 119 years as an independent testing and certification laboratory for all types of electrical and mechanical equipment. On 1 January 2012 Underwriters Laboratories Inc. transferred the bulk of its assets, staff and intellectual property related to US conformity assessment services to a newly formed, wholly owned subsidiary UL LLC. Some staff were also transferred to UL Verification Services Inc., a wholly owned subsidiary of UL LLC. The employees of UL Verification Services Inc. are responsible for US conformity assessment services related to energy efficiency in general and of energy efficiency service for electric motors specifically.
UL Verification Services utilizes technical staff and laboratories of its own and of its parent (UL LLC) in the delivery of energy efficiency services.

2. The UL family of companies maintain over 100 different accreditations as a product certification body (ISO/IEC Guide 65) or testing laboratory (ISO/IEC 17025) in a wide range of technical and service areas. The following accreditations and other recognitions demonstrate the qualification of UL Verification Services Inc. (along with its parent company UL LLC) to operate a certification system in a highly competent manner, particularly in the field of energy efficiency.

3. Underwriters Laboratories Inc. has been a Recognized product safety certification organization by the US Occupational Safety and Health Administration (OSHA) under the

Nationally Recognized Testing Laboratory program (29 CFR 1910.7) since 1988. (Efforts are underway to transfer this Recognition to UL LLC). The current Certificate of Recognition from OSHA is included as Appendix D. Underwriters Laboratories Inc.'s scope of OSHA NRTL Recognition includes standards for the electrical safety of small electric motors (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, UL 1004-6 – Servo and Stepper Motors, UL 1004-7 – Electronically Protected Motors, UL 1004-8 – Inverter Duty Motors)

4. UL LLC and UL Verification Services Inc. are both accredited product certification organizations to ISO/IEC Guide 65, "General requirements for bodies operating product certification systems," by the American National Standards Institute (ANSI). Both these accreditations are based on previous ANSI accreditation of Underwriters Laboratories Inc. which has been in place for 15 years. The scope of ANSI accreditation of UL Verification Services includes energy efficiency certification services including the EPA EnergyStar program. Based on this ANSI accreditation UL Verification Services Inc. is an EPARecognized Certification Body for EnergyStar as shown at http://corporate.ul.com/depts/accreditation/index.htm. The scope of ANSI accreditation of UL LLC includes the UL product safety certification of small electric motors (same coverage as OSHA NRTL Recognition). The current ANSI accreditation certificates for UL LLC and for UL Verification Services Inc. are included as Appendix E – ANSI Accreditations.

5. The US Department of Energy recognized the Energy Verification Services Program of

Underwriters Laboratories Inc. as a Nationally Recognized Certification Program in a Federal Register Notice dated 27 December 2002 (67 FR 79490). This Energy Verification Services Program has also been under the scope of the above ANSI accreditation for more than 10 years and today is the responsibility of UL Verification Services Inc. While improvements in the program have been made on an ongoing basis the general principles of the program remain the same and this program is the basis for this new petition for US DOE Recognition as a Nationally Recognized Certification Program for small electric motors. UL Verification Services Inc. is responsible for the Energy Verification Services Program and also offers the Energy Efficiency Certification Program. The Energy Efficiency Certification Program utilizes the EPA Energy Star certification process for products not within the scope of the EPA EnergyStar program.

6. ISO/IEC Guide 65 requires all testing laboratories utilized in the certification process to meet applicable requirements in ISO/IEC 17025:2005. As a result, assessment to ISO/IEC Guide 65 for the above accreditations includes assessment of the process used to meet ISO/IEC 17025 by the involved testing laboratories. UL LLC and UL Verification Services Inc. utilize primarily internal resources (including internal audit and management review) to demonstrate fulfillment of ISO/IEC 17025 by internal testing laboratories. Those internal resources and processes are assessed by ANSI and OSHA as part of their ISO/IEC Guide 65 assessments.

7. In addition to internal mechanisms to fulfill ISO/IEC 17025, the internal laboratories involved in UL LLC and UL Verification Service Inc. product certification are accredited to ISO/IEC 17025. Numerous laboratory accreditations are in place for many laboratories. Included with this petition are Certificates of Laboratory Accreditation for the laboratories at Northbrook IL (from

the Standards Council of Canada and International Accreditation Service) and Plano TX (from the International Accreditation Service). These are included as Appendix F – Certificates of Laboratory Accreditations. Many other laboratory accreditation certificates can be provided to show the extensive experience with fulfillment of ISO/IEC 17025.

APPENDIX D

OSHA NRTL Certificate of Recognition

[To view the Certificates of Recognition issued to UL by OSHA, see UL Petition, No. 01, pp. 58-59]

APPENDIX E

ANSI Accreditations

[To view the Certificates of Accreditation issued to UL by ANSI, see UL Petition, No. 01, pp. 60-68]

APPENDIX F

Standards Counsel of Canada and IAS Accreditations

[To view the Certificates of Laboratory Accreditation issued to UL by the Standards Council of Canada and the International Accreditation Service, see UL Petition, No. 01, pp. 69-73]

EXPERTISE IN MOTOR TEST PROCEDURES –

General

UL has been in the business of certifying electric motors since just a few years after the first alternating current electric motor was patented in August of 1890. At present, we maintain well over 10,000 motor certification reports with, on average, 15 models in each report.

UL has been providing Energy Verification certification services since 1995. UL has evaluated motors in sizes ranging from ¼ Hp to 500 Hp using the standards IEEE 112 Test Methods A and B, CSA C390, CSA C747 and IEEE 114 and was one of the first certification organizations to be classified by the US Department of Energy as a nationally recognized certification program for electric motor efficiency (see Federal Register / Vol. 67, No. 249 / Friday, December 27, 2002 / Notices). As of the date of this Petition, UL has certified 518 motors to US DOE requirements and an approximately equal number to NRCan requirements.

Review of the attached Products Verified to Energy Efficient Standards will reveal the number of manufacturers and models that UL currently maintains Listings for in each category. UL Energy Verification Certifications can also be accessed on-line by using the following address: http://www.ul.com/database/index.htm.

Personnel

UL's technical organizational structure is characterized by a hierarchical and robust system of checks and balances.

L1 – Laboratory technicians are assessed and certified to conduct testing and are bound by Laboratory Procedural Guides (LPGs). The guide for energy efficiency work for

electric motors is included in pages 8-22 of this document. The guide serves as an adjunct or practical application guide to the actual technical requirements which are contained in the Standard. The work of L1's is reviewed by L2's.

L2 – Project Handlers are assessed and certified to conduct engineering evaluations to specific product categories and to review the lab results and work of the L1's. In turn, the work of L2's is reviewed by L3's.

L3 – Reviewers are each assessed by The Principal Engineer (PDE) for the product category, in this case, electric motor energy efficiency. Reviewers provide the final review of the evaluation and test and make the final certification decision.

Regional Lead Reviewer (RLR or L4) – UL has one senior engineer in each of its 3 Regions (Europe/Latin America, Asia, North America). It is the responsibility of the RLR to oversee the quality and consistency of work within their Region and to serve as the focus of technical questions or issues arising within the Region. These individuals, from a technical standpoint, report up to the PDE or Principal Engineer for the product category.

Principal Engineer or Primary Designated Engineer (PDE – The PDE for the product category has global responsibility for Standards, guidelines, datasheets, technical training, etc. and serves as the final word on technical questions/decisions arising in the product category. PDEs are further responsible for writing/presenting technical white papers and representing UL in industry organizations and international standards making

committees. PDEs are selected by UL's Global Chief Engineer for technical knowledge and experience in their respective product categories. Out of an organization of almost 12,000 staff, UL has 82 PDEs.

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