IEA Implementing Agreement
4E Efficient Electrical End-Use Equipment
EMSA Electric Motor Systems Annex

EMSA Testing Centres Workshop AGENDA

The Westin Alexandria
400 Courthouse Square
Alexandria, VA, US

Monday 12 September 2011

8.30	Registration	
9.00	Introduction	Chair – Sarah Hatch
9.10	Overview of IEC activities relating to motor test standards and efficiency categorisation	Martin Doppelbauer *KIT*
9.30	Testing best practice towards international harmonisation (overview of the *Guide for the Use of Electric Motor Testing Methods Based on IEC 60034-2-1*)	Andrew Baghurst *CalTest*
10.15	Break	
10.30	Test methods for other motor technologies	Hugh Falkner *WS Atkins*
11.30	Development of IEC 60034-2-3 for the testing of inverter-fed induction motors	Andrew Baghurst *CalTest*
12.00	Workshop Close	

Testing Centres Workshop - MINUTES

Alexandria, 12 September 2011

The Testing Centres work is part of the International Energy Agency (IEA) 4E Electric Motor Systems Annex (EMSA). (www.motorsystems.org). The third Testing Centres workshop was held on Monday 12 September 2011 in Alexandria, VA, US.

The workshop was a success with around 40 attendees from North America, Europe and the Asia-Pacific region. There were attendees from manufacturers, universities and independent laboratories, as well as government representatives and other experts.

Introduction – Sarah Hatch, Chair

The Chair welcomed attendees and gave an overview of the agenda.

IEC test method – Andrew Baghurst, Australia (IEC WG 28 member)

Andrew Baghurst from CalTest, Australia, and member of IEC TC2 Working Group 28 gave a history of motor testing:

- Need to be able to measure motor efficiency, otherwise it is not possible to monitor, control and regulate motors.
- Induction motor tests were fully developed by the middle of the 20th century. However, we are still dealing with issues of conformity between test methods and test laboratories.
- IEC 34-2 was one of the original test method standards. Area of contention – additional load losses, assigned as 0.5% of input power, but to be confident of the results, the actual additional load losses need to be measured.
- The US developed IEEE112, method B which indirectly measures additional load losses by smoothing the residual losses.
- In 2007, the new edition IEC 60034-2-1 test method was published. It lists ten different test methods for induction motors and included two major additions:

- The determination of additional load losses using smoothing of residual losses and
- The Eh star method

- The IEC TC2 WG28 organised a testing round robin and Bob Bartheld from the US analysed the results. The results showed that there appears to be little agreement between test results from different laboratories using the the present standard. It is clear that there are deficiencies in the test method and/or the way it is described, and also the clarity of the calculation algorithms. Therefore work needs to be done to improve the standard.
- Based on the outcomes of the last two Testing Centres workshops, a guide for using IEC 60034-2-1 has been developed and was circulated to Testing Centres members in May 2011.
- The current intention is that the IEC test method standard will be updated and refined, and hence there should be no need for a guide for the next edition of IEC 60034-2-1. The last IEC WG28 meeting (in Zurich) made good progress in generating a more uniform standard, which is expected in 2012.
- Andrew Baghurst is seeking any comments on the guide.

The third Testing Centres workshop in Alexandria VA, US on 12 September 2011.

IEC update - Martin Doppelbauer, Germany (IEC WG28 member)

- Martin Doppelbauer, Germany, gave an overview of recent work on IEC 60034-2-1.
- The intention is to have a 'perfect' second edition so that no guide will be needed.
- IEC WG28 met in November 2010 and began redrafting IEC 60034-2-1. WG28 produced a first committee draft of the new version and comments have been received from national committees. The last WG28 meeting was in June 2011. The second committee draft was expected to be released for comment to national committees by November 2011.

Two main changes in the next edition of IEC 60034-2-1:

- For improved readability, each type of machine (induction, synchronous, DC) will be covered in a separate chapter.
- Each machine type chapter will be split into subsections for preferred and non-preferred testing methods.

There will also be:

- New tables on preferred testing methods.
- Flow charts on how to do tests, including the order of tests and measurements.
- Other methods for field or routine-testing.

Discussion of the Guide to IEC 60034-2-1 – Sarah Hatch and Andrew Baghurst, Australia

- Sarah Hatch and Andrew Baghurst went through the 'Guide for the Use of IEC 60034-2-1' in detail and explained each of the sections.
- Note that the guide predates the IEC CDV, so some of the suggested interpretations have already been taken into account in the draft revision of the standard.
- The revised edition of IEC 60034-2-1 will have a single preferred method which is the method of summation of losses, with direct measurement of stray load losses by smoothing of the residual losses.

- The order of tests is very important but this is ambiguous in the current edition of 60034-2-1. The guide incorporates a flow chart of test order to make this clear. The flow chart will be included in the next edition of the standard.
- There is currently a proposal to have software supplied with the new standard. Two purposes for the software are:
    - to compare against, so that people can still use their own software.
    - to be used directly. This will be useful for smaller labs and manufacturers.
- Removal of sealing elements. This question has been resolved. There is still the issue of where to place the instructions for the removal of sealing elements: either in the regulatory efficiency classes standard (IEC 60034-30) or in IEC 60034-2-1. For compliance testing, the motor must not be dismantled except for the removal of any external drive-end sealing elements. The no-load test provides the greatest uncertainty.
- Selection of measurement points. There was lengthy discussion at the WG28 meeting. Requirement is currently up to 150% of rated load. This causes internal motor heating and other measurement issues. Andrew Baghurst suggested that the highest loading point at which measurements should be made is 100%, however the revised edition of IEC 60034-2-1 may include other point(s) e.g. 110%.
- Correction of iron losses for stator resistance voltage drop. This caused great confusion in the software round robin. There is a strong argument to be made for not correcting no-load loss measurement data because it adds complexity to the calculation but only contributes a small amount to the final calculation. The theoretical basis for such corrections is also seriously flawed.

Comment/discussion:

- Measurement points – more points should provide better smoothing, and allow for bad/mistaken readings to be excluded. However, digital equipment may reduce some of these errors. There is a need to make the measurements quickly in order to reduce the effects of motor cooling (isothermal issue) and generally there are very few outliers with digital instrumentation anyway.
- Measurement points – is 40% too high for the voltage lowest level in the no-load test? What is the best way to extrapolate for friction and windage losses? The current drawn by the motor will decrease with lower voltage. A curve fit with a correlation factor greater than 0.95 is an indication that the measurement is satisfactory.
- Smaller motors – these measurement points tend to be a little more scattered, so some engineering input is required in order to draw a curve. Andrew Baghurst stated that data averaging is crucial for both the load and no-load tests.
- Other issues raised:
    - There is a need to decouple a motor from the loading machines in seconds prior to the no load tests. Should the standard specify the time more specifically?
    - There is a general requirement for all measurements to be made at the same temperature if at all possible. This is difficult because motor winding temperature starts to drop immediately after the load tests.
    - The timing of all measurements needs tighter specification in the test procedure (some indication of speed would be useful, for example measurements to be

made at intervals not exceeding 1 minute). (The flow chart in the guide states 'As quickly as possible').

Test Methods for Other Motor Technologies

Hugh Falkner led the discussion on testing other motor technologies, such as permanent magnet motors and switched reluctance motors.

- The input/output method is currently the only test method for other motor technologies (except for calorimetric methods).
- Issues to solve include the ambient temperature in which the motor is tested and what equipment is best suited to load and make measurements on these types of motors.
- There was a suggestion that the first step is to measure the overall efficiency of the motor-inverter (VSD) combination.
- Some laboratories are already working in this area.

In conclusion, there is a need for a test method standard for other motor technologies and ambient temperature will be an important factor.

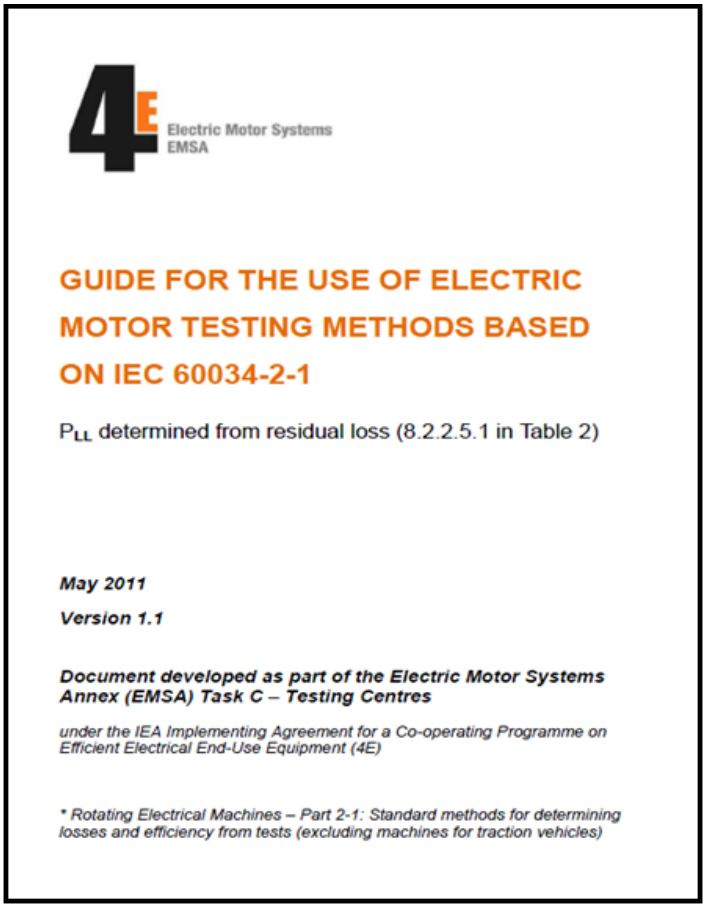
Development of IEC 60034-2-3 for the testing of inverter (VSD) fed induction motors

- There was a broad agreement that testing of VSDs is needed in order that possible EU regulations on VSD performance (that would result from a recent call for EUP Preparatory studies) are based on sound technical information and test methods.
- Technical standards groups have a sometimes hidden responsibility to construct regulations that are appropriate for MEPS regulation. It is therefore important that there is good dialogue between standards makers and policy makers. VSDs are a particular case in point.
- Clarity needs to given on which motors and drives are included within each test standard.
- Care must be taken to ensure that when comparing different types of motors, key characteristics other than just efficiency are taken into account.
- We now have a clear standard for testing induction motors, using the summation of losses method. But for all other types, with the exception of the line start PM motor, the input-output method is required. Policy makers need to be reminded that it is not acceptable to use the input-output method for testing induction motors.
- Peter Zwanziger (Siemens) gave an outline of the Europump work on the "Extended Product Approach". This is a major initiative that aims to enable users to assess the energy performance of complete pump systems, which includes taking account of the efficiencies of the motor, pump, controls (including a VSD) and the immediate system. The first system to be characterised in this way is for building heating systems, and uses a similar approach to the Blue Angel load:time duration curve that underpins the EUP Circulator regulations. Of particular relevance to VSD testing are pumping curves with a defined head:flow characteristic.
- However, there is also a realisation that there are limits to what can be achieved through defined MEPS for motor systems.

- Further work is needed in order to develop best practice in the use of the input-output method.
- There is a question-mark over the load points at which motors and VSDs should be assessed, with it being noted that IEC standards, induction motors are regulated at 100% load, rather than the more typical 75% load point where they are just as likely to have their peak efficiency.
- Guidelines need to be given on the relationship between motor and VSD losses and how this varies with VSD switching frequency.
- IEC WG28 is currently working on a draft standard IEC 60034-2-3 which aims to describe a test method to compare how different motors perform when driven by a standardised inverter waveform. This standard is not intended to be used as a regulatory standard.

Conclusion

The Chair thanked all the speakers and attendees for their valuable input to the discussions on motor testing.



Electric Motor Systems EMSA

GUIDE FOR THE USE OF ELECTRIC MOTOR TESTING METHODS BASED ON IEC 60034-2-1

P_{LL} determined from residual loss (8.2.2.5.1 in Table 2)

May 2011

Version 1.1

Document developed as part of the Electric Motor Systems Annex (EMSA) Task C – Testing Centres

under the IEA Implementing Agreement for a Co-operating Programme on Efficient Electrical End-Use Equipment (4E)

** Rotating Electrical Machines – Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)*