34A/PRESCO(MED)039

GE Appliances & Lighting
Lighting

1975 Noble Road
Cleveland, Ohio 44112
USA

June 1, 2012

To the experts of PRESCO

Re: **Proposed compliance criteria for sample life test in IEC 60969: Self-ballasted lamps for general lighting services – performance requirements**

Dear Colleagues,

During the PRESCO WG meeting March 26, 2012 in Auckland, I was requested to develop a revised proposal for IEC 60969 (34A/1524/DC, 34A/1551/INF) Table 3 compliance criteria for the lifetime parameter. The following proposal to revise Table 3 is made for your consideration.

Kind regards,

Mark E. Duffy

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Head of Delegation for TC34

Att: IEC 60969 Life Compliance.xls

Supporting Information – Not part of the proposal

A typical CFLi will exhibit a wear-out survival curve that approximates a Weibull distribution with a shape factor of ~2.7. Thus, even without manufacturing variation, a ratio $\sigma/\mu = 0.334$ (33.4%) will be observed typically. As the life test is proposed in 34A/1524/DC, a CFLi design meeting a median life rating of 8700 hours will take about 1 year to collect life data and the variation in results will be unacceptable to determine compliance using the presently proposed criteria that "≥50% of the samples shall survive to 90% of the rated value."

With established product types, such as CFLi, many years of data have been collected and can be used to include the effect of "between lot" variation. Individual production run data becomes a single data point, even if several test samples from that run are used. As long as test conditions and designs remain constant, so that failure mechanisms and failure rates are not changed, this data can be used to predict the performance of new products of similar technology, well before 50% failure of a sample has been reached. Since some conventional lamp types are now being introduced with expected lives greater than 50,000 hours, the ability to predict the life well before the 50% failure point is invaluable. Various statistical tools, such as Weibull and other parametric fits are employed in the analysis of this data.

In responding to a US Department of Energy Notice of Proposed Rulemaking (75 FR 56796; Sept. 16, 2010) NEMA industry members used a Monte Carlo simulation method to estimate the effect of the NOPR. This data is also useful for evaluating and setting a reasonable life test compliance criteria for IEC 60969. The simulation examines the scenario in which different test labs draw sample from the same population of compliant CFLi lamps. Just for interest, not a recommendation, the possibility of collecting complete failure data is examined as well as using data that is censored (stopped) when the rated lifetime is reached or more than half of the sample fails (see 34A/1524/DC, Annex G). Sampling 10 lamps at random from an ideal Weibull distribution (η = 10,000 hr, β = 2.7, true median life = 8731 hr) of CFLi meeting Energy Star requirements and a 8700 hour life rating, then

burning them to complete failure will take an average of 15,000 hours, almost two years of testing. For the less fortunate labs the result may take up to 19,000 hours or 2.5 years as estimated by this Monte Carlo simulation of 20 runs. Each run can be considered a separate lab performing a life test on a sample of lamps from the same population. A secondary Weibull analysis was used to measure the median life of each 10-lamp sample. The 20-run simulation taking lamps to complete failure shows high variation in the measured sample median life (ranged from 7143 to 11957 hr). Four (4) of the 20 runs (or labs) in the simulation would conclude failure to comply with the minimum median life criteria at 7830 hours (90% of 8700 hours). That's 20% false determination of non-compliance from an acceptable population after two or more years of testing!

Applying the censor proposed in Annex G to the data and reanalyzing each data set using Weibull analysis with suspended (still functioning) lamps using a maximum likelihood estimate for the median life reduces the simulated test duration to less than 1 year for all labs. However, it makes the risk of false non-compliance determination even more onerous. Indeed, the median life measured by this method ranged from 6519 to 12289 hours for the 20 simulation runs. This approach led to a false non-compliance conclusion in nine (9) of the 20 runs using the 90% of rating criteria. That's nearly half of the cases, note tossing a coin to determine compliance takes less time and energy!

The following proposal is based on a lighting industry consensus by USA NEMA members and more fully detailed in a draft white paper (Draft LSD 63-2012) currently in the approval process. An excerpt from the draft reads:

> *For field verification purposes, various statistical tools, such as Weibull analysis and parametric fits may be used to estimate median life of the sample. The estimated median value shall not be less than 70% of the rated median life.*

Changing the minimum median life criteria to 70% of the rated value reduces the risk of false determination of non-compliance to less than 5%. In the Monte Carlo simulation, all 20 runs (labs) would reach a proper conclusion that there is no conclusive evidence for lack of compliance to the rating (70% of 8700 hours = 6090 hours).

Proposal

Table 3 Row 14 Median Life

Modify Table 3, Row 14, Column B Parameter for Test entry with the following text,

"Median lamp life"

Modify Table 3, Row 14, Column D Compliance entry with the following text,

"Statistical tools, such as Weibull analysis and parametric fits may be used to estimate median lamp life of the sample. The estimated median value shall not be less than 70% of the rated value."