Accelerated Cycling Thermal Voltage Stress Test

Updated Final Report

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Executive Summary

The US Environmental Protection Agency asked the Lighting Research Center (LRC) at Rensselaer Polytechnic Institute to help develop and test an accelerated cycling thermal voltage (ACTV) stress test for ballasts used in residential light fixtures. The purpose of such a test would be to reveal inadequate circuit designs, manufacturing problems, defective materials or components, as a means to eliminate products not suitable for the residential market in terms of performance. The LRC worked with ENERGY STAR® partners to develop a proposed method agreeable to all participants, which was then experimentally tested by the LRC in three phases over a two-year period (2005-2007).

Results from Phases 1 and 2 were presented in March 2006 and November 2006, respectively. Phase 1 provided insight into the number of cycles to be used for testing, which then led to a modification of the testing procedure. Phase 2 investigated testing parameters applicable to integral GU24 products, which were not widely available at the time. The results from Phase 2 were inconclusive, raising concern that the proposed ACTV test method was inappropriate for higher wattage integral GU24 products. The results of Phases 1 and 2 were posted publicly on the LRC website in November 2006 (www.lrc.rpi.edu/ACTV.asp). Due to the high wattage failures in Phase 2, Phase 3 further investigated whether the proposed ACTV stress test method, as modified based on the findings of Phase 1, could be extended to integral GU24 products. The experiment tested low-, medium-, and high-wattage modular and integral GU24 products, which were more widely available.

The results were separated into two categories. The first category was product failures, where the product stopped operating or operated erratically. The second category was electrical data, describing products that showed significant electrical changes due to the ACTV stress test. Of the products tested, 40% of the models did not have any failures at any temperature. Similarly, 40% of the models did not have any samples that exceeded 15% variation in electrical performance at any temperature. Further analysis of the experimental results was performed to compare the results using a short-term test method with those using a long-term test method, based on the procedure modifications and requests for two testing methods made after Phase 1. When comparing the two methods for product failures, 11 of the 15 models had results that were consistent for both methods. When comparing the methods for electrical performance, 12 of the 15 models had results that were consistent for both methods.

The findings from Phase 3 of this experiment show that the proposed ACTV stress test is appropriate for integral GU24 products since it was demonstrated that high wattage GU24 products can pass the test. The results and analysis show that the majority of the integral GU24 products passed the test using either the short-term or long-term method, independent of wattage. The positive results from Phase 3 eliminate the concern raised during Phase 2 that the test procedure might not be appropriate for high wattage GU24 products. Further, the Phase 3 analysis indicated that in most cases, the short-term testing method will produce results similar to the long-term testing method.

Background

During the review process of the ENERGY STAR® Light Fixture Specification (Version 4.0), a suggestion was made to the US Environmental Protection Agency (US EPA) to develop an accelerated cycling thermal (ACTV) stress test for ballasts used in residential light fixtures. This test was previously called an Accelerated Life Test, but has been renamed to reflect the intent of the test, which was never to predict life. The purpose of the testing would be to help reveal inadequate circuit designs, manufacturing problems, defective materials or components, and eliminate products that may not perform well.

A roundtable was held on May 25, 2005 to discuss a strawperson prepared by the Lighting Research Center (LRC). The goal of the roundtable was to obtain technical input and develop a new strawperson for an ACTV stress test method for residential light fixture ballasts with which all participants would be comfortable. The strawperson was distributed to all ENERGY STAR partners for comments prior to the roundtable. The focus of the meeting was to “tear apart” the proposed strawperson and build another one with input from the roundtable participants[1]. A new strawperson was developed, and the roundtable participants agreed that three aspects may influence ballast reliability in terms of input circuitry to the ballast: 1) heat, 2) operating cycle, and 3) voltage variation and/or spikes. A draft testing procedure was sent to the meeting participants on June 3, 2005 (Appendix A).

After the first roundtable, one question remained regarding the number of cycles that would constitute a meaningful ACTV stress. The LRC started “Phase 1” of an experiment in July 2005 to acquire some insight into this question. The methodology used in Phase 1 was based on the discussions held during the roundtable in May 2005. During Phase 1, pilot studies were performed to determine how the experiment would be conducted and to evaluate the thermal chamber, described in Appendix C. After the pilot studies were completed, the experiment was started. Originally, the experiment was proposed using an elevated ambient temperature of 60°C. Later, a 80°C elevated ambient temperature was included. Phase 1 was completed in March 2006.

On March 16, 2006, a conference call was held between the LRC, EPA, and ACTV stress test roundtable participants in which the LRC presented the results of Phase 1. The call participants agreed to a modified testing method, which is described in the Procedure section. The participants also agreed that manufacturers can opt to perform one of two possible methods to conduct the test: a short-term method or a long-term method. These methods are described in the Analysis section.

The call participants further agreed to the following discussion about the analysis of the test results:

> The ballast manufacturers would remove five samples from the production line and measure power factor, input power, lamp current, and lamp voltage. Manufacturers would then submit these five ballast samples to the proposed ACTV stress test.
>
> If one failure occurs when testing the first five samples, manufacturers would test another set of five samples. No failures would be permissible in this second set of testing. Therefore, no failures are permissible if five samples are used; one failure is permissible if ten samples are used. Manufacturers should report the number of samples tested (whether it was five or ten samples) and how many failures occurred (whether it was zero or one).

[1] The roundtable participants consisted of the following companies and organizations: Acuity Brands, Fulham, Good Earth Lighting, Lutron Electronics, MaxLite, OSRAM SYLVANIA, National Electrical Manufacturers Association, Robertson, Super X Ballast, Technical Consumer Products, and Universal Lighting Technologies.

> Manufacturers would also conduct another set of electrical measurements on the ballasts after they undergo the ACTV test, with an expectation that measurements of power factor, input power, and lamp current and current crest factor (CCF) made after the ACTV test would not vary by more than 15% from the measurements made prior to the test. Manufacturers have the choice to run the ACTV test with a separate lamp, as long as the before and after electrical measurements are made with the same lamp to ensure that a relative change of these parameters is determined. For ballasts that can operate more than one lamp or type of lamp, the highest connected load would be used for this test.

In May 2006, the LRC started "Phase 2" of the experiment to identify testing method parameters applicable for the integral GU24 products. Phase 2 of the experiment was completed in September 2006. The Phase 2 experimental results for integral GU24 products were inconclusive. Two 13-watt products and one 23-watt product were tested. All of the 23-watt samples failed very early for both the 60°C and 80°C ambient temperatures, which raised a concern that the testing method may need to be modified for higher wattage integral GU24 products.

On November 6, 2006, the LRC presented its findings of Phase 1 and Phase 2 to the US EPA and also posted its report on the LRC website. The report was emailed on January 12, 2007 (Appendix B) to the participants from the previous meeting and conference calls. Neither the LRC nor US EPA received any comments on the report.

In March 2007, the LRC started "Phase 3" of the experiment using low-, medium-, and high-wattage modular and integral GU24 products. This experiment investigated whether the same test method could be extended to the integral GU24 products. Phase 3 of the experiment was completed in August 2007. The results of Phase 3, combined with those of Phases 1 and 2, are provided herein.

Procurement

During Phase 1 of the experiment, the LRC purchased 72 residential light fixtures from four different manufacturers. Three of the product types were hardwired products (A, B, and C), and one type was a modular GU24 type (D1). All fixtures were purchased from local stores (Lowe's and THORPE Electrical) or from lighting distributors in the Northeast (Energy Federation, Inc., and Bellevue Distributor). All fixtures were received and disassembled to obtain the ballasts.

During Phase 2 of the experiment, integral GU24 products were not widely available. LRC researchers were able to purchase only three different types of integral GU24 products (H, I, and M). A total of 45 integral GU24 products from two different manufacturers (at least 15 lamps from each type) were tested. Two product types from one manufacturer were purchased from a local store (Troy Lighting); the other product type was purchased directly from the manufacturer.

For Phase 3 of the experiment, the LRC purchased eight different models of GU24 ballasts from six different manufacturers (at least 15 samples from each model) were tested. Four of the eight models were modular GU24 type (D2, E, F, and G), and the other four models were integral GU24 type (J, K, L, and N). These products were purchased from a local store or lighting distributors whenever possible, or purchased from the manufacturers directly when the products were not available on the public market.

The product samples were inventoried and labeled with a unique product ID. Table 1 lists the input power for the products tested.

Table 1: **Products used in the ACTV stress test**

Type	Ballast	Power (W)
Hardwired	A	13
	B	17
	C	58
Modular GU24	D1*	13
	D2*	13
	E	18
	F	26
	G	27
Integral GU24	H	13
	I	13
	J	13
	K	18
	L	23
	M	23
	N	26

*Products D1 and D2 were the same model number, but were tested at different times

Apparatus

In Phases 1 and 2, the LRC used one gravity convection oven (Model No. 30 GC Quincy Lab, Inc.), referred to here as the “thermal chamber,” with a capacity of two cubic feet. In Phase 3, two thermal chambers were used to expedite testing. The thermal chambers featured two holes (two-inch diameter) on its two sides to accommodate electrical connections from the ballasts to the lamps. Four layers of wire mesh shelves were arranged inside the thermal chamber to hold ballasts (Figure 1) spaced three inches apart. For the control group, a similar setup was prepared, and the layout of the ballasts was comparable to the layout in the thermal chamber (Figure 1).

In Phase 1, five ballasts from each manufacturer were arranged on one shelf, and lamp holders for the lamps powered by those ballasts were fixed directly outside the thermal chamber wall. The lead wire length from ballast to lamp was about 2 feet. For the control group, the lead wire length and ballasts arrangement were the same as the group in the thermal chamber. The lamp/ballast combination was then retrofitted with wires and connectors to supply power during testing. A control box was used to connect the sample to the electrical measurement equipment (Figure 2).

For Phase 2 of the experiment, only the top three shelves of the thermal chamber and the control system were used, since there were only three integral GU24 models tested. In this testing, the lamps were inside the thermal chamber, unlike the Phase 1 experiment, as lamps and ballasts were integrated. In Phase 3 testing, lamps were inside the thermal chamber for both the modular and integral GU24 products.

A thermocouple was attached to the hot spot of the ballast to measure ballast case temperature. In addition, thermocouples were placed in the thermal chamber and the control group on different shelves to measure ambient temperatures. All thermocouples were then connected to a miniature jack panel and from the jack panel to an Agilent channel multiplexer (Figure 3). Ballast case and ambient temperatures were collected during the testing in 10-minute intervals using a LabVIEW™ program.

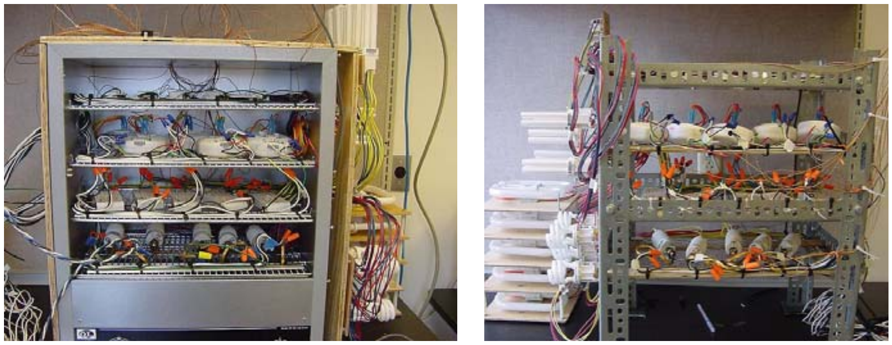

Figure 1: Ballasts and lamps arrangement inside thermal chamber (left) and the control group (right)

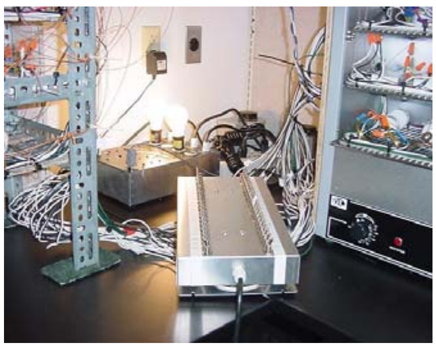

Figure 2: Control box and test box for the ACTV stress test

Figure 3: Thermocouples connected to jack panel and Agilent channel multiplexer

Procedure

The testing process for this experiment is shown Figure 4. The initial and final electrical measurements were measured with the samples operating at an input voltage of 120 volts. There were three batches of products: two for the thermal chamber for testing at two different temperatures (60°C and 80°C), and one for the control group. One batch consisted of five ballast samples from four different model numbers, for a total of 20 ballasts per batch.

Testing was performed inside a thermal chamber at ambient temperatures of 60°C ± 3°C and 80°C ± 3°C. In addition, a control group of ballasts and lamps was tested at room temperature (25°C) outside the thermal chamber. Initially, only the 25°C and 60°C testing was conducted based on feedback from the group. A second test at 80°C was conducted after the results were analyzed.

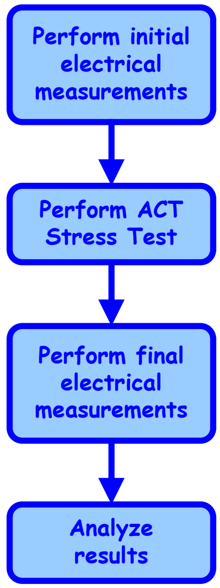

Figure 4: Testing process

Input power, power factor, lamp current, and CCF were measured for hardwired systems. For modular and integral GU24 systems, only input power and power factor were measured. The measurement of one ballast required about 20 minutes, considering handling the ballast and allowing for stabilization. All electrical measurements were performed at nominal voltage (120 volts). The LRC performed the electrical measurements at five points: 0, 480, 1440, 2400, 2880 cycles.

The following agreed-upon procedure is based on the initial testing method proposed on June 3, 2005 and was modified during the conference call on March 16, 2006.

> Initially, the ballasts (not operating) were heated for a period of one hour. The ballasts and lamps were then turned on and remained on for a period of eight hours at the high voltage level (132 volts). During this time, the ballasts and lamps were subjected to 15 cycles of rapid cycling (20 seconds ON/20 seconds OFF) at the end of each hour, totaling 120 cycles throughout the initial eight-hour period. The ballasts under test and the thermal chamber were then turned off for two hours. Afterward, the ambient temperature was again raised to 60°C for one hour, and then the ballasts and lamps were turned back on at a low voltage (108 volts) for a period of eight hours. During this time, the lamps and ballasts were subjected to 15 cycles of rapid cycling (20 seconds ON/20 second OFF), totaling 120 rapid cycles throughout this second eight-hour period. For the purposes of this discussion, a "trial" consists of two runs of elevated temperature and rapid cycling (20 seconds ON/ 20 seconds OFF) as specified in the ACTV Strawperson. Each trial requires about 25 hours to complete and subjects the ballasts to 240 ON/OFF cycles and 17 hours of operation. This study performed 12 trials for a total of 2880 cycles and 204 hours of ballast operation.

Results

The results from this experiment have been separated into two categories. The first category is product failures, where the product stopped operating or operated erratically, such as cycling on and off. The second category is electrical data, which describes products that showed significant electrical changes due to the ACTV stress test. Tables 2 and 3 show the results of this experiment that were either observed or measured after 480, 1440, 2400 and 2880 cycles.

Failure data

Of the products tested, 40% of the models did not have any failures at any temperature (B, C, E, F, I, and N). The results shown in Table 2 only show products that had at least one sample failure during the experiment. The numbers shown below the cycles represent the number of failures that were observed at that particular cycle for the temperature to which the samples were subjected. The right column of Table 2 totals all the failures for each product at each of the testing temperatures.

Table 2: Product Failures

Type	ID	Nominal input wattage (W)	Ambient temperature (°C)	Failures				
				480 cycles	1440 cycles	2400 cycles	2880 cycles	Total
Hardwired	A	13	25			1		**1**
			60				2	**2**
			80			2		**2**
Modular GU24	D1	13	25					0
			60		1			**1**
			80	4				**4**
	D2	13	25	2				**2**
			60			1	1	**2**
			80	2				**2**
	G	27	25	1				**1**
			60					0
			80	1				**1**
Integral GU24	H	13	25					0
			60					0
			80	1				**1**
	J	13	25	1				**1**
			60					0
			80			2	2	**4**
	K	18	25				1	**1**
			60					0
			80					0
	L	23	25					0
			60	1				**1**
			80		1			**1**
	M	23	25					0
			60	5				**5**
			80	5				**5**

Electrical data

Of the products tested, 40% of the models did not have any samples that exceeded 15% variation in electrical performance at any temperature (D1, D2, E, F, I, and L). Table 3 shows the results of products that had samples with results greater than 15% compared to their initial measurements. Lamp current and CCF were measured on the hardwired products only since there was a convenient location to measure these parameters. Product M was not measured for electrical performance at both 60°C and 80°C since all five of the samples failed at these temperatures prior to the first measurement point at 480 cycles. At 25°C all the samples for Product M varied less than 15%.

The numbers under the cycle columns represent the number of samples with measured values greater than 15%. As shown in the table, some samples were greater than 15% at earlier cycles, and then were less than 15% at later cycles. For example, the power measurements for Product G that had been subjected to an ambient temperature of 60°C had four samples at 480 cycles and three samples at 1440 cycle that were greater than 15%. Later, at 2400 cycles and 2880 cycles, none of the samples were greater than 15%.

Table 3: Electrical Results

Type	ID	Nominal input wattage (W)	Ambient temperature (°C)	480 cycles	1440 cycles	2400 cycles	2880 cycles
Power greater than 15%							
Modular GU24	G	27	25				
			60	4	3		
			80				
Integral GU24	H	13	25				
			60			1	1
			80				
	J	13	25				
			60				
			80			1	
	K	18	25				
			60	3			
			80	1			1
	N	26	25				
			60		2		
			80				
Lamp Current greater than 15%							
Hardwired	A	13	25				
			60	1	1	1	
			80				
	B	17	25				
			60	1			
			80				
	C	58	25				
			60				
			80	1			1
Current Crest Factor greater than 15%							
Hardwired	A	13	25				
			60				
			80				1
	B	17	25				
			60	1			
			80				

Analysis

During the conference call on March 16, 2006, the meeting participants favored having the choice of either a shorter test at a higher ambient temperature, or a longer test at a lower ambient temperature. The methods are described below:

Long-term Method (Method 1)
(204 hours of ballast operation):

- high (132 volts) and low (108 volts) voltages
- ambient temperature of 60°C
- 2880 cycles (1440 cycles at high voltage and 1440 cycles at low voltage)

Short-term Method (Method 2)
(51 hours of ballast operation):

- high (132 volts) and low (108 volts) voltages
- ambient temperature of 80°C
- 720 cycles (360 cycles at high voltage and 360 cycles at low voltage)

This section compares the results of the experiment using these two methods for both failures and electrical performance.

Failure data

Table 4 shows the failure analysis based on the methods described above using the failure data from Table 2. Since only five samples were used for this experiment, one failure was not considered a pass or fail, but was marked with a question mark. Overall, the analysis seemed to be consistent across the two methods. When comparing the two methods, 11 of the 15 models had results that were consistent for both methods (8 passed, 2 failed, and 1 inconclusive). For the remaining four models, three had inconclusive results (D1, G and H) for one of the methods. Further testing would be required to determine if the models would actually pass or fail. One model (Product A) passed on Method 2, but failed on Method 1.

Table 4: Failure Analysis

Type	ID	Nominal input wattage (W)	Method 1 60°C 2880 cycles		Method 2 80°C 720 cycles	
			Failures	Pass/Fail	Failures	Pass/Fail
Hardwired	A	13	2	Fail	0	Pass
	B	17	0	Pass	0	Pass
	C	58	0	Pass	0	Pass
Modular GU24	D1	13	1	?	4	Fail
	D2	13	2	Fail	2	Fail
	E	18	0	Pass	0	Pass
	F	26	0	Pass	0	Pass
	G	27	0	Pass	1	?
Integral GU24	H	13	0	Pass	1	?
	I	13	0	Pass	0	Pass
	J	13	0	Pass	0	Pass
	K	18	0	Pass	0	Pass
	L	23	1	?	1	?
	M	23	5	Fail	5	Fail
	N	26	0	Pass	0	Pass

Electrical data

The electrical results were analyzed similarly to the failure data. Table 5 shows the analysis of the electrical data from Table 3. Very few samples did not pass this test. In three cases, there were inconclusive tests for one method compared to the other. The remaining 12 models were consistent for both methods, with the exception of Product M, which could not be measured due to failure of all samples.

Table 5: Electrical Analysis

Type	ID	Nominal input wattage (W)	Method 1 60°C 2880 cycles		Method 2 80°C 720 cycles	
			>15%	Pass/Fail	>15%	Pass/Fail
Hardwired	A	13	0	Pass	0	Pass
	B	17	0	Pass	0	Pass
	C	58	0	Pass	1	?
Modular GU24	D1	13	0	Pass	0	Pass
	D2	13	0	Pass	0	Pass
	E	18	0	Pass	0	Pass
	F	26	0	Pass	0	Pass
	G	27	0	Pass	0	Pass
Integral GU24	H	13	1	?	0	Pass
	I	13	0	Pass	0	Pass
	J	13	0	Pass	0	Pass
	K	18	0	Pass	1	?
	L	23	0	Pass	0	Pass
	M	23	N/A	N/A	N/A	N/A
	N	26	0	Pass	0	Pass

Discussion

The findings from Phase 3 of this experiment show that the proposed ACTV stress test is appropriate for high wattage integral GU24 products. The results and analysis show that the majority of the integral GU24 products passed the test using either the short-term or long-term method, independent of wattage. During Phase 2, the failure of many integral GU24 product samples raised concern that the ACTV stress test was not appropriate for higher wattage products of this type. However, the positive results from Phase 3 eliminate that concern.

Further, the Phase 3 analysis indicated that in most cases, the short-term testing method will produce results similar to the long-term testing method.

Some of the models tested in this experiment were also tested in previous LRC experiments. The product failures in this experiment were consistent with failures from two other long-term tests performed by the LRC (unpublished data that was submitted to US EPA); that is, products that did not pass the long-term testing did not pass the ACTV stress test as well. Again, this is as indication that accelerated testing methods can provide similar results to long-term testing methods.

One improvement to the testing procedure that has been suggested is to season the test samples for 100 hours prior to initial electrical measurements. This step is consistent with other lighting industry test procedures. Therefore, the revised testing procedure would be as follows (Figure 5):

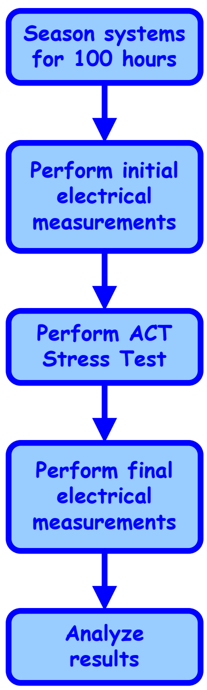

Figure 5: Revised testing process

The LRC will work with the US EPA and the industry to implement the finding from this report into the ENERGY STAR specification for Residential Light Fixtures.

Acknowledgements

The LRC would like to thank the US EPA for their support on this project, and the round table and conference call participants for the development and improvement of this test method. The authors also acknowledge Terry Klein, Howard Ohlhous, Martin Overington and Jennifer Taylor from the LRC for all their efforts on this project.

June 3, 2005

Accelerated Life Testing (ALT) for Residential Light Fixtures

DRAFT FOR COMMENTS

Goals: During the review process of the ENERGY STAR Light Fixture Specification (Version 4.0), it was suggested to the US Environmental Protection Agency (USEPA) that an accelerated life testing (ALT) for ballasts used in residential light fixtures be developed to help reveal inadequate circuit designs, manufacturing problems, or defective materials or components, and "weed out" products that may not perform well. It is important to note that a proposed ALT is not intended to predict life of the ballast in the field.

Rationale for requiring the ALT: Based on the version 4.0 of the ENERGY STAR Light Fixture specification, only indoor light fixtures with electronic ballasts will be qualified for the program. Electronic ballasts are more sensitive to damage from heat and from supply voltage spikes and other transients, although filters, protection circuits, design and component selection can reduce or eliminate the problem.

ALT Round Table: A round table was held on May 24, 2005 to discuss a strawperson prepared by the Lighting Research Center (LRC) (see participants list attached). The strawperson was distributed to all ENERGY STAR partners for comments prior to the round table. The focus of the meeting was to "tear apart" the proposed strawperson and build another one with input from the round table participants. It was agreed that when the ALT would be incorporated in the ENERGY STAR Light Fixture Specification and how it would be implemented would be discussed later in the process. The goal of the round table was to get technical input and develop a new strawperson for an ALT method for residential light fixture ballasts that all participants would be comfortable with. The following ALT was developed:

ALT Round Table Participants' Proposal: Minimum requirements for ALT are described below. Three aspects that may influence ballast reliability in terms of input circuitry to the ballast are: 1) heat, 2) operating cycle, and 3) voltage variation and/or spikes. Based on discussion during the round table, it was agreed that an ALT looking into the input to the ballast and their interactions should include the following parameters:

A) Input Variables:

Heat vs. voltage vs. operating cycle: The ballast should be exposed to a series of thermal cycles in a thermal chamber at two different voltages (high and low) while operating at rapid cycling. To pass the proposed ALT, ballasts should operate for at least 10,000 hours. The number of cycles (assuming a 3hour ON/20 minute OFF cycle) needed to meet this expected life is 3000 cycles. To pass the ALT then, the ballast is expected to go through roughly 3000 cycles under the conditions described below.

Initially, it is recommended that ballasts remain off in a thermal chamber until ambient temperature reaches the maximum temperature required for the test (60°C). Lamps will be placed outside the thermal chamber. The ballast under testing is then turned on at a high input voltage (132V). The ballast and lamp will remain on for 8 hours at the high voltage. During this 8-hour period, at the end of every hour the ballast and lamp will go through 15 cycles of rapid cycling (20 seconds ON/20 seconds OFF), totaling 120 cycles throughout each 8-hour period. The ballast under test will be then turned off and the ambient temperature will be brought down to 25°C and ballasts will remain at this temperature for 60 minutes. The ambient temperature will be again raised to 60°C and the ballast and lamp will then be turned back on at a low input voltage (108V). The ballast and lamp will remain on for 8 hours. During this 8-hour period, every hour the lamps will again go through 15 cycles of rapid cycling (20 seconds ON/20 seconds OFF), totaling 120 rapid cycles throughout each 8-hour period that the ballast is on. This same 2-part procedure (high and low voltage) will be performed twelve times (with one hour of ballast turned off at 25°C between successive 2-part procedures), so a total of 2,880 cycles be achieved. Figure 1 describes the proposed ALT.

Steps	Voltage (V)	Temp (°C)	Cycle*	Accum. # of short cycles	Time (min)	Accum. time (min)
1	132	60	Continuous	0	60	60
2	132	60	Short cycle	15	10	70
3	132	60	Continuous	15	60	130
4	132	60	Short cycle	30	10	140
5	132	60	Continuous	30	60	200
6	132	60	Short cycle	45	10	210
7	132	60	Continuous	45	60	270
8	132	60	Short cycle	60	10	280
9	132	60	Continuous	60	60	340
10	132	60	Short cycle	75	10	350
11	132	60	Continuous	75	60	410
12	132	60	Short cycle	90	10	420
13	132	60	Continuous	90	60	480
14	132	60	Short cycle	105	10	490
15	132	60	Continuous	105	60	550
16	132	60	Short cycle	120	10	560
17	Lamps off	25	Lamps off	Lamps off	60	620
1	108	60	Continuous	120	60	680
2	108	60	Short cycle	135	10	690
3	108	60	Continuous	135	60	750
4	108	60	Short cycle	150	10	760
5	108	60	Continuous	150	60	820
6	108	60	Short cycle	165	10	830
7	108	60	Continuous	165	60	890
8	108	60	Short cycle	180	10	900
9	108	60	Continuous	180	60	960
10	108	60	Short cycle	195	10	970
11	108	60	Continuous	195	60	1030
12	108	60	Short cycle	210	10	1040
13	108	60	Continuous	210	60	1100
14	108	60	Short cycle	225	10	1110
15	108	60	Continuous	225	60	1170
16	108	60	Short cycle	240	10	1180
17	Lamps off	25	Lamps off	Lamps off	60	1240

*Short cycle: 15 consecutive cycles of 20 sec ON/ 20 sec OFF
Similar procedure will be repeated 12 times to accumulate 2,880 cycles

Figure 1: Proposed accelerated life test.

Ballast manufacturers will remove 5 samples from the production line and measure power factor, current crest factor, lamp current, and input power. Manufacturers will then submit these 5 samples to the proposed ALT. If one failure occurs when testing the first 5 samples, manufacturers are allowed to redo the testing using another set of 5 samples. No failures are permissible in this second set of testing. In other words, no failures are permissible if 5 samples are used and 1 failure is permissible if 10 samples are used. Manufacturers should report the number of samples tested (whether it was 5 or 10 samples) and how many failures occurred (whether it was zero or one). Manufacturers will also be asked to conduct another set of electrical measurements on the ballasts after they underwent the ALT, and it is expected that measurements of power factor, current crest factor, lamp current, and input power made after the ALT be no more than 10% off the measurements made before the ALT.

For ballasts that can operate more than one lamp, or type of lamp, the highest connected load will be used for this test.

In the case of lamps that cannot be separated from the ballast, thus the lamps have to be placed inside the thermal chamber, (e.g., line voltage socket and replaceable ballast with and without replaceable lamps) the testing will be performed with an ambient temperature of 60°C or maximum ballast case temperature plus 5°C, whichever is greater. The lamps should be placed inside the chamber in a base up position. Everything else remains the same as described above. Ideally manufacturers would provide a reporting template that listed out preliminary ballast characteristics, sample size, post test ballast characteristics, percent deviations, and number of failures.

From: O'Rourke, Conan Patrik
Sent: Friday, January 12, 2007 11:30 AM
To: 'mitch.hand@acuitybrands.com'; 'fred.carpenter@acuitybrands.com'; 'gmurphy@maxlite.com'; 'rpelino@robertsonww.com'; 'howard.wolfman@sylvania.com'; 'ronbezdon@superballast.com'; 'alex.kowalenko@goodearthlighting.com'; 'dnatarelli@tcpi.com'; 'cra_updyke@nema.org'; 'vchitta@lutron.com'; 'mike.stein@worldnet.att.net'; 'bbrosius@universalballast.com'; 'dshiller@maxlite.com'; 'Bob Erhardt'
Cc: O'Rourke, Conan Patrik; 'Banwell.Peter@epamail.epa.gov'; Figueiro, Mariana Gross
Subject: ALT Status Update

Attachments: ALT_Progress_Report_November2006_Final.doc
Hello ALT Roundtable Participants,

ENERGY STAR is continuing to investigate the integral GU24 products to see if the testing method that the roundtable participants agreed upon for discrete ballasts works for the integral GU24 products.

In the next week or two, ENERGY STAR is planning to update the stakeholders for Residential Light Fixtures on the status of the ALT to date. The intent of the update is to let the stakeholders know about the work that has been done, and that the ALT will be added to the specification in a future revision. ENERGY STAR looks to the Roundtable Participants for their support on the ALT since it has been agreed upon by consensus of the Roundtable Participants.

Please review the attached document and provide any questions or comments by the end of next week. We will be placing this report on our website in two weeks.

Best Regards,

Conan O’Rourke

Evaluation of Thermal Chamber Prior to ACT Testing

Preparation

Before starting the test the LRC conducted two pilot studies. One determined the temperature stability of a thermal chamber. The other was tested any effects caused by the increased lead wire length, which was necessary because the testing was performed with the lamps outside the thermal chamber.

Pilot study 1

To determine the temperature stability of a thermal chamber already at the LRC, a first pilot study was conducted. Five thermocouples were placed in five different locations on a horizontal plane inside the thermal chamber, and temperature was recorded for a period of three hours. These measurements were repeated at three different heights in the thermal chamber (Figure 5). The results of this test are shown in Figures 6 and 7. For a given shelf, temperature did not change more than 10.2°C. The temperature variation with time did not exceed 5.5°C at an ambient temperature of 80°C; 5.1°C at an ambient temperature of 60°C; and 7.0°C at an ambient temperature of 40°C.

Pilot study 2

A second pilot study was conducted to test any effects caused by the increased lead wire length. For this study, three different lamp/ballast combinations were selected and evaluated in three conditions: both lamp and ballasts outside the thermal chamber (baseline), both lamp and ballast inside the thermal chamber, and with the lamp outside and the ballast inside the thermal chamber (Figure 8). Input power, power factor, ballast case temperature, and ambient thermal chamber temperature were measured every 15 minutes for a period of three hours. During this experiment, the ambient temperature of the heat chamber was maintained at 65±5°C. The results of this test are shown in Figure 9. Overall, ambient temperature did not change significantly when lamps were inside the thermal chamber, although ballast case temperature did increase.

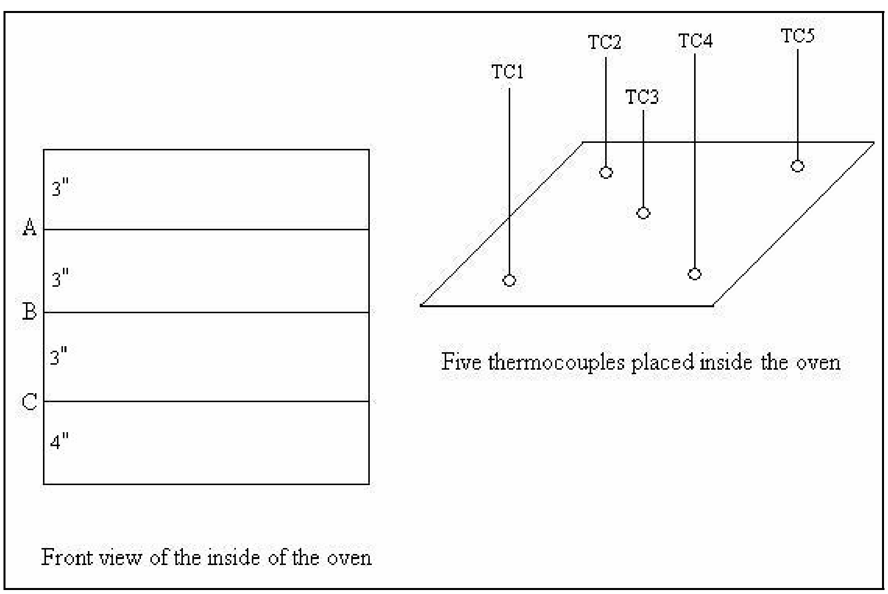

Figure 5: Temperature stability measurement locations in thermal chamber

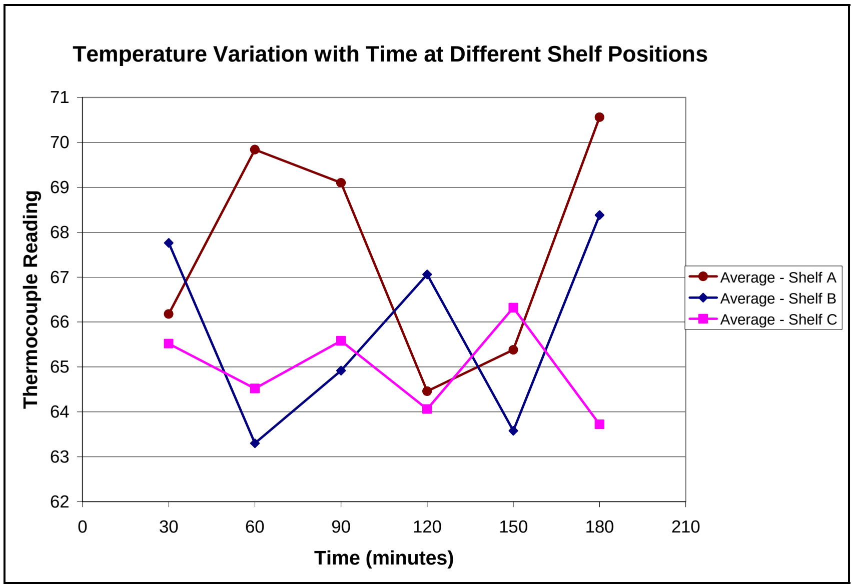

Figure 6: Temperature stability within thermal chamber

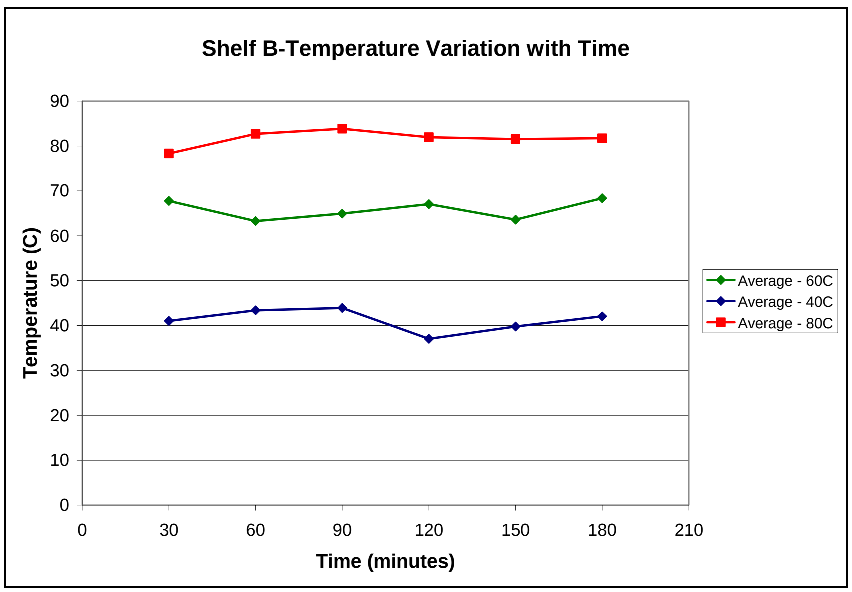

Figure 7: Temperature stability at different temperatures

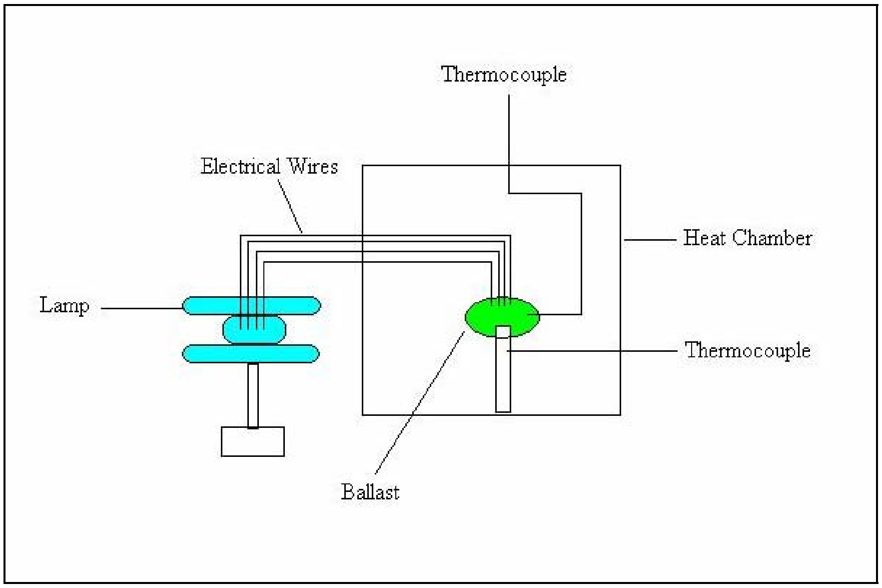

Figure 8: Experimental setup with the lamp outside thermal chamber

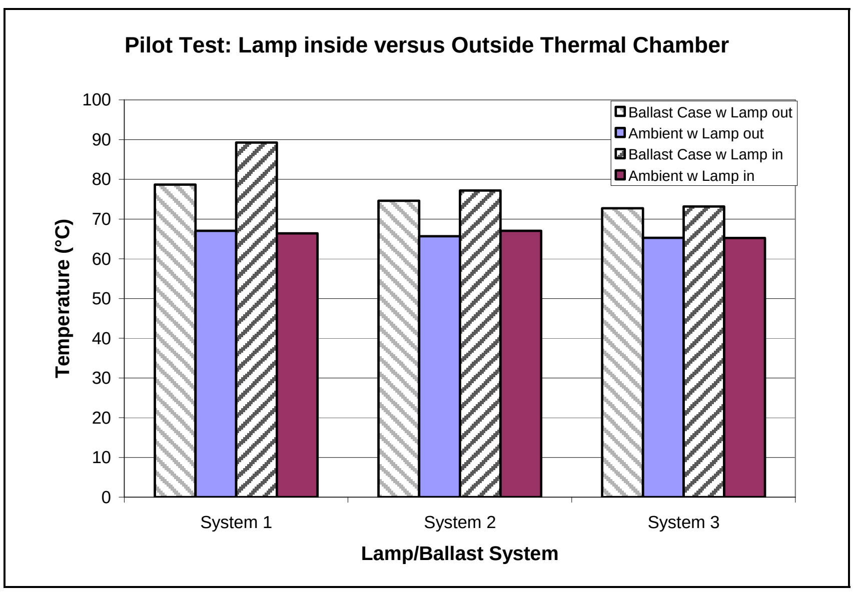

Figure 9: Ambient and ballast-case temperatures with the lamp inside and outside thermal chamber