Testing Guideline for the
Accelerated Cycling, Thermal, and Voltage (ACTV) Stress Test

September 14, 2007

Introduction

The Accelerated, Cycling, Thermal, and Voltage (ACTV) Stress Test is designed for residential light fixtures using hard-wired ballasts, modular GU24 ballasts, or integrated GU24 ballasts. The goal of the test is to provide stresses to the ballasts to reveal inadequate circuit designs, manufacturing problems, defective materials or components, and to "weed out" products that may not perform well. It is important to note that this proposed stress test is not intended to predict ballast life in the field.

The testing guidelines stated here were developed by the Lighting Research Center, the United States Environmental Protection Agency, and ENERGY STAR® partners. For background on the test development, visit www.lrc.rpi.edu/programs/lightingTransformation/actv.

This test stresses the ballasts in four different ways by providing starting/cycling, thermal, thermal cycling, and input voltage stresses in an accelerated manner. These stresses are applied at the same time. Any one of the stresses applied individually would not provide the same effect.

Two ACTV stress test methods are available: a shorter test at a higher ambient temperature, or a longer test at a lower ambient temperature. Both tests are suitable, and manufacturers may pick the test that best fits their needs. The methods are described in Table 1 below:

Table 1: Test Methods

	Long-term Method (Method 1)	Short-term Method (Method 2)
Ballast input voltage	132V & 108V	132V & 108V
Ambient temperature	60°C	80°C
Ballast cycles	2880	720
Ballast operating time	208 hours	52 hours
Test duration	296 hours	74 hours

Equipment

The following equipment is needed for this test:

- Oven/thermal chamber
- Power supplies, for the stress test and the electrical test
- Thermocouple
- Power meter
- Oscilloscope

Oven/thermal Chamber. The oven/thermal chamber must be capable of maintaining the specified ambient temperature (60°C or 80°C) while products are being operated. It is recommended to use circulation fans to provide uniform temperature to minimize thermal stratification if necessary. Also, the oven/thermal chamber needs to be sized appropriately.

Power supplies. The power supply for the stress test must be capable of providing 108V and 132V while products are being operated, maintaining the output voltage within ±2%. Also, the output voltage total harmonic distortion (THD) for the power supply needs to be less than 3%. The power supply for the electrical measurements must be capable of providing 120V±0.12V while systems are being operated. Also, the output voltage THD for the power supply needs to be less than 3%. The same power supply used for the stress test can also be used for electrical measurements.

Thermocouple. A Type J thermocouple should be used in the oven/thermal chamber to measure the ambient temperature during the stress test.

Power meter. The power meter must be a true RMS power meter and be capable of measuring power factor.

Oscilloscope. The oscilloscope must be at least 300 mHz frequency response, for measuring high frequency lamp current.

Preparation

Method selection. The first step of preparation is to choose one of the methods: Method 1 with a specified ambient temperature of 60°C, or Method 2 at 80°C. There is a trade-off between specified temperature and the number of starts, or cycles. For Method 1, the ballasts need to go through a total of 2880 cycles, and for Method 2 the ballasts need to go through a total of only 720 cycles. It is the manufacturer's choice to use Method 1 or 2.

Sample size. The second step of preparation is sampling. Two choices are available for the initial sample size: 5 or 10. For an initial sample size of 5, if one fails, then 5 additional samples will have to be tested.

Testing apparatus. The third step is to prepare the testing apparatus, including setting the temperature and voltage of the testing equipment. It is necessary to set the oven's interior temperature so that it is at the specified ambient temperature (60°C or 80°C) while product samples are being operated. The oven interior temperature needs to be maintained at the specified ambient temperature with different supply voltages (i.e., 108V and 132V), and the oven interior temperature needs to be uniform for all systems being operated inside the oven. It is also necessary to set the power supplies to 108V and 132V while product samples are being operated, depending on the testing procedure. The power supplies need to maintain the output voltage within ±2% for the stress test, and to maintain the output voltage within ±0.1% for the electrical test.

Process

In general, the testing process includes seasoning, initial electrical measurements, ACTV stress test, and final electrical measurements, as shown in the flow chart in Figure 1 and explained in the following paragraphs.

Seasoning. Before testing, the samples need to be seasoned (operated) for 100 hours in base-up position (or other manufacturer specified position) to allow for representative initial electrical measurements.

Initial electrical measurement. The following electrical parameters need to be measured after the seasoning: input power, power factor, lamp current (for hard-wired products only), and lamp current crest factor (for hard-wired products only).

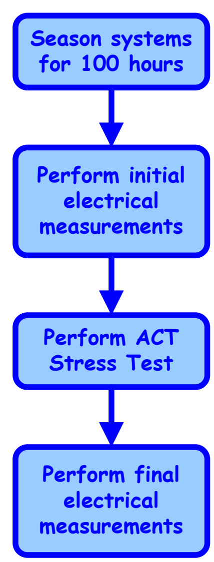

Figure 1: Testing process

ACTV stress test. This step is represented in the flow chart in Figure 2 and explained in the following paragraphs.

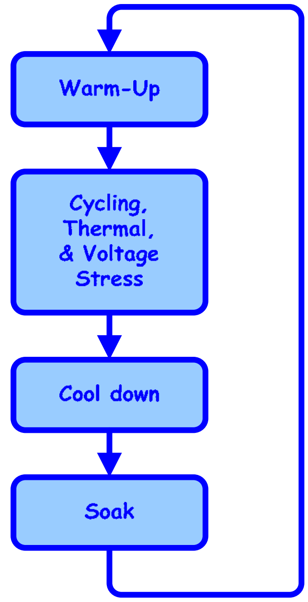

Figure 2: ACTV process

Warm-up step:
This step warms up the oven to reach the specified temperature. The intent of this warm-up step is to get the product to the desired temperature prior to applying the cycling, thermal, and voltage stresses. The exact time of this step is not, but the minimum rate of change of temperature should not be less than 0.5°C/min.

Cycling, thermal, and voltage stress step:
Manufacturers have determined that cycling, thermal, and voltage are stressors for the ballasts. This test intends to apply these stresses at the same time. Any one of the stresses applied individually would not provide the same effect. This step is represented in the flow chart in Figure 3 and explained in the following paragraphs.

These sub-steps in Figure 3 are repeated eight times, stressing the ballasts for a total of 560 minutes (70 minutes each iteration). Each 70-minute iteration includes 60 minutes of continuous operation at the specified temperature and voltage, and 10 minutes of rapid cycling (20 seconds on and 20 seconds off).

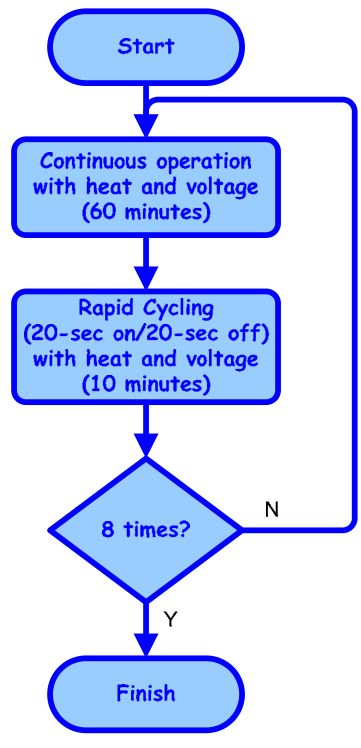

Figure 3: Cycling, thermal & voltage stress process

A rapid cycling rate of 20 seconds on and 20 seconds off achieves the goal of a large number of cycles within a short time. Also, the alternating operating pattern of one-hour-continuous and 10-minutes-cycling is more stressful than eight-hours-continuous and 80-minutes-cycling. The tolerance for the rapid cycling time (20 seconds) is ±1 second.

The specified temperature depends on the test method chosen by the manufacturer: 60°C for Method 1, and 80°C for Method 2, with a tolerance of ±5°C.

The specified voltage is either 132V or 108V, alternating for each repetition of the steps in Figure 2. These two voltages were chosen because the voltage supplied to the ballasts in practical applications may vary by 10%. Both high voltage and low voltage may stress the ballasts. When the ballasts do not regulate power, the high voltage is more stressful. When the ballasts regulate power, the low voltage is more stressful because the ballast generates higher current to maintain the power.

Cool-down step:
This step cools down the oven to room temperature (25°C). The goal of this cool-down step is to get the product cooled down prior to the soak step and to ensure the ballasts stay at room temperature. The minimum rate of change of temperature should not be less than 0.5°C/min.

Soak step:
This step keeps the ballasts in the cooled oven at room temperature for one hour so that all the components can cool. This step in combination with the cool-down step provides a thermal cycling stress to the ballasts when they are warmed up again.

Depending on the test method chosen by the manufacturer, the steps in Figure 2 should be repeated 12 times for both high voltage (132V) and low voltage (108V) for Method 1 (60°C), or repeated 3 times for each voltage in Method 2 (80°C). See the flow charts in Figure 4 below. Additionally, Appendix A has an example step-by-step partial testing procedure in a tabulated format to demonstrate a 132V stress step followed by a 108V stress step.

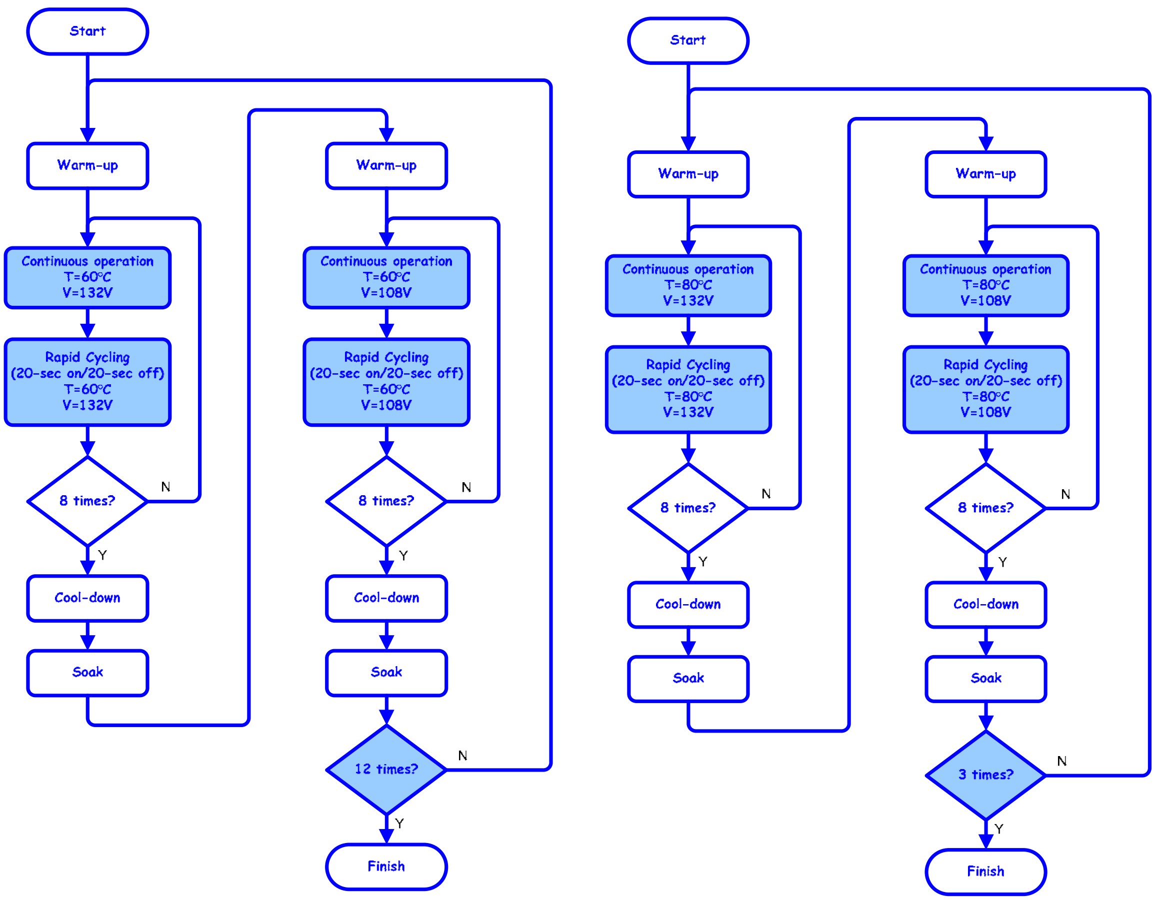

Figure 4: Detailed ACTV testing process, Method 1 (left), Method 2 (right). Colored bubbles indicate the differences between these two methods.

Final electrical measurement. The following electrical parameters need to be measured at the end of test: input power, power factor, lamp current (for hard-wired products only), and lamp current crest factor (for hard-wired products only).

Analyze Results

The results can be separated into two categories. The first category is product failures, where the product stopped operating or operated erratically, such as cycling on and off by itself. The second category is electrical data, which describes products that showed significant electrical changes as a result of the ACTV stress test.

For the product failures, if the initial sample size is 5, and 5 samples survive, then this product model passes the test. If 4 samples survive, then 5 additional samples need to be tested, and if these 5 additional samples survive, then this model passes. If the initial sample size is 10, and 9 or more samples survive, then this model passes. All other results constitute failure of this model.

For the electrical data, it is necessary to compare the final electrical results to the initial results for each sample. If the variation is less than 15% for all of the electrical parameters, this sample is considered as passing. If the initial sample is 5, and 5 samples are within 15%, then this model passes. If 4 samples are within 15%, then 5 additional samples need to be tested, and if these 5 additional samples pass, then this model passes. If the initial sample is 10, and 9 or more samples are within 15%, then this model passes. All other results constitute failure of this model.

Report Content

The testing data report needs to include:

- Manufacturer’s name
- Product model number
- Product type (hard-wired ballast, modular GU24 ballast, or integrated GU24 ballast)
- Method chosen (Method 1 or 2)
- A conclusion of whether the ballast model tested passes the ACTV stress test
- Results for each sample, including the survive-or-fail result and the electrical parameter variation

Appendix A: An Example Partial Testing Procedure Including Both High (132V) and Low (108V) Voltages

Step#	Operation	Oven Status	Power Supply Output Voltage (volts)	Ballasts Status	Accumulated Starts/Cycles	Duration (minutes)	Accumulated Time (hours)
1	**Warm up**	On	0	Off		60*	1.0
2	Continuous	On	132	On		60	2.0
3	Cycling	On	132	Cycling	15	10	2.2
4	Continuous	On	132	On		60	3.2
5	Cycling	On	132	Cycling	30	10	3.3
6	Continuous	On	132	On		60	4.3
7	Cycling	On	132	Cycling	45	10	4.5
8	Continuous	On	132	On		60	5.5
9	Cycling	On	132	Cycling	60	10	5.7
10	Continuous	On	132	On		60	6.7
11	Cycling	On	132	Cycling	75	10	6.8
12	Continuous	On	132	On		60	7.8
13	Cycling	On	132	Cycling	90	10	8.0
14	Continuous	On	132	On		60	9.0
15	Cycling	On	132	Cycling	105	10	9.2
16	Continuous	On	132	On		60	10.2
17	Cycling	On	132	Cycling	120	10	10.3
18	**Cool down**	Off	0	Off		60*	11.3
19	**Soak**	Off	0	Off		60	12.3
20	**Warm up**	On	0	Off		60*	13.3
21	Continuous	On	108	On		60	14.3
22	Cycling	On	108	Cycling	135	10	14.5
23	Continuous	On	108	On		60	15.5
24	Cycling	On	108	Cycling	150	10	15.7
25	Continuous	On	108	On		60	16.7
26	Cycling	On	108	Cycling	165	10	16.8
27	Continuous	On	108	On		60	17.8
28	Cycling	On	108	Cycling	180	10	18.0
29	Continuous	On	108	On		60	19.0
30	Cycling	On	108	Cycling	195	10	19.2
31	Continuous	On	108	On		60	20.2
32	Cycling	On	108	Cycling	210	10	20.3
33	Continuous	On	108	On		60	21.3
34	Cycling	On	108	Cycling	225	10	21.5
35	Continuous	On	108	On		60	22.5
36	Cycling	On	108	Cycling	240	10	22.7
37	**Cool down**	Off	0	Off		60*	23.7
38	**Soak**	Off	0	Off		60	24.7

* These values are only used for this example. Actual warm-up and cool-down time may vary.