



A Corrosion Analysis of BetaLED[®] Fixtures

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An analysis of BetaLED fixtures to determine corrosion resistance of all components exposed to the environment. This is a continuation of an analysis published in May 2008 that focused exclusively on the painted cast aluminum parts used for BetaLED luminaires.

Abstract

The aluminum castings used for BetaLED luminaires, in conjunction with the DeltaGuard™ coating system, have already been subjected to corrosion testing and reported on in a [White Paper published May 2008](#). The results of that study showed that after 5,000 hours in a salt fog cabinet, the castings passed the corrosion test with a rating of 4, as per ASTM Standard 1694 D, procedure A. After the 2008 White Paper was published, BetaLED was questioned whether other parts of BetaLED luminaires exposed to the environment would provide as good of results as the castings did. In particular, the concern focused on the extruded aluminum heat sinks, and the patented NanoOptics™ used to refract light from each LED. The premise of this paper is to show that not only will the complete BetaLED fixture survive a 5,000 hour salt fog test; the light output will not be compromised. Based on this study, it is concluded that the extruded aluminum alloys met or exceeded the corrosion resistance of the castings, and the light output of the BetaLED fixture suffered no negative consequences after being exposed to 5,000 hours in a salt fog cabinet.

Section 1: Introduction

Context of the paper.

In this paper, we are reviewing the corrosion resistant attributes of different materials used in BetaLED luminaires that will be exposed to the elements. Two complete fixtures, a BetaLED THE EDGE™ product and a BetaLED LEDway™ product, were subjected to 5,000 hours of salt fog testing by an independent A2LA accredited lab that specializes in metals evaluations. The salt fog testing was performed in compliance with the ASTM B 117 standard, which defines the Standard Practice for Operating Salt Spray (Fog) Apparatus.

Goal of the paper.

It is the intent of this paper to provide significant evidence that BetaLED luminaires, including castings, extrusions, hardware and optics, can withstand the challenge provided by the environments they are subjected to. To that effect, this paper will provide independent test lab findings for photometrics and efficacies before and after the 5,000 hour salt fog test, along with pictures of the components in question when the testing was completed.

Outline of the paper.

This paper is organized as follows:

Section 1: Introduction

Section 2: Test Preparations

Section 3: Test Results

Section 4: Pictures

Section 5: Conclusions

Section 2: Test Preparations

Sample Determinations

One BetaLED THE EDGE area luminaire and one BetaLED LEDway street light were selected to provide an analysis of both forms of extruded heat sinks used. Castings and optics are made of similar materials for both lights. Cast materials were not the focus of the test since this was thoroughly examined in the April 2008 White Paper. THE EDGE extruded heat sink is made of 6063-T6 aluminum alloy, while the LEDway heat sink uses a 6061-T6 aluminum alloy. Both extruded aluminum alloys have very low copper content and are clear coat anodized for additional corrosion resistance.

Sample Preparations

Both BetaLED products were taken from the assembly lines and wired to a timer programmed to turn the lights off and on in one-hour increments. Prior to the start of the salt fog test, THE EDGE unit was sent to Independent Testing Laboratories, Inc, Boulder, Colorado, to perform photometric testing as per IESNA TM-15-07. This provided a benchmark for comparison after the salt fog testing was complete. A single straight scribe line was cut into painted cast and extruded surfaces by Anderson Labs as per Procedure A of ASTM D 1654. The scribe penetrated all organic coating layers on the samples, and was performed under low power magnification to verify its quality.

Test Preparations

Anderson Laboratories, Inc. of Greendale, Wisconsin, an independent A2LA accredited lab, installed the two BetaLED luminaires into a salt fog chamber meeting ASTM B 117 requirements.

Section 3: Test Results (Data)

Table 1 below provides the statistical analysis for the alloy/coating combination used on BetaLED cast parts. This data was retrieved from the White Paper published in May 2008. Scribe lines etched in the painted aluminum castings, extrusions and screens on the completed fixtures exhibited similar results, as can be seen on the pictures in Section 4.

Table 1:

Creep as per ASTM Standard 1654 Procedure A	Aluminum Alloy 413 with maximum of .4 copper content
Average in MM	5.8
ASTM Rating	(4)
Range	4
Standard Deviation	1.32
95% Conf. Level	0.73

Table 2 below provides the photometric efficacy numbers and ratios for THE EDGE unit before and after the 5,000 hour salt fog exposure. The efficacy numbers provided below are representative of product built in early 2008. These numbers are not reflective of the significant improvement in the lumen output and efficacy numbers currently achieved. The efficacy numbers are being presented in this format to provide substantiated evidence that optical performance will not degrade in hostile environments.

Table 2:

Fixture Status	Efficacy	Ratio Increase/Decrease
Pre Salt Fog	62.6 Lm/W	Benchmark
Post Salt Fog Pre Clean	62.2 Lm/W	.64% decrease
Post Salt Fog Post Clean	63.6 Lm/W	1.6% increase

Anderson Labs also verified throughout the 5,000 hour salt fog test that the two fixtures continued to cycle on and off in an hourly fashion, and that no LED's stopped illuminating.

Section 4: Pictures (After 5,017 hours of salt fog testing. Fixtures were rinsed in tap water and hand dried prior to pictures being taken.)

BetaLED LEDway Streetlight Luminaire:



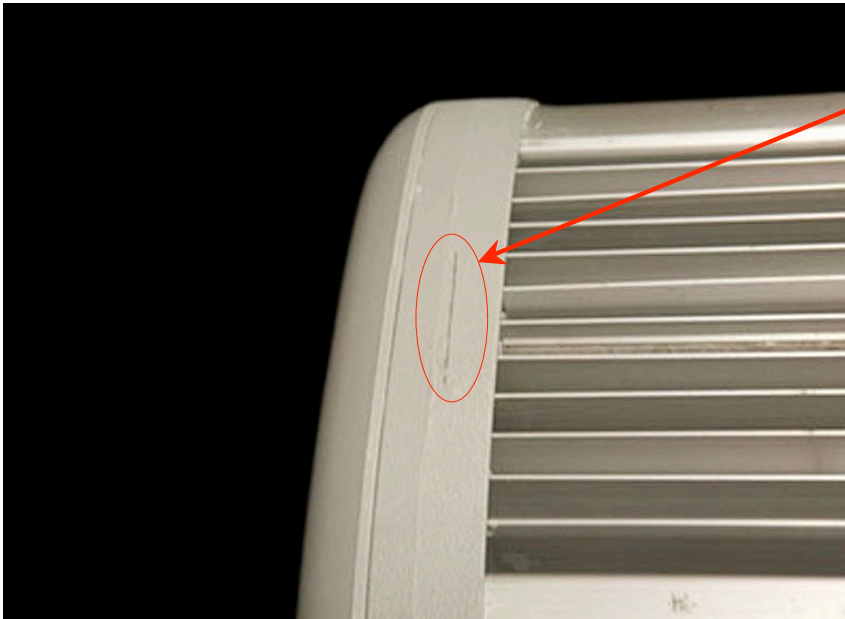
View:

- LED optics
- Extruded aluminum heat sink
- Hardware used to attach LED cover to extruded aluminum heat sink



View:

Top of extruded aluminum heat sink

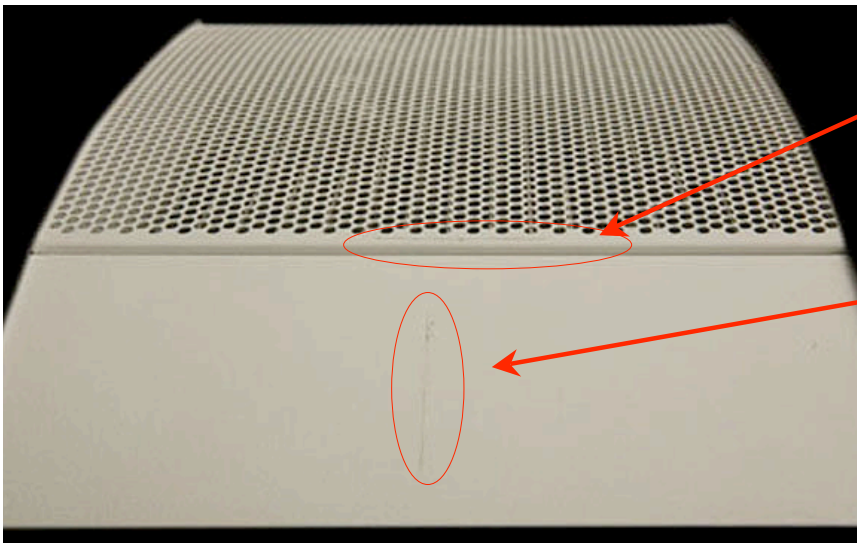


- View:**
- Scribe line on cast aluminum end cap
 - Creep: 6mm
 - ASTM Rating: 4

BetaLED THE EDGE Luminaire:



- View:**
- LED optics
 - Hardware used to attach LED cover to extruded aluminum heat sink

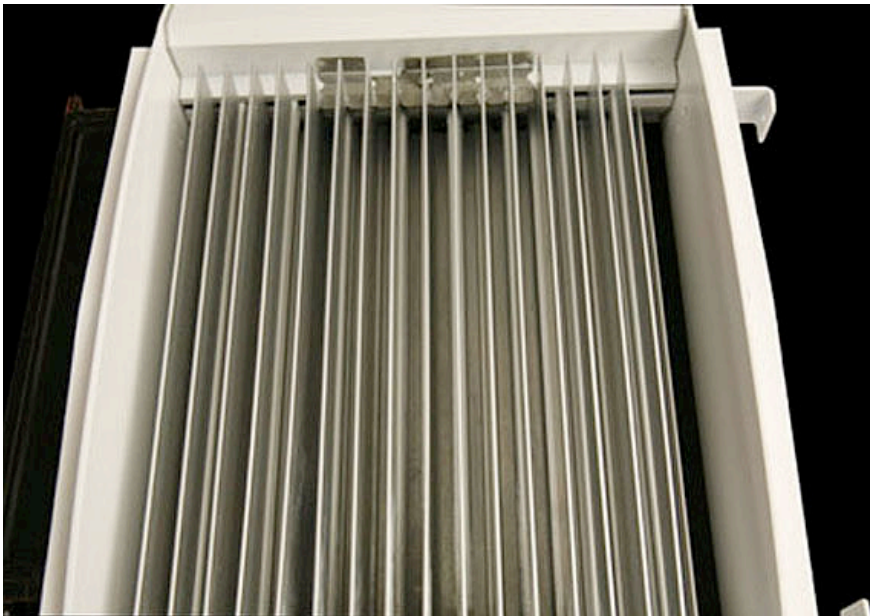


- View:**
- Scribe line on painted aluminum 3000-H14 alloy screen
 - Creep: 1mm
 - ASTM Rating: 8
 - Scribe line on painted aluminum 6063 extrusion
 - Creep: 4mm
 - ASTM Rating: 5



View:

- Internal heat sinks



View:

Close up of internal heat sinks

Section 5: Conclusions

Based on the test data and the pictorial evidence, the two complete BetaLED fixtures survived the 5,000-hour salt fog test with no significant difference in corrosion resistance than what was reported in the May 2008 white paper. The extruded aluminum heat sinks and the LED optics were virtually unaffected by the salt fog experience. It was also clear that 5,000 hours in the adverse environment had no negative impact to the fixtures lumen output.