

Airport Visual Aid Technologies

ICAO Workshop on Air
Navigation Visual Aids
New Technologies

May 7-11, 2012

ICAO South American
Regional Office

Lima, Peru

Presented by Alvin Logan

FAA AAS-100



Federal Aviation
Administration



AGENDA

- Mixing of Light Source Technologies
- Load Characteristics
- Electrical Noise from Other Airfield Components
- Electronic Devices Can Provide a Non-Linear or Reactive Load
- EB-67 Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Light Fixtures

AGENDA

- Obstruction Lighting Equipment
- Light Fixture Performance Criteria
- Intensity of a Fixture With an Alternative Light Source
- Chromaticity – Fixture Daytime Viewing
- LED Light Fixture Testing
- Innovative and Energy-Saving Product Utilizing LED Light Source

Mixing of Light Source Technologies

Mixing of Light Source Technologies

AC 150/5340-30F, para 1.4

1.4. MIXING OF LIGHT SOURCE TECHNOLOGIES.

The increasing use of airport light emitting diode (LED) light fixtures on the air operations area (AOA) has caused concerns when LED light fixtures are interspersed with their incandescent counterparts. LED light fixtures are essentially monochromatic (aviation white excepted) and may present a difference in perceived color and/or brightness than an equivalent incandescent fixture. These differences can potentially distort the visual presentation to a pilot. Therefore, LED light fixtures must not be interspersed with incandescent lights of the same type.

Example: An airport adds an extension to a runway. On the existing runway, the runway centerline light fixtures are incandescent. The airport decides to install LED runway centerline fixtures on the new section of runway and retains the incandescent fixtures on the existing section. This interspersing of dissimilar technology is not approved for installation.

In addition, defective incandescent fixtures must not be replaced with their LED counterparts. When replacing a defective light fixture, make certain that the replacement uses the same light source technology to maintain a uniform appearance.

LED Technology System(s) that are not to be interspersed:

Mixing of Light Source Technologies

- There are concerns regarding the interspersions of LED light fixtures and incandescent filament lamps.
- Intensity requirements are the same. However:
 - LED fixtures may be perceived as having a difference in color saturation and/or brightness.
 - Results in distortion of the visual presentation to the pilot.
 - Due to the LED emitting essentially a narrow frequency range light signal.
- Added paragraph 1.4 “Mixing of Light Source Technologies” to AC 150/5340-30E to prohibit interspersions of dissimilar technologies.

ATL Hartsfield-Jackson Airport



Raleigh Durham(RDU) Approach

LED RCLs and TDZs
Incandescent HIRLs



Incandescent MALSR



LED Flight Testing at Raleigh Durham (RDU) North Carolina



Mixing of Light Source Technologies

- Touchdown Zone Lights
- Runway Edge Lights including Threshold, End and Stopway
- Runway Guard Lights
 - Each pair of elevated RGLs must be the same technology. For in-pavement lights, do not mix LED with incandescent fixtures in the same bar.
- Signs per location
 - Do not collocate LED signs with incandescent signs. Example: runway holding position signs on both sides of a taxiway, holding position signs on both sides of a runway, separate signs that form a sign array.

Mixing of Light Source Technologies

- Taxiway curved segments (centerline and edge)
- Taxiway Straight Segments (centerline and edge)
- Approach Lighting Systems
- Stop Bars
- Runway Centerline
- Rapid Exit Taxiway Indicator Lights (RETIL) (up until the holding position or runway vacated position)
- Precision Approach Path Indicator (PAPI)

Load Characteristics

Load Characteristics

- AC 150/5340-30F
 - Appendix A6-2.7. Load characteristics
- Most addressable devices are designed to handle incandescent loads. Generally, circuit current is checked to the load. If other types of loads (for example, LED or flashing) are to be used, consult the manufacturer to determine compatibility.

Load Characteristics

- Power line carrier (PLC) manufacturers do not guarantee that their products are compatible with LED fixture as a plug in (similar to an incandescent).
- The circuitry in the PLC unit expects a “resistive load” similar to an incandescent lamp.
- Some LED fixtures have switching supplies and other electronics on the input.

Load Characteristics

- The effective impedance on the "front end" of the fixture changes depending on what the supply is doing.
 - If the hardware is looking for continuity similar to using an ohmmeter, it expects current to flow in the lamp.
 - The amount of current may not be what is expected if the impedance is switching around in real time.
- In some cases it might work, but the way the front end behaves is not specified and the way PLC modules detect lamp failure is not published or standardized.

Electrical Noise from Other Airfield Components

Electrical Noise from Other Airfield Components

- AC 150/5340-30F
 - A6-2.4.1. Systems using power line carrier communications. The cable layout design for the series lighting circuit must be considered.
 - The optimal layout of the cable can maximize communications performance and improve communications noise and interference operating margins. For new installations, separating the series circuit from other circuits on the airfield may improve communications reliability.
 - The prevention of undesirable crosstalk arising from coupling from one cable to another is of importance. Electrical noise from other airfield components (i.e., CCRs, LED fixtures, certain types of signs or flashing lights) can also interfere with reliable communication. The designer should consult with the manufacturer to develop the best cable layout design.

Electrical Noise from Other Airfield Components

- Strong EMI limits are required to obtain certification per Engineering Brief 67D.
 - 2.11 Electromagnetic Emissions - The alternate light source fixture and associated on-board circuitry must meet Federal Communications Commission (FCC) Title 47, Subpart B, Section 15, "Unintentional Radiators", regulations concerning the emission of electronic noise. Both conducted and radiated emission limits must be tested.
- These requirements are currently in effect.

Electrical Noise from Other Airfield Components

- Updated EB-67 to include Title 47, Part 15, Subpart B, Incidental Radiator, classification, and testing for conducted and radiated interference.



U.S. Department
of Transportation

**Federal Aviation
Administration**

Memorandum

Subject: **INFORMATION:** Engineering Brief No.67D
Light Sources Other Than Incandescent and Xenon
For Airport and Obstruction Lighting Fixtures

Date: March 6,
2012

2.11 Electromagnetic Emissions - The alternate light source fixture and associated on-board circuitry must meet Federal Communications Commission (FCC) Title 47, Subpart B, Section 15, "Unintentional Radiators", regulations concerning the emission of electronic noise. Both conducted and radiated emission limits must be tested.

Electrical Noise from Other Airfield Components

- Updated FAA AC 150/5345-10 to include Title 47, Part 15, Subpart B, Incidental Radiator, classification, and testing for conducted and radiated interference.



U.S. Department
of Transportation

Federal Aviation
Administration

Advisory Circular

Subject: SPECIFICATION FOR CONSTANT
CURRENT REGULATORS AND
REGULATOR MONITORS

Date: 6/24/05

AC No: 150/5345-10F

Initiated by: AAS-100 **Change:**

3. PRINCIPAL CHANGES. The following principal changes are in this specification:

a. The addition of Title 47, Part 15, Subpart B, Incidental Radiator, classification, and testing for conducted and radiated interference.

Electrical Noise from Other Airfield Components

- DOT/FAA/AR-TN05/10 – “Light Emitting Diode Taxiway Edge Lights Emissions Evaluation”
 - Study conducted to evaluate taxiway edge light fixtures utilizing light emitting diode (LED) technology to determine:
 - (1) If electrical emission levels from these fixtures are sufficient to cause interference to airfield circuits and warrant further investigation and
 - (2) If there is a need to change the certification requirements for these electrical emissions.

Electrical Noise from Other Airfield Components

- Testing only performed on LED Taxiway Edge Lights
 - Relatively low power
- Runway Center/Edge Lights are much higher power
 - More likely to have PWM noise
- Future consideration

Electronic Devices Can Provide a
Non-Linear or Reactive Load

Electronic Devices Can Provide a Non-Linear or Reactive Load

Appendix A6-3.5 of AC 150/5340-30F

- Electronic devices such as LED fixtures, style 2 and 3 signs, and addressable components, can provide a non-linear or reactive load on the circuit. These devices can include switching power supplies which may impart a capacitive characteristic to the circuit load. In addition, when the circuit is energized, these devices can initially appear to provide a relatively high voltage drop and suddenly change to a lower drop. The designer should consult with the CCR and electronic component manufacturer to determine if there are compatibility issues to consider.

Electronic Devices Can Provide a Non-Linear or Reactive Load

- A non-linear or reactive type load typically results in a lower fixture input Power Factor.
- More rigorous Power Factor requirements will be required as of the Effective Date of EB67D.
- Specified in paragraph 2.5.1 “Light Fixture Power Factor”
 - The true power factor for all fixtures powered by a Constant Current Regulator must not be less than 0.7 when measured at the isolation transformer primary input power leads of the fixture on all constant current regulator current steps.
- Increasing the Power Factor requirements reduces the risk of interoperability issues between system components.

Electronic Devices Can Provide a Non-Linear or Reactive Load

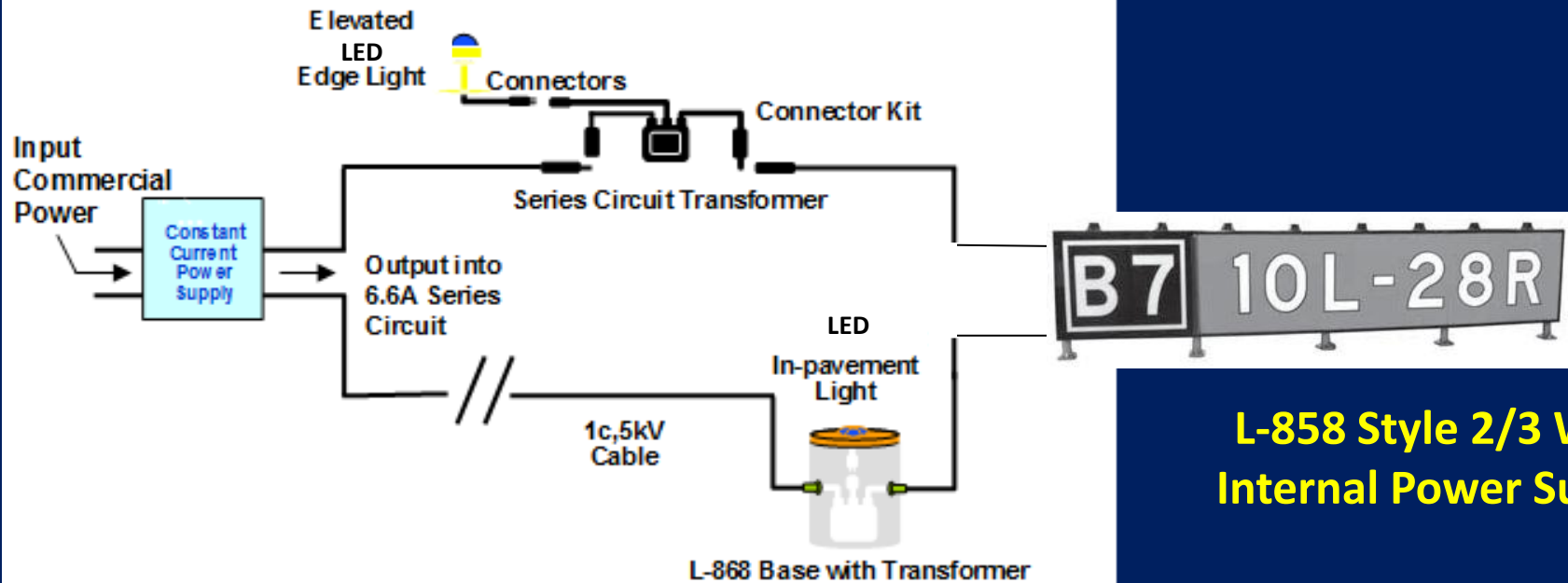
- Several airports have reported erratic operation from the constant current regulator caused by atypical circuit loads.
- An initial investigation proposed there may be compatibility issues with the airfield lighting circuit when using the combination of LED taxiway edge lights and Style 2/3 runway or taxiway signs.

Electronic Devices Can Provide a Non-Linear or Reactive Load

- Signs may be placing an unusually high demand of charging current that the constant current regulator is not capable of delivering.
 - Resulting action is the inability of the airfield lighting circuit to achieve all desired light intensities at the various step settings.

Electronic Devices Can Provide a Non-Linear or Reactive Load

Typical Existing Airport Lighting Power Distribution Circuit



**L-858 Style 2/3 With
Internal Power Supply**

Electronic Devices Can Provide a Non-Linear or Reactive Load

- Style 2 lighted signs are for circuits powered by a 3 step constant current regulator (CCR) where the sign input current ranges from 4.8 to 6.6 amps.
- Style 3 lighted signs are for circuits powered by a 5 step CCR where the sign input current ranges from 2.8 to 6.6 amps

Electronic Devices Can Provide a Non-Linear or Reactive Load

- Signs may be installed on a circuit that also has other lighting fixtures that must have their brightness controlled by selecting CCR current steps.
- Signs are required to maintain their brightness at 10 to 30 foot lamberts.
- The sign lamp intensity must remain constant independent of the CCR current setting.

Electronic Devices Can Provide a Non-Linear or Reactive Load

- The issue occurs when varying the intensity of the lighting fixtures (at lower steps) while having to maintain the sign brightness between 10 – 30 foot-lamberts.
- The CCR has to deliver more voltage to the circuit to maintain the sign brightness at the same time providing a low intensity setting to the LED taxi fixtures.

Electronic Devices Can Provide a Non-Linear or Reactive Load

- Therefore, the sign power supply must continue to provide the same wattage to the load when the CCR current is changed to a lower step (to dim the lighting fixtures).
- The sign power supply will require more input voltage from the circuit when the circuit current decreases to continue to supply the load with the same wattage.

Power Factor

- The power factor was measured for the circuit containing the LED taxiway edge light fixtures at Griffiss AFB.
 - pf = 0.23

What Causes Low Power Factor in Electrical Systems?

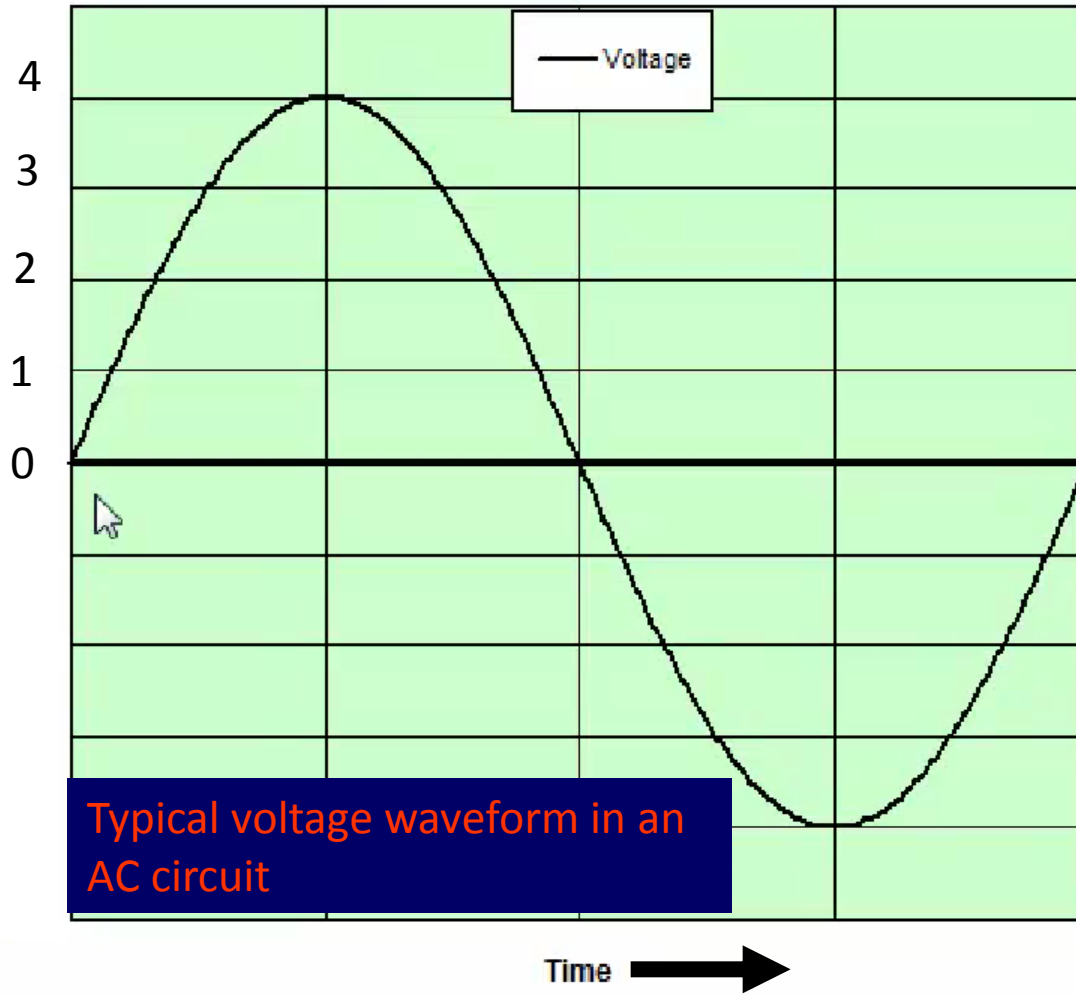
- Various causes, which can be attributed for low PF, may be listed as follows.
 - Inductive loads, especially lightly loaded motors, and transformers.
 - High Voltage
- The reactive power required by these loads increases the amount of apparent power in the distribution system and this increase in reactive power and apparent power results in a lower power factor.

) L-861T Light Emitting Diode (LED) Fixture Failures

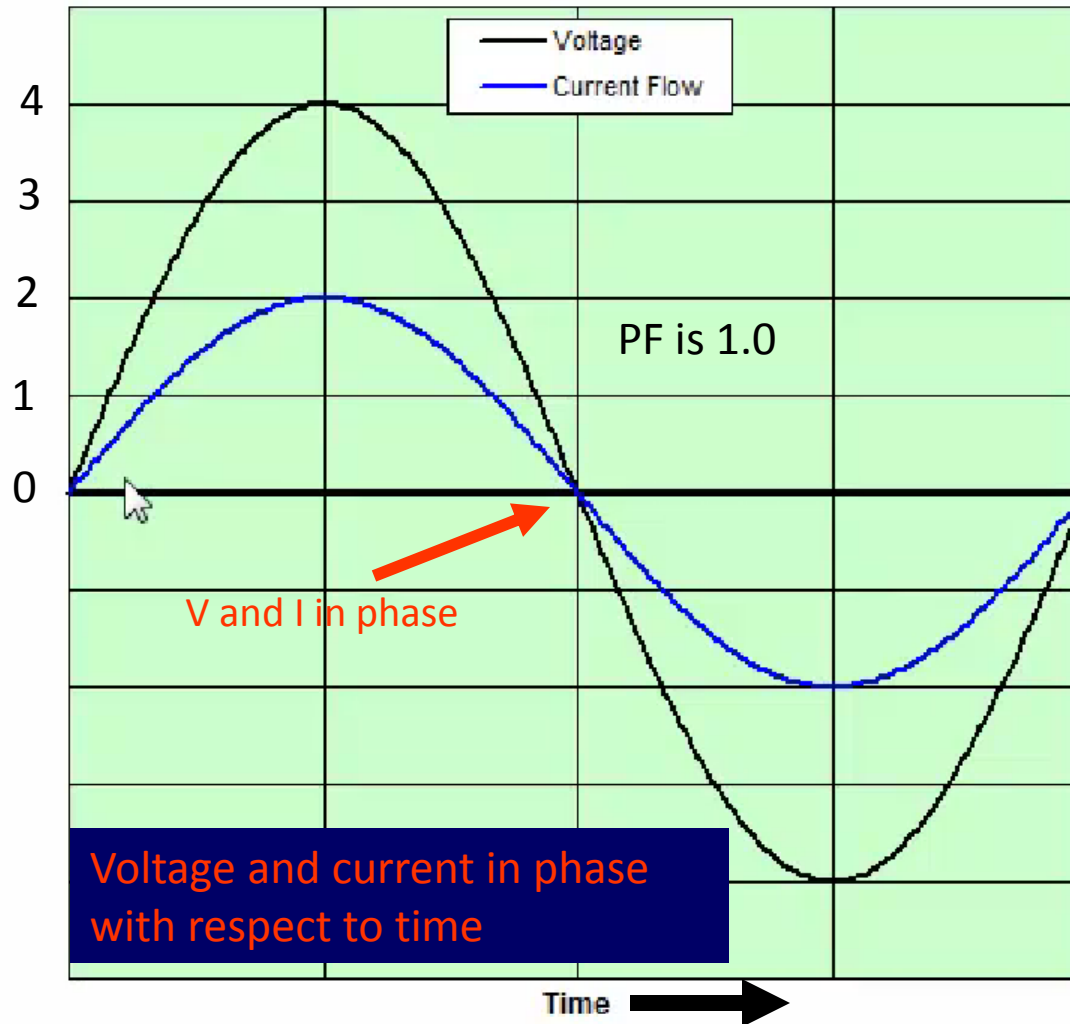
Background: The FAA began receiving reports from smaller airports about the failure of ALC L-861T LED fixtures in September, 2008. The following is a list of airports that have experienced problems. The manufacturer (ALC) claimed that fixtures failed as a result of lightning strikes. No specific component failures were identified.

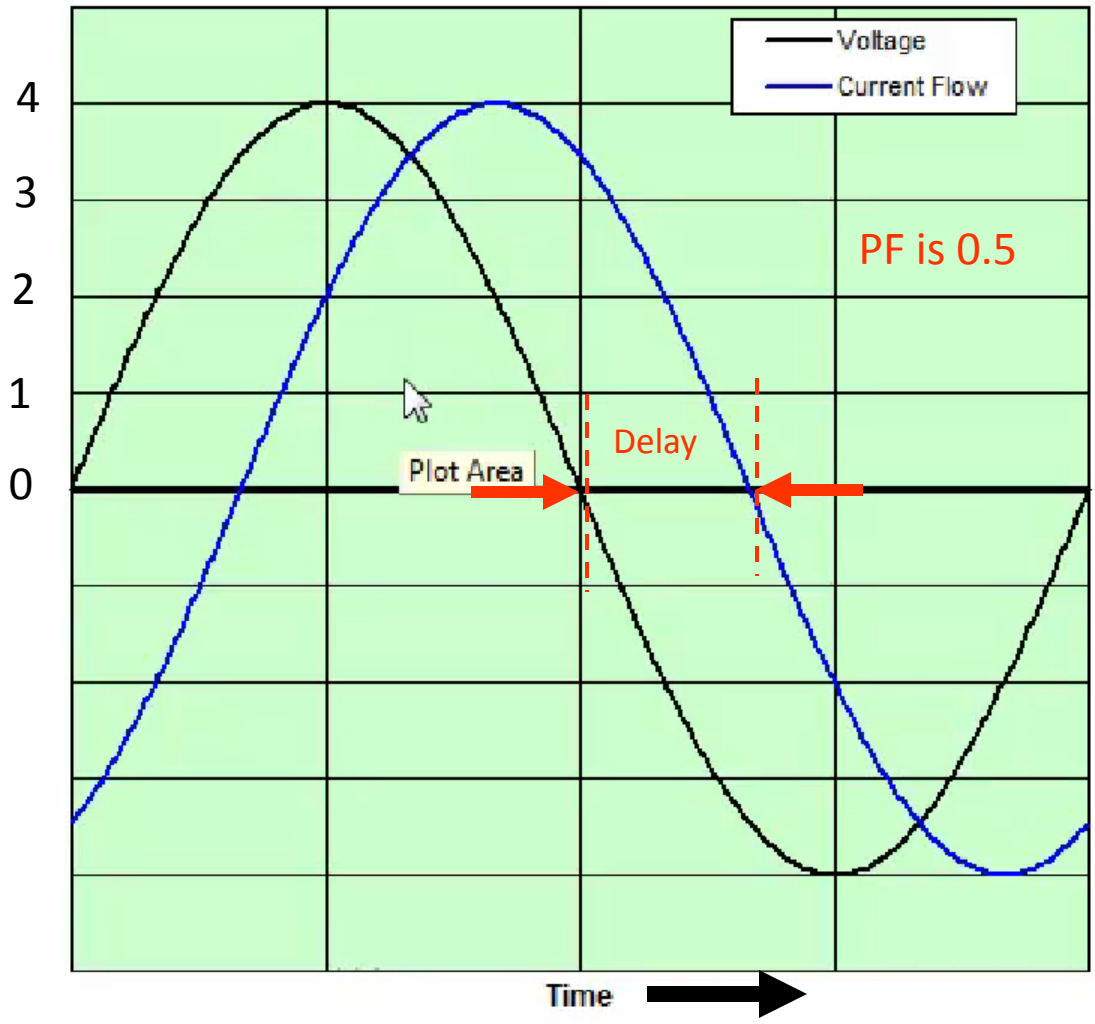
1. Cleburne, TX – installed early 2009. Lights first go intermittent (flashing off and on) and then fail dark. Cleburne has approximately 200 lights installed. There was no information available relevant to the total number of failures. However, at least 20 lights have failed since the installation in early 2009. An additional 12 lights have failed in 2010. Confirmed by email and phone call.
2. Sydney, Nebraska – installed late 2005. Approximately 124 lights have failed as of 2007. Approximately 250 lights installed. All lights are now replaced with halogen bulb fixtures. Confirmed by phone call.
3. Tekamah, Nebraska – installed May 2006. 89 lights installed. 2 initial failures in 2007, 12 more lights failed by June 2007. No further information. Confirmed by email.
4. San Angelo, TX – airport refused to provide any details. But problems were reported by maintenance. Confirmed by phone call.
5. Houston, TX (Executive Airport – privately owned and operated) – airport refused to provide any details. But replacement was underway with halogen fixtures. Confirmed by phone call.
6. Petit-Jean, AR – installed February 2009. 64 lights installed. Almost all failed within 8 months. Are in the process of being replaced with halogen fixtures. Confirmed via email and telephone.
7. Rome/Griffiss, NY – Approximately 400 lights installed in Fall 2009. 24 failures initially documented after install power up. Additional 88 lights failed in October. Confirmed by email.
8. Tucson, AZ – Approximately 860 lights installed in August 2008. In September 2008, the airport was concerned about the number of failures experienced. No specific counts were available. Documented failure of 5 lights in less than a year. Confirmed by email.
9. Carson City, NV – Airport refuses to go on record. No information obtained via phone call.

- Airports with reported failed LED taxiway edge lights manufactured by Airport Lighting Company.



Typical voltage waveform in an AC circuit

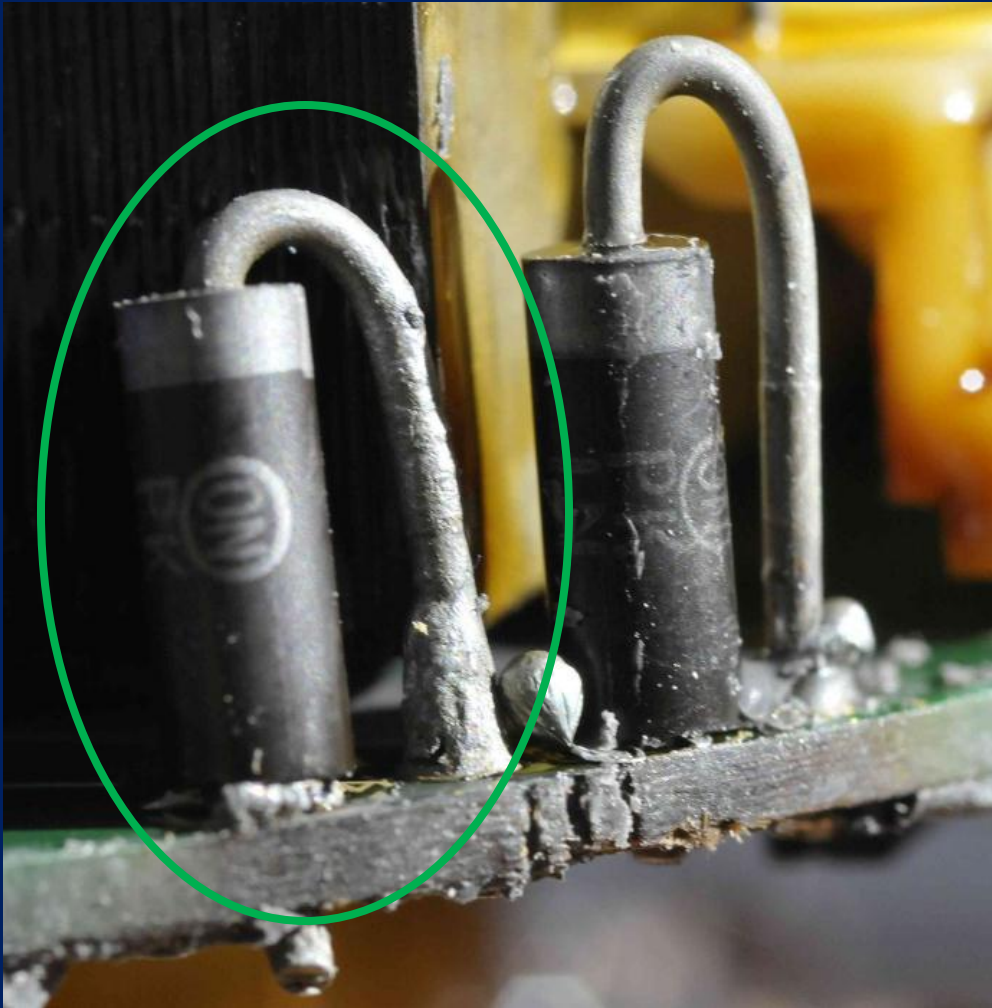




Airport Series Lighting Systems

- Until recently, airport runway/taxiway lights and signs used incandescent light sources (an electrically heated filament) that is primarily a resistive load on the constant current regulator (CCR).
- Most light emitting diode light fixtures and signs use a power supply that conducts current in short pulses.
- The rapid changes in current vs. time for the power supply can generate harmonic currents in the series lighting power system.

Examination of Griffiss AFB LED Fixture



A visual inspection the electronics revealed 2 rectifier diodes that appeared to be damaged by over-heating. Partially melted lead and solder extrusion from the damaged circuit board on the diode within the green circle.

Damaged Rectifier Diodes and PCB in Fixture #3

Power Factor

- As power factor decreases, the delay between the current and voltage increases, which causes elevation in current.
- It takes more current flow to deliver the same amount of power with a degrading pf.

Transients/Spikes/Surges

- Refers to short duration (less than 1 cycle) events.
 - Low frequency transients are often called “capacitor switching transients”.
 - High frequency transients are often called impulses, spikes, or surges.
- They can be caused when a discharged power-factor-correction capacitor is switched on across the line.
- High frequency transients are caused by lightning, and by inductive loads turning off.

New CCR Technology

- Single-phase constant current regulators, have been designed to provide power to airport lighting series circuits to assure sinusoidal current
 - high power factor
 - elevated efficiency
 - low total harmonic distortion
 - also in case of very low load



Engineering Brief 67

Light Sources Other than Incandescent and Xenon for
Airport and Obstruction Lighting Fixtures

Engineering Brief-67 “Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Light Fixtures”

- Provides additional requirements for "Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures" subject to certification under AC 150/5345-53, Airport Lighting Equipment Certification Program, and/or other applicable documents
- Inclusive to design requirements specified in AC 150/5345-46D, “Runway and Taxiway Light Fixtures”

Changes To Engineering Brief 67B

- A minimum power factor of 0.8 is added in paragraph 2.2.
- A rated fixture lifetime is added in paragraph 2.5.
- A life test per AC 150/5345-53C, Appendix V is added.
- Lightning protection is changed from location category C1 to C2 in paragraph 2.13.
- Paragraph 2.18 is added for requirement to separate lightning protection system grounds from equipment grounds.

Changes To Engineering Brief 67B

- 2.2 Power Factor – The power factor for all fixtures must not be less than 0.8 when measured at the isolation transformer primary leads.
- Power Factor = Cosine of phase angle between voltage and current.
- Power factor has no units.
- The value of PF ranges from 0 to 1.
- Loads that are only resistive (no capacitance or inductance) have a PF of 1.

Changes To Engineering Brief 67B

- 2.5 Rated Life - Alternative light sources must have a minimum rated life of two years (this is inclusive of any electronics).

Changes To Engineering Brief 67B

- 2.6 Life Test A life test (inclusive of any drive electronics) that addresses the light emitter technology shall be conducted per AC 150/5345-53C, Appendix V for all alternative lighting device light fixtures under third party certification body cognizance.

Changes To Engineering Brief 67B

- **2.14** The interface circuitry (if any) and solid state devices shall be designed to withstand and/or include separate surge protection devices which have been tested against defined waveforms detailed in Table 4, Location Category C2 of ANSI/IEEE C62.41-1991 “Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits”, Standard 1.2/50 microsecond (μ S) – 8/20 μ S Combination Wave. Peak voltage is 10 kilovolts, peak current is 5 kilo-amps with a nominal ratio of peak open circuit voltage to peak short circuit current of 2 ohms.

Changes To Engineering Brief 67B

- 2.18 The equipment manufacturer must clearly state in their installation instructions that under no circumstances should the building/tower lightning protection system down conductors be used as an equipment ground or otherwise connected to the tower lightning system.


Engineering Brief 67C Updates

- EB 67C, Light Sources Other than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures (1/7/2011)
 - Defined new dimming curve for white light
 - Redefined aviation white chromaticity boundaries
 - Alternative lighting fixture accelerated life test
 - Alternative light fixture power factor and method of determination
 - Include new Category C2 surge protection requirements

Engineering Brief-67 “Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Light Fixtures”


Engineering Brief 67D

- Provides additional requirements for "Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures" subject to certification under AC 150/5345-53, Airport Lighting Equipment Certification Program, and/or other applicable documents

 **Memorandum**

U.S. Department
of Transportation
**Federal Aviation
Administration**

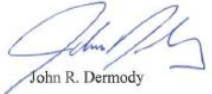
Subject: **INFORMATION:** Engineering Brief No.67D
Light Sources Other Than Incandescent and Xenon
For Airport and Obstruction Lighting Fixtures
Date: March 6,
2012

From:  Manager, Airport Engineering Division, AAS-100
**Reply to
Attn. of:**

To: All Regions
Attn: Manager, Airports Division

Engineering Brief No.67D provides additional requirements for light sources other than incandescent and xenon technologies subject to certification under Advisory Circular (AC) 150/5345-53, *Airport Lighting Equipment Certification Program*, and other applicable documents as required. It includes the required specific test and design requirements for alternative light sources that will be used in certified airfield lighting fixtures. This Engineering Brief ensures these new lighting technologies are seamlessly integrated with existing lighting technologies on the airfield.

Airfield Lighting Equipment Manufacturers employing alternative light sources in equipment certified under AC 150/5345-53 must meet the requirements contained in each applicable AC. The third party certification activity must verify the airfield lighting manufacturers' equipment meets the design and operational provisions as dictated by changing illuminating technology.


John R. Dermody

Attachment

1

Engineering Brief 67

LED Runway Lighting Flight Check
Raleigh-Durham N.C. (RDU)

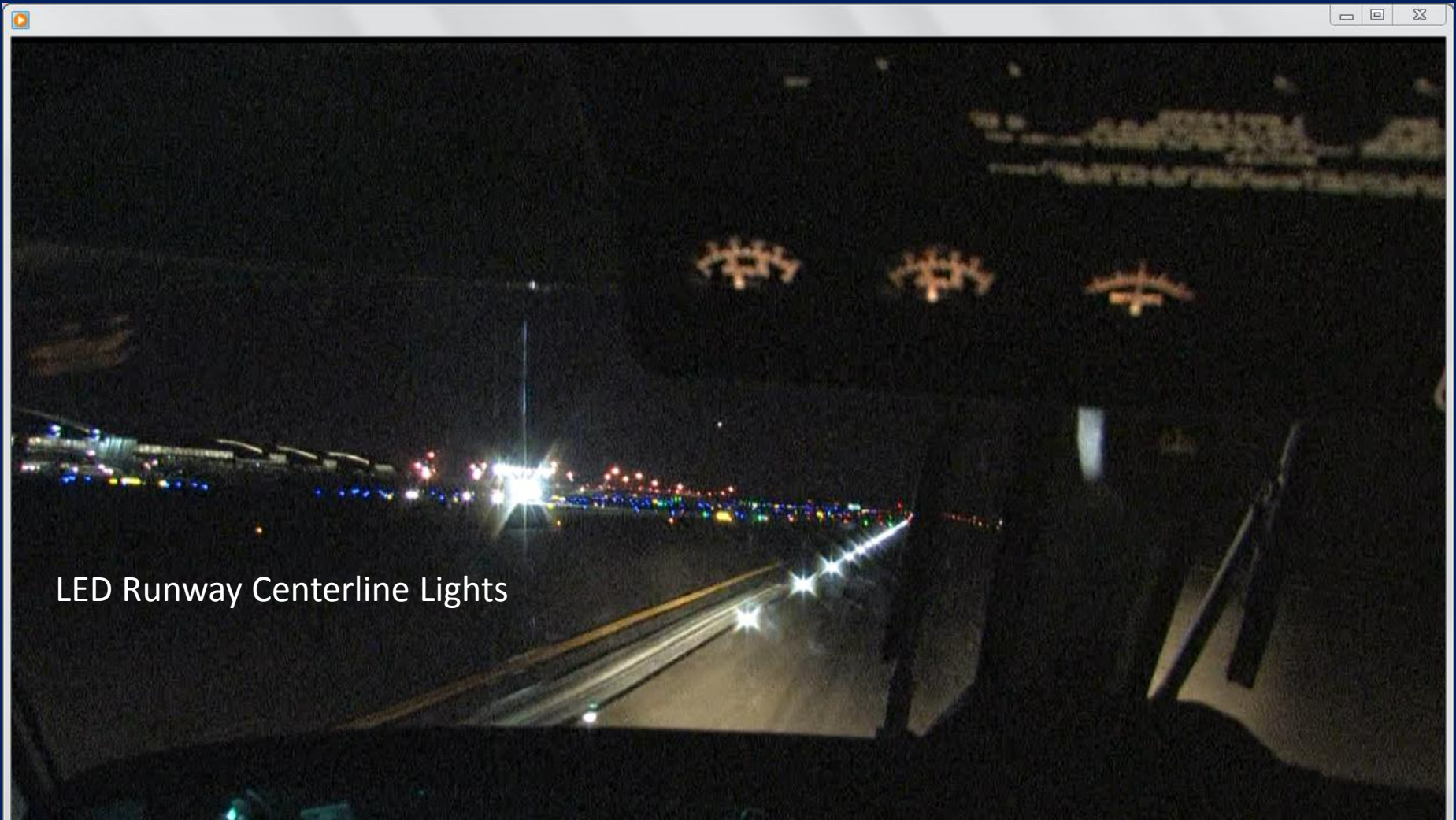
Engineering Brief-67 “Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Light Fixtures”

- Raleigh-Durham International Airport Runway Lighting System Study
 - Commercial Pilots Reported “Bright” LED Runway Centerline and Touchdown Zone Lights
 - FAATC Visual Guidance Program and supporting personnel traveled to RDU on November 17, 2010 to conduct an examination of this brightness issue
 - Lowered intensity settings for CCR Current Steps 1 and 2

LED Flight Testing at Raleigh Durham (RDU)



LED RCLs at RDU



LED Runway Centerline Lights

Moratorium for LED RCLs/TDZ



Federal Aviation Administration

Memorandum

Date: SEP 17 2010
To: All Regional Airports Division Managers
From: *Rick Marinelli*
Rick Marinelli, Manager, Airport Engineering Division, AAS-100
Prepared by: Alvin Logan, Airport Engineering Division, AAS-100
Subject: Acquisition & Installation of Light Emitting Diode (LED) Runway Centerline and Touchdown Zone Lighting Systems

The purpose of this memorandum is to announce a moratorium on the acquisition and installation of FAA LED Runway Centerline (L-850A) and LED Touchdown Zone (L-850B) Lighting Fixtures built in accordance with Engineering Brief 67, "Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures" and listed in Appendix 1 of FAA AC 150/5345-53C Addendum, "Airport Lighting Equipment Certification Program".

Flight testing of the subject lighting systems has recently been conducted at Raleigh-Durham International Airport during nighttime VFR. The consensus reached was the lighting intensity of the LED fixtures exhibited bright signals even at the lowest step setting (step 1 of 5) of the constant current regulator.

The Airport Engineering Division is currently coordinating with industry to address this issue. We anticipate subsequent modifications to the Engineering Brief in the near future. Once the issue is resolved, we will notify the Regions of the product updates.

Please contact Alvin Logan at (202) 267-8743 with any questions.

Moratorium on
LEDS announced.

Engineering Brief 67D Updates

- All LED light fixtures with the exception of obstruction lighting (AC 150/5345-43) must be warranted by the manufacturer for a minimum of 4 years after date of installation inclusive of all electronics.
- All LED type fixtures shall be designated as "L-XXX(L)"
- Example: The LED version of the taxiway edge light type will be specified as "L-861T(L)".

Engineering Brief 67D Updates

- “Where a light fixture type is available as both incandescent (L-XXX) or LED (L-XXX(L)), the owner must select the fixture type to be used, or must specify that either incandescent or LED are acceptable.”

LED Program Guidance Letter



U.S. Department
of Transportation
**Federal Aviation
Administration**

Memorandum

Subject: **ACTION:** Program Guidance Letter 12-02

Date: March 5, 2012

From:

A handwritten signature in blue ink, appearing to read "Nancy S. Williams".

Manager, Airports Financial Assistance Division,
APP-500

Reply to
Attn. of:

Nancy S. Williams
202-267-8822

To: PGL Distribution List

This Program Guidance Letter (PGL) discusses the impact of Engineering Brief (EB) 67D which allows for the design selection of LEDs (or other than incandescent lighting equipment) as stipulated in EB 67D during the design phase of a project to be funded with AIP funds.

Engineering Brief 67D Updates

- Program Guidance Letter (PGL) has been prepared to discuss the impact of Engineering Brief (EB) 67D on AIP funded projects.
- Sponsor must specify either LED or incandescent.
- A life cycle cost analysis will no longer be required to permit the selection and use of LED fixtures for an AIP funded project.

Engineering Brief 67D Updates

- Exceptions: The FAA is reviewing the use of :
 - *LED Obstruction Lights*
 - *LED Approach Lights*
 - *LED High Intensity Runway Edge lights*
- For these reasons, LED obstruction lights, LED approach lights and LED high intensity runway edge lights are not AIP eligible at this time.

Obstruction Lighting Equipment

DRAFT AC 5345-43G

SPECIFICATION FOR
OBSTRUCTION
LIGHTING
EQUIPMENT



DRAFT AC 5345-43G, PRINCIPAL CHANGES

- Para 3.3.3, Light Colors, is corrected to not state aviation red. The color for red obstruction light must be per *ICAO Annex 14, Vol.1, App 1, Colours for Aeronautical Ground Lights*. Reference to EB #67's chromaticity is removed.
- Paragraph 3.3.14.4, Alternative Lighting Devices (ALD) Equipment, reference to Engineering Brief #67 is removed to avoid any confusion about warranty requirements.
 - Minimum rated life of 2 years without maintenance or loss of light output below the minimum specified intensity.

DRAFT AC 5345-43G, PRINCIPAL CHANGES

- Para 3.4.1.1, the Blondel-Rey-Douglas formula is updated to correct form per Yoshi Ohno at the National Institute of Standards and Technology (NIST).
- Paragraph 3.4.1.1d, add statement that multiple pulse flashes cannot be used in day or twilight applications.

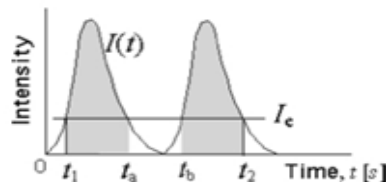
DRAFT AC 5345-43G, PRINCIPAL CHANGES

The effective intensity for multiple pulse flashes as used in lights during nighttime operation must be calculated by (Blondel-Rey-Douglas equation). Multiple pulse flashes cannot be used in day or twilight applications.

$$I_e = \frac{\int_{t_1}^{t_a} I(t)dt + \int_{t_b}^{t_2} I(t)dt}{a + (t_2 - t_1)}$$

$$I_e = I(t_1) = I(t_2)$$

Where: I_e = effective intensity
 $I(t)$ = instantaneous luminous flash intensity
 a = Blondel-Rey constant (0.2 seconds)
 t = time (seconds)



DRAFT AC 5345-43G

- Table 1, 2, and 3 – change Peak Intensity (candela) to Effective Intensity (candela)
- Paragraph 3.4.1.5, L-864 Light Unit, add a requirement for multiple light units.
- Paragraph 4.2.10, System Operational Test – add a note about excluding Type L-810 lights from the requirements paragraphs 4.2.10c through f.
- EB 67D does not apply to this AC; only arctic kit*
- Flashing L-810* ...is coming!

Obstruction Lighting/Wildlife R&D Project

- In 2009 at the request of the Obstruction Evaluation Services Team (AT), Airport Engineering Division (AAS-100) asked the Airport Safety Technology Team to conduct a research project that includes the following requirements:

Obstruction Lighting/Wildlife R&D Project

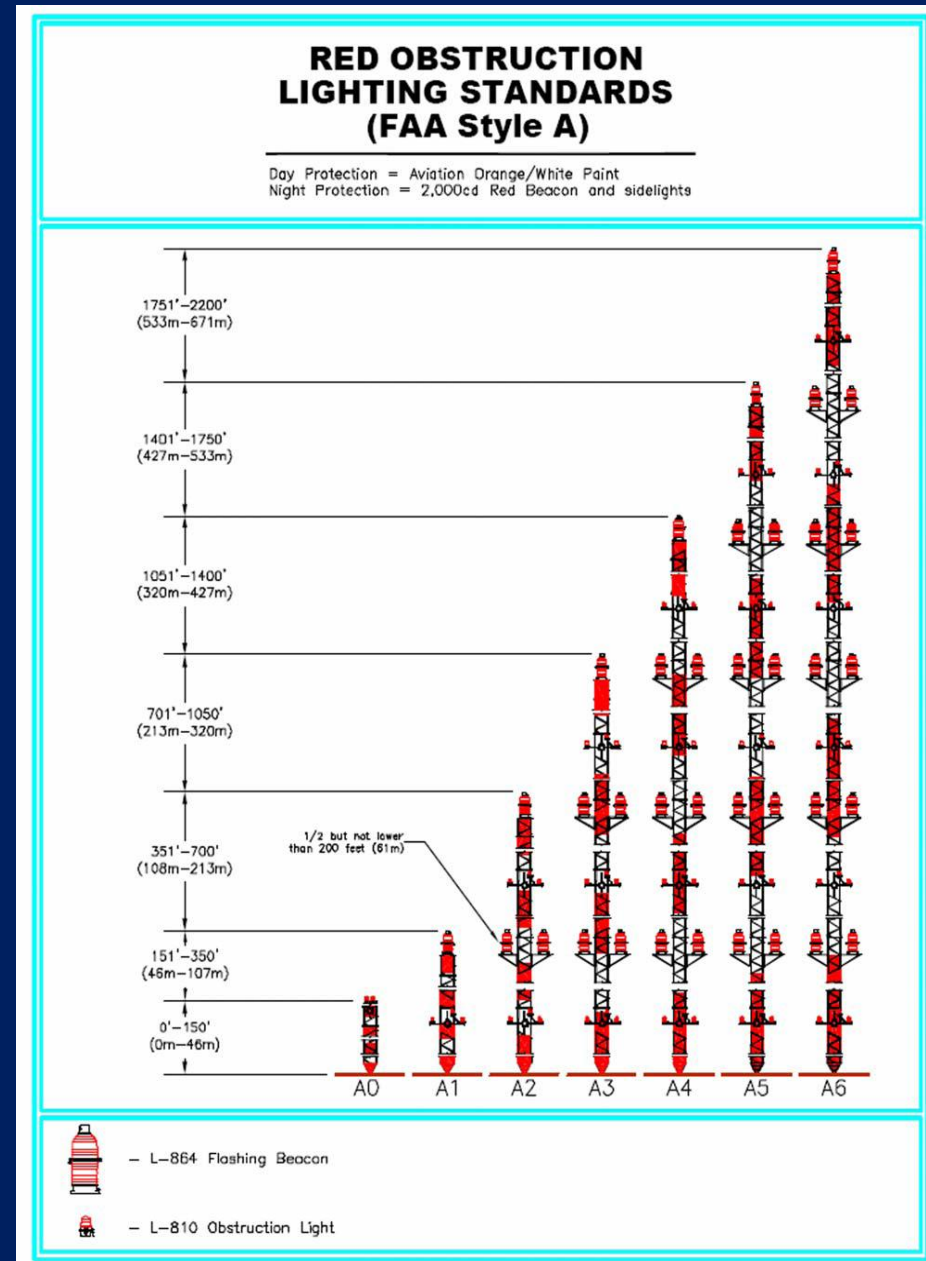
- Evaluate the concept of either omitting or flashing the normally steady burning red lights;
- Evaluate differences in the conspicuity of flashing vs. steady burning obstruction lights; and
- Evaluating the benefits of using new light emitting diode (LED) obstruction lights over conventional incandescent obstruction lights.

Contributing Factors: Flashing vs. Steady

- There are several factors involved in this issue:
 - Migratory birds love obstruction lighting
 - Wildlife research studies pointing at steady burning lights (L-810s) as problem.
 - Wildlife organizations, the telecommunication industry, and the FCC collectively approached the FAA and requested that the FAA consider re-defining the standards for obstruction lighting to either omit or flash the normally steady burning red lights to reduce their impact on the mortality rates of migratory birds
 - Increased construction of communication towers and wind turbines.
 - AC 70/7460-1K needs updated.

Proposed Change To AC 7460-1K

- FAA Lighting Style A
- Size “A0” – No change.
- Size “A1” – No change, but offer option to flash L-810 and L-864 together simultaneously.
- Size “A2 thru A5” – Omit L-810s, L-864s continue to flash in unison.



Obstruction Lighting Equipment

- Draft Engineering Brief – “Aviation Obstruction and Ground Lighting Visibility with Night Vision (NVIS) Systems”
 - Provides information about the interaction of light emitting diodes (LEDs) used for both obstruction and aviation ground lighting with night vision systems on board both rotary and fixed wing aircraft.

Light Fixture Performance Criteria

Light Fixture Performance Criteria

- 2.5 Light Fixture Performance Criteria - Manufacturers are required to publish the performance criteria for all light generating devices.
- This performance criteria is defined as worst-case wattage and VA at both the input leads of the fixture and, for fixtures powered from a series circuit, across the primary winding of an appropriately sized isolation transformer.

Light Fixture Performance Criteria

- The fixture lead length shall not exceed 24 inches for this test. This information shall be listed on the manufacturer's datasheets and verified by third party certification body.
- The manufacturer shall also state the operational current range, for series circuit powered fixtures, or input voltage range, for voltage powered fixtures, on their datasheets and verified by the third party certification body test laboratory.

Light Fixture Performance Criteria

- What is the motivation for requiring this testing?
- Achieving a good Power Factor(pf)!

Intensity of a Fixture With Alternative Lighting Source

Intensity of a Fixture With Alternative Lighting Source

- Brightness perception
 - Pilots have reported a higher brightness of LED fitted lights, especially when taxiing in good visibility conditions.
 - Tungsten Halogen lamps have a continuous spectrum. LED fitted lights emit all their light in a very narrow bandwidth
 - Typically between 10 and 50 nm

Intensity of a Fixture With Alternative Lighting Source

- Light Emitting Diodes (LED)
 - Standard Incandescent lights have been around for over 60 years.
 - LEDs while not new, have finally achieved intensity levels to be considered for use on airports.
 - NOT just another “light bulb” that can plug and play!

Intensity of a Fixture With Alternative Lighting Source

- The eye is very sensitive to contrast.
 - The higher the contrast is the higher the brightness perception (good visibility).
- There is a quantifiable “brightness/luminance” ratio.
 - The conversion factor equals
 - 1.4 for blue and green
 - 1.6 for white

Intensity of a Fixture With Alternative Lighting Source

- However, light scattered by Fog can desaturate LED signal colors reducing or eliminating the brightness advantage.

Chromaticity – Fixture Daytime Viewing

Chromaticity – Fixture Daytime Viewing

- A means must be provided on all L-860E, L-861T, L-861E, L861SE and L-862E elevated airport to indicate specified light color during daytime viewing.
- Defined chromaticity boundaries for LEDs per EB-67D

LED L-861T Taxiway Edge

- Original LED Taxiway Edge Light
 - Transparent light filter
 - Small surface area for color blue to denote type of fixture



LED L-861T Taxiway Edge

- Present LED Taxiway Edge Light
 - Standard globe
 - Larger surface area for color blue



Innovative and Energy-Saving Product Utilizing LED Light Source

Electrical Infrastructure Research Team (EIRT)

A team of FAA and Industry experts formed to design an Airport Lighting Infrastructure to take full advantage of new lighting technologies.

Electrical Infrastructure Research Team (EIRT)

Goals

- A system that promotes interoperability.
- Reduced life cycle cost without dependence upon a single source.
- A standards-based, robust architecture airfield lighting system.

Innovative and Energy-Saving Product Utilizing LED Light Source

- Circuits considered:
 - 450 V, AC Parallel Circuit
 - 2 Amp, DC Series Circuit
 - 2.8 Amp, AC Series Circuit
 - AC Series Circuit w/ Control and Monitoring
- Currently conducting small scale circuit testing

Electrical Infrastructure Research Team (EIRT)

- Currently developing the test criteria and metrics for testing these circuits.
- Once criteria established:
 - Start conducting small scale testing at the William J. Hughes Technical Center.

Innovative and Energy-Saving Product Utilizing LED Light Source

LED Advanced Power System



REPORT

3933 US ROUTE 11 CORTLAND, NEW YORK 13045

Order No. G100337647

Date: May 12, 2011

REPORT NO. 100337647CRT-001

TEST OF TAXIWAY AND RUNWAY LIGHT FIXTURES

RENDERED TO:

ADB AIRFIELD SOLUTIONS, LLC
977 GAHANNA PARKWAY
COLUMBUS OH 43230

INTRODUCTION

This report contains the results of examinations and tests of the above device to demonstrate compliance with the applicable requirements of U. S. Department of Transportation, Federal Aviation Administration, Advisory Circular, Specification for Runway and Taxiway Light Fixtures, AC No. 150/5345-46D, dated 05/19/09.

Summary

The following is a summary of the results of tests of the device performed in accordance with the following portions of AC No.150/5345-46D.

<u>Test</u>	<u>Requirement Paragraph (AC 150/5345-46D)</u>	<u>Test Method (AC 150/5345-46D)</u>	<u>Remarks</u>
Photometric	3.3	4.3	Complies

***A Solution for an Airfield Lighting Architecture
that is Optimized for LED Technology***

Advanced Power Supply System

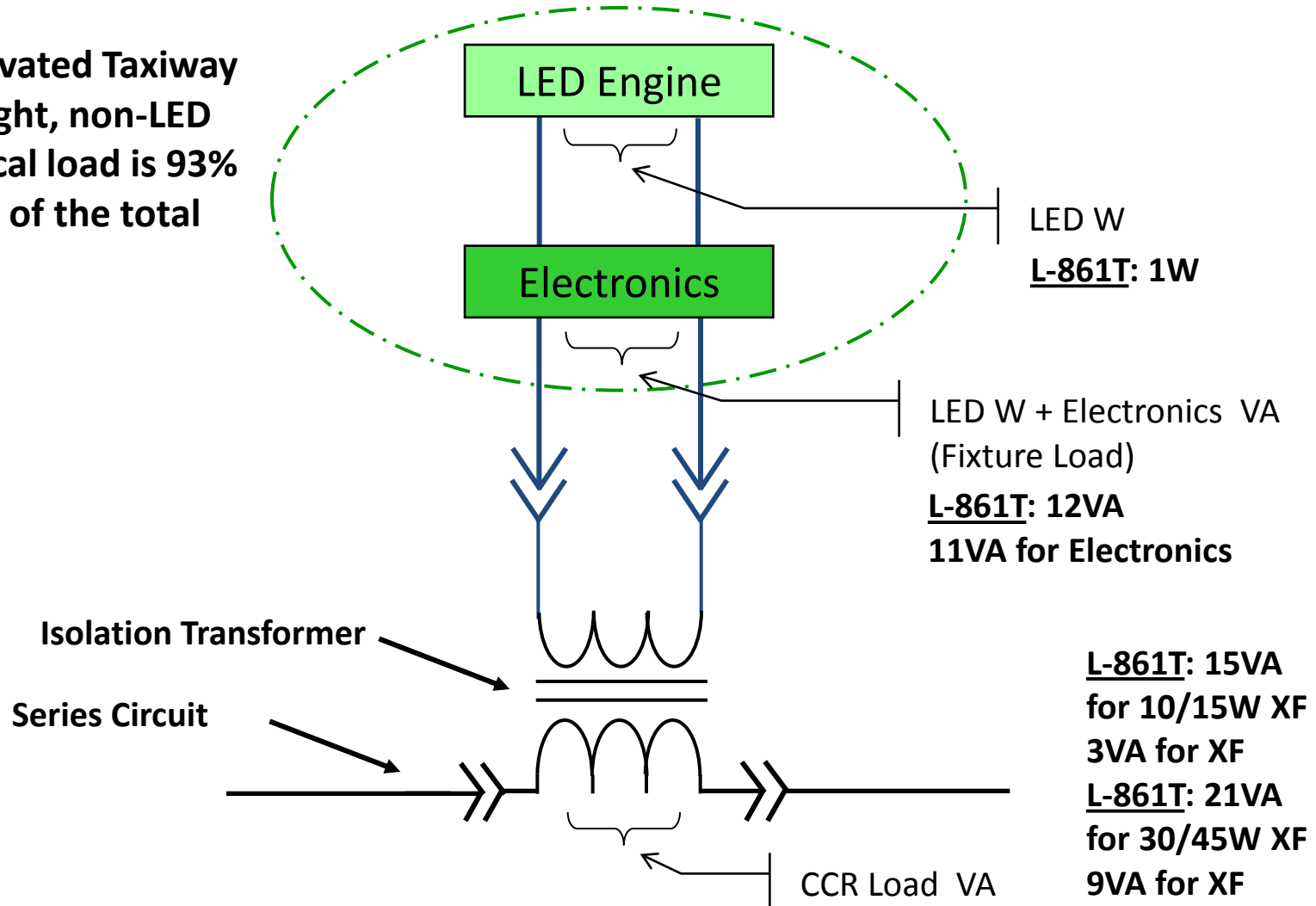
Alternating PWM Power Supply for LEDs

APS - What are the Primary Goals?

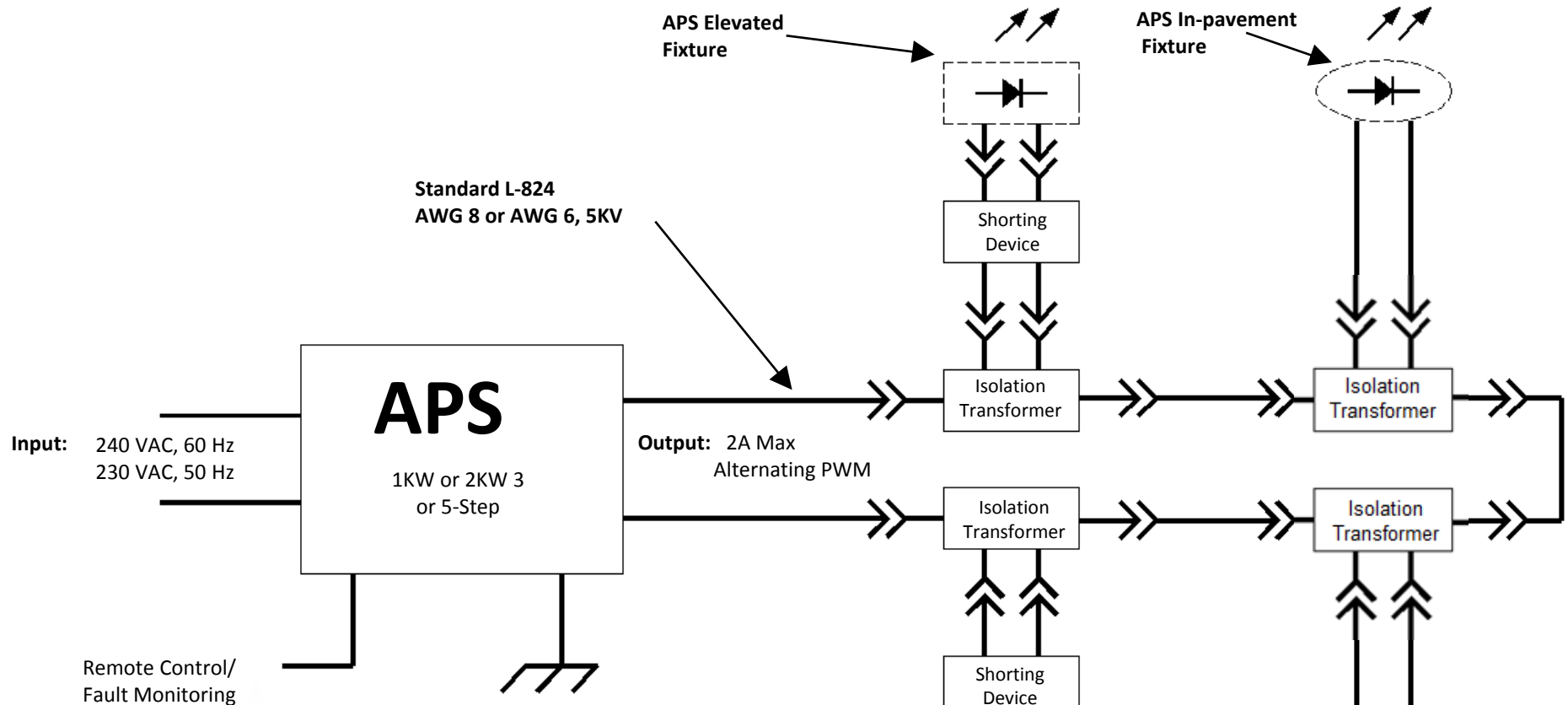
- Minimum fixture complexity
 - Greater reliability, due to lower equipment component part count
 - Further reduced energy consumption (compared to 6.6A LED systems)
- Based on a series circuit

6.6A LED Fixture Loading

For Elevated Taxiway
Edge light, non-LED
electrical load is 93%
to 95% of the total
load



APS Architecture

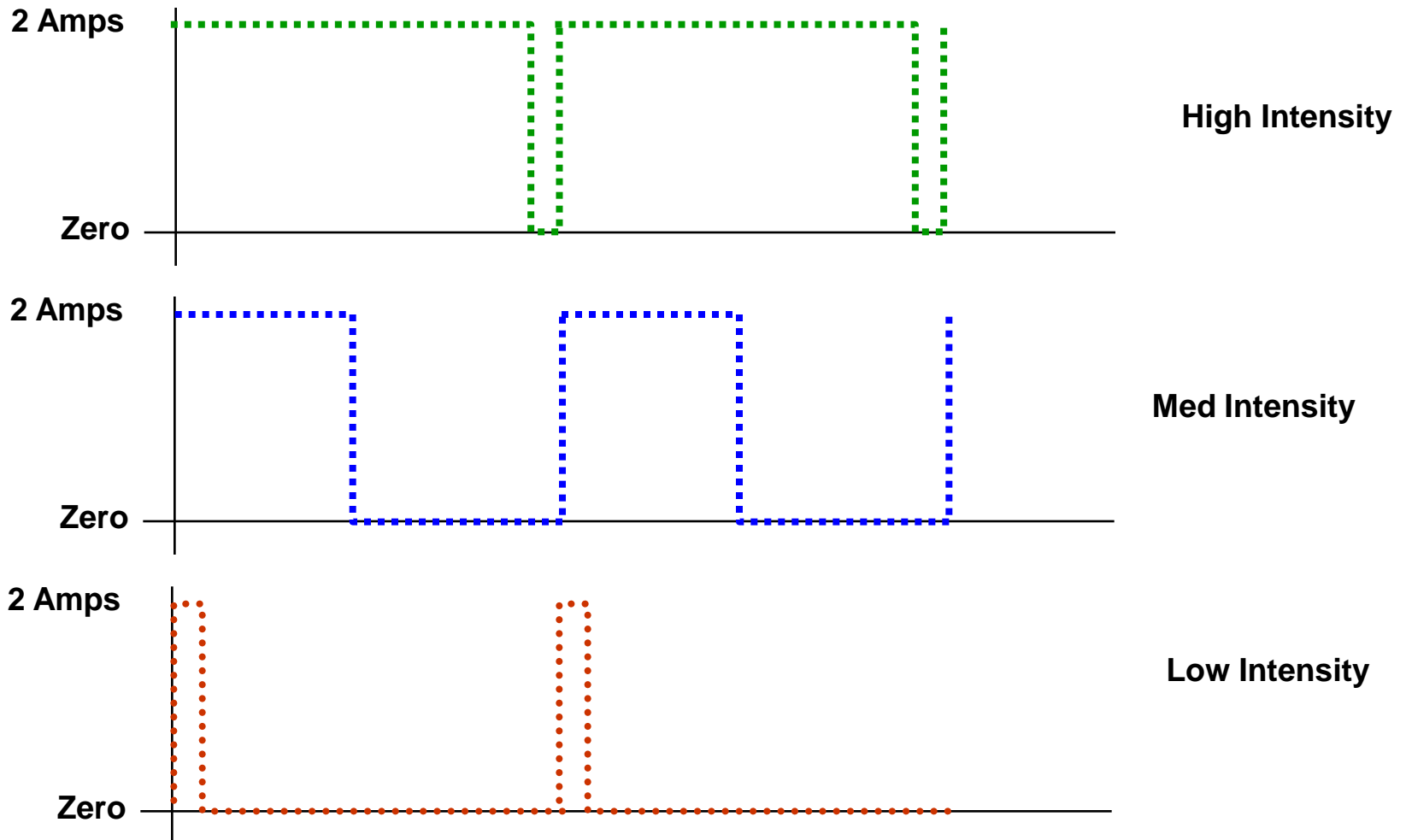


Isolation Transformer and Shorting Device:

- Transformer isolates the fixture from the series circuit, insuring there is a low voltage on the fixture input terminals
- Bypasses the Alternating PWM current in case an elevated fixture is knocked over

APS Output is Pulse Width Modulated in Order to Communicate Intensity Level

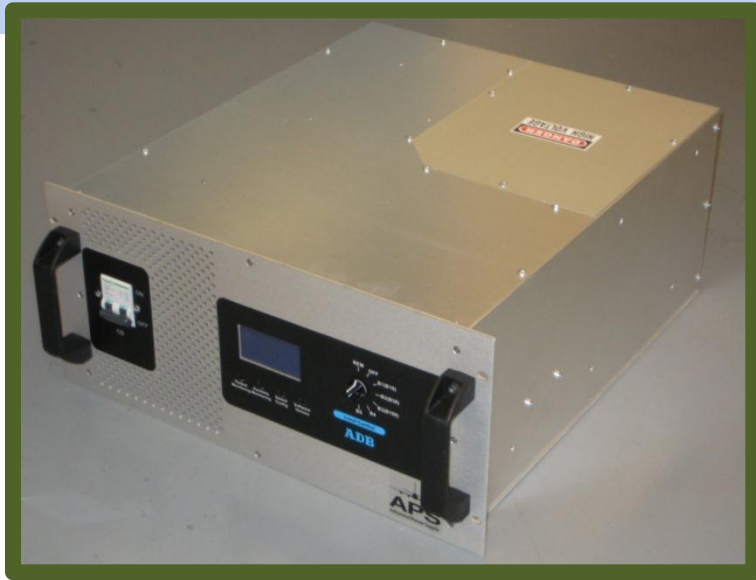
- PWM: Vary width of ON time, but (when ON) current is at nominal level



APS- Benefits

- Decreased overall system complexity (i.e. greater reliability)
- Uses lower operating voltages (safety)
- Increase savings on energy costs due to reduction in:
 - Fixture losses
 - Series Circuit wire line loss
 - Power Supply losses

APS Installation Benefit



9.06" H x 19.00" W x 20.10" D

Space Savings

Up to **5** APS in a single Cabinet
(2 x Runway, 2 x Taxiway, 1 Spare)



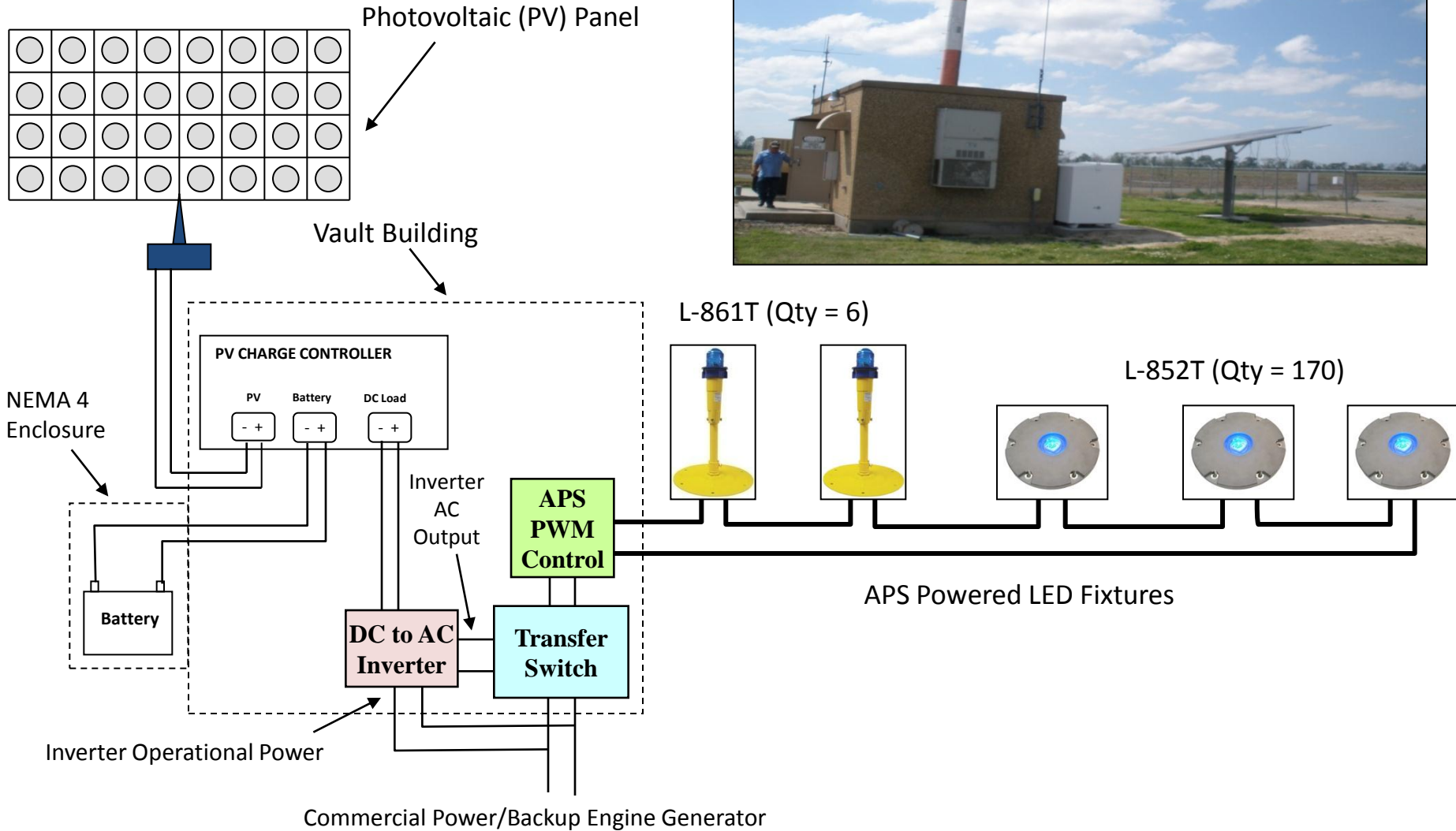
APS- Airfield Fixture Availability

- Elevated Taxiway Edge Light
- In-pavement Taxiway Edge Light
- In-pavement Taxiway Centerline Light
- Obstruction Light
- Medium Intensity Elevated Runway Edge Light
- Airfield Signs

Some APS Installation References

- **Atlanta, GA- Operational October 2006**
 - 1 circuit with 30 L-852T and nine L-810 fixtures
 - 1 circuit with 60 L-852C fixtures
- **RAF Mildenhall, UK- Operational May 2010**
 - 1 circuit with 62 ICAO Taxiway in-pavement edge fixtures
- **Windsor, ON- Operational July 2010**
 - 1 circuit with 91 elevated taxiway edge fixtures
- **Calgary, AB- Operational October 2010**
 - 1 circuits with 30 total elevated taxiway edge fixtures
- **False River, LA- Operational May 2010**
 - Solar powered system
 - 1 Circuit with 170 L-852T and 6 L-861T fixtures
- **Niagara, ON- Operational June 2011**
 - 4 circuits with 60 total elevated medium intensity runway edge and 131 total elevated taxiway edge fixtures

Louisiana Solar Powered Project



Louisiana Solar Powered Project



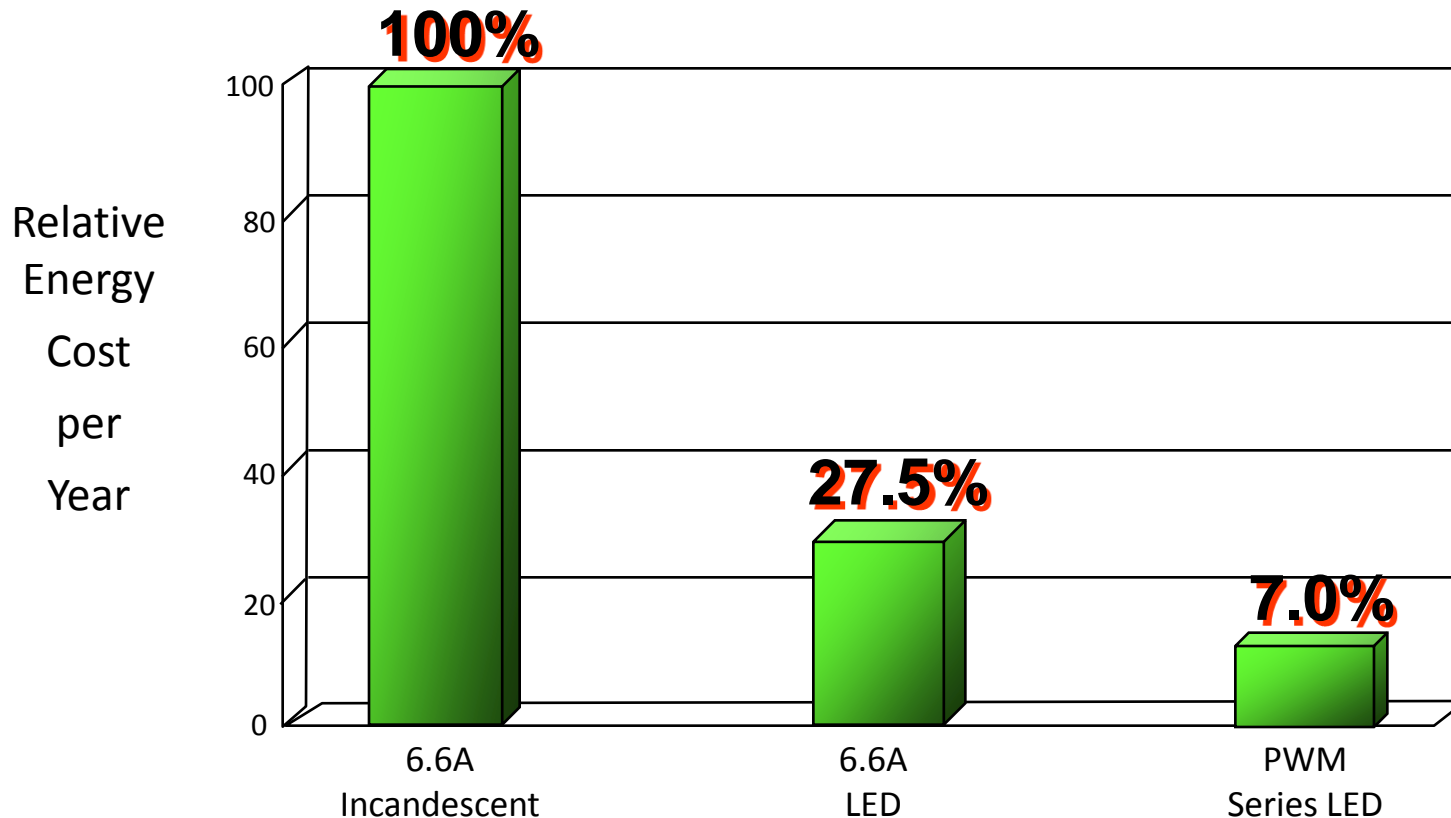
APS Business Case

False River Airport, Louisiana- Operational since May 2010

	Traditional Circuit	APS Circuit
Elevated Taxiway Fixtures	45 Watts	3.8W (LED)
Transformer Loss	9 Watts	0
Quantity	164	164 (In-pavement)
Circuit Length	18,000 feet	18,000
Circuit Power Loss	517 Watts	47.52 Watts
Total Circuit Load	8,906 Watt	670 Watts
CCR Size Required	15kW	1kW APS

Energy Savings **93%**

System Energy Use Comparison



Based on average energy use for 164 elevated taxiway edge fixtures
(Data obtained from False River Regional Airport project)

Atlanta International Airport



- (2) 1kW APS units

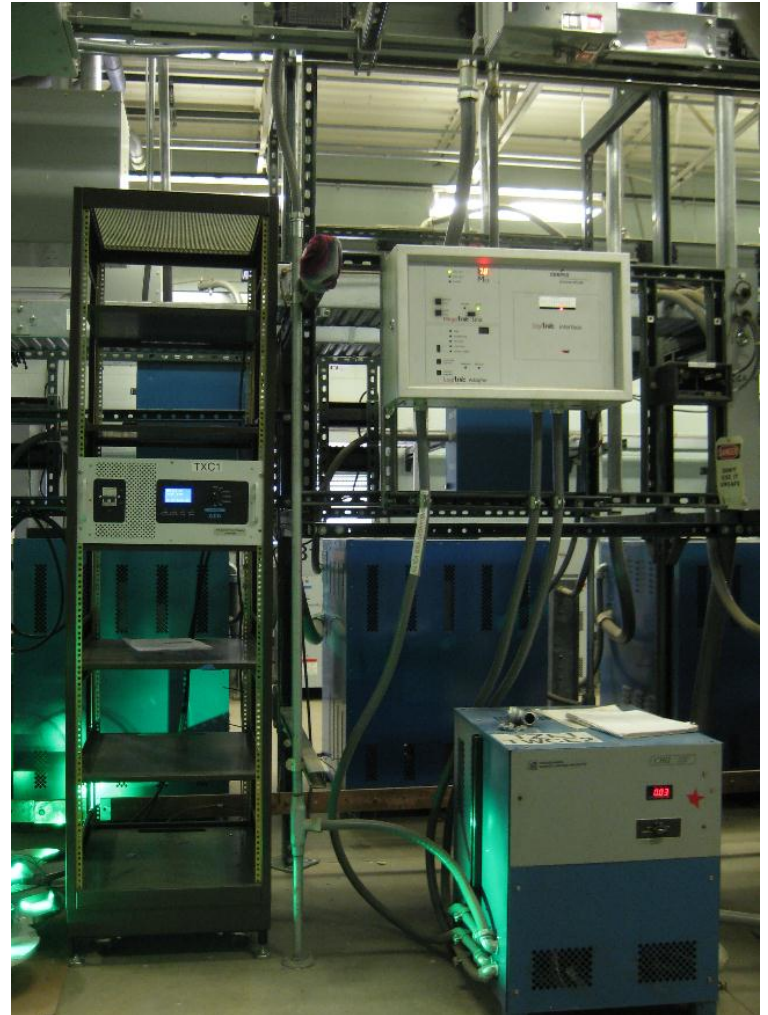
Installed Oct 06. ATL installation of DC LED fixtures consists of 2 circuits:

30 L-852T and 9 L-810 on Ramp 6N and along Taxiway F
60 L-852C on Taxiway D between Taxiway F and Ramp 6N



Denver International Airport

- (1) 2 KW APS
- (60) Taxiway C/L In-pavement fixtures



Niagara District, ON

Power on June 2011

- 4 circuits with 60 total elevated medium intensity runway edge and
- 131 total elevated taxiway edge fixtures



Questions?

DRAFT AC 5345-43G, PRINCIPAL CHANGES

$$I_e = \left(\frac{\int_{t_1}^{t_A} Idt}{0.2 + t_A - t_1} \right) + \left(\frac{\int_{t_B}^{t_C} Idt}{0.2 + t_C - t_B} \right) + \left(\frac{\int_{t_D}^{t_E} Idt}{0.2 + t_E - t_D} \right) + \dots + \left(\frac{\int_{t_X}^{t_Z} Idt}{0.2 + t_Z - t_X} \right)$$

- The method of computation is different.
- The previous equation from the Edwards AFB Experiment:

Notice that the values in the denominator are different than Yoshi Ohno's equation from NIST where: the sums of integrals are divided by the entire time from t1 to t2.

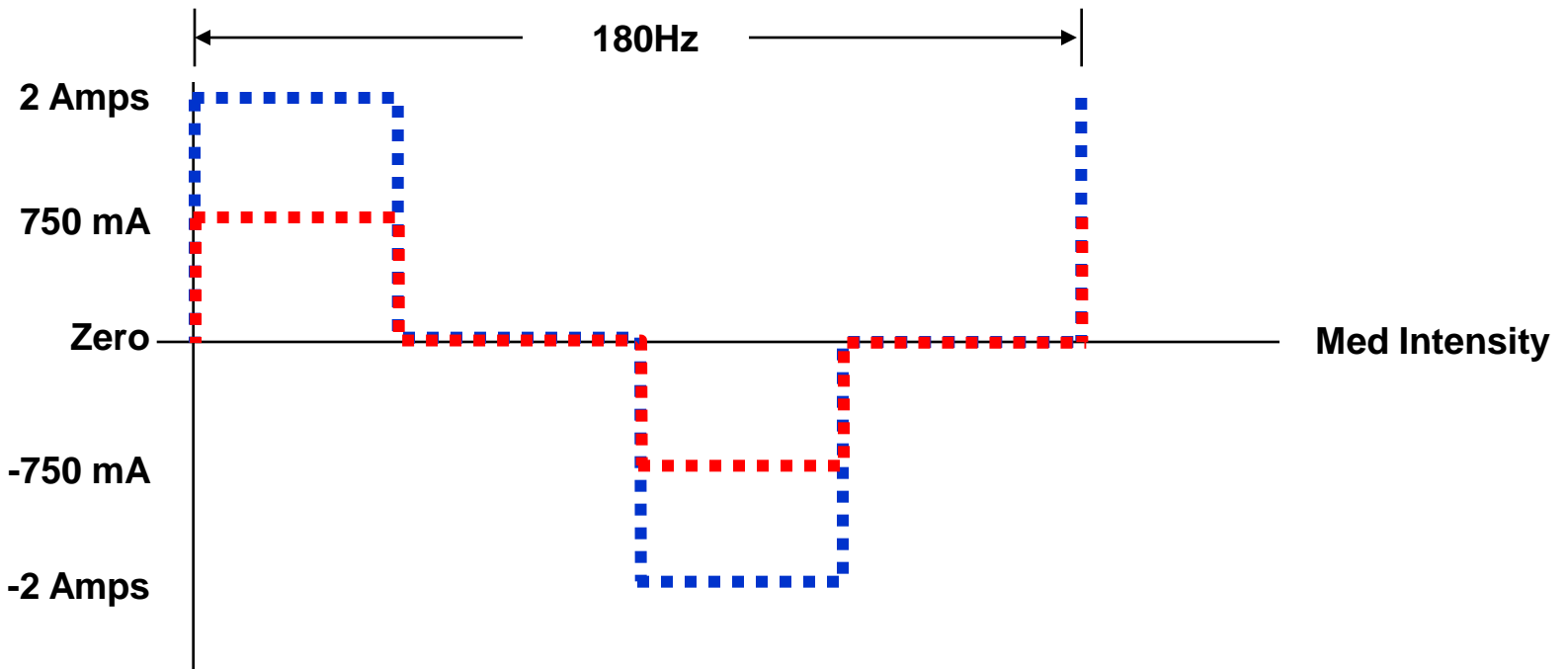
The denominator of the Ohno equation: $1/a + (t_2 - t_1)$

Power Factor Definition

- Power Factor = Cosine of phase angle between voltage and current.
- Power factor has no units.
- The value of PF ranges from 0 to 1.
- Loads that are only resistive (no capacitance or inductance) have a PF of 1.

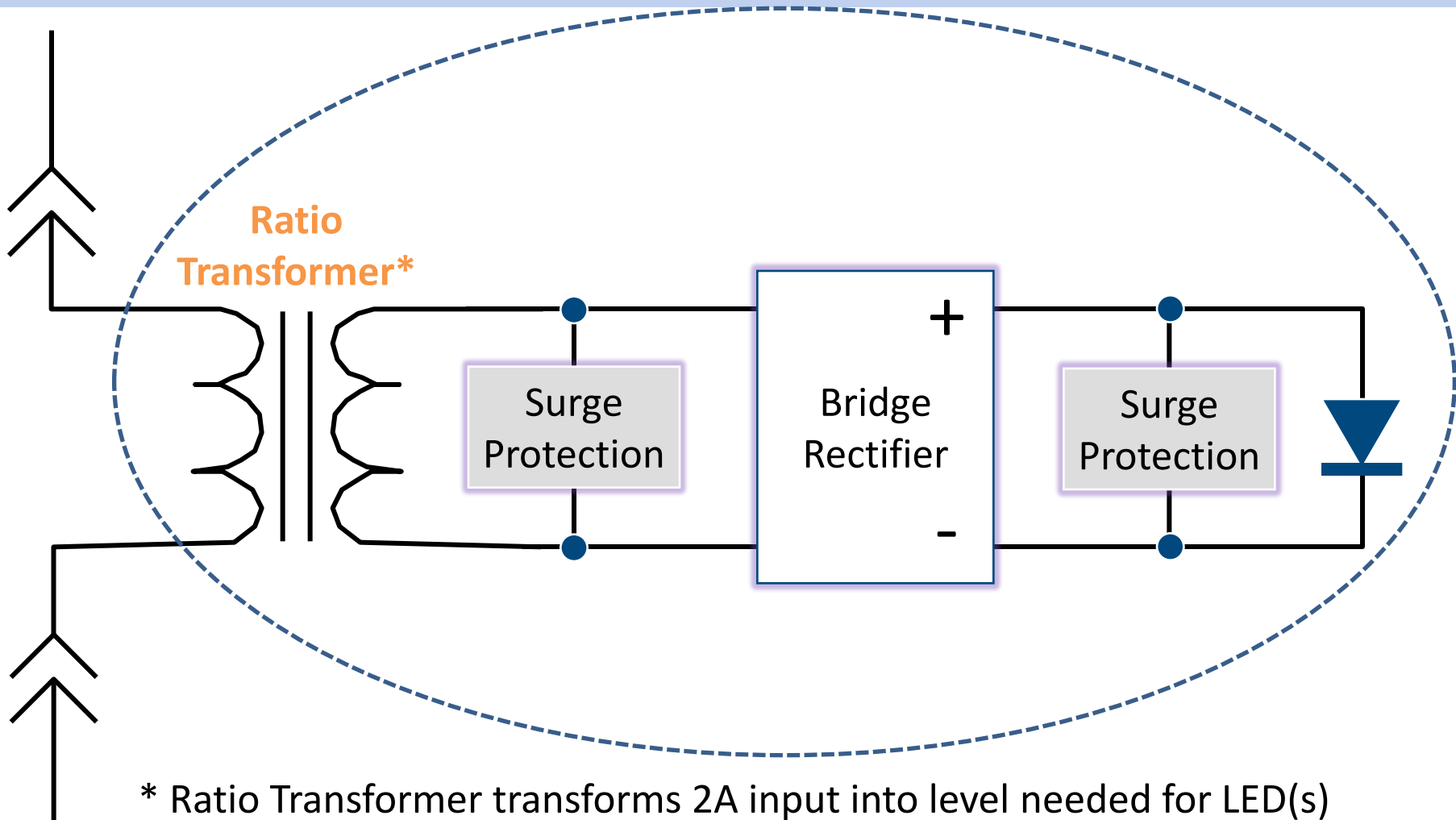
APS Output- Alternating PWM

- Power Supply output alternates in order to pass through fixture isolation transformer



- Fixture isolation ratio transformer outputs current needed by fixture LED(s)

APS Fixture Implementation



Alternating PWM

- After passing through ratio transformer, current to LED(s) are converted to all positive cycles by the Bridge Rectifier

