Energy savings
Airfield lighting systems

Presented by
Eric Cantin, ing.
&
Nancy Majoulian

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Presentation content

- Typical Series circuit
- Components
- LED Airfield Lighting
- APS System
- ROI
- Methods of saving
- Typical interventions
- Example of project
- Solar systems
General airfield lighting layout
Electrical Components

- Constant Current Regulator
- Cable
- Transformer
- Lights
Typical installation – One circuit
Typical installation – Three circuits
Solutions

Evolution of LEDs on Airfields

Building Partnerships for the Future

Intensity

100,000 Elevated LED
Shipped Nov 08

Time

2002 2003 2004 2005 2006 2007 2008 2009 2010

L-861T L-810 L-852A-D L-852T 7 L-858 L-804 L-852G L-862 L-861 L-850A & B
LED Technology

Efficiency
• 150,000+ hrs
• Two to four times more energy-efficient than incandescent fixtures
• Reduces existing load on CCR equipment

Operational Value
• Can plug directly into existing circuits
• Operates on wide voltage range of 95-264Vac, 50/60 Hz
• Can be used on existing isolation transformers and all types of CCRs:
  • 3 and 5-step
  • Ferroresonant
  • Thyristor

“Smart electronics”
• LED current to match light output of incandescent fixtures
If output not corrected, LED fixtures in midst of T-H or incandescent fixtures could be much brighter than surrounding fixtures.
Taxiway Edge In-pavement/Elevated LED

- World's first Single LED ETL Certified Taxiway Edge Light
- Glass lens provides better daytime visibility
- Polycarbonate lens withstands damage if fixture is knocked over
- Heater* option, thermostatically controlled cycles on and off
- L-861T: 12VA without heater and 25VA with heater
- L-852T: 19.5 VA without heater and 44VA with heater

Return on Investment (ROI)

- Typical L-861T (w/o heater) ROI: 2.4 years
  (w heater) ROI: 2.8 years
- Typical L-852T (w/o heater) ROI: 2.6 years

* Heater switches on at 4° Celsius. Test demonstrate that the heater was on only 40% of the time when ambient temperature was -4° Celsius
Taxiway Centerline In-pavement LED

Benefits
- Style III (<1/4” above pavement)
- Lower temperature of the lens prevents contaminant baking effect
- 100% factory leak, insulation resistance, and light tested - Greater reliability in the field

Return on Investment (ROI)
- Typical L-852D ROI: 2.1 Years
Stop Bar and Lead-On In-pavement LED Fixtures

- ICAO/TP 312E Compliant
- 8” dia; Style 2 (<0.5”)
- Available in Red for Stop Bar; Green or Yellow for Taxiway Lead-On
- Fast turn On or Off time
- No color shifts at wide angles or varying CCR intensity steps
- Provides for individual control and monitoring using the BRITE system
Minimizing Risk of Snow Plow Damage

12” Fixture with Snow Plow Ring

8” Fixture with 12” Snow Plow Ring
Elevated L-804 RGLs

- Eliminates re-lamping expenses & reduces maintenance costs
- Traffic signal yellow color does not vary with intensity step, increasing visibility to pilots
- Options for instant on/off or incandescent curve
- Option for external LED monitoring available

Return on Investment (ROI)
- Typical L-804 ROI: 3.2 Years
Runway In-pavement Centerline and Touchdown Zone Fixtures

- Available either FAA Certified or ICAO/TP 312E compliant
- Style 3, (<0.25 in.)
- 12”
- Direct replacement for existing tungsten-halogen fixtures
- Eliminates the need to shut down the runway for lamp maintenance
- Eliminates color shift which occurs with Tungsten-Halogen lamps in lower CCR steps

Return on Investment (ROI)
- Typical L-850A ROI: 3.5 Years
Prince George, C.-B., Canada – 1st LED Runway Centerline in the World

- YXS (Prince George Airport, BC Canada)
- NUW (Whidbey Island Naval Air Station, WA)
- DFW (Dallas Fort Worth International, TX)
- RDU (Raleigh Durham International, NC)
- CAE (Columbia Metro Airport, SC)
- RYG Rygge Air Base, Norway
- JQF (Concord Regional Airport, NC)
- LCK (Rickenbacker International Airport, OH)
- SGJ (St. Augustine Airport, FL)
- ASY (Eareckson Air Station, Alaska)
- TPA (Tampa International Airport, FL)
- ADW (Andrews AFB, MD)
- RIC (Richmond International Airport, VA)
- CLT (Charlotte Douglas International)
- POS (Piarco International Airport, Trinidad & Tobago)
- PUJ (Punta Cana International Airport, DOM)
Medium Intensity Elevated Runway Edge and Runway End LED Fixtures

• Available either FAA Certified or ICAO/TP 312E compliant
• Available as white, white/yellow or red/green
• Eliminates the need to shut down the runway for lamp maintenance
• Hinged top easily removed for maintenance
• Direct replacement for existing tungsten-halogen fixtures
• Eliminates color shift which occurs with Tungsten-Halogen lamps in lower CCR steps
• Available with Canadian external cordset option

• Niagara (YQN), ON, Canada
• Nakina (YCM), ON, Canada
• Merrill Field (MRI) - Anchorage, Alaska
• Vero Beach (VRB), Florida
• Raleigh Durham (RDU) – North Carolina
**LED Three-Step and One-Step REILs**

- Improved Safety
- Increased Energy Savings
- Lower Maintenance Costs

- Elimination of expensive xenon flash lamp replacement
- Very low voltage internal to LED REIL vs. 2000V DC in traditional xenon flash lamp units
- Energy savings of up to 33% to 78% for voltage-driven units, and up to 96% for any series circuit application with power adapters
- Elimination of ozone, generated by xenon flash lamps, an oxidant that degrades internal component life

**Return on Investment (ROI)**

- Typical L-849E ROI: 6 months

Compared with Series Circuit powered using Power Adapter
Internally Illuminated FAA Airfield Signs

• Virtually eliminates runway/taxiway shutdowns
• More uniformly illuminated than conventional signs - Provides optimal pilot visibility
• Eliminates re-lamping expenses and reduces on-going maintenance costs
• Improved safety with low, regulated DC voltage inside sign
• Has fewer legs than conventional signs - Reduces installation cost

Return on Investment (ROI)
• Typical Sign ROI: 1.9 Years
On the horizon

- LED L-862 Runway Edge and L-862E Runway End
- Eliminates the need to shut down the runway for lamp maintenance
- Top cover with optics/ electronic module easily removed and replaced
- Lens available as either glass or polycarbonate
- Available with Canadian external cordset option

L-862 Runway Edge
L-862E Runway End
## System Parameters
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of fixtures</td>
<td>100</td>
</tr>
<tr>
<td>Energy Price (present cost) per kWh</td>
<td>$0.120</td>
</tr>
<tr>
<td>Average Operating Time per year in hours</td>
<td>4380</td>
</tr>
<tr>
<td>Optional ROI calculation methodology:</td>
<td>100%</td>
</tr>
<tr>
<td>Percentage of investment using local funds</td>
<td></td>
</tr>
</tbody>
</table>

## Maintenance Costs

<table>
<thead>
<tr>
<th></th>
<th>LED</th>
<th>Incandescent</th>
<th>Savings (Cost)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Replacement Lamp Cost</td>
<td>$0.00</td>
<td>$0.00</td>
<td></td>
</tr>
<tr>
<td>Average Replace Lamp Labor, Fuel Cost, Coordinate Airfield Closure per fixture</td>
<td>$0.00</td>
<td>$35.00</td>
<td></td>
</tr>
<tr>
<td>Average lamp replacements per year</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Routine Maintenance Cost per year</td>
<td>$0.00</td>
<td>$7,000.00</td>
<td>$7,000.00</td>
</tr>
</tbody>
</table>

## System Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>LED</th>
<th>Incandescent</th>
<th>Investment (Savings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Equipment Cost- CCR</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Fixture Purchase Cost</td>
<td>$180.00</td>
<td>$130.00</td>
<td>$50.00</td>
</tr>
<tr>
<td>Capital Equipment Cost- Isolation Transformer</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Total of Capital Equipment Investment</td>
<td>$5,000.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Energy Costs and Savings

<table>
<thead>
<tr>
<th>Energy Costs and Savings</th>
<th>LED</th>
<th>Incandescent</th>
<th>Savings (Cost)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Size Used (Watts)</td>
<td>4,000</td>
<td>7,500</td>
<td></td>
</tr>
<tr>
<td>Average CCR Efficiency</td>
<td>85%</td>
<td>85%</td>
<td></td>
</tr>
<tr>
<td>Average Fixture Load (VA)</td>
<td>6</td>
<td>22.5</td>
<td></td>
</tr>
<tr>
<td>Average Isolation Transformer load (VA)</td>
<td>1.5</td>
<td>4.5</td>
<td></td>
</tr>
</tbody>
</table>

### Total Yearly Savings (Energy + Lamp + Labor): $8,301
On Total Investment of: $5,000
Investment portion using local funds: $5,000
LED Return on Investment (ROI): 0.60 years

**NOTE:** ROI value should be considered as a conservative estimate because other savings may be present such as airport operations savings due to reduced airfield down time.

Total Ongoing Energy & Labor Costs/Year if Incandescent is used instead of LED: ($8,301)

### Percentage Savings due to:

- **Energy Cost**: 15.7%
- **Lamp Replacement Cost**: 0.0%
- **Lamp Replacement Labor**: 84.3%
- **Capital Equip (Power + Fixture equipage) – only if savings**: n/a

100%
### Life Cycle Cost

<table>
<thead>
<tr>
<th>Fixture Lifetime (years)</th>
<th>15</th>
<th>Cost (Savings)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total System Acquisition Cost</td>
<td>LED</td>
<td>$18,000.00</td>
<td>$5,000.00</td>
</tr>
<tr>
<td></td>
<td>Incandescent</td>
<td>$13,000.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Installation Cost</td>
<td>LED</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td></td>
<td>Incandescent</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Total Operating Cost (energy)</td>
<td></td>
<td>$10,643.40</td>
<td>$30,156.30</td>
</tr>
<tr>
<td>Routine Maintenance Cost (light-source + labor only)</td>
<td></td>
<td>$0.00</td>
<td>$105,000.00</td>
</tr>
<tr>
<td>Other Maintenance Cost (over lifetime)</td>
<td></td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Total Life Cycle Cost</td>
<td></td>
<td>$28,643.40</td>
<td>$148,166.30</td>
</tr>
</tbody>
</table>

After 15 years, the total estimated reduction of emissions is 91.5 metric tons of CO₂, or about one year’s worth of emissions from 18 vehicles or 7.8 to 11.1 homes.
Consumption Calculations
Methods of saving

➢ Operation

1. Procedures – Air traffic control
2. Electrical system – ARCAL
Methods of saving

- Equipment replacement - Case Study

Small Regional Airport

- 5,000 foot runway
- Small apron (4-5 plane parkings)
- 500 foot taxiway between runway and apron
Methods of saving

Electrical costs

Equipment:
- Runway: 45 W lamps, 45 W transformers
- Taxiway and apron: 45 W lamps, 45 W transformers
- Cable length: 4 km

Consumption: 29,200 KWH = 2 050$/year

(based on 12hours/day, 365 days/year operation, price of electricity = 0.07$/kwh)
Methods of saving

- Physically

1. Maintenance project – minor change
2. Maintenance project – major change
3. Construction project – major change
Maintenance project
Minor changes

➢ Light fixture replacement
Maintenance project
Minor changes

Equipment:

- Runway: 20 W lamps, 45 W transformers
- Taxiway and apron: 12 W lamps, 45 W transformers
- Cable length: 4 km

Consumption: 15,950 KWH = 1 125$/year

Savings: approximately 45%

(based on 12 hours/day, 365 days/year operation, price of electricity = 0.07$/kwh)
Maintenance project
Major changes

➢ Light fixture and transformer replacement
Maintenance project
Major changes

Equipments:
- Runway: 20 W lamps, 25 W transformers
- Taxiway and apron: 12 W lamps, 15 W transformers
- Cable length: 4 km

Consumption: 12,375 KWH = 875$/year

Savings: approximately 60%

(based on 12 hours/day, 365 days/year operation, price of electricity = 0.07$/kwh)
Solutions
Advanced Power Supply System

Alternating PWM Power Supply for LEDs
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
Initial design was based on supplying Constant Current DC

But it changed…

Why?

• Welding Arc Effect
• Galvanized Corrosion
• Intensity Control
For Elevated Taxiway Edge light, non-LED electrical load is 93% to 95% of the total load

LED Engine

Electronics

Isolation Transformer

Series Circuit

LED W

L-861T: 1W

LED W + Electronics VA (Fixture Load)

L-861T: 12VA

11VA for Electronics

L-861T: 15VA

for 10/15W XF

3VA for XF

L-861T: 21VA

for 30/45W XF

9VA for XF

CCR Load VA
Isolation Transformer and Shorting Device:

- 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
- Optionally used on in-pavement fixtures, depending on customer’s preference, since they are not subject to knock over
Airfield Solutions

Alternating PWM

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

```
| Zero | 750mA | 360Hz | Med Intensity |
```

360Hz
• Atlanta, GA - Operational October 2006
  ▪ 2 circuits with 30 L-852T and nine L-810 fixtures, 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
• Denver, CO - Operational October 2010
  ▪ 1 circuits with 65 total flush taxiway centerline fixtures (44 000 feet cable length)
• 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
• Fredericton, NB - Operational November 2011
  ▪ 1 circuit with elevated taxiway (blue) and apron (amber) fixtures, roughly a total of 105 fixtures.
• Montreal, QC - Operational January 2012
  ▪ 1 circuits with 30 total elevated taxiway edge fixtures
APS System
✓ Advantages

✓ Fixtures are series connected using isolation transformers, if one fixture is damaged or removed from the circuit, the remaining fixtures remain operational.

✓ Uses 5kV airfield lighting cable on all circuits. Edge lighting circuit can be run with other circuits in the same conduits, reducing installation costs.

✓ Uses square wave PWM AC current = no connector corrosion issues.

✓ APS Power Supplies are available in 1,000W & 2,000W units to suit present and future load requirements. Greater number of lights in one circuit possible.

✓ Circuits can power many types of elevated and inset lights.

✓ LED edge lighting is certified to FAA requirements and compliant with Transport Canada and ICAO requirements.
Construction project
Major changes

- Light fixture, transformer, cable and electrical source replacement
Construction project
Major changes

- Based on a replacement of complete system (electrical source, cable, transformers, lights) - up to 90%

- Based on replacement of all components but cable – up to 75%
Application

- Trudeau Airport – Montréal
- Taxiway Thimens
- Complete replacement of the system
  1. New electrical source (APS)
  2. New underground cabling and conduits
  3. New transformers and light fixtures
New cabinet and electrical source
New underground system
New underground system
New transformers and shorting device
End result
APS Commissioning January 2012
Montréal-Pierre Elliott Trudeau International Airport
Conclusions

- Results may vary depending on circuit length and equipment powered on the circuit;

- Savings on lamp replacement/maintenance, (LEDs vs Incandescent).
Louisiana Solar Powered Project

- Photovoltaic (PV) Panel
- Vault Building
- PV Charge Controller
- Battery
- DC Load
- NEMA 4 Enclosure
- Inverter AC Output
- DC to AC Inverter
- APS PWM Control
- Transfer Switch
- Inverter Operational Power
- Commercial Power/Backup Engine Generator
- APS Powered LED Fixtures
- L-852T (Qty = 170)
- L-861T (Qty = 6)
False River Regional Airport
False River Regional Airport
False River Regional Airport
**False River Airport, Louisiana**

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

**Energy Savings 93%**
Based on average energy use for 164 elevated taxiway edge fixtures
(Data obtained from False River Regional Airport project)
• Elevated Taxiway Edge Light (ETES)
• In-pavement Taxiway Edge Light (ITEL)
• In-pavement Taxiway Centerline Light (ITCF)
• Obstruction Light (SBOL)
• Medium Intensity Elevated Runway Edge Light (EMIL)

Future Availability
• Signs
• High Intensity Elevated Runway Edge Light (EREL)
Space Savings

9.06” H x 19.00” W x  20.10” D

Up to 5 APS in a single Cabinet
(2 x Runway, 2 x Taxiway, 1 Spare)
SMALLER F.E.C. =

Prefab F.E.C.
(3.5m large x 6 m long)

- SAVINGS
- FLEXIBILITY
- OPTIONS

9.06” H x 19.00” W x 20.10” D
Power on June 2011

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

Nancy Majoulian
National Sales Manager
ADB Airfield Solutions
Burlington, Ontario L7L 6W6
Office/ Bureau: (905) 331-9244
Nancy.Majoulian@adb-air.com
www.adb-airfield.com

Eric Cantin
Director Airport Sector
BPR, Tetra Tech Company
Montréal, Québec, H1V 3R9
Office/Bureau: (514) 257-0707
eric.cantin@bpr.ca
www.bpr.ca