Issues with the Use of Airfield LED Light Fixtures

John D. Bullough, Ph.D.
Lighting Research Center, Rensselaer Polytechnic Institute

Illuminating Engineering Society Aviation Lighting Committee

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Background

- Technological advantages of LEDs:
  - Durability and longevity (when designed properly)
  - Wide range of available colors
  - Narrowband output – saturated color appearance
  - High efficacy – low energy requirements
  - Immediate “switch-on/switch-off” time

- Questions about LEDs:
  - Lack of heat/infrared output
  - Compatibility with electrical infrastructure
  - Cost/return on investment
Airport Cooperative Research Program

- Transportation Research Board (TRB) of the National Academies commissioned a synthesis study
  - Funding from Federal Aviation Administration (FAA)
  - Overseen by topic expert panel from industry, academia and government (FAA and airports)
  - Review literature and published findings about airport experience with LEDs
  - Survey airports with LED experience to (hopefully) corroborate literature

- Provide a resource for airports considering LEDs to help set expectations and ensure they ask the right questions
The TRB Process

- Topic expert panel members are instrumental
  - Develop preliminary scope of work
  - Select contractor
  - Review outline and survey materials
  - Review initial and subsequent drafts
- TRB reviews final report for “sensitive statements,” editing and final production
- Report is published in hardcopy and PDF formats
Report Outline: ACRP Synthesis 35

- Methods
- Current practices and challenges
- Installation issues
- Operation and maintenance issues
- Economic issues
- Future outlook
- Resources for airports
Methods

- Literature review
  - IES Aviation Lighting Committee conference presentations
  - Transport Research International Documentation (TRID) database maintained by TRB
  - Trade press: *International Airport Review, Airport World, Aviation Week and Space Technology*, etc.
  - Newswires: *TendersInfo, States News Service*, etc.

- Survey of 22 airports/aviation agencies with LED experience
  - Input from topic expert panelists to identify respondents
Current Practices: Types of Systems

![Diagram showing the types of lighting systems and their frequency as perceived by respondents.](image-url)
LED System Experience
Perceived LED Challenges

- Electrical compatibility
- Questions about heat/ice build-up
- Higher initial costs
- Finding objective technical information
Installation Issues: Expectations

- Primary reasons for LED installation:
  - Reduce maintenance costs (20)
  - Reduce energy use (18)
  - Improve visibility (13)

- Not concerned about incandescent lamp availability following Energy Independence and Security Act (EISA) of 2007
  - EISA exempts rough service lamps and certain applications such as airfield lighting
Installation Issues: Ease

- Most survey respondents (16) reported that LED installation was easy
  - No special tools/training necessary
  - A few mentioned modifications to improve compatibility with thyristor-type constant-current regulators (CCRs), or replacement of some transformers

- Installation led by contractors (18) with some assistance (10) by airport staff
Installation Issues: Compatibility

- Most respondents (19) reported compatibility with existing infrastructure
  - Minor issues with silicon controlled rectifier (SCR) regulators (replaced with ferroresonant regulators to improve compatibility)
  - One respondent adjusted regulators to correct flickering upon installation
Operation and Maintenance (O&M) Issues

- Failures were relatively infrequent
  - In comparison, most common annual failure rates for road traffic signals were <1% and 1%-5% (Urbanik 2008)
O&M Issues: Weather

Few airports have conducted analyses regarding need for heaters
O&M Issues: Monitoring

- FAA guidance requires fixtures to maintain 70% of initial light output, and no more than 25% of LEDs within a lighting fixture to fail (Eng. Brief 67D)
O&M Issues: Other

- Maintenance issues such as water/fluid ingress and broken fixtures from plowing/sweeping are no different than incandescent systems.

- LED systems use substantially less energy and require less maintenance.
  - Energy savings with lower-current circuits could increase energy savings from 50% to nearly 90%.
  - Maintenance cost reductions are not documented precisely or on a widespread basis.

- LED airfield lighting is often judged brighter or more visible.
Economic Issues

- Half of survey respondents (11) conducted an economic analysis prior to LED installation
- Initial cost of fixtures was reported as higher than conventional lighting (20)
- Most (14) reported similar labor costs
- Three airports reported that they recovered initial costs within 3 years, five expected to recover within 2-10 years
## Economics: Energy and Maintenance Costs

<table>
<thead>
<tr>
<th>Airport and (Author Date)</th>
<th>Airfield Lighting System(s)</th>
<th>Savings (Expected or Realized)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prescott Municipal Airport (U.S. Fed News Service 2006; Klein and Napit 2007)</td>
<td>Taxiway lights (one taxiway)</td>
<td>$9,800/year: energy and maintenance (expected)</td>
</tr>
<tr>
<td>Raleigh–Durham International Airport (Pittman 2010)</td>
<td>Airfield lights</td>
<td>$400,000/year: energy and maintenance (realized)</td>
</tr>
<tr>
<td>Tulsa International Airport (Stewart 2011)</td>
<td>Taxiway edge lights</td>
<td>$25,000/year: energy (expected)</td>
</tr>
<tr>
<td>Vero Beach Municipal Airport (TendersInfo 2010)</td>
<td>Taxiway lights (one taxiway)</td>
<td>$7,700/year: operating costs (expected)</td>
</tr>
<tr>
<td>Will Rogers World Airport (Hough and Gilbreath 2010; Brus 2011)</td>
<td>Airfield lights (800+)</td>
<td>$60,000/year: energy and maintenance (expected)</td>
</tr>
</tbody>
</table>
Future Outlook

- Most (18) respondents planned future LED installations
- But not major electrical infrastructure work (19)
Conclusions

- LED airfield lighting systems for taxiway and runway lighting are available and functional
  - FAA guidance (EB 67) continues to evolve to address issues found in earlier installations
  - FAA maintains a list of certified LED airfield lighting fixtures through Advisory Circular (AC) 150/5345-53

- Lower energy and maintenance costs offset higher initial costs within a few years
  - Most savings come from reduced maintenance
Conclusions (cont’d.)

- No special equipment or training is needed for LED installation, and reliability improves with each product generation
- Current electrical power infrastructure is not optimized for LED energy savings, nor reliability
  - FAA is currently investigating through its Electrical Infrastructure Research Team (EIRT)
Information Gaps

- Long-term LED fixture performance data are rare
- Impacts on maintenance costs are scarce although they likely are the primary source of savings
- Analysis methods for identifying if/when LED fixture heaters are needed are lacking
- Characteristics of electrical infrastructure for optimizing energy and reliability need to be identified
Additional Resources in ACRP Synthesis 35

- 80+ bibliographic reference citations
- Technical overview of LED lighting systems
- Detailed survey responses
- List of 50+ airports with LED airfield lighting
- List of FAA guidance and resources
- Pointers to technical resources (including IESALC)
- Links to economic analysis tools
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onlinepubs.trb.org/onlinepubs/acrp/acrp_syn_035.pdf