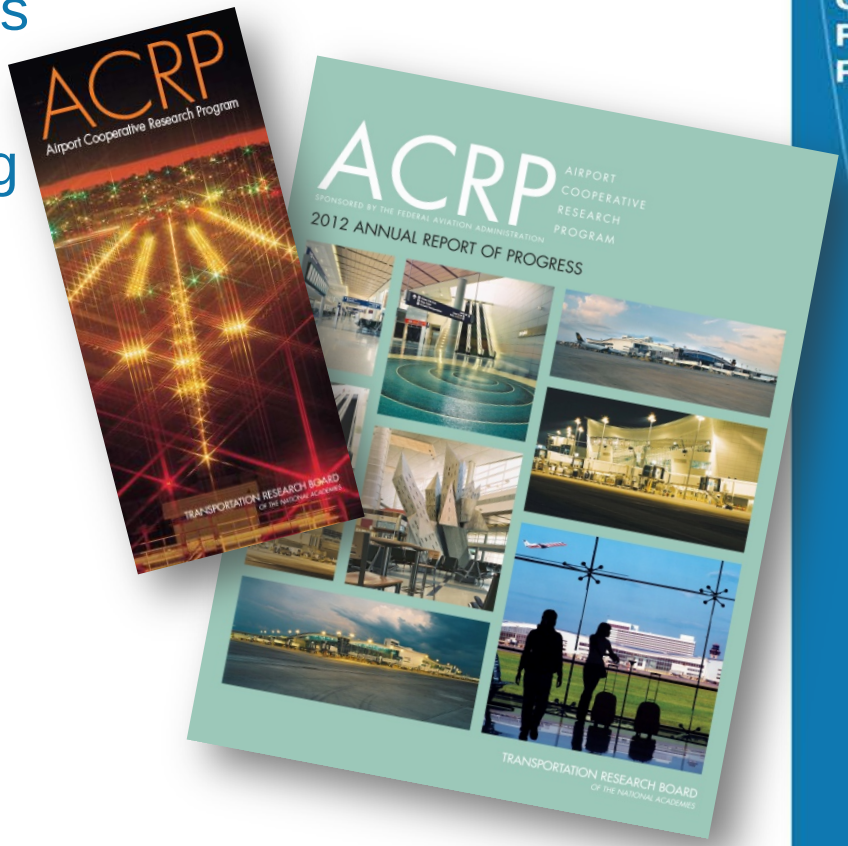
Information on ACRP

- www.TRB.org/ACRP
- Regular news and updates on:
  - Upcoming and ongoing research projects
  - New publications
  - Success stories
  - Announcements
  - Webinars
- Find ACRP on Facebook and LinkedIn



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Upcoming ACRP Webinars

- ***February 22 – Tools for Optimizing Performance of Airport Operations and Maintenance***
- ***March 15 – Air Service Strategies for Small, Medium, and Non-Hub Airports in Today's Competitive Environment***
- ***March 17 – Identifying and Developing New Sources of Airport Revenue***

You can register for and learn more about upcoming 2016 webinars by visiting:
http://www.trb.org/ACRP/ACRPwebinars.aspx

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Opportunities to Get Involved!

- ACRP's Champion program is **a new initiative**!
- Designed to help early- to mid-career, young professionals grow and excel within the airport industry.
- Airport industry executives sponsor promising young professionals within their organizations to become ACRP Champions.
- Visit ACRP's website to learn more.

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Additional ACRP Publications Available on this Topic

- **ACRP Report 108** – Guidebook for Energy Facilities Compatibility with Airports and Airspace
- **ACRP Report 141** – Renewable Energy as an Airport Revenue Source
- **ACRP Report 151** – Developing a Business Case for Renewable Energy at Airports
- **ACRP Synthesis 21** – Airport Energy Efficiency and Cost Reduction
- **ACRP Synthesis 28** – Investigating Safety Impacts of Energy Technologies on Airports and Aviation

You can learn more about these publications by visiting ***www.trb.org/publications***

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Today's Speakers

Moderated by Eddie Clayson,
Salt Lake City Airport

1) Report 117: Airport Escalators and Moving Walkways – Cost-Savings and Energy Reduction Technologies
   - Ashly Spevacek, PPC

2) Synthesis 35: Issues With Use of Airfield LED Light Fixtures
   - John Bullough, Lighting Research Center, Rensselear Polytechnic Institute

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ACRP Report 117: Airport Escalators and Moving Walkways—Cost-Savings and Energy Reduction Technologies

Ashly Spevacek &
Vestal Tutterow, PPC

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Project Team

Company	Team Member	Role	Background
Project Performance Company	Tim Kolp	Principal Investigator	Mechanical Engineering
	Vestal Tutterow	Technical Lead: Engineering and Technology Assessment	Mechanical Engineering
	Ashly Spevacek	Senior Analyst: Engineering and Technology Assessment	Mechanical Engineering
	Cathy Elrod	Technical Consultant: Engineering and Technology Assessment	Electrical Engineering
	Yogita Dhond	Technical Lead: Financial Tool Development	Computer Engineering
	Jason White	Analyst: Financial Tool Development	Business Administration
The Cadmus Group	Damon Fordham	Deputy Principal Investigator	Civil Engineering
HKA Elevator Consulting	Alan Taylor	Technical Consultant	Mechanical Engineering

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ACRP Report 117 Oversight Panel

Michael Shumack, Greater Orlando Aviation Authority, Panel Chair
Stephen Carr, Technology Litigation Corporation
Ed Clayson, Salt Lake City International Airport
Ray Eleid, Solucore, Inc.
Sara Gielow, Schindler Elevator Corporation
Theodore S. Kitchens, Newport News/Williamsburg Intl. Airport
Michael Riseborough, Greater Toronto Airports Authority
Jose de Leon, FAA Liaison
Nelson Lam, Airports Council International - North America Liaison
Christine Gerencher, TRB Liaison

Joe Navarrete, Program Officer, ACRP

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Project Objective

- Develop a guidebook that helps airports compare and select appropriate cost-saving and energy reduction technologies for escalators and moving walkways.
- Develop an associated financial tool that allows airports to estimate the energy and cost savings associated with technologies presented in the guidebook.

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Guidebook and Financial Tool Value

Why read the ACRP 117 guidebook and financial tool?

- Escalators and Walkways can account for 3% to 5% of airport energy usage.
- The energy savings potential for escalators and walkways in the U.S. is estimated to be in the range of 10% to 40% per upgraded escalator.
- The ACRP 117 guidebook consolidates key information necessary to assess and begin selecting energy saving technologies for escalators and moving walkways.
- The associated financial tool provides a quick estimate of the energy and cost savings.

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ACRP Report 117: *Airport Escalators and Moving Walkways—Cost-Savings and Energy Reduction Technologies*

- Provides an overview of the energy saving technologies available as of March 2014 specific to escalators and moving walkways;
- provides an *estimation* of the potential savings that would result from the installation of said technologies; and
- provides guidance on how to select and implement an energy saving technology.
- Published November 2014

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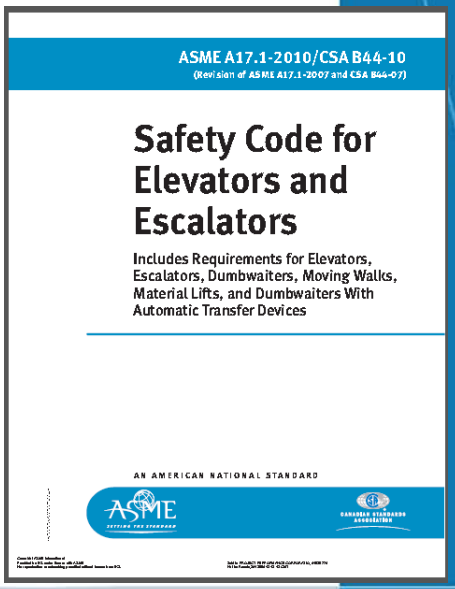
Safety Considerations

- Safety regulations vary by state.
- Codes specific to your state and county should be reviewed before any speed varying technology is installed.
- Code variances can be received in certain circumstances.

Variable	Requirement
Minimum allowable speed for an escalator or moving walkway, without a variance.	10 ft./min
Maximum acceleration/deceleration rate	1.0 ft./s^2
Maximum allowable speed for an escalator or moving walkway	100 ft./min


ASME A17.1-2010/CSA B44-10
(Revision of ASME A17.1-2007 and CSA B44-07)

Safety Code for Elevators and Escalators

Includes Requirements for Elevators, Escalators, Dumbwaiters, Moving Walks, Material Lifts, and Dumbwaiters With Automatic Transfer Devices

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ASME

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Identifying Technologies

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Literature Review

- Reviewed trade organization websites, manufacturer brochures, case studies, magazine articles, white papers, broad internet searches.
- Identified over 80 sources of information (see report ACRP 117 Interim Report Bibliography for sources).

Manufacturers Interviews

- Goal: Gain an understanding of current energy savings technologies, where technologies have been applied, measured and verified savings of each technology.

Identifying Decision Making Factors

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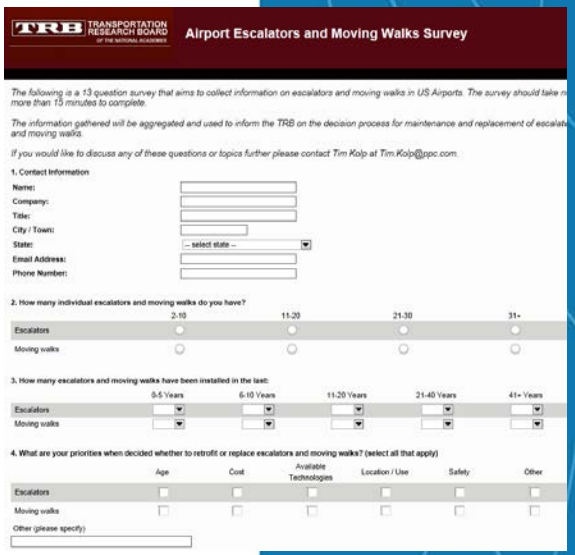
- A survey was provided to 74 individuals at 46 airports.
- Of the 74 contacts, 12 replies were received.
- Questions were designed to determine the profile of escalators currently installed in airports and factors considered when making equipment purchase decisions for an escalator or walkway system.

- **Result:** Primary factors considered when evaluating energy reduction technologies (in order of importance) are: cost, downtime associated with installation, payback, energy savings



TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

Airport Escalators and Moving Walks Survey

The following is a 13 question survey that aims to collect information on escalators and moving walks in US Airports. The survey should take n more than 15 minutes to complete.

The information gathered will be aggregated and used to inform the TRB on the decision process for maintenance and replacement of escalat and moving walks.

If you would like to discuss any of these questions or topics further please contact Tim Kolp at Tim.Kolp@ppc.com.

1. Contact Information

Name:
Company:
Title:
City / Town:
State: -- select state --
Email Address:
Phone Number:

2. How many individual escalators and moving walks do you have?

	2-10	11-20	21-30	31+
Escalators				
Moving walks				

3. How many escalators and moving walks have been installed in the last:

	0-5 Years	6-10 Years	11-20 Years	21-40 Years	41+ Years
Escalators					
Moving walks					

4. What are your priorities when decided whether to retrofit or replace escalators and moving walks? (select all that apply)

	Age	Cost	Available Technologies	Location / Use	Safety	Other
Escalators						
Moving walks						

Other (please specify)

Informational Interview Results

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Airports with Energy Efficient Systems

Seattle-Tacoma International Airport

- Intermittent drive (2 speed operation – slow down)

Portland International Airport

- Intermittent drive (2 speed operation – start-stop)

Toronto Pearson International Airport

- Motor Efficiency Controller (MEC)

Energy Saving Technologies

Included in the Financial Tool

- LED Lighting
- Capacitors
- High/Premium Efficiency Motors
- Motor Efficiency Controller (MEC)
- Intermittent Drive
- Intermittent Drive with MEC/Variable Voltage-Variable Frequency Drive/Regenerative Drive

Not Included in the Financial Tool

- Regenerative Drive
- Wye-Delta Configured Motors
- Direct Drives
- Intermittent Drive with MEC and Variable Voltage-Variable Frequency Drive

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Guidebook: Key Components

Applicable standards

Energy saving technologies

- Overview of Technology
- Benefits
- Limitations

Tables summarizing technologies

- Description, benefits, and limitations
- Manufacturer's that offer the technologies (as of 2014)
- Potential Savings

Guidance on how to select and implement technologies

Steps for using the financial tool

Best practices

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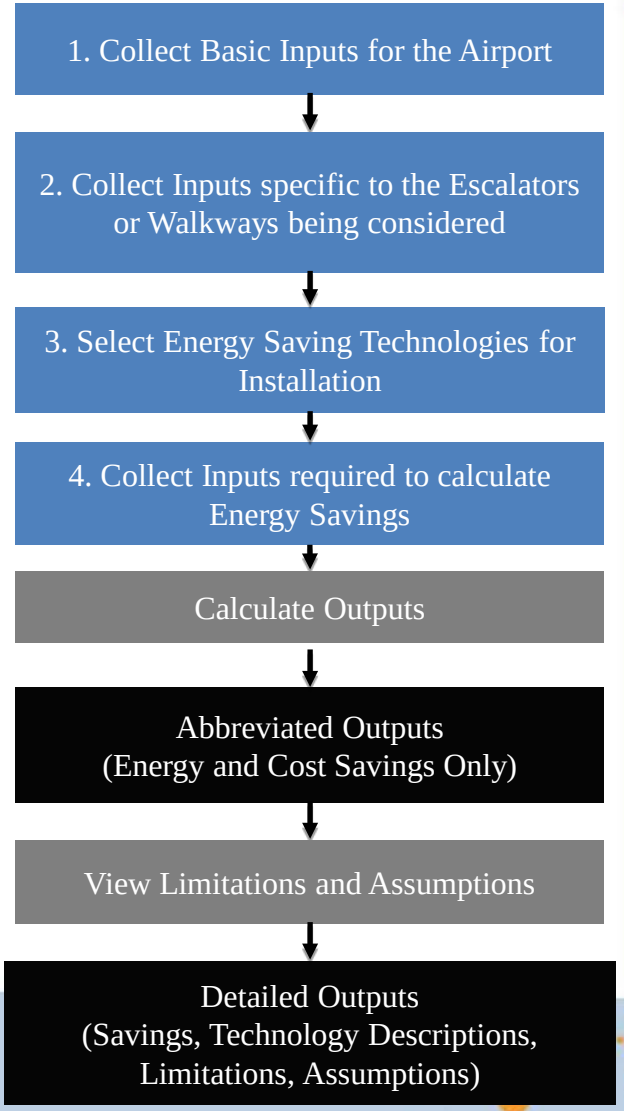
Financial Evaluation Tool

- Microsoft Excel based tool that utilizes Macros
- Produces both a detailed and summary view of the results
- Definitions are provided for each of the energy saving technologies as tool tips in the inputs
- Definitions of inputs are provided as tool tips
- Default values are provided for some inputs
- Inputs requested from the user depend on the energy saving technologies selected for analysis



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Tool Inputs

Escalator and Moving Walkway Evaluation Tool

Please enter inputs in the white cells and select drop down values shown in the green cells. For detailed instructions on how to use the tool, see the "Instructions" tab.

General Information (OPTIONAL INFORMATION)

Enter information used to identify your airport and the upgrade being evaluated.

Company Name/Airport	ACME Airport	Address	123 Main St
Case Name	January Evaluation	City	Arlington
Evaluation Date	1/12/2014	State	VA

Escalator(s) or Walkway(s) Specifications

Enter information used to identify the single or group of escalators or walkways considered for upgrade.

Location of Escalators/Walkways	
Number of Escalators/Walkways*	
Type of transport device*	
Manufacturer	
Age of Escalator/Walkway	years
Does the unit have lighting?*	Yes ☐ No ☐

Energy Savings Technologies to Consider for Evaluation

Select a technology configuration to consider installing on your escalator or walkway system.

LED Lighting	☐
High Efficiency Motors	☐

Motor Controllers and Capacitors

None	○
Capacitors	○
Motor Efficiency Controller	○
Intermittent Drive (Star-Stop Operation)	○
Intermittent Drive (Slow Down Operation)	○
Intermittent Drive (Start-Stop) with Motor Efficiency Controller	○
Intermittent Drive (Start-Stop) with Variable Voltage-Variable Frequency Drive (VVVF)	○
Intermittent Drive (Slow Down) with Variable Voltage-Variable Frequency Drive (VVVF)	○
Intermittent Drive (Slow Down) with Regenerative Drive	○

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Tool Inputs

Escalator(s) or Walkway(s) Specifications Continued

Please enter specification data for the escalators being considered in this analysis. All escalators must have the same specifications (e.g. motor horsepower, speed, passenger flow, etc.). Default values for some of the inputs are shown in blue. The default values can be modified if they do not align with your system. Please note, the default value for "Maximum Capacity per Step" will be populated after a value is selected for "Type of transport device" in the section above and "Width of step" in the section below.

Width of step*		inches	Number of motors per Escalator/Walkway*		
Depth of step*		inches	Type of motor installed*		
Maximum Capacity per Step*		Lbs./Step	Motor Horsepower*		
Max Speed of escalator/walkway*	1.5	ft/s	Power Factor	0.5	
Average weight per passenger*	184	Lbs.	Is the motor inverter rated?*		
			Motor controls currently installed*		
Estimated Installation Cost*		$	Estimated Life Expectancy of Escalator/Walkway*	16	years

Average Passenger Flow

In the section below, fill out the average number of passengers over the selected time span along with the corresponding unit electricity cost and the percent of time the escalator/moving walkway is not in use. An average rate including all extra charges (generation, distribution, transmission, demand, power factor etc.) should be entered for the unit electricity cost. Please note, cost savings calculated by the tool do not consider reductions in demand charges for rescheduling loads.

In order to accurately evaluate an escalator/moving walkway configuration, the Average Passenger Flow Table should contain information inclusive of an entire day of operation. For additional information regarding the data required for each column, hover over the column name to see the tool tip.

The Average Passenger Flow table has the capacity to track information for up to 24 discrete time periods. If it is necessary to add another row to the table, click the button "Add More Rows," located underneath the Average Passenger Flow table.

Number of passengers*	Start Time*	End Time*	Unit Electricity Cost ($/kwh)*	Percent of Time not in Use*
200	5:00 AM	8:00 AM	0.1	30%
120	8:00 AM	9:00 AM	0.08	10%
300	9:00 AM	12:00 PM	0.15	10%
400	12:00 PM	5:00 PM	0.2	10%
600	5:00 PM	11:00 PM	0.2	20%

Add More Rows | Calculate Savings | Reset

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Output Screens

Escalator and Moving Walkway Upgrade Evaluation Tool
Summarized Results

General Airport Information

Enter information used to identify your airport and the upgrade being evaluated.

Company Name/Airport	ACME Airport	Address	123 Main St
Case Name	January Evaluation	City	Arlington
Evaluation Date	1/12/2014	State	VA

Current and Potential Energy Consumption

Current Energy Consumption

Energy use per escalator/walkway	34,102	kWh/year
Total use for all escalators/walkways	68,205	kWh/year

Potential Energy Consumption

Energy use per escalator/walkway	27,667	kWh/year
Total use for all escalators/walkways	55,335	kWh/year

Potential Annual Energy Savings

Energy savings per escalator/walkway	6,435	kWh/year
Total savings for all escalators/walkways	12,870	kWh/year

Cost and Other Financial Considerations

Current Energy Cost

Cost per escalator/walkway	5,739	$/year
Total Cost for all escalators/walkways	11,479	$/year

Potential Annual Cost Savings

Cost savings per escalator/walkway	$1,064	$/year
Total cost savings for all escalator/walkways	$2,128	$/year

Installation Costs

Total Installation Cost	5,000.00	$

Financial Metrics

Payback Period	2.35	years
Return on Investment	197.0	%
Cost Savings over the Life of the System	14,852	$

Hide Assumptions & Limitations

Show Assumptions & Limitations

Technology	Limitations
LED Lighting	LED or Light Emitting Diode lighting is a semiconductor light source which can be used above the skirt panel throughout the length of the step band, under the handrail, and below the step at the top and bottom landings on an escalator or moving walkway. LED lighting can also be used for indicator signs at the entrance to the escalator and/or moving walkway. Studies have shown that LED lighting can reduce the lighting energy consumption by up to 38%. LED lights also require less maintenance since they have a longer lifetime.
High Efficiency Motors	As the name implies, high efficiency motors have higher efficiencies than standard motors and result in reduced energy consumption due to the increased efficiency. The most common AC motor seen in escalators are the induction asynchronous squirrel-cage motors, composed of an external stator core and rotating rotor. The standard fully-loaded efficiency of induction motors is around 84%, whereas the typical efficiency of a NEMA premium efficiency motor is 90.2%. By replacing the motor in an escalator, savings are not only achieved due to the higher efficiency, but often times the motor selected for an escalator or moving walkway system is oversized. Significant savings can be achieved by selecting an accurately sized motor. High efficiency motors may not be compatible for all escalator and moving walkway systems. Modifications may need to be

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Financial Tool Evaluation

Data Sources

- Eaton Corporation
- *Performance of T12 and T8 Fluorescent Lamps and Troffers and LED Linear Replacement Lamps*, U.S. DOE Pacific Northwest Laboratory
- Portland International Airport (Intermittent Drive – 2 Speed Operation: Start/Stop)
- Seattle-Tacoma International Airport (Intermittent drive - 2 speed operation: slow down)
- Omega Controllers (data from Toronto Pearson International Airport)
- *MEC vs VSD* report by Power Efficiency Corporation

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For additional information:

ACRP Report 117*: Airport Escalators and Moving Walkways—Cost-Savings and Energy Reduction Technologies*

http://www.trb.org/Main/Blurbs/171719.aspx

- Ashly Spevacek
  - Ashly.Spevacek@ppc.com
- Vestal Tutterow
  - Vestal.Tutterow@ppc.com

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ACRP Synthesis 35: Issues With Use of Airfield LED Light Fixtures

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

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John D. Bullough, Ph.D., FIES
Consultant

- Director of Transportation and Safety Lighting Programs, Lighting Research Center, Rensselaer Polytechnic Institute
- Chair, TRB Committee on Visibility (AND40)
- Fellow, Illuminating Engineering Society
- Member, Society of Automotive Engineers, International Municipal Signal Association

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ACRP Synthesis 35
Topic Panel

Frank Barczak, Orlando International Airport
Richard A. Cunard, Transportation Research Board
Somnath Mukherjee, Port Authority of New York and New Jersey
Steve Pittman, Rifenburg Construction, Inc., Durham, NC
Ed Runyon, ADB Airfield Solutions, Columbus, OH
Verne R. Skagerberg, Alaska DOT and Public Facilities, Juneau
Thomas Zeidlik, University of North Dakota, Grand Forks
Alvin Logan, Federal Aviation Administration
Thomas Mai, Federal Aviation Administration (Liaison)
Alex Baker, US Environmental Protection Agency (Liaison)
Gail R. Staba, ACRP Senior Program Officer

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ACRP Synthesis 35: *Issues With Use of Airfield LED Light Fixtures*

- Documents airport experience with light emitting diode (LED) airfield lighting fixtures
- Describes LED light source technology
- Reviews published information and case studies of airports using LED lighting systems
- Describes results from a survey of U.S. airports on:
  - Current practices and challenges
  - Installation issues
  - Operation and maintenance
  - Economic issues
- Includes pointers to relevant FAA guidance, technical resources about airfield lighting
- Published July 2012

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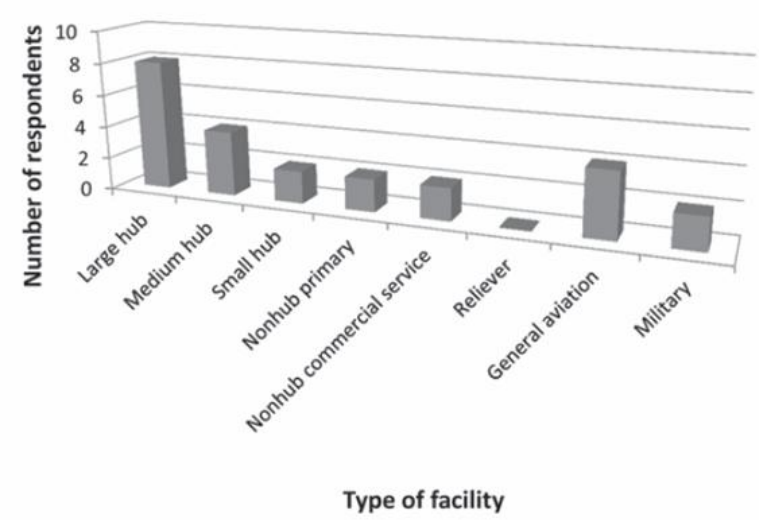
Research Problem and Approach

- As LED technology evolves and becomes increasingly feasible for airfield lighting applications, information about airports' initial experiences has not been readily found in a single location
  - Often, information has been kept "in-house"
- As a result, a literature review (including so-called "gray literature") and survey of airports was conducted to document issues related to installing, operating, maintaining and paying for LED airfield lighting (n=22)



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LED Technology

- 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
  - Human factors (e.g., color identification, brightness, visibility in fog)

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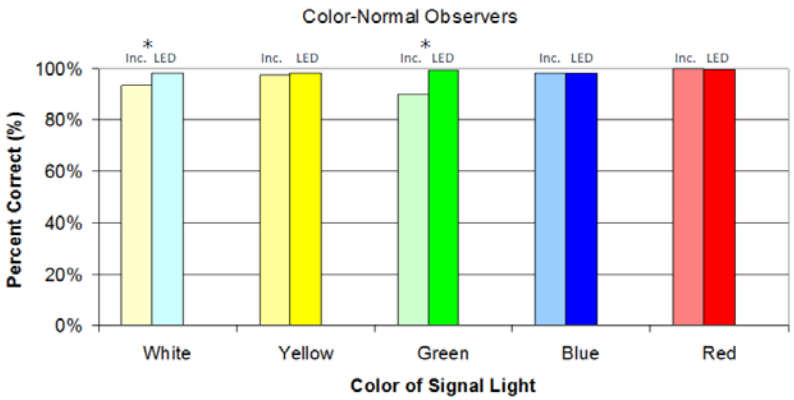
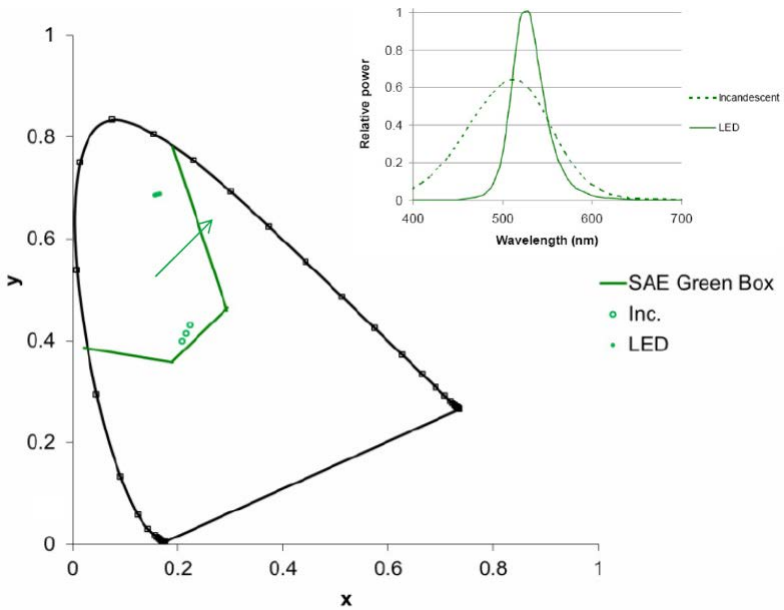
Safety First!

The photometric and colorimetric properties of LEDs make them especially suitable for many airfield lighting applications:

- LED colors are less likely to be misidentified than incandescent (Bullough et al. 2012)
- Colors will not shift in hazy atmospheres (Bullough 2014)





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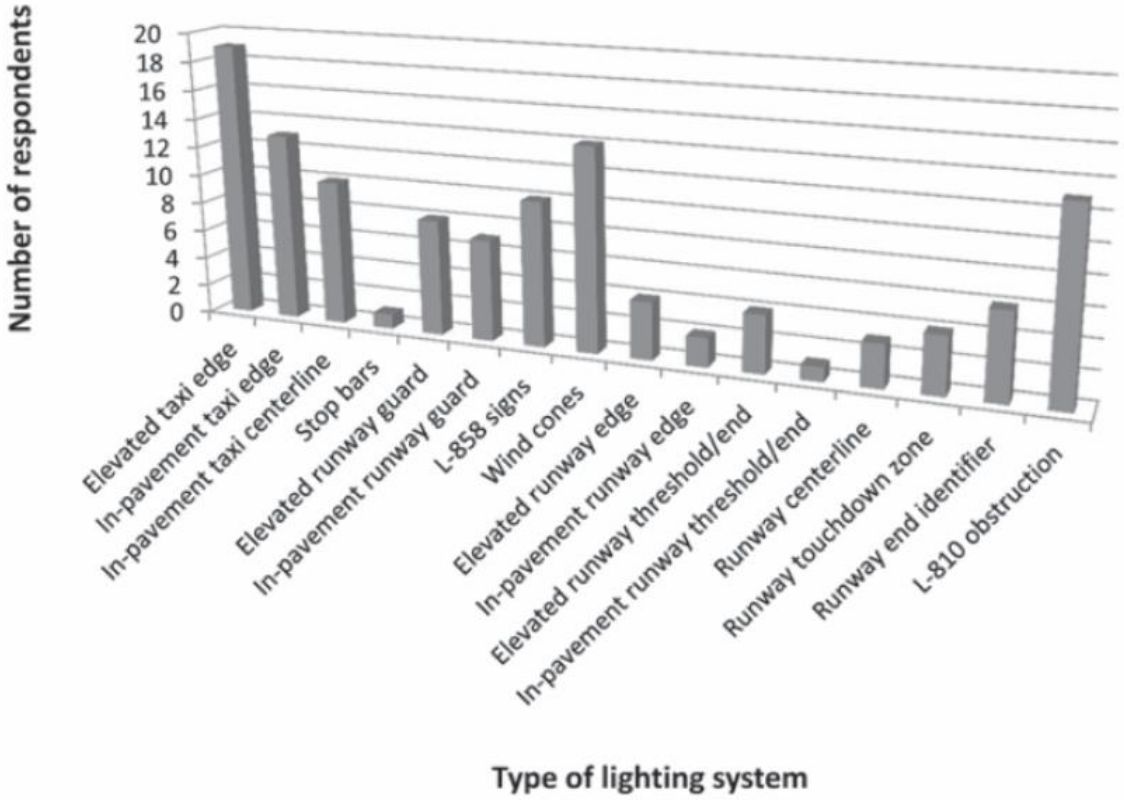
Current Practices: Types of Systems



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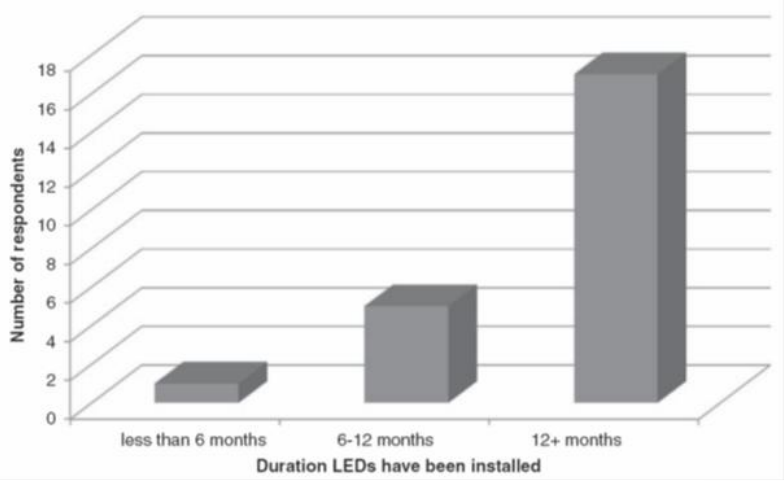
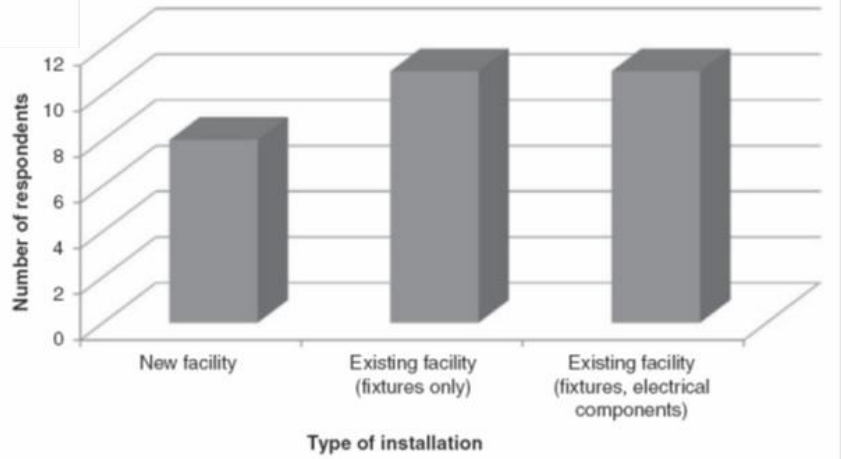
LED System Experience





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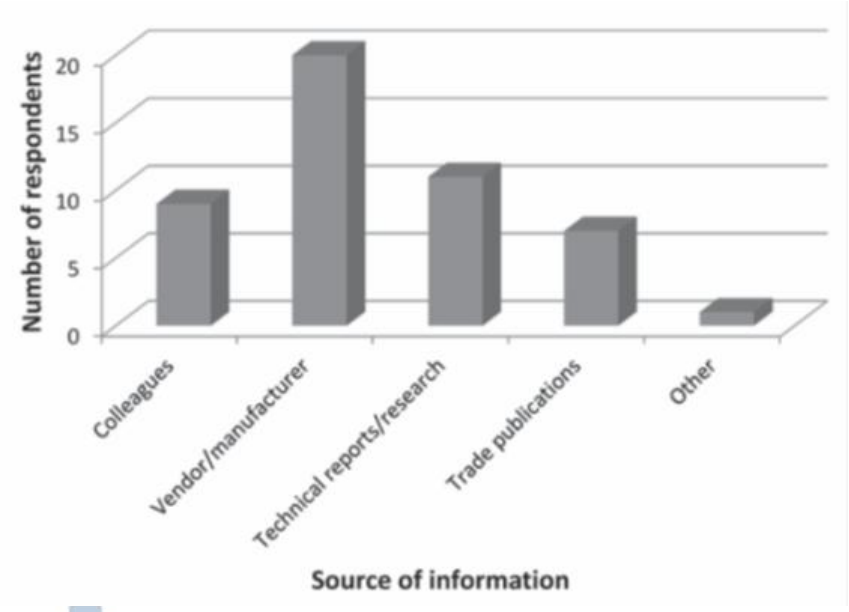
Perceived LED Challenges

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



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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

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Installation Issues: Ease

- Most survey respondents (16) reported that LED installation was relatively 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

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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

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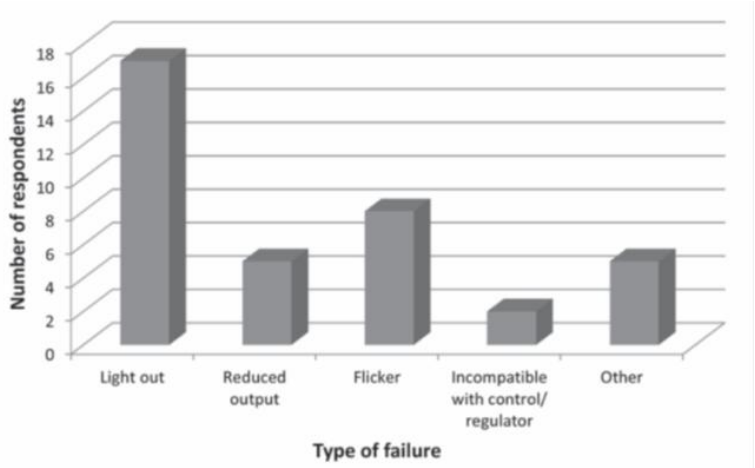
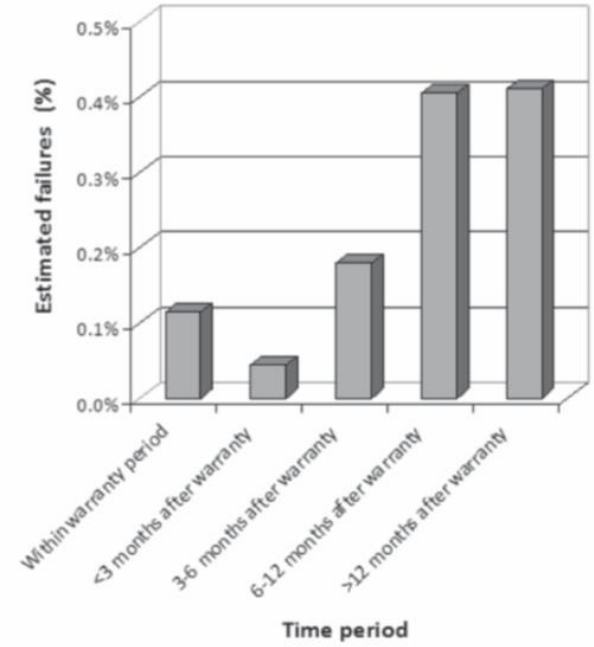
Operation and Maintenance (O&M) Issues

- LED failures were relatively infrequent
  - In comparison, most common annual failure rates for road traffic signals were <1% and 1%-5% (Urbanik 2008)





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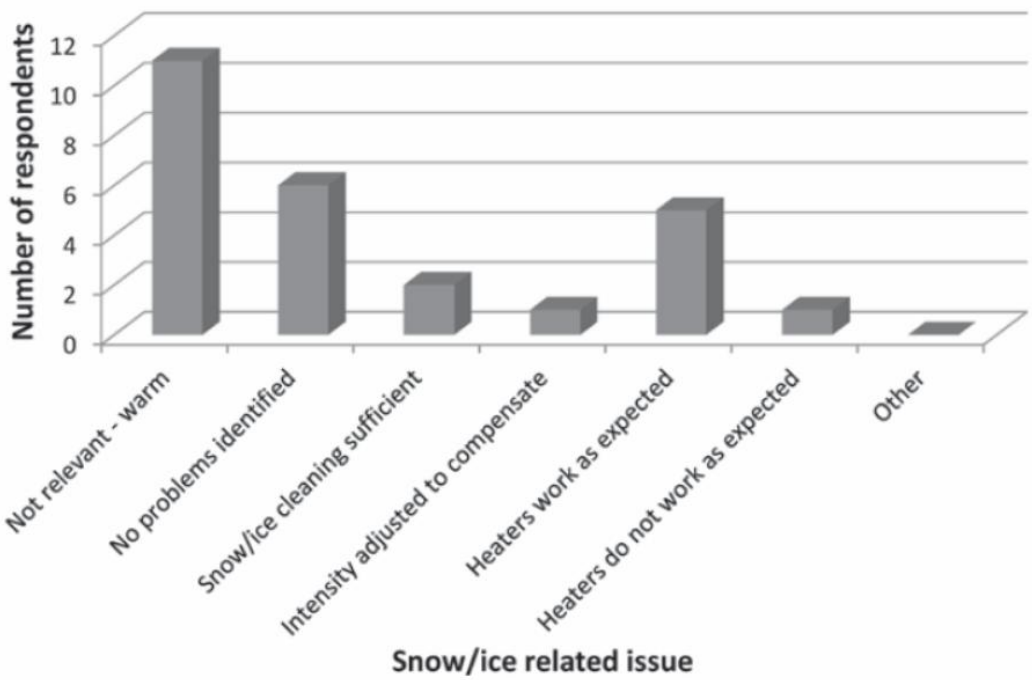
O&M Issues: Weather



Few airports have conducted analyses regarding need for heaters

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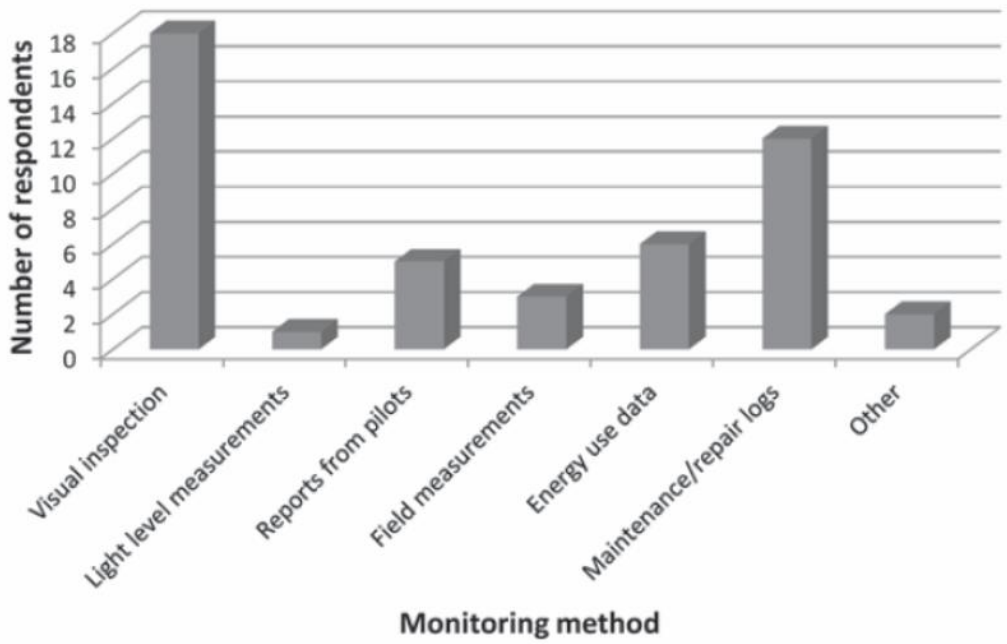
O&M Issues: Monitoring

FAA guidance requires fixtures to maintain 70% of initial light output, and no more than 25% of LEDs within a lighting fixture to fail (Engineering Brief 67D)



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O&M Issues: Other

- Maintenance issues such was 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

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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

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Economics: Energy and Maintenance Costs

SUMMARY OF REPORTS OF EXPECTED OR REALIZED ECONOMIC COST SAVINGS ASSOCIATED WITH LED AIRFIELD LIGHTING

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

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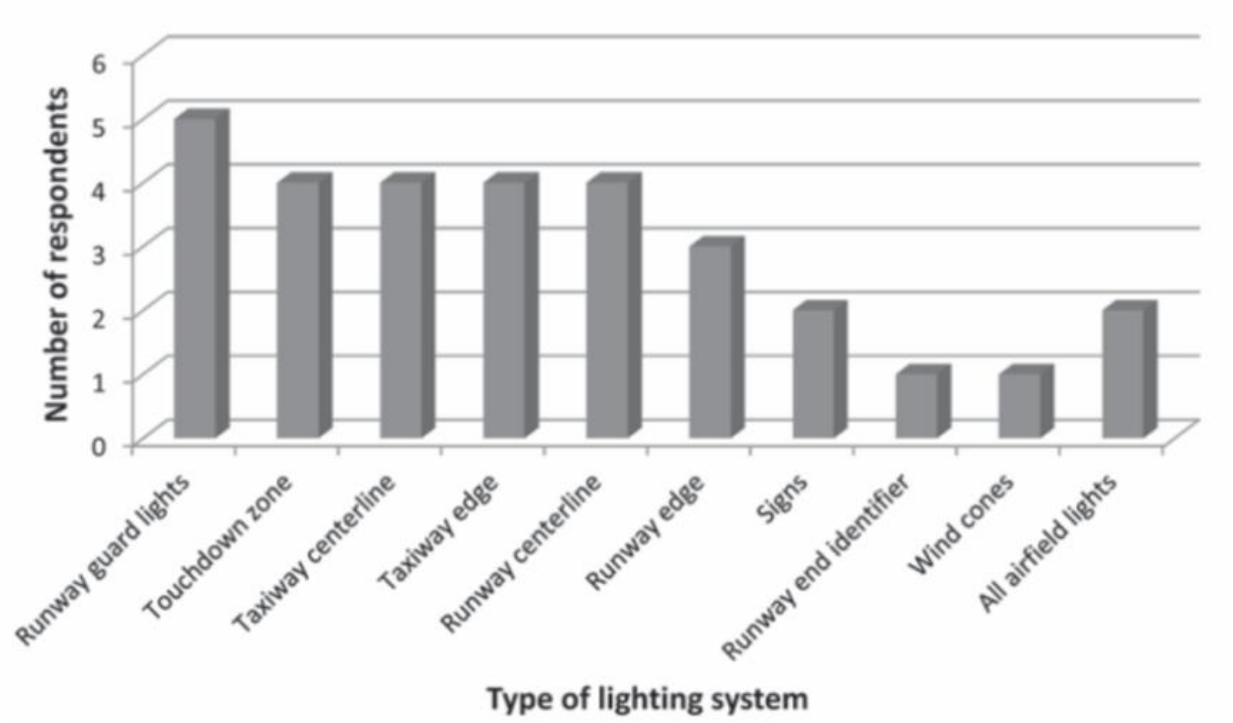
Future Outlook

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



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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

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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)

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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
  - ACRP Report 148: *LED Airfield Lighting System Operation and Maintenance*
- 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
- Human factors issues may need more clarification (see *2014 FAA Worldwide Airport Technology Transfer Conference* for additional information)

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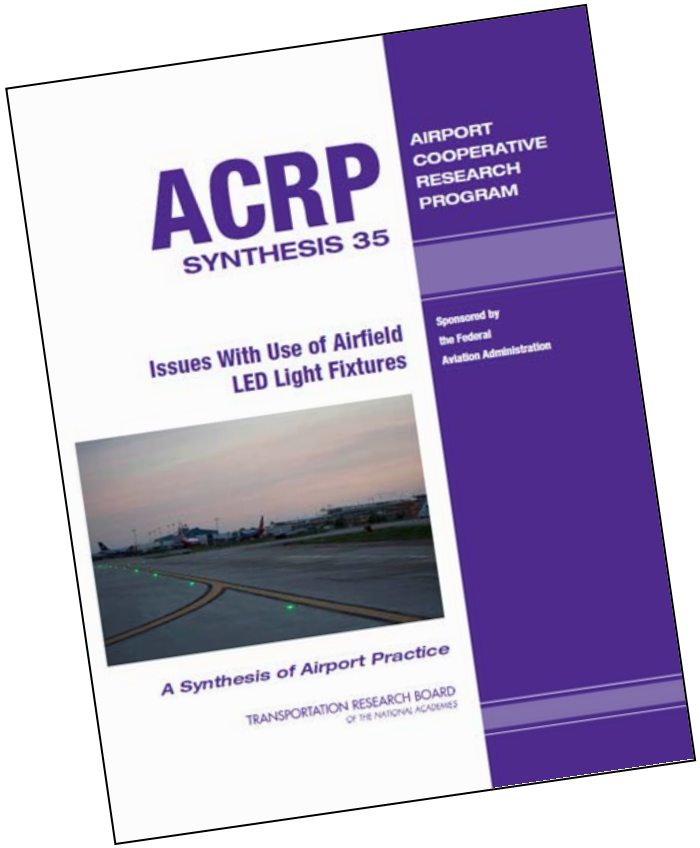
For additional information:



ACRP Synthesis 35*: Issues With Use of Airfield LED Light Fixtures*

http://www.trb.org/Main/Blurbs/167509.aspx

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