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Can the Intensity of LED-Based Runway Guard Lights Be Reduced?

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Elevated Runway Guard Lights (ERGLs)

- ◆ Light source technology
 - › Traditionally ERGLs use incandescent
 - Flash at 45-50 flashes per minute (FPM)
 - Intensity = 3000 cd
 - Defined by AC150-5345-46D
 - › Now ERGLs are beginning to use LEDs
 - Potential energy and maintenance savings



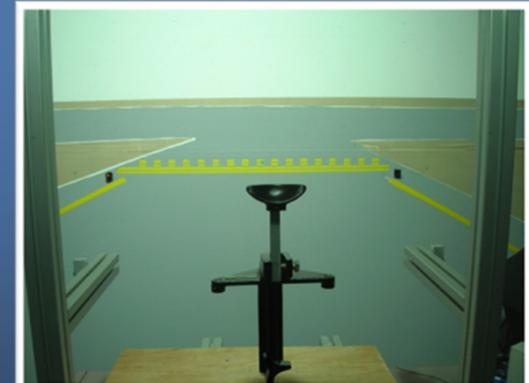
Study Objective

- ◆ The objective of this study was to understand the benefits of using LED light sources in ERGL applications and determine **if the intensity of LED-based RGLs could be reduced**
 - > 2008 LRC Lab Study:
 - Investigate signal visibility when flash rate, duty cycle, wave form, brightness, and visibility conditions were changed.
 - > 2011 LRC Study:
 - Conducted a field study at an airport near to Albany NY (Schenectady County Airport) to validate lab results using a moving vehicle (not airplane)
 - > 2012 Embry Riddle Study:
 - Per LRC's specifications, prototype ERGL's were procured by FAA and sent to ER at Daytona Beach Florida to further validate lab results at an airport using planes and pilots.

LRC Laboratory Study Results

- ◆ Increased conspicuity and faster reaction can be achieved with frequencies and duty cycles in the range 1.25 – 2.50 Hz and 30-70% on time.
- ◆ The average minimum LED intensity could be reduced to
 - > **Step 1**: 70 cd from 94 cd for the 10% intensity
 - > **Step 3**: 1164 cd from 3000 cd for the 100% intensity condition
- ◆ LED based RGLs with appropriate frequency and duty cycle can provide equal or better visibility compared to incandescent based RGLs at reduced light levels (nearly one-third)

Lab setup



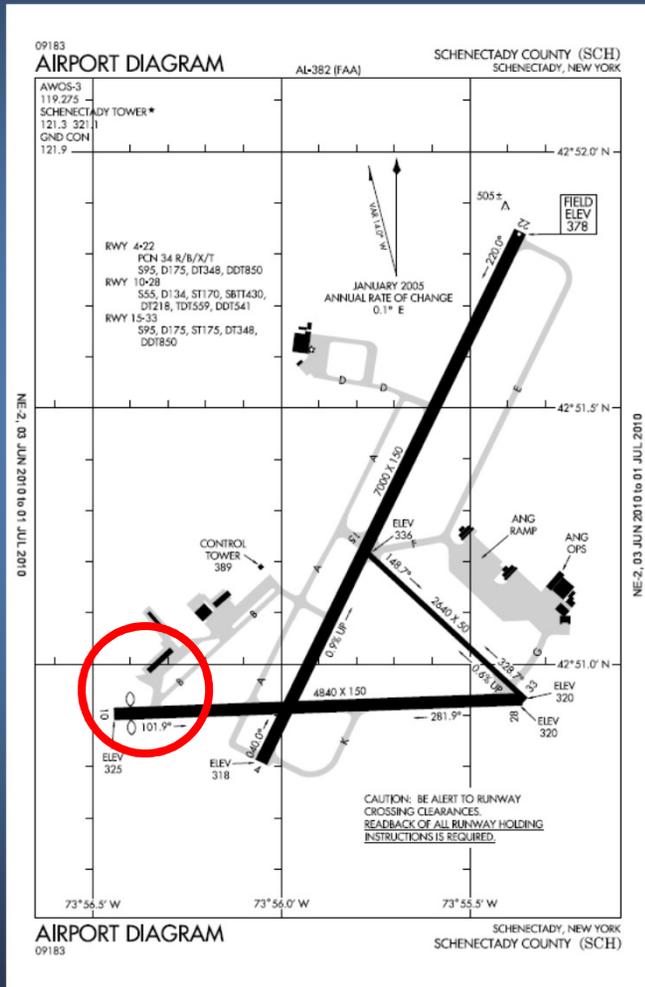
Preliminary Field Study

Flash Patterns for Preliminary Field Study

- ◆ Developed with guidance from LRC lab study findings
- ◆ Specifications for
 - > Incandescent:
 - 45 - 50 FPM
 - 3000 candela (per AC150-5345-46D)
 - > LED:
 - 1000 candela

Flash Rate (flashes/min)	Frequency (Hz)	Duty Cycle (%)
45	0.75	100
90	1.5	30
		70
135	2.25	30
		70
180	3.0	30
		70

Site



- ◆ Schenectady County Airport (KSCH)
 - › Class D; ~170 Operations/Day
- ◆ Hold line adjacent to RWY 10
 - › Taxiway width ~90 ft. (at hold line)



LED ERGL



- ◆ LRC staff modified commercial ERGLs
 - › LED systems with custom driver unit programmed with flash patterns
 - › Incandescent systems with custom 120 VAC drivers
- ◆ Observers were driven in a small truck (mimicking a small plane)

Subject Pool

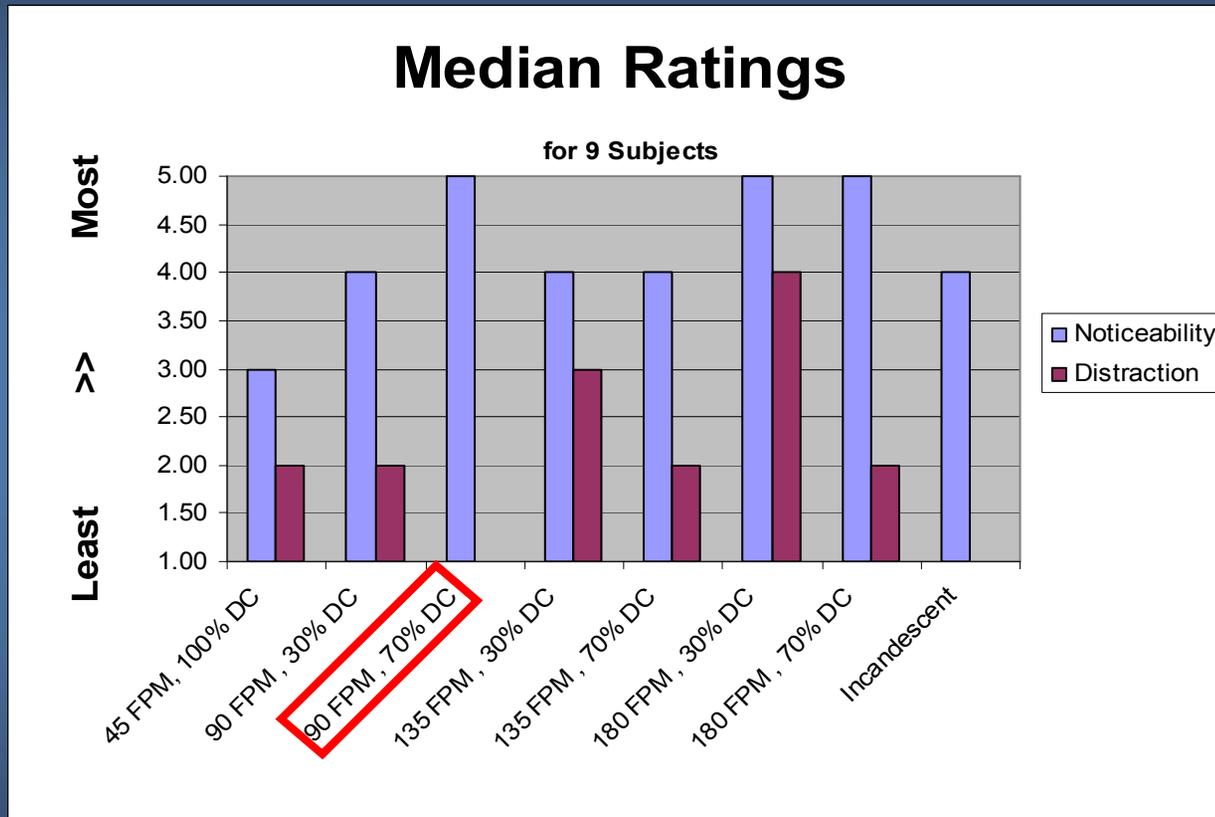
- ◆ Total number of subjects: 9
 - > Pilots
 - 3 Commercial
 - 2 Private
 - All >100 hrs. (2 >500, 1 >10,000)
 - Subjects with RGL experience: 4

Procedure

- ◆ Subjects briefed and given rating form
- ◆ Lighting condition setup by experimenters (waiting area out of sight)
- ◆ Subjects driven one at a time through the ERGL set
- ◆ All subjects in each group see the same condition before it is changed.
- ◆ Incandescent set run either first or last



Median Ratings for all Conditions



Brightness Ratings: Incandescent = 2.5, LED = 3.0
(Too bright (5); Acceptable (3); Too dim (1))

Conclusions:

- ◆ 1000 cd LED ERGLs set to 90 FPM, 70% DC performed as well as 3000 cd incandescent ERGLs
- ◆ The distraction ratings of incandescent and LEDs (90FPM, 70%DC) are not statistically different
- ◆ 90FPM, 70%DC was selected for the field study at ERAU

Embry Riddle Field Study

Study conducted by John French and
Hilary Greenfield

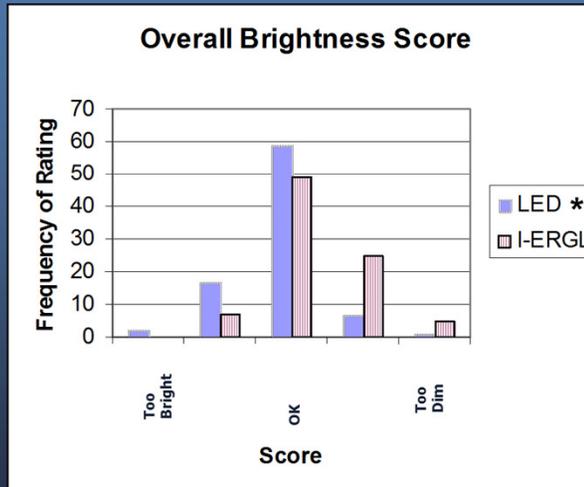
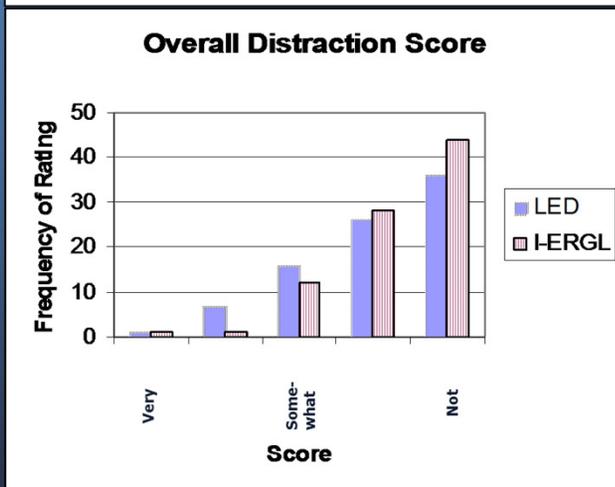
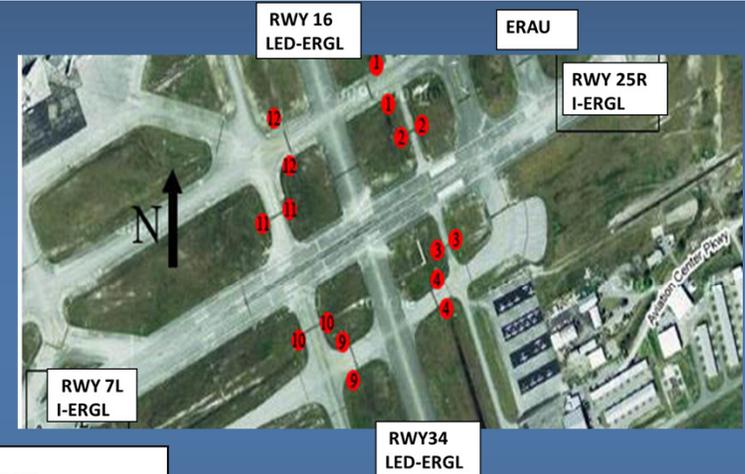
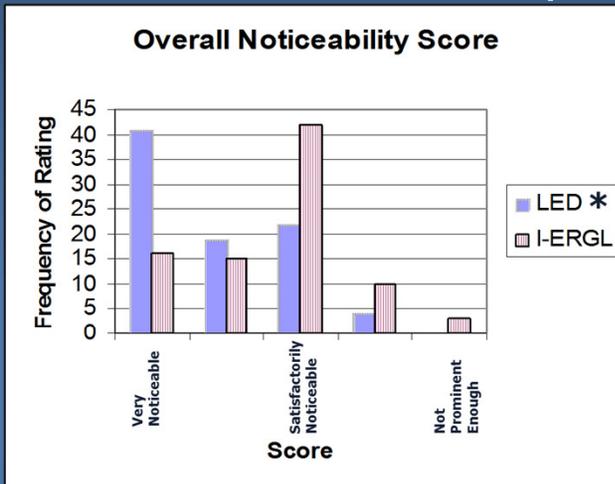


ERAU Study



> 86 Pilot Participants

1000 cd LED ERGLs set to 90 FPM, 70% DC
3000 cd incandescent ERGLs



ERAU Study



◆ Comments from Pilots

> LED

- GREAT
- Noticeable
- Seem brighter from straight on, but not from side
- Perfect brightness
- More noticeable and pointed for a lower cockpit
- They seem to "pop" more than the others

◆ According to the ERAU researchers

- > LED system rated more noticeable and is preferred over incandescent ERGL

Final Remarks

- ◆ Laboratory and field studies showed that LED light sources in ERGL can be beneficial
- ◆ LED based RGLs with appropriate frequency and duty cycle can provide equal or better visibility compared to incandescent based RGLs at reduced light levels (nearly one-third)
- ◆ **Note:** Any fast reacting light source will provide similar results

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- ◆ Donald Gallagher
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- ◆ John French
- ◆ Hilary Greenfield

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Thank you.