

Task 14: Effective Intensity of Flashing LED Lights (Milburn, Mead)

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Project Start Date: 7/01/2009

Anticipated End Date: 12/31/2010

Requirements Statement

Operational Shortfall or Knowledge Gap

Research is needed to provide a measurement technique for the effective intensity of flashing lights, such as aircraft anticollision lights, that incorporate new technologies. The method incorporated in 14 CFR 25.1401(e) has been adequate for use with xenon flash tube technology, but it is inappropriate for anticollision lights using LED technology. The effective light intensity for an anti-collision light must be determined by the Blondel-Rey formula, specified in §§ 23.1401, 25.1401, 27.1401 and 29.1401. This requirement was intended for anti-collision light systems with rotating beacons or with flash tube lights using xenon strobe light technology. Applicants have recently begun to propose use of light emitting diode (LED) technology anti-collision lights rather than xenon strobe light sources. These new LED anticollision lights use various pulse durations, pulse shapes, and groupings of pulses to generate the intensity and flashing characteristics required in §25.1401.

For designs using flash patterns comprised of relatively complex pulse trains, as well as ones using pulses with durations that are not very much briefer than 200 msec., it is often uncertain how to determine the flash time interval (t_2-t_1) in the Blondel-Rey formulation above. Because of this and because data have indicated that the Blondel-Rey metric may underestimate the effective intensity of these flashing lights with complex pulse patterns, Blondel-Rey may be inappropriate for determining the effective intensity of anti-collision lights using LED technology.

Benefit in Closing the Shortfall or Gap

The results of this research will be used to establish visual recognition parameters for LED anti-collision lights.

Description of the Desired Product

1. Summarize the work on existing and candidate methods for measuring the effective intensity and/or conspicuity of flashing lights.
2. Review the feasibility of a more valid, practical and generally applicable method to measure the effective intensity and/or conspicuity of aircraft anti-collision lights.
3. Describe a formalized definition of a proposed method suitable for use in airworthiness approvals (assuming a positive result in Output #2).
4. A research plan for validation of the proposed method and for establishing appropriate certification criteria.
5. A set of empirical data based on the research plan.
6. A set of recommendations for criteria and methods to show adequate conspicuity of lights.

Schedule

Summarize the work that is ongoing with intensity of flashing lights, such as aircraft anticollision lights, that incorporate new technologies.

Research Objective

Identify and provide solutions to issues regarding the replacement of xenon strobe lights with LED technology as anticollision lights.

Background

Applicants have recently begun to propose use of light emitting diode (LED) technology anti-collision lights rather than xenon strobe light sources. These new LED anticollision lights use various pulse durations, pulse shapes, and groupings of pulses to generate the intensity and flashing characteristics required in §25.1401.

For designs using flash patterns comprised of relatively complex pulse trains, as well as ones using pulses with durations that are not very much briefer than 200 msec., it is often uncertain how to determine the flash time interval (t_2-t_1) in the Blondel-Rey formulation above. Because of this and because data have indicated that the Blondel-Rey metric may underestimate the effective intensity of these flashing lights with complex pulse patterns, Blondel-Rey is inappropriate for determining the effective intensity of anti-collision lights using LED technology.

A number of alternative methods have been proposed. Many of these, like the Blondel-Rey formula, are based on a characterization of the sensitivity of the visual system to flashing lights based only on the premise that the visual system is a perfect integrator over approximately a 200 millisecond window. Thus for pulses or pulse groups briefer than 200 milliseconds, the detectability is proportional to the product of flash intensity and duration (i.e., total energy). This has been assumed to be completely independent of the flash's temporal fine structure (pulse shape, number of pulses, etc.). The detectability of flashes longer than 200 milliseconds are assumed to be proportional only to the intensity, and not to the duration.

In addition to the calculation difficulty noted above for Blondel-Rey, problems with this class of methods include:

- The 200 msec. "critical duration" is only an approximation and is not applicable to all conditions in which anti-collision lights may need to be effective.
- Different methods, all based on this same 200 msec. "critical duration," produce significantly different values of effective intensity for specific designs. These differences can be dependent on the flash characteristics of particular designs.

Previous Activity on this Task

Over the past forty years or so a more complete and generally applicable characterization of visual sensitivity has been developed, based on the spatial and temporal impulse responses or modulation transfer functions of the visual system. Such an approach appears to offer promise for development of a more valid and generally applicable method for estimating the intensity of flashing lights. This research requirement seeks to find better methods and criteria that will support a standardized approach to airworthiness approval of anti-collision lights.

Proposed or Planned Research

1. Summarize the work on existing and candidate methods for measuring the effective intensity and/or conspicuity of flashing lights.
2. Review the feasibility of more valid, practical and generally applicable methods to measure the effective intensity and/or conspicuity of aircraft anti-collision lights.
3. Describe a formalized definition of proposed methods suitable for use in airworthiness approvals (assuming a positive result in Output #2).
4. A research plan for validation of proposed methods and for establishing appropriate certification criteria.
5. A set of empirical data based on the research plan.
6. A set of recommendations for criteria and methods to show adequate conspicuity of lights.

Research Question(s)

What are the existing and candidate methods for measuring the effective intensity and/or conspicuity of flashing lights?

What are the visual recognition parameters for LED anti-collision lights?

Does the flashing provided with the LED provide a warning similar to that of the traditional strobe?

Technical Approach

Current Year

CAMI personnel will work with the Transport Airplane Directorate to summarize the work on existing and candidate methods for measuring the effective intensity and/or conspicuity of flashing lights.

CAMI personnel have engaged in multiple teleconferences with the University of Dayton and FAA sponsors to determine the current status of knowledge and research design. A Statement of Work has been completed, including a single-source justification, and those documents have been submitted to the Contracting Office for review.

Out-Years

Develop a research plan for validation of proposed methods and for establishing appropriate certification criteria. Collect empirical data based on the research plan. Submit a set of recommendations for criteria and methods to show adequate conspicuity of lights.

Air Traffic Resources Required

None

Information Technology Resources Required

Contract support

Calibration

None

FY10 Milestone Schedule		
Description	Proposed Start Date	Proposed Completion Date
Identify current work on existing and candidate methods for measuring the effective intensity and/or conspicuity of flashing lights.	FY09 Q3	FY10 Q2
Review the feasibility of more valid, practical and generally applicable methods to measure the effective intensity and/or conspicuity of aircraft anti-collision lights.	FY09 Q4	FY10 Q3
Describe a formalized definition of alternative methods to Blondel-Rey that are suitable for use in airworthiness approvals	FY10 Q1	FY11 Q1

FY10 Deliverables		
Description	Proposed completion date	Actual completion date
Draft report on existing and candidate methods for measuring the effective intensity and/or conspicuity of flashing lights.	FY10 Q4	