Energy Star for Residential Light Fixtures

Quality and Durability Efforts

Mariana G. Figueiro
Lighting Research Center
Rensselaer Polytechnic Institute

Sponsor: US EPA

Project Team

- Mark Rea
- Conan O’Rourke
- Ramesh Raghavan
- Andrew Bierman
- Nick Pandya
- Charles Fay
- Jennifer Brons

Efforts

- Durability Testing
- Market Acceptance of CFLs
  - Overall acceptance of CFLs
  - Color consistency
- Heat Management
  - Heat management techniques
  - Simple application tips

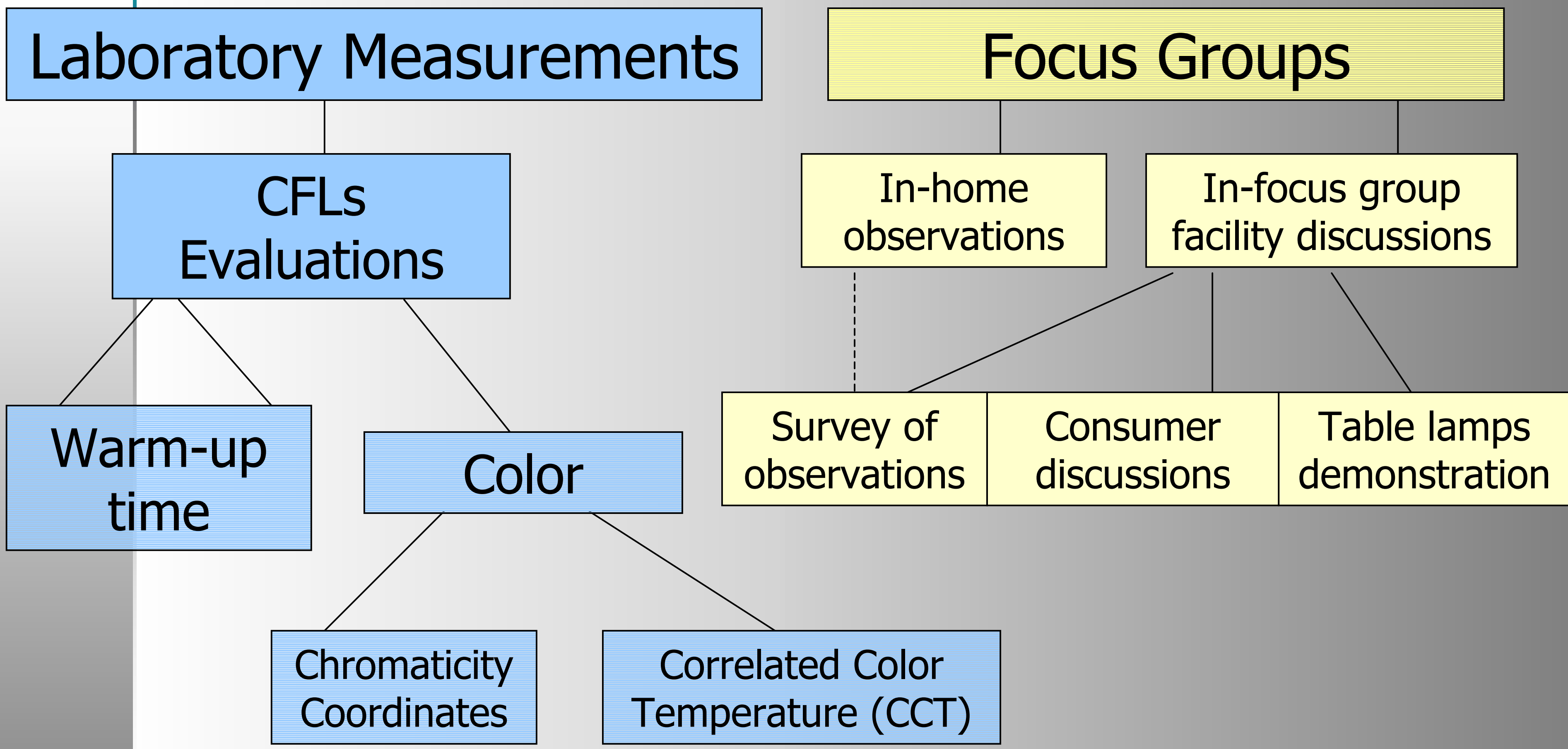
Durability Testing

- Worked with industry to prioritize causes of premature failure
- Established testing procedure
  - Temperature testing
  - Stress testing
- Pilot-tested ENERGY STAR fixtures
  - Many samples operated within UL limit (90° C), but near or above ballast manufacturer temperature limit (65-75° C)
- US EPA implemented LRC's recommendations
  - Ballast manufacturer lists maximum case temperature and location
  - Fixture manufacturer tests that ballast in fixture does not exceed this temperature

Market Acceptance of CFLS
Scope of the Project

- Perform limited laboratory measurements
  - Color
  - Warm-up time
- Verify the ranking of the issues/barriers associated with consumer acceptance of CFLs
- Suggest actions to overcome the identified issues.

Market Acceptance of CFLs Research Methods

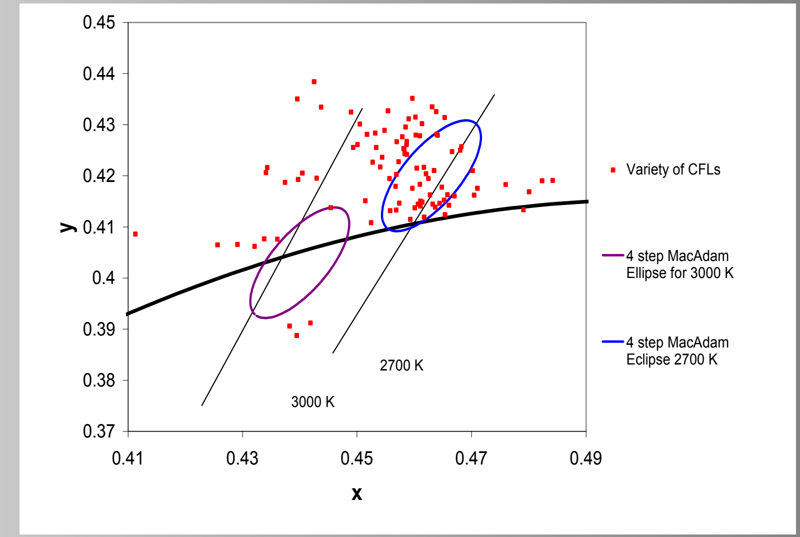


Market Acceptance of CFLs
Lab Measurements

Summary of Results

- Wide variation in CCT and chromaticity coordinates
  - Between manufacturers
  - Within manufacturers

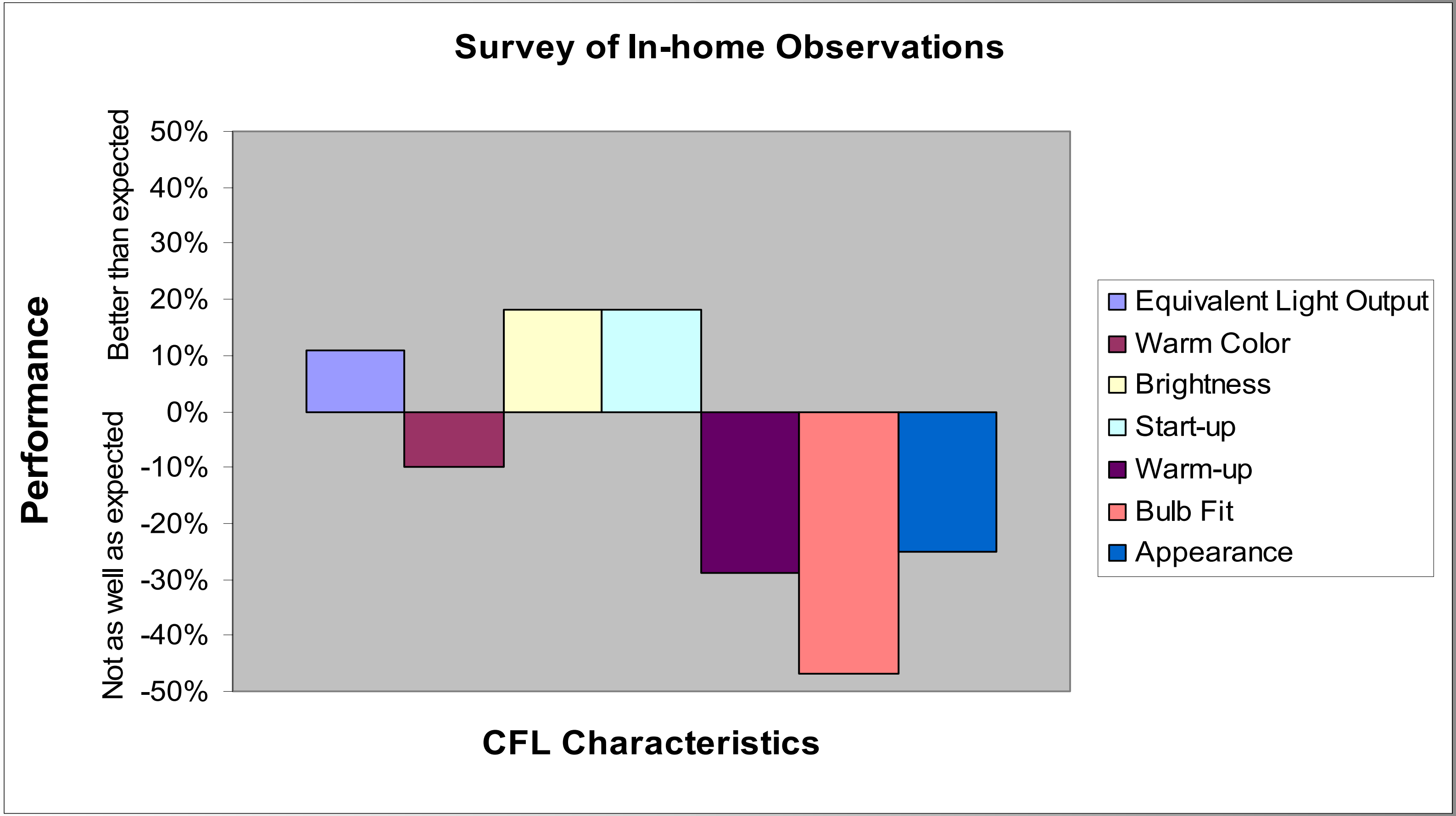
- Average warm-up times for most current CFLs is around 20 seconds, well within Energy Star® specifications.



CCT is not an unambiguous description of color

Market Acceptance of CFLs
Focus Group - Consumer Discussions

Survey Results: Experience with CFLs



Market Acceptance of CFLs Project Findings - Summary

- Issues that seem to be main barriers to the acceptance of CFLs are:
  - Size
  - Color
  - Initial cost
  - Warm-up time
  - Fluorescent technology itself
- Issues that do not seem to be main barriers to the acceptance of CFLs are:
  - Life
  - Light Output Equivalence (3:1 ratio is satisfactory)

Market Acceptance of CFLs Actions

- Color
  - Need to greater precision in color specification
    - CCT is not a good metric
  - Communication needs to be simpler
    - Avoid using industry jargon
- Size
  - Investigate best physical size for typical residential fixtures
- Initial Cost
  - Publicize cost of lighting energy use in homes and the benefits of energy-efficient lamps

Market Acceptance of CFLs Actions

- Reduce “noise” in packaging
  - Provide more useful information and less “noise” in the packaging to make it simple and predictable for consumers to buy a CFL
- ENERGY STAR® metrics for size and color
  - Specify lamps and ballast dimensions
  - Establish more predictable way to characterize and “communicate” color
- Publicize of benefits of energy savings

Market Acceptance of CFLs
Color Round Table Focus

- Color
  - Need to greater precision in color specification
    - CCT is not a good metric
  - Communication needs to be simpler
    - Avoid using industry jargon

Color Round Table was held on February 26, 2004

Market Acceptance of CFLs Color Round Table

- Current Status
  - Ed Yandek submitted proposed “hockey stick”, which is being evaluated by LRC, EPA, and DOE
  - LRC proposed a “strawperson” for color communication

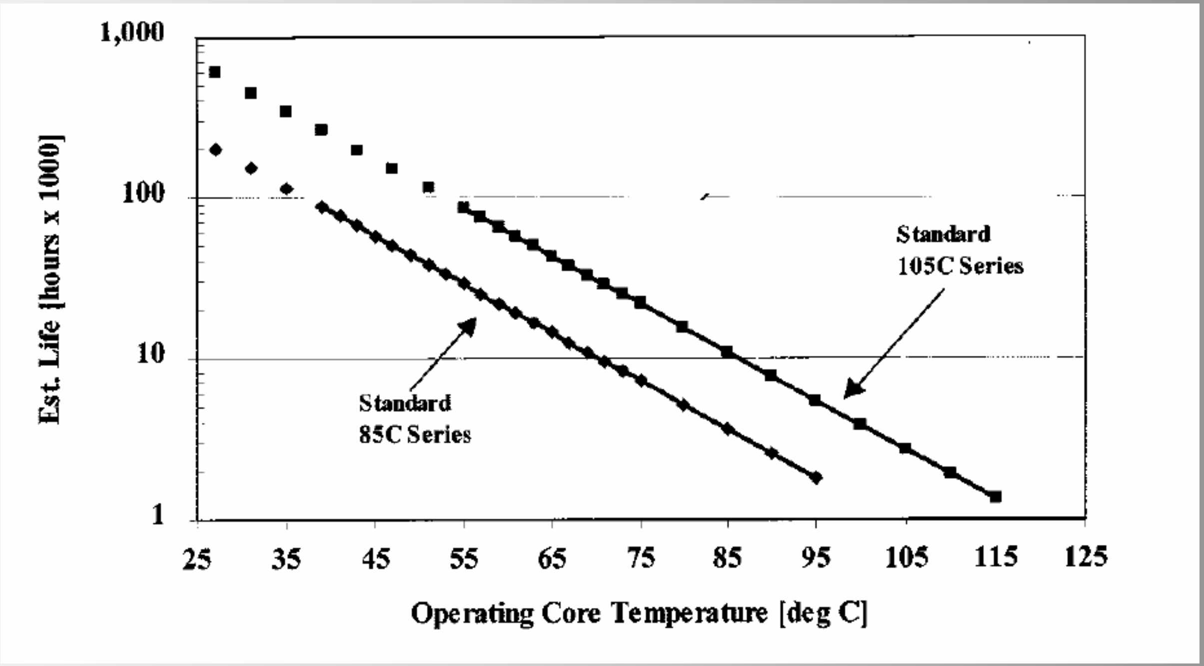
For more information, please go to www.lrc.rpi.edu

Heat Management Efforts

- Literature review to understand better the effects of heat on capacitor life
- Limited testing heat management techniques
- Application tips pamphlet

Heat Management

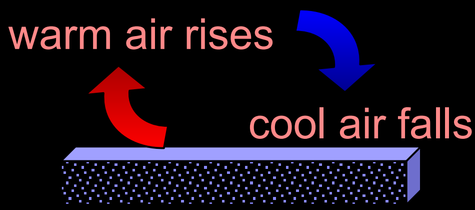
Electrolytic capacitor estimated life as a function of operating temperature



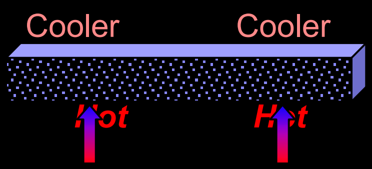
Stevens, Shaffer, and Vandenham; "The Service Life of Large Aluminum Electrolytic Capacitors: Effects of Construction and Application"; *IEEE TRANSACTIONS ON INDUSTRY APPLICATIONS*, VOL. 38, NO. 5, 2002 P-1441

Heat Management Techniques

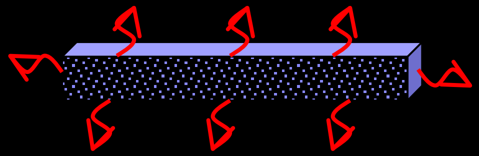
Convection
(Natural or Forced)



Conduction



Radiation

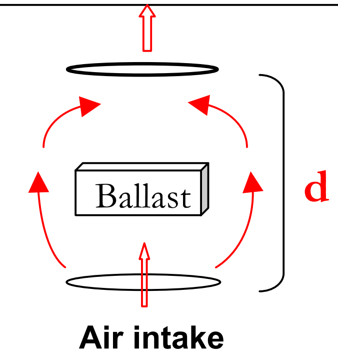


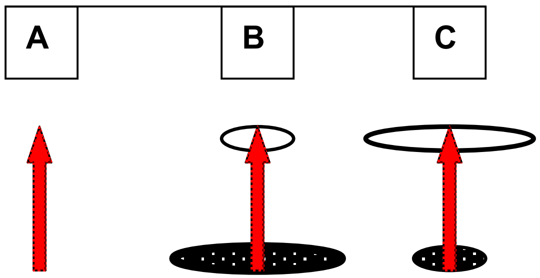
Natural convection is the simplest and most effective technique

Heat Management Techniques
Natural Convection

- **Air intake (from bottom of fixture) is required.**
- **Air exhaust (at top of fixture) is required.**
- **To achieve a temperature gradient (ΔT), there must be a vertical displacement d between the location of the intake and the exhaust openings.**
- **The larger the ΔT the greater the potential for air flow.**
- **In addition to ΔT, the other limiting factor affecting airflow is the size (total area) of the smallest opening (either intake or exhaust).**

Natural convection reduced ballast case temperature by up to 15%

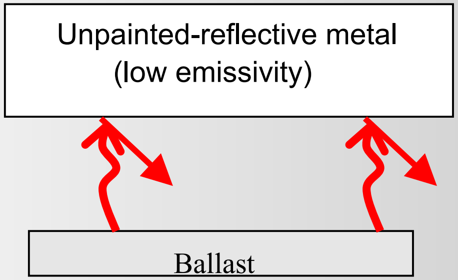




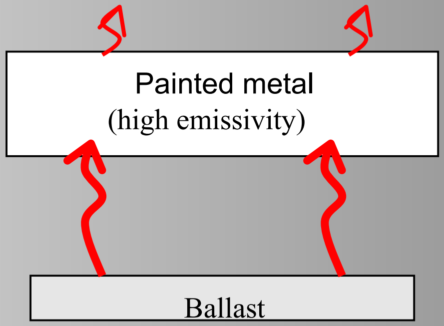
Potential airflow for **A** is greater than for **B** and **C**. While potential air flow for **B** and **C** will be equivalent since the smallest area is the limiting factor.

Heat Management Techniques Radiation

Radiation can be increased by increasing the emissivity of the surfaces inside the fixture. A low emissive surface will absorb less heat than a high emissive surface and re-radiate less heat to environment outside the fixture. Painting a surface is a common way of increasing emissivity and thereby increasing the effectiveness of radiation as a heat management technique.



A large percentage of radiation gets reflected back, making this scenario less effective in dissipating heat.

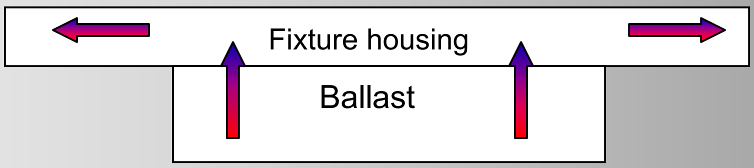


A painted surface allows for the radiation to be absorbed by the receiving surface, providing a more effective heat management technique.

Metal housing painted in white reduced ballast case temperature by up to 8%

Heat Management Techniques Conduction

If the ballast case housing is metal, conduction can aide with heat removal by attaching the ballast directly to the fixture housing. Conduction is directly related to the surface area of contact (a larger surface area will conduct more heat energy). This method of heat management will only be effective if the fixture housing is able to release the heat energy to the environment outside the fixture (via convection, conduction and radiation).



Heat Management Application Tips Pamphlet

- Pamphlet applying pilot tests findings was developed and is available at www.lrc.rpi.edu

This pamphlet is intended as an initial guide to managing excessive ballast case temperatures with simple-cost effective solutions. It is assumed that fixture designers will utilize these suggestions in a creative way to achieve their goals.