

# Durability Testing for ENERGY STAR<sup>®</sup> Residential Light Fixtures

Roundtable Meeting  
Dallas Trademart

June 23, 2003



# Overview

- Project Goals
- Roundtable Summaries
- Methodology
  - Temperature Test
  - Stress Test
  - Voltage Test
- Results
- Conclusions/Recommendations



# Project Goals

- Investigate possible causes of premature failures with ENERGY STAR<sup>®</sup> fixtures
- Develop test method to minimize premature failures, based on investigation

# Roundtable Recommendations

- Elevated temperatures inside the fixtures are the most likely cause of premature failures
  - Focus on highly enclosed fixtures
- “Weed out” lesser quality components that are incompatible or do not meet ANSI specs by stress testing
- Measure impact of voltage variation

# Temperature Test

- Purpose
  - Sample actual temperature conditions in operating fixtures
  - Develop test procedure for manufacturers to follow before ENERGY STAR approval

# Temperature Test

- Sample selection
  - ENERGY STAR products
  - Recessed
  - Ceiling-mounted
  - Magnetic ballasts
  - Electronic ballasts

# Temperature Test

- Selection of fixture types
  - Non-IC recessed and surface mounted fixtures
- Sample quantity
  - One from each fixture type and model
- Testing location
  - Ambient room temperature  $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$

# Temperature Test

- Fixture characteristics
  - Total samples = 29
    - Ceiling-mounted = 22
      - Magnetic ballasts = 12
      - Electronic ballasts = 10
    - Recessed = 7
      - All had electronic ballasts

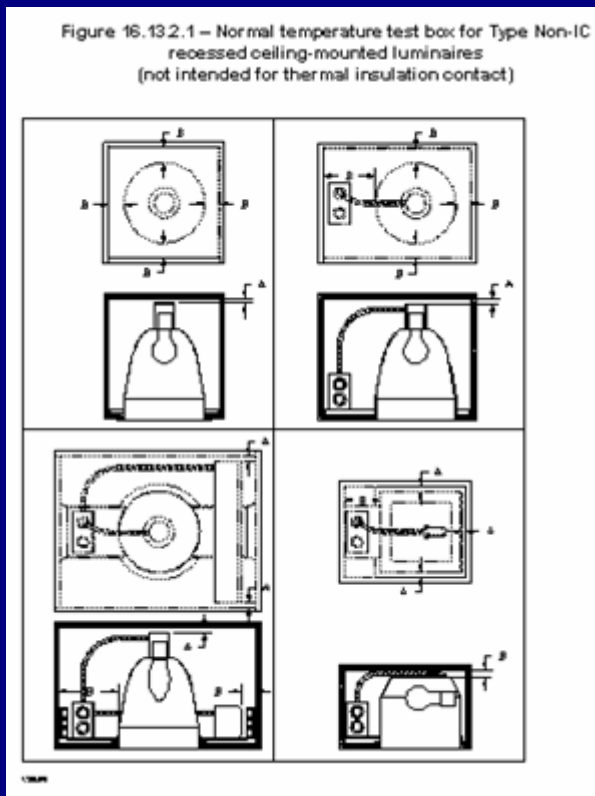
# Temperature Test Method

- Apparatus

- Follow UL 1598, *UL Standard for Safety of Luminaires*
- Thermocouple locations differ from ballast to ballast

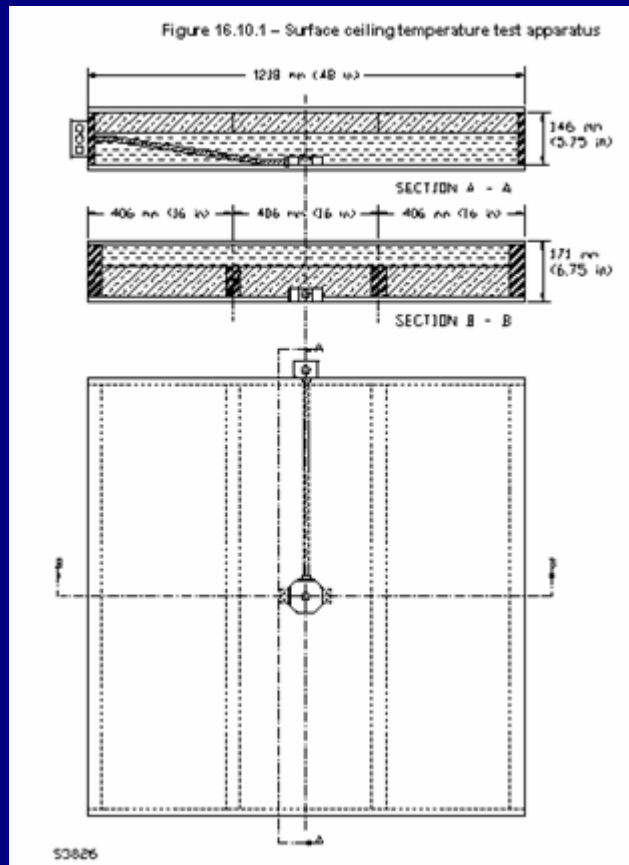
# Temperature Test Method

- Apparatus examples



# Temperature Test Method

- Apparatus examples

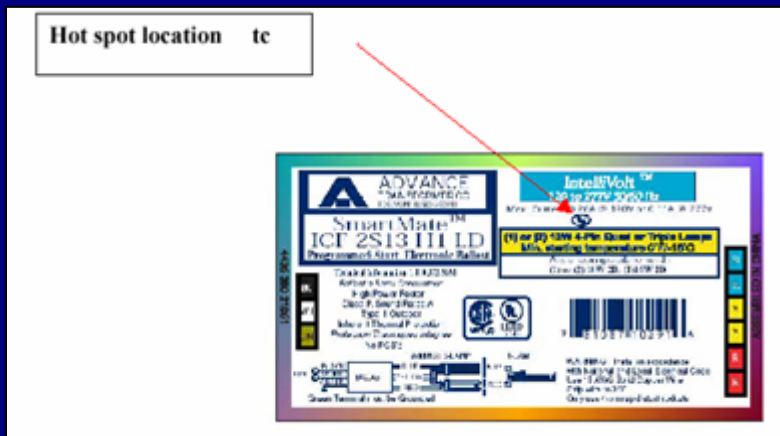
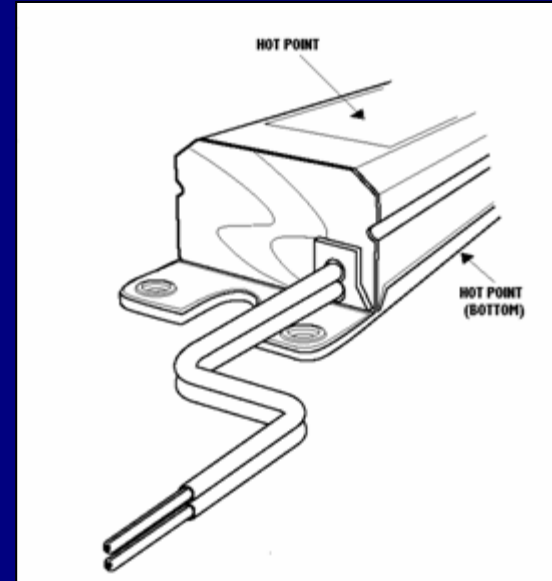
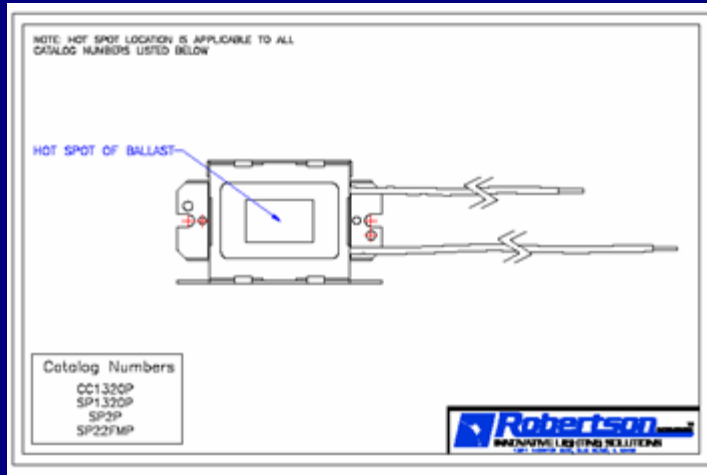


Source: UL Standard for Safety for  
Luminaires, UL 1598, 1st Ed., January 31,  
2000



# Temperature Test Method

- Thermocouple locations



Courtesy: Robertson, Magnetek/Universal and Advance Transformer

# Temperature Test Method

- Procedure
  - Ballast manufacturer indicates maximum allowable temperature
    - If not cited, assume 65°C
  - Stabilize temperature for 7.5 hours minimum

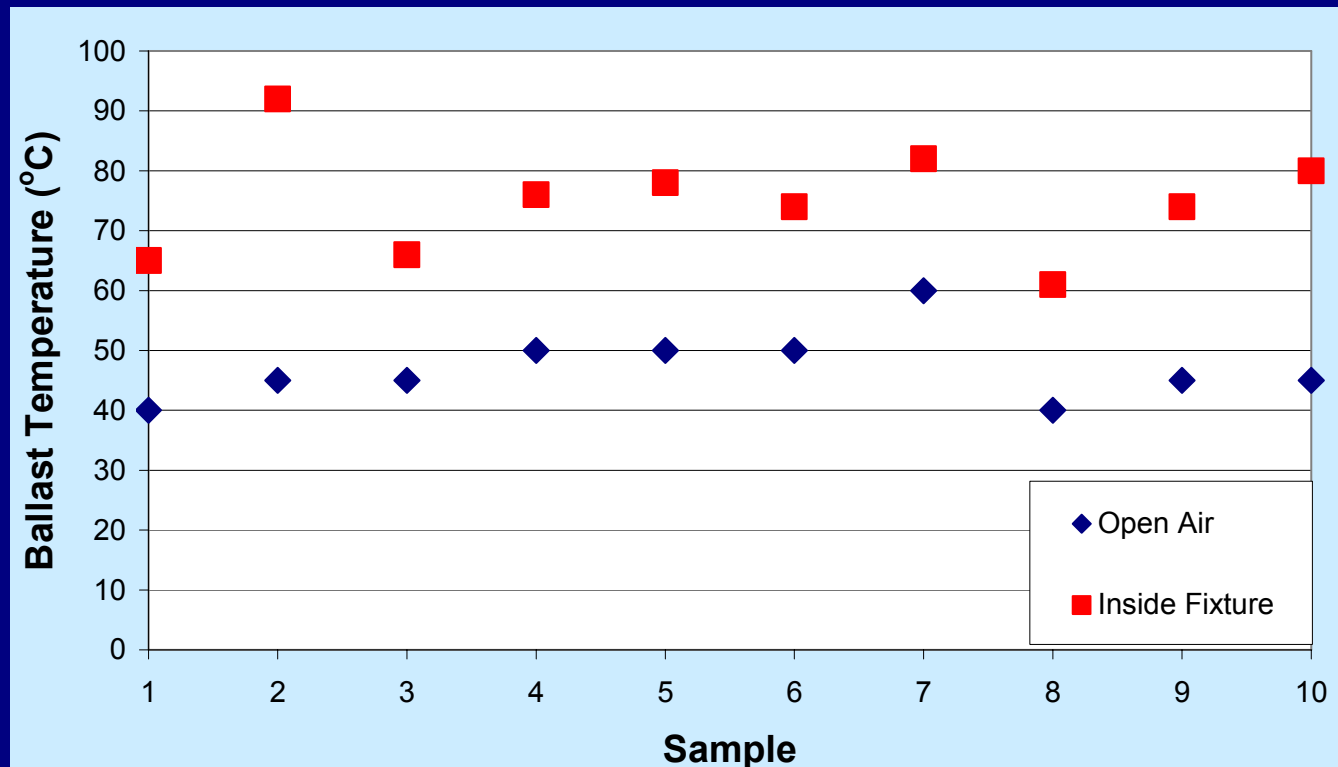
# Temperature Test Results

- Percentage exceeding allowable ballast operating case

	<64°C	65-74°C	75-89°C	90°C+
Ceiling mounted fixture, magnetic ballast (n=12)	8%	8%	25%	58%
Ceiling mounted fixture, electronic ballast (n=10)	10%	40%	40%	10%
Recessed fixture, electronic ballast (n=7)	71%	14%	0%	14%

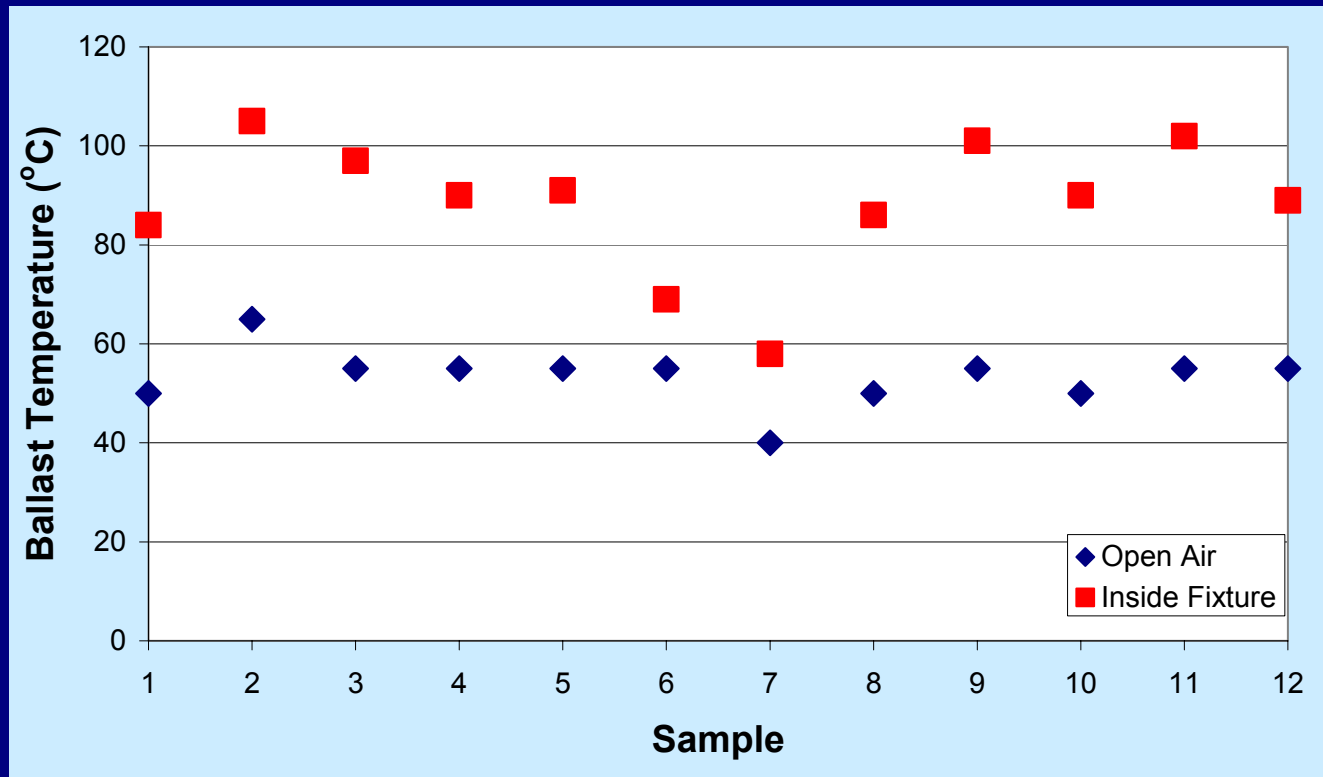
# Temperature Test Results

- Ceiling mounted fixtures with electronic ballasts



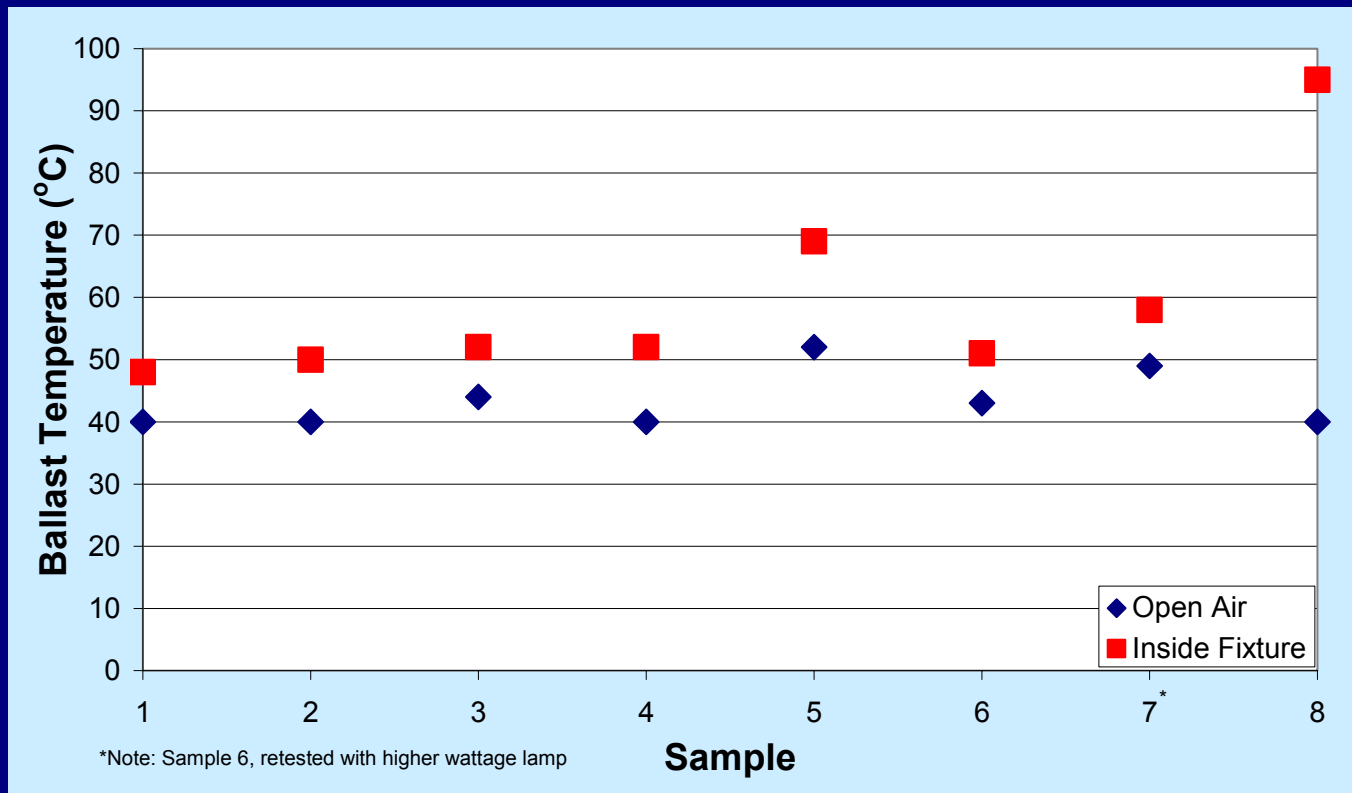
# Temperature Test Results

- Ceiling mounted fixtures with magnetic ballasts



# Temperature Test Results

- Recessed fixtures with electronic ballasts



# Temperature Test Results

- As maximum allowable ballast operating case temperature becomes more strict, percentage of samples exceeding limit

	90°C+	75°C	65°C
Ceiling mounted fixture, magnetic ballast	58%	83%	92%
Ceiling mounted fixture, electronic ballast	10%	50%	90%
Recessed fixture, electronic ballast	14%	14%	29%

# Stress Test

- Purpose

- Conduct a rapid-cycle test to stress the lamp/ballast system
- Quickly identify any starting or operating characteristics of the ballast that may damage the lamps
- Determine failures caused by substandard components or lamp/ballast incompatibility

# Stress Test

- Sample selection
  - Wide wattage range
    - 13W CFL to high-wattage Circline® lamps
  - Not based on ANSI or IEC standards, price, nor potential quality indicator

# Stress Test

- Fixture characteristics
  - Nine lamp/ballast products selected for test
  - Six samples of each product

# Stress Test

- Setup
  - Remove lamps and ballasts from fixtures; place in racks in a base-up position
  - Regulate voltage to  $120\text{ V} \pm 0.5\%$
  - Regulate temperature in lab to  $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$
  - Lamps “seasoned” for 100 hours before test start

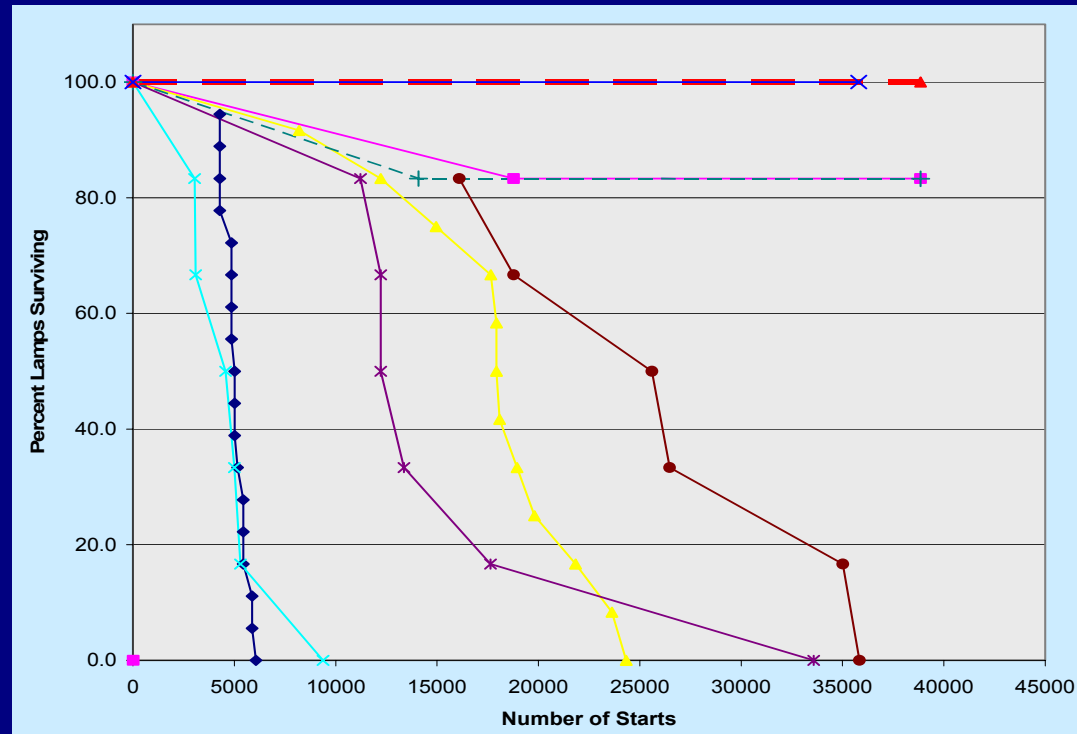


# Stress Test

- Procedure
  - Rapid-cycle test of 5 minutes on/5minutes off
    - Computer-controlled and monitored
  - Cycle operation until failure
  - Manually turn off lamps not failing by April 20, 2003

# Stress Test Results

- Majority of products had at least 32,000 starts
- Two products had premature failure
  - Neither achieved 10,000 starts



# Voltage Test

- Purpose

- Measure impact of high and low supply voltage on life of typical ENERGY STAR fixtures
- Concentrate efforts on constant over- or under-voltage conditions

# Voltage Test

- Sample selection
  - Common lamp wattages recommended by ICF Consulting
    - 13W twin-tube and double twin-tube lamps
    - 30W Circline lamps
    - 40W double-Circline lamps
  - All products electronically ballasted
  - Two examples in each category, six samples of each

# Voltage Test

- Setup
  - Use 104 V and 130 V as residential extremes
  - Use 2 samples for under-voltage; 2 samples for over-voltage; 2 samples as control

# Voltage Test

- Procedure
  - Continual operation at constant under- or over-voltage conditions
    - Constant power used to eliminate switching as potential failure cause
  - Daily monitoring to note failures
    - Replace lamps as necessary to continue ballast tests

# Voltage Test Results

- After eight weeks of constant operation, no failures occurred
  - Neither lamp nor ballast failure
- After an additional three weeks at greater voltage extremes (84 V and 156 V), still no failures occurred

# Conclusions/recommendations

- Temperature test recommendation
  - Adopt LRC's proposed test method based on pilot testing
    - Maximum allowable temperature and thermal probe location to be determined by ballast manufacturer

# Conclusions/recommendations

- Temperature test recommendation
  - Documentation
    - Photographs of tested fixtures mounted in/on test apparatus
    - Ballast documentation from manufacturer for location and max. performance temperature
    - Temperature recorded at test start and after 7.5 hours of stabilization

# Conclusions/recommendations

- Stress test conclusion
  - Studies inconclusive
    - Lamp/ballast incompatibility beyond ANSI compliance must be investigated
- Stress test recommendation
  - ANSI compliance as interim step
  - Further testing is warranted

# Conclusions/recommendations

- Voltage test conclusion
  - Voltage alone does not appear to be a cause of premature failure; no requirements beyond ANSI standard line voltage ranges
- Voltage test recommendation
  - Since transient protection is already required by the ENERGY STAR specification, no additional requirements are necessary until test for interaction with other factors is conducted

# Next Steps

- Further investigate mechanisms through which temperature may be involved in premature failure
- Determine acceptable target field failure rate/return rate for ENERGY STAR residential fixtures

# Next Steps

- Test for interaction (“doe”)
  - Temperature vs. voltage
  - Temperature vs. stress
  - Voltage vs. stress
  - Temperature vs. voltage vs. stress

Thank you.