ENERGY STAR®
Lamps Specification Draft 1.0 Stakeholder Meeting

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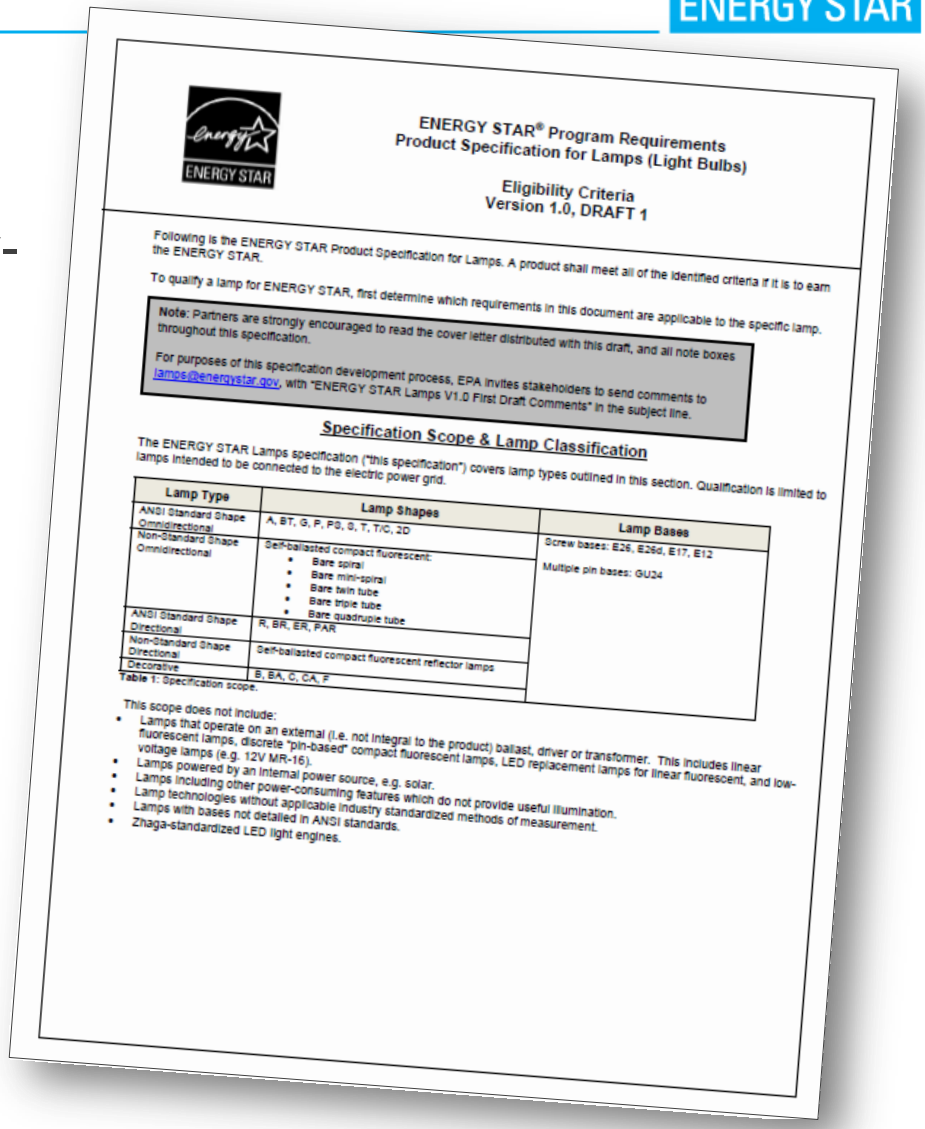
Part 1: ENERGY STAR Lamps Specification:

General Walkthrough of
Draft 1

ENERGY STAR Lamps Draft 1

- Issued October 21, 2011
- EPA's intent: merge existing specifications into one technology-neutral specification, taking the opportunity to further increase quality and reliability.
- Focus on remaining consumer detractors.
- Only minor efficacy increases are proposed.
- Efficacy levels will need to be revisited after completion of phase-in of new minimum efficiency standards required by EISA 2007.



ENERGY STAR® Program Requirements
Product Specification for Lamps (Light Bulbs)

Eligibility Criteria
Version 1.0, DRAFT 1

Following is the ENERGY STAR Product Specification for Lamps. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

To qualify a lamp for ENERGY STAR, first determine which requirements in this document are applicable to the specific lamp.

Note: Partners are strongly encouraged to read the cover letter distributed with this draft, and all note boxes throughout this specification.

For purposes of this specification development process, EPA invites stakeholders to send comments to lamps@energystar.gov, with "ENERGY STAR Lamps V1.0 First Draft Comments" in the subject line.

Specification Scope & Lamp Classification

The ENERGY STAR Lamps specification ("this specification") covers lamp types outlined in this section. Qualification is limited to lamps intended to be connected to the electric power grid.

Lamp Type	Lamp Shapes	Lamp Bases
ANSI Standard Shape Omnidirectional	A, BT, G, P, PS, S, T, T/C, 2D	Screw bases: E26, E26d, E17, E12 Multiple pin bases: GU24
Non-Standard Shape Omnidirectional	Self-ballasted compact fluorescent: • Bare spiral • Bare mini-spiral • Bare twin tube • Bare triple tube • Bare quadruple tube	
ANSI Standard Shape Directional	R, BR, ER, PAR	
Non-Standard Shape Directional	Self-ballasted compact fluorescent reflector lamps	
Decorative	B, BA, C, CA, F	

Table 1: Specification scope.

This scope does not include:

- Lamps that operate on an external (i.e. not integral to the product) ballast, driver or transformer. This includes linear fluorescent lamps, discrete "pin-based" compact fluorescent lamps, LED replacement lamps for linear fluorescent, and low-voltage lamps (e.g. 12V MR-16).
- Lamps powered by an internal power source, e.g. solar.
- Lamps including other power-consuming features which do not provide useful illumination.
- Lamp technologies without applicable industry standardized methods of measurement.
- Lamps with bases not detailed in ANSI standards.
- Zhaga-standardized LED light engines.

Outline

- Specification Scope & Lamp Classification
- Photometric Performance Requirements
- Lumen Maintenance & Reliability Requirements
- Luminous Intensity Distribution Requirements
- Electrical Performance Requirements
- Lamp Toxics Reduction Requirements
- Dimensional Requirements
- Lamp Labeling & Packaging Requirements

Specification Scope & Lamp Classification

Specification Scope & Lamp Classification

Lamp Type	Lamp Shape	Base Types
ANSI Standard Shape Omnidirectional	A, BT, G, P, PS, S, T, T/C, 2D	Edison bases (E26, E12, E17, etc.) Bayonet bases Single pin bases Multiple pin bases (GU24, etc.)
Non-Standard Shape Omnidirectional	Self-ballasted compact fluorescent: • Bare spiral • Bare mini-spiral • Bare twin tube • Bare triple tube • Bare quadruple tube	
ANSI Standard Shape Directional	R, BR, ER, PAR	
Non-Standard Shape Directional	Self-ballasted compact fluorescent reflector lamps	
Decorative	B, BA, C, CA, F	

EPA

Specification Scope & Lamp Classification: Lamps Excluded

- Lamps that operate on an external ballast or transformer.
  - This includes linear fluorescent lamps, discrete “pin-based” compact fluorescent lamps, LED replacement lamps for linear fluorescent, and low voltage lamps (e.g. 12V MR-16).
- Lamps powered by an internal power source, e.g. solar.
- Lamps including other power consuming features which do not provide illumination.
- Lamp technologies without industry standardized methods of measurement.
- Lamps with bases not detailed in ANSI standards.
- Zhaga-standardized LED light engines.

Specification Scope & Lamp Classification

- Permissible lamp shapes encompass the majority of lamps included under the current CFL and Integral LED Lamps program requirements.
- E17 intermediate base included per stakeholder recommendation.
- GU10 base and ANSI “K” shape not included.
- EPA plans to incorporate test methods and reference documents for integrated ceramic metal halide in a subsequent draft.

Specification Scope & Lamp Classification: Low-Voltage Lamps

- Low-voltage lamps (e.g. MR16 lamps) excluded from specification because energy savings:
  - Dependent on user behavior.
  - Not consistent across all applications and cannot be attributed to the product alone.
  - Dependent (for Integral LED Lamps) on matching lamp to type of transformer (AC or DC operation).
  - Form factor makes meeting lamp labeling requirements difficult.

Specification Scope & Lamp Classification: Non-Standard Lamps

- EPA seeks input on an approach to labeling non-standard lamps recognizing that:
  - Solid state lamps need not conform to ANSI-standardized shapes to produce high efficiency.
  - Self-ballasted CFLs do not conform to ANSI standards.
  - Non-standard provisions in V1.4 of Integral LED Lamps specification are being re-evaluated.

Non-Standard Lamps: Integral LED Lamps V1.4 Requirements

- Non-standard requirements in Integral LED Lamps V1.4:
  - Non-standard may not state equivalency to existing standard electric lamps in terms of wattage or type/shape of lamp.
  - Use both recessed and table fixture icons on packaging and shall select a minimum of two additional icons to display.
  - Applications for which lamp is appropriate shall be circled.
  - Applications for which the lamp's luminous intensity distribution would fail to meet the requirement shall be marked with an "X".

Criteria Item	ENERGY STAR Requirements
Minimum Luminous Efficacy	
- LED lamp power <10W	50 lm/W
- LED lamp power ≥10W	55 lm/W
Minimum Light Output	200 lumens
Luminous Intensity Distribution	No specific distribution is required. Must submit goniophotometry report showing luminous intensity distribution produced by the lamp.

Effective Date

- The ENERGY STAR Lamps Version 1.0 specification shall take effect on [Date TBD].
- To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on its date of manufacture.
- The date of manufacture is specific to each unit and is the exact date on which a unit is considered to be completely assembled.

Product Families

- EPA seeks input on allowable variations with product families.

Photometric Performance Requirements

Photometric Requirements: Sample Size

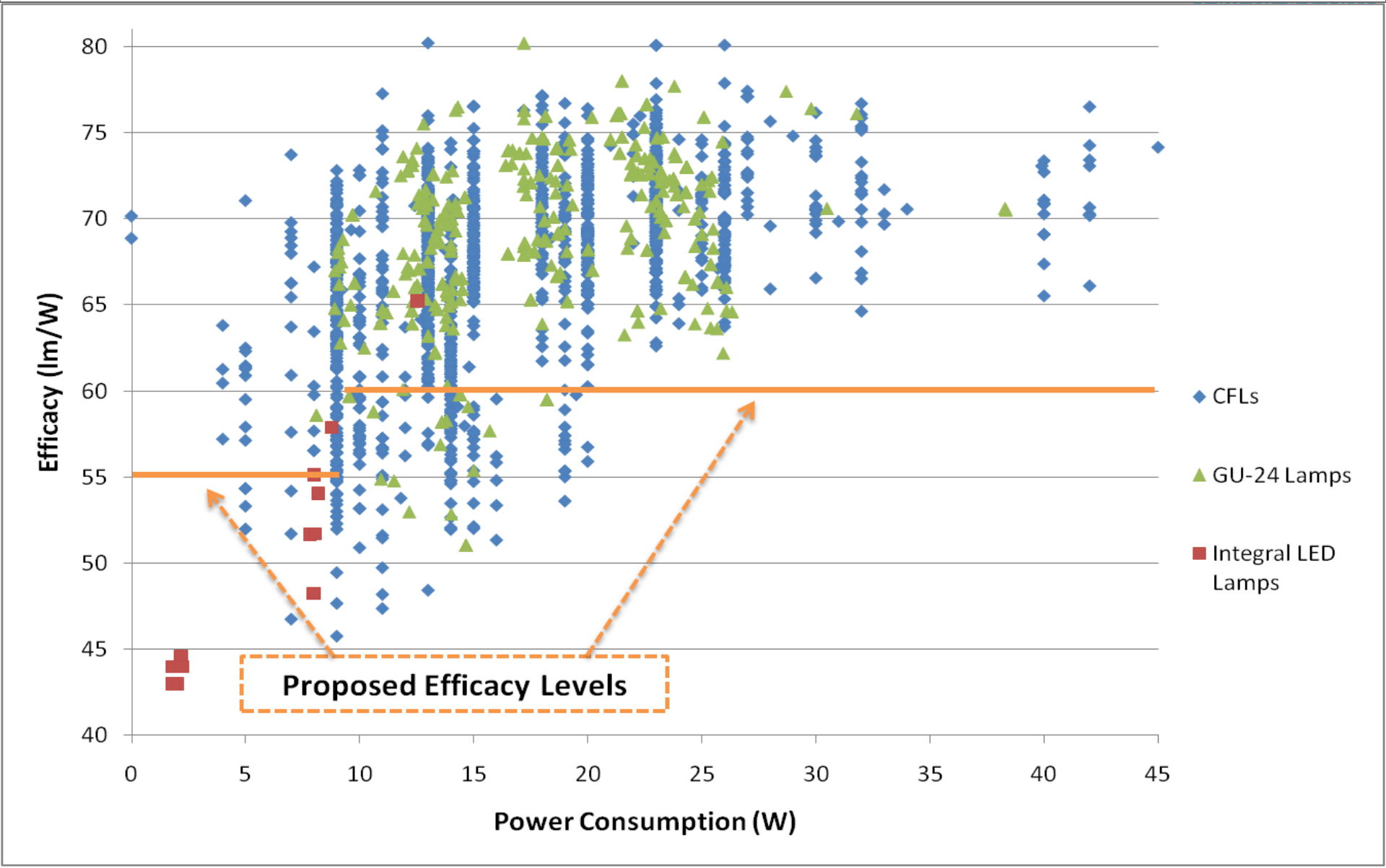
- For photometric requirements:
  - Sample size is 10 units per model with 5 units tested base-up and 5 units tested base down unless the manufacturer restricts specific use or position.
  - If position is restricted, all units shall be tested in restricted position.

Luminous Efficacy Requirements

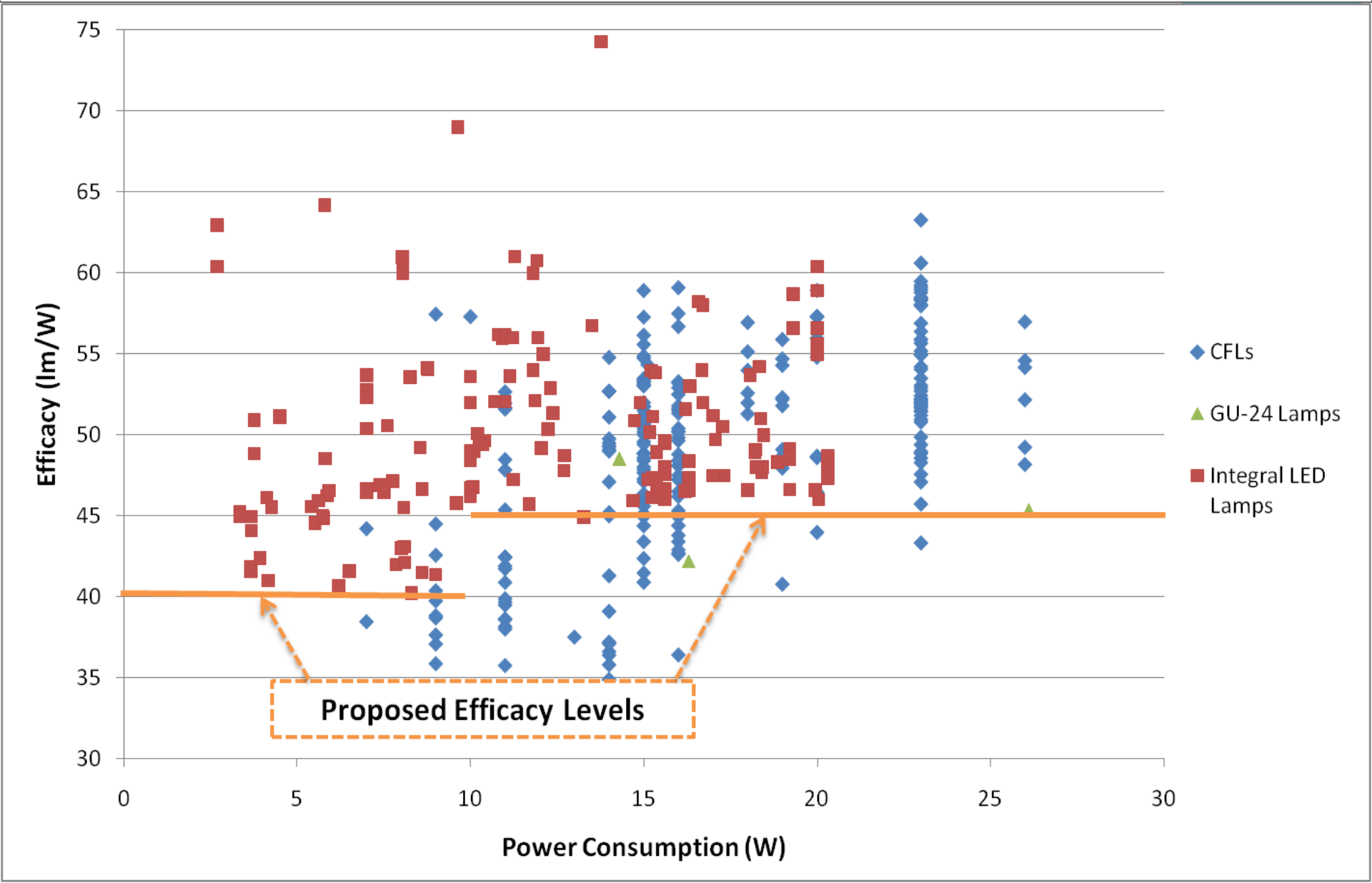
	Minimum Lamp Efficacy (initial)		Passing
Lamp Type	**Wattage**	**Efficacy**	
Omnidirectional	<10w	55 lm/watt	Average of unit values shall meet the requirement, and ≥ 9 units individually shall meet the required value. If units are tested both base-up and base-down, averages shall be calculated for both subsets, and the efficacy shall be the lesser of the two averages.
	≥10w	60 lm/watt	
Directional	<10w	40 lm/watt	
	≥10w	45 lm/watt	
Decorative	<10w	45 lm/watt	
	≥10w	50 lm/watt	

- Proposed values represent nominal increases above existing requirements, which analyses have indicated are accessible and cost effective.
- Higher wattage lamps are capable of achieving higher efficacy levels, so efficacy requirement increases at 10 W.
- Of currently qualifying CFLs (including GU-24) and Integral LED Lamps:
  - Approximately 91% of omnidirectional lamps will be able to meet the proposed criteria.
  - Approximately 89% of directional lamps will be able to meet the proposed criteria.
  - All high-wattage decorative lamps meet the proposed efficacy levels. 85% of low wattage directional lamps meet the proposed criteria.

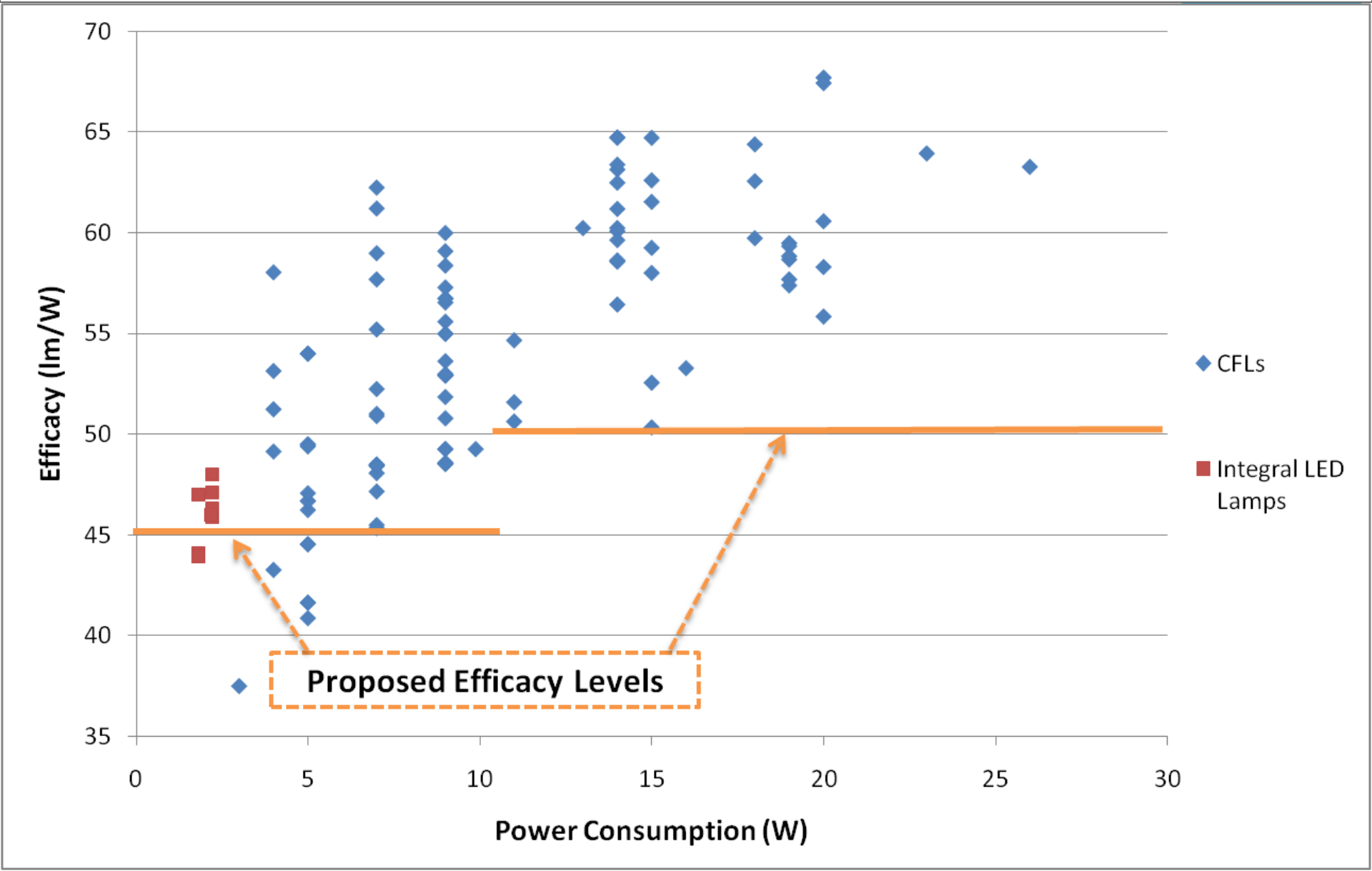
Omnidirectional Lamp Efficacy



Directional Lamp Efficacy



Decorative Lamp Efficacy



Light Output: Omnidirectional (except Globe)

Lamp Light Output Range (initial)		Survey of A-Line Incandescents Lumen Output	
Standard Incandescent Equivalent Wattage	Light Output Total Lumens	Mean	Median
25	250-449	211	198
40	450-799	462	465
60	800-1,099	828	850
75	1,100-1599	1,133	1,170
100	1,600-1,999	1,627	1,635
125	2,000-2,549	No Data	No Data
150	2,550-3,000	2,637	2,685

- A survey of A-Line incandescent lamps found that the average and median lumen outputs fell within ENERGY STAR levels at all wattage levels except 25W.
- Maintains existing CFL specification except for 125W and 150W levels.
- Passing requirement same as the Efficacy criterion passing requirement.
- Lamp output must fall into Lamp Light Output Range to claim equivalency.

Light Output: Omnidirectional Globe

Lamp Light Output Range (initial)		Survey of Globe Incandescents Lumen Output	
Standard Incandescent Equivalent Wattage	Light Output Total Lumens	Mean	Median
25	250-349	298	303
40	350-499	365	372
60	500-574	544	595
75	575-649	No Data	No Data
100	650-1,099	655	710
150	1,100-1,300	1,110	1,110

- A survey of frosted globe incandescent lamps found that the average and median lumen outputs fell within ENERGY STAR levels at all wattage levels except for the median value at 60W.
- Values carried forward from existing lamp specifications.
- Passing requirement same as the Efficacy criterion passing requirement.
- Lamp output must fall into Lamp Light Output Range to claim equivalency.

Light Output: Directional (R, BR and ER)

Lamp Light Output Range (initial)	
Standard Incandescent Equivalent Wattage	**Minimum Light Output Total Lumens**
20	TBD
40	TBD
60	TBD
75	TBD
100	TBD
125	TBD
150	TBD

- Will propose light output values in Draft II.
- PAR Lamps exempt from light output requirement. Must satisfy other intensity distribution requirements.

Light Output: Decorative

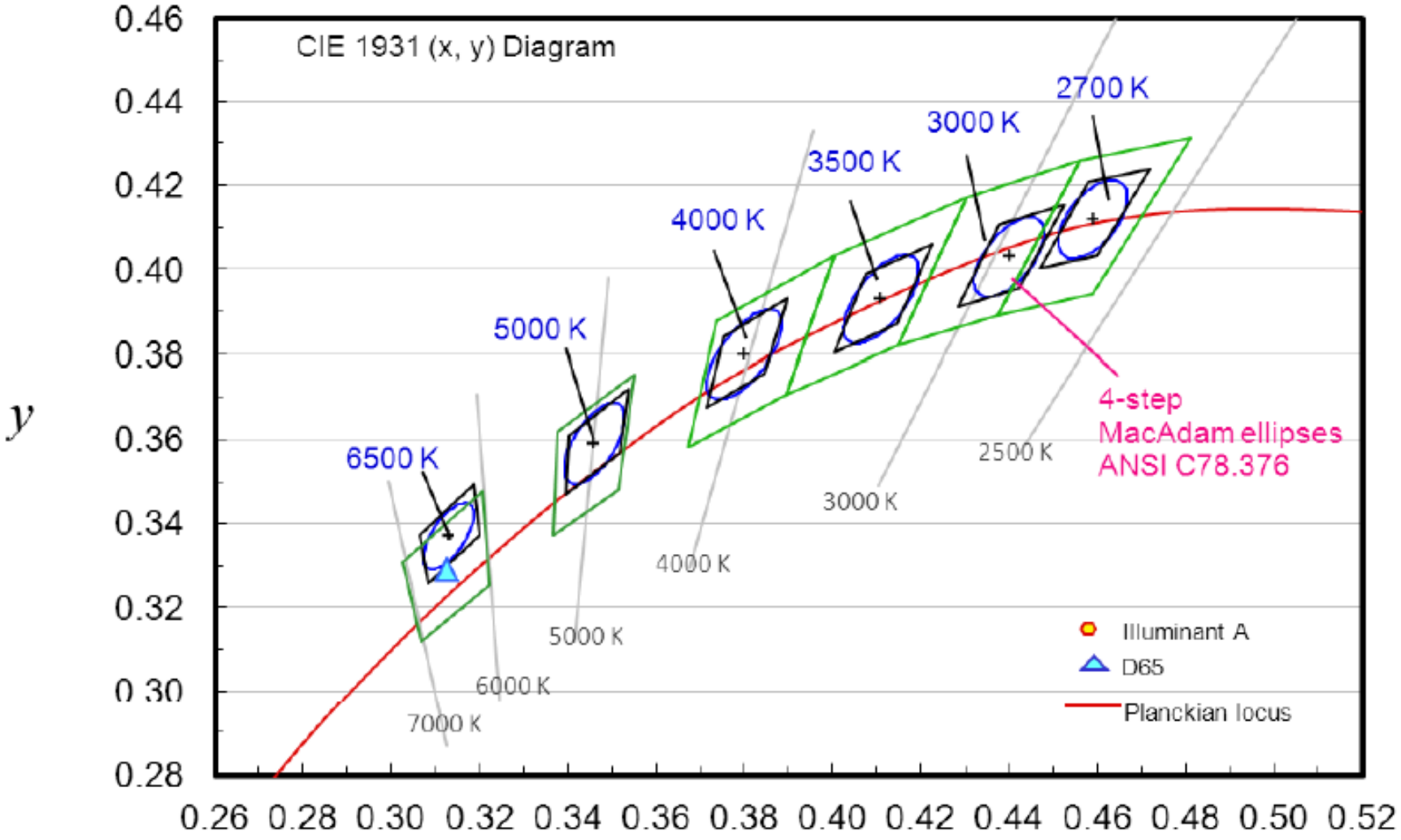
Lamp Light Output Range (initial)		Survey of Decorative Incandescents Lumen Output	
Standard Incandescent Equivalent Wattage	Light Output Total Lumens	Mean	Median
10	70-89	No Data	No Data
15	90-149	No Data	No Data
25	150-299	181	175
40	300-499	335	340
60	500-699	612	575

- A survey of decorative incandescent lamps found that the average and median lumen outputs fell within ENERGY STAR levels for all wattage categories where data was available.
- Values carried forward from existing lamp specifications.
- Passing requirement same as the Efficacy criterion passing requirement.
- Lamp output must fall into Lamp Light Output Range to claim equivalency

Correlated Color Temperature (CCT) Requirements

- Solid state lamps shall meet target values (with tolerance) and compact fluorescent shall meet one of the following nominal CCTs:
  - 2700K, 3000K, 3500K, 4000/4100K, 5000K
- Passing:
  - **CFLs**: ≥ 9 units shall fall within the defined 4-step ANSI MacAdam ellipse for the target color temperature. No units shall fall outside of a 7-step ANSI MacAdam ellipse.
  - **Solid State**: ≥ 9 units shall fall within the defined 4-step ANSI quadrangle for the target color temperature. No units shall fall outside of a 7-step quadrangle.

Correlated Color Temperature



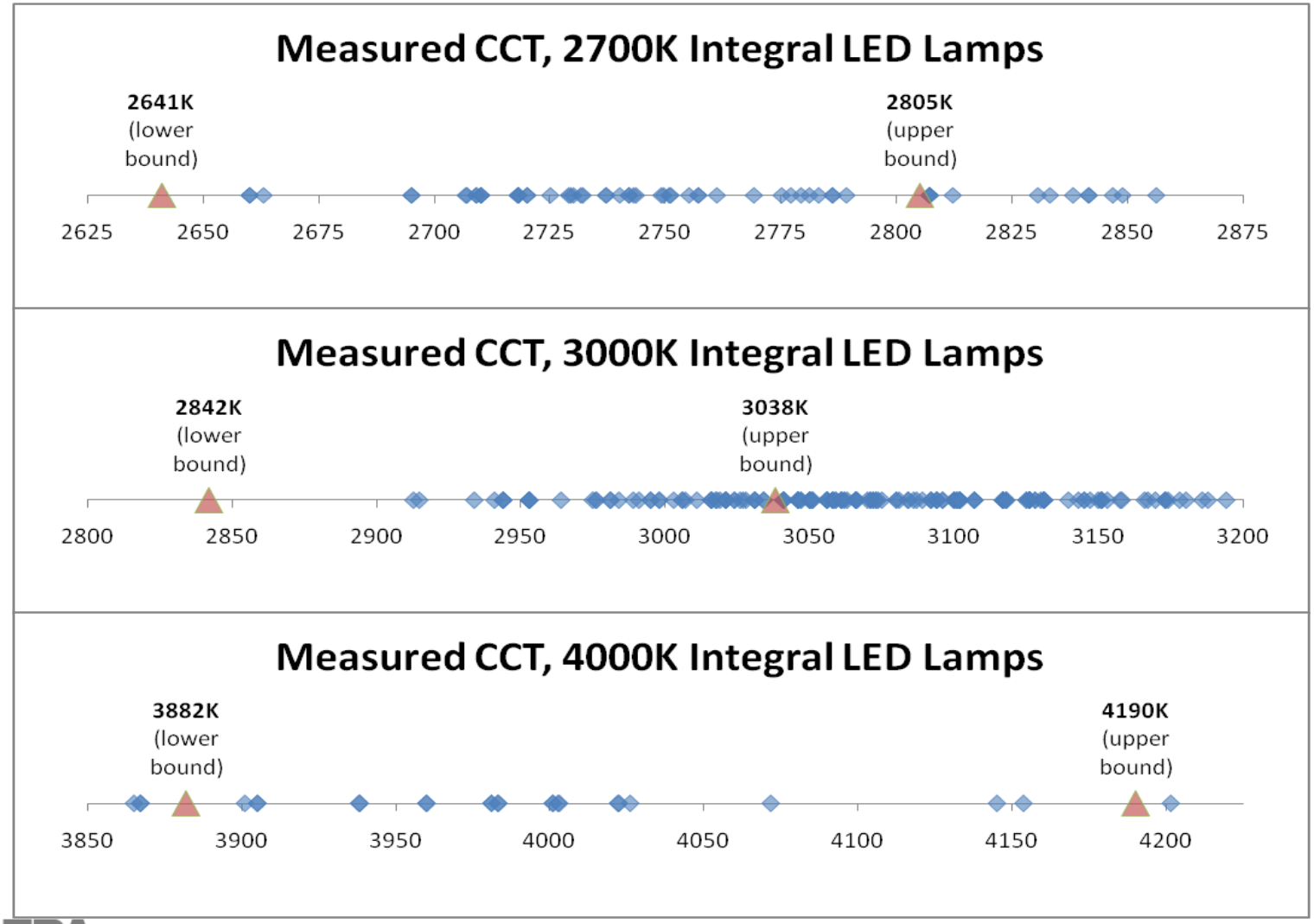
ANSI_ANSLG C78.377-201X
Revision of ANSI_ANSLG C78.377-2008

Correlated Color Temperature: CFLs

MacAdam Ellipse Size	CFLs: ANSI Nominal CCT Percent of ENERGY STAR Qualified CFLs meeting criteria					Percent Total
	2700K	3000K	3500K	4100K	5000K	
7-step	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
4-step	37.78%	48.98%	40.95%	62.56%	50.89%	43.37%

- 7-step ellipses and quadrangles allow lamps with magenta or green tints to be qualified.
- Move from 7-step to 4-step intended to improve consumer satisfaction and a consistent experience across makes, models, and technologies.
- Some manufacturer support for 4-step.

Correlated Color Temperature: Integral LED Lamps



79% Pass

26% Pass

80% Pass

Correlated Color Temperature: Price Analysis

- Collected pricing data to compare price difference in products meeting a 7-step and a 4-step.
  - Data collected for 2700K, single-pack, bare spiral CFLs with lumens between 500-1,600.
- Averaged prices from 3 or 4 retailers for the same product.
- Analysis based on 28 CFL products.
- No easily distinguishable price difference between products meeting 7-step and products meeting 4-step.
  - Other factors appear to have greater impact on pricing in cursory analysis

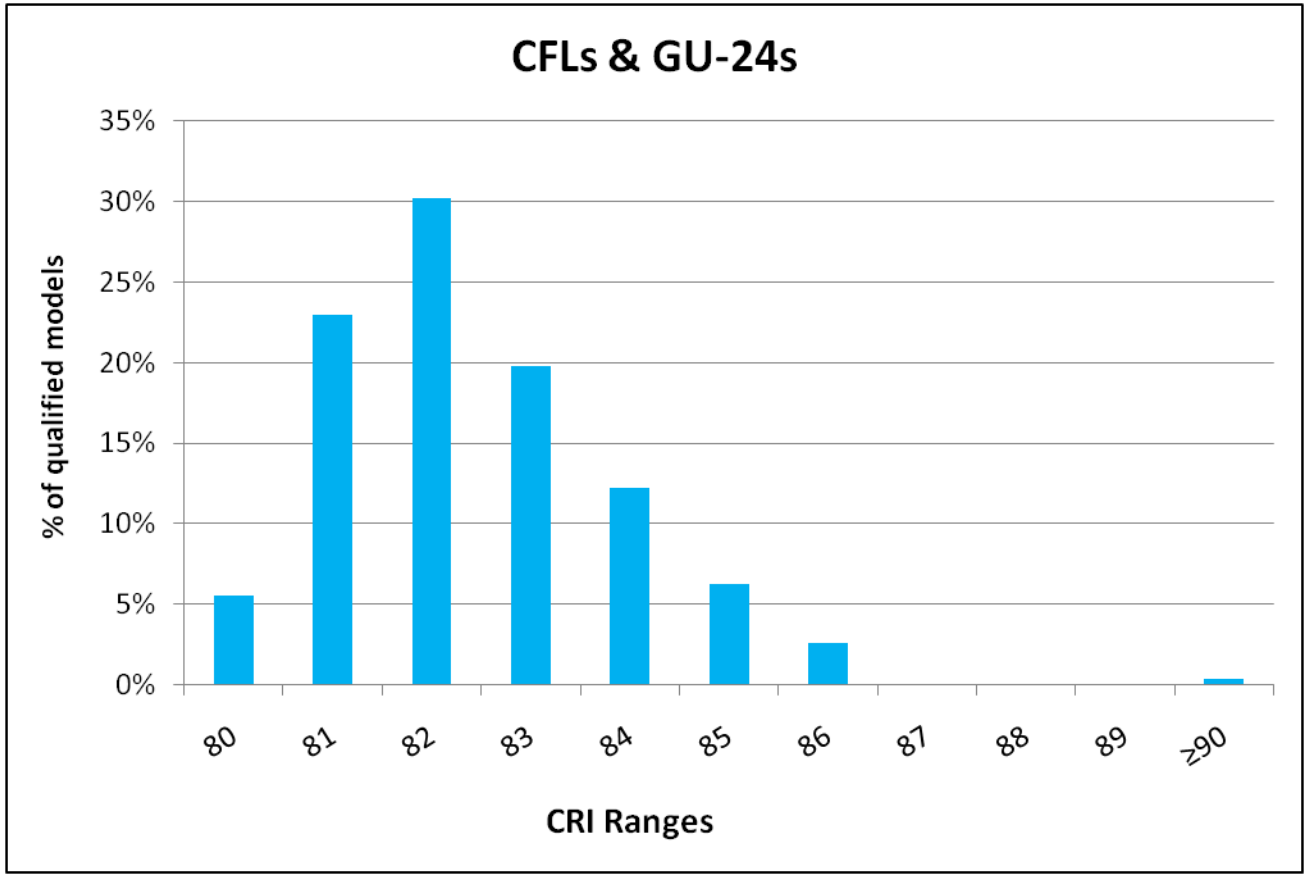
Color Rendering Requirements

Lamp Type	ENERGY STAR Requirements	Passing
All lamps	Lamps shall exhibit color rendering index scores of $R_a \geq 80$ and $R_9 > 0$.	Average of units tested shall meet the requirement and no more than 3 units shall have $R_a < 77$. No units shall have $R_a < 75$.

- The above is a combination of requirements from the existing lamp specifications.
- EPA believes that most CFLs and Integral LED lamps should be able to meet these requirements.

Color Rendering

	CRI Distribution										
Category	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**≥90**
All CFLs	5.5%	23.0%	30.2%	19.8%	12.2%	6.2%	2.6%	0.1%	0.0%	0.0%	0.4%



- Determined that moving the criteria above 80 does not produce a noticeable benefit for consumers and would eliminate the majority of products.

Color Maintenance

Lamp Type	ENERGY STAR Requirements	Passing
Solid State	Lamp change in chromaticity from initial/0-hour measurement, at any measurement point during the first 6,000 hours of lamp operation, shall be within 0.004 on the CIE 1976 u'v' diagram.	≥ 9 units shall meet the requirement.

- The requirement:
  - moves from the current 0.007 in the Integral LED Lamps V1.4 to 0.004.
  - is intended to be consistent with proposed improvements in initial performance.
  - is intended to improve consumer satisfaction.

Color Angular Uniformity

Lamp Type	ENERGY STAR Requirements	Passing
Directional (LEDs only)	When measured, the variation of chromaticity shall be within .004 from the weighted average point on the CIE 1976 (u'v') diagram.	The unit (1 sample) shall meet the requirement.

- Requirement aligns with the Luminaires specification.
- Intended to help ensure that solid state directional lighting products provide similar performance whether a luminaire is installed or a qualified lamp is retrofitted.

Lumen Maintenance & Reliability Requirements

Lumen Maintenance & Reliability

Goal is to align requirements across technologies when possible.

- Lumen maintenance requirements:
  - CFLs:
    - Maintains 40% of rated life requirement.
    - Eliminates 1,000 hour requirement.
  - Solid State:
    - Maintains existing Integral LED Lamps V1.4 requirements, while providing option to claim a minimum rated lumen maintenance life of 10,000 hours.
    - Partners will be allowed to use TM-21 projection based on LM-80 report during Early Interim Qualification.
- Reliability requirements:
  - Lamps have ≥10,000 hour rated life.
  - Analysis has demonstrated that 10,000 hours is highly feasible for CFLs.

EPA

Lumen Maintenance & Reliability: Testing Requirements

- EPA recognizes that some of the proposed changes would require re-testing of most lamps.
- Both CFL and Integral LED Lamp programs required products to be requalified after 36-months.
  - This requirement has been eliminated from CFL V4.3 (forthcoming) and Integral LED Lamps V1.4 in anticipation of the Lamps specification development and new testing requirements developed under the specification.

Lumen Maintenance & Reliability Requirements

- Proposed extension of Elevated Temperature Test to all lamps ≥ 5W to:
  - Evaluate robustness of lamp in thermal environment created by luminaires.
  - Help improve consumer experience.
- Testing:
  - Draft 2 will include an annexed ENERGY STAR Elevated Temperature Test Procedure.

Lumen Maintenance & Reliability: Sample Size

- For lumen maintenance and reliability requirements:
  - Sample size is 10 units per model with 5 units tested base-up and 5 units tested base down unless the manufacturer restricts specific use or position.
  - If position is restricted, all units shall be tested in restricted position.

Lumen Maintenance Requirements

Lamp Type	ENERGY STAR Requirements	Passing
Compact Fluorescent	Lamp shall maintain 80% of initial lumen output at 40% of rated life.	Average lumen maintenance of the samples shall meet the requirement. No more than 3 units may have lumen maintenance < 75%. No units may have lumen maintenance < 70%.

Portion of Qualified CFLs meeting select 40% Lumen Maintenance Levels							
	80%	82%	84%	85%	86%	88%	90%
ALL CFLs	99%	85%	59%	44%	33%	22%	12%
CFLs with 10,000 hour rated life	99%	87%	56%	38%	25%	14%	8%

Lumen Maintenance for Solid State: 3,000-Hour Early Interim Qualification

- Manufacturers can submit solid state products for qualification after 3,000 hours.
- Products must meet the following the minimum lumen maintenance values and meet the 3,000 hour reliability requirement to make the designated life claim:

Maximum Life Claim (hours)	Minimum Lumen Maintenance at End of Test Period
10,000	89.9%
12,000	91.5%
15,000	93.1%
20,000	94.8%
25,000	95.8%

- Products must meet lumen maintenance and reliability requirements at 6,000 hours for full qualification.

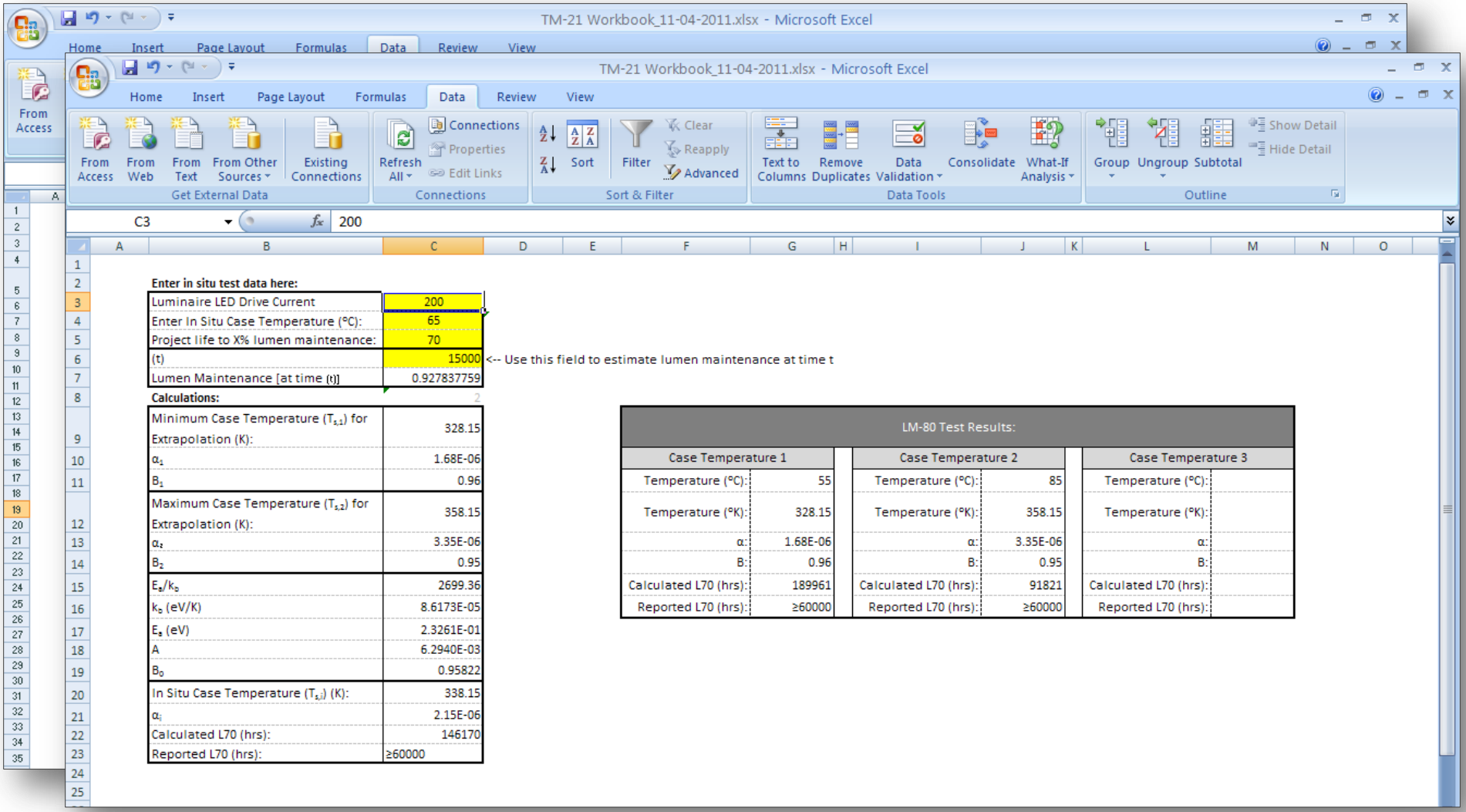
To qualify at 3,000 hours manufacturers should submit the following:

- LM-79 report with 3,000 hours of testing
- LM-80 report with 6,000 hours of testing
  - ENERGY STAR TM-21 Calculator can be used to project rated lumen maintenance life.
- in situ Temperature Measurement Test report

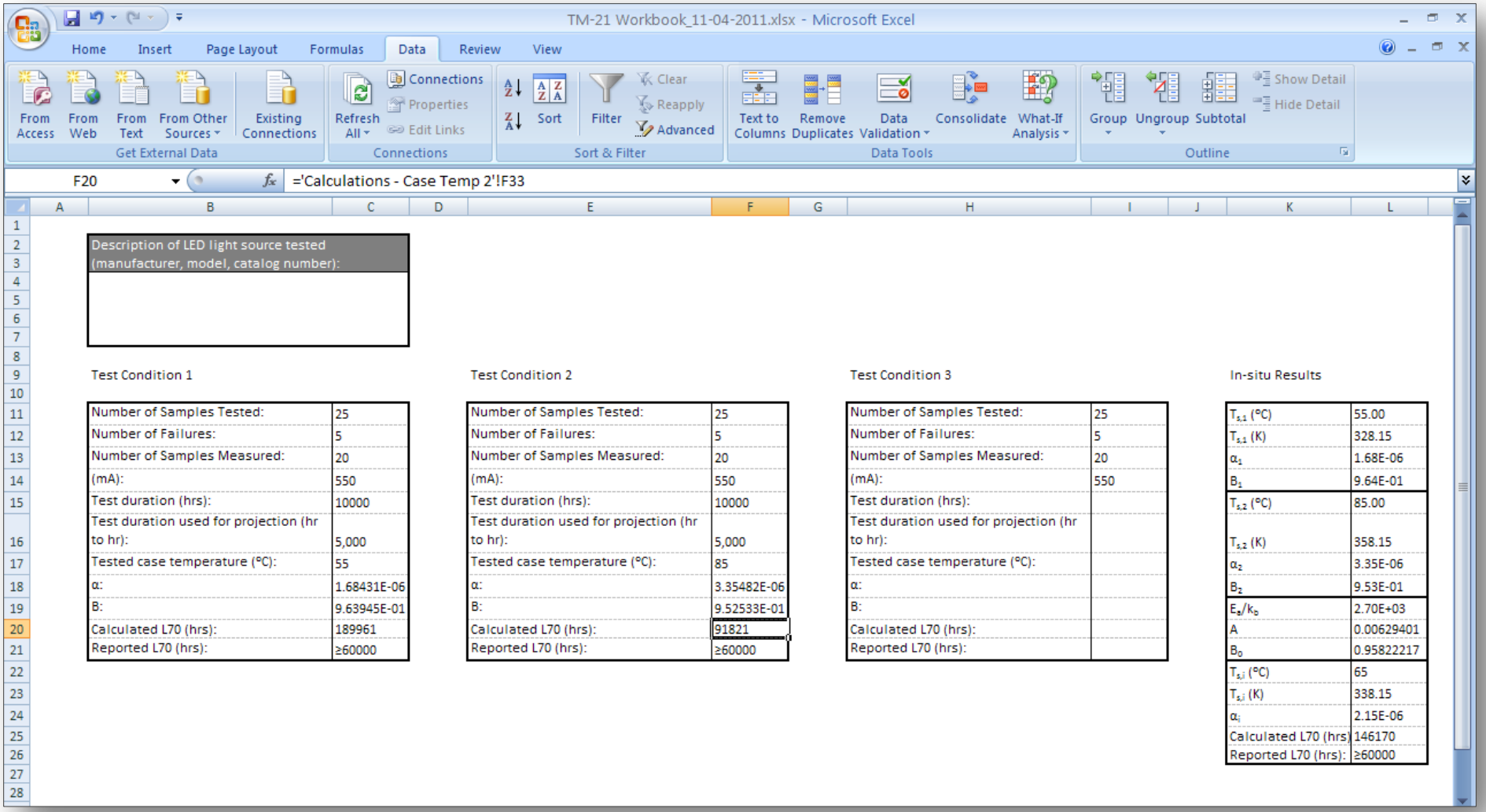
ENERGY STAR TM-21 Calculator

- A lumen maintenance projection calculation using LM-80-08 test report for LED package/module/array model and the forward drive current applied to each device shall support a rated lumen maintenance life of ≥10,000 hours.
- For use by manufacturers, EPA-recognized laboratories and CBs
- Mitigates the need for accreditation
- Any concern re: Excel format, please advise EPA immediately

ENERGY STAR TM-21 Calculator



ENERGY STAR TM-21 Calculator



Description of LED light source tested (manufacturer, model, catalog number):

Test Condition 1

Number of Samples Tested:	25
Number of Failures:	5
Number of Samples Measured:	20
(mA):	550
Test duration (hrs):	10000
Test duration used for projection (hr to hr):	5,000
Tested case temperature (°C):	55
α:	1.68431E-06
B:	9.63945E-01
Calculated L70 (hrs):	189961
Reported L70 (hrs):	≥60000

Test Condition 2

Number of Samples Tested:	25
Number of Failures:	5
Number of Samples Measured:	20
(mA):	550
Test duration (hrs):	10000
Test duration used for projection (hr to hr):	5,000
Tested case temperature (°C):	85
α:	3.35482E-06
B:	9.52533E-01
Calculated L70 (hrs):	91821
Reported L70 (hrs):	≥60000

Test Condition 3

Number of Samples Tested:	25
Number of Failures:	5
Number of Samples Measured:	20
(mA):	550
Test duration (hrs):	
Test duration used for projection (hr to hr):	
Tested case temperature (°C):	
α:	
B:	
Calculated L70 (hrs):	
Reported L70 (hrs):	

In-situ Results

$T_{s,1}$ (°C)	55.00
$T_{s,1}$ (K)	328.15
α_1	1.68E-06
B_1	9.64E-01
$T_{s,2}$ (°C)	85.00
$T_{s,2}$ (K)	358.15
α_2	3.35E-06
B_2	9.53E-01
E_a/k_o	2.70E+03
A	0.00629401
B_o	0.95822217
$T_{s,i}$ (°C)	65
$T_{s,i}$ (K)	338.15
α_i	2.15E-06
Calculated L70 (hrs)	146170
Reported L70 (hrs):	≥60000

Lumen Maintenance: 6,000-Hour Full Qualification

- After 6,000 hours of testing manufacturers can make the following life claims:

Maximum Life Claim (hours)	Minimum Lumen Maintenance at 6,000 Hours	Status After 6,000 Hour Test
10,000	80.7%	Testing completed
12,000	83.7%	
15,000	86.7%	
20,000	89.9%	
25,000	91.8%	
30,000	93.1%	Interim qualification; additional testing required.
35,000	94.1%	
40,000	94.8%	
45,000	95.4%	
50,000	95.8%	

- For full qualification at 6,000 hours, manufacturers should provide:
  - LM-79 report with 6,000 hours of testing
- Manufacturers claiming beyond 25,000 hour must meet the minimum lumen maintenance requirement at 6,000 hours and must continue to test to the extended lifetime claim requirements.

Lumen Maintenance: Optional Extended Lifetime Claims

- Manufacturer can make the designated life claim after testing for the minimum amount of time and meeting the minimum lumen maintenance requirements.
- After the minimum required test period manufacturers should provide:
  - LM-79 report through designated test period

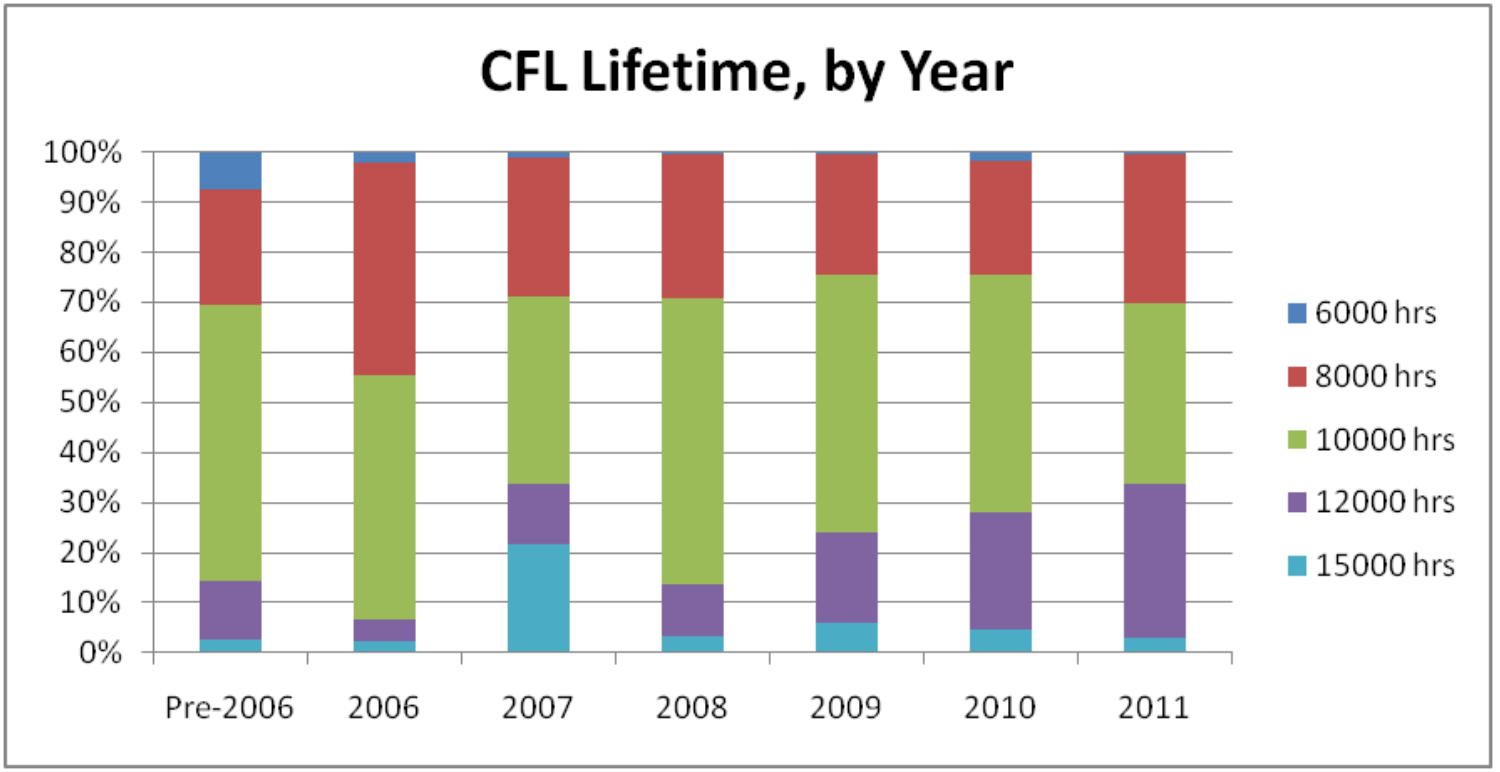
Maximum Life Claim (hours)	Minimum Test Period	Minimum Lumen Maintenance at End of Test
30,000	7,500	91.2%
35,000	8,750	91.5%
40,000	10,000	91.5%
45,000	11,250	91.5%
50,000	12,500	91.8%

Reliability

Lamp Type	ENERGY STAR Requirements	Passing
Compact Fluorescent	Lamps shall have a rated life ≥ 10,000 hours. All tested units shall be operational at 40% of rated life or 6,000 hours, whichever comes first. If the testing intervals are coincident, ≥ 90% of the tested units shall be operational. ≥ 90% of the tested units shall be operational at 40% of rated life or 6,000 hours, whichever comes second. ≥ 50% of the tested units shall be operational at rated life.	All of the requirements shall be met.
Solid State	All tested units shall be operational at 3,000 hours. ≥ 90% of the tested units shall be operational at 6,000 hours.	All of the requirements shall be met.

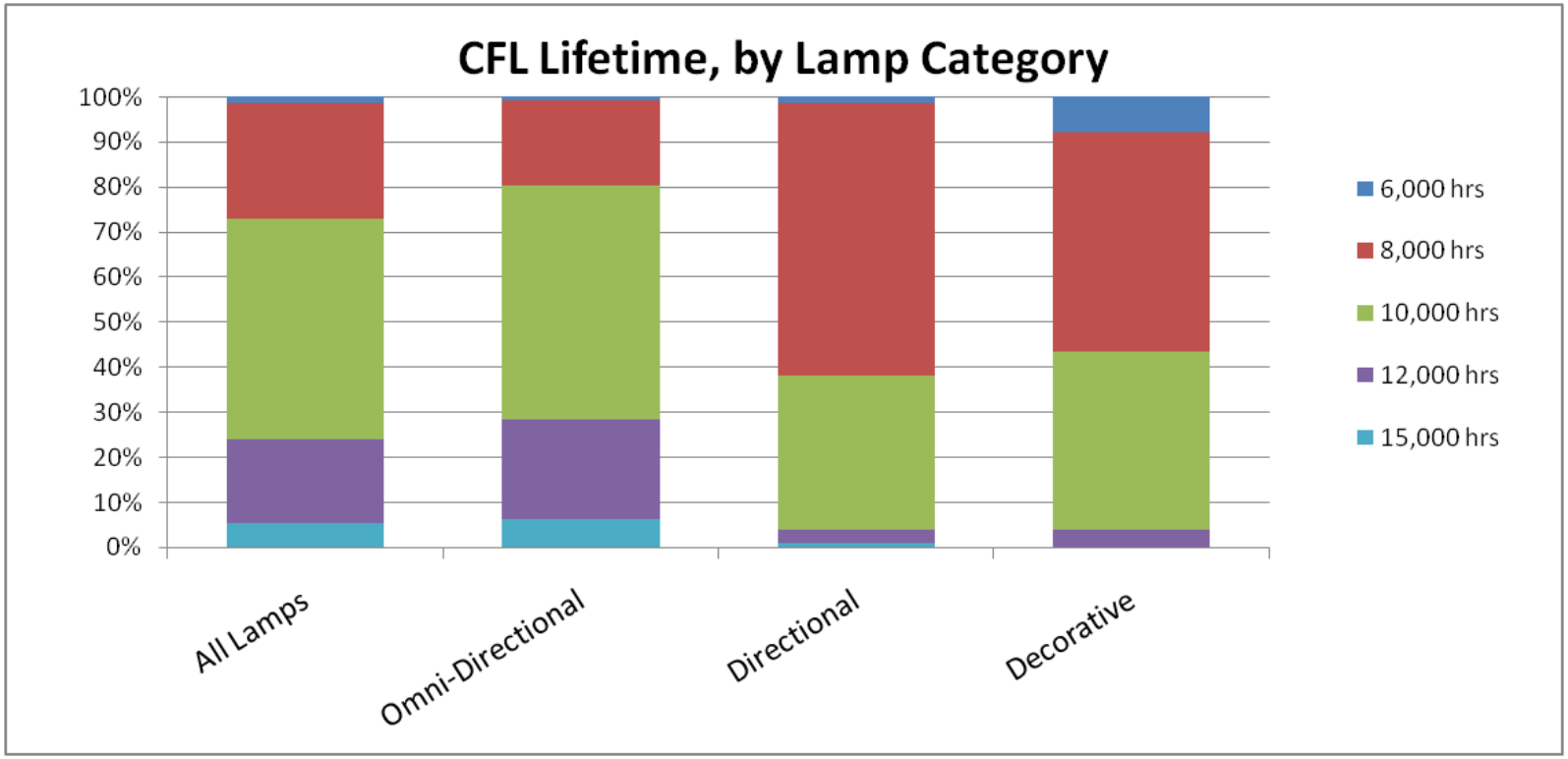
- 100% of qualified Integral LED Lamps currently meet this criteria.
- 99% of qualified GU-24 CFLs currently meet this criteria.
- 73% of qualified screw-base CFLs currently meet this criteria, and the average CFL lifetime is increasing year-over-year.

Reliability



- The proportion of CFLs at or above 10,000 hours has remained relatively constant over time, however there has been an increase of high lifetime lamps (12,000+ hours).

Reliability

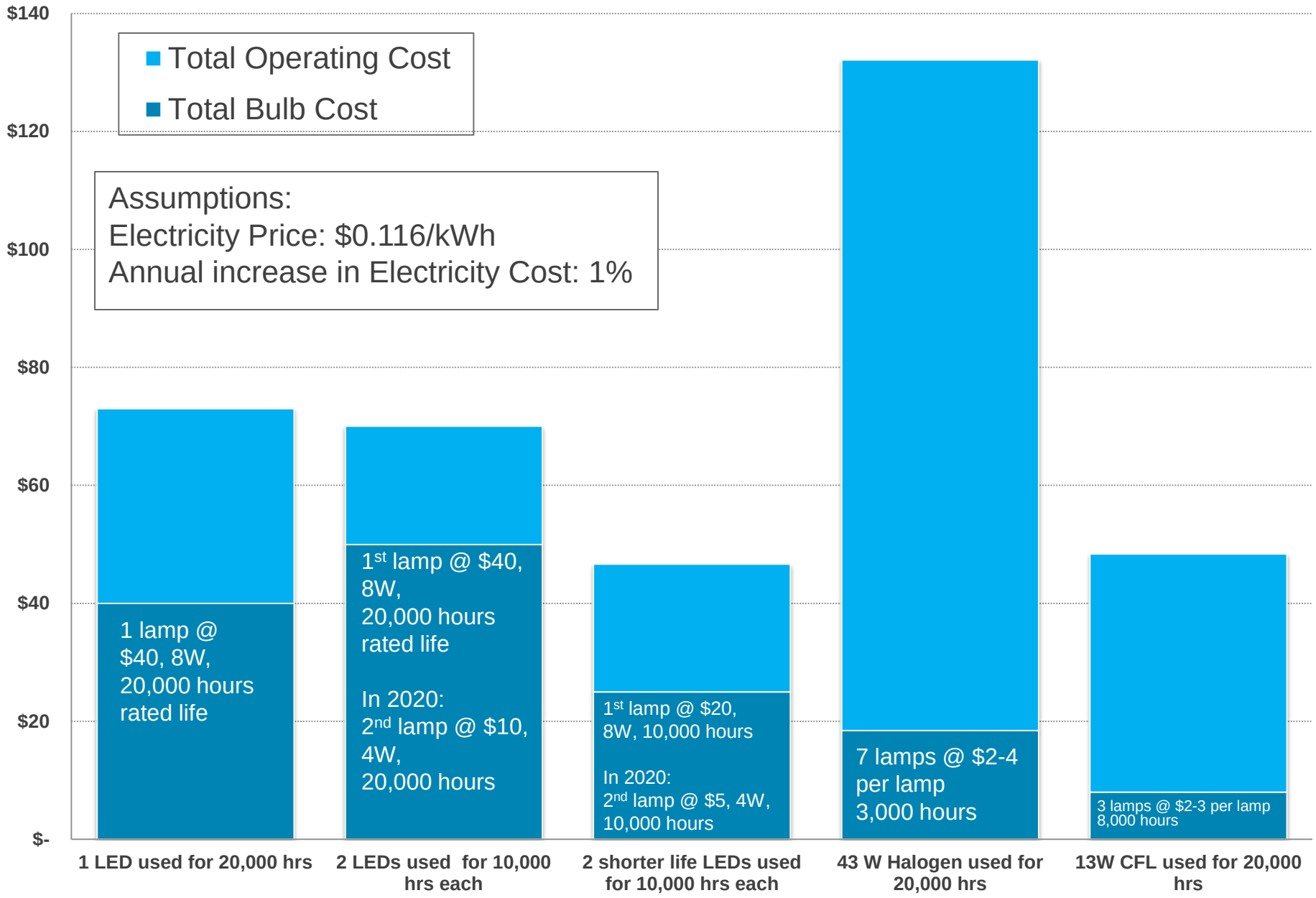


- 80% of omnidirectional CFLs can meet the proposed criteria
- 38% of directional CFLs can meet the proposed criteria
- 44% of decorative CFLs can meet the proposed criteria

Lifetime Cost of Ownership

- EPA seeks input on proposal for lower lifetime of Integral LED Lamps based on the following considerations: technological neutrality, first cost, rapid improvement in technology.
- Analysis based on 20,000 hours of use.
- Examined current LED Lamps, CFLs, Halogens.
- Projected future LED Lamp costs and performance.

Total Cost by End-Use
3 hr/day Scenario



Rapid Cycle Stress Test

Lamp Type	ENERGY STAR Requirements	Passing
All Lamps	Lamp shall survive cycling once for every hour of rated life (minimum of 10,000 cycles). Each cycle shall be 5 minutes on, 5 minutes off.	≥ 9 units shall survive the minimum number of cycles.

- CFL verification testing has shown that rapid cycling is most common reason for early failure. EPA proposes the following to reduce instances of premature lamp failure:
  - Increase requirement from one cycle per two hours of rated life to one cycle per hour of rated life.
  - Increase sample size from 6 (CFL V4.2) to 10 units, maintaining the allowable single unit failure.
  - Maintain 5 minutes on/5 minutes off in the CFL specification to ensure that lamp is thermally stressed to the appropriate degree.

Rapid Cycle Stress Test

Under CFL V4.2:

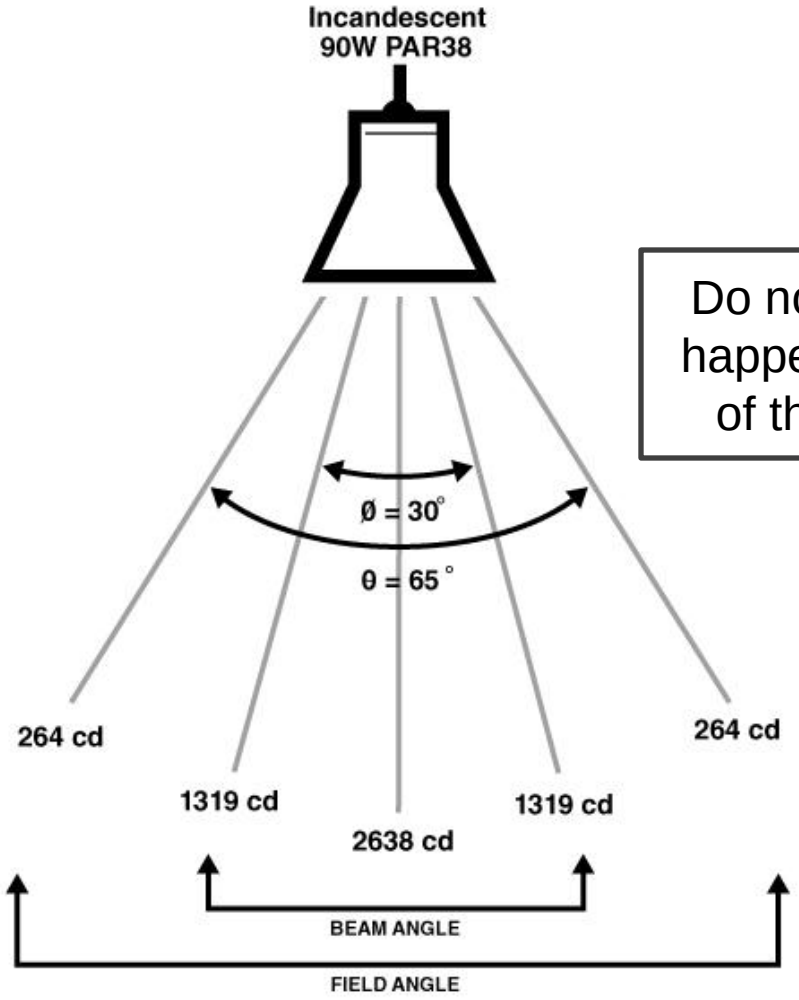
- Minimum number of cycles required: 5,000
- Number of samples: 6
- Passing: ≥ 5 units shall survive minimum number of cycles

Proposed Lamps V1.0:

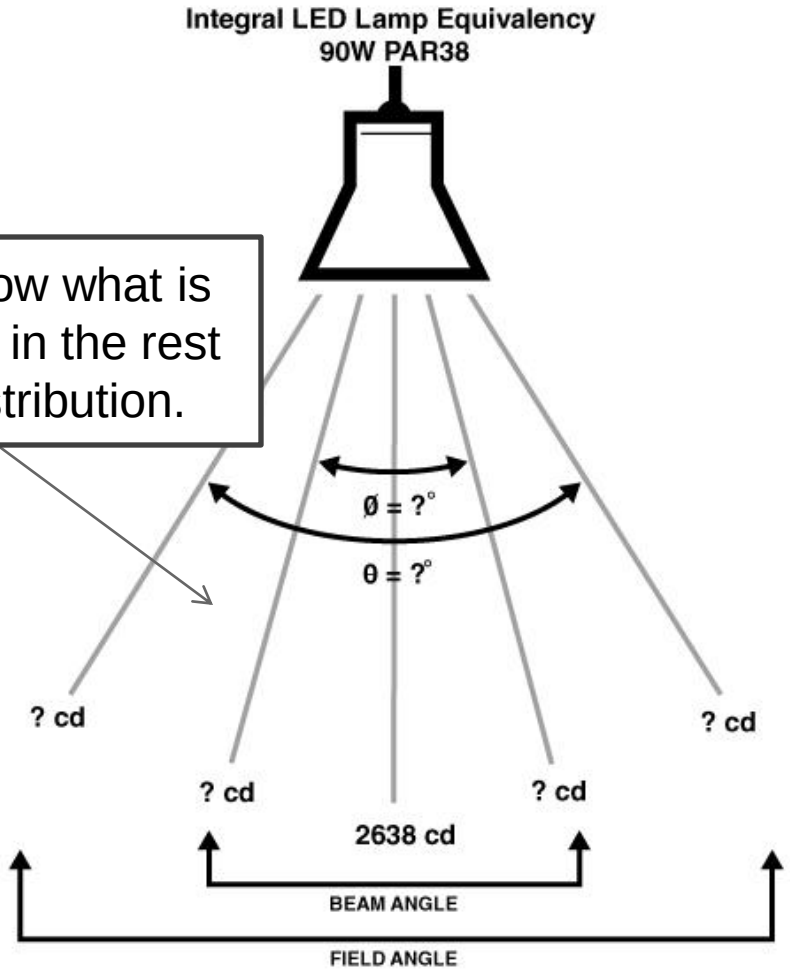
- Minimum number of cycles required: 10,000
- Number of samples: 10
- Passing: ≥ 9 units shall survive minimum number of cycles
- Required testing time doubled from CFL V4.2
  - For 10,000 rated life, ~70 days of testing
- Draft 2 will include proposal for lamps > 10,000

Luminous Intensity Distribution Requirements

Luminous Intensity Distribution



Do not know what is happening in the rest of the distribution.



Luminous Intensity Distribution Requirements

Lamp Type	ENERGY STAR Requirement	Passing
Omnidirectional	TBD	TBD
Directional	TBD	TBD

- Will propose requirement in Draft 2. Intensity distribution requirements will not be necessary for bare CFLs and decorative lamps.

Center Beam Candle Power Requirement

Lamp Type	ENERGY STAR Requirement	Passing
PAR	TBD	TBD

Minimum Center Beam Candle Power Calculator

	A	B	C	D	E	F	G	H	I	J	K	L
4												
5	**Target Incandescent/Halogen Lamp Parameters**											
6												
7	Enter PAR type/value:		lamp diameter in ⅛ of inch									
8	Enter Nominal Lamp Wattage:		watts									
9	Enter Nominal Beam Angle*:		degrees									
10												
11	Minimum Center Beam Intensity:	183	cd									
12												
13	Term	Coefficient	PAR Type	Nominal Wattage	Beam Angle		Predicted Log CBCP	Log CBCP Two-sigma Lower Bound		Predicted CBCP	CBCP Two-sigma Lower Bound	
14	Intercept	5.5102112	0	0	0		5.510	5.208		247	183	
15	PAR	0.1395448										
16	Watts	0.0448725										
17	Beam Angle	-0.088493										
18	PAR*Watts	-0.000521										
19	PAR*Beam Angle	-0.000719										
20	PAR^2	-0.001192										
21	$Watts^2$	-5.981E-05										
22	$Beam\ Angle^2$	0.0008786										
23	Root Mean Square Error	0.151113										

Electrical Performance Requirements

Electrical Requirements: Sample Size

Criteria	Sample Size
Power Factor Start-up Time Run-up Time	10 units per model with 5 units tested base-up and 5 units tested base down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position.
Transient Protection	5 units per model. Units shall be tested base-up unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position.
Electrical Safety, Operating Frequency, EMI	1 unit per model
Dimming, Noise	TBD

Electrical Safety Requirements

Lamp Type	ENERGY STAR Requirements	Passing
All Lamps	Product shall comply with ANSI/UL 1993-2009.	Unit (1 sample) shall meet the requirement.

- This safety requirement has been carried forward from existing specifications.

Power Factor

Lamp Type	ENERGY STAR Requirements	Passing
All lamps Exemption: Lamps ≤ 5 watts	Lamps shall have a power factor of ≥ 0.7.	Average of units tested shall meet the requirement.

- Stakeholders and partners indicated interest in:
  - moving towards higher minimum power factor requirements.
  - alignment of requirements across technologies.

Operating Frequency

Lamp Type	ENERGY STAR Requirements	Passing
Compact Fluorescent and HID	Lamp shall have an operating frequency within 20 to 33kHz, or ≥ 40kHz.	Unit (1 sample) shall meet the requirement.
Solid State	TBD	

- Operating frequency requirements and method of measurement will be refined in subsequent draft.
- EPA working with IEEE, IES, ASSIST to identify appropriate methods of measurement to ensure that qualified lamps do not produce visible flicker, stroboscopic effects, or adverse health effects.

Lamp Start Time Requirement

Lamp Type	ENERGY STAR Requirements	Passing
All Lamps	Lamp shall remain continuously illuminated within 0.5 second of application of electrical power.	Average of units tested shall meet the requirement.

- Stakeholders expressed interest in moving towards shorter start times if feasible.
- To develop a method of measurement for start time, EPA is working with the CFL Technical and Research Working Group.
  - The draft method will be added to a subsequent draft of this specification for broad stakeholder review and comment.

Lamp Start Time

Portion of CFLs meeting select starting times					
Lamp Type	**0.1 s**	**0.25 s**	**0.5 s**	**0.75 s**	**1.0 s**
All CFLs	66%	78%	89%	97%	100%
Non-Dimmable	68%	80%	90%	97%	100%
Dimmable	31%	56%	73%	94%	100%
3-Way	39%	61%	82%	85%	100%
Long Life (>12,000 hrs)	51%	69%	89%	99%	100%

- The current criteria requires all fluorescent lamps to start-up within 1 second.
- 89% of qualified CFLs are have start-up times <0.5 seconds.
- 74% of dimmable and 3-way lamps can meet 0.5 second starting time.
- Analysis shows that neither high lifetime nor covered lamps will be disproportionately affected by a reduction in starting time.

Lamp Run-Up Time

Lamp Type	ENERGY STAR Requirement	Passing
Covered Compact Fluorescent	Lamp shall achieve full stabilized light output in ≤ 90 seconds.	Average of units tested shall meet the requirement.
All Other Lamps	Lamp shall achieve: ≥ 50% of stabilized light output in ≤ 30 seconds; and, ≥ 80% of stabilized light output in ≤ 45 seconds; and, full stabilized light output in ≤ 60 seconds.	

- Run-up time is a well-understood consumer dissatisfier.
- Proposed values have been adopted from the Super Lamps specification developed by California electric utilities.
- CFL Technical and Research Working Group is examining effectiveness of current approach to testing and evaluation.
  - The draft method will be added to a subsequent draft of this specification for broad stakeholder review and comment.

Run-up Time Justification

Portion of CFLs meeting select run-up times									
CFL Type	**Count**	**30 s**	**45 s**	**60 s**	**75 s**	**90 s**	**120 s**	**150 s**	**180 s**
All	2,491	28%	59%	81%	87%	91%	96%	99%	100%
Bare	1,948	34%	70%	92%	98%	99%	99%	100%	100%
Covered	543	5%	21%	39%	50%	63%	85%	94%	100%

- An analysis of currently qualified CFLs found that 70% of bare lamps were qualified with a run up time of 45 seconds, and 92% were qualified with a run up time of 60 seconds.
- For qualified covered CFLs, 63% were qualified with a run up time of 90 seconds.

Dimming

Lamp Type	ENERGY STAR Requirements	Passing
All Lamps Marketed As Dimmable	TBD	TBD

- EPA is working with industry stakeholders and the Lighting Research Center (LRC) to develop a definition, method of measurement, and compatibility metric for dimmable lamps.
- EPA seeks to establish a definition of dimming which emphasizes:
  - quality,
  - ensuring that qualified dimmable lamps dim down to levels meeting consumer expectations,
  - are compatible with the majority of the installed base of dimmers, and are free from noise and flicker, among other criteria.

Transient Protection

Lamp Type	ENERGY STAR Requirement	Passing
All Lamps	Lamp shall survive 7 strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode.	All units shall be fully operational at the completion of testing.

- The above is an update of the requirement appearing in the existing specifications.

Electromagnetic and Radio Frequency Interference Requirements

Lamp Type	ENERGY STAR Requirement	Passing
All Lamps	Lamps shall meet applicable FCC requirements for consumer or non-consumer use.	Unit shall meet the applicable requirements.

- Requirement references federal regulations that are carried forward from the existing specifications.

Noise

Lamp Type	ENERGY STAR Requirement	Passing
All Lamps	TBD	TBD

- Past specifications have included noise/sound rating requirements.
- The Agency will explore options for this new specification, to be included in a subsequent draft, with the intent of minimizing testing burden.

Lamp Toxics Reduction Requirements

Lamp Toxics Reduction

Lamp Type	ENERGY STAR Requirements	Method of Compliance
All Lamps	Lamps ≤ 23.0 watts shall contain ≤ 2.5 milligrams (mg) mercury per lamp Lamps > 23.0 watts shall contain ≤ 3.0 milligrams (mg) mercury per lamp Lamps shall contain restricted levels of the following materials, where the maximum concentration values allowed by weight in homogeneous materials are: • lead (0.1%) • cadmium (0.01%) • hexavalent chromium (0.1%) • polybrominated biphenyls (PBB) (0.1%) • polybrominated diphenyl ethers (PBDE) (0.1%)	For purposes of third-party certification, lamp toxics documentation shall not be reviewed when products are initially certified or during verification testing. Instead, consistent with EU RoHS requirements, manufacturers shall maintain documentation on file to demonstrate that certified products meet these requirements. EPA reserves the right to request this documentation at any time. Partner may rely on component suppliers to provide certification or declaration documents to show that homogenous materials used in lamps comply with the requirement. Alternatively, Partner may have lamp components tested in accordance with IEC 62321 or other appropriate analytical technique to verify that homogenous materials do not exceed the concentration limits of the six regulated substances. Handheld XRF analyzers/scanners may also be used to verify compliance.

Dimensional Requirements

Lamp Base Dimensions and Tolerances

Lamp Type	ENERGY STAR Requirement	Supplemental Testing Guidance
All Lamps	Lamp base shall fully comply with ANSI C81.61-2009.	TBD

- EPA is concerned with ensuring that qualified lamps are able to fit into the fixtures in which consumers will install them, and notes that many of the ANSI dimensional limits articulated above are considerably larger than the typical incandescent forms found on the market today.
- Partners are encouraged to compare their lamp designs to the ANSI dimensional limits.
- For lamps not fitting within the relevant ANSI limits, the Agency is reevaluating requirements for non-standard lamps.

Lamp Shape Dimensions and Tolerances:
Claiming Shape or Wattage Equivalency with Standard or Halogen Incandescent

Lamp Type	ENERGY STAR Requirement	Supplemental Testing Guidance
All Lamps	Lamp shape shall fully comply with relevant ANSI minimum overall length (min OAL), maximum overall length (MOL) and maximum lamp diameter values if claims of equivalency with a standard or halogen incandescent lamp are made on any of the following: • lamp base • lamp packaging • product literature (printed or electronic) • point-of-purchase materials (printed or electronic)	TBD

Product Labeling & Packaging Requirements

Lamp Labeling Requirements

Lamp Labeling Requirements: All Lamps

Lamp Type	ENERGY STAR Requirement
All Lamps	Each of the following shall be printed on the lamp: • lamp manufacturer or brand name • phone number for questions or complaint resolution • lamp model number • lamp input power in watts including "watts" or "W" • lamp rated lumen output including "lumens" or "lm" • lamp nominal correlated color temperature including "Kelvin" or "K" • "dimmable", "non-dimmable", "not dimmable", "not for dimming" or the like • "Do not use in totally enclosed fixtures" or the like, as applicable • "Do not use in recessed fixtures" or the like, as applicable • "contains mercury" (for compact fluorescent lamps) • electrical safety marking

Packaging Requirements

- In English with or without additional languages
- Model number
  - Model number shall be different from any earlier, non-qualified versions of the product already introduced into the market.
- Federal Trade Commission's (FTC) Lighting Facts Label
  - Lamp packaging for ENERGY STAR qualified lamps sold in the United States shall comply with the labeling requirements of the U.S. Federal Trade Commission
- Equivalency claims (minimum light output)
  - Packaging shall display on the front panel equivalent target wattage based on its total measured light output and equivalency as outlined in the Light Output Requirements section.

Packaging Requirements

- Warranty
  - Backed by a minimum 2 year warranty based on usage of no less than 3 hours a day.
  - Packaging shall state “Warranty” or “Limited Warranty” terms and provide a phone number or website address for consumer complaint resolution.
  - In addition, the complete written warranty shall be included on the exterior packaging or within lamp packaging.
- Mercury content labeling
  - Packaging shall state “Lamp contains mercury”
  - The FTC Lighting Facts label for lamps containing mercury, if used, shall satisfy this requirement
  - Packaging for lamps not within the scope of FTC labeling requirements shall include “epa.gov/cfl”.

Packaging Requirements: Dimmable Lamps

- Dimmable Lamps
  - Packaging shall display on the front panel an indication of lamp's dimming capability, e.g. "dimmable" or "non-dimmable"
  - Dimmable lamp packaging shall indicate, on any panel except the bottom panel, that lamp may not be compatible with all dimmers and shall reference a website address providing regularly updated dimmer compatibility information for the lamp model.

Packaging Requirements: Incompatibility with Controls

- Incompatibility with Controls
  - packaging for lamps not designed for operation with photosensors, motion sensors or timing devices shall indicate, on any panel except the bottom panel, in a minimum of 8 point type, “non-dimmable”, “not compatible with photosensors”, “not compatible with timers”, “not compatible with motion sensors”, “not compatible with photosensors, motion sensors, or timers”, or the like.

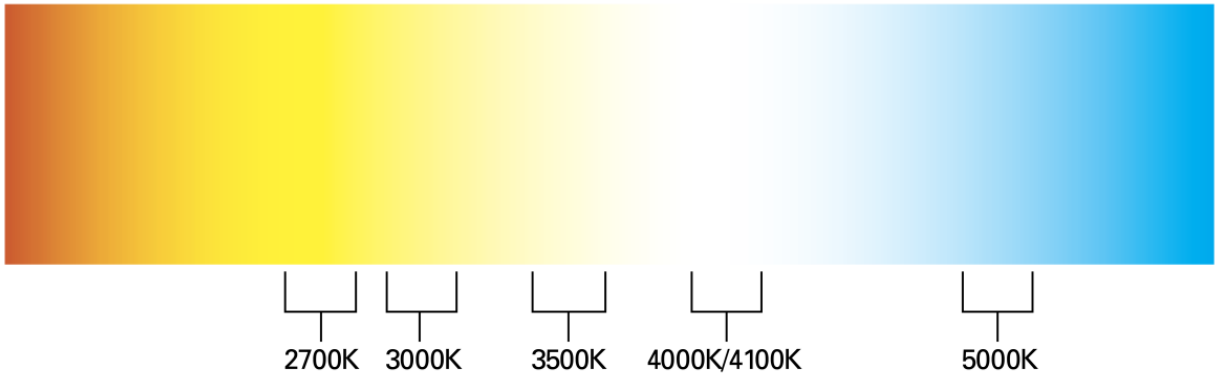
Packaging Requirements: Incompatible Applications

- Incompatible Applications:
  - packaging exterior shall state specific applications that would compromise the performance of the lamp.
  - This includes installations which would result in a lamp's noncompliance with the ENERGY STAR specification performance requirements.
  - Examples include totally enclosed fixtures, insulated ceiling air-tight (ICAT) recessed downlights, damp locations, and any other application restrictions.

Packaging Requirements

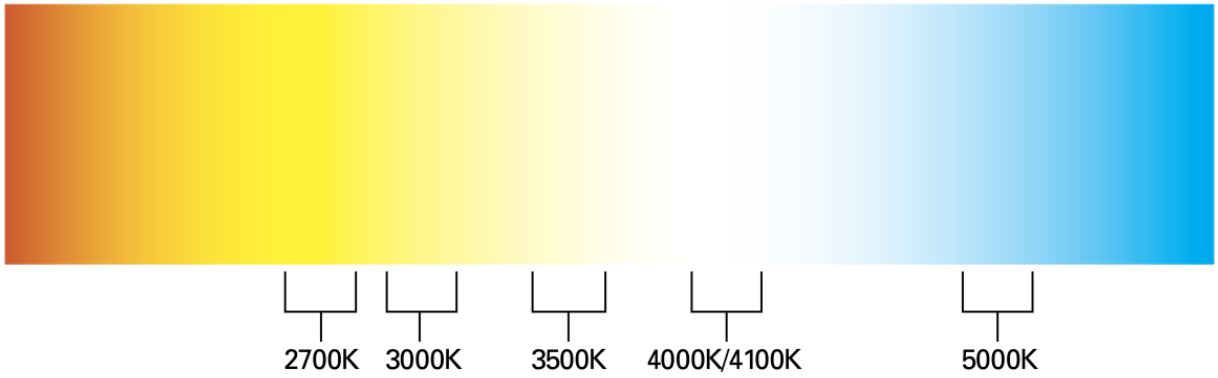
- Restricted Position
  - Lamp packaging shall indicated restricted operating position (e.g. base up, base down) if applicable.
- Maximum/Minimum Starting Temperature
  - Lamp shall have a minimum ambient operating temperature of 0°F (-18°C) or below. Package shall state the maximum and minimum recommended starting temperatures or geographical zone of use and any other conditions required for reliable starting.

Packaging Requirements: Color Spectrum Educational Tool



- After years of collective effort, many consumers (and media!) still don't fully understand color temperature.
- POP is not always referenced, but product packaging is.
- A consistent, uniform message should help.

Packaging Requirements:
ENERGY STAR Lamps Color Spectrum Tool

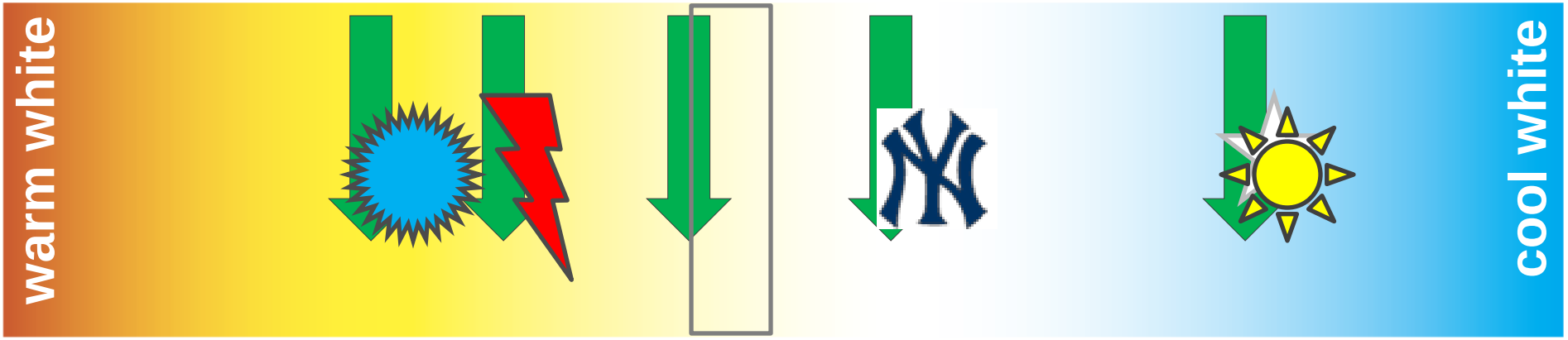


- Lamp packaging front panel shall include the color spectrum educational tool, available for free download without royalties in high resolution TIFF file format at www.energystar.gov/lamps.
- A visual indicator of the partner's choosing (e.g. an arrow) shall be placed adjacent to or overlaid on the spectrum, indicating the lamp's nominal CCT value. The visual indicator shall be placed within the portion of the spectrum applicable to the lamp indicated by the brackets and CCT values included in the spectrum file.
- The brackets and values shall be employed for indicator placement purposes and then removed (not printed).

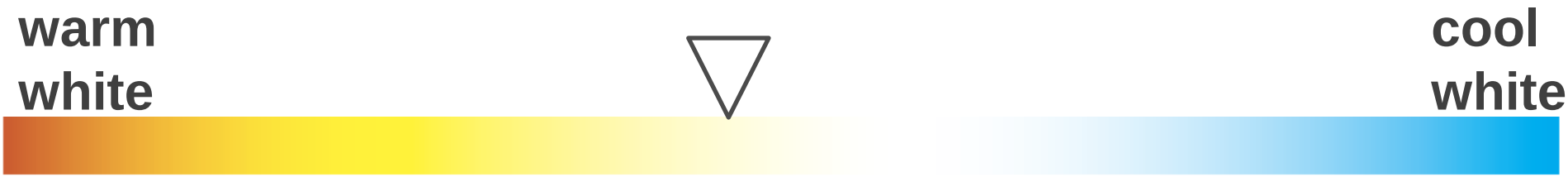
Packaging Requirements:
ENERGY STAR Lamps Color Spectrum Tool

- The spectrum may be adjusted as follows:
  - may be cropped along the dimension perpendicular to the red-blue gradient
  - may be cropped to be incorporated into a shape so long as the continuous red to blue gradient is maintained
  - may be scaled, i.e. adjusted proportionally in both horizontal and vertical dimensions, to a total length from red to blue no less than half the shortest dimension (i.e. length, width, height) of the lamp packaging; brackets shall also be scaled, prior to removal
  - may be rotated
- The term “warm white” shall be printed at the red end of the spectrum, adjacent or overlaid, in a typeface and type size of the partner’s choosing. The term “cool white” shall be printed at the blue end of the spectrum with the same treatment.
- The dimension perpendicular to the red-blue gradient shall not be diminished by the above adjustments to less than the height of 8 point font at any point along the gradient. The spectrum may not be printed in gray scale, or horizontally cropped (removing a portion of the gradient), or horizontally compressed.

Possible Designs:
ENERGY STAR Lamps Color Spectrum Tool



Possible Designs:
ENERGY STAR Lamps Color Spectrum Tool



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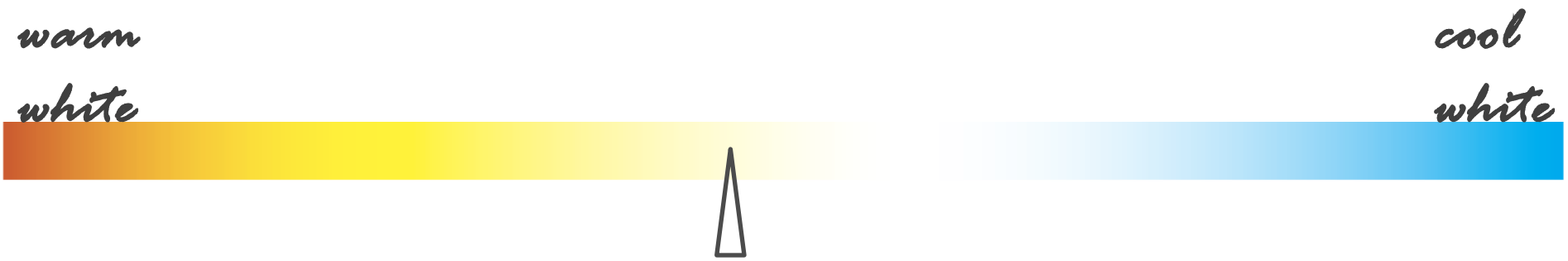

Possible Designs:
ENERGY STAR Lamps Color Spectrum Tool

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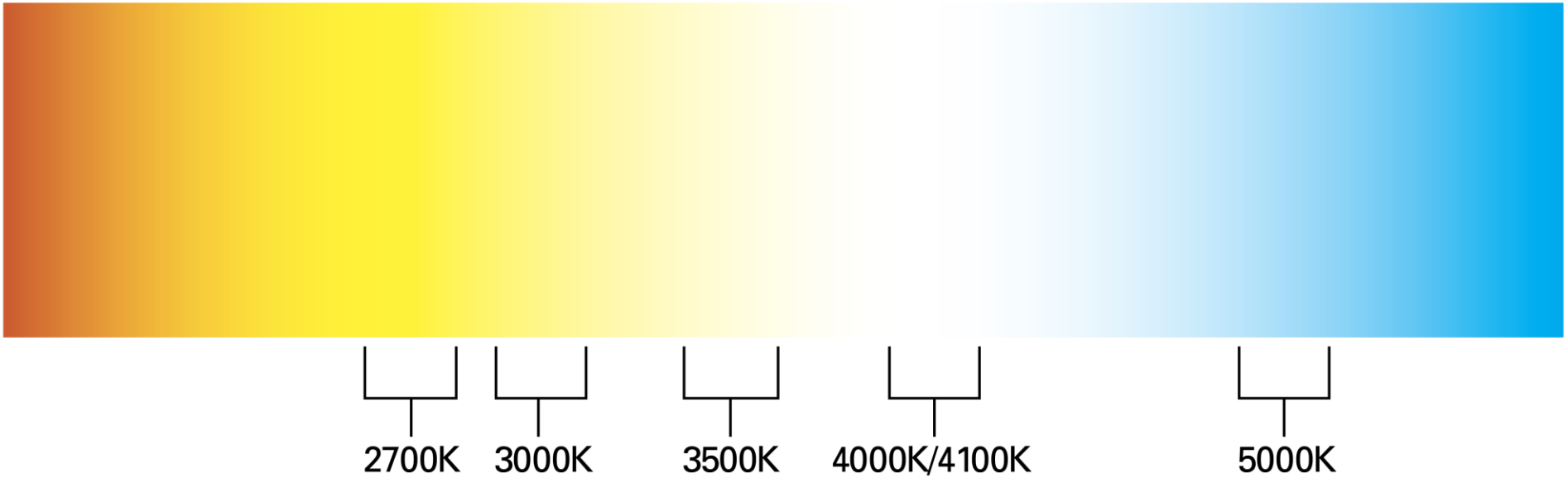

Possible Designs:
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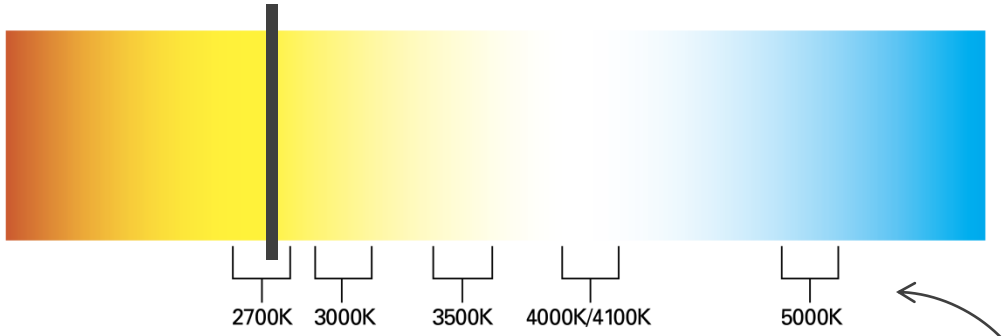
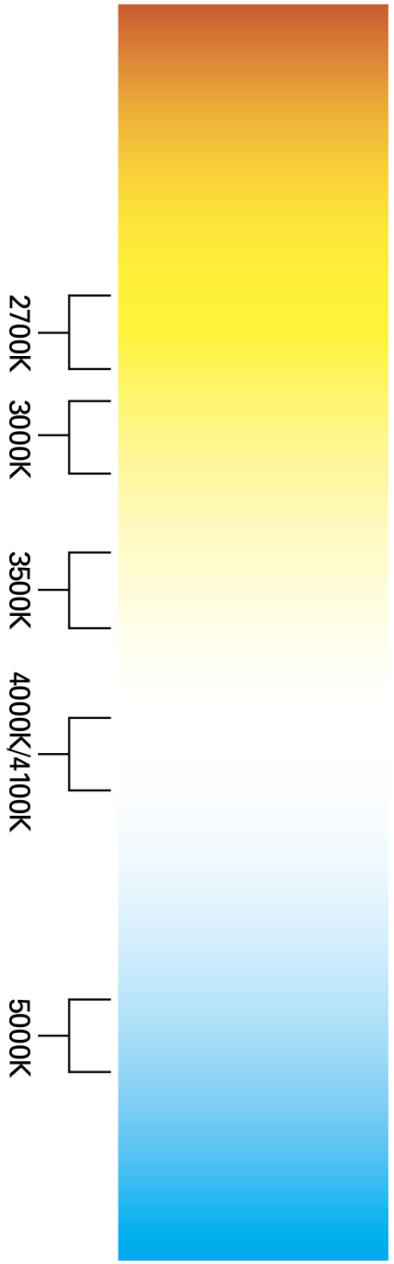


Placement brackets scaled with gradient

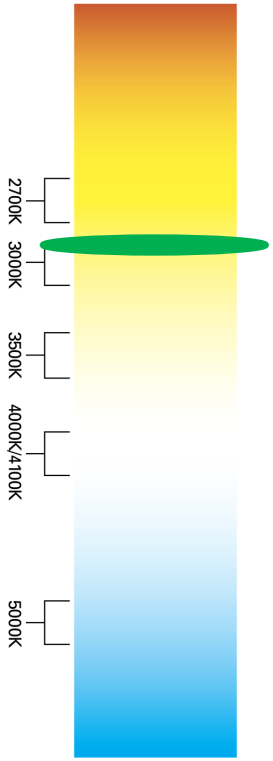
Possible Designs:
ENERGY STAR Lamps Color Spectrum Tool

Possible Designs:

ENERGY STAR Lamps
Color Spectrum Tool



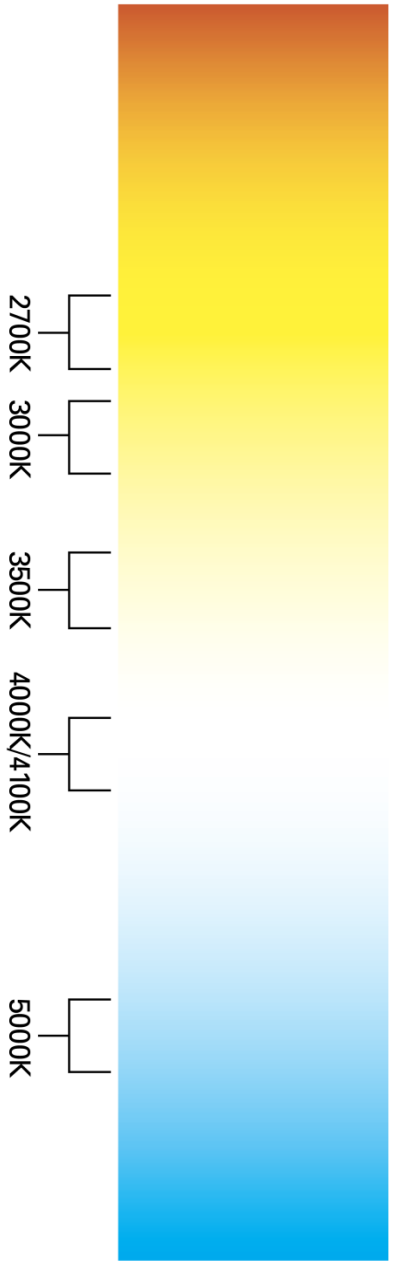
Possible Designs:
ENERGY STAR Lamps Color Spectrum Tool



Possible Designs:
ENERGY STAR Lamps Color Spectrum Tool

Possible Designs:

ENERGY STAR Lamps
Color Spectrum Tool



Possible Designs:
ENERGY STAR Lamps Color Spectrum Tool

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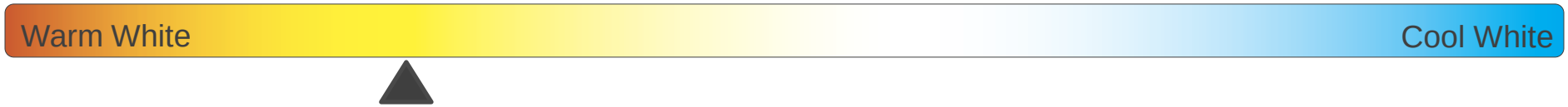
ENERGY STAR Lamps Color Spectrum Tool



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ENERGY STAR Lamps Color Spectrum Tool

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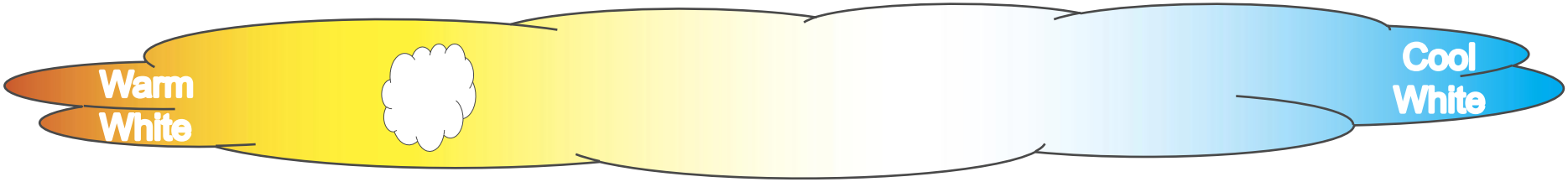
ENERGY STAR Lamps Color Spectrum Tool



Packaging Requirements

- Nominal Color Temperature Nomenclature
  - Lamp packaging front panel shall include the term “warm white”, “neutral white” or “cool white” in no less than 8 point type as defined below.
    - Warm white (2600K-2999K)
    - Neutral white (3000-3500K)
    - Cool white (3501K-5000K)

Packaging Requirements: ENERGY STAR Lamps Color Spectrum Tool

Comments due by
Friday, December 9, 2011

Submit comments to:
lamps@energystar.gov

Thank You!

Alex Baker
Lighting Program Manager
Baker.Alex@epa.gov
202-343-9272

Part 2: ENERGY STAR Lamps Specification:

Discussion of Minimum Lifetime Requirements

What is the Meaning of Life?

A Reevaluation of ENERGY STAR's Minimum Life Requirements for Solid State Lighting

ENERGY STAR Lighting Round Table: Lamps V1.0 Draft 1

November 30, 2011

Alex Baker, MSc, LC, IES
ENERGY STAR Lighting Program Manager

ENERGY STAR: Current Life Requirements

- CFL V4.2:
  - **8,000** hours: bare, covered, globe, outdoor reflector
  - **6,000** hours: indoor reflectors
- Integral LED Lamps V1.4:
  - **15,000** hours: decorative
  - **25,000** hours: omnidirectional, directional and non-standard

By the Hours

Life Claim (Hours)	Number of Years (resi, 3 hr/day)	Number of Years (commercial, 12 hr/day)
1,000	0.9	0.2
8,000	**7.3**	1.8
10,000	9.1	2.3
15,000	**13.7**	3.4
20,000	18.3	4.6
25,000	**22.8**	5.7
30,000	27.4	6.8
35,000	32.0	8.0
40,000	36.5	9.1
50,000	45.7	11.4
100,000	91.3	22.8

What Lasts 14 or 23 Years?

- “Durable goods”:
  - Appliances?
  - Home HVAC?
  - Car?
- Portable audio:
  - Walkman?
  - Discman?
- Computers:
  - Laptop?
  - Desktop?
  - Tablet?
- Displays:
  - Televisions
  - Computer monitors
- Cell phones

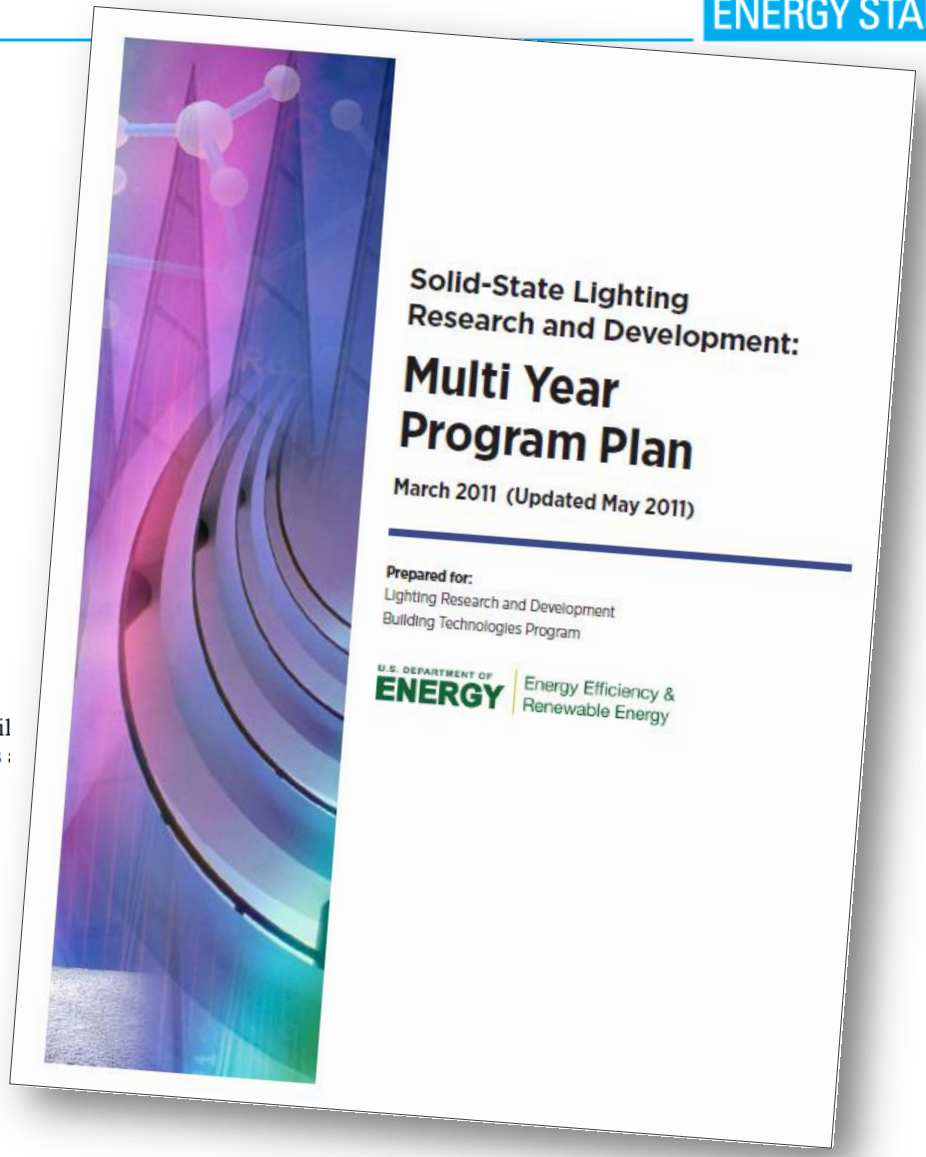
DOE Roadmap

- Today's warm white efficacy is only half-way to the goal

Table 5.4: Summary of LED Package Performance Projections

Metric	2010	2012	2015	2020
Cool White Efficacy (lm/W)	134	176	224	258
Warm White Efficacy (lm/W)	96	141	202	253

Note: Projections for cool white packages assume CCT=4746-7040K and CRI=70-80, whil
warm white packages assume CCT=2580-3710K and CRI=80-90. All efficacy projections
packages are measured at 25°C with a drive current density of 35 A/cm^2.



What is “Quality”?

- Efficacy: product or application
- Light output: ample and maintained
- Color: consistent initially and long-term
- Color: well rendered
- Flicker: none visible
- Noise: none audible

- Longevity??
- Is standard or halogen incandescent low quality because of its rated life?

What Do Consumers Want?

- Do consumers want a 14 year lamp?
- Do consumers want a 23 year lamp?
- Does LED initial cost seem to be a barrier?
- Does it make sense to sell consumers today's efficacy levels for 14 / 23 years?
- Will consumers appreciate greater LED quality and consistency?

About the 10,000 Hour Proposal

- It's a minimum
- Not every manufacturer will re-engineer for lower life
- Likely to lower initial costs, helping to increase adoption
- The next bulb will likely be cheaper and higher efficacy than today's
- Consumers don't necessarily believe / understand elongated life claims
- Consumers don't have $30+ for a light bulb (especially when sitting next to the < $1 CFL!)