



Lighting Specification Development Update: Luminaires and Lamps

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2011 ENERGY STAR® Products Partner Meeting

Charlotte, North Carolina

November 7, 2011



Learn more at energystar.gov

Outline



- Lighting Integration Plan
- Luminaires / Light Fixtures:
 - ENERGY STAR Luminaires V1.0
 - ENERGY STAR Luminaires V1.1
 - Certified Lighting Subcomponent Database (CSD)
 - Ceiling Fans V3.0 & Ventilation Fans V3.1
- Lamps / Light Bulbs:
 - Lamps V1.0 (draft)
 - Compact Fluorescent Lamps V4.3 (draft)
 - Integral LED Lamps V1.4
- Program Guidance Regarding LED Lumen Maintenance Data
- Decorative Light Strings V1.5 (draft)
- Testing & Certification Infrastructure
- Questions



Lighting Integration Plan

ENERGY STAR Lighting History: Four Existing Specifications



- Residential Light Fixtures (est. 1997)
- Compact Fluorescent Lamps (est. 1999)
- Solid State Lighting Luminaires (est. 2007)
- Integral LED Lamps (est. 2009)



ENERGY STAR Lighting Specification Integration



Residential Light Fixtures V4.2

Solid State Lighting Luminaires V1.3

ENERGY STAR Luminaires V1.1

- finalized February 16, 2011
- effective April 1, 2012
- www.energystar.gov/luminaires

Compact Fluorescent Lamps V4.2

Integral LED Lamps V1.3

ENERGY STAR Lamps V1.0

- currently in development
- first draft issued October 21
- to be finalized in 2012
- www.energystar.gov/lamps

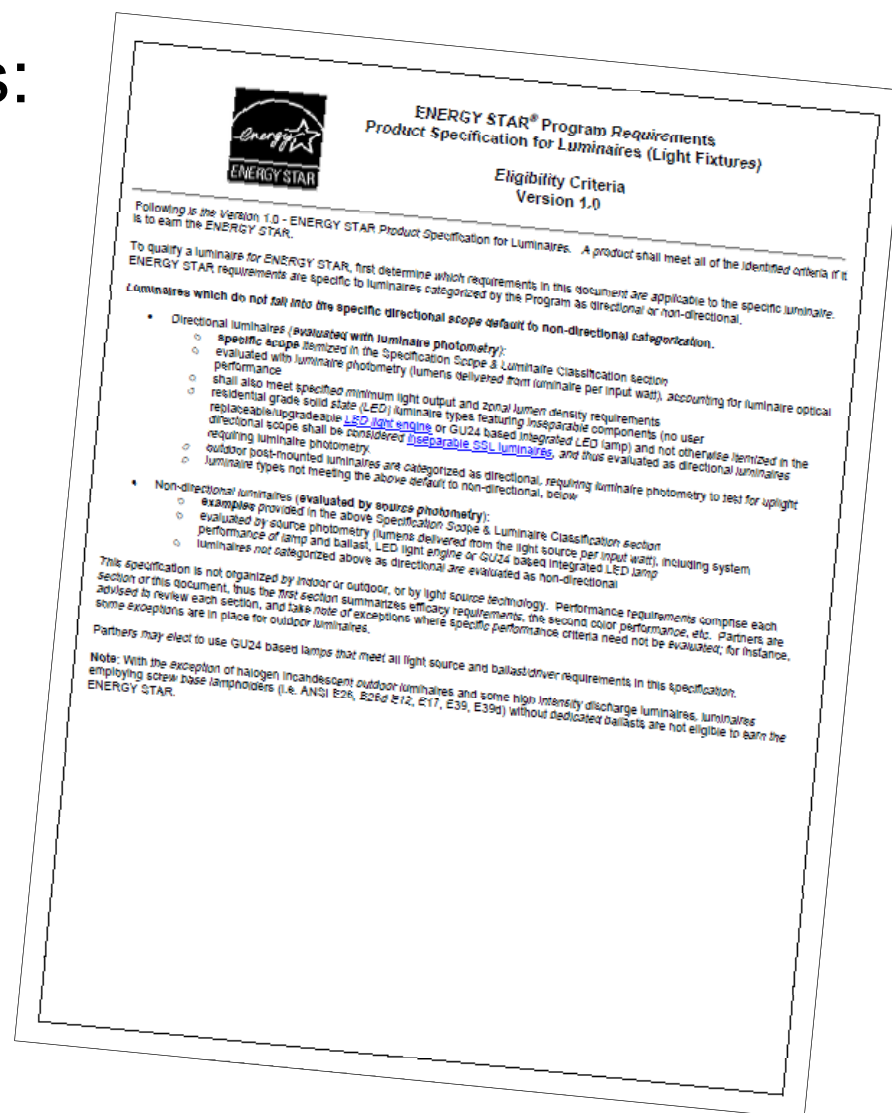


ENERGY STAR Luminaires Specification

ENERGY STAR Luminaires V1.0



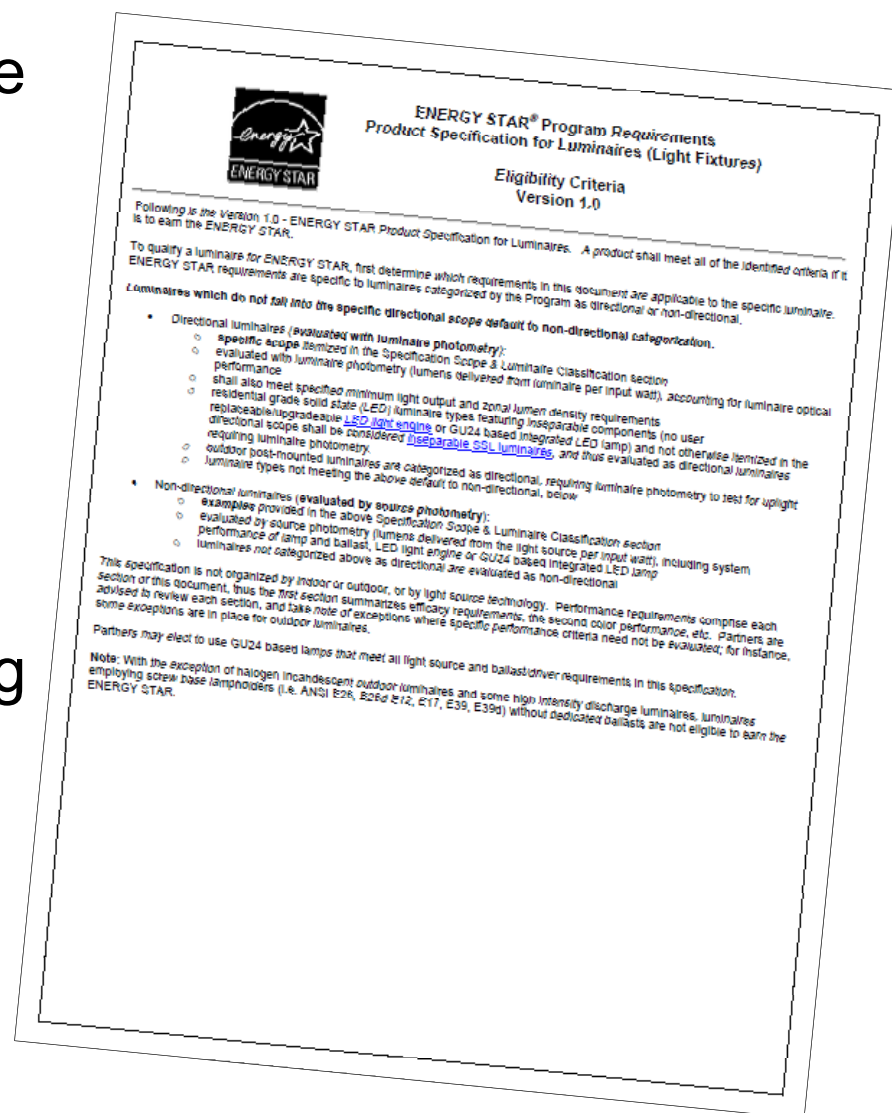
- Spec development process:
 - Draft 1: May 10, 2010
 - Draft 2: October 4, 2010
 - Final Draft: December 20, 2010
 - Finalized February 16, 2011



ENERGY STAR Luminaires V1.0



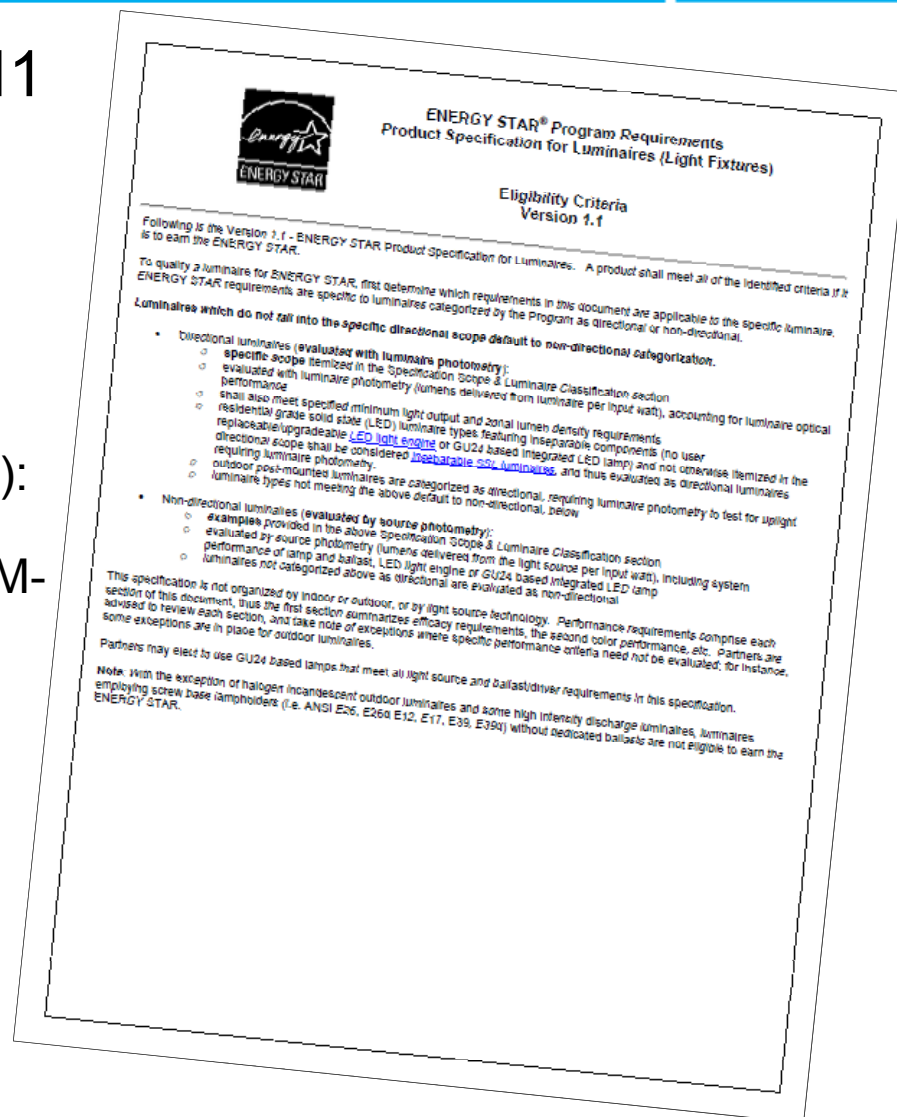
- Technology-neutral performance requirements
- Industry standard methods of measurement
- Categorizes fixtures as directional or non-directional independent of technology
- For non-directional, maintains optional component-level testing approach to qualification



ENERGY STAR Luminaires V1.1



- Version 1.1 finalized July 1, 2011
 - Reduced sample sizes for directional goniophotometry
 - Reduced LM-80 sample sizes to align with TM-21
 - Other changes related to:
 - Extended SSL V1.3 spec for (only): ceiling mount w/ diffuser, outdoor porch and desk task lights, until LM-82 is published
 - Mounting variations for outdoor
 - Directional vent fans lighting
 - Amended effective date to April 1, 2012



ENERGY STAR Luminaires V1.1: Directional Luminaires



- IES RP-16-10 “direct lighting”
- Put light on a specific surface or area
- Evaluated with luminaire photometry: delivered lumens per input watt: IES LM-79 (SSL), LM-41 (fluorescent)
- Zonal lumen density requirements (requires goniophotometry)
- Minimum light output requirements
- **Specific scope** detailed in spec, including limited scope for commercial grade products

Luminaires not listed in directional scope are treated as non-directional

ENERGY STAR Luminaires V1.1: Non-Directional Luminaires



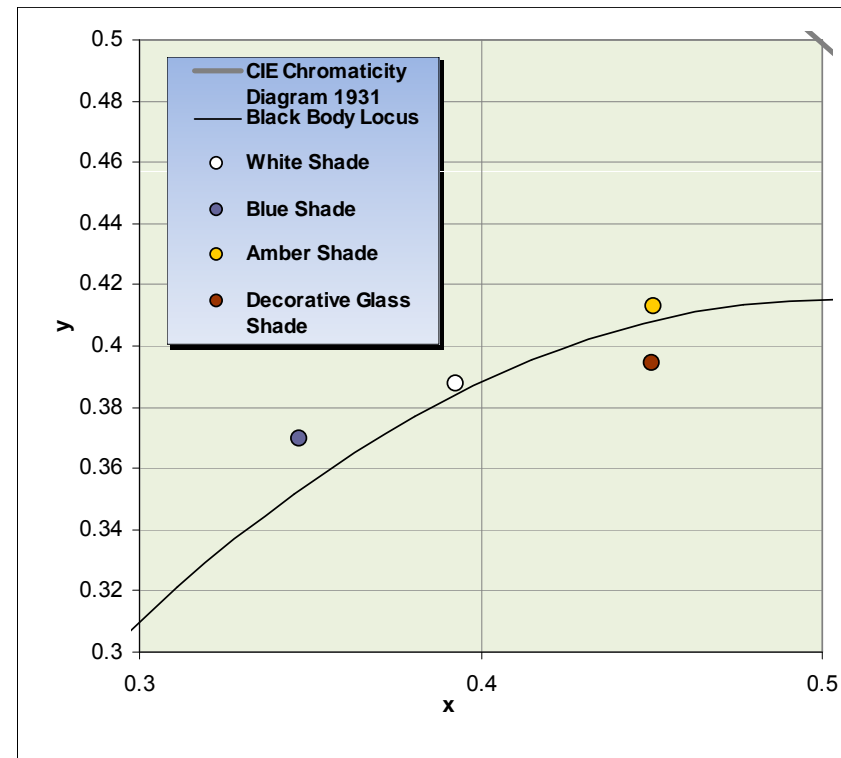
- Not intended to illuminate specific surfaces
- Evaluated with source photometry: source lumens per input watt: IES LM-82 (SSL), LM-9 & LM-66 (fluorescent)
- Minimum source light output requirements
- Does not measure luminaire optical loss
- Does not have specific scope – **examples only** provided in spec







LM-79 Problems



LM-79 Problems



Product Description	Ambient Temperature (°C)	Input Voltage (V)	Input Power (W)	Luminous Flux (lm)	Luminous Efficacy (lm/W)	x	y	CCT	CRI
White shade	24.7	120.11	4.48	165.0	36.83	0.3929	0.3876	3761	73.6
Blue shade	24.7	120.11	4.48	129.9	28.99	0.3468	0.3698	4998	72.0
Amber Shade	24.7	120.02	4.48	82.6	18.44	0.4507	0.4129	2851	69.0
Decorated glass	24.7	120.12	4.48	34.9	7.78	0.4499	0.3942	2711	78.1

Testing Decorative LED Fixtures Per IES LM-79-08

Lighting Research Center (NVLAP Lab Code: 200480-0)

2/13/2011



LED Light Engines

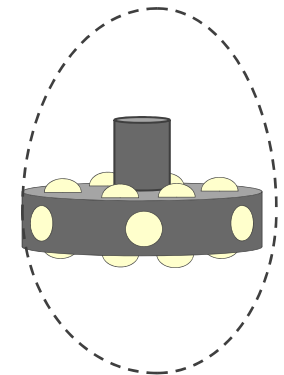
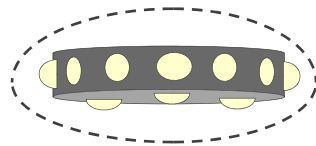
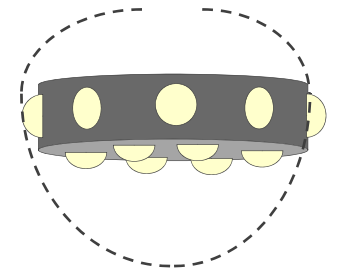
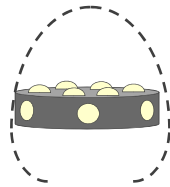


LED Light Engine:

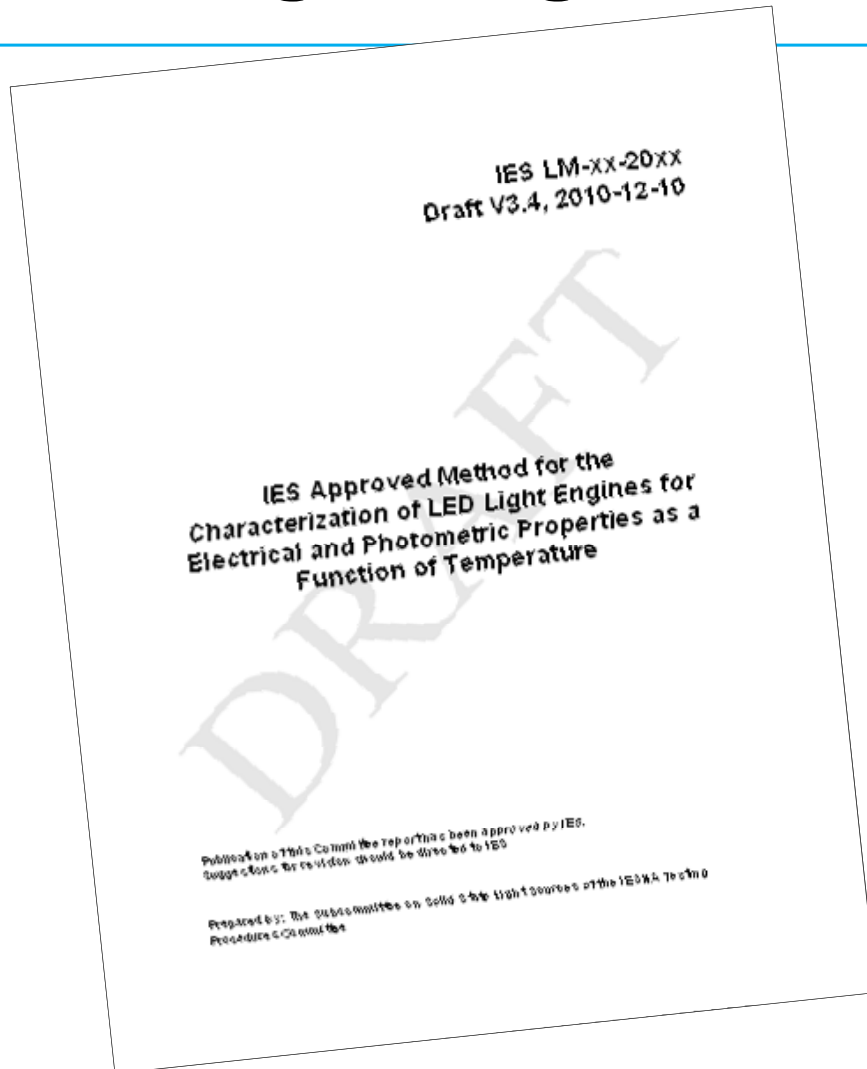
An integrated assembly comprised of LED packages (components) or LED arrays (modules), LED driver, and other optical, thermal, mechanical and electrical components. The device is intended to connect directly to the branch circuit through a custom connector compatible with the LED luminaire for which it was designed and does not use an ANSI standard base. (IES RP-16-10)



LED Light Engines



IES LM-82-11 for Testing LED Light Engines

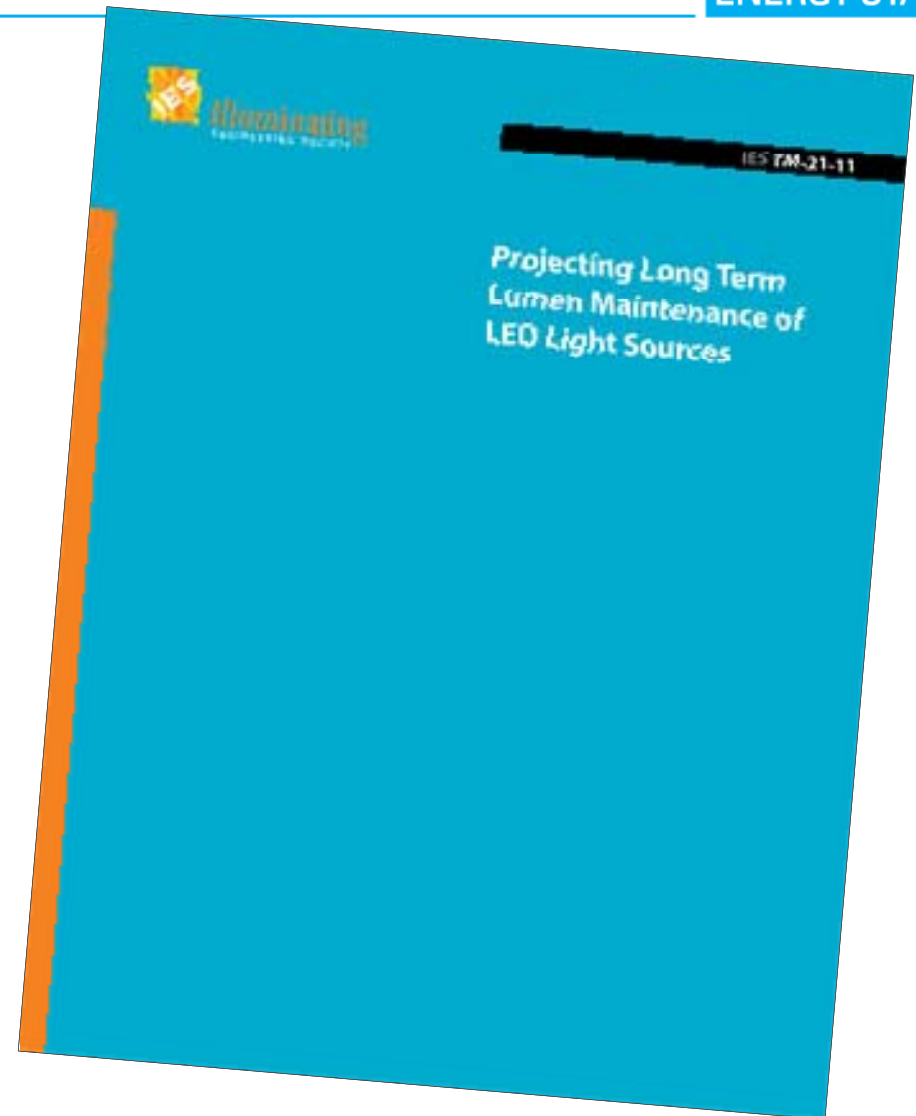


- **IES LM-82-11 (in draft)**
 - Normative reference:
IES LM-79-08 for photometric and electrical measurements
- **‘LM-79 as a function of temperature’**
- **Passed working group balloting**
- **Likely publication in January**
- **Several labs with accreditation pending**

IES TM-21-11: Projecting Long Term Lumen Maintenance of LED Sources



- Lumen maintenance projections using LM-80 data using IES TM-21-11
- Covers LED packages, arrays, modules
- Sample size recommendation adopted by EPA (LM-80 silent)
- Available now through IES



ENERGY STAR TM-21 Calculator



TM-21 Workbook_11-04-2011.xlsx - Microsoft Excel

Home Insert Page Layout Formulas Data Review View

From Access From Web From Text From Other Sources Existing Connections Refresh All Properties Edit Links Connections Sort & Filter Filter Clear Reapply Advanced Text to Columns Remove Duplicates Data Validation Consolidate What-If Analysis Group Ungroup Subtotal Show Detail Hide Detail Outline

C3 200

Enter in situ test data here:

Luminaire LED Drive Current	200
Enter In Situ Case Temperature (°C):	65
Project life to X% lumen maintenance:	70
(t)	15000
Lumen Maintenance [at time (t)]	0.927837759

-- Use this field to estimate lumen maintenance at time t

Calculations:

Minimum Case Temperature (T_{s1}) for Extrapolation (K):	328.15
α_1	1.68E-06
B_1	0.96
Maximum Case Temperature (T_{s2}) for Extrapolation (K):	358.15
α_2	3.35E-06
B_2	0.95
E_a/k_B	2699.36
k_B (eV/K)	8.6173E-05
E_a (eV)	2.3261E-01
A	6.2940E-03
B_0	0.95822
In Situ Case Temperature ($T_{s,i}$) (K):	338.15
α_i	2.15E-06
Calculated L70 (hrs):	146170
Reported L70 (hrs):	≥60000

LM-80 Test Results:

Case Temperature 1			Case Temperature 2			Case Temperature 3		
Temperature (°C):	55		Temperature (°C):	85		Temperature (°C):		
Temperature (°K):	328.15		Temperature (°K):	358.15		Temperature (°K):		
α :	1.68E-06		α :	3.35E-06		α :		
B:	0.96		B:	0.95		B:		
Calculated L70 (hrs):	189961		Calculated L70 (hrs):	91821		Calculated L70 (hrs):		
Reported L70 (hrs):	≥60000		Reported L70 (hrs):	≥60000		Reported L70 (hrs):		



ENERGY STAR TM-21 Calculator



TM-21 Workbook_11-04-2011.xlsx - Microsoft Excel

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From Access From Web From Text From Other Sources Existing Connections Refresh All Properties Edit Links Connections Sort & Filter Sort Filter Clear Reapply Advanced Text to Columns Remove Duplicates Data Validation Consolidate What-If Analysis Group Ungroup Subtotal Outline

F20 fx =Calculations - Case Temp 2!F33

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A B C D E F G H I J K L

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

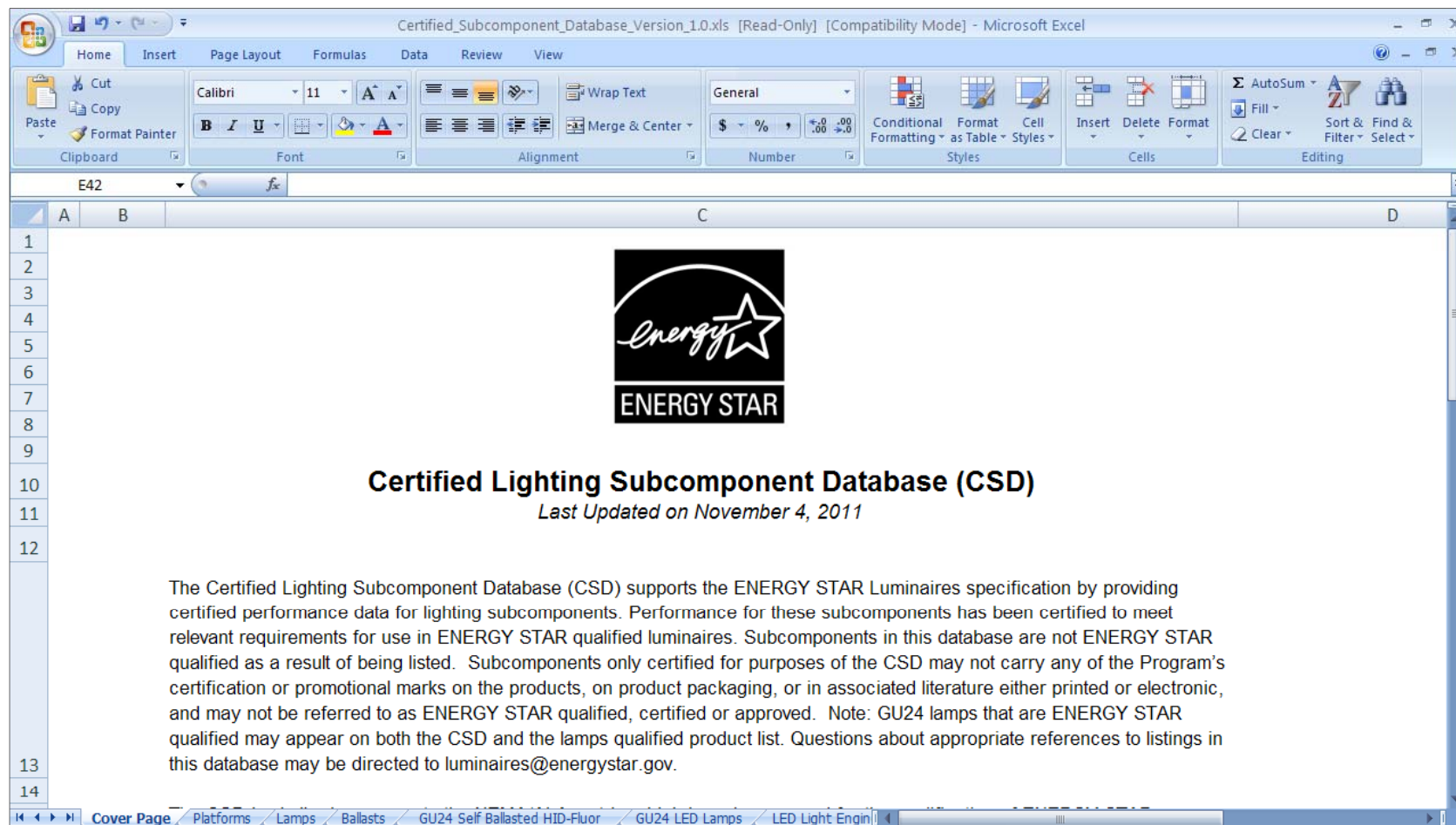
$T_{s,1}$ (°C)	55.00
$T_{s,1}$ (K)	328.15
α_1	1.68E-06
B_1	9.64E-01
$T_{s,2}$ (°C)	85.00
$T_{s,2}$ (K)	358.15
α_2	3.35E-06
B_2	9.53E-01
E_s/k_s	2.70E+03
A	0.00629401
B_0	0.95822217
$T_{s,i}$ (°C)	65
$T_{s,i}$ (K)	338.15
α_i	2.15E-06
Calculated L70 (hrs)	146170
Reported L70 (hrs):	≥60000

ENERGY STAR TM-21 Calculator



- For use by manufacturers, EPA-recognized laboratories and CBs
- To be validated by NIST prior to issuance
- Mitigates the need for accreditation
- Should be available within 2 weeks
- Any concern re: Excel format, please advise EPA immediately

Certified Lighting Subcomponent Database (CSD)



Certified Lighting

Subcomponents: GU24 Lamps



<u>Manufacturer</u>	<u>CCT</u>	<u>Lumens</u>	<u>Power</u>
Feit Electric	3000	900	13
Feit Electric	3000	1600	23
Feit Electric	3000	1800	27
First Green Lighting Limited	2700	800	13
First Green Lighting Limited	2700	900	13
First Green Lighting Limited	2700	1150	18
First Green Lighting Limited	2700	1200	18
First Green Lighting Limited	2700	1600	26
First Green Lighting Limited	2700	1650	26
Golo Chang Co., Ltd.	2700	900	13
Golo Chang Co., Ltd.	2700	900	13
Golo Chang Co., Ltd.	2700	1140	18
Golo Chang Co., Ltd.	2700	1200	18
Golo Chang Co., Ltd.	2700	1500	23
Golo Chang Co., Ltd.	2700	1560	26
Golo Chang Co., Ltd.	2700	1650	26
Good Earth Lighting	3000	900	13
Good Earth Lighting	3000	1600	23
Good Earth Lighting	3000	1800	27
Hengdian Group Tospo Lighting Co.,Ltd	2700	800	11
Hengdian Group Tospo Lighting Co.,Ltd	2700	900	13



Certified Lighting Subcomponents: GU24s in Testing



MaxLite

<u>Shape</u>	<u>CCT</u>	<u>Lumens</u>	<u>Power</u>
A-line	2700	850	13
Dimmable Spiral	2700	975	15
Dimmable Spiral	2700	1750	25
Globe	2700	850	13
Low Profile Spiral	2700	850	13
Low Profile Spiral	2700	1250	18
Low Profile Spiral	2700	1690	26
Spiral	2700	1260	18
Spiral	2700	1690	26
Spiral	2700	2080	32
Spiral	2700	2730	42

Certified Lighting Subcomponents: GU24s in Testing



Satco Products

<u>Shape</u>	<u>CCT</u>	<u>Lumens</u>	<u>Power</u>
Spiral	2700K	800	13
Spiral	2700K	1200	18
Spiral	2700K	1600	23

Certified Lighting Subcomponents: Ballasts



- OSRAM SYLVANIA
QTR4x32T8120ISNSC
- Philips Advance: many models

Certified Lighting Subcomponents: Ballasts



THE CSD
IS
OPTIONAL

Ceiling Fan Lighting



- Ceiling Fans V3.0 (effective April 1, 2012) references Luminaires V1.1 for light kits



Non-directional



Directional

Ventilation Fan Lighting



- Ventilation Fans V3.0 (effective April 1, 2012) references Luminaires V1.1 for lighting
 - Exemptions included for Luminaires spec safety requirements, product labeling & packaging
 - Exemptions for range hoods being considered

First Certified to ENERGY STAR Luminaires V1.1



- Amerlux Global Lighting Solutions
- Bright Yin Huey Company Limited
- Cooper Lighting a Division of Cooper Industries
- Cree LED Lighting Solutions
- Evolution Lighting (ASIA) Ltd
- Grainger Industrial Supply
- Juno Lighting Inc.
- Osram Sylvania, Inc.
- Summerwind International, LLC
- Tach Lighting & Electronics Ltd
- TCP Inc
- Tons Lightology Inc.
- UPEC Electronics Corp.

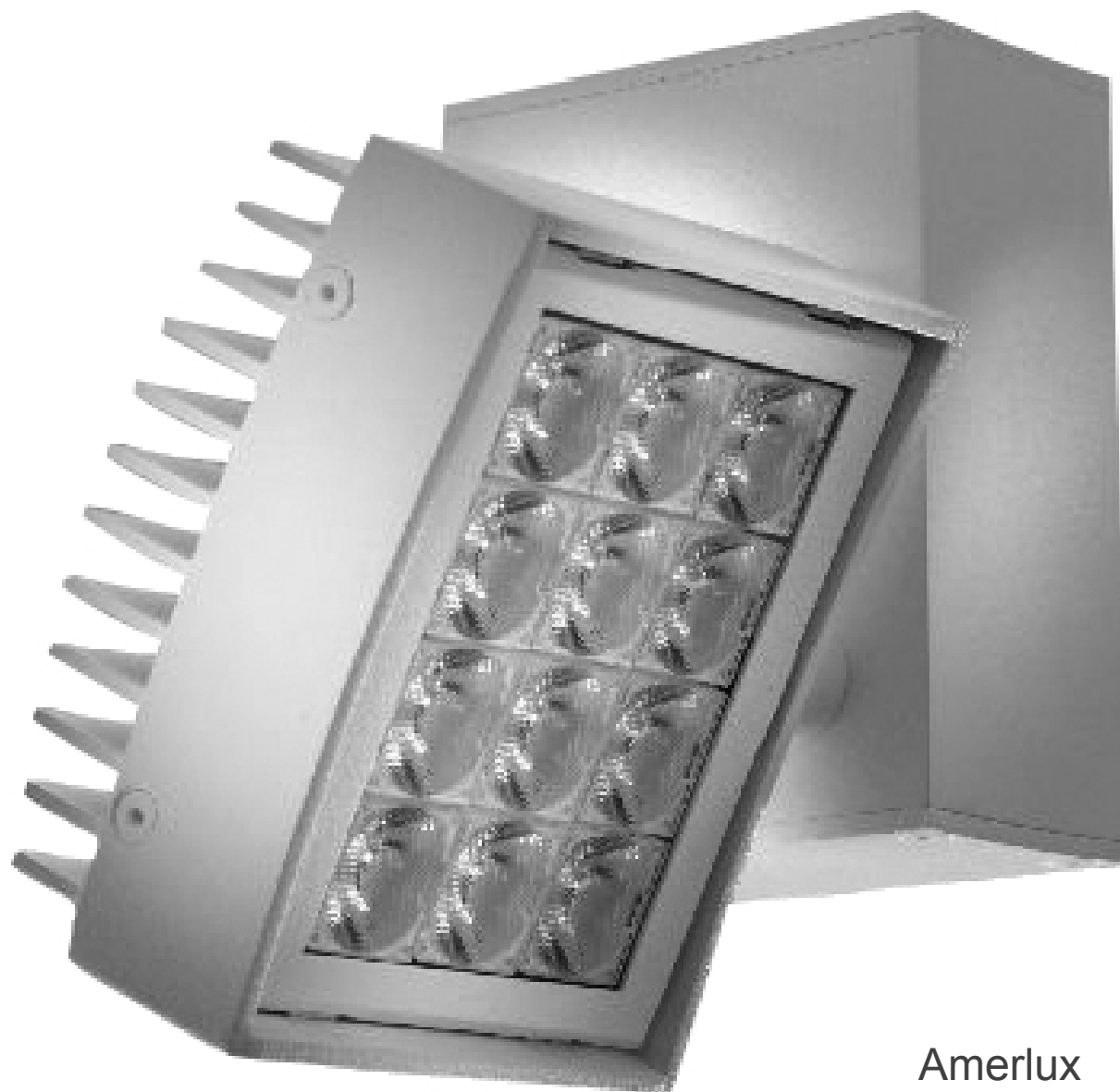
First Certified to ENERGY STAR Luminaires V1.1



- More than 100 models qualified thus far
- Mix of residential and commercial
- Mix of fluorescent and solid state
- Mix of fixture types:
 - Accent lights
 - Recessed downlights
 - Solid state downlight retrofits
 - Portable desk task lights
 - Ceiling fan light kits
 - Wall sconces
 - Under cabinet



Amerlux
CNTRV44-40-LED-E-XX-
XXXX-120-XX-XXXX



Amerlux
CNTRV34-32-LED-E-XX-
XXXX-120-XXX-XXXX



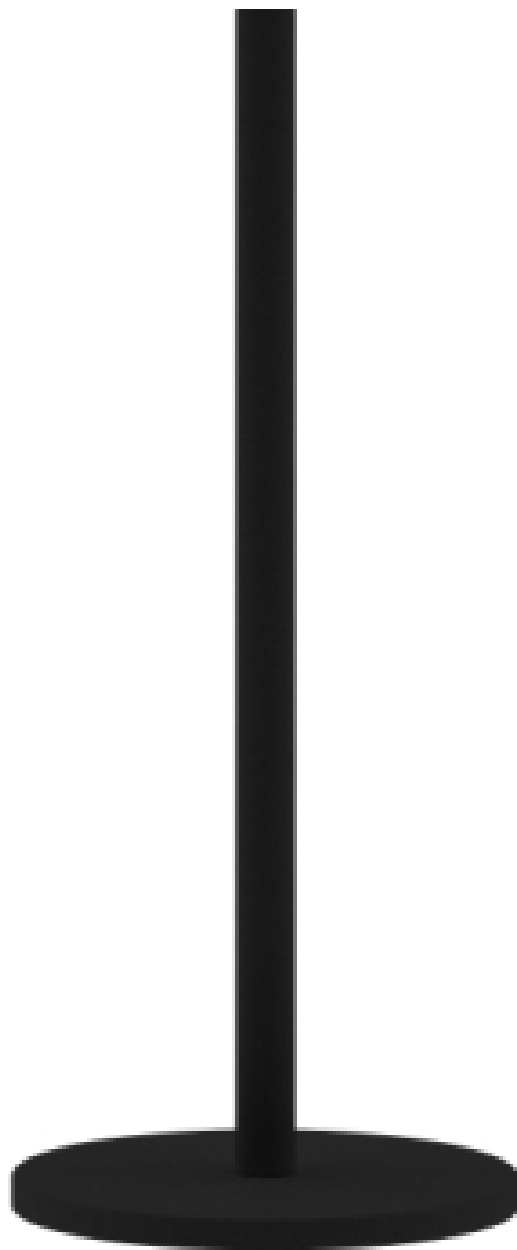
Powered with
CREE 
TRUE WHITE
TECHNOLOGY



CREE CR6-575



Exceedlite Ltd. ELC1001x



Exceedlite Ltd. ELF4004x



Juno Lighting
IC22LEDG3-3K-1



Lamps Plus T4201



Lamps Plus T4198



Lamps Plus T4200



SYLVANIA
LED/RT6/625/827/FL80/WRFL/WRT



SYLVANIA
LED/550/RT4/827/FL80/WRFL/WTR



Technical Consumer Products
DES1X1841KGUWALLBS



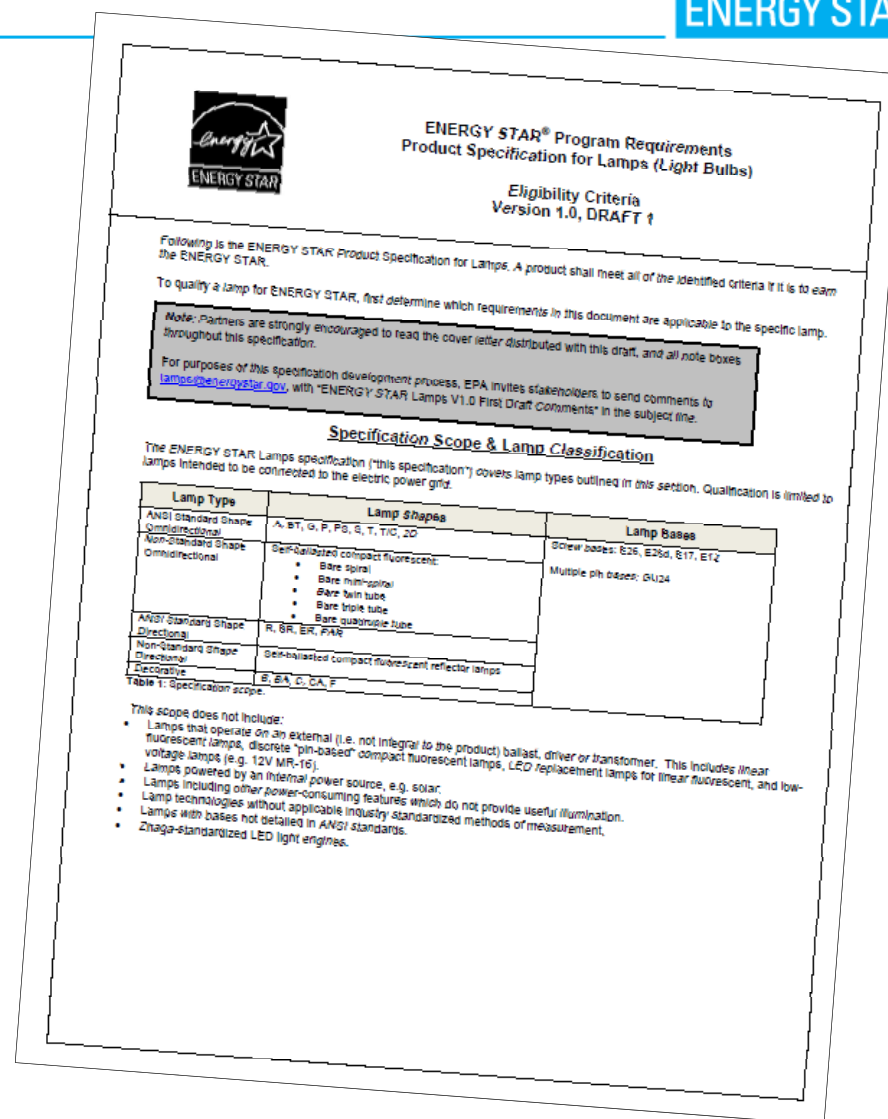
ENERGY STAR

Lamps Specification

ENERGY STAR Lamps V1.0 Draft 1



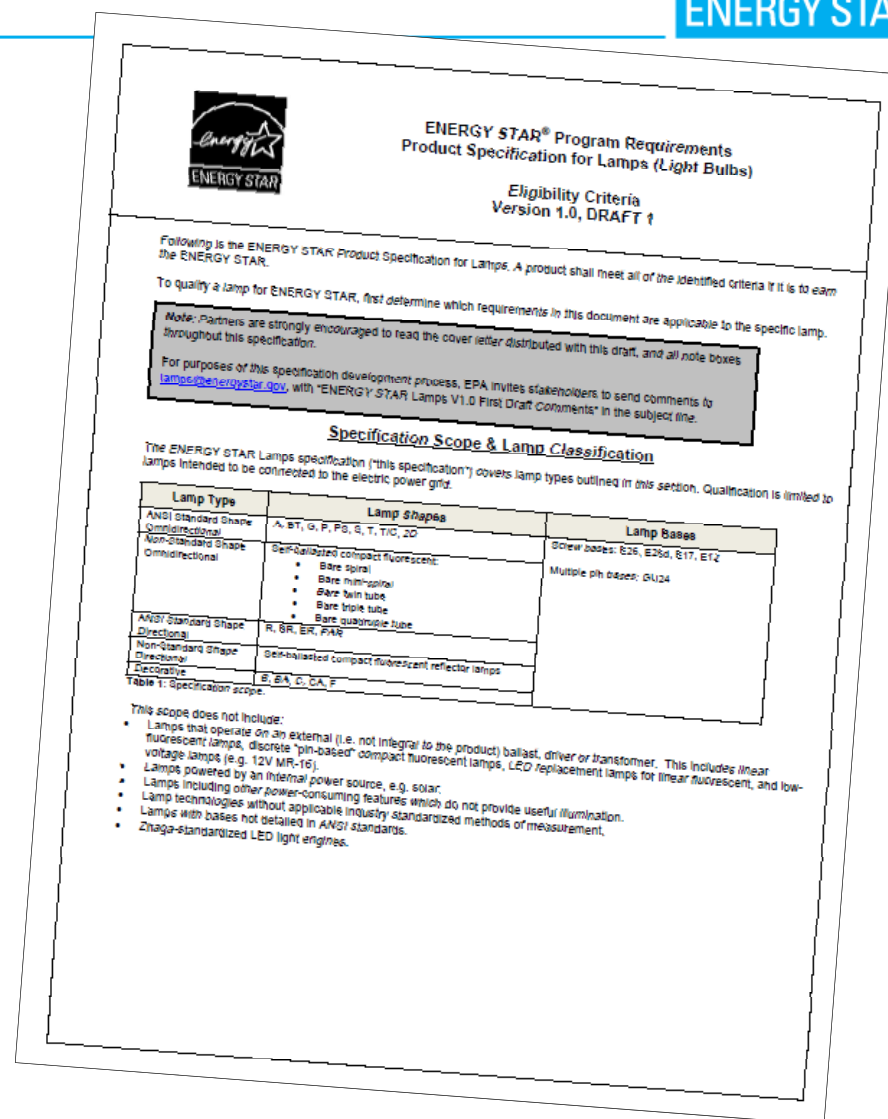
- Issued October 21, 2011
- EPA's intent: merge existing specifications into one technology-neutral specification, taking the opportunity to further increase quality and reliability



ENERGY STAR Lamps V1.0 Draft 1



- Focused 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 Lamps V1.0 Draft 1: Scope



- ANSI standard omni-directional A, BT, G, P, PS, S, T, T/C, 2D
- ANSI standard directional R, BR, ER, P
- ANSI standard decorative B, BA, C, CA, F
- Non-standard CFL shapes for directional and omni-directional
- Lamp bases: E12, E17, E26, E26d, GU24

ENERGY STAR Lamps V1.0 Draft 1: Scope



- Not included:
 - ANSI K shape, GU10 and GX5.3 bases
 - low-voltage MR-16 lamps:
 - Opportunity is small compared to other lamp types
 - Energy savings potential is highly dependent on consumer behavior:
 - Old transformer upgraded or not?
 - Transformer properly loaded or underloaded?
 - Difficulty testing:
 - what transformer should be used?
 - test with AC or DC?
 - Consumer experience: light output can vary dramatically with AC or DC operation.
 - Packaging and lamp labeling opportunity very limited by form

ENERGY STAR Lamps V1.0 Draft 1: Efficacy



Luminous Efficacy Requirements: All Lamps

Lamp Type	ENERGY STAR Requirements	
	Lamp Input Power (watts)	Lamp Efficacy (initial lm/W)
Omnidirectional	<10	55
	≥10	60
Directional	<10	40
	≥10	45
Decorative	<10	45
	≥10	50

- Of qualified lamps, these levels are met by:
 - 92% of omnidirectional lamps
 - 80% of directional lamps

ENERGY STAR Lamps V1.0 Draft 1: Minimum Light Output



- Same requirements as previous for:
 - Non-globe (G) shape omnidirectional
 - Decorative
- Proposed globe (G) shape requirements based on analysis of soft white standard incandescent globe lamps on the market
- R, BR and ER: TBD
- PAR lamps: not applicable

ENERGY STAR Lamps V1.0 Draft 1: Correlated Color Temperature (CCT)



- 2700K to 5000K inside 4-step MacAdam ellipses / quadrangles

Proposal intended to ensure greater consistency between makes, models & technologies

- Current requirements allow lamps with obvious magenta or green tints to share the same CCT
- Fluorescent ANSI standard established 4-step, ANSI SSL standard predicted return to 4-step
- Some manufacturer support

ENERGY STAR Lamps V1.0 Draft 1: Color Rendering



Color Rendering Requirements: All Lamps	
Lamp Type	ENERGY STAR Requirements
All Lamps	Lamps shall exhibit color rendering index scores of $R_a \geq 80$ and $R_9 > 0$.

- Requirement from the Integral LED Lamps spec:
 $R_a \geq 80$ and $R_9 > 0$
- Most lamps should be able to meet this requirement
- Note: Color Quality Scale (CQS) is not yet available

ENERGY STAR Lamps V1.0 Draft 1: Reliability / Lumen Maintenance



- Compact Fluorescent: minimum 10,000 hour rated life
- Solid State: 10,000 hour minimum life claim
 - Early interim qualification option @ 3,000 hours
 - Lamp-level testing to 6,000 hours for life claims $\leq 25,000$ hours
- Elevated Temperature Test for all lamps ≥ 5 watts

ENERGY STAR Lamps V1.0 Draft 1: Reliability / Lumen Maintenance



- Do consumers want a 14 year lamp? (15,000 hr @ 3 hr/day)
- Do consumers want a 23 year lamp? (25,000 hr @ 3 hr/day)

what else do they expect it or 20 years from:

— “Durable Goods”:

- Appliances?
- Home HVAC?
- Car?
- Does initial cost seem to be a barrier?
- Does it make sense to lock consumers into today's efficacy levels for 14 / 23 years?

ENERGY STAR Lamps V1.0 Draft 1: Reliability / Lumen Maintenance



- About 10,000 hours:
 - 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!)

ENERGY STAR Lamps V1.0 Draft 1: Rapid Cycle Stress Test



Rapid Cycle Stress Test: All Lamps	
Lamp Type	ENERGY STAR Requirements
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.

- Need to ensure qualified lamps are robust replacements for incandescent
 - 1 cycle for each hour of rated life
 - Sample size 10 instead of 6, maintaining single failure
 - 5 min on / off to ensure adequate ΔT

ENERGY STAR Lamps V1.0 Draft 1: Power Factor



Power Factor Requirements (Exemption: Lamps \leq 5 Watts)	
Lamp Type	ENERGY STAR Requirements
All Lamps	Lamp shall have a power factor \geq 0.7.

- Proposed in a technology neutral manner
- Several manufacturers stated this is possible
- Some proposed > 0.9 ; support was not broad
- Interested in feedback, particularly from utilities

ENERGY STAR Lamps V1.0 Draft 1: Start Time



Start Time Requirements: All Lamps	
Lamp Type	ENERGY STAR Requirements
All Lamps	Lamp shall remain continuously illuminated within 0.5 second of application of electrical power.

- 89% of ENERGY STAR qualified lamps meet this
 - 74% of 3-way and dimmable

ENERGY STAR Lamps V1.0 Draft 1: Run-Up Time



Run-Up Time Requirements	
Lamp Type	ENERGY STAR Requirements
Covered Compact Fluorescent	Lamp shall achieve full stabilized light output in ≤ 90 seconds.
All Other Lamps	Lamp shall achieve: $\geq 50\%$ of stabilized light output in ≤ 30 seconds; and, $\geq 80\%$ of stabilized light output in ≤ 45 seconds; and, full stabilized light output in ≤ 60 seconds.

- Run-up times are a known consumer dissatisfier
- Proposal taken from California Super Lamp spec
- 70% of bare lamps were qualified with a run up time of 45 seconds
- 92% were qualified with a run up time of 60 seconds
- Covered CFLs: 63% were qualified with a run up time of 90 seconds

ENERGY STAR Lamps V1.0 Draft 1: Lighting Toxics Reduction

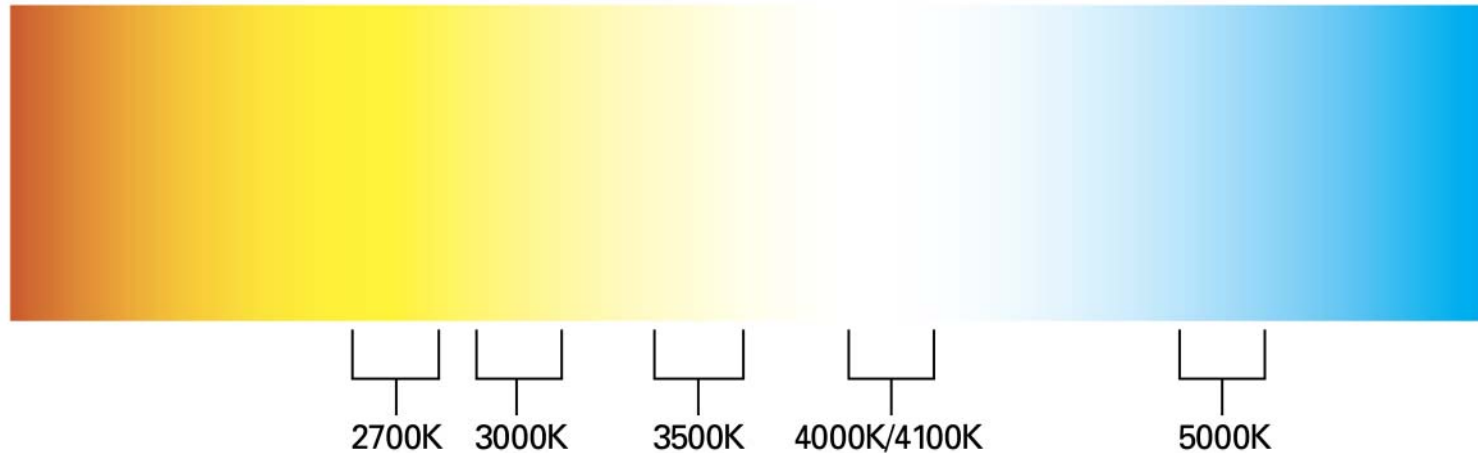


Lamp Type	ENERGY STAR Requirements
All Lamps	Lamps \leq 23.0 watts shall contain \leq 2.5 milligrams (mg) mercury per lamp Lamps $>$ 23.0 watts shall contain \leq 3.0 milligrams (mg) mercury per lamp

Note: The above requirements for mercury content are based upon analyses of what is technically feasible today for compact fluorescent lamps. Beyond the mercury requirements, in the interest of transparency the relevant toxics reduction requirements have been printed in the specification draft, rather than a reference to

- ... EU RoHS resources

ENERGY STAR Lamps V1.0 Draft 1: Color Spectrum 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

ENERGY STAR Lamps V1.0 Draft 1: Color Spectrum Tool

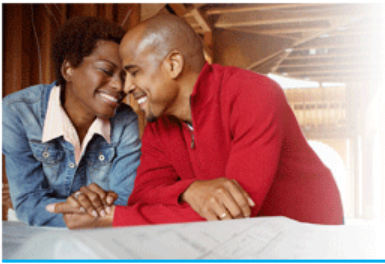


ENERGY STAR

Lamps V1.0 Draft 1



- Comment period open until December 9, 2011:
lamps@energystar.gov
- Partner & stakeholder round table to be held in Washington, DC on Wednesday, November 30
- Live webinar for those who can't attend in person
- Please register at: lamps@energystar.gov
- Complaints: jantz-sell.taylor@epa.gov

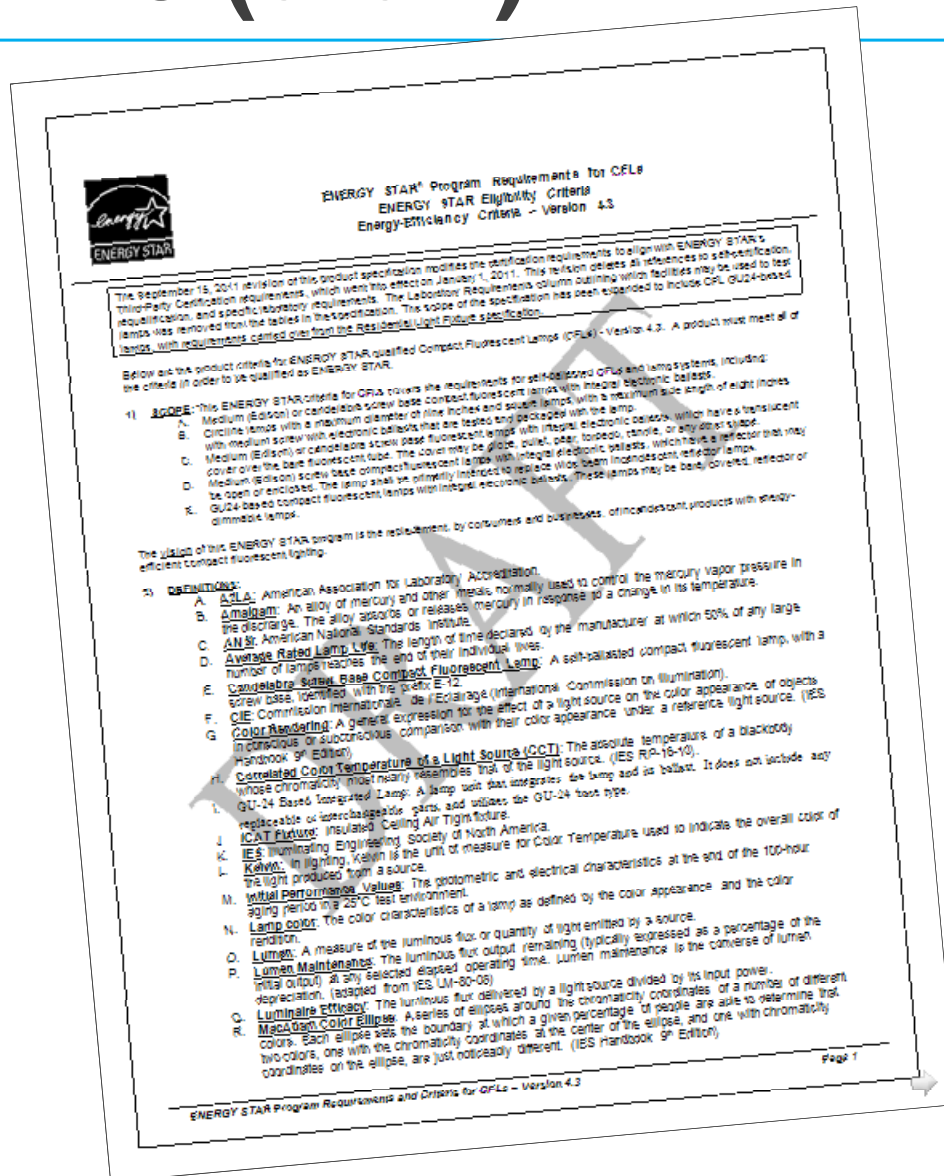


ENERGY STAR

Compact Fluorescent Lamps V4.3

(draft)

Compact Fluorescent Lamps V4.3 (draft)



- Interim relocation of GU24 replacement lamp requirements
- Elimination of the 36 month requalification requirement
- Changes to verification testing procedures
- Draft to be issued shortly



ENERGY STAR

Integral LED Lamps V1.4

ENERGY STAR

Integral LED Lamps V1.4



- Expanded upon packaging requirements for non-standard lamps
- Updated specification language to reflect Program change to third party certification
 - Removed references to NVLAP accredited or CALiPER recognized labs
 - Removed verification testing language; will be handled by CBs going forward
- Added provisions for minor product variations

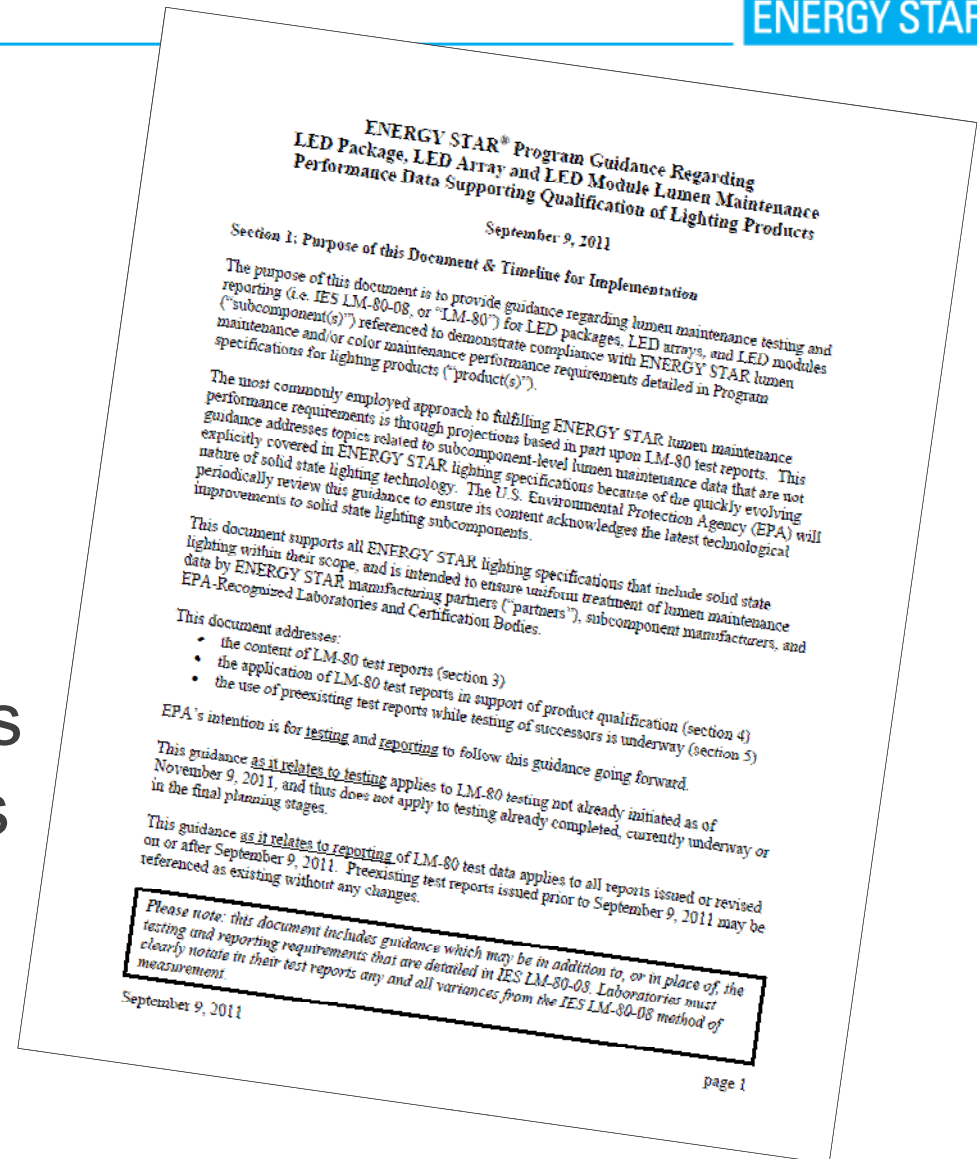


Program Guidance Regarding LED Lumen Maintenance Data

Program Guidance Regarding LED Lumen Maintenance Data



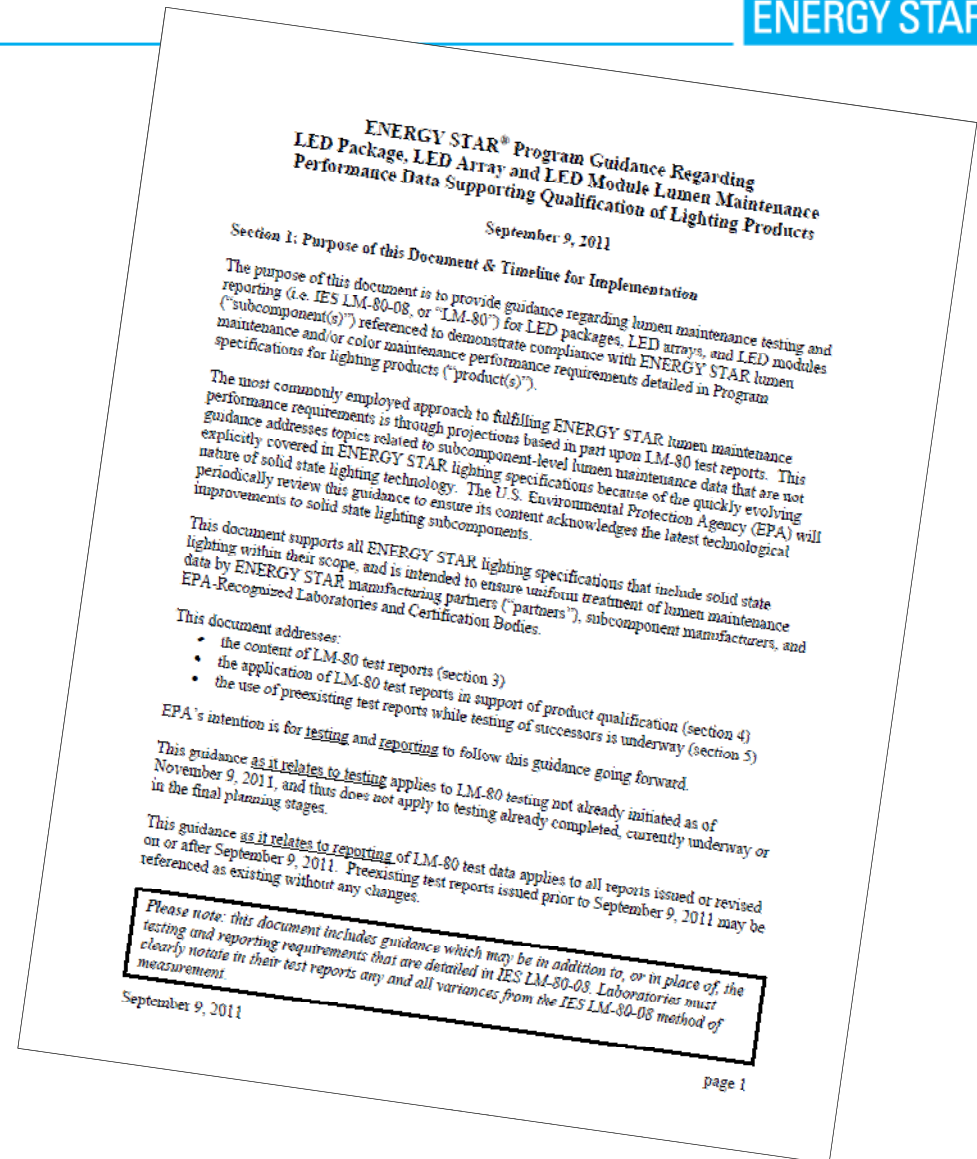
- Builds upon SSL Manufacturers Guide
- Intended to ensure uniform treatment of data by partners, LED manufacturers, EPA-recognized laboratories and certification bodies



Program Guidance Regarding LED Lumen Maintenance Data



- Guides Certification Bodies on:
 - Content of LM-80 reports
 - Application of LM-80 reports
 - Use of preexisting test reports while successor testing is underway





ENERGY STAR

Decorative Light Strings V1.5 (draft)





Testing & Certification Infrastructure

New Certification Infrastructure



- 8 EPA-recognized certification bodies (domestic)
- 40 EPA-recognized lighting laboratories worldwide:
 - Arizona, California, Colorado, Georgia, Massachusetts, North Carolina, New York, Ohio, Pennsylvania, Washington
 - Canada, China, Germany, Hong Kong, Japan, Malaysia, Singapore, South Korea, Taiwan
- Laboratory capacity expanding
- EPA continuing to receive applications for recognition

New Certification Infrastructure



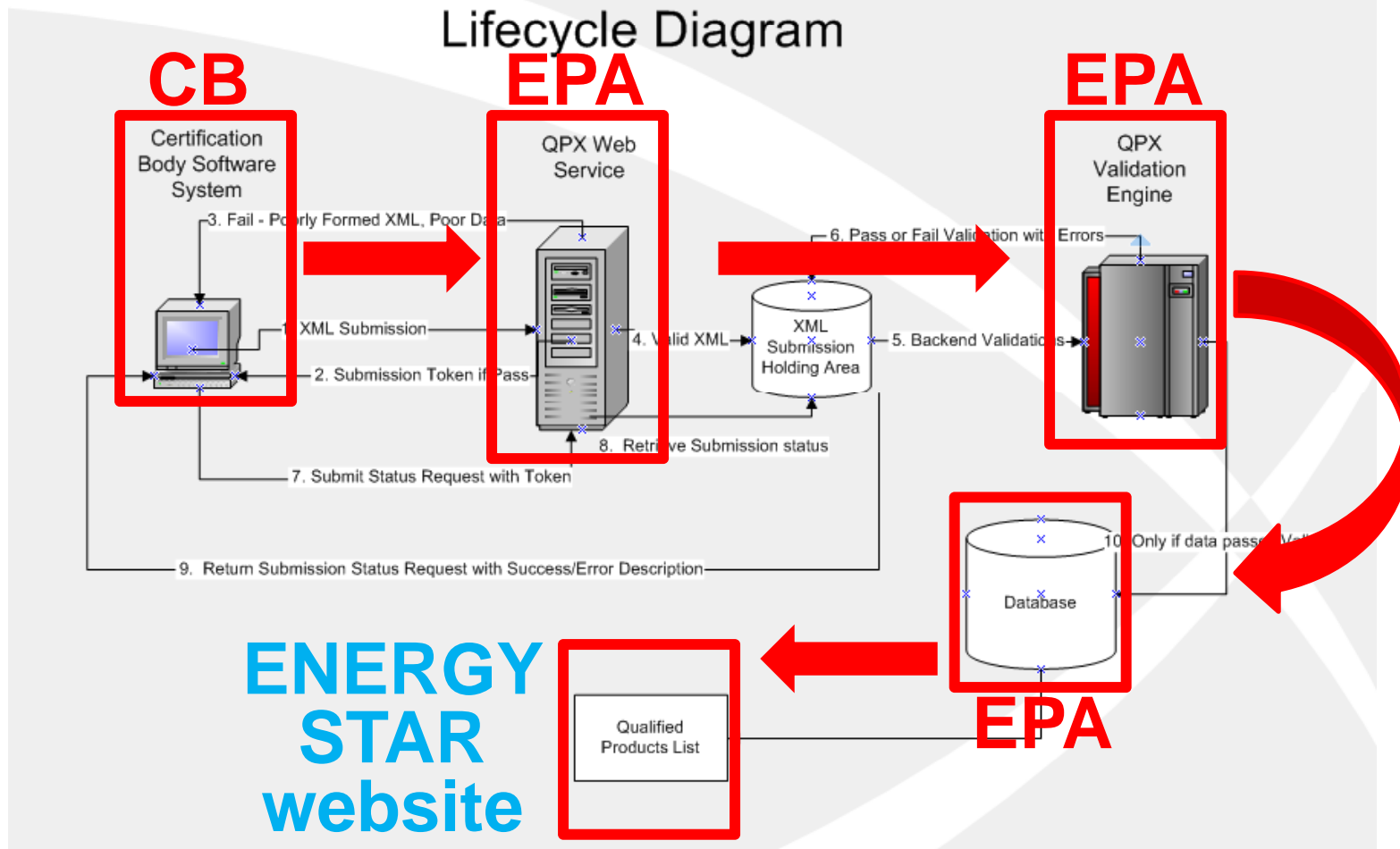
- XML-based data transfer system
- CB enters data into their own XML-based software
- EPA system validates data, posts to website

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peration> </binding>
```

New Certification Infrastructure



Qualified Products Exchange (QPX) XML Transaction Lifecycle Diagram





Questions?





Thank you!

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