



CALiPER

ROUNDTABLE REPORT

May 2011

DOE Solid-State Lighting CALiPER Program

2011 Roundtable

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency &
Renewable Energy

Prepared for the U.S. Department of Energy
by Pacific Northwest National Laboratory

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DOE Solid-State Lighting CALiPER Program

CALiPER Standards and Testing 2011 Roundtable Proceedings

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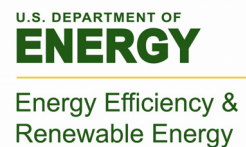


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DOE Solid-State Lighting CALiPER Program 2011 Roundtable

Introduction

On April 4 and 5, 2011, the Department of Energy’s Building Technologies Program hosted its sixth Roundtable meeting among standards-setting efforts, lighting testing laboratories, and key stakeholders in the solid-state lighting (SSL) industry. This Roundtable discussion built upon DOE-led sessions on SSL testing standards held since 2006.¹ The 2011 Roundtable meeting was held in cooperation with the Illuminating Engineering Society of North America Testing Procedures Committee (IES TPC) meeting, preceding the TPC working group sessions. For this meeting, 40 experts from the lighting industry who are also involved in key related organizations — such as IES, National Institute of Standards and Technology (NIST), National Electrical Manufacturers Association (NEMA), American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE), Pacific Northwest National Laboratory (PNNL) — and independent photometric testing laboratories, SSL manufacturers, and research laboratories gathered in Gaithersburg, Maryland, to discuss current issues related to SSL testing and related standards development.

Ruth Taylor of PNNL opened the meeting and welcomed participants. The group was reminded of the importance of their participation and the guidance they provide to a wide array of SSL activities that are helping to bring high-quality, energy-efficient SSL technologies to market. By bringing deep experience and expertise to the table, the CALiPER Roundtable participants help to identify issues, brainstorm options, and propose constructive actions for DOE SSL commercial product testing and other DOE SSL commercialization support activities, the standards communities, and SSL manufacturers.



The Roundtable meetings are targeted working sessions benefiting from expertise contributed by all attendees. Participants divided into three breakout groups and were tasked to examine issues, brainstorm options, and identify possible solutions to challenges facing the market application of

¹ An initial DOE-hosted SSL Standards Workshop was held in March 2006. A second DOE-hosted workshop was held in October 2006 along with a kick-off workshop for the DOE’s commercial product testing program (later named CALiPER). A third DOE-hosted standards workshop and CALiPER Roundtable meeting was held in November 2007, a fourth Roundtable was held in March 2009, and a fifth Roundtable was held in February 2010. Proceedings from the 2007, 2009, and 2010 Roundtable meetings are available online: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2010_caliper_Roundtableproceedings.pdf, http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2009_caliper_Roundtableproceedings.pdf, and http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2007_caliper_Roundtableproceedings.pdf.

standards/testing, program treatment of standards/testing, and SSL product reliability. The current SSL standards and testing context for the meeting is summarized briefly below, followed by highlights of the working sessions on each topic.

Updates Providing Meeting Context

LED Standards and Test Methods Progress

Eric Richman of PNNL summarized the current status of the development of LED standards and test methods, citing an impressive list of efforts that have been completed or initiated since the initial DOE standards workshop on March 6, 2006. Numerous performance standards, test methods, safety standards, and other related standards impacting SSL and LED products are currently under development, including (but not limited to):²



- The core group of five completed standards and test methods
 - C78.377 – LED Chromaticity for White Light LED
 - LM-79 – LED Photometric Testing (luminaires)
 - RP-16 – Modified to include LED defined terms
 - LM-80 – LED Lumen Depreciation Testing (packages, modules)
 - UL 8750 – LED Safety
- The latest addition (almost complete)
 - TM-21 – Projecting Long Term Lumen Maintenance of LED Light Sources
- Other completed documents (white papers and standards)
 - White papers:
 - NEMA LSD-44 – Solid State Lighting – Sockets & Interconnects
 - NEMA LSD-45 – Recommendations for Solid-State Lighting Sub-Assembly Interfaces for Luminaires
 - NEMA LSD-49 – Solid State Lighting—Best Practices for Dimming
 - Standards:
 - NEMA SSL-1 – Electric Drivers for LED Devices, Arrays, or Systems

² For more information about SSL standards, visit www.ssl.energy.gov/standards.html and download the DOE fact sheet, “LED Measurement Series: Solid-State Lighting Standards,” http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_standards.pdf.

- NEMA SSL-3 – High Power White LED Binning for General Illumination
 - NEMA SSL-6 – Solid State Lighting for Incandescent Replacement – Dimming
- Other documents underway or in planning
 - CIE TC1-69 – Color Quality Scale (new CRI-type metric)
 - IEEE-P1789 – Biological Effects and Health Hazards from Flicker (now 3 subcommittees)
 - IES LM-XX1 – High Power LED Measurement (pulse and DC mode)
 - IES LM-XX2 – LED Light Engine Measurements
 - IES LM-XX3 – LED Luminaire Life
 - NEMA SSL-4 – LED Product Form Factors
- Other efforts in process
 - Commission Internationale de l’Eclairage (CIE) and International Electrotechnical Commission (IEC) also working on similar parallel LED standards for worldwide focus
 - IEC 62560 – Self-ballasted LED for general lighting (greater than 50 volts)
 - IEC 62612 – LED performance
 - IEC 62031 – LED module
 - IEC 62504 – LED definitions
 - IEC 61345-2-13 – Safety specs for ballasted LED
- Recently completed lab testing uncertainty budget report in development
 - C78.377-2008 – Review Considerations
 - IEC looking at standard with higher 2700K bin — not typical for U.S. market or programs
 - Confusion with C78.377 (luminaire) vs. diode-level tests. Working group formed (T. Stimac).
 - NIST proposing study of 2700K issue as part of LED color response study (Y. Ohno)
 - Review cycle of C78.377 is on hold to consider these issues
- The process still needs your support...
 - Current standards and new standards need champions, drivers, *and critical commenters*
 - Original standards and test methods are currently under scheduled review/update

CALiPER Program Update: April 2011

Mia Paget of PNNL provided a quick synopsis of current CALiPER activities and recent CALiPER results. Beginning with pilot testing in 2006, the DOE CALiPER program has purchased and tested commercially available solid-state lighting products for over four years. CALiPER program has tested more than 300 SSL products and many benchmark lamps and

luminaires, reported on the results, and provided feedback to standards and testing stakeholder communities. CALiPER results and expertise also feed into a number of related DOE SSL activities such as support for standards activities, SSL Quality Advocates, SSL Manufacturer Initiative, SSL Manufacturing R&D Roadmap, GATEWAY demonstration projects, Next Generation Lighting Industry Alliance (NGLIA) Solid-State Lighting Product Quality Initiative, design competitions, and the Technical Information Network.

In 2010, the most prominent independent and manufacturer lighting testing laboratories were able to complete laboratory accreditation for IESNA LM-79 and IESNA LM-80 testing of SSL products. Working with lighting testing laboratories and other key users of standardized SSL testing, CALiPER guidelines were developed to determine what constitutes appropriate accreditation and verification for IESNA LM-79, such that CALiPER qualification of testing laboratories is no longer needed. CALiPER will now use laboratories which have acquired LM-79 accreditation from bodies that have experience in conducting accreditation for lighting testing methods and that use teams of assessors which include experts with appropriate technical knowledge and experience in general and SSL lighting testing. To ensure traceability and minimize variations in measurements, acceptable accreditation must include SSL LM-79 proficiency testing — which was discussed in further detail by Working Group A during the 2011 Roundtable meeting.

CALiPER summary reports covering rounds 10 and 11 of testing were issued in 2010. These testing rounds included parking garage, wall pack, cove lights, roadway arm-mount, roadway post-top, and high-bay luminaires, along with a wide variety of SSL replacement lamps such as 4-foot linear replacement lamps, PAR lamps, MR16 lamps, and A-lamps. CALiPER rounds 10 and 11 revealed an increasing number of larger, higher-wattage products, competitive in an increasing variety of lighting applications, but still exhibiting wide ranges of performance. In general, manufacturer product performance reporting is increasingly based on LM-79 testing, with an increasing use of the Lighting Facts[®] label — which is not a guarantee of good performance but does increase the probability of accurate claims.³ Unfortunately some products still provide no ratings or false ratings and manufacturer equivalency statements are very often false or misleading.



Supplementing the regular rounds of CALiPER LM-79 testing, CALiPER has supported or is conducting exploratory studies on measurement uncertainty, flicker, glare, long-term product performance, and dimmability. These studies have often come from Roundtable group suggestions.

Testing Laboratory Accreditation Update

Cameron Miller provided an update on the status of the National Voluntary Laboratory Accreditation Program (NVLAP) Energy Efficient Lighting Program for Solid-State Lighting

³ For more information on Lighting Facts, see www.lightingfacts.com.

testing.⁴ With support from DOE, NIST developed proficiency testing artifacts to support NVLAP LM-79 accreditation processes and, in 2010, presented a workshop to provide guidance to lighting testing laboratories across the U.S. for LM-79 accreditation (the 2010 CALiPER Roundtable meeting was held just following this workshop). Since then numerous laboratories in the U.S. and abroad have received or are in the process of receiving NVLAP accreditation for SSL testing. A few other accreditation bodies are providing LM-79 accreditation services but do not conduct proficiency testing.

Starting with Public Law 102-486, “Energy Policy Act of 1992” (October 24, 1992), which required DOE to specify energy-efficient standards for certain types of fluorescent and incandescent reflector lamps, test procedures for determining energy efficiency were to be prescribed by DOE, and were to be conducted by accredited laboratories using applicable IES or ANSI standards. The Lighting Equipment Division of NEMA requested that NVLAP establish an accreditation program for laboratories to test certain types of lamps and luminaires. Continuing along the path started in the 1990s, NVLAP and NIST have been actively engaged in SSL testing, working with standards efforts and DOE to enable development and implementation of standardized photometric testing for SSL.

Bilateral proficiency testing conducted by NIST during the process of NVLAP LM-79 accreditation has enabled examination of power, flux, and correlated color temperature (CCT) variation across laboratories and across artifacts representing a variety of photometric and electrical characteristics. The process of bilateral proficiency testing for SSL accreditation has underscored the importance of performing such verifications to reduce measurement differences and uncertainties.

Lumen Uncertainty Measurements Report Review

One recent area of study linked to SSL testing is measurement uncertainty. In 2010 and 2011, DOE provided support for developing procedures for determining uncertainty of photometric measurements surrounding LM-79 testing, and related uncertainty budgets. Rolf Bergman presented an initial introduction to lumen measurement uncertainties. Procedures for determining uncertainty of lumen flux draw from the 8-step Guide for Uncertainty Measurement (GUM procedure). Spreadsheets are established to guide determination of input variables that contribute to uncertainty, combined uncertainties, expanded uncertainties, and potential of error and corrections.



⁴ Reference to NVLAP handbooks and contact for MAP services. The DOE-sponsored NVLAP workshops were held on February 16–17, 2010, covering details about HB150 National Voluntary Laboratory Accreditation Program Procedures (NVLAP) and General Requirements (ISO/IEC 17025; general requirements for the competence of testing and calibration laboratories) and covering the program-specific details of the energy-efficient lighting handbook with respect to solid-state lighting, HB150-1A.

Breakout Sessions: Examining SSL Standards/Testing

The CALiPER Roundtable meetings actively engage experts to help guide the CALiPER program and DOE support of standards activities. Each year, working together in breakout groups, these experts explore an array of current topics surrounding SSL testing to identify and prioritize issues, brainstorm possible solutions, and define actions to be taken by DOE, standards groups, trade groups, and manufacturers to address the issues. For the 2011 CALiPER Roundtable, the suggested topics for breakout groups were as follows. Each breakout group brainstormed issues and gave a number of recommendations as summarized in the following pages.

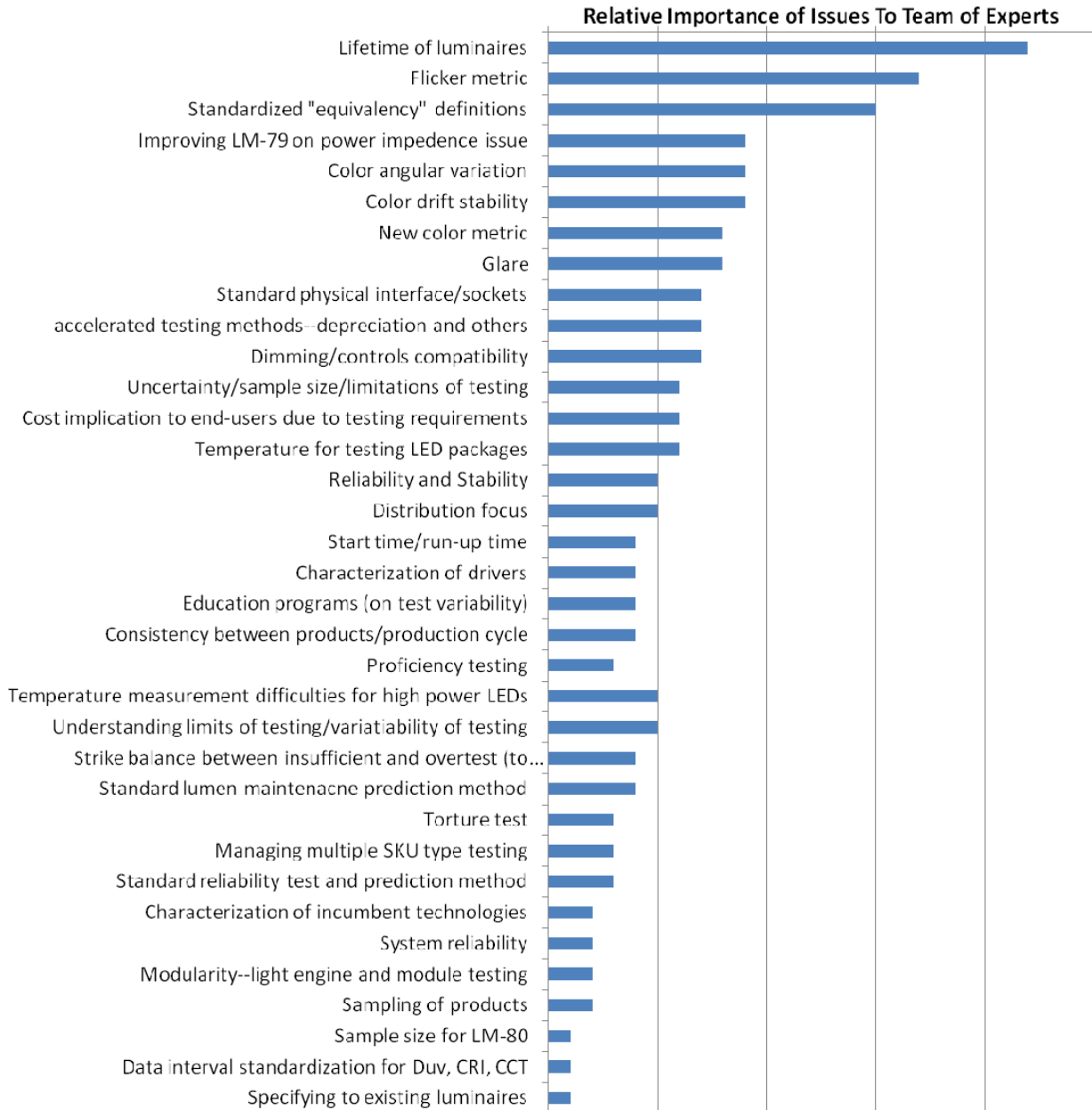


The working groups addressed the practical market application of SSL standards and testing, programmatic treatment of SSL standards and testing, and methodologies surrounding SSL system reliability and life testing.

Before the breakout sessions, the group was asked to brainstorm current/upcoming SSL testing issues. The following chart summarizes the responses, based on weighted votes. Grouping the various brainstormed issue areas, the general topic areas generating the most concern are:

- Reliability/lifetime testing methods and concerns
- New/updated testing methods (LM-79, flicker, glare)
- Color concepts and metrics
- Uncertainty in testing
- Equivalency and characterization of incumbent technologies

Brainstorm of Current/Upcoming SSL Testing Issues





Group A – Market Application of Standards

Working Group A discussed the practical application of standards and testing. The initial brainstorming activities led to more detailed discussions on interchangeability, equivalency claims, and consistent application of standards. The issues discussed and recommendations are summarized below.



Interchangeability

Issues and Context

- Definitions are needed (perhaps by NEMA)
- Specifications are needed
 - U.S. needs to start program or adopt Zhaga
 - Need involvement of NEMA and ANSI
- Interchangeability of electrical system, thermal system, and photometric system all need to be considered

Recommendations

- Group suggests the following definitions
 - For replacement products:
 - No modification of luminaires used
 - Must meet existing form factor, electrical, thermal, and photometric performance of incumbent product
 - For retrofits:
 - Requires modification of luminaires
 - Original lamp type should not be able to be put back in retrofitted luminaire

Equivalency Claims

Issues and Context

- No standard for claiming equivalency
- Labeling requirement for equivalency claim
 - Need more than what Lighting Facts offers
 - Need Federal Trade Commission (FTC)/NEMA involvement
- No linear LED lamp test methods
 - Replacement vs. retrofit



- Need to be sure optical and distribution issues are dealt with

Recommendations

- New equivalency claim standard could:
 - Be similar to ENERGY STAR
 - Include form factor, electrical, thermal, and photometric performance
 - Include life claims consistency language

Consistent Application of Standards

Issues and Context

- Currently SSL products are penalized vs. other technologies
 - More testing required than other technologies
 - Other higher requirements for SSL:
 - Life – L70 vs. B50
 - Power factor, lumen maintenance, CCT
- Standardized test requirement is needed (NEMA/DOE)
 - National vs. International – need common standards
 - Multiple testing of same product is expensive
 - Different performance requirements are a problem

Recommendations

- Standardized testing requirements
 - One suggestion: No charge for testing if product passes; fine/high fee for failure

Other Discussion Topics

- Flicker
 - Need to define a metric
- Toxicity
 - Need to define toxic ratings
- Educational Opportunities
 - Interchangeability
 - Equivalency
 - How to compare FTC/Lighting Facts labels
 - Meaning of “life” in lighting

Group B – Program Treatment of Standards/Testing

Breakout group B examined programmatic treatment of standards and testing within the context of the ENERGY STAR program, utility rebate programs, appliance standards, and educational concerns. The working group focused on current developmental process of standards and tests, how standards and tests are used, credibility of laboratories using the standards, and international

concerns and issues. The issues discussed and recommendations developed by the breakout group are summarized below.

Standards Development

Issues and Context

- IES and ANSI create standards based on products and processes
 - Regulatory
 - Industry
- Voluntary work on development
 - Timeliness of development
 - Writing document, approval document, research
 - Timeliness of revision (availability of obsolete documents)
- TPC and communication with the industry
- International concerns and issues
 - Lighting Measurement documents (LMs) are not considered standards
 - International community is using LMs as standards
 - IEC is starting to add Annexes that resemble LMs
 - CIE is considering process standards
 - IEC only refers to IEC and International Organization for Standardization (ISO) documents
 - CIE does not recognize IES

Recommendations

- IES and ANSI work together to develop LMs into standards
- Harmonization with IES/ANSI standards and IEC
- LM Standards vs. Best Practices
 - Best practice is developed
 - Best practice is rewritten to standard



Usability of Standards

Issues and Context

- Different performance levels
 - ENERGY STAR
 - Utility rebates
 - International energy policies
- Specifications without test methods
- Specifications without industry feedback
- Needs are a moving target (glare, flicker)

Recommendations

- Review current specifications to harmonize the test methods required

- Environmental Protection Agency (EPA) outreach to the industry (manufacturers vs. labs and certification bodies (CBs) soliciting feedback (mirror DOE Roundtables)
 - EPA currently:
 - Submits three drafts of all specs in order to solicit feedback
 - Has been offered webinars to solicit feedback
 - Has recently sent a framework document for lamps
 - Perhaps still needs a face-to-face before paper copy is generated
 - Has interaction that does not involve paperwork

Credibility of Testing Laboratories

Issues and Context

- Availability of proficiency testing
 - LM-79 Sphere and Gonio (integrated measures)
- Needed proficiency topics
 - LM-79 Gonio (intensity distributions)
 - LM-82 Light Engine
 - LM-80 Lumen Maintenance
- Understanding capabilities of testing labs
 - Rigor of written standard – tolerance
 - Quality of management process and technical expertise
 - Uncertainty of measurements
 - Round-robin testing between laboratories (International Laboratories Corporation [ILC])
 - Correlation with National Metrology Institutes (NMI) and industry

Recommendations

- Require proficiency testing for all accredited laboratories
 - Use the NIST-available Measurement Assurance Program (MAP) testing
 - Long term, use recognized providers, perhaps including International Energy Agency (IEA) 4E SSL Annex methodology under development
- Prepare mechanisms for inter-laboratory comparisons
 - Find a organizing body to develop and handle management
 - Find organization to technically handle ILC
 - Possibly Lamp Testing Engineers Conference (LTEC) or similar new organization. Perhaps NEMA, NIST, or other impartial organization.
 - Continue Roundtable discussions with industry laboratories to determine principles
 - DOE/EPA programs facilitate the development of inter-laboratory comparison testing (ILCs)

High-Level Recommendations and Action Items

- Begin informal discussions with IES and ANSI concerning standards development
- EPA needs to state requirement for proficiency testing (PT), and CALiPER needs to update their requirements

- NIST needs to announce MAP availability
- EPA needs to review their criteria for consistency as far as ENERGY STAR (needed test methods vs. performance)
- IES policy with respect to printing LMs
- DOE/EPA should update legislation that references dated versions and provide mechanism for regular updates
- Accreditation and certification bodies need to be notified that PT is available and required
- IEA Task 2 Round 2 should invite all NMIs and accredited laboratories to participate in the round robins
- Accredited laboratories that have not participated in PT should act now to initiate participation
- ABs submit handbook to CALiPER program that demonstrates their technical expertise in SSL

Group C – SSL System Reliability and Life Testing

After brainstorming and identifying several areas of interest for consumer or regulatory arenas, Working Group C discussed the following topics to help them form a methodology for determining failures:

- Identify what fails
- Identify causes of failures
- Identify things that should be qualified or tested
- Identify responsible organizations to develop applicable standards and tests

Working Group C brainstormed a number of reliability issues including:

- Limited knowledge of issues beyond lumen depreciation
- No method for evaluation of driver reliability — needs to be separately evaluated
- How can long-lived SSL systems be measured with short-term testing?
- Incompatibility of materials can cause components combinations to have bad consequences
- LM-80 depreciation capture vs. reality of depreciation in situ (fixture and other component effects)
- Accuracy of temperature measurement is important; millimeter difference can be big
- TM-21 and LM-80 work not completely done — need reality of operation (on-off vs. continuous on, etc.). Perhaps cycling tests.
- Failures other than predicted LED lumen depreciation of LED diode/package may be significant (LED lumen depreciation is not always the weakest link)

After reviewing these issues, the group decided to focus on the last key issue above. Discussions surrounded developing a potential methodology for characterizing failure modes beyond LED lumen depreciation.

Methodology to Characterize Failure Modes

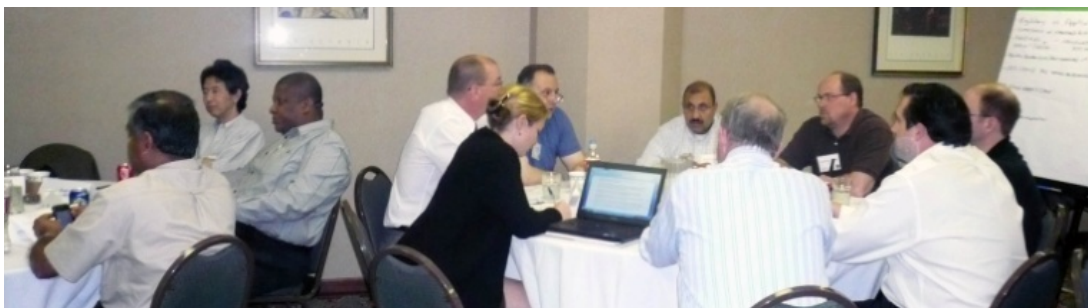
The group chose to identify pathways to characterize failure modes beyond LED lumen depreciation in order to determine SSL system reliability and project lifetime using accelerated test methods where feasible. The group discussed the following methodology topics:

- Identify the reliability (life capability) of the weakest link in a system
- Identify the interactions of system components on other components related to reliability
- Identify truly bad construction practices/materials vs. components that may reduce life but save costs leading to a specific “life capability” product if possible
- What are the other links to consider?
 - Effect of driver function on operation (electrical spikes, etc.)
 - Driver reliability (catastrophic failure)
 - Material incompatibility (chemical, electrical)
 - Environmental compatibility (ambient gases, solar, temperature, humidity, etc.)
 - Optical degradation
 - Mechanical
 - Accelerated testing

Process

The group ultimately came up with the following process for identifying failure modes:

1. Identify what fails
2. Identify causes of the failures
3. Identify items that should be tested
4. Identify standard methods to perform the tests
5. Determine how to accelerate (reduce cost/time for) tests



Matrix of Failures and Causes

What Causes/ What Fails	Normal Operating Conditions	Assembly Process ¹	Power Supply / Driver Output	Internal Materials	Environment
LED	Heat Current	Over temp Mechanical	Transients Current (Switching?)	Outgassing Corrosion	Humidity Contaminants
Power Supply Components	Capacitors Switching	Solder Joints	NA	NA	Thermal Cycling Heat Connectors Moisture Ingress Surge
Controller	Heat	Solder joints	Transients	NA	Thermal Cycling Heat Connectors Moisture Ingress
Housing	Heat	Improper mech. assy Sealing	NA	Corrosion	Corrosion Vibration UV Moisture Ingress
Optical: Lens, Reflector, etc.	UV Heat Dirt	Sealing	NA	Outgassing Corrosion	UV Heat Dirt

Red = highest priority

Green = already covered with an existing standard or test

Assembly Process column contains items that are important to be aware of but that are not strictly testable, and therefore not possible to effectively add to any equation or metric of reliability.

High-Level Recommendations and Action Items

General approaches:

- Add failure analysis to DOE’s CALiPER and GATEWAY long-term testing programs to identify the root causes of observed failures
- Solicit common failure modes and percentages from manufacturers to better understand failure causes in the industry
- Many of these issues can be addressed through design, design for manufacturability, and quality assurance in manufacturing
- (SSL Reliability Working Group is also active)

Specific technical exploration recommendations (What Component Fails => Cause of Failure):

- Power supply => Capacitor failure
 - Search available standards and literature – LRC?

- Determine what should be reported in specifications for a power supply/controller (driver) – ANSI
 - Make information available to industry – PNNL
- Power Supply => Surge
 - Make manufacturers and users aware of standards and classes of protection available (ANSI/IEEE C62.41-1991, IEC 61000-4-5)
 - Make manufacturers and users aware of ENERGY STAR luminaire requirements: Ballast or driver shall comply with ANSI/IEEE C62.41-1991, Class A operation. The line transient shall consist of seven strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode.
- Controller, LED => Electrical Transients
 - Call attention to LED manufacturer application notes defining maximum transient levels – PNNL
- Power Supply, Controller => Thermal Cycling
 - Make manufacturers and users aware of NEMA SSL1, section 6.2
- Power Supply, Controller, Housing => Moisture Ingress
 - Call attention to LED manufacturer application notes defining incompatible materials – PNNL
 - Call attention to Ingress Protection (IP) standards: IEC 60529, UL wet location
- LEDs, Optical System => Material Outgassing /Corrosion
 - Call attention to LED manufacturer application notes defining incompatible materials – PNNL
 - Recommend that manufacturers select materials for internal fixture use that do not outgas
 - Suggest short-term accelerated testing as a method to detect outgassing
 - Identify incompatible materials on LEDs and optical systems

Conclusions

SSL technology has advanced rapidly in recent years, with improvements in product performance and visible increases in the numbers and varieties of market-available products. Nevertheless, to ultimately meet its significant potential as an energy-saving technology and achieve widespread market penetration, SSL still has a number of hurdles to overcome. To move forward in addressing these challenges, a variety of mechanisms will be needed: research and studies, communication, coordination, consensus development, and standards development. The DOE CALiPER Testing and Standards Roundtable meetings provide a constructive forum for identifying what the industry needs with respect to standards, CALiPER testing, education and information, leadership, and support.

The first DOE SSL Standards and CALiPER Roundtables were focused on solidifying basic SSL testing standards needs and issues. Subsequent years focused on a variety of issues including

product life and reliability, lighting quality, and various programmatic and general market concerns.

The 2011 Roundtable continued with many of these themes, but in many cases brought discussions to a much more tangible, actionable place. For example, discussions about long-term testing and reliability were key components in the last two Roundtable meetings, but this year the Reliability Working Group took great strides to formulate a proposed methodology for characterizing possible failure modes of SSL systems. This could prove to be an important step in helping the industry come to grips with this difficult problem.



Other important discussion topics surrounding how markets are using and understanding standards carried through to this year as well. Discussions again built on previous Roundtable work and real-life experience in the field and were focused on more detailed issues such as interchangeability and equivalency claims.

Discussions on a variety of programmatic issues including the application and usability of standards were again strengthened by in-the-field experience from representatives of programs such as ENERGY STAR. The frank discussions about testing lab credibility and a number of international issues yielded a number of actionable recommendations for various stakeholder groups.

Each stakeholder group has important roles to play to fill the SSL testing and standards gaps. With an enormous expansion in the number of standards efforts under way, there is a clear need for industry experts to get involved in SSL standards committees — particularly from SSL manufacturers at every level of the industry and from all testing laboratories and trade organizations. Photometric testing labs are ideally situated to provide feedback to standards groups, contributing their expertise toward developing solutions. DOE will continue to provide leadership and support cooperation across the various stakeholder groups.

The concerted effort and constructive, engaged enthusiasm of CALiPER Roundtable participants and other SSL industry leaders are paying off as we see rapid progress and growing credibility of SSL testing. While the list of issues and recommendations is still long, industry-wide progress is significant.

Appendix

List of CALiPER Roundtable 2011 Participants

Name		Company
Anderson	Jim	Philips Color Kinetics
Berger	Robert	Independent Testing Laboratories, Inc. (ITL)
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Chesley	Jason	CSA International
Curry	Ku'uipo	ICFI — ENERGY STAR EEL Support
Dimerjian	Jeff	GE Lighting
Elizondo	Phil	Bridgelux
Ellis	David	Intertek
Grather	Mike	UL/Luminaire Testing Laboratory
Grove	Eliza	Lighting Science Group Corp.
Hodapp	Mark	Philips
Hospodarsky	Jim	Acuity Brands Lighting, Conyers Lab
Jacques	Merlande	Spectralux
Jiao	Jianzhong	OSRAM Opto Semiconductors Inc.
Karimi	Azim	Bay Area Compliance Laboratories
Lee	Rand	Orb Optronix, Inc.
McKee	Greg	Labsphere
Miller	Cameron	NIST
Narendran	Nadaranjah	Lighting Research Center
Ohno	Yoshi	NIST
Paget	Mia	PNNL
Radkov	Emil	Illumitex, Inc.
Richman	Eric	PNNL
Taylor	Ruth	PNNL
Tuttle	Ralph	Cree, Inc.
Welsh	Fred	Radcliffe Advisors, Inc.
Zhu	Yiting	Lighting Research Center
Zong	Yuqin	NIST (Photometry & Colorimetry Group)

CALiPER Roundtable 2011: Agenda

Monday–Tuesday, April 4–5, 2011 — San Antonio, TX

Format: facilitated working sessions, breakouts, identification of paths forward

Day 1, Monday, April 4		
9:00	Registration and networking, welcome and introductions	<i>Ruth Taylor, PNNL</i>
9:30	Standards activity update CALiPER update, upcoming testing concerns Testing lab accreditation update	<i>Eric Richman, PNNL</i> <i>Mia Paget, PNNL</i> <i>Cameron Miller, NIST</i>
11:00	Upcoming issues in lighting testing and standards	<i>Facilitated exercise all participants</i>
Noon	Working lunch, Presentation: Accounting for Uncertainty in Lumen Measurements (CALiPER-funded study)	<i>Rolf Bergman, Rolf Bergman Consulting</i>
1:00	Framework and goals for breakout groups	
1:30	Breakout groups : various topic areas	<i>Facilitated groups</i>
5:30	Wrap-up Day 1	
Day 2, Tuesday, April 5		
8:00	Reconvene working groups <ul style="list-style-type: none"> • Address remaining issues and assemble final thoughts • Prepare summary of issues, options, paths forward • Prepare action items for key stakeholder groups 	<i>Facilitated groups</i>
10:00	Working group reports <ul style="list-style-type: none"> • Summary per breakout topic • Brief summary of issues, options, paths forward • Short discussion for each topic area 	<i>Group leads</i>
11:00	Assemble and discuss action items <ul style="list-style-type: none"> • Implications for testing labs • Implications for standards efforts, trade groups • Implications for manufacturers • Implications for DOE CALiPER 	<i>Facilitated discussion</i>
Noon	Wrap-up and Adjournment	

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