

James R Benya PE FIES FIALD LC  
BENYA LIGHTING DESIGN

Developed with  
ABBY VOGEN HORN  
THE DAYLIGHTING COLLABORATIVE  
THE ENERGY CENTER OF WISCONSIN

# Lighting Design with Efficiency

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Assistance including example product literature and/or AIA-qualified educational materials have been provided by several manufacturers and vendors.

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# About the Developers

## JAMES R BENYA PE FIES FIALD LC

- Principal, Benya Lighting Design
  - Members of the Light Collaborative, the International Lighting Alliance, the US Green Buildings Council, IESNA Sustaining Member, Fellow of IESNA, Fellow of IALD
  - 35 years in architectural lighting design
- Professional Engineer, California
- Editor at Large, ***Architectural Lighting*** Magazine
- Member of the Board, International Dark Sky Association
- Fellow IES
- Fellow IALD
- Winner 2008 Edison Award

## ABBY VOGEN HORN

- Senior Project Manager, Energy of Wisconsin
- Project Manager, Daylighting Collaborative
  - Member AIA Board of Directors, Wisconsin Chapter
  - Member IES Daylighting Committee
  - Member IFMA
  - Member USGBC
  - Member Green Globes Energy Committee

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**Thank you!**



# Goals

This material is designed to teach you how to:

- Evaluate lighting designs in existing buildings for quality, power and energy efficiency
- Analyze daylighting strategies to meet LEED standards
- Incorporate the latest lighting technologies into your lighting designs
- Utilize the latest lighting technology to ensure energy efficient design
- Integrate daylighting principles in future projects
- Select from a toolbox of design strategies and lighting technologies to meet building standards and occupant needs

# Benefits

We hope you will:

- Learn how to produce better projects by correctly designing and implementing sophisticated lighting for commercial, retail and institutional spaces
- Find out how low you can go – use the lowest amount of light for the job
- Understand why daylighting is key – for healthy buildings and healthy people
- All in the context of good lighting design

# Regulatory Environment

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# Regulatory Framework

- ASHRAE/IESNA 90.1-2001, 2004 and 2007
- IECC-2006 and 2009
- Federal Energy Independence Act of 2007
- Federal Energy Policy Act of 2005
- LEED NC 2.2 and other LEED documents
- National Electric Code

# Principal Energy Codes

- National : ASHRAE/IESNA 90.1-2001/4/7
- National: International Energy Conservation Code IECC-2006 and 2009
- California: California Code of Regulations Title 24-2005 (new effective 10/1/05) and 2009

# International Energy Conservation Code (IECC)

- International Energy Conservation Code (IECC) is an Simplified 90.1 to which it is essentially equivalent
  - Dumbed down to make it “easier”
  - But according to IECC, you should always have the option of using 90.1. Don't forget this!!!!

# Code Quality

- Highly variable
- Worst codes are generally state-specific codes (except Title 24)
- Many problems and issues not addressed by codes, especially IECC

# Got the Latest Code?

- Purchase Codes
  - 90.1 from ASHRAE
  - IECC from ICC
- Download Codes
  - Some state codes, including Title 24, are public domain and downloadable

# Code Compliance Software

- Use ComCheck for all IECC and 90.1 projects
- Free download from [www.energy.us.gov](http://www.energy.us.gov)

# Current Energy Code Structures

## Non-residential lighting

- Mandatory requirements for Interior Lighting
- Mandatory requirements for Exterior Lighting
- Daylighting requirements (CA)
- Interior lighting power density allowance
  - For whole buildings
  - Space by space
- Exterior lighting power allowance

## Residential lighting

- Mandatory requirements for Interior Lighting (CA)
- Mandatory requirements for exterior lighting (CA)
- Mandatory high efficacy lighting requirements (CA)

# Mandatory Requirements

- Controls in every space
- Automatic shut off controls (buildings >5KSF)
- Automatic daylight zone controls
- Automatic outdoor lighting controls
- Separate control zones for display lighting

# Indoor Power Density

## Whole building

- Easiest
- Fastest
- Least complicated
- No wiggle room

## Space by Space

- More complex
- More work
- More wiggle room

# Example: JEWELRY STORE

## Space by Space

- 2400 sf (60 x 40)
- Three separate areas with at least three walls (800 sf each) 12' ceiling
- 360 sf of display cases
- 320 lf of full height walls with 4 shelves 16" deep
- 1706 sf of display shelves



# 90.1-2004

- General Lighting  $1.7\text{w/sf} \times 2400\text{sf} = 4080\text{ w}$
- Fine Allowance cabinets  $3.9\text{w/sf} \times 360\text{sf} = 1404\text{ w}$
- Fine allowance shelves  $3.9\text{w/sf} \times 1706\text{sf} = 6653\text{ w}$
- Chandelier allowance  $1.0\text{w/sf} \times 2400\text{sf} = 2400\text{ w}$

**TOTAL ALLOWED      14,537 w      6.1w/sf**  
**Note use it or lose it allowances**

# 90.1-2007

## Major change is to define 4 classes of store

- Retail Area 1 = the floor area for all products not listed in Retail Area 2, 3 or 4.
- Retail Area 2 = the floor area used for the sale of vehicles, sporting goods and small electronics.
- Retail Area 3 = the floor area used for the sale of furniture, clothing, cosmetics and artwork.
- Retail Area 4 = the floor area used for the sale of jewelry, crystal, and china.

## For Jewelry

- General  $2400\text{sf} * 1.7 \text{ w/sf} = 4080 \text{ w}$
- Display allowance  $1000\text{w} + 2400\text{sf} * 4.2 \text{ w/sf} = 11,080 \text{ w}$
- Chandelier allowance  $1.0 \text{ w/sf} * 2400\text{sf} = 2400 \text{ w}$

**TOTAL ALLOWED      16,560 w      6.9 w/sf**

**Note use it or lose it allowances**

# Summary of Example Jewelry Store Allowances

## Major Codes

California T24-2005	7.5 w/sf
90.1-2004	6.1 w/f
90.1-2007	6.9 w/sf

## State specific codes

Oregon	5.2 w/sf
Washington	3.0 w/sf

# Example: DESIGN CLOTHING STORE

- 4,800 sf (80 x 60)
- 12' high ceiling spaces divided into 600 sf areas with full height partitions
- 480 lf of full height walls with average 3 shelves  
18" deep = 2160sf of display shelves – 120 sf of cases



# 90.1-2004

- General  $1.7 \text{ w/sf} \times 4800 \text{ w} = 8160 \text{ w}$
- Fine Allowance cabinets  $3.9 \text{ w/sf} \times 120 \text{ sf} = 468 \text{ w}$
- Fine allowance shelves  $3.9 \text{ w/sf} \times 2160 \text{ sf} = 8,424 \text{ w}$
- Decorative Allowance  $4800 \text{ sf} \times 1.0 \text{ w/sf} = 4800 \text{ w}$

**TOTAL ALLOWED      21,852w      4.6 w/sf**

**Note use it or lose it allowances**

# 90.1-2007

- General 4800 sf \*1.7 w/sf = 8160 w
- Category 3 display 1000 +(2.6w/sf \* 4800 sf)= 13,480 w
- Decorative Allowance 4800 sf\*1.0 w/sf = 4800 w

**TOTAL ALLOWED 26,440 w 5.5 w/sf**  
**Note use it or lose it allowances**

# Summary of Designer Clothing Store Allowances

California T24-2005	6.0 w/sf
California T24-2008	5.4 w/sf
90.1-2007	5.5 w/sf
90.1-2004	4.6 w/sf
IECC 2009	3.5 w/sf
Oregon 2005	3.75 w/sf
Washington 2005	3.0 w/sf

# What We Need to Know

1. Lighting energy codes are becoming increasingly enforced.
2. Code developing bodies are constantly increasing stringency.
3. There is a public process for code development in which there is very little participation by the public and we are poorly represented.

# Special Issue: Track Power

The wattage of line voltage lighting track and plug-in busway which allows the addition or relocation of luminaires without altering the wiring of the system shall be **the volt-ampere rating of the branch circuit feeding the luminaires or an integral current limiter controlling the luminaires**, or **the higher of the maximum relamping rated wattage of all of the luminaires included in the system**, listed on a permanent factory installed label, or **30 W/linear foot**.

# Related Issue: Track Circuit Requirements (NEC)

## Through 1993

- Article 410-103 required track be rated at 90 watts/foot
- A new branch circuit every 21' 4"
- No special arrangement for Low Voltage

## Starting in 1996

- 1996: 410-103 added FPN indicating 90 w/ft was for feeders only
- 1999: Removed article 410-103
- 1999: Reduced feeder calculations to 75 w/ft
- 1996 Added Article 411 on low voltage

# Track Power Methods

For a 20 foot track with (8) 39 watt metal halide luminaires

Method 1

Actual Load

$$8 \times 45 \text{ w} = \mathbf{360 \text{ w}}$$

Method 2

Watts per foot

$$20 \times 30 = \mathbf{600 \text{ w}}$$

(ASHRAE/IECC)

$$20 \times 45 = \mathbf{900 \text{ w}}$$

(California)

Method 3

Branch Circuit Capacity

$$20\text{A} \times 120 \text{ volts} =$$
$$\mathbf{2400 \text{ W}}$$

Method 4

Inline Current limiter

$$3\text{A} \times 120 \text{ volts} =$$
$$\mathbf{360 \text{ watts}}$$

# EPACT 2005

- New ballast efficiency standards
- Other product efficiency standards
- Set criteria for up to 60¢ per SF tax deduction for efficient buildings (extended and increased recently?)

# EISA 2007

- Established program to make general lighting more efficient by 2020
- Additional standards for metal halide and fluorescent lamps and ballasts
- Requirements for Federal Energy Efficiency programs at all levels



# And Now....LEED

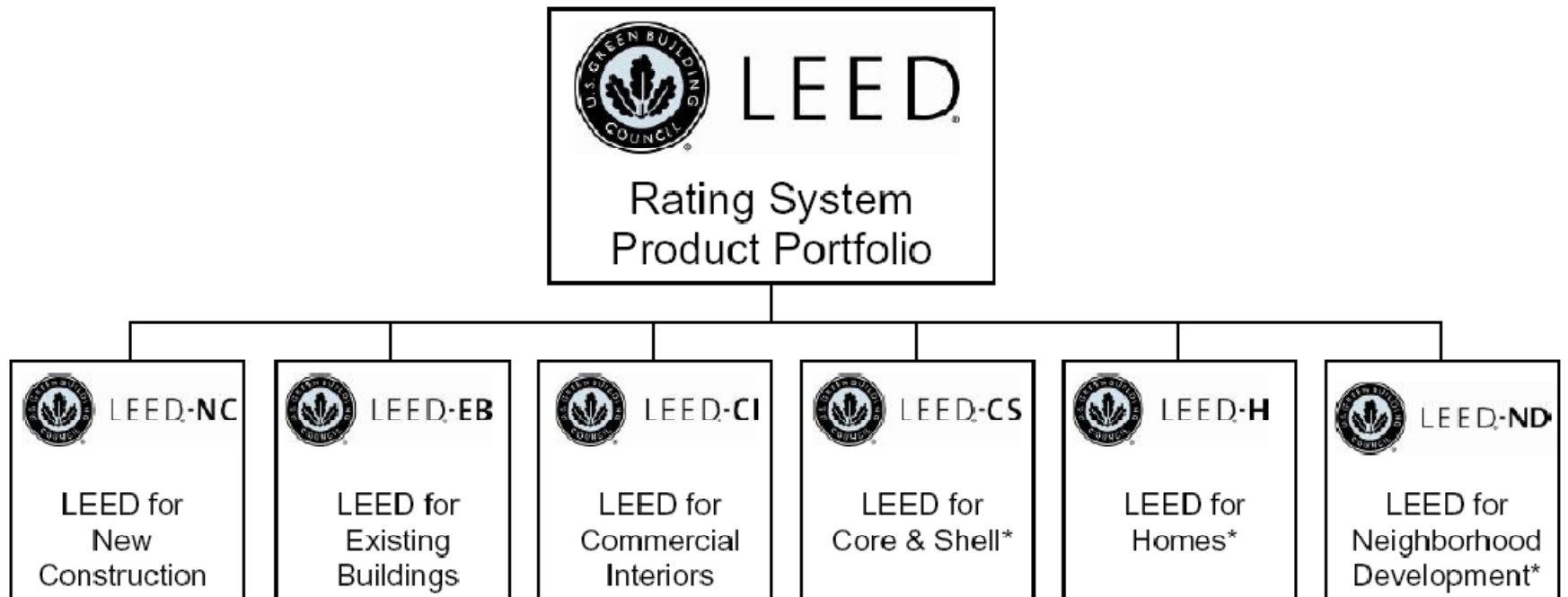
- Leadership in Energy Efficiency and Environmental Design
- Product of US Green Buildings Council
- Increasingly important on commercial and institutional projects
- Points based system

## **LEED 2009 for New Construction and Major Renovations**

100 base points; 6 possible Innovation in Design and 4 Regional Priority points

Certified	40–49 points
Silver	50–59 points
Gold	60–79 points
Platinum	80 points and above

# The LEED Family



A special presentation of the Energy Center of Wisconsin

# How To Get LEED 2009 Credits

- Up to 19 points for energy efficiency (EA1)
- 1 point for daylighting (IEQ8.1)
- 1 point for views (IEQ8.2)
- 1 point for lighting controls (IEQ6.1)
- 1 point for controlling light pollution (SSc8.1)

**LIGHTING can help get 23 points!**



# Daylighting Points

- Performance
  - Calculate using lighting software
  - At least 250 lux at 9AM and 3PM on the equinox
- Prescriptive
  - Specific amounts of fenestration using formulas in the LEED standard and manual
- Measurement
  - In a completed design, take lighting measurements to prove performance requirement is met
- Combination
  - Of any of the above

# Energy Efficiency

- Prerequisite EA2
  - Option 1: Whole Building Energy Simulation 10% better than baseline
  - Option 2: ASHRAE Advanced Energy Design Guide (smaller buildings)
  - Option 3: Prescriptive Path, Advanced Buildings Core Performance Guide

# Energy Efficiency Points


- Up to 19 points available
- Compared to 90.1-2007 baseline
- Title 24 2005 also acceptable

New Buildings	Existing Building Renovations	Points
12%	8%	1
14%	10%	2
16%	12%	3
18%	14%	4
20%	16%	5
22%	18%	6
24%	20%	7
26%	22%	8
28%	24%	9
30%	26%	10
32%	28%	11
34%	30%	12
36%	32%	13
38%	34%	14
40%	36%	15
42%	38%	16
44%	40%	17
46%	42%	18
48%	44%	19

# The Quadruple Dip of Efficiency


- Better than energy code
- Get tax deduction for 40% better than 90.1-2001 (\$0.60/sf)
- Get LEED points for energy efficiency
- Get incentives from utility companies (\$1/sf)
- Total benefit \$1.60/sf plus LEED and code

# Demonstration



**COMcheck**<sup>TM</sup>

**DOE's Building Energy Codes Program**  
*Internet Address: [www.energycodes.gov](http://www.energycodes.gov)*  
*Technical Support: [techsupport@becp.pnl.gov](mailto:techsupport@becp.pnl.gov)*



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