



High Performance Lighting For New Construction...

Meeting Today's Energy Codes and Beyond

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Kelly Carls, LC – Reflex Lighting
June 24, 2010

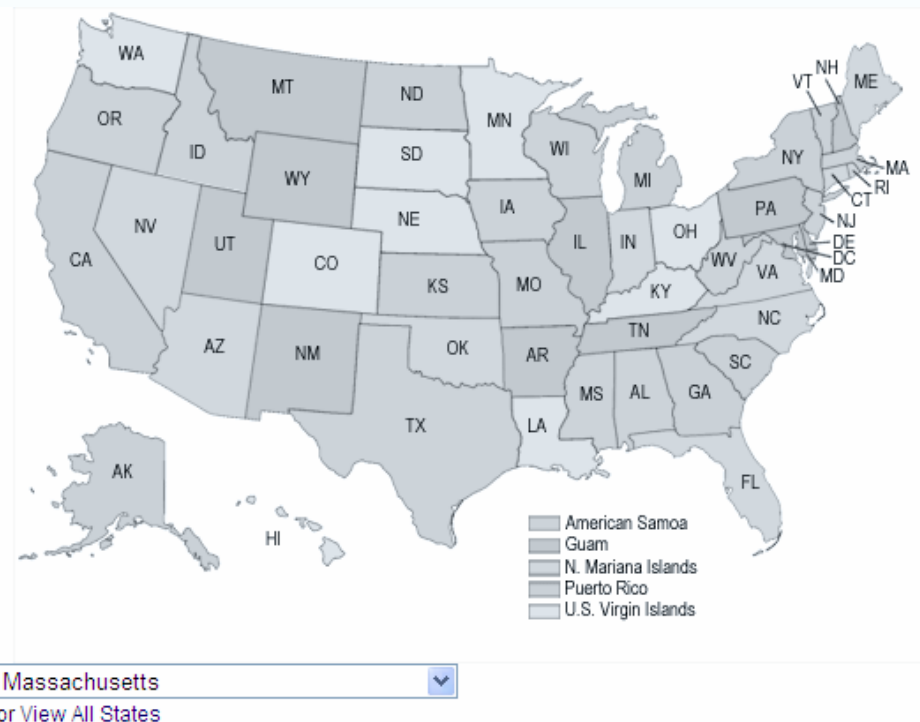
Learning Objectives

- Understand Current Building Energy Codes
 - IECC 2009 and ASHRAE 90.1 2007
 - MA Appendix 120.AA – ‘Stretch’ Energy Code
 - Compliance Tool – COMcheck Review
- Commercial Office Lighting Design Case Studies
 - Design Meets Code – No incentives
 - Design Below Code – Prescriptive Utility Incentive
 - Design >15% Below Code – Performance Incentive & LEED points

Understanding Current Building Codes that Impact Lighting Design

Department of Energy Resources

- Website: <http://www.energycodes.gov>
- Free Software downloads of REScheck & COMcheck
- Updated Status of Energy Codes by State



Massachusetts Building Code

7th Edition – 2010 Updates

“In accordance with the statutory requirements of the Green Communities Act, the BBRS has amended the Building Code as of January 1, 2010, requiring the use of the 2009 IECC with MA amendments, instead of 2006. Recognizing the burden this may place on projects under design, **BBRS is allowing a 6-month concurrency period, through June 30, 2010**, during which either the IECC 2006 w/ 2007 IECC Supplement and MA amendments or IECC 2009 with MA amendments may be used.”

(780 CMR January 2010)

IECC 2009 Model Energy Code Highlights

- Forced choice of compliance with entirety of IECC or ASHRAE 90.1
 - Change forces all disciplines to comply with one code
- Task Lighting Exemption recognized by IECC
- Daylight zone control updates
- New Exterior lighting zones

IECC 2009 vs. ASHRAE 90.1 2007

IECC 2009

LPD Calculation:
Whole Building
Method Only

Lighting Controls:
Bi-level switching

ASHRAE 90.1
2007

LPD Calculation:
Whole Building or
Space by Space
Method

Lighting Controls:
Automatic Shutoff

Lighting Power Density: Whole Building

**TABLE 505.5.2
INTERIOR LIGHTING POWER ALLOWANCES**

| LIGHTING POWER DENSITY | |
|---------------------------------|----------------------|
| Building Area Type ^a | (W/ft ²) |
| Automotive Facility | 0.9 |
| Convention Center | 1.2 |
| Court House | 1.2 |
| Dining: Bar Lounge/Leisure | 1.3 |
| Dining: Cafeteria/Fast Food | 1.4 |
| Dining: Family | 1.6 |
| Dormitory | 1.0 |
| Exercise Center | 1.0 |
| Gymnasium | 1.1 |
| Healthcare-Clinic | 1.0 |
| Hospital | 1.2 |
| Hotel | 1.0 |
| Library | 1.3 |
| Manufacturing Facility | 1.3 |
| Motel | 1.0 |
| Motion Picture Theater | 1.2 |
| Multi-Family | 0.7 |
| Museum | 1.1 |
| Office | 1.0 |
| Parking Garage | 0.3 |
| Penitentiary | 1.0 |
| Performing Arts Theater | 1.6 |
| Police/Fire Station | 1.0 |
| Post Office | 1.1 |
| Religious Building | 1.3 |
| Retail ^b | 1.5 |
| School/University | 1.2 |
| Sports Arena | 1.1 |
| Town Hall | 1.1 |
| Transportation | 1.0 |
| Warehouse | 0.8 |
| Workshop | 1.4 |

Office = 1.0
Watts/sqft

Lighting Power Density: Space-by-Space

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method

| Common Space Types ^a | LPD (W/ft ²) | Building Specific Space Types | LPD (W/ft ²) |
|---------------------------------|--------------------------|--|--------------------------|
| Office-Enclosed | 1.1 | Gymnasium/Exercise Center | |
| Office-Open Plan | 1.1 | Playing Area | 1.4 |
| Conference/Meeting/Multipurpose | 1.3 | Exercise Area | 0.9 |
| Classroom/Lecture/Training | 1.4 | Courthouse/Police Station/Penitentiary | |
| For Penitentiary | 1.3 | Courtroom | 1.9 |
| Lobby | 1.3 | Confinement Cells | 0.9 |
| For Hotel | 1.1 | Judges Chambers | 1.3 |
| For Performing Arts Theater | 3.3 | Fire Stations | |
| For Motion Picture Theater | 1.1 | Fire Station Engine Room | 0.8 |
| Audience/Seating Area | 0.9 | Sleeping Quarters | 0.3 |
| For Gymnasium | 0.4 | Post Office—Sorting Area | 1.2 |
| For Exercise Center | 0.3 | Convention Center—Exhibit Space | 1.3 |
| For Convention Center | 0.7 | Library | |
| For Penitentiary | 0.7 | Card File and Cataloging | 1.1 |
| For Religious Buildings | 1.7 | Stacks | 1.7 |
| For Sports Arena | 0.4 | Reading Area | 1.2 |
| For Performing Arts Theater | 2.6 | Hospital | |
| For Motion Picture Theater | 1.2 | Emergency | 2.7 |
| For Transportation | 0.5 | Recovery | 0.8 |
| Atrium—First Three Floors | 0.6 | Nurse Station | 1.0 |
| Atrium—Each Additional Floor | 0.2 | Exam/Treatment | 1.5 |
| Lounge/Recreation | 1.2 | Pharmacy | 1.2 |
| For Hospital | 0.8 | Patient Room | 0.7 |
| Dining Area | 0.9 | Operating Room | 2.2 |
| For Penitentiary | 1.3 | Nursery | 0.6 |
| For Hotel | 1.3 | Medical Supply | 1.4 |
| For Motel | 1.2 | Physical Therapy | 0.9 |
| For Bar Lounge/Leisure Dining | 1.4 | Radiology | 0.4 |
| For Family Dining | 2.1 | Laundry—Washing | 0.6 |
| Food Preparation | 1.2 | Automotive—Service/Repair | 0.7 |
| Laboratory | 1.4 | Manufacturing | |

Office = 1.1
Watts/sqft

Commercial Code Compliance Tool

- Used to show compliance with energy code restrictions for all building systems
- Simplified way for inspectors to validate code compliancy
- Must know the following to complete report:
 - Governing Energy Code for project (select from menu)
 - Space Type & Square Footage
 - Wattage for each various lighting system in Design
 - Quantity of Fixtures per Type
(per Lighting Design &/or Reflected Ceiling Plan)



Interior Lighting Power Calculation

Incandescent/Halogen
Medium Bases

- Max Labeled Wattage

Fixtures with Ballasts /
Transformers

- Operating Input Watts of ballast

Line Voltage
Track Lighting

- Specified wattage of fixture, min. 30W / ft of track
- Wattage Limit of Circuit Breaker
- Wattage limit of permanent current-limiting device

Low Voltage
Track Lighting

- Wattage of Transformer

COMcheck Example

example99.cck - COMcheck 3.7.1 Code: 90.1 (2007) Standard

File Edit View Options Code Help

Project Envelope Interior Lighting Exterior Lighting Mechanical

Linear Fluorescent Compact Fluorescent HID Incandescent Halogen

| Component | Fixture ID | Fixture Description | Lamp Description/ Wattage Per Lamp | Ballast | Lamps Per Fixture | Num Fix |
|--|------------|-----------------------------|--|-----------------------|----------------------|------------|
| Building Allowed wattage = 14936 Proposed wattage = 12478 | | | | | | |
| Common Space Types Office Allowed wattage = 4972 Proposed wattage = 1976 | | | | | | |
| 1 | | Incandescent 1 | Recessed wall washer | Incandescent 150W | 1 | |
| 2 | | Incandescent 2 | Accent track lighting | Incandescent 50W | 1 | |
| 3 | | Compact Fluorescent 1 | Down light, twin tube | Twin Tube 18W | 2 | |
| 4 | | Common Space Types Confer | Allowed wattage = 546 Proposed wattage = 3900 | | | |
| 5 | | T8 / T12 Fluorescent 5 | 8 ft. Industrial, penda... | 96" T8 75W | 2 | |
| 6 | | Common Space Types Corrid | Allowed wattage = 700 Proposed wattage = 128 | | | |
| 7 | | T8 / T12 Fluorescent 4 | 4 ft. Strip, surface mount | 48" T8 32W | 1 | |
| 8 | | Warehouse and Parking:Medi | Allowed wattage = 2268 Proposed wattage = 260 | | | |
| 9 | | T8 / T12 Fluorescent 3 | 4 ft. Wall mout, wrap-... | 48" T8 32W | 2 | |
| 10 | | Manufacturing:Detailed Manu | Allowed wattage = 5670 Proposed wattage = 1274 | | | |
| 11 | | HID 1 | Recessed mtl halide do... | Metal Halide 50W | 1 | |
| 12 | | HID 2 | Low bay, pendant mount | High-Pressure Sodi... | 1 | |
| 13 | | Common Space Types Lobby | Allowed wattage = 780 Proposed wattage = 4940 | | | |
| 14 | | T8 / T12 Fluorescent 1 | 2x4 Troffer, parabolic l... | 48" T8 32W | 3 | |
| 15 | | T8 / T12 Fluorescent 2 | 2x4 Troffer, parabolic l... | 48" T8 32W | 3 | |



COMcheck Software Version 3.7.1

Interior Lighting Application Worksheet

90.1 (2007) Standard

Section 1: Allowed Lighting Power Calculation

| A Area Category | B Floor Area (ft ²) | C Allowed Watts / ft ² | D Allowed Watts (B x C) |
|---|---------------------------------------|---|-------------------------------|
| Common Space Types Office - Enclosed | 4520 | 1.1 | 4972 |
| Common Space Types Conference/Meeting/Multipurpose | 420 | 1.3 | 546 |
| Common Space Types Corridor/Transition | 1400 | 0.5 | 700 |
| Warehouse and Parking Medium/Bulky Material Storage | 2520 | 0.9 | 2268 |
| Manufacturing-Detailed Manufacturing | 2700 | 2.1 | 5670 |
| Common Space Types Lobby | 600 | 1.3 | 780 |
| Total Allowed Watts = | | | 14936 |

Section 2: Proposed Lighting Power Calculation

| A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast | B Lamps/ Fixture | C # of Fixtures | D Fixture Watt | E (C X D) |
|--|------------------------|-----------------------|----------------------|--------------|
| Common Space Types Office - Enclosed (4520 sq.ft.) | | | | |
| Incandescent 1: G: Recessed wall washer / Incandescent 150W | 1 | 2 | 150 | 300 |
| Incandescent 2: H: Accent track lighting / Incandescent 50W | 1 | 5 | 50 | 250 |
| Compact Fluorescent 1: F: Down light, twin tube / Twin Tube 18W / Magnetic | 2 | 31 | 46 | 1428 |
| Common Space Types Conference/Meeting/Multipurpose (420 sq.ft.) | | | | |
| T8 / T12 Fluorescent 5: E: 8 ft. Industrial, pendant mount / 96" T8 75W / Electronic | 2 | 30 | 130 | 3900 |
| Common Space Types Corridor/Transition (1400 sq.ft.) | | | | |
| T8 / T12 Fluorescent 4: D: 4 ft. Strip, surface mount / 48" T8 32W / Electronic | 1 | 4 | 32 | 128 |
| Warehouse and Parking Medium/Bulky Material Storage (2520 sq.ft.) | | | | |
| T8 / T12 Fluorescent 3: C: 4 ft. Wall mout, wrap-around / 48" T8 32W / Electronic | 2 | 4 | 65 | 260 |
| Manufacturing-Detailed Manufacturing (2700 sq.ft.) | | | | |
| HID 1: I: Recessed mtl halide down light / Metal Halide 50W / Magnetic | 1 | 2 | 67 | 134 |
| HID 2: J: Low bay, pendant mount / High-Pressure Sodium 150W / Magnetic | 1 | 6 | 190 | 1140 |
| Common Space Types Lobby (600 sq.ft.) | | | | |
| T8 / T12 Fluorescent 1: A: 2x4 Troffer, parabolic louver / 48" T8 32W / Electronic | 3 | 51 | 95 | 4845 |
| T8 / T12 Fluorescent 2: B: 2x4 Troffer, parabolic louver / 48" T8 32W / Electronic | 3 | 1 | 95 | 95 |
| Total Proposed Watts = | | | 12478 | |

Section 3: Compliance Calculation

If the Total Allowed Watts minus the Total Proposed Watts is greater than or equal to zero, the building complies.

Total Allowed Watts = 14936
Total Proposed Watts = 12478
Project Compliance = 2458

Interior Lighting PASSES: Design 16% better than code.

Interior Lighting Passes: Design 16% better than Code

Envelope +1% Interior Lighting +16% Exterior Lighting TBD

Add/move fixtures to an appropriate building use category.

MA Appendix 120.AA – “Stretch” Energy Code

- Creates Green Communities Program
 - >\$10M/year funding to cities & towns
 - 5 requirements include life-cycle building energy efficiency
 - Currently 26 municipalities have adopted
- Towns that adopt ‘Stretch’ code must adopt Residential & Commercial
- Effective Dates of either January 1 or July 1 with 6mo concurrency requirement
- Utility Incentives based upon 2009 IECC LPD Limits (not the reduced ‘Stretch’ LPD limits)



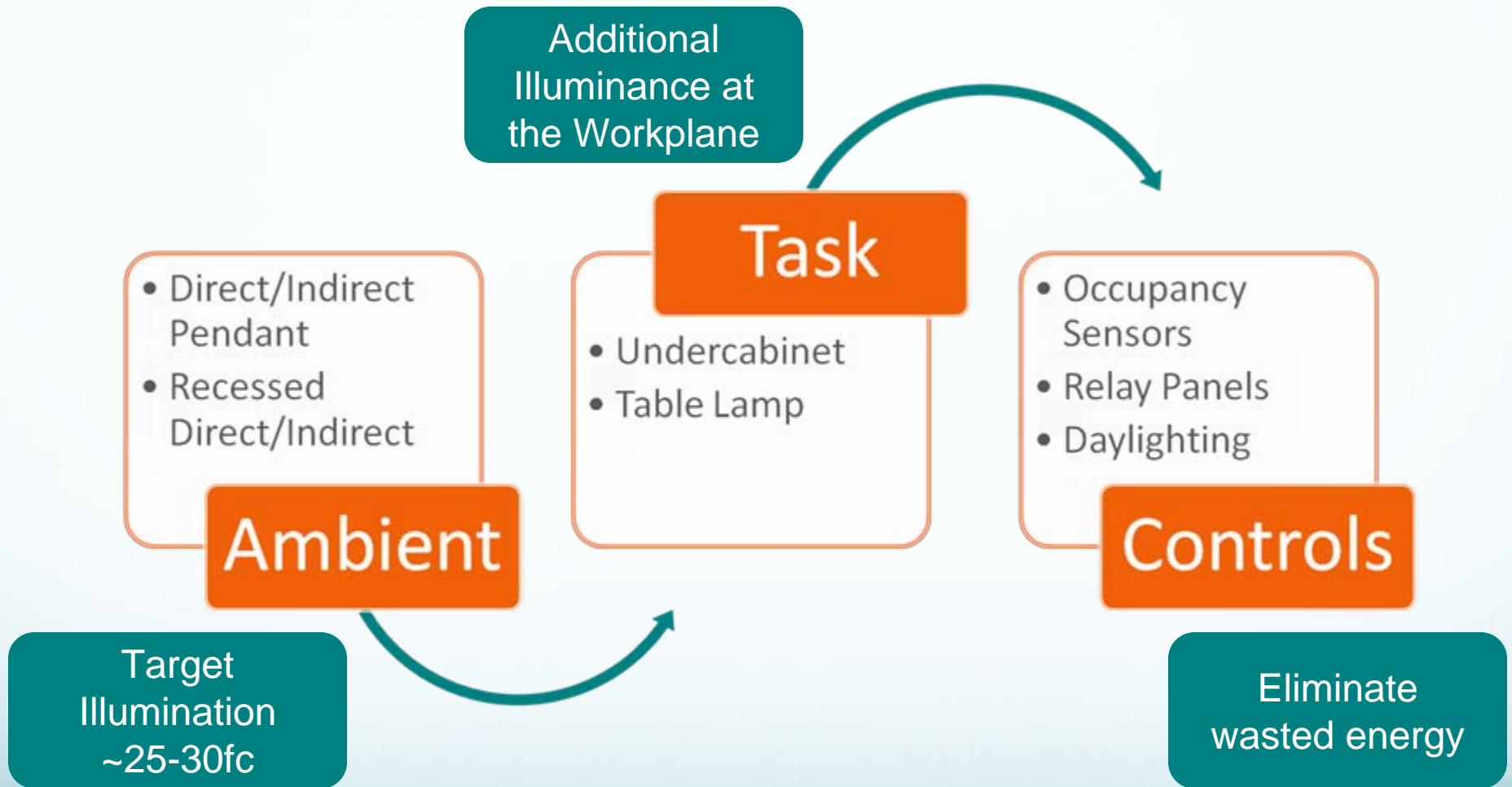
Commercial Highlights for 'Stretch' Appendix

- Only for New Construction > 5000sqft
 - New Buildings or Building additions
- Performance option for all Buildings
 - Design 20% below ASHRAE 90.1 2007 LPD Levels
- Prescriptive option for most building types
 - 5,000 to 100,000sqft
- Exemptions (comply with base code)
 - Commercial buildings < 5,000sqft
 - Special cases smaller than 40,000sqft
 - Commercial renovations and existing interior fit-outs

*Content taken from presentation by Ian Finlayson,
Executive Office of Energy and Environmental Affairs.

Implementing a Lighting Design Strategy that Goes Beyond Code

Sustainable Lighting Design Strategy



Lighting Design Case Study

- **Baseline Information:**
 - 10' x 12' office space (9' ceiling)
 - Standard Reflectances (80/50/20)
 - Maintained Light Levels Shown at Workplane Height (2.5' AFF)
- **Key Comparison Metrics:**
 - Lighting Power Density per Space (W/sqft)
 - Light Levels (Average and Task Specific)
 - Functionality & Aesthetics of the Design

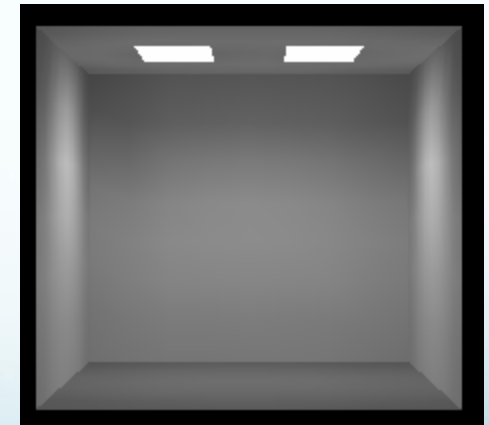
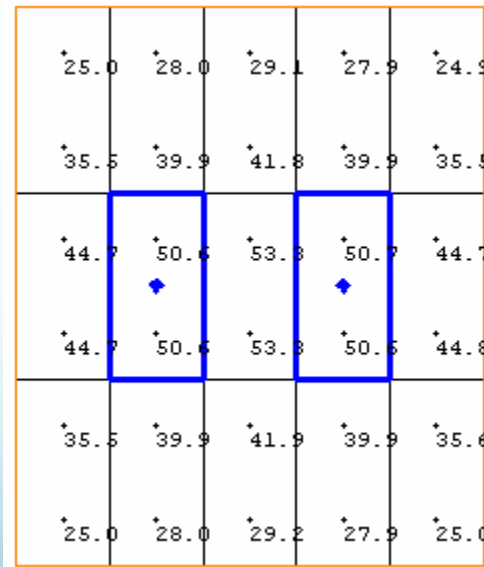
Design 1

Typical Design Build using Standard Technology

Design Summary:

- (2) 2x4 16 cell Silver Parabolics
- (2) Standard T8 Lamps & Ballast per Fixture (60 W)
- Fixtures spaced 4' on center

Average
Illuminance = 38fc
LPD = 1.0 W/Sqft



Improved Design using Energy Efficient Technology

Design Summary:

- 2x4 Advanced Recessed Direct/Indirect (> 85% Efficiency)
- (2) High Performance T8 Lamps & NEMA Premium .78BF Ballast (47 W)

Average

Illuminance = 38fc

LPD = .78 W/Sqft

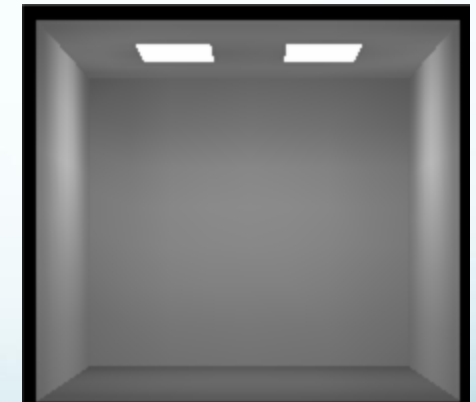
Same light levels

\$35 Incentive/Fixture!

22% Energy Savings!



| | | | | |
|------|------|------|------|------|
| 24.6 | 28.7 | 30.1 | 28.6 | 24.6 |
| 34.2 | 40.5 | 42.7 | 40.5 | 34.1 |
| 42.1 | 50.7 | 53.7 | 50.9 | 42.1 |
| 42.1 | 50.7 | 53.7 | 50.7 | 42.2 |
| 34.2 | 40.5 | 42.7 | 40.4 | 34.2 |
| 24.6 | 28.6 | 30.1 | 28.6 | 24.6 |



Design 3

Advanced Design using Energy Efficient Technology

Design Summary:

- (2) 4' High Efficiency D/I Pendants (98% Efficient with 30% Direct)
- (1) High Performance T8 Lamp & NEMA Premium 1.15BF Ballast (38W)
- Optional Step-Dim ballast and Task Light

Average

Illuminance = 26fc

LPD = .63 W/Sqft

37% Energy Savings!

\$30 Incentive/Fixture

OR \$44/Office!

5 LEED Points!



| | | | | |
|------|------|------|------|------|
| 18.8 | 26.8 | 31.1 | 26.6 | 18.7 |
| 22.8 | 33.6 | 39.8 | 33.4 | 22.7 |
| 24.1 | 36.0 | 42.7 | 35.8 | 24.0 |
| 22.1 | 32.6 | 38.9 | 32.5 | 22.0 |
| 18.5 | 25.8 | 29.8 | 25.7 | 18.5 |
| 14.4 | 19.2 | 21.7 | 19.2 | 14.4 |



Case Study Summary Analysis

| Design | Details | Watts/ Sqft | Maint. Light Levels | Meets Code? | % Saved vs. IECC 2009 | LEED CI V3.0 Pts Earned | Utility Incentive |
|--------|--|----------------|---------------------------|----------------|-----------------------------|-------------------------------|--|
| 1 | 2x4 Parabolics Standard T8 Technology | 1.0 | 38fc | Y | 0% | 0 | \$0 |
| 2 | 2x4 Advanced Recessed D/I HPT8 Technology | .78 | 38fc | Y | 22% | 2 | \$35 / Fixture |
| 3 | 4' High Efficiency D/I Pendants HPT8 Technology | .63 | 26fc* | Y | 37% | 5 | \$30 / Fixture OR \$1.00 / Watt Saved |

*Note that Advanced Design puts adequate light where you need it most, can't look at average alone!