U.S. Department of Energy
Energy Efficiency and Renewable Energy

Building Energy Codes

U.S. Department of Energy's Building Energy Codes Program

Presents

Advanced Lighting Design and the Energy Code

by

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U.S. Department of Energy
Energy Efficiency and Renewable Energy

Building Energy Codes

Building Energy Codes Program

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About the Program

Compliance Tools

- Residential (REScheck)
- Commercial (COMcheck)
- On-line Com
- Federal Building Codes - Commercial

Training/Education

- Training Presentations
- State Training
- Consumer Education
- Energy Codes Glossary
- 2004 National Workshop

Implementation Tools

- DOE 2004 Proposals
- DOE Determinations
- DOE Assistance
- Resource Materials
- Status of State Energy Codes
- Setting the Standard

Technical Support/FAQs

DOE's Building Energy Codes Program is an information resource on national model energy codes. We work with other government agencies, state and local jurisdictions, national

The Program recognizes that energy codes maximize energy efficiency only when they are fully embraced by users and supported through education, implementation, and enforcement.

Free Software

RE*Scheck*

RE*Scheck*, RE*Scheck-Web*, RE*Scheck* Package Generator

COM*check*

COM*check-EZ*, COM*check* Package Generator

Site Map
HELP - Ask a Codes Expert

EERE Information Center

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EVENTS

2004 National Workshop on State Building Energy Codes

NEWS

RE*Scheck* Now Includes the 2003 IECC

Newly Released — *Setting the Standard* Update
July 2004

ICC Final Action Hearings
May 17-20, 2004

RScheck-Web™

COM*check-EZ*™ Package

www.energycodes.gov

techsupport@becp.pnl.gov

Commercial Compliance Tools

Free

Desktop Software Tools

COMcheck-EZ™

Web-Based Tools

COMcheck-Web™

COMcheck™ Package Generator

Printed Materials

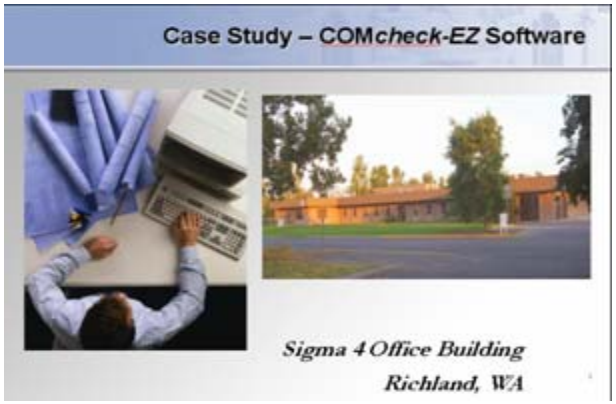
Compliance Guides

Prescriptive Tables

IES 100 1906-2006

Training Tools

- PowerPoint presentations with faculty notes
- Case studies
- Online training
- Online videos



BECP Resource Center

Building Energy Codes
RESOURCE CENTER

SEARCH: Graphics FOR: duct system approach HVAC » SEARCH BROWSE: Select a Topic... » GO!

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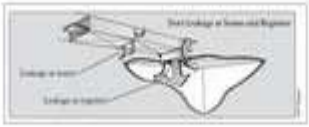
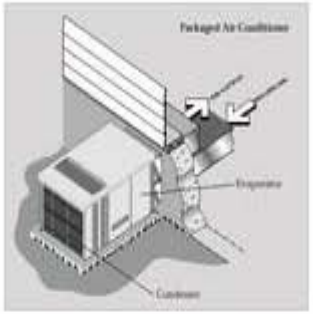
Graphics Search Results

Keywords: *duct system approach HVAC*

Viewing: **1-9** of **92**





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ADDITIONAL RESOURCES

- Articles
- Online Tools
- Presentations
- Videos

National Lighting Energy Code: ASHRAE/IESNA 90.1 and IECC

- Current published versions: ASHRAE/IESNA 90.1-2004, IECC 2003 (2004 supplement)
- Both have previous versions adopted by various states and local jurisdictions
- Latest versions of both contain the new LPD values
- Both provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings
- Neither is a design nor advanced building guide
- Both cover Envelope, Mechanical, Lighting, Water Heating, Power/other equipment

Basic Lighting Code Requirements

- Installed interior power must not exceed wattage allowances (with some exceptions/allowances)
- Mandatory control requirements
  - Individual space control
  - Automatic shutoff
  - Bi-level switching capability (IECC only)
  - Exterior photocell/timeclock controls
- Exterior lighting power
  - Lamp efficacy
  - Power density limits (ASHRAE/IESNA 90.1 only)

IECC vs. ASHRAE/IESNA 90.1

IECC 2003

- Includes bi-level control requirement
- Generally simpler requirements
- Fewer connected power exceptions (5 vs. 15 in 90.1)
- Offers alternate compliance path using 90.1

ASHRAE/IESNA 90.1-2004

- Includes extensive exterior lighting power density requirements
- Offers more space type LPD options
- Includes limited occupancy sensor requirements

Installed Interior Power Requirement

- Based on set of specified whole building or space type Lighting Power Densities (LPD)
- LPDs have become tighter in past few years
- Basis for tightening: Complete review lighting design components
  - New illuminance recommendations
  - Recent depreciation research
  - Technology review
  - Current design practice

How Were the Lighting Power Densities (LPD) developed?

- Current values in 90.1 and IECC developed within the ASHRAE/IESNA 90.1 committee
- Basis: A space type lighting design modeling that applies:
  - Current lighting product performance data
  - Current lamp/ballast efficacy and light loss factors
  - Latest IES recommended light levels
  - Professional consensus of quality lighted environments
- Combine these elements into building space models to calculate lighting power densities
- Apply space type LPDs to real building data to generate whole building LPDs

Latest IES Recommended Light Levels

9th Edition OPTIONS			LUX		8th Edition			LUX
Court Rooms	Seating area (spectators)	C	100					
Reading	Photograph, moderate detail	E	500		Reading	Photograph, moderate detail	E	500-750-1000
Reading	Photocopies	D	300		Reading	Photocopies	D	200-300-500
Reading	VDT screens	A	30		Reading	VDT screens	B	50-75-100
Reading	keyboard reading	D	300		Reading	keyboard reading	D	200-300-500
Reading	6-point type	E	500		Reading	6-point type	E	500-750-1000
Reading	8- and 10-point type	D	300		Reading	8- and 10-point type	D	200-300-500
Reading	Glossy magazines	D	300		Reading	Glossy magazines	D	200-300-500
Reading	Maps	E	500		Reading	Maps	E	500-750-1000
Reading	Newsprint	D	300		Reading	Newsprint	D	200-300-500
Reading	Typed originals	D	300		Reading	Typed originals	D	200-300-500

Application Model Inputs

- Appropriate illuminance for general and task lighting
- Percent of space lighting associated with general and task use

These determine average weighted illuminance for the space

Task Area %	Task Area FC		General Area %	General Area FC		Total FC
50	50		50	20		35

...More Model Inputs

- Percentage of illuminance provided by each luminaire (up to 3)
- Illuminance delivery efficiency of each luminaire as determined by efficacy (LE), CU, and loss factors (LLD, LDD, RSDD)

These determine the light delivery efficiency of the luminaires

SYSTEM #1		
% FC	*Light Source*	*Light Distribution*
75	FL	Linear Dir/Indir
SYSTEM #2		
% FC	*Light Source*	*Light Distribution*
15	FL	Task
SYSTEM #3		
% FC	*Light Source*	*Light Distribution*
10	FL	Linear WW open - 2 walls

…and Finally….

- Consensus choice of appropriate RCR category based on space type characteristics

This helps set luminaire efficiency at expected room geometry

Out of 123 models

22 RCR < 2.5

79 RCR between 2.5 & < 7.0

22 RCR > 7.0

LIGHTING POWER DENSITY				
RCR <2.5	RCR>2 & <7.0	RCR >7.0	**PRIMARY LPD**	**PRIMARY RCR**
0.478	0.711	0.858	0.711456	2
0.84	1.279	1.558	1.279026	2
1.226	1.759	2.076	1.759399	2
0.239	0.395	0.465	0.464545	3
0.875	1.431	1.759	1.430762	2

Older vs. New (Space by Space LPD)

Model	Building Type	Space Type description	2004 LPD	2001 LPD	% Change
1.02	Auditorium	Audience/Seating Area	1.76	2.47	(28.69)
3.1	NA (typical all bldgs)	Classroom/Lecture/Training	1.43	1.59	(9.84)
3.2	Court House	Courtroom	1.94	2.13	(9.16)
7.03	Lounge/Leisure Dining	Dining Area	1.40	1.24	13.19
7.04	Family Dining	Dining Area	2.10	2.23	(5.87)
15	Office	Laboratory	1.38	1.84	(24.94)
17	Library	Stacks	1.71	1.89	(9.55)
19	Library	Reading Area	1.17	1.77	(33.54)
20.1	NA (typical all bldgs)	Lobby	1.32	1.75	(24.60)
22	NA (typical all bldgs)	Atrium - first three floors	0.63	1.31	(52.28)
23	NA (typical all bldgs)	Atrium - each additional floor	0.16	0.20	(16.43)
25	NA (typical all bldgs)	Office - enclosed	1.13	1.54	(26.56)
27	NA (typical all bldgs)	Office - open plan	1.06	1.28	(17.16)
31	NA (typical all bldgs)	Conference Meeting/Multipurpo	1.25	1.50	(16.58)
35.1	Manufacturing Facility	General Low Bay	1.15	2.14	(46.15)
35.2	Manufacturing Facility	General High Bay	1.67	2.98	(43.97)
37	Manufacturing Facility	Detailed	2.08	6.22	(66.54)
84	Museum	General exhibition	1.02	1.57	(35.10)
85	Museum	Restoration	1.69	2.47	(31.49)
91	Performing Arts Theatre	Audience/Seating Area	2.60	1.76	47.51
92	Motion Picture Theatre	Audience/Seating Area	1.16	1.31	(11.11)
93.1	Performing Arts theatre	Lobby	3.27	1.24	163.06
93.2	Auditorium	Lobby	1.05	0.80	31.80
118	Gymnasium	Playing Area	1.35	1.88	(28.13)
201	Retail [ave of 94,97,98,	Merchandising Sales Area	1.70	2.47	(30.96)

Whole Building LPD Development

- Develop detailed space by space data for commercial buildings
  - Source: DODGE Construction data plans sets - best available current, multiple commercial building data.
  - Perform space type area takeoffs for detailed square footage by space type
  - Current set at 246 buildings for 31 bldg types
- Assign applicable space type model LPD for each space
- Calculate whole building LPD

POST OFFICE Whole Building

Building and Space Description	Space Appl. Factor	Model #	Model LPD	Space Wtd LPD	LPD Sum	Bldg Appl %	Bldg Wtd LPD	Bldg Type Wtd Avg LPD
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
17,342 ft^2					1.56	0.25	0.39	**1.55**
Conference	0.013	31.00	1.50	0.019				
Corridor	0.009	2.00	0.73	0.006				
Locker Room	0.070	24.00	0.81	0.057				
Elec/Mech	0.009	4.00	1.29	0.011				
Recreation	0.048	9.00	1.40	0.068				
Office - encl.	0.024	25.00	1.54	0.037				
Office - open	0.020	27.00	1.28	0.026				
Lobby	0.069	20.10	1.75	0.121				
[illegible]	0.003	12.00	0.97	0.003				
[illegible]	0.006	11.00	0.93	0.006				
[illegible]	0.042	41.00	1.13	0.048				
Workshop	0.021	35.00	2.47	0.051				
Lobby	0.115	88.00	1.52	0.176				
Sorting Area	0.551	34.00	1.70	0.934				
	1.000							
13,971 ft^2					1.53	0.25	0.38	
Active storage	0.058	41						
Workshop	0.022	35						
Dining Area	0.025	6		0.036				
Restrooms	0.012	12.00	0.97	0.012				
Locker Room	0.046	24.00	0.81	0.037				

Data from bldg plans

Space model & LPD

B x D

Sum of column E for bldg

F x G

Sum of column H for bldg type

Whole Building Comparison

Bldg Type	2004 Whole BLDG LPD	2001Whole BLDG LPD	% Change from 2001
AUTOMOTIVE FACILITY	0.9	1.5	(40.00)
CONVENTION CENTER	1.2	1.4	(14.29)
COURTHOUSE	1.2	1.4	(14.29)
DINING: BAR LOUNGE/LEISU	1.3	1.5	(13.33)
DINING: CAFETERIA/FAST FC	1.4	1.8	(22.22)
DINING: FAMILY	1.6	1.9	(15.79)
DORMITORY	1.0	1.5	(33.33)
EXCERCISE CENTER	1.0	1.4	(28.57)
FIRE STATIONS	0.8	1.3	(38.46)
GYMNASIUM	1.1	1.7	(35.29)
HEALTHCARE-CLINIC	1.0	NA	NA
HOSPITAL	1.2	NA	NA
HOSPITAL/HEALTHCARE	NA	1.6	NA
HOTEL	1.0	1.7	(41.18)
LIBRARY	1.3	1.5	(13.33)
MANUFACTURING	1.3	2.2	(40.91)
MOTEL	1.0	2.0	(50.00)
MOTION PICTURE THEATRE	1.2	1.6	(25.00)
MULTI-FAMILY	0.7	1.0	(30.00)
MUSEUM	1.1	1.6	(31.25)
OFFICE	1.0	1.3	(23.08)
PARKING GARAGE	0.3	0.3	0.00
PENITENTIARY	1.0	1.2	(16.67)
PERFORMING ARTS THEATE	1.6	1.5	6.67
POLICE STATIONS	1.0	1.3	(23.08)
POST OFFICE	1.1	1.6	(31.25)
RELIGIOUS BUILDINGS	1.3	2.2	(40.91)
RETAIL	1.5	1.9	(21.05)
SCHOOL/UNIVERSITY	1.2	1.5	(20.00)
SPORTS ARENA	1.1	1.5	(26.67)
TOWN HALL	1.1	1.4	(21.43)
TRANSPORTATION	1.0	1.2	(16.67)
WAREHOUSE	0.8	1.2	(33.33)
WORKSHOP	1.4	1.7	(17.65)

- Hospital / Healthcare category split
- Average weighted change = 25% reduction across national building mix

Exception/Allowances for LPD requirements?

- Both IECC and 90.1 have exempted lighting
- Both have interior LPD allowances:
  - Decorative luminaires in addition to the general lighting 1.0 W/ft^2
  - Use of specific luminaires designed to eliminate computer screen glare - 0.35 W/ft^2
  - Retail Display Lighting:
    - Additional 1.6 W/ft^2 , or
    - Additional 3.9 W/ft^2 for fine merchandise

  But only for display area!

Exterior Building Grounds Lighting

IECC - all (except low voltage landscape) must be at least 45 lm/W

ASHRAE/IESNA 90.1

- Building grounds lighting over 100 W must be at least 60 lm/W (unless exempted or occupancy sensor controlled)
- All others as specified in W/sf or W/lin ft (unless exempted)

Exterior Lighting Power Densities (Tradable)

Applications	Lighting Power Densities
Tradable Surfaces	
Uncovered Parking Areas	
Parking Lots and drives	0.15 W/ft^2
Building Grounds	
Walkways less than 10 feet wide	1.0 Watts/linear foot
Walkways 10 feet wide or greater, Plaza areas and Special feature areas	0.2 W/ft^2
Stairways	1.0 W/ft^2

Exterior Lighting Power Densities (more Tradable)

Applications	Lighting Power Densities
Tradable Surfaces	
Building Entrances and Exits	
Main Entries	30 Watts/linear foot of door width
Other doors	20 Watts/linear foot of door width
Canopies and Overhangs	
Canopies (free standing & attached) and overhangs	1.25 W/ft^2
Outdoor Sales	
Open areas (including vehicle sales lots)	0.5 W/ft^2
Street Frontage for vehicle sales lots in addition to "open area" allowance	20 Watts/linear foot

Exterior Lighting Power Densities (Non - Tradable)

Applications	Lighting Power Densities
Non-Tradable Surfaces	
Building Facades	0.2 W/ft^2 for each illuminated wall or surface or 5.0 Watts/linear foot for each illuminated wall or surface length
Automated Teller Machines & Night Depositories	270 watts per location plus 90 watts per additional ATM per location
Entrances and Gatehouse Inspection Stations at guarded facilities	1.25 W/ft^2 of uncovered area (covered areas are included in the Canopies and Overhangs)
Loading Areas for Law Enforcement, Fire, Ambulance and other Emergency Vehicles	0.5 W/ft^2 of uncovered area (covered areas are included in the Canopies and Overhangs)
Drive-up Windows at Fast Food Rest.	400 watts per drive-through
Parking near 24-hour Retail Entrances	800 watts per main entry