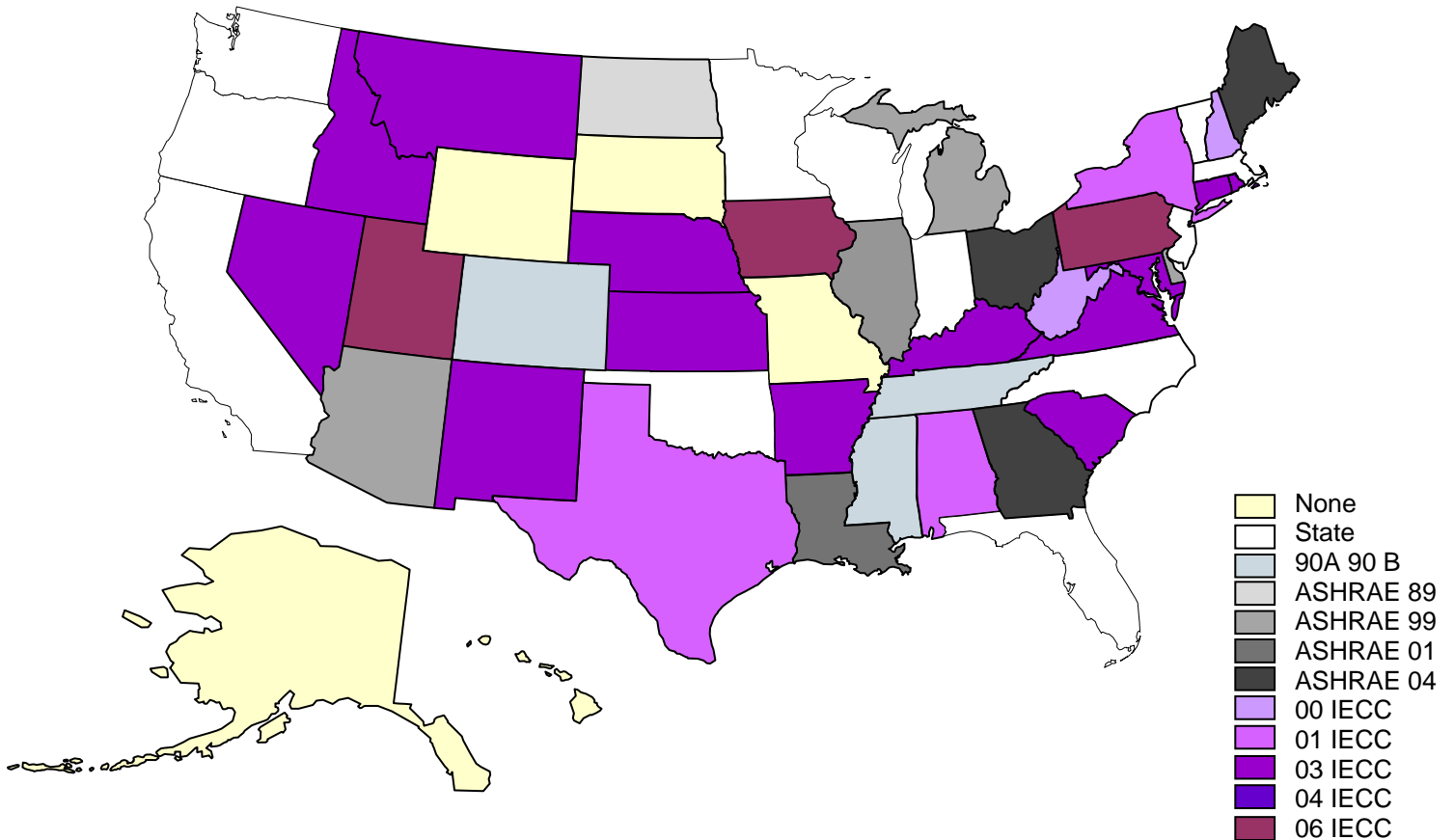


90.1-2004: An Overview of the Lighting and Power Requirements
April 19, 2007

The Basis for Energy Requirements – slide 2

- Energy Conservation and Production Act, as amended by EPAct, requires States to adopt a commercial energy code
.....This drives state adoption of energy codes
- DOE determines the effective stringency level to meet or exceed
- Many code/standard versions available and currently adopted – varies by state:
 - Some adopt nationally available codes/standards
 - Some develop state-specific codes
 - Some have no code!

Commercial Energy Codes Adoption by State – slide 3



Standard 90.1-2004 Basics – slide 4

- Jointly sponsored by ASHRAE and IESNA
- 2004 is the current version...but many states have older versions of 90.1 in place (2001, 1999, 1989)
- Many State-specific codes and the IECC are based on 90.1. IECC references 90.1 as compliance option
- 2004 version is the commercial building energy code reference in NFPA 5000
- 2004 version lighting power limits are approximately 25% more stringent than previous versions

Building Power Requirements – slide 5

- Voltage Drop:
 - Feeder conductors
 - Run between the service entrance and the branch circuit 2% maximum voltage drop allowed
 - Branch circuit conductors
 - Run from the final circuit breaker to the outlet or load
 - 3% maximum voltage drop allowed

Building Power Requirements – slide 6

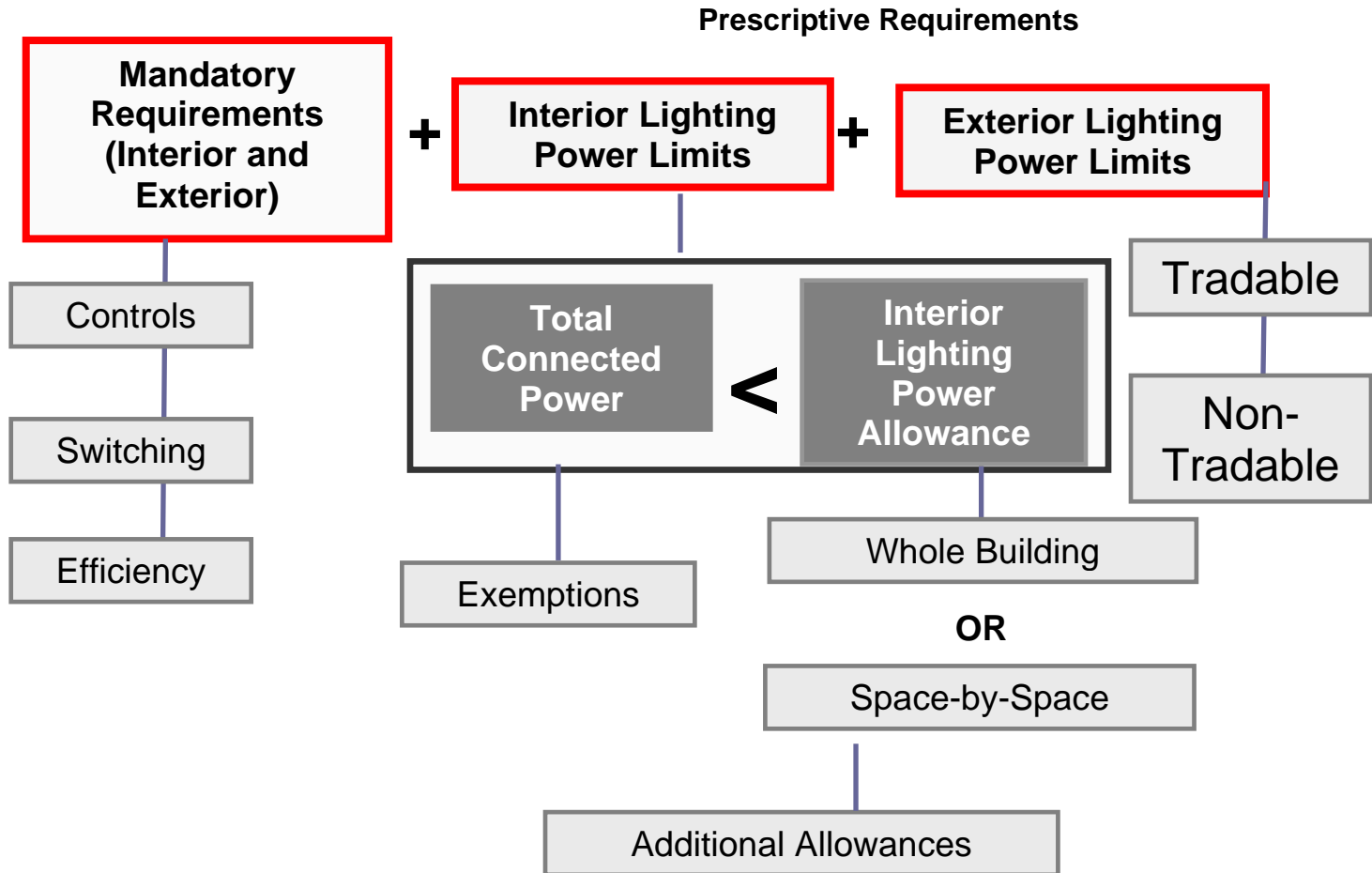
- Document submittals: owner gets information about the building's electrical system
 - Record drawings of actual installation within 30 days
 - Single-line diagram of electrical distribution system
 - Floor plans showing location of distribution equipment and areas served by equipment
 - Manuals
 - Submittal data stating equipment nameplate rating
 - O&M manuals for equipment
 - Qualified service agency
 - Complete narrative and schematic of system as it's normally intended to operate

Standard 90.1 Lighting Scope – slide 7

- New Construction and Additions
 - All commercial type buildings including residential structures of 4 or more stories above grade
 - Interior and exterior lighting
 - Some exceptions to all requirements:
 - Lighting in dwelling units
 - Emergency lighting that is normally off
 - Lighting required by life, health, safety statute

- Historic buildings (whole code exemption)
- Alterations/Renovations
 - Generally treated as new construction
 - Some exemptions apply

Basic Lighting Requirements – slide 8



A Few Words About Alterations/Renovations – slide 9

- The requirements are effectively the same as for new construction or additions:
 - The replacement of lighting systems in building spaces must comply
 - Any new or replacement control devices must comply
- Exception: Replacement of less than 50% of the luminaires in a space need not comply (if no increase in power density)

Mandatory: Individual Space Control – slide 10

- At least one for each room or space enclosed by ceiling-height partitions
 - in spaces $\leq 10,000 \text{ ft}^2$, each control serves 2500 ft^2 maximum and in spaces $> 10,000 \text{ ft}^2$, serves $10,000 \text{ ft}^2$ maximum
- Readily accessible to occupants

- Remote location is allowed to accommodate areas where safety or security is a concern

Intent: Allow occupants to control unneeded lighting

Mandatory: Additional Space Controls – slide 11

- Hotel/motel guest room lighting must be controlled at room entry

Intent: Allow occupant to turn off lights at exit point

- Occupancy sensors are required in:
 - Classrooms (except shop,lab,K-12)
 - Conference/meeting rooms
 - Employee lunch/break rooms

Intent: Capture major occupied hours wasted light

Mandatory: Individual Space Control – slide 12

- Additional control required for:
 - Display/accent lighting
 - Case lighting
 - Task lighting
 - Nonvisual lighting
 - Demonstration lighting

Intent: Provide opportunity to turn off special application lighting

Mandatory: Automatic Shutoff – slide 13

Automatic lighting shutoff control device required in all buildings larger than 5,000 ft²

- Override of automatic shutoff required for not more than 4 hours
- Exceptions to automatic shutoff:
 - Lighting for 24-hour operation
 - Patient care spaces

- Areas with safety or security concerns

Intent: Eliminate after hours lighting waste

Mandatory: Automatic Shutoff – slide 14

- Compliance options:
 1. Control lights on a scheduled basis (automatic time switch)
 - Time-of-day controller
 - Controls $\leq 25,000 \text{ ft}^2$ and not more than one floor
 2. Occupant sensor
 - Turn lights off within 30 minutes of occupant leaving the space
 3. Signal from another control or alarm that indicates the area is unoccupied

NOTE: earlier versions include faulty “occupant intervention” phrase

Application of Automatic Shutoff – slide 15

Intent is to apply to business entities or structures where whole building control is practical

Example applications:

- Strip mall – individual business unit
- Multi-tenant office – whole building with tenant schedule control

Mandatory: Exterior Lighting Control – slide 16

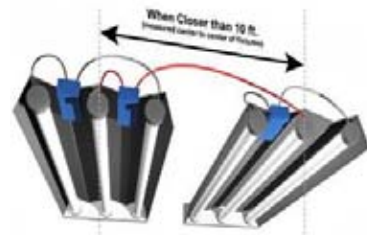
Intent: Eliminate exterior lighting left on during the day

- Photocell (for dawn-to-dusk lighting) **OR**
- Seven-day/seasonal programmable with astronomic correction and 4 hour battery backup
- Exceptions:
 - Covered vehicle entrances
 - Exits from buildings or parking structures (where required for safety, security, or eye adaptation)

Mandatory: Tandem Wiring/Exit Signs – slide 17

- Tandem wiring: eliminate use of single lamp ballast where possible

Intent: Eliminate use of magnetic ballasts driving single lamps



- Exit signs: limited to 5 watts per face maximum

Intent: Control extended use applications where practical

Prescriptive: Interior Lighting Power – slide 18

- Prescriptive Option
 - Whole Building or Space-by-space method
 - Compare actual **Installed Power** (wattage) to **Lighting Power Allowance** (lighting power density LPD) limits
 - Additional power allowances and exemptions available

A few words about the Performance Option “Energy Cost Budget”

- Whole building energy use modeling
- Compare prescriptively compliant base building with proposed building
- Can provide flexibility but requires detailed modeling inputs

Intent: Eliminate waste by promoting thoughtful design and application

Prescriptive: Determine Installed Power – slide 19

- Calculate installed lighting wattage for entire lighted space(s)
- Include all permanent and portable interior lighting designed for general, ambient, or task illumination
 - Exception: for 2 or more mutually exclusive lighting systems only count the system with highest wattage

Prescriptive: Determine Installed Power – slide 20

- Standard incandescent = labeled wattage of the luminaire
- Luminaires with ballasts = wattage of the lamp/ballast combination – not just nominal lamp wattage!
- Line voltage track = actual wattage with minimum 30 W per foot
- Low voltage track = transformer wattage
- All others as specified on equipment

Prescriptive: Wattage Exemptions – slide 21

- Lighting for the following can be excluded:
 - Theatrical, stage, film, and video production
 - Used only during medical and dental procedures
 - Display/accent in exhibits/displays for museums, monuments, and galleries
 - Plant growth or maintenance
 - Integral to equipment or instrumentation installed by manufacturer
 - Integral to both open and glass-enclosed refrigerator and freezer cases
 - Food warming and food prep equipment
 - In retail display windows when the display is enclosed by ceiling-height partitions
 - For use in areas specifically designed for the visually impaired
 - In spaces specifically designated as registered interior historic landmarks
 - Integral part of advertising or directional signage
 - Exit signs
 - Sale or lighting educational demonstration systems
 - For television broadcasting of sporting activities
 - Casino gaming areas
 - (90.1-2007 will add task lights that are occupancy sensor controlled)

Prescriptive: Lighting Power Allowance – slide 22

- Choose appropriate Lighting Power Density (LPD)
 - Whole Building Path
 - Easier
 - Less flexibility
 - Space-by-Space Path
 - More math
 - Often higher potential total allowance
- Multiply LPD by square footage
 - Whole building LPD times total building area
 - Space-by-space LPD times space area(s) and sum values

Space LPDs – slide 23

90.1-2004 Space type LPD sample

90.1-2004 Space Type (LPD) Allowance - Partial List		
Building Type	Space Type description	Watts/sqft
Common Space Type	Corridor/Transition	0.5
Common Space Type	Classroom/Lecture/Training	1.4
Common Space Type	Electrical/Mechanical	1.4
Common Space Type	Dining Area	0.9
Common Space Type	Food Preparation	1.2
Common Space Type	Lounge/Recreation	1.2
Common Space Type	Stairs - Inactive	0.4
Common Space Type	Stairway	0.6
Common Space Type	Restrooms	0.9
Common Space Type	Lobby	1.3
Common Space Type	Atrium - first three floors	0.6
Common Space Type	Atrium - each additional floor	0.2
Common Space Type	Office - enclosed	1.1
Common Space Type	Office - open plan	1.1
Common Space Type	Conference Meeting/Multipurpose	1.3
Common Space Type	Inactive storage	0.3
Common Space Type	Active storage	0.8
Auditorium	Lobby	1.0
Convention Center	Exhibit space	1.3
Court House	Courtroom	1.9
Exercise Center	Dressing/Locker/Fitting Room	0.6
Hospital/Healthcare	Exam/Treatment	1.5
Hospital/Healthcare	Emergency	2.7
Hospital/Healthcare	Recovery	0.8
Library	Stacks	1.7
Library	Reading Area	1.2
Manufacturing Facility	General Low Bay	1.2
Manufacturing Facility	General High Bay	1.7
Museum	General exhibition	1.0
Parking Garage	Parking Area - Pedestrian	0.2
Performing Arts Theatre	Audience/Seating Area	2.6
Police/Fire Station	Fire Station Engine room	0.7
Post Office	Sorting Area	1.2
Transportation	Airport - Concourse	0.6
Transportation	Terminal - Ticket counter	1.5

Whole Building LPDs – slide 24

90.1-2004 whole building LPD values as shown

90.1-2004 Whole Building (LPD) Allowance	
Building Type	Watts per Square Foot
RETAIL	1.5
OFFICE	1
POST OFFICE	1.1
DINING: BAR LOUNGE/LEISURE	1.3
CONVENTION CENTER	1.2
MUSEUM	1.1
PARKING GARAGE	0.3
COURTHOUSE	1.2
POLICE STATIONS	1
HEALTHCARE/CLINIC	1
HOSPITAL	1.2
MANUFACTURING	1.3
PERFORMING ARTS THEATER	1.6
SCHOOL/UNIVERSITY	1.2
SCHOOL/UNIVERSITY	1.2
SCHOOL/UNIVERSITY	1.2
TOWN HALL	1.1
PENITENTIARY	1
TRANSPORTATION	1
WORKSHOP	1.4
FIRE STATIONS	1
LIBRARY	1.3
HOTEL	1
MOTEL	1
MOTION PICTURE THEATRE	1.2
DINING: CAFETERIA/FAST FOOD	1.4
DORMITORY	1
MULTI-FAMILY	0.7
EXCERCISE CENTER	1
SPORTS ARENA	1.1
DINING: FAMILY	1.6
GYMNASIUM	1.1
AUTOMOTIVE FACILITY	0.9
RELIGIOUS BUILDINGS	1.3
WAREHOUSE	0.8

How Were the Space Type LPDs Developed? – slide 25

- Developed within the ANSI/ASHRAE/IESNA 90.1 Lighting subcommittee with IESNA committee support
- Similar general process for 90.1-1999, 2001, 2004
- Apply:
 - 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

...and Whole Building LPDs? – slide 26

- 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 for “typical” buildings
 - Current set at 246 buildings for 31 building types
- Assign applicable space type model LPD for each space
- Calculate whole building LPD

Process Detail Available at IESNA – slide 27

- Interactive version of the process is available at IESNA at:

<http://12.109.133.232/cgi-bin/lpd/lpdhome.pl>

Prescriptive: Additional Lighting Power – slide 28

- Additional power allowed for design flexibility and specific needs
- These are use-it-or-lose-it allowances
- They must be used only for specific designed use and not for general illumination
- Should be separately switched from other general lighting

Prescriptive: Additional Lighting Power – slide 29

- Decorative luminaires in addition to the general lighting at 1.0 W/ft²
- Use of specific luminaires designed to eliminate computer screen glare at 0.35 W/ft²
- **Retail Display Lighting:**
 - **Additional 1.6 W/ft² of specific display, or**
 - **Additional 3.9 W/ft² of specific display for valuable merchandise, such as jewelry, fine apparel and accessories, china and silver, art, and similar items, where detailed display and examination of merchandise are important**

Exterior Lighting Power – slide 30

- Building grounds lighting luminaires over 100 watts must have lamp efficacy of at least 60 lumen/Watt
- Exterior Building Lighting Power must meet prescribed wattage limits. Exterior applications divided into 2 categories:

Tradable: allowed wattage may be traded among these applications

Non-Tradable: allowed wattage **cannot** be traded between surfaces or with other exterior lighting

Exterior Lighting Power – slide 31

- The total exterior lighting power allowance is the sum of the individual lighting power densities [LPD]....
- ...plus an additional unrestricted allowance of 5% of that sum. Trade-offs are allowed only among “Tradable Surfaces” applications.
- Some exemptions apply

Exterior LPDs: 90.1-2004 – slide 32

Applications	Lighting Power Densities
Tradable Surfaces (Lighting Power Densities for open parking areas, building grounds, building entrances and exits, canopies and overhangs, and outdoor sales areas may be traded)	
Uncovered Parking Areas	
Parking lots and drives	0.15 W/ft ²
Building Grounds	
Walkways less than 10 feet wide	1.0 W/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 LPDs: 90.1-2004 – slide 33

Applications	Lighting Power Densities
More Tradable Surfaces...	
Building Entrances and Exits	
Main entries	30 W/linear foot of door width
Other doors	20 W/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 W/linear foot

Exterior LPDs: 90.1-2004 – slide 34

Applications	Lighting Power Densities
Non-Tradable Surfaces (Lighting Power Density calculations for the following applications can only be used for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the Tradable Surfaces section of this table.)	
Building facades	0.2 W/ft ² for each illuminated wall or surface or 5.0 W/linear foot for each illuminated wall or surface length
Automated teller machines & night depositories	270 W 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 section of Tradable Surfaces)

Exterior LPDs: 90.1-2004 – slide 35

Applications	Lighting Power Densities
Non-Tradable Surfaces	
Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft ² of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces)
Drive-up windows at fast food restaurants	400 W per drive through
Parking near 24-hour retail entrances	800 W per main entry

Exterior Lighting Power Exemptions – slide 36

- The following are exempt when equipped with separate control:
 - Specialized signal, directional, and marker lighting associated with transportation;
 - Lighting that is integral to advertising signage or directional signage;
 - Lighting that is integral to equipment or instrumentation and is installed by its manufacturer;
 - Lighting for theatrical purposes, including performance, stage, film, and video production;
 - Lighting for athletic playing areas;
 - Temporary lighting;
 - Lighting for industrial production, material handling, transportation sites, and associated storage areas;
 - Theme elements in theme/amusement parks;
 - Lighting used to highlight features of public monuments and registered historic landmark structures or buildings.

More Information – slide 37

- Standard 90.1-2004, the Users Manual, and more detailed training opportunities are available from:

www.ashrae.org

www.iesna.org

- More information on the standard and compliance tools available from:

www.energycodes.gov