Appendix B

Illuminance Assignments for CBECS Building Activity Categories

Illuminance ranges were adopted from the 1987 Illuminating Engineering Society (IES) Lighting Handbook. The IES illuminance ranges represent the amount of light required for certain activities that take place in various types of buildings. Illuminance is measured in either **lux** (lumens per square meter) or **footcandles** (lumens per square foot). The two measurements differ by a factor of approximately 10 (i.e., 20 lux ≈ 2 footcandles). The illuminance categories with the corresponding lux and footcandle ranges are displayed in Table B1.

Table B1. Illuminance Categories and Lux/Footcandle Ranges

Illuminance Category	Lux Range			Footcandle Range		
	Low	Medium	High	Low	Medium	High
A	20	30	50	2	3	5
B	50	75	100	5	7.5	10
C	100	150	200	10	15	20
D	200	300	500	20	30	50
E	500	750	1000	50	75	100
F	1000	1500	2000	100	150	200
G	2000	3000	5000	200	300	500
H	5000	7500	10000	50	750	1000
I	10000	15000	20000	1000	1500	2000

Source: Illuminating Engineering Society of North America, IES Lighting Handbook 1987: Application Volume.

As a first step toward attaching illuminances to the CBECS data, a category was assigned to detailed activities from the 1979 CBECS. This assignment was based on a judgment of the predominant function that would take place in a building of that activity classification. For example, education buildings from the 1979 CBECS were assigned an illuminance category corresponding to reading and writing activities. The assigned category implied an assigned low, medium, and high illuminance for each building in the 1979 CBECS data set.

The 1979 CBECS data set was used in the initial stages of the assignment process because the 1986 CBECS grouped commercial buildings into only 19 broad activity categories, whereas the 1979 CBECS had a much finer classification scheme of 181 categories. This finer breakdown of building classification simplified the assigning of illuminance categories since the IES handbook gave guidelines for very specific activities. Even with the finer classification, however, some of the CBECS building types were difficult to match to an IES activity.

The total floorspace in the detailed building configuration was also determined from the 1979 CBECS data. For each of the broader CBECS activity categories used for the 1986 data, the floorspace-weighted average of the assigned low, medium, and high illuminances were computed across the buildings in that activity category in the 1979 CBECS data set. These averages were then assigned to the 1986 CBECS building activity categories.

This approach assumes that the distribution of detailed activities within each broad category did not change substantially between 1979 and 1986. Even if changes did occur, the effect on the average illuminance ranges might be minimal, unless the detailed activities whose proportions shifted had substantially different illuminances assigned.

The activity categories used for CBECS refer to the building as a whole, whereas the IES handbook refers to separate functions taking place in the building. Hence, there were very few exact matches between the two sources. Therefore, after assigning illuminance categories to CBECS building activities that matched to IES activities exactly, the remainder

of the CBECS activities were matched with the most closely corresponding IES building activity and were then assigned the respective illuminance category. Table B2 lists the detailed building activities from the 1979 CBECS and the illuminance categories assigned to each.

Changes in Illuminance Over Time

The IES recommended illuminance ranges have been reduced somewhat in recent years, so that design illuminances were somewhat higher for buildings built in the 1960's, for example, than for those built in the 1980's. On the other hand, lighting equipment efficiency tends to degrade over time, so that in-place illuminance may be about the same for buildings of different ages. A more detailed analysis would either assume higher illuminance for older buildings, with uniform equipment efficiency, or would assume lower efficiency for older buildings, with the same illuminance. Either of these approaches would result in somewhat higher derived lighting power densities for older buildings. This level of detail was not incorporated in this analysis, which assigns the same illuminance and efficacy regardless of building age.

Table B2. Illuminance Categories for the Commercial Buildings Energy Consumption Survey Building Types

Building Types	Illuminance Category
Assembly:	
Entertainment	
art gallery/museum/exhibit hall	C
coliseum/arena	D
concert hall	D
observatory/planetarium	A
nightclub	B
radio/TV station/studio	G
theater/movie house/cinema	A
Recreation	
amusement arcade	B
bowling alley	C
gymnasium/YMCA/indoor racquet sports	D
indoor pool	C
poolroom	D
skating rink	C
Religious	
chapel	D
church	D
mosque	D
synagogue	D
Social/Public/Civic	
assembly hall	D
auditorium	B
convention hall	D
funeral home	C
lecture hall	D
lodge hall	C
meeting hall	D
student union	D
town hall	D
Other Enclosed Buildings	
armory	C
passenger terminal	C
Nonenclosed/Partial Structure	
grandstand	D
stadium	D
Education:	
Preschool	E
Elementary	E
Junior High	E
Senior High	E
College/University	E
Vocational School	E
Food Sales:	
Convenience Store	D
Farmer's Market/Vegetable Stand	D
Meat/Seafood Store	D
Retail Bakery	D
Specialty Foods Store	D
Supermarket/Grocery Store	D

See footnotes at end of table.

Table B2. Illuminance Categories for the Commercial Buildings Energy Consumption Survey Building Types (Continued)

Building Types	Illuminance Category
Food Service:	
Prepared Meals	
cafeteria	C
Carry Out	
caterer	C
fast-food	C
pizza parlor	C
sandwich shop	C
Full Service	
bar	C
bar/grill	C
coffee shop	C
diner	C
full menu	C
Health Care:	
Medical Care Hospital	
chronic disease	F
ear, eyes, nose, throat	F
general medical/surgical	F
maternity	F
medical infirmary	F
orthopedic	F
tuberculosis/respiratory disease	F
Mental Facility	
metal retardation/schools	F
psychiatric	F
Rehabilitation Facility	
alcoholism	D
substance abuse	D
physical therapy	F
Veterinary Facility	
animal hospital	F
kennel	D
Dental Clinic	D
Medical Clinic	
abortion/birth control	F
ear, eyes, nose, throat	F
emergency walk-in	E
general	D
mental health/psychiatric	D
veterinary	F
Laboratory:	
Mechanical/Electrical	E
Medical/Dental	E
Agricultural	E

See footnotes at end of table.

Table B2. Illuminance Categories for the Commercial Buildings Energy Consumption Survey Building Types (Continued)

Building Types	Illuminance Category
Lodging:	
Short-Term Residence	D
convention hotel	D
hotel	D
inn	D
motel	D
shelter home	D
tourist home	D
Long-Term Residence	
boarding house	D
convent/monastery	D
dormitory/sorority/fraternity	D
orphanage	D
Mercantile/Service:	
Automotive	
automobile dealers	D
gasoline station	D
motor vehicle repair/service	E
Retail Sales	
building materials/garden supply	D
department stores/apparel stores	D
drugstores	D
furniture/home furnishings/equipment	D
multiretail establishments	D
Services	
laundry/dry cleaning/car wash	D
multiservice establishment	D
personal services	D
post office	D
shopping mall	D
strip shopping center	D
wholesale goods	D
Office:	
Data Processing	
computer center	E
Financial Office Buildings	
bank	D
brokerage firm	D
insurance	D
real estate	D
securities	D
Professional Office Buildings	
administration	D
consulting	D
corporate	D
engineering	D
law	D
management	D
medical	D
mixed professional	D

See footnotes at end of table.

Table B2. Illuminance Categories for the Commercial Buildings Energy Consumption Survey Building Types (Continued)

Building Types	Illuminance Category
Other:	
Crematorium	C
Hangar	D
Parking Garage	C
Public Restrooms/Showers	C
Telephone Exchange	C
Public Order and Safety:	
Courthouse	E
Fire Station	D
Jail/Prison	D
Penitentiary	D
Police Station	E
Reformatory	D
Sheriff's Office	E
Residential Care:	
Skilled Nursing	
homes for the aged	D
nursing homes	D
Warehouse:	
Refrigerated Warehouse	C
Non-refrigerated Storage	C
Vacant:	A

Sources: Energy Information Administration, Office of Energy Markets and End Use, Nonresidential Buildings Energy Consumption Survey: *Characteristics of Commercial Buildings 1979* and Illuminating Engineering Society of North America, *IES Lighting Handbook: 1987 Application Volume.*