

LIGHTING DESIGN/GUIDELINES

INDOOR LIGHTING DESIGN

LAMP LIFE

There are applications where the cost of lamp replacement is very high due to lack of access to the fixture; making lamp life a primary consideration. Careful comparison of various lamps can be made using the lamp data in the Technical section.

Other considerations such as lamp lumen depreciation, design factor and budget may enter into selecting the lamp. Since lamp data tends to change rapidly, always request the latest information from the lamp manufacturer when working with a critical application.

Fixture Selection

ILLUMINANCE LEVEL

To select an illuminance level, you must first determine what task is being performed and select the closest task on the list below. Whatever value you select for your general area illumination, remember that the value should represent the minimum maintained footcandles from the luminaires involved. Furthermore, the values are given as horizontal footcandles — the component of all illumination falling on a horizontal surface at the point of measurement.

In some cases, vertical components may be equally important (shelf faces, control panels, brake presses, etc.) and design allowance should be made accordingly. Point-by-point analysis may be required. If you are not familiar with this method, simply ask for the assistance of your ExcelLine representative.

The following tables show I.E.S. recommended levels of illuminance covering a broad range of activities and should aid in determining most needs.

The first table provides generic illuminance categories and values according to general type of activity. The remaining tables recommend specific illuminance categories for more exact activities and locations. With a few exceptions that provide foot-candle values, the letter shown should be used to select a foot-candle range from the first table. Each footcandle range consists of three values. The specific value to be used should be selected by scoring four factors with a -1, 0 or +1. They are:

1. Precision of the task being performed.
2. Occupant ages.
3. Importance of speed.
4. Importance of accuracy.

After adding the four values together, use the lowest footcandle value given in the illuminance category if the total score is -3 or -4. Use the middle footcandle level if the score is -1, 0 or +1. The highest footcandle value will be used with scores of +3 and +4.

For additional information regarding methods of selection and more detailed listings, please refer to the latest Applications Volume of the I.E.S. Handbook.

ILLUMINANCE CATEGORIES FOR INTERIOR ACTIVITIES

Type of Activity	Illuminance Category	Footcandles	Reference Work-Plane
Public spaces with dark surroundings	A	3	General lighting throughout spaces
Simple orientation for short temporary visits	B	5	
Working spaces where visual tasks are only occasionally performed	C	10	
Performance of visual tasks of high contrast or large size	D	30	Illuminance on task
Performance of visual tasks of medium contrast or small size	E	50	
Performance of visual tasks of low contrast or very small size	F	100	
Performance of visual tasks of low contrast and very small size over a prolonged period	G	300-1000	

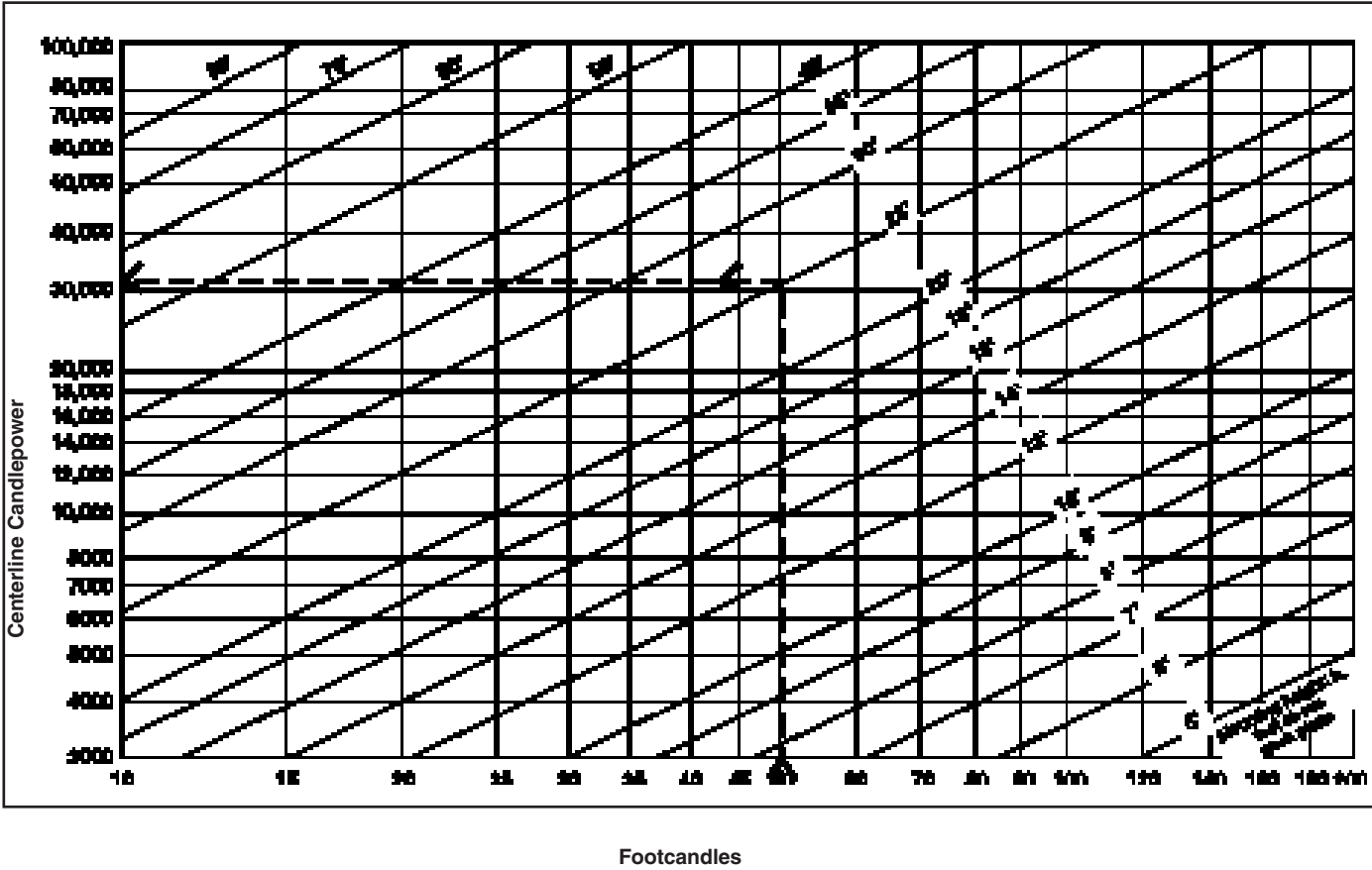
CENTERLINE CANDLEPOWER

Once the footcandle level being designed for has been determined, refer to the chart shown below. This chart gives centerline candlepower versus footcandles directly under a fixture at various mounting heights. With this number, refer to fixture photometric reports using the lamp source that has been selected and find those having similar centerline candlepower. For good design, select a value close to, but somewhat less than, the indicated value.

SPACING CRITERIA

To further narrow the selection, spacing criteria should be considered. Expressed as a single number, it represents the maximum distance that fixtures can be spaced apart and still achieve reasonable uniformity. If a luminaire has a spacing criterion of 1.5, this means that the fixtures can be mounted with a distance between their centers that equals no more than one and one half times their mounting height.

DESIGN START CANDLEPOWER



Example: (Shown by dashed line above) Design calls for 50 footcandles on the work plane and luminaires mounted at 25 feet above the work plane. Enter at 50 fc, go "up" to 25 feet — then "back" to about 32,000 candlepower. So, select a design value of about 30,000 cp.

Product information is subject to change without notice.

LIGHTING DESIGN/GUIDELINES

COMMERCIAL AND INSTITUTIONAL INTERIORS RECOMMENDED ILLUMINANCE LEVELS

Area and Seeing Task	Footcandles	Area and Seeing Task	Footcandles
Auditoriums		Restaurants, Cafeterias	
Assembly	C	Cashier	D
Social activities	B	Quick service (bright)	E
Exhibitions	B	Quick service (normal)	D
Recreation Hall	B	Food displays	E
		Kitchen inspection	E
Banks		Parking Garages	
Lobby (general)	C	Entrance	50
Writing areas	D	Traffic lanes	1
Tellers, posting, keypunch	E	Storage	1
Depots, Terminals, and Stations		Schools	
Concourse	A	Reading printed material	D
Platforms	C	Reading pencil material	E
Waiting, restrooms	B	Reading spirit-duplicated material (good reproduction)	D
Baggage	D	(bad reproduction)	F
Ticket counter	E		
Hotels		Sports (indoor)	
Corridors, stairs	B	Gymnasiums, exhibition	50
Entrance foyer, lobby	C	General exercise	30
		Locker rooms	20
Libraries		Swimming pools	
Study and notes	D	Exhibition	35
Ordinary reading	D	Recreational	15
Stacks	D	Tennis	
Cataloging	D	Tournament	100
Card files	D	Club	75
Check-out desk	D	Recreational	50
		Handball and racquetball	
Municipal Buildings		Tournament	50
Police ID records	F	Club	30
Jail cells	D	Recreational	20
Fire hall dormitory	D	Hockey, ice	
		College or professional	200
Offices		Amateur	100
Cartography, designing, drafting	E	Recreational	50
Accounting, auditing, tabulation	E	Stores	
Bookkeeping, business machine operation close reading	E	Circulation areas	C
General office work, (reading good reproductions, active filing, index references, mail sorting, reading, transcribing, handwriting in ink/med. pencil)	E	Merchandising areas	E
Intermittent filing	D	Show case	F
Reading high contrast or well printed material (non-critical)	D	Features displays	F
		Stockroom	D
Post Office (mail sorting)	E		

Note: Applications noting a letter refer to page 296
Indoor Lighting Design Guide

**INDOOR INDUSTRIAL AREAS
RECOMMENDED ILLUMINANCE LEVELS**

Area and Seeing Task	FC	Area and Seeing Task	FC	Area and Seeing Task	FC
Airplane Manufacturing		Inspection (fine)	G	Meat Packing	
Assembly, sub-assembly, spray booth	E	Inspection (medium)	F	Slaughtering	D
Drilling, riveting, screw fastening	D	Molding, pouring, sorting	E	Processing and packing	D
Welding	D	Cupola	C	Paint Manufacturing	
Stock parts inspection	F	Shakeout	D	General	D
Final assembly inspection	E	Garages (automobile and truck)		Comparing mix with a standard	F
Airplane Hangers (repair service)	75	Service repairs	E	Paint Shops	
Armories	D	Parking (entrance)	D	General	D
Automobile Manufacturing		Parking (traffic lanes)	B	Fine hand painting and finishing	E
Frame assembly	D	Storage	A	Extra fine painting and finishing	G
Body and chassis assembly	E	Glass Works		Paper Manufacturing	
Body manufacturing (parts)	E	Mix and furnace, pressing		Beater, grinding, calandering	D
Finishing and inspecting	F	blowing machines	C	Finishing, cutting, trimming, paper-making	E
Bakeries		Fine grinding, beveling polishing	D	Hand counting (wet end of machine)	E
Mixing and decorating		Inspection, etching, decorating	F	Machine reel, inspection, laboratories	F
Mechanical	D	Iron and Steel		Rewinder	F
Hand	E	Manufacturing Open Hearth (footcandles)		Printing Industries	
Make-up, oven, room, wrapping and other	D	Stock yard	10	Type foundries Matrix making, dressing type	E
Breweries		Charging floor, pouring	20	Font assembly, sorting, casting	D
Brewing, cleaning	D	slide slag pits	30	Printing Plants	
Filling	D	Control platforms	5	Color inspection	F
Canning and Preserving		Mold yard	30	Machine composition	E
Initial grading	D	Hot top	30	Composing room	E
Color grading	F	Hot top storage, checker cellar	10	Presses	E
Sorting, cutting, canning	E	Buggy and door repair	30	Proofreading	F
Inspection	F	Stripping yard	20	Electrotyping, Photoengraving	
Labeling and cartoning	D	Scrap stockyard	10	Molding, routing, finishing	E
Chemical Works	D	Mixer building	30	Blocking, tinning, etching, electroplating	D
Clay and Cement Products		Calcining building, skull cracker	10	Rubber Goods-Mechanical (footcandles)	
Kiln rooms, grinding, molding and cleaning	D	Rolling Mills		Stock preparation	30
Enameling, color and glazing (rough)	E	Blooming, slabbing, hot strip, hot sheet	30	Fabric preparation	50
Color and glazing (fine)	F	Cold strip, plate	30	Inspection	200
Cloth Products		Pipe, rod, tube, wire drawing	50	Sawmills (grading)	300
Cloth inspection	I	Merchant and sheared plate	30	Sheet Metal Works	
Cutting	G	Tin Plate Mills		Machines, bench work, punches	E
Sewing	G	Tinning and galvanizing	50	Tin plate inspection, scribing	F
Pressing	F	Cold strip rolling	50	Structural Steel Fabrication	50
Electrical Equipment and Manufacturing		Motor room, machine room	30	Sugar Refining	
Impregnation	D	Inspection	100	Grading	E
Insulating: coil winding	E	Laundries		Color inspection	F
Testing	E	Washing	D	Textile Mills	
Elevators, Freight and Passenger	B	Flatwork ironing, weighing, marking	D	Manufacturing (preparation)	D
Flour Mills		Machine and press finishing	E	Grading	E
Rolling, sifting, purifying	E	Fine hand ironing	E	Carding, winding, combining	D
Product control	F	Leather Manufacturing and Working		Spinning, weaving	E
Packing, cleaning, bin checking	D	Cleaning, tanning and stretching	D	Inspection	
Forge Shops	E	Cutting, fleshing and stuffing	D	Cotton	G
Foundries		Finishing and scarfing	E	Woolens (perching)	I
Annealing, cleaning	D	Pressing, winding and glazing	F	Welding (general)	D
Core making (fine)	F	Grading, matching, cutting, scarfing and sewing	G	Precision manual arc welding	H
Core making (medium)	E	Machine Shops		Woodworking	
Grinding and chipping	F	Rough bench and machine work	D	Rough sawing, benchwork	D
		Medium bench and machine work	E	Medium benchwork	D
		Fine bench and machine work	G	Fine benchwork, fine sanding and finishing	E
		Extra fine bench and machine work	H		

Note: Applications noting a letter refer to page 296 Indoor Lighting Design Guide.

These values are for reference only. The IES has amended their standards for all these areas, and reference to the latest APPLICATIONS volume of the IESNA Handbook is recommended.

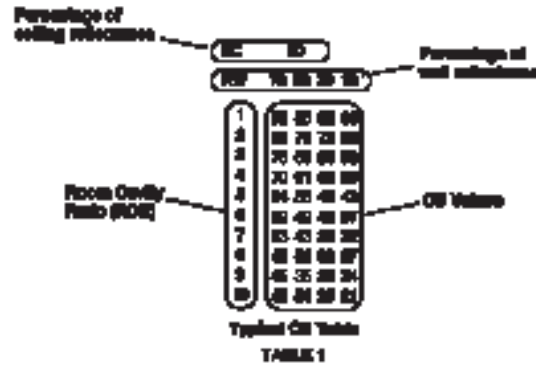
LIGHTING DESIGN/GUIDELINES

COEFFICIENT OF UTILIZATION (CU) TABLES

Coefficient of Utilization refers to the amount of light (lumens) available to perform useful work, It is expressed as a percentage of the total light produced by the lamp.

Each Coefficient of Utilization (CU) table is specific to a fixture, lamp type and wattage. Values found in Coefficient of Utilization (CU) tables are needed to perform interior lighting calculations such as determining fixture quantity of maintained footcandle levels.

Coefficient of Utilization (CU) tables are set up as a matrix. The values change with wall reflectance, ceiling reflectance and room cavity ratio. Typical reflectances are shown in Table 1. The room cavity ratio (RCR) is calculated as follows:



$$RCR = \frac{5 \times \text{ROOM CAVITY HEIGHT} \times (\text{ROOM LENGTH} + \text{ROOM WIDTH})}{\text{ROOM LENGTH} \times \text{ROOM WIDTH}} = \text{RCR FACTOR}$$

The RCR and reflectance values are used to select the appropriate values from the CU table. This value is used to calculate fixture quantity or maintained footcandle levels, as shown below.

QUICK FIXTURE ESTIMATOR

FIXTURES REQUIRED –

To maintain a given footcandle level.

$$\text{FIXTURE QUANTITY} = \frac{\text{REQUIRED FOOTCANDLES} \times \text{LENGTH} \times \text{WIDTH}}{\text{LAMPS PER FIXTURE} \times \text{INITIAL LUMENS PER LAMP} \times \text{LLD} \times \text{LDD} \times \text{CU}}$$

$$\text{MAINTAINED FOOTCANDLES} = \frac{\text{FIXTURE QUANTITY} \times \text{LAMPS PER FIXTURE} \times \text{INITIAL LUMENS PER LAMP} \times \text{LLD} \times \text{LDD} \times \text{CU}}{\text{LENGTH} \times \text{WIDTH}}$$

LLD = $\frac{\text{Mean Lamp Lumens}}{\text{Initial Lamp Lumens}}$

LDD = $\frac{\text{“Luminaire LDD Depreciation”}}{\text{See Table 1}}$

CU = $\frac{\text{“Coefficient of Utilization”}}{\text{See Table 1}}$

Reflectance Guide

Class	Surface Finish	Color	% Light Reflected
Light	Plaster	White	.90
	Paint	White	.81
	Paint	Ivory	.79
	Paint	Cream	.74
	Stone	Cream	.69
Medium	Paint	Buff	.63
	Paint	Light Green	.63
	Paint	Light Gray	.58
	Stone	Gray	.56
	Paint	Tan	.48
	Concrete	Med. Gray	.40
Dark	Block	Med. Gray	.38
	Paint	Dark Gray	.26
	Cement	Natural	.25
	Paint	Olive Green	.17
	Paint	Dark Oak	.13
	Brick	Red	.13

Luminaire Dirt Depreciation Table

Industrial Fixture Types	Cleaning Every Year			Cleaning Every 2 Years			Cleaning Every 3 Years		
	Clean	Med.	Dirty	Clean	Med.	Dirty	Clean	Med.	Dirty
Fluorescent open reflector type									
Solid-No Uplight	0.89	0.82	0.73	0.80	0.69	0.59	0.75	0.64	0.52
Slotted-10% uplight	0.90	0.87	0.83	0.84	0.80	0.75	0.79	0.74	0.68
Slotted-20% uplight	0.94	0.90	0.86	0.89	0.85	0.80	0.86	0.82	0.75
Fluorescent Enclosed type									
Enclosed type	0.88	0.83	0.77	0.83	0.77	0.71	0.80	0.74	0.66
HID luminaires									
Open reflector	0.90	0.87	0.83	0.84	0.80	0.75	0.79	0.74	0.68
Enclosed reflector	0.88	0.83	0.77	0.83	0.77	0.71	0.80	0.74	0.66
Dust tight	0.97	0.96	0.95	0.94	0.92	0.90	0.91	0.88	0.85

Clean: Light assembly, inspection, gymnasiums
Medium: Light machining assembly, warehousing
Dirty: Heat treating, rubber processing for "very dirty" derate factors

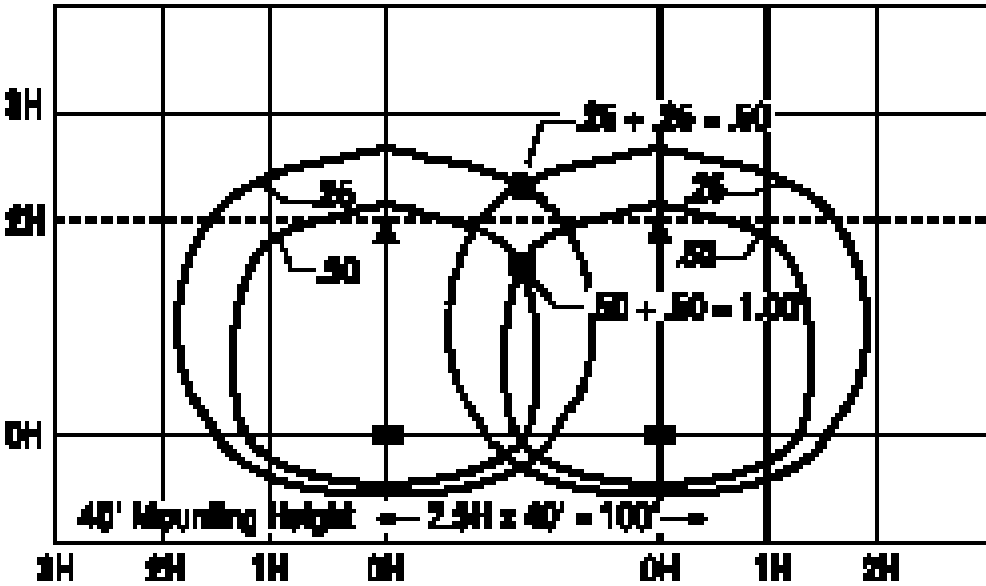
OUTDOOR LIGHTING DESIGN

MULTIPLE FIXTURES

The use of more than one fixture on a pole will result in a change in footcandle levels and the distribution pattern. For this reason, most isofootcandle charts include configurations for one, two and four fixtures. However, since a multi-fixture pattern is simply an additive combination of single patterns, reasonable estimates can be made in cases where multiple fixture combinations are not available. Single fixture charts can also be overlaid with the fixtures pointed in the appropriate directions, and the footcandle values added where contours cross.

Determining fixture spacing that gives a minimum footcandle level can be easily performed using isofootcandle charts.

For example, if a minimum level of one footcandle between fixtures is desired, then fixture spacing should be adjusted so that touching contours have a combined minimum value of one footcandle. The same holds true regardless of the number of fixtures used.



**OUTDOOR SITE/AREA
RECOMMENDED ILLUMINANCE LEVELS**

Area/Activity	FC	Area/Activity	FC
GENERAL			
Airports			
Hangar apron	1	Log grading–water or land	5
Terminal building apron		Log bins(land)	2
Parking area	0.5	Lumber yards	1
Loading area	2	Piers	
Building (construction)		Freight	20
General construction	10	Passenger	20
Excavation work	2	Active shipping area surrounds	5
Building Exteriors		Railroad yards	
Entrances		Retarder classification yards	
Active(pedestrian and/or conveyance)	5	Receiving yards	
Inactive(normally locked, infrequently used)	1	Switch points	2
Vital locations or structures	5	Body of yard	1
Building surrounds	1	Hump area(vertical)	20
Building and monuments, floodlighted		Control tower and retarder area(vertical)	10
Bright surroundings		Head end	5
Light surfaces	15	Body	1
Medium light surfaces	20	Pull-out end	2
Medium dark surfaces	30	Dispatch or forwarding yard	1
Dark surfaces	50	Hump and rider classification yard	
Dark surroundings		Receiving yard	
Light surfaces	5	Switch points	2
Medium light surfaces	10	Body of yard	1
Medium dark surfaces	15	Hump area(vertical)	5
Dark surfaces	20	Flat switching yards	
Bulletin and poster boards		Side of cars(vertical)	5
Bright surroundings		Switch points	2
Light surfaces	50	Trailer-on-flatcars	
Dark surfaces	100	Horizontal surface of flatcar	5
Dark surroundings		Hold-down points(vertical)	5
Light surfaces	20	Container-on-flatcars	3
Dark surfaces	50	Service Station(at grade)	
Gardens		Dark surrounding	
General lighting	0.5	Approach	1.5
Path, steps, away from house	1	Driveway	1.5
Backgrounds-fences, walls		Pump island area	20
trees, shrubbery	2	Building faces(exclusive of glass)	10
Flower beds, rock gardens	5	Service areas	3
Trees, shrubbery when emphasized	5	Landscape highlights	2
Focal points, large	10	Light surrounding	
Focal points, small	20	Approach	3
Loading and unloading		Driveway	5
Platforms	20	Pump island area	30
Freight car interiors	10	Building faces(exclusive of glass)	30
Logging (see also Sawmills)		Service areas	7
Yarding	3	Landscape highlights	5
Log loading and unloading	5	Ship yards	
Log stowing(water)	0.5	General	5
Active log storage area(land)	0.5	Ways	10
Log booming area(water)–		Fabrication areas	30
foot traffic	1	Storage yards	
Active log handling area(water)	2	Active	20
		Inactive	1

Open Parking Facilities

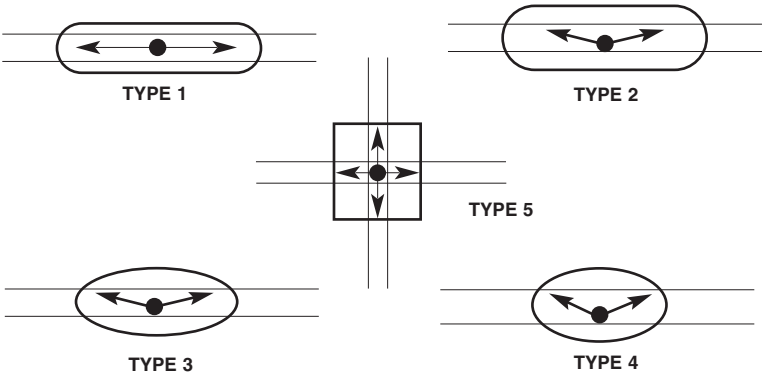
Level of Activity	General Parking and Pedestrian Area		Vehicle Use Area	
	Footcandles (Minimum on Pavement)	Uniformity Ratio (Avg.:Min.)	Footcandles (Average on Pavement)	Uniformity Ratio (Avg.:Min.)
High	0.9	4:1	2	3:1
Medium	0.6	4:1	1	3:1
Low	0.2	4:1	0.5	4:1

Covered Parking Facilities

Areas	Day	Night	Uniformity Ratio (Avg.:Min.)
	Footcandles (Average on Pavement)	Footcandles (Average on Pavement)	
General parking and Pedestrian areas	5	5	4:1
Ramps and corners	10	5	4:1
Entrance areas	50	5	4:1

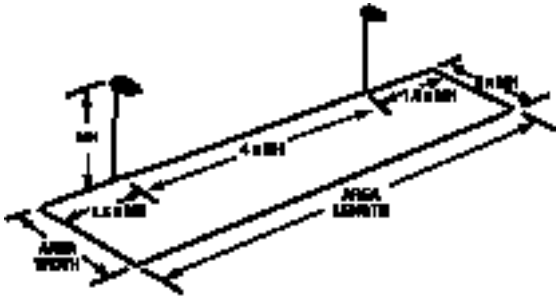
SITE/AREA LIGHTING GUIDELINES

AREA LIGHTING CLASSIFICATIONS

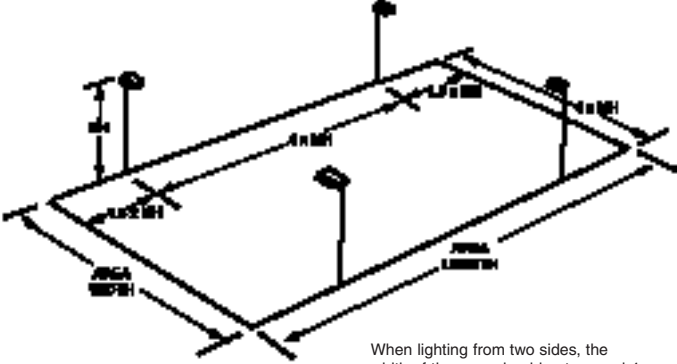


Width Classification	Mounted at Pavement	Normally used for:
Type 1	Center	Roadways up to 2 times the Mounting Hgt. in width
TYPE 2	Edge	Up to 1 times the MH for one side mounting Up to 2 times the MH for both side mounting
TYPE 3	Edge	Up to 1.5 times the MH for one side mounting Up to 3 times the MH for both side mounting
TYPE 4	Edge	Up to 2 times the MH for one side mounting Up to 4 times the MH for both side mounting
TYPE 5	Center	Up to 4 times the MH in total width

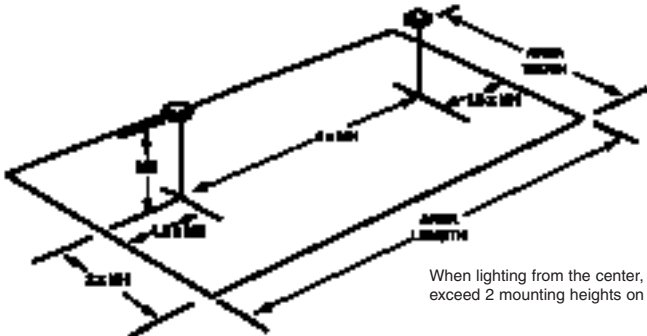
POLE/FIXTURE PLACEMENT



When lighting from one side, the width of the area should not exceed 2 mounting heights.



When lighting from two sides, the width of the area should not exceed 4 mounting heights.

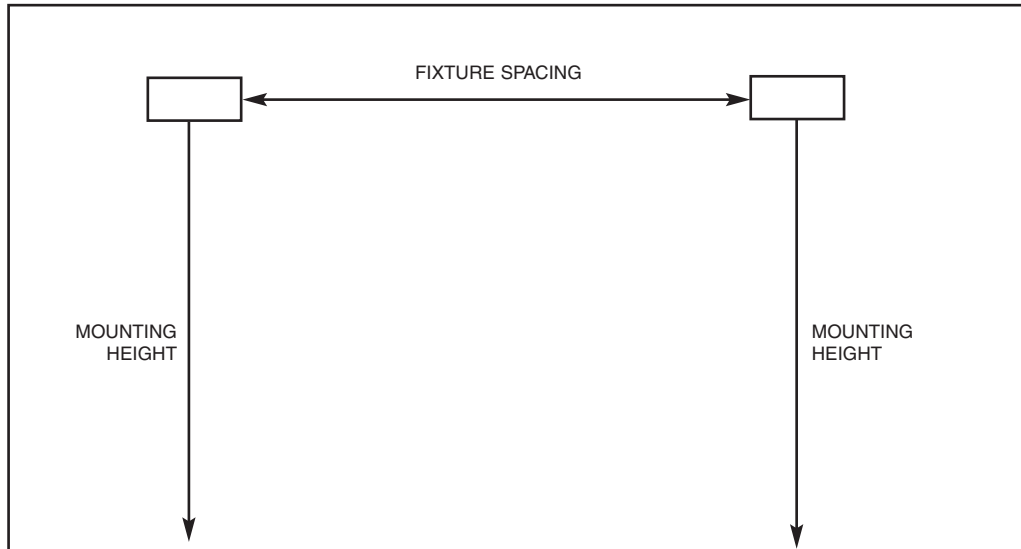


When lighting from the center, the width of the area should not exceed 2 mounting heights on either side of the pole.

Product information is subject to change without notice.

LIGHTING DESIGN/GUIDELINES

WALLPACK LIGHTING GUIDELINES



SPACING RULES:
STANDARD SERIES
 3 x mounting height for uniform lighting
 5 x mounting height for security lighting

SPACING RULES:
PRECISION SERIES
UNIFORM LIGHTING
 6 x mounting height--Type 2
 4 x mounting height--Type 3
 3 x mounting height--Type 4

SECURITY LIGHTING
 8 x mounting height--Type 2I

RECOMMENDED MOUNTING HEIGHTS

High Pressure Sodium	Metal Halide	Mercury Vapor	Mounting Height in Feet
50W	50W	100W	6 to 8
70W	70-100W		8 to 12
100W	150W	175W	8 to 15
150W	175W		12 to 18
200W	250W	400W	15 to 20
250W			18 to 25
310W	400W		20 to 30
400W			25 to 35

FLOODLIGHTING LIGHTING DESIGN

IES/NEMA BEAMSPREAD CLASSIFICATIONS

The light distribution of a floodlight is typically described in degrees of beam spread or by NEMA Type. Beam spread is determined by measuring the angle of the beam from one side of the aiming point to the other where the candlepower drops to 10% of its maximum value. Symmetrical floodlights have the same horizontal and vertical beam spread and are classified with one NEMA number. Asymmetrical beam spreads have separate horizontal and vertical designations (H, V). The horizontal (H) value is always given first.

Example: 80° (H) x 60° (V); = NEMA 5 x 4

The NEMA type should only be used as a general reference. Shape of the light pattern and peak illumination levels can vary greatly from one flood to another, even though they are the same NEMA types. **NEMA Field Angle**

(Beam Spread)	NEMA Type
10° to 18°	1
18° to 29°	2
29° to 46°	3
46° to 70°	4
70° to 100°	5
100° to 130°	6
130° and over	7

ROADWAY AND AREA LUMINAIRE CLASSIFICATIONS

There are 5 basic classification types used to describe the distribution patterns of roadway and area luminaires. These are based upon shapes determined by where the half maximum

NEMA Field Angle (formerly beam spread) Classifications And Their Effective Projection Distances.

As illustrated from this intensity distribution curve on polar coordinates, the maximum intensity is 100,000 cd. The field angle is 60°, the angle included between the intersecting points of the curve at 10,000 cd (10% of 100,000 cd). The beam angle is 48°, the angle included between the intersecting points of the curve at 50,000 cd (50% of 100,000 cd). According to NEMA classification, the illustrated floodlight is classified as Type 4, having a field angle between 46° and 70°.

candlepower level falls as measured in units of fixture mounting height. The following is a general representation of these five types. As with the classifications used for floodlighting, these are a general guide that should only be used as a starting point in the fixture selection process.

CUTOFF CRITERIA

Outdoor light pollution and light trespass are growing design issues on both local and federal levels. Not only can luminaires having excessive amounts of light spill be sources of discomfort and a nuisance, they frequently do not provide the most efficient utilization of light.

Most ExcelLine area luminaires meet I.E.S. roadway criteria for cutoff. This even includes Aktra II, Aktra Floods and Aktra Sport floodlights when they are aimed at a point that is at a distance of 2 times their mounting height. They meet semi-cutoff criteria when aimed at 2 ½ times their mounting height.

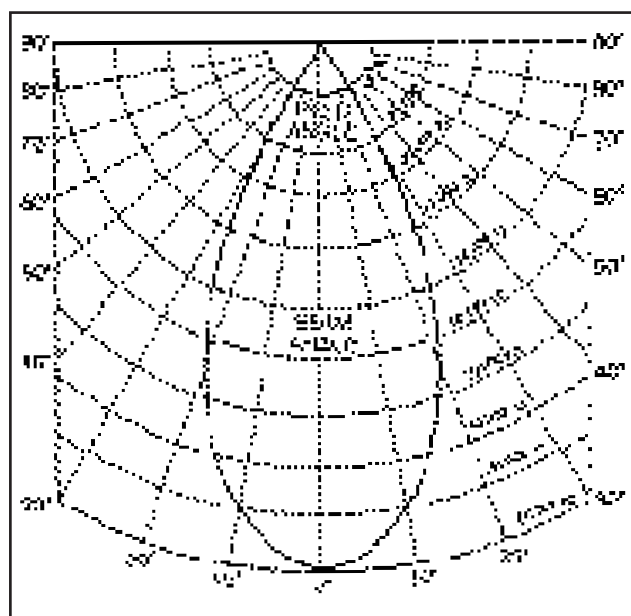
I.E.S. Cutoff Criteria

A luminaire's light distribution is designated as cutoff when the candlepower per 1,000 lamp lumens does not numerically exceed 25 (2.5 percent) at an angle of 90° above nadir (horizontal), and 100 (10 percent) at a vertical angle of 80° above nadir. This applies to any lateral angle around the luminaire.

I.E.S. Semi-cutoff Criteria

A luminaire's light distribution is designated as semi-cutoff when the candle power per 1,000 lamp lumens does not numerically exceed 50 (5 percent) at an angle of 90° above nadir (horizontal), and 200 (20 percent) at a vertical angle of 80° above nadir. This applies to any lateral angle around the luminaire.

Non-cutoff

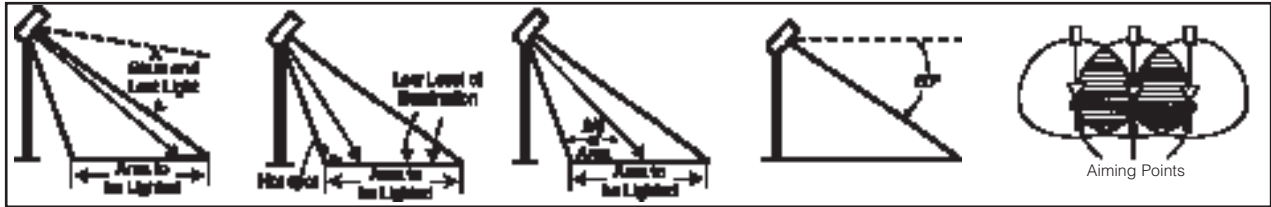


LIGHTING DESIGN/GUIDELINES

FLOODLIGHTING GUIDELINES

AIMING

These drawings illustrate floodlight aiming in typical applications.



When luminaire is aimed at the far side, light loss is substantial and the result is glare.

When luminaire is aimed at the near side, the far side will not receive adequate illumination and the near side has a hot spot.

A good "rule of thumb" is to aim the luminaire two thirds the distance across the area to be illuminated or two times the mounting height, whichever is the lowest value.

To provide visual comfort aim luminaire at least 30 degrees below the horizontal.(or 60° above nadir)

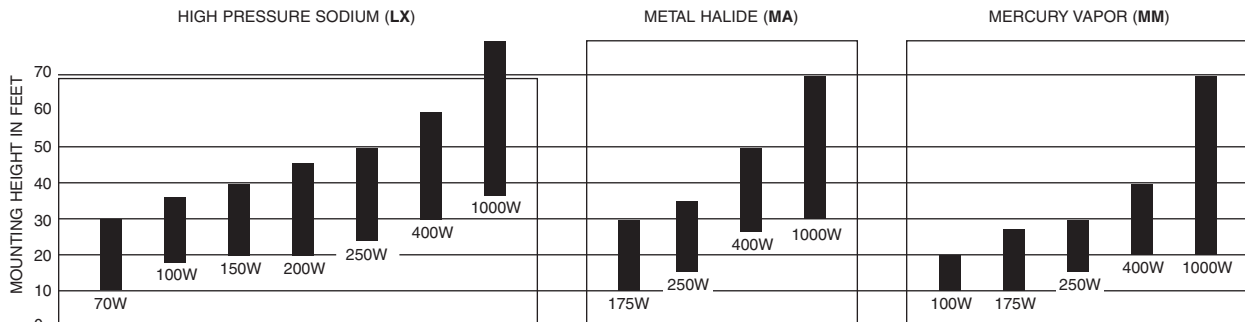
When floodlights are aimed in such a way that the illumination patterns of adjacent luminaires overlap, then acceptable uniformity is usually achieved.

MOUNTING HEIGHT

Mounting height can greatly affect the light levels produced by a fixture. The type of lamp and its wattage are major factors in determining pole height. The three graphs presented here give height ranges for different

wattages of three types of HID lamps. High Pressure Sodium (LX), Metal Halide (MA) and Mercury Vapor (MM). Choosing mounting heights within these ranges will produce more

uniform light as well as better utilization of light from the chosen fixture. The first step in any lighting job is to decide the type of fixture and its mounting height.



FLOODLIGHT FOOTCANDLE ESTIMATOR

AVERAGE MAINTAINED FOOTCANDLES = $\frac{\text{FIXTURE QUANTITY} \times \text{BEAM LUMENS} \times \text{"CBU"} \times \text{"LLD"} \times \text{"LDD"}}{\text{AREA LENGTH} \times \text{AREA WIDTH}}$

1

2

DEFINITIONS
 BEAM LUMENS — Lumens produced by fixture.
 CBU — Coefficient of beam utilization. This is the ratio of lumens striking the area to be illuminated to the beam lumens generated by the floodlight. Both horizontal and vertical beam spread must be considered. See "estimating" factor at right.
 LLD — Lamp lumen depreciation factor.
 LDD — Luminaire dirt depreciation factor.

CBU "ESTIMATING" FACTOR RULE OF THUMB

- For floodlights monitored inside a given area to be lighted use a CBU factor of .80.
- For floodlights mounted on the perimeter of an area to be lighted use a CBU factor of .60.

EXCELINE FLOODLIGHT BEAM SPREADS

Catalog No.	NEMA Type (Horizontal)	NEMA Type (Vertical)	Beam Spread (Horizontal)	Beam Spread (Vertical)
TFS175MA	7	7	133.5	137.5
TFS250MA	7	7	133.5	137.5
TFS400MA	7	7	134.8	136.4
TFM150MA	6	5	124.3	87.9
TFM175MA	6	5	124.3	87.9
TFM250MA	6	5	124.2	87.9
TFM400MA	6	5	128.9	92.9
TFL1000MA	6	6	133.4	108.3
TFL1500MA	7	6	133.4	107.3
VRA175MAL	6	5	112.0	78.0
VRA150LXL	5	4	74.0	63.0
VRC175MAL	6	5	115.0	99.0
VRC150LXL	5	5	94.0	85.0
VRF175MAL	6	6	128.0	113.0
VRF150LXL	6	6	127.0	105.0
VRG100MAL	7	7	132.7	133.0
VRG150NLXL	7	7	148.2	142.4
VRG70NLXL	7	7	149.2	136.8
KFA1001LX	7	6	131.8	122.5
KFA1001MA	7	7	131.8	129.0
KFA1001MA	7	7	144.1	141.9
CFT250MA	6	5	117.1	99.1
CFT400LX	6	6	108.8	106.4
CFT400MAL	6	6	117.7	103.8
QAF250LX	6	6	109.3	104.6
QAF250LX	5	5	87.0	99.0
QAF250LX	5	5	88.3	95.8
QAF250MA	6	6	108.3	102.2
QAF400LX	6	6	129.1	108.6
QAF400LX	5	5	100.0	101.9
QAF400MA	5	5	99.0	97.9
QAF400MA	6	6	123.1	105.3
XLF150NLXL	7	7	145.1	150.8
XLF050NMAL	6	6	116.5	144.9
CPH1525L	6	5	123.8	94.3

FLOODLIGHT BEAM PROJECTION CHART

This chart can be used to determine the number of feet a floodlight beam is projected when the luminaire is aimed perpendicular to the surface.

	Projection Distance (Setback) in feet																			
	Beam Spread in Degrees Horizontal (H) or Vertical (V)																			
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
5°	0.4	0.9	1.3	1.7	2.2	2.6	3.1	3.5	3.9	4.4	4.8	5.2	5.7	6.1	6.6	7.0	7.4	7.9	8.3	8.7
10°	0.9	1.7	2.6	3.5	4.4	5.2	6.1	7.0	7.8	8.7	9.6	10	11	12	13	14	15	15.5	16	17
20°	1.8	3.5	5.3	7.0	8.8	10	12	14	16	18	19	21	23	25	26	28	30	32	33	35
30°	2.7	5.4	8.1	11	13	16	19	21	24	27	30	32	35	37	40	43	45	48	51	54
40°	3.6	7.2	11	14	18	22	25	29	33	36	40	44	47	51	55	58	62	65	69	72
50°	4.6	9.3	14	19	23	28	33	37	42	46	51	56	60	65	70	74	79	84	88	93
60°	5.7	12	17	23	29	34	40	46	52	57	63	69	75	80	86	92	97	103	109	115
70°	7.0	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
80°	8.4	17	25	34	42	50	59	67	75	84	92	101	109	118	126	134	143	151	160	168
90°	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
100°	12	24	36	48	60	72	84	95	107	119	131	143	155	167	179	191	203	215	227	239
110°	14	29	43	57	71	86	100	114	129	143	157	172	186	200	214	229	243	257	272	286
120°	17	35	52	69	87	104	121	139	156	173	191	208	226	243	260	278	295	312	330	347
130°	21	43	64	86	107	129	150	172	193	215	236	258	280	301	322	344	366	387	409	430
140°	27	55	82	110	137	165	193	220	248	275	303	330	358	385	413	440	468	495	523	550

Product information is subject to change without notice.

LIGHTING DESIGN/GUIDELINES

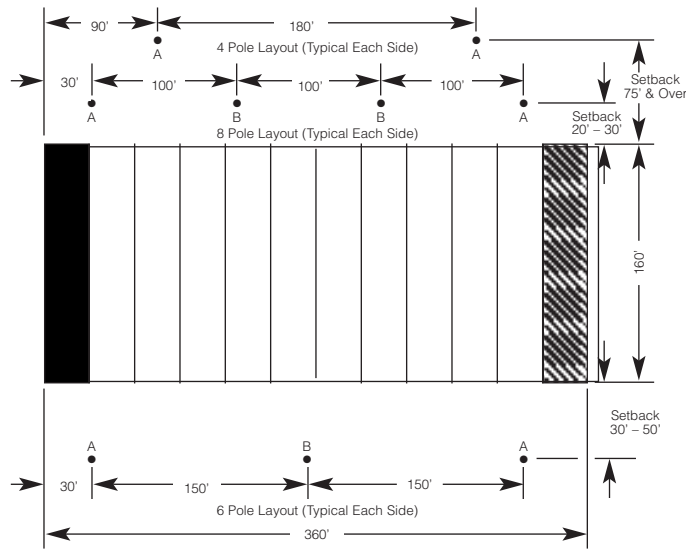
SPORTS LIGHTING DESIGN

The rising popularity of amateur sports has increased the demand for high levels of glare-free illuminance and uniformity for improved quality of play, player safety and spectator viewing. A growing number of local light trespass and pollution ordinances have also placed the additional burden of strict cutoff control on sports lighting. The level of sophistication of application tools and techniques has risen to a level that requires the use of computer driven programs and models to

meet these needs. This means that manual lighting calculations and layouts usually cannot meet the task. The following recommendations are given as general guidelines and should only be used to determine basic requirements for fixture quantities, pole heights and pole spacings. Exact layouts and aiming diagrams should be created using appropriate applications programs.

SPORTS LIGHTING RECOMMENDED ILLUMINANCE LEVELS			
Area/Activity	FC	Area/Activity	FC
Archery		Football	
Target,tournament	10	Distance from nearest sideline to	
Target recreational	5	the farthest row of spectators	
Shooting line, tournament	10	Class I over 30 meters(100 feet)	100
Shooting line, recreational	5	Class II 15 to 30 meters(50 to 100 feet)	50
Baseball		Class III 9 to 15 meters(30 to 50 feet)	30
Major league		Class IV under 9 meters(30 feet)	20
Infield	150	Class V no fixed seating facilities	10
Outfield	100	Football, six-man	
AA and AAA league		High school or college	20
Infield	70	Jr. high and recreational	10
Outfield	50	Golf	
A and B league		Tee	5
Infield	50	Fairway	1-3
Outfield	30	Green	5
C and D league		Driving range	
Infield	30	at 180 meters(200 yards)	5
Outfield	20	Over tee area	10
Semi-pro and municipal league		Miniature	10
Infield	20	Practice putting green	10
Outfield	15	Gymnasiums (refer to individual sports listed)	
Recreational		General exercising and recreation	30
Infield	15	Rodeo	
Outfield	10	Arena	
Junior league(Class I and II)		Professional	50
Infield	30	Amateur	30
Outfield	20	Recreational	
Basketball		Pens and chutes	5
College and Professional	50	Skating	
College Intramural and	30	Roller rink	10
high school		Ice rink, indoor	10
Recreational(outdoor)	10	Ice rink, outdoor	5
Combination(outdoor)		Lagoon, pond or flooded area	1
Baseball/football		Softball	
Infield	20	Professional and championship	
Outfield and football	15	Infield	50
Industrial softball/football		Outfield	30
Infield	20	Semi-professional	
Outfield and football	15	Infield	30
Industrial softball/6-man football		Outfield	20
Infield	20	Industrial league	
Outfield and football	15	Infield	20
Recreational (6 pole)		Outfield	15
Infield		Recreational	
Outfield		Underwater–600[60]lamp lumens per square	10
Slow-pitch, tournament–see industrial	10	meter[foot]of surface area	
league	7	Tennis(outdoor)	
Slow pitch, recreational		Tournament	300
(6 pole)–see recreational		Club	20
(6 pole)		Recreational	10
Swimming(outdoor)		Volleyball	
Exhibitions	20	Tournaments	20
		Recreational	10

FOOTBALL LIGHTING LAYOUTS



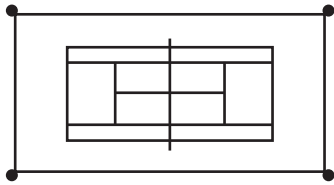
Rec Sports Floodlight— 1500W Metal Halide

Average Footcandles	Number of Poles	Mounting Height	Setback	Pole Types	Fixture Quantity	Reflector Types				Fixture Total
						2	3	4	5	
30	8	50	30	A	5				5	36
				B	4				4	
	6	60	50	A	5		5			32
				B	6		4	2		
4	75	75	A	9		8	1		36	
4	90	100	A	10		10			40	
50	8	50	30	A	8		8			60
				B	7		7			
	6	60	50	A	8		8			52
				B	10		10			
	4	75	75	A	15		15			60
	4	90	100	A	17		17			68
4	105	125	A	18		18			72	
4	115	150	A	20		20			80	
100	4	115	150	A	42		42			168

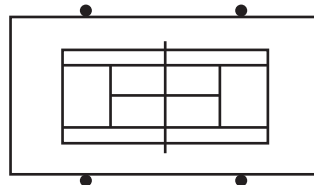
- Notes:
1. A light loss factor of .90 was used for the calculations.
 2. Calculations include the effect of lamp burning position.
 3. Rec Sports Floodlight calculations based on 155,000 initial lamp lumens.

LIGHTING DESIGN/GUIDELINES

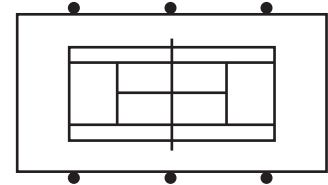
TENNIS LIGHTING LAYOUTS



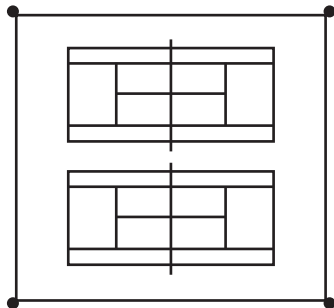
Court 1



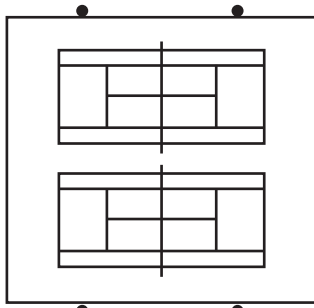
Court 2



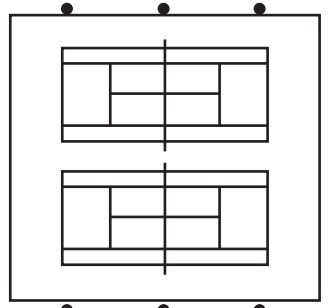
Court 3



Court 4



Court 5



Court 6

Panorama — 1000W Metal Halide

All layouts use Type 3 Distributions.

Type of Court	Class of Play FC	Court No.	No. Poles/ Mounting Height	No. Fixtures/ Reflector Type Per Pole			Lamp Type
				3	3*	Total	
Single Court	REC-20+	2	4-30'	1	—	4	Coated
	CLUB-30+	2	4-30'	2	—	8	Coated
		3	6-30'	1	—	6	Coated
	TOURN-50+	3	6-30'	2	—	12	Coated
Double Court	REC-20+	5	4-35'	—	2	8	Clear
	CLUB-30+	5	4-35'	—	3	12	Clear
		6	6-35'	—	2	12	Clear
	TOURN-50+	6	6-35'	—	3	18	Clear

REC = Recreational Level

TOURN = Tournament Level

FC = Initial Horizontal Footcandles

Notes: 1. Calculations are based on 110,000 rated initial lamp lumens.

2. Calculations include the effect of lamp burning position.

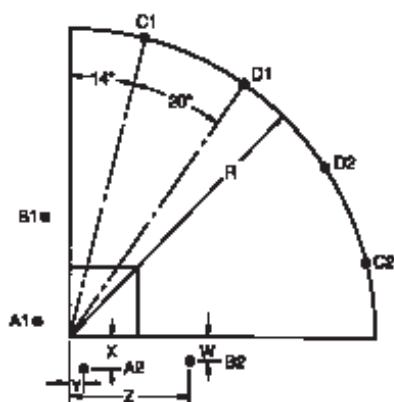
* For Double Courts 108' wide, use S5DEG Arm.

* For Double Courts 120' wide, use S10DEG Arm.

LIGHTING DESIGN/GUIDELINES

BASEBALL FIELD LIGHTING LAYOUTS

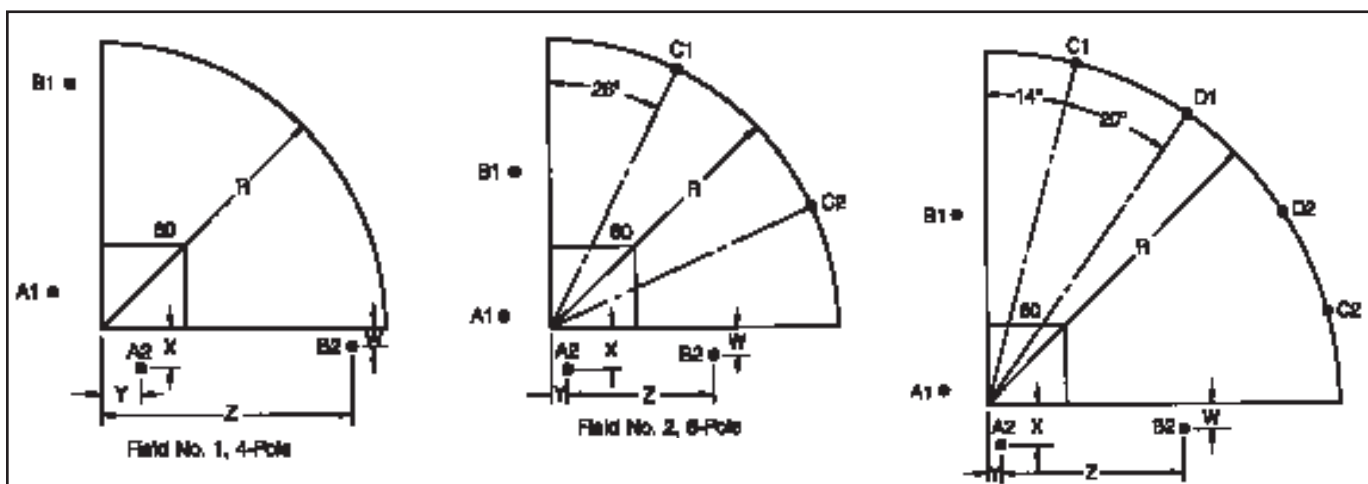
Rec Sports Floodlight



Class of Play Footcandle Levels* Poles Per Field	Pole and Mounting Height	# of Reflector Types Per Pole			Field Dimensions (Feet)					
		3	4	5	Total	R	W	X	Y	Z
Senior League 30/20 MFC 8 Poles	A1-A2-608	2	1		3	300	30	40	30	130
	B1-B2-608	2	2		4					
	C1-C2-608	1	1	2	4					
	D1-D2-608	2		2	4					
Senior League 30/20 MFC 8 Poles	A1-A2-708		2	1	3	400	30	40	20	160
	B1-B2-708	3	1	3	7					
	C1-C2-708	3		4	7					
	D1-D2-708	2		4	6					

* Infield/outfield maintained footcandles.
Based upon light loss factor of .90 and 155,000 initial lamp lumens. Includes the effect of lamp burning position.

SOFTBALL FIELD LIGHTING LAYOUTS



Field No. 1, 4-Pole

Field No. 2, 6-Pole

Field No. 3, 8-Pole

Rec Sports Floodlight

Class of Play Footcandle Levels* Poles Per Field	Pole and Mounting Height	# of Reflector Types Per Pole			Field Dimensions (Feet)					Field Diagram Number	
		4	5	6	Total	R	W	X	Y		Z
League 30/20 MFC 6 Poles	A1-A2-408	1	1	1	3	200	20	30	15	115	2
	B1-B2-408		2		2						
	C1-C2-408		2	1	3						
League 30/20 MFC 6 Poles	A1-A2-508		3		3	240	20	30	15	120	2
	B1-B2-508	2	1		3						
	C1-C2-508	2	2		4						
League 30/20 MFC 6 Poles	A1-A2-608	2	1		3	280	20	30	15	135	2
	B1-B2-608	3	1		4						
	C1-C2-608	5			5						
League 30/20 MFC 8 Poles	A1-A2-608	2	1		3	280	25	30	15	125	3
	B1-B2-608	3			3						
	C1-C2-608	2	1		3						
	D1-D2-608	1	2		3						
League 30/20 MFC 6 Poles	A1-A2-608	1	2		3	300	20	30	15	135	2
	B1-B2-608	5			5						
	C1-C2-608	5	2		7						
League 30/20 MFC 8 Poles	A1-A2-608	1	2		3	300	20	30	15	135	3
	B1-B2-608	3			3						
	C1-C2-608	1	2		3						
	D1-D2-608	2	2		4						

Notes:

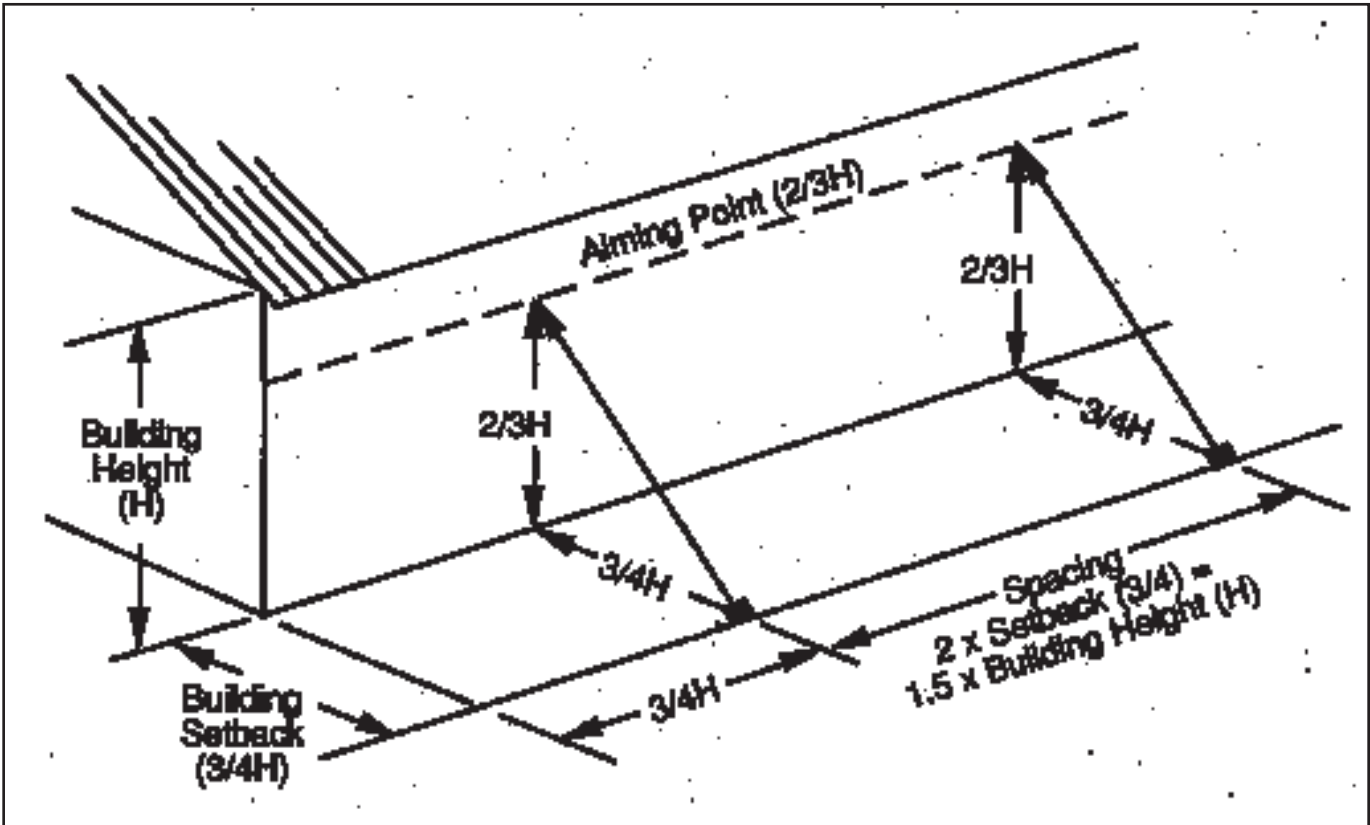
- Calculations are based on a Light Loss Factor of .90.
- Calculations include the effect of lamp burning position.
- Rec Sports Floodlight calculations based on 155,000 initial lamp lumens.

*Infield/outfield maintained footcandles.
Based upon light loss factor of .90 and 155,000 initial lamp lumens includes the effect of lamp burning position.

Product information is subject to change without notice.

LIGHTING DESIGN/GUIDELINES

FACADE LIGHTING GUIDELINES



BUILDING AND SIGN LIGHTING

Floodlighting the exterior of commercial buildings, walls and signs has many purposes. It may produce a striking visual effect, attract attention, create an attractive appearance, make a favorable impression, advertise a product or service, or give information or direction. Public buildings, churches and monuments are usually lighted as an expression of civic pride, unless the lighting is used to accent particular features or create special effects, uniformity should be a major goal of the design.

The luminaire setback from the building or sign should be $3/4$ the height of the building (or vertical distance). Closer to the building will reduce uniformity, farther away will reduce lighting efficiency.

The luminaire spacing for uniform lighting should not exceed twice the setback ($2 \times 3/4H$ or $1/2$ times the building height).

ACCENT LIGHTING GUIDELINES

Flag Pole

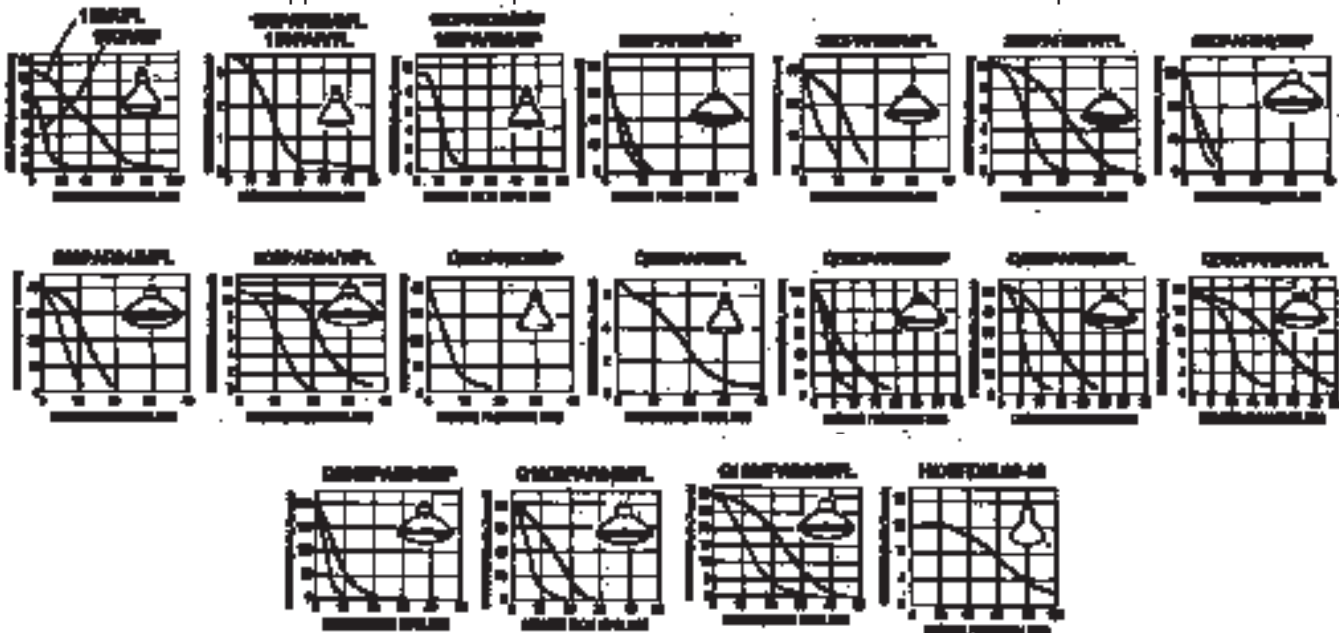
HOW TO USE CANDLEPOWER DISTRIBUTION CURVES TO CALCULATE ILLUMINATION.
To calculate footcandle at any point P on a surface lighted by a PAR or R lamp use this formula:

$$FC = \frac{\text{CANDLEPOWER}}{\text{DISTANCE}^2} \times \cos^3 \alpha$$

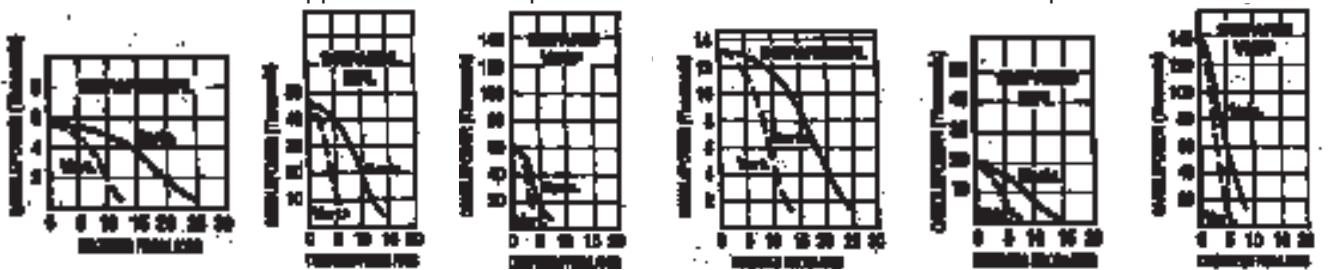
WHERE: CANDLEPOWER is found from the curve of the applicable lamp. DISTANCE is measured from lamp to point P. α is the angle at P between the lamp and perpendicular at P.

LAMP PHOTOMETRY

Approximate Candlepower Distribution Curves for PAR and R Lamps



Approximate Candlepower Distribution Curves for 12V PAR Lamps



LIGHTING DESIGN/GUIDELINES

ACCENT LIGHTING LAMP DATA

12 VOLT PAR & R LAMPS IN SPOTS & FLOODS

Watts	Bulb	Base	Filament	Max. Overall Length (Inches)	Beam Description	Average Beam Spread @ to 20% Max. Candlepower	To 10% Max. Candlepower	Initial Candlepower @
120	PAR56	Screw Threaded	C-6	4-1/2	Very Narrow Spot	8" x 8"	10" x 12"	80,000
			C-6	4-1/2	Medium Flood	9" x 18"	15" x 24"	19,000
			C-6	4-1/2	Wide Flood	18" x 35"	25" x 50"	5,625
240	PAR56	Screw Threaded	C-6	4-1/2	Very Narrow Spot	9" x 9"	10" x 12"	140,000
			C-6	4-1/2	Medium Flood	9" x 18"	15" x 24"	95,000
			C-6	4-1/2	Wide Flood	18" x 35"	25" x 50"	13,000

Lamps listed above have an average rated life of 2000 hours.

© For asymmetric beams, the vertical spread is listed first, then the horizontal.

© Peak candlepower for PAR's, average in center 1" cone for MR's, WFL, WWL.

6.0 VOLT "BULLET BEAM SPOTS"

Watts	Volts	Bulb	Base	Filament	Maximum Overall Length	Beam Spread 10% of Max.		Maximum Initial Beam CP	Average Rated Life (hrs.)
						Y	H		
120	6.0	PAR54	Screw Threaded	C-6	4"	3"	8"	180,000	2000
120	6.0	PAR54	Screw Threaded	C-6	4"	3"	5"	180,000	2000

"HID BULLET" SPOT & FLOOD

Watts	Volts	Bulb	Base	Filament	Beam Spread 10% of Max.	Maximum Initial Beam CP	Average Rated Life (hrs.)
					Y		
100	4000E	R40	Medium	Flood	78"	3000	10,000
100	4000E	R40	Medium	Spot	15"	60,000	10,000
175	4000E	R40	Medium	Flood	78"	6,000	10,000
175	4000E	R40	Medium	Spot	18"	90,000	10,000