UMC
Science and Technology
GUIDE
Published by the University of Missouri - Columbia Extension Division

Poultry Farm and Processing Plant Lighting

Kenneth L. McFate, Department of Agricultural Engineering, College of Agriculture

Poultrymen and poultry industry specialists have known for years the value of specialized controlled lighting for stimulating bird growth and egg production. But the very low lighting level (usually 2 foot-candles or less) required for better egg production has often led to low worker productivity. Houses are windowless to control light, summer heat, winter heat loss, and year-round ventilation.

Well-designed artificial lighting systems allow workers to perform tasks easily, efficiently, and safely. This is also true for related agri-industry processing plants often located in rural areas close to producers. Great emphasis placed on consumer protection and satisfaction brings strict sanitary practices in food processing facilities. Proper illumination helps achieve these objectives.

Lighting systems must provide proper quantity, quality, and color of light. Worker comfort and safety is important, but light is also needed for production efficiency and for poultry protection whether birds are housed or reared on the range.

Good lighting for farm or industry must be planned with the following factors evaluated:

1. Lighting levels desired to perform specific tasks.
2. Factors affecting light quality.
3. Room characteristics and reflectivity, factors.
4. Type of lamps and luminaires used.
5. Illumination level and lamp output relationships.
6. Room height and lamp spacing relationships.
7. Types of supplementary lights for specific jobs.
8. Care and maintenance of the system once installed.

The tasks that workers and poultry specialists perform require different *levels* of illumination, some low and some extremely high. Recent studies by a joint Farm Lighting Committee (members of the American Society of Agricultural Engineers, and the Illuminating Engineering Society) provide new guidelines for designing good lighting systems.

Specific levels of illumination in Table 1 relate to worker productivity, *not* to bird growth nor egg production. A lighting system should provide the recommended foot-candle level at any time during the life of the lamps, even after the lighting system has depreciated or has collected dust and

TABLE 1. RECOMMENDED ILLUMINATION LEVELS FOR POULTRY FARM AND INDSUTRY TASKS

Areas and Visual Tasks	Footcandles
Brooding production & haying houses	
feeding, inspection & cleaning	20
read charts & records	30
read thermometers, thermostat & time clock	50
Hatcheries	
general & loading platform	20
inspect & clean inside incubators	30
dubbing station	150
sexing	1,000
Egg handling, packing & shipping	
general cleaning	50
inspecting for egg quality	50
loading platform, egg storage area, etc.	20
Egg processing	
general lighting (clean-up for food preparation areas)	70
Fowl processing plant	
general lighting (clean-up)	70
government inspecting & grading	100
unloading & killing	20
Feed storage	
prepare & process feed rations	10
read charts & records	30
Machine storage	
move machinery in & out safely	5
Farm shop	
active storage area	10
general shop lighting - machinery repair	30
rough bench-machine work (painting, sheet metal work, welding)	50
medium bench-machine work (metal lathe, grinding & drill press)	100
Miscellaneous	
farm office (bookkeeping, etc.)	70
restrooms	30
pumphouse	20
Exterior	
general inactive areas (discourage prowlers)	0.2
light barn lots, paths, rough storage	1
service areas (fuel storage, shop feedlots & building entrances)	3

TABLE 2. GENERAL COMPARISON OF LAMP TYPE AND OUTPUT

Type of Lamp	Typical Lamp Ratings: By Size Watts	Typical Lamp Ratings: Avg. Output Lumens	Typical Lamp Ratings: Avg. Life Hours	Factors Affecting Avg. Life	Relative Light Output: Avg. Lumens Per Rated Lamp Watts (b)	Relative Light Output: Near End of Lamp Life	Special Characteristics or Considerations
Incandescent (Standard	25	225			9.0		
	40	430		(vibration)	10.8		Use "rough service" lamps where subject to vibration or shock. (Ex.: portable extension cords)
	60	810	750 to 1,000		13.5	(80% of initial light output.)	
	100	1,600			16.0		
	150	2,500			16.7		
	200	3,500			17.5		
	300	5,490			18.3		
Fluorescent (Standard)	20	900		(Number of starts) (Ballast type)	45.0	80% of initial light output at 85% of rated life; 68-70% at end of life.	Diffuse light more uniformly over broader areas than do other two.
	40	2,300	7,500 to 10,000(a)		57.5		
	60	3,300			55.0		
	100	5,500			50.0		
	210	11,000			52.4		
Mercury	75-85	2,000		(Number of starts) (Ballast type)	26.7	Up to 87% of initial lumens near end of economic rated life.	Most require special fixtures and ballast. Only Mercury lamps with less efficient built-in ballasts can interchange with incandescent lamps. If power is interrupted, lamp must cool before it will restart.
	100	2,800			28.0		
	175	6,000	12,000 to 16,000		34.3		
	250	9,500			38.0		
	400	18,000			45.0		
	700	31,000			44.5		

(a) Avg. life, based on 3 hours of operation per start.
(b) Power for ballasts must be added.

dirt. Consequently, the initial system design should provide a slightly higher level than given in Table 1. Data were obtained with scientific measuring equipment and in consultation with poultry specialists at Cornell University, Ithaca, New York.

Good *quality* light prevents glare. Glare is controlled by shading windows, shielding lamps and by painting interior surfaces with a flat, non-glossy paint for a "matte" finish.

When practical, improve light quality, and obtain more useful light by painting ceilings, walls, floors, and equipment with a white or light color. Ceilings should reflect 80 percent; walls, 40-60 percent; and floors at least 20 percent of the light striking them. As a guideline, the reflective value of white cement is about 50 percent. Color reflectance charts are available from most paint dealers.

Great differences in brightness between a lighted task-area and the remainder of the room can be annoying and often uncomfortable. Therefore, it is desirable to have a brightness ratio between light and dark areas of 2 to 1 for difficult seeing jobs; a ratio of 5 to 1 for less critical tasks.

Lighting Equipment Compared

A comparison of three common lamp types listed in Table 2 is a general guide. While there is little difference in the amount of light emitted by a particular size of standard incandescent lamp, the lumen output* of a specific size of fluorescent lamp varies considerably with color and design. Values in Table 2 are for daylight fluorescent lamps. Lumen output of mercury lamps also varies with design and degree of color correction built into them.

For a more true comparison of efficiency, lumens-per-watt-factors for fluorescents must generally be reduced from 20 to 30 percent to offset power consumed by the ballast which produces heat and not light. For mercury lamps, the lumen/watt factor must be lowered by about 11 to 14 percent to account for energy used by their ballasts. (These adjustments were not made in Table 2 because of wide differences in energy consumed when one, two or more lamps are used with a specific ballast).

When accounting for power consumed by ballasts, fluorescent lamps are 2.5 to 3 times more efficient to operate than incandescent and 1.5 to 1.8 times more efficient to operate than mercury lamps. The *life* of mercury lamps is 1.5 to 2.0 times as great as fluorescents; and life of fluorescent lamps is 7.5 to 12 times as great as incandescent. The life of fluorescent and mercury lamps may be greater than shown in Table 2 if operations average more than three hours per start.

Where to Use Different Lamp Types

Electric lamps give off light in nearly all directions. For most efficient operation, one of several typical luminaires shown in Figure 1 will normally be used. Properly selected, they will direct light where you need it.

All light from incandescent and mercury lamps comes from a "point" source. Even though incandescent bulbs are usually coated to reduce glare, fluorescents diffuse light more uniformly over a broader area. Most rapid-start fluorescent lamps are made with invisible silicone coating that disperses moisture film. This insures reliable starting where high humidity conditions exist.

Incandescent or fluorescent lamps will satisfy interior

*The total amount of light emitted from a lamp or luminaire is measured in lumens. The amount of light on a surface is measured in footcandles.

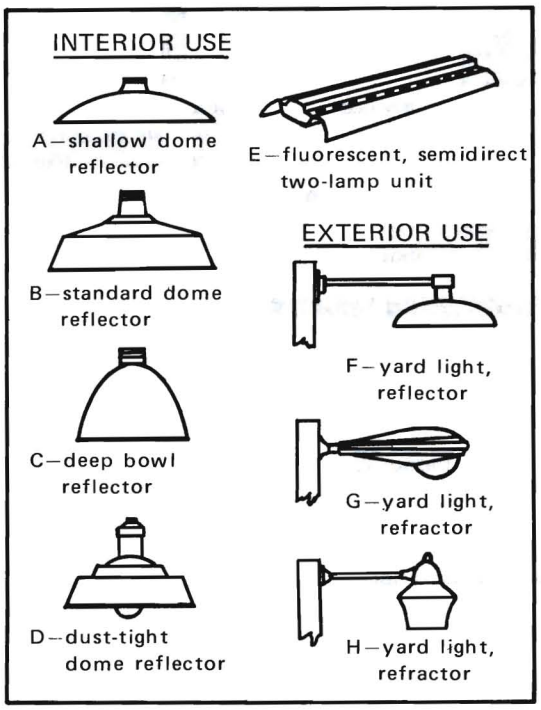


Fig. 1 Typical Luminaires for Poultry Industry Facilities.

lighting needs. Incandescents are recommended when lamps must be switched on and off for short time periods. Mercury lamps are suited to outdoor applications and normally mounted at heights of 16 feet or more. However, they require a 5 to 10 minute warm-up period between stop and start. Mercury lamps are not as efficient as fluorescents. But lamps in the 300 to 400-watt range give twice as much light per watt of energy as incandescents. With long life and low maintenance, the higher fixed cost of mercury often can be justified for outdoor lighting jobs. The outdoor lighting guide in Table 3 is from USDA Farmers Bulletin No. 2243.

TABLE 3. OUTDOOR LIGHTING RECOMMENDATIONS

Area or activity	Recommended footcandles	Typical installation[1]
Protective lighting	0.2	175-w. mercury refractor mounted 25 feet high for lighting 8,000 sq. ft.; or incandescent floodlight.[2]
General work areas, driveway, walks, barn lots.	1.0	400-w. mercury refractor mounted 25 feet high for lighting 8,000 sq. ft.; or incandescent floodlight.[2]
Activity areas, fuel storage, building entrance, electrical load center, feedlots and equipment, livestock loading, recreation area.	3.0	400-w. mercury refractor mounted 25 feet high for 2,000 sq. ft.; or incandescent floodlight or spotlight.

1 Based on ratings of clear mercury lamps.
2 Distance between lamps should not exceed 5 times mounting height.

System Plans and Layout

Specific factors affecting overall performance of lighting systems are room size and height, color of walls, ceiling and equipment, type of lamp and luminaire, and lamp height and spacing. Generally speaking, most luminaires can be suspended at from 7 to 10 feet above the floor in poultry buildings. Interior surfaces can have from medium to average reflectance values.

With the above assumptions in mind, use one basic guideline to account for most of the judgment factors of design—*allow 2 lumens of lamp output for each square foot of floor area to provide a lighting level of 1 foot-candle.*

Lamp and luminaire height and spacing is related to the uniformity of light to be obtained. Agricultural and lighting engineers recommend that lamps be spaced a distance of 1 to 1½ times their mounting height if desired illumination level is between 5 and 10 footcandles. If the lighting level is to be higher than 10 footcandles, the lamp spacing should be limited to its mounting height. When using the former spacing with incandescent lamps, use shallow dome reflectors; when using the latter spacing, use standard dome reflectors. With either, the distance of outside lamps to walls should be no more than one-half the distance between lamps.

Applying the Guidelines and Recommendations

A typical problem can serve to illustrate how the data can be applied. Let us assume that we must plan a lighting system for a 20 x 40 foot egg handling room with light colored walls and ceiling. The ceiling height is 8 feet.

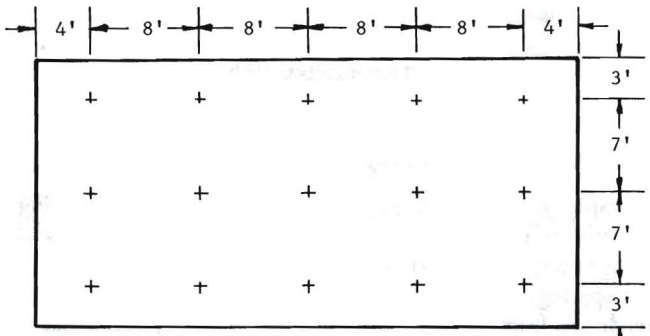
Table 1 shows we need 50 footcandles (ftc.) for both inspecting and for general cleanup. Our "lighting guideline" calls for 2 lumens/sq. ft./ftc. Therefore:

Floor area is 20′ x 40′ or 800 sq. ft. and, 800 sq. ft. x 2 lumens/sq. ft./ftc. is 1600 lumens for each footcandle requirement. So, 1600 x 50 ftc. (level required) is 80,000 lumens or, total amount of light required for the handling room is 80,000 lumens.

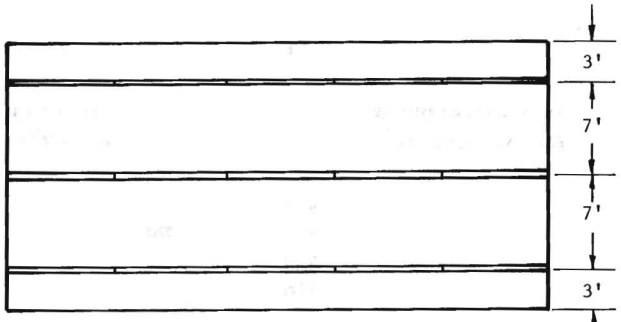
Since this is a high level of lighting, our maximum lamp spacing should not exceed the floor to ceiling height of 8 feet; and since the first row of lamps cannot be more than 4 feet from each of the long walls, we'll need at least three rows of lamps. Thus, let's estimate use of 15 lamps placed as shown in Figure 2. This means that each of the 15 lamps must have an output of $\frac{80{,}000}{15}$ or 5333 lumens.

Referring to Table 2, we see that we'd need a 300 watt incandescent lamp if we chose that *type.* The low mounting height might cause bright spots and eye discomfort for workers near the light sources. So, if we chose *incandescent* lamps we may prefer more lamps spaced closer together with small bulbs for uniform lighting.

A fluorescent system appears more desirable as the light from the "line" source is spread over a broader area and is more diffused. Fifteen fluorescent single tube 100-watt lamp



a. Estimated Lamp Spacing and Placement, incandescent



b. Recommended Installation-three rows of single lamp strip lights on ceiling, fluorescent

Fig. 2 Egg Handling Room, Lighting System Design

and fixtures, as located in Figure 2b, would meet our criteria. Since the 100-watt lamp is approximately 8 feet long the system would be three continuous lines of single fluorescent lamps, making a uniformly lighted egg handling room. The lamps should be shielded to prevent glare. Make a cost comparison of 15 fluorescent fixtures vs. 21 or 24 incandescent fixtures at local prices.

Fluorescent lamps and fixtures are higher in first cost than incandescents but fewer fluorescents are needed. With higher efficiency considered, along with fixed cost comparison, fluorescents will usually give the most light per dollar investment for lighting rooms of this type.

To continue with the lighting system design, locate a 300-watt incandescent lamp in an outdoor fixture similar to that shown in "F", Figure 1. Place it 8 to 10 feet above the loading platform. If an egg storage area is located nearby, calculate the lighting as above but on the basis of 20 ftc. (rather than the 50 ftc.) for the egg handling area. Be sure to provide adequate wiring to limit voltage drop to 3 percent inside the building.

Special Lighting Considerations

Supplementary lighting is the most economical and practical way to achieve the high footcandle levels required for specific tasks such as sexing. Such tasks are usually performed in small areas where supplemental lighting is more practical. R-40 flood or spot lamps with built-in reflectors are a good choice. Tungsten-iodine lamps can also be used. Where used in dusty locations or in explosive atmospheres, lamps should be enclosed in dust-tight reflectors. Revolving tools, like grinding or buffing wheels, should be lighted with incandescent lamps to avoid hazardous stroboscopic effects that can be created by some fluorescent lamps. (Fluorsecent lamps will sometimes make running tools falsely appear to be at a standstill). Deep-bowl reflectors will concentrate incandescent lamp light onto the working area.

Electrical Wiring Important, Too

Most lamps are rated at 120 volts for single phase wiring systems. When purchasing, don't take this for granted—check the voltage rating stamped on the lamp itself. Your wiring system should be designed for a minimal voltage drop from the transformer to the lighting outlet. The outlet voltage should be within 3 or 4 volts of rated lamp voltage. Too high a voltage will increase light output but will greatly shorten lamp life. On the other hand, too low a voltage will increase the lamp life but will give considerably lower light output.

Always use UL (Underwriter's Laboratories) approved wiring, fixtures and wiring materials. If wiring is to be installed in a wet, corrosive atmosphere, use type NMC or UF-NMC grounded cable; if underground, use type UF or USE. For overhead exterior use, use the proper size of "tri-plex" for easy maintenance of minimum clearances and for a neat appearing farmstead.

Ample use of 3 and 4-way switches will allow you to have "switch ahead" lighting systems—systems that will allow you to light up paths, walkways, stairs, and entrances *before* you use them and then allow lights to be turned off after you have reached your destination. All lights should be properly controlled at, in, or from frequently used buildings if they are to serve maximum usefulness in convenience, efficiency, and safety.

System Maintenance

Any well designed lighting system will deliver the light for which it was designed *only* if the system is properly maintained. A good maintenance program involves prompt replacement of blackened or burned out lamps, washing lamps and luminaires periodically, cleaning and repainting walls and ceilings on a scheduled basis.

A check of illumination levels with a simple footcandle light meter, immediately after installation and again at three-month intervals, will help you set up a maintenance schedule for your particular conditions. Such checking should be done over a full-year period to account for seasonal variations in dust and dirt collection. A light meter can often be borrowed from a power supplier, extension home economist, or from a local physics teacher.

References:

ASAE Recommendation R332, Poultry Industry Lighting. P 409-412, Agricultural Engineers Yearbook, 17th Edition, 1970.

Farm Lighting, Farmers' Bulletin No. 2243, December 1969. U. S. Government Printing Office.

■ Issued in furtherance of Cooperative Extension Work Acts of May 8 and June 30, 1914 in cooperation with the United States Department of Agriculture. Leonard C. Douglas, Acting Director, Cooperative Extension Service, University of Missouri and Lincoln University, Columbia, Missouri 65211. ■ An equal opportunity institution.