LIGHTING IN EQUIPMENT BUILDINGS

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Figures

1. GENERAL

1.01 This section discusses and provides standards for lighting in equipment buildings. These standards are provided for use in the design of new buildings or building additions that are intended to house telephone equipment that meets the requirements of Bell System Practice 800-610-164, "New Equipment-Building System (NEBS), General Equipment Requirements."

1.02 This section supersedes Section 9.5 of Specification X-74300, "NEBS Building Engineering Standards (BES). Whenever this section is reissued, the reason for reissue will be listed in this paragraph.

SCOPE

1.03 In the planning of a telephone equipment building it is important to provide for adequate and efficient lighting at all locations. Adequacy implies that the quantity and quality of illumination are sufficient for the task or other activity, while efficiency implies that unnecessarily high illumination levels have been avoided and that the high-performance light sources selected are being used economically.

1.04 Economical use means, first, that lights are placed only where needed; second, that a sufficient number of switched circuits are provided so that unneeded light can be turned off; and third, that there is an adequate plan for maintenance of the lighting system so that its performance will not deteriorate below the design values.

1.05 To assure continued telephone service if commercial power fails, small amounts of light, derived from Central Office battery power

or local power packs, must be provided to certain areas. For power outages of relatively long duration, there are many areas that must be lighted with power from the engine generator plant.

2. ILLUMINATION STANDARDS

Central Office Equipment Areas

2.01 Illumination levels for Central Office equipment areas are listed in Part 3 of Section 800-610-164, NEBS General Equipment Requirements, and at the end of this section. They are listed in both documents so that those responsible for providing the illumination will know what is required, and so that physical designers will know the lighting levels available in the environment within which their equipment must operate.

2.02 The listed values represent minimum maintained levels of illumination. New lighting systems should provide initial illumination levels not less than 25 percent higher than those listed to account for losses due to lamp lumen depreciation and luminaire (lighting fixture) depreciation due to dirt accumulation, and not more than 50 percent higher to account for modularity of the lighting equipment.

2.03 The new standard lighting system, per J85515, is mounted under the cross-aisle cable troughs in the maintenance aisles. Some direct or reflected light enters the wiring aisle, usually giving an illumination level that is adequate for safe passage of maintenance personnel. The adequacy of this wiring aisle illumination level will be assured by conformance to the Cable Pathways Plan, (see BSP layer 760-1 and Section 801-801-182, General Equipment Requirements, Cable Distribution Systems and Systems Assembly in Electronic Offices Using 7-foot Frameworks); and by providing high-reflectance finishes on equipment room ceilings, see Part 6. Portable work lamps are used for maintenance operations.

2.04 The illumination for areas having LED displays is under study. The output of light-emitting diodes is low, so that careful control of the light level in the surrounding area will be needed for maximum visibility.

Nonequipment Areas in Equipment Buildings

2.05 In EL 2963, AT&T recommends illumination levels for nonequipment areas. These levels, which are consistent with the long-term worldwide need to reduce energy consumption, are listed at the end of this section. They are given in terms of average maintained footcandles; this is the ***maintained*** level of illumination that represents the average of all points in the work plane. The initial level of a new system is set higher than this to allow for losses due to luminaire dirt and lamp lumen depreciation.

2.06 These recommendations represent illumination levels at the tasks. Often, a task will require a higher level than that required by the surrounding area. Examples are switchboards and drafting tables. In such cases, it may be practical to provide a lower level of general room lighting and to use supplemental lighting at the tasks.

2.07 Interior lighting systems should be simple and economical. In particular, luminous ceilings are not recommended, because they are expensive to install, operate, and maintain.

2.08 Wherever practical, fluorescent lamps should be used in preference to incandescent lamps. The fluorescent lamp is about four times as efficient as the incandescent lamp; thus, it gives far more light per dollar, and much less heat. The use of fluorescent lighting should be stressed in areas where the lights are on for many hours per day.

2.09 Exterior lighting systems likewise should be simple and efficient and should provide only that illumination essential for security, walkways, driveways, and parking lots. Exterior building and landscape lighting that does not perform an essential function should be minimized, particularly building floodlighting. The circuits of any exterior building lighting should be equipped with timers so that their on-off periods can be controlled. This is recommended particularly for unattended buildings.

3. LIGHTING SYSTEMS FOR EQUIPMENT AREAS

3.01 A new lighting system, J85515, has been developed to replace the ESS-type system covered in ED-4C011-10, formerly used with 7-foot equipment frames. The J85515 system uses a new fluorescent lighting fixture, KS-21559. The fixture has a single 40-watt, U-shaped lamp in a compact

housing measuring 1 foot by 1 foot, 11-1/8 inches by 3-5/32 inches, and is mounted beneath cross-aisle cable troughs. Instead of a plastic light diffuser, it has a steel louver with baffles aligned at 45 degrees to the equipment surfaces, to direct light toward the equipment and to control glare.

3.02 The new lighting supplies illumination comparable to that from the older system using the KS-20768 fixture (see Fig. 1 for comparisons), but with greatly reduced energy requirements, simplified supports, less blockage of cooling air flow, improved access for placing cable in adjacent racks, and easier fixture maintenance. Also, there is a substantial reduction in the number of fixtures and lamps, with a proportional effect on the amount of copper, sizes of panelboard and quantity of circuit breakers needed in the power distribution system. Figure 2 compares the relative annual costs of owning and operating the J-85515 and ED-4C011-10 light-systems and reflects the savings achieved by using the J-85515 system.

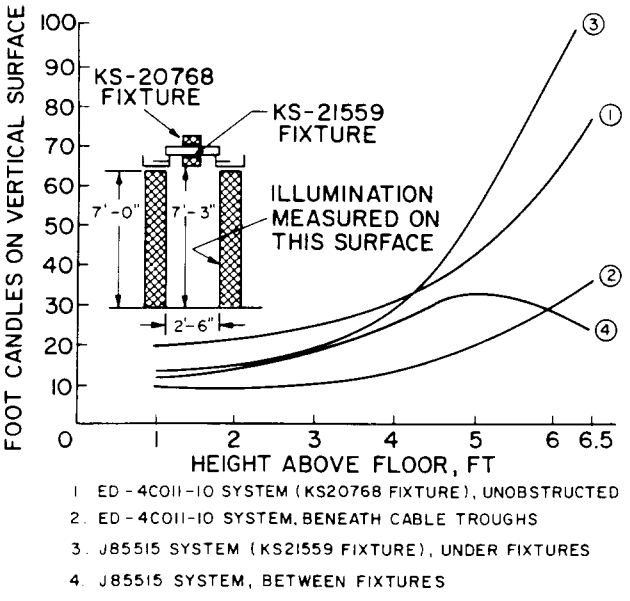

Fig. 1—The J85515 Lighting System Supplies Illumination Comparable to that From the ED-4C011-10 System

3.03 The new system, described in specification J-85515 (Section 802-015-160), will be applicable to most areas of NEBS offices.

3.04 The principal drawings for lighting systems for use in NEBS offices are listed below.

For No. 1, No. 2, and No. 4 ESS (including terminals), ETS, TSPS, AIS, VF transmission and terminal equipment, and carrier system:

Drawings ED-4C011-11, ED-4C011-31, SD-4C003-01 are needed. Use KS-21559 fixture.

For No. 3 ESS:

Drawings ED-3H151-30 and SD-3H908-01 are needed. Use KS-21559 fixture.

For broadband carrier:

Drawings ED-97799-50 and SD-4C003-01 are needed. Use KS-21559 fixture.

For 415A Power Plant:

Drawings ED-82782-12, ED-82782-13, SD-4C003-01 are needed. Use KS-21559 fixture.

For engine rooms and 111A, 326, 411, 412, and 413 power plants:

Drawings ED-82013-11, SD-81035-01, SD-81126-01 are needed. Use KS-20440 fixture; however, work is underway to apply the KS-21559 fixture in these areas.

For COSMIC main distributing frame:

Drawings ED-6C015-10, SD-81035-01, SD-81126-01 are needed. Use KS-20440 fixture.

For low profile main distributing frame:

Drawings ED-97788-10, SD-81035-01, SD-81126-01 are needed. Use KS-20440 fixture.

4. EMERGENCY LIGHTING

4.01 When commercial electrical power is lost to a Central Office building, certain areas receive small amounts of illumination from an emergency-lighting circuit powered by a Central Office battery. This

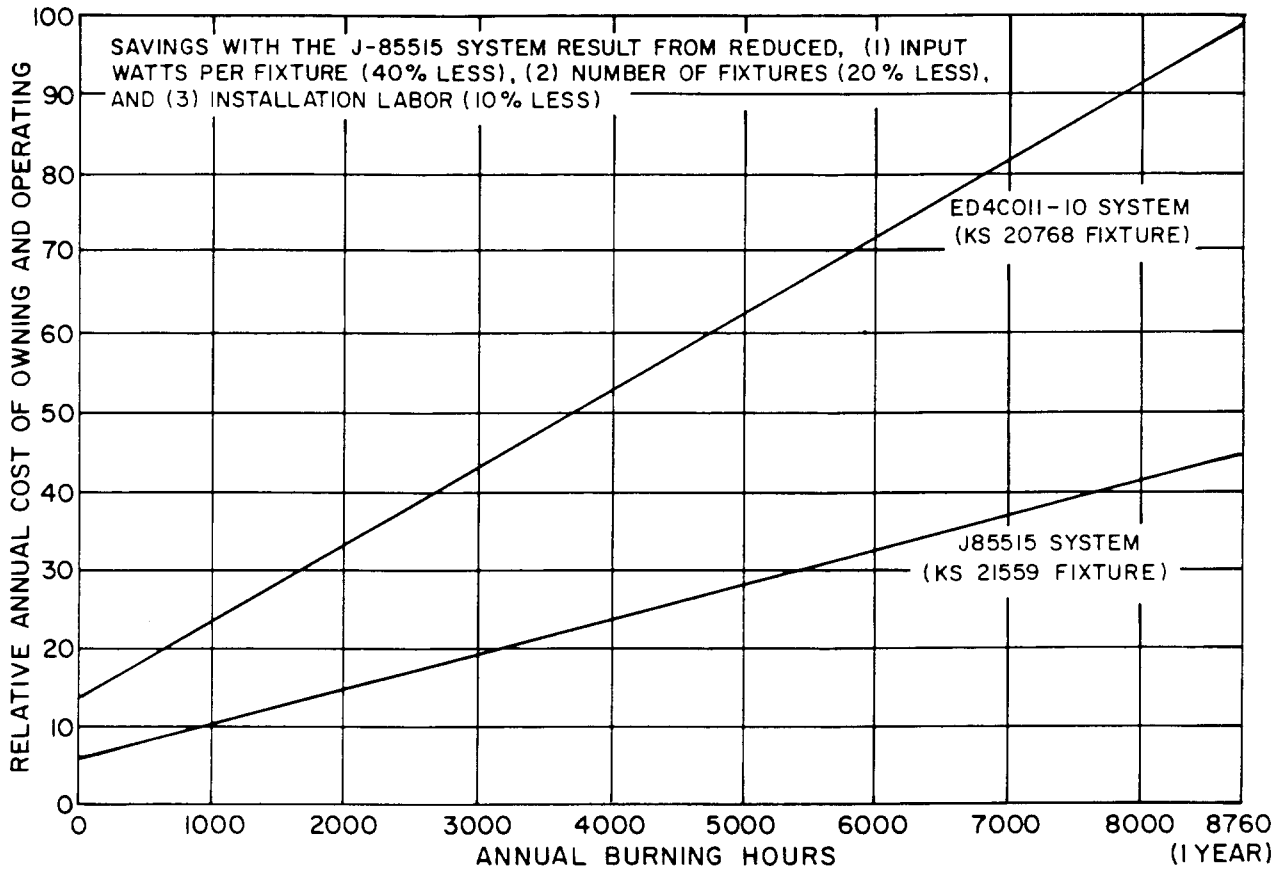

Fig. 2—The J85515 Frame and Aisle Lighting System Cuts Costs by Half in Comparison to the ED-4C011-10 System

circuit is energized instantly and automatically when commercial power fails.

4.02 The areas to be equipped with emergency lighting are listed in J95502 (Section 802-015-158), "Emergency Lighting Equipment, Battery Type for Central Offices." They include switchboards, operating room desks, terminal and switch rooms, power machine rooms, battery rooms, and engine rooms.

4.03 The illumination levels provided by this system in terminal and switch rooms are just enough to enable people to find their way around the rooms. Emergency lighting is needed only during the period between commercial power failure and emergency AC start-up. In offices with automatic-start engines, this period would be only seconds.

4.04 It is traditional to use incandescent lamps in the emergency lighting circuit. In recent years, various solid-state inverter units have become available; powered by the Central Office battery, these can drive fluorescent lamps. A seeming advantage of this system is that the same lighting fixtures can be used for normal and emergency lighting; however, this is outweighed by a number of disadvantages:

(a) The inverter unit tends to produce electrical noise. It is believed that noise from a malfunctioning inverter caused a Central Office service failure which lasted for more than an hour.

(b) Because of the number of parts, the inverter unit has a relatively high failure rate. Failure is accelerated by temperature when the inverter unit is housed in the lighting fixture.

(c) Inverter units are relatively costly (about 4 or 5 times the cost of an incandescent fixture). Therefore, it is recommended that incandescent lamps be used in the emergency lighting circuit.

4.05 Normally, the small emergency lighting system is needed only until the engine-driven power plant is operating, providing power for additional lighting. A letter from AT&T to all Chief Engineers, dated February 17, 1967, gives recommendations on the areas in telephone buildings that should be lighted by generator power during prolonged emergencies.

5. QUALITY OF ILLUMINATION

5.01 In most situations, it is not enough to provide an adequate illumination level on the task; the illumination also must be of good quality. The first considerations are the luminance (photometric brightness) ratios of ***appreciable*** areas within the field of view. When these ratios are excessively large, people may experience discomfort, fatigue, and reduced efficiency.

5.02 Glare, the next consideration, is the sensation produced by luminances within the visual field that are sufficiently greater than the luminance to which the eyes are adapted that annoyance, discomfort, or loss in visual performance and visibility results. It is produced either by the direct light from windows or luminaires, or by the light reflected from polished or glossy surfaces.

5.03 Direct glare can be minimized or eliminated by one or more of the following measures:

(a) Remove the light source from the field of view.

(b) Modify the light source to reduce or eliminate the direct light seen by the observer.

(c) Reduce the brightness of the source.

5.04 Reflected glare can be minimized or eliminated by one or more of the following measures:

(a) Reduce surface reflectances.

(b) Mount reflecting surfaces at angles that do not reflect light into the eye.

(c) Control relative locations of luminaires and work surfaces.

(d) Control directions in which light is radiated from luminaires.

5.05 The efficient performance of a visual task depends not only upon the illumination level but also upon the task contrast, which is defined by:

$$C = \frac{B_1 - B_2}{B_1},$$

where C is contrast, B_1 is the brightness of the background (paper, in typical reading tasks), and B_2 is the brightness of the information (pencil or ink, in typical reading tasks).

5.06 Any reduction in task contrast lowers the visual performance. If, for example, the white paper is changed to dark gray, a very large increase in the illumination level is required to restore the initial legibility.

5.07 Suppose that an overhead light source is located somewhat in front of a desk worker who is reading hard black pencil writing on white paper. The shiny pencil marks may reflect enough light to cause a large increase in brightness B_2 in the above equation, thus reducing the task contrast as well as the worker's comfort and efficiency. These effects, which can be so subtle that they go unnoticed, are called "veiling reflections." Reflections from glossy paper or from console surfaces and controls cause the same effect.

5.08 If the locations of desks can be exactly controlled, the lighting system designer can locate the light sources slightly behind the worker's head, as indicated in Fig. 3, so that light is not reflected from the task to the eye. If the worker tilts the reading material, however, the reflections may return.

5.09 With consoles having two or more surfaces inclined at different angles, the problem is even more severe. An arrangement that can be very effective for both desks and consoles is the use of "bat-wing" luminaires. (See Fig. 4). These

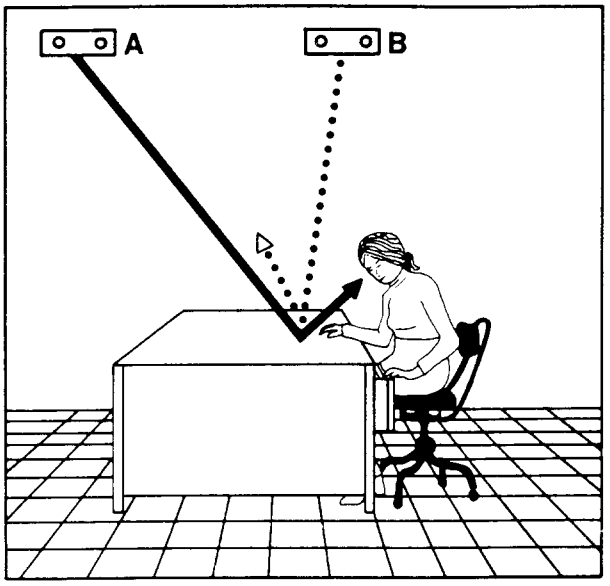

Fig. 3—Luminaire at A May Produce Reflections. With Luminaire at B, Light Reflected Away from Worker's Eyes

radiate light from their long sides, but not from the ends. Mounted above the aisles at the ends of desks or consoles, and oriented at 90 degrees to the long axis of the desks or consoles, these provide directional light that cannot be reflected into the worker's eyes. Ideally, this yields the maximum possible task contrast.

5.10 Windows without luminance control are a frequent cause of visual discomfort and disability glare. Undesirable conditions may require that some combination of reduced-transmission glass, shades, or louver or baffle systems be used on windows.

6. SURFACE REFLECTANCES AND COLORS

6.01 The surface reflectances of ceilings, walls, and floors should be treated as elements of the lighting system. Light (high reflectance) surfaces are much more efficient than dark surfaces in conserving light and distributing it uniformly. Finish textures should be matte or flat rather than glossy; this aids in distributing light evenly and minimizes reflected glare.

6.02 However, if colors are required for decorative purposes, their reflectances should be carefully checked. Unless all the colors in a room are very light, well over 50 percent of the light may be absorbed. If the Munsell Value of a color is known, the Luminance Factor, or reflectance, can be determined from a chart such as Figure 5-10 in the ***IES Lighting Handbook.***

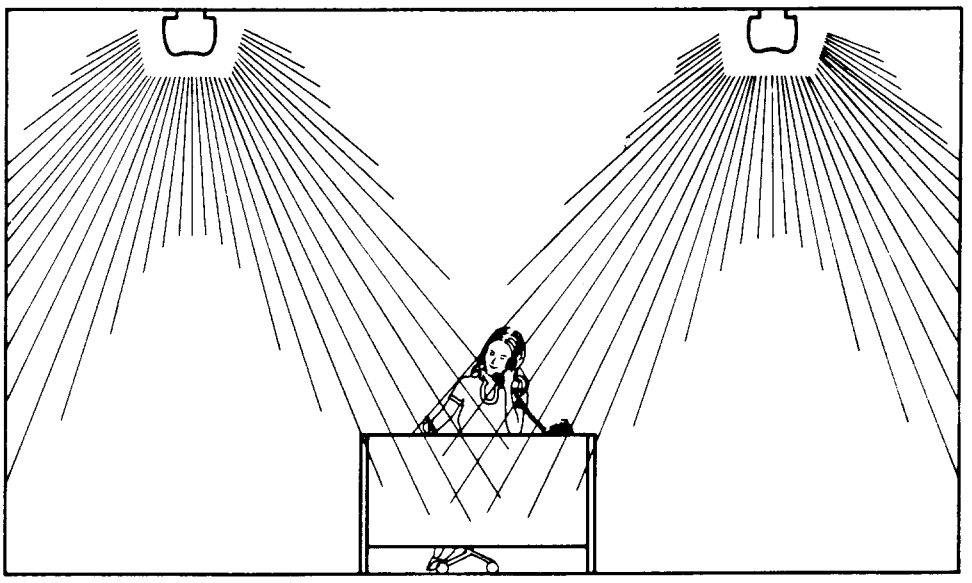

Fig. 4—Use of "Bat-Wing" Luminaires to Prevent Reflection of Light Into Worker's Eyes. Relative Locations of Desks and Luminaires Must be Controlled

7. MEASUREMENT OF ILLUMINATION

7.01 Illumination measurements can be affected by light-meter characteristics and accuracy, by the way in which the meter is used, and by the arrangement of the lighting equipment. The General Electric Type 214 light meter shown in Fig. 5, is recommended for most field meaurements where relatively low accuracy is acceptable. It is small, inexpensive, and fully color and cosine corrected. The latter term means that it gives the correct relative responses to light arriving from all directions within a hemisphere. The scale covers 0 to 1000 footcandles; however, the meter is not recommended for measuring in the 0-to-10-footcandle region.

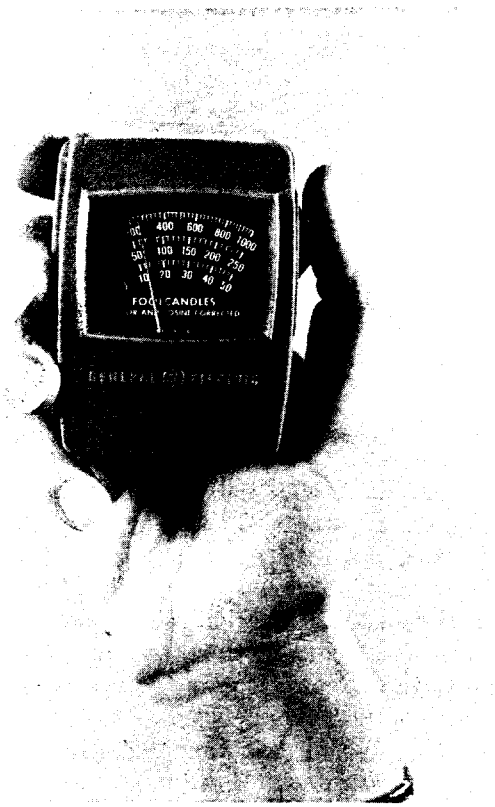

Fig. 5—General Electric Type 214 Light Meter

7.02 When taking readings, the observer should avoid casting a shadow on the light-sensitive cell. Reflections from bright clothing, etc, can also affect readings.

7.03 When measuring the illumination on a plane — horizontal, vertical, or inclined — the instrument should be positioned so that the surface of the light-sensitive cell is parallel to the plane.

7.04 For further information on light measurement, see the ***IES Lighting Handbook.***

8. LIGHTING MAINTENANCE

8.01 For a more detailed treatment, see Section 770-120-305, "Maintenance of Fluorescent Lighting Systems."

8.02 The output of a new lighting system always drops with the passage of time. The more significant factors contributing to increasing light loss are luminaire surface depreciation, luminaire depreciation due to dirt accumulation, lamp burnouts, lamp lumen depreciation, and room surface depreciation due to dirt accumulation.

8.03 Luminaire surface depreciation refers to the tendency of some surface materials, such as enamels, to deteriorate with time. Most plastics used for light transmission and control suffer changes in transmittance and color when exposed to ultraviolet radiation and heat. Use of improper cleaning materials or methods on plastics also can cause chemical action or surface scratching.

8.04 There can be an appreciable loss of light when a lamp burns out and is not replaced immediately. When fluorescent lamps are wired as series pairs, the failure of one lamp turns off the other lamp.

8.05 Lamp lumen depreciation is the gradual drop of a lamp's light output as the lamp ages. This is illustrated in Fig. 6 for fluorescent lamps; it is characteristic of all lamp types.

8.06 Luminaire depreciation and room surface depreciation due to the accumulation of dirt are important considerations in any area where the reflectances are initially high and where the surfaces play a large part in the light distribution.

8.07 Lighting maintenance is essential to the continued effectiveness of any lighting installation. It involves the cleaning and replacement of lamps, the cleaning of luminaires, and the cleaning or repainting of room surfaces. In all but the simplest installations, systematic maintenance plans are essential if the illumination levels are to be held within their design limits. While in some circumstances the work can be done efficiently by

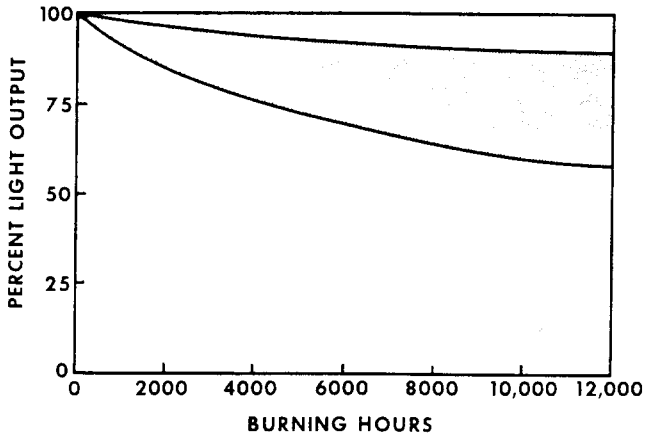

Fig. 6—Light Output Depreciates as Fluorescent Lamps Age. Most Lamps Follow a Curve Near the Top of the Shaded Area

employees of the building owner or tenant, it may be necessary or desirable in other cases to engage a specialized lighting maintenance contractor.

8.08 Maintenance plans are described in the ***IES Lighting Handbook*** and in "Lighting Maintenance," General Electric pamphlet TP-105.

8.09 Finally, good lighting must be planned with maintenance in mind. The lighting system designer can do the best and most economical job of meeting the performance requirements if he has full knowledge of the maintenance plan that will be followed.

9. REFERENCES

(1) AT&T letter to Chief Engineers, "Continuity of Communications and Operational Services During Prolonged Power Failures," Feb. 17, 1967

(2) Section 770-120-305, "Maintenance of Fluorescent Lighting Systems"

(3) Section 800-610-164, "NEBS General Equipment Requirements"

(4) ED-3H151-30, "No. 3 Electronic Switching System, AC Power Distribution, Hardware, Assembly and Wiring for AC Power and Lighting Circuits"

(5) ED-4C011-11, "Common Systems, Frame and Aisle Lighting, Wiremold AC Distribution, Electronic Switching System Areas"

(6) ED-4C011-31 "Common Systems, Frame and Aisle Lighting, Wiremold AC Distribution, Electronic Switching Area, Stocklist and Assembly Figures"

(7) ED-6C015-10, "COSMIC Frame System, Typical Cable Rack and Lighting Arrangements"

(8) ED-82013-11, "Frame and Aisle Lighting — Power and Engine Rooms — Fluorescent Type"

(9) ED-82782-12, "Power Systems, Frame and Aisle Lighting with Wiremold AC Distribution for one 200 kW 415A Power Plant Module, NEBS Applications"

(10) ED-82782-13, "Power Systems, Frame and Aisle Lighting with Conduit AC Distribution for One 200 kW 415A Power Plant Module, NEBS Applications"

(11) ED-97788-10, "LPCDF, Typical Cable Rack and Lighting Arrangements

(12) ED-97799-50, "Common Systems, Specification for Lighting Assembly for Broadband Cableway System"

(13) EL 2963, "Bell System Energy Conservation Program — Building Engineering," Jan 23, 1974

(14) J85515, Section 802-015-160, "Central Office Lighting, Fluorescent Type, Equipment Design Requirements, Power Systems"

(15) J95502, Section 802-015-158, Emergency Lighting Equipment, Battery Type for Central Offices"

(16) SD-3H908-01, "Electronic Switching System No. 3, AC Power Distribution Circuit"

(17) SD-4C003-01, "Common Systems,, Lighting Circuit, Fluorescent Type for Electronic Switching System Areas"

(18) SD-81035-01, "Lighting Circuit, Fluorescent Type"

(19) SD-81126-01, "Control Circuit — Frame and Aisle Lighting and Appliance Outlets"

(20) ***IES Lighting Handbook,*** 5th Ed., Illuminating Engineering Society, 345 East 47th Street, New York, N. Y. 10017

(21) W.J. McGuiness and B. Stein, ***Mechanical and Electric Equipment for Buildings,*** 5th Ed. (N. Y.: John Wiley & Sons, Inc., 1971)

(22) "Fluorescent Lamps," General Electric Company Pamphlet TP-111

(23) "Lighting Maintenance," General Electric Company, TP-105

10. LIGHTING STANDARDS

(1) Wherever practical, use fluorescent rather than incandescent lamps.

(2) Specify only "Cool White" fluorescent lamps.

(3) Maintain room surface reflectances within the following limits: ceilings, 80 to 90 percent; wall, 50 to 70 percent; floors, 20 to 50 percent.

(4) Provide localized switching in all small areas, rooms, and cubicles.

(5) In large areas, provide ample switching so that as much of the lighting as practical can be turned off when not needed.

(6) Provide switching for controlling one-half of the lamps in four-lamp luminaires, so that occupants can reduce illumination when the full level is not needed.

(7) Surface luminances shall be controlled as follows:

(a) Luminances of surfaces immediately adjacent to the visual task must be at least one-third that of the task and must not exceed the luminance of the task.

(b) Luminance of any significant, more remote surface, normally viewed directly, shall be between one-third and five times the luminance of the task.

(8) For each area, show the design maintained footcandle level on the lighting system layout drawings.

(9) Use simple, efficient outdoor lighting systems to provide only the essential illumination for security, walkways, driveways, and parking lots.

(10) Minimize the use of exterior building and landscape lighting that does not perform an essential function — particularly building floodlighting.

(11) Circuits of exterior building lighting are to be controlled by timers rather than by photocells.

(12) Provide the minimum maintained levels of illumination listed at the right for the equipment areas listed at the left:

AREA	LEVEL (FOOTCANDLE)
EQUIPMENT FRAME AREA	
Maintenance (front) aisle, 2 ft 6 in. wide	15 (Note A)
Maintenance (front) aisle, 4 ft 6 in. wide	15 (Note A)
Maintenance (front) aisle, 6 ft 10 in. wide	15 (Note A)
Wiring (rear) aisle (Use portable lighting units during maintenance periods.)	No design level
MAIN FRAME AREA	
Maintenance (front) aisle	20 (Note A)
Wiring (rear) aisle	10 (Note A)
POWER AND BATTERY AREAS	
Aisles and open spaces	30 (Notes B, C)
AC switchboards and dc battery distribution boards (Measure at center of board.)	20
CABLE ENTRANCE AREA	
Aisles and open spaces (Use portable lighting units during maintenance periods.)	5 (Note B)
CONTROL, TEST, AND MAINTENANCE AREAS	
Control center or test frame (Measure on shelf.)	50
Print display board (Measure at center of board.)	50
Desk top (Measure on writing surface.)	50-70
LED display	Under study

Note A: Measure illumination on vertical equipment surface 30 inches above floor with meter aimed across aisle. Do not allow shadows to fall on light-sensitive cell.

Note B: Measure illumination in aisle center, 5 feet above floor, with meter aimed upward.

Note C: This is consistent with a different value listed under nonequipment areas. In this case, illumination is measured in aisle center, 5 feet above the floor; in the table for nonequipment areas, the measurement is made at the task.

(13) Provide average maintained illumination levels as indicated for the following nonequipment areas, where such areas are associated with equipment buildings:

Assignment bureaus	70	Locker rooms	10
Basements (general)	10	Lounges	10
Boiler Rooms	10	Mechanical equipment room	10
Business Offices	70	Medical rooms	70
Cable Vaults	5*	Operating rooms	40-70
Cafeterias	25	Parking lots	0.5
Computer rooms	70	Power rooms (dc)	10*
Conference rooms	70	Receiving and shipping room	10
Corridors	5	Stairways	10
Drafting rooms	70	Storage areas	5
Elevator machine rooms	10	Switchgear rooms (ac)	10
Emergency engine rooms	10	Test bureau - general	50
Employment offices	50-70	Test bureau - keyshelf	30
General office spaces	50-70	Toilets	10
Janitors' closets	5	Training rooms	70
Kitchens	70	Transformer vaults	10
Lobbies	5		

*These are consistent with different values listed under equipment areas. In this case, illumination is measured at the task; in the table for equipment areas, the measurements are made in aisle center, 5 feet above floor.