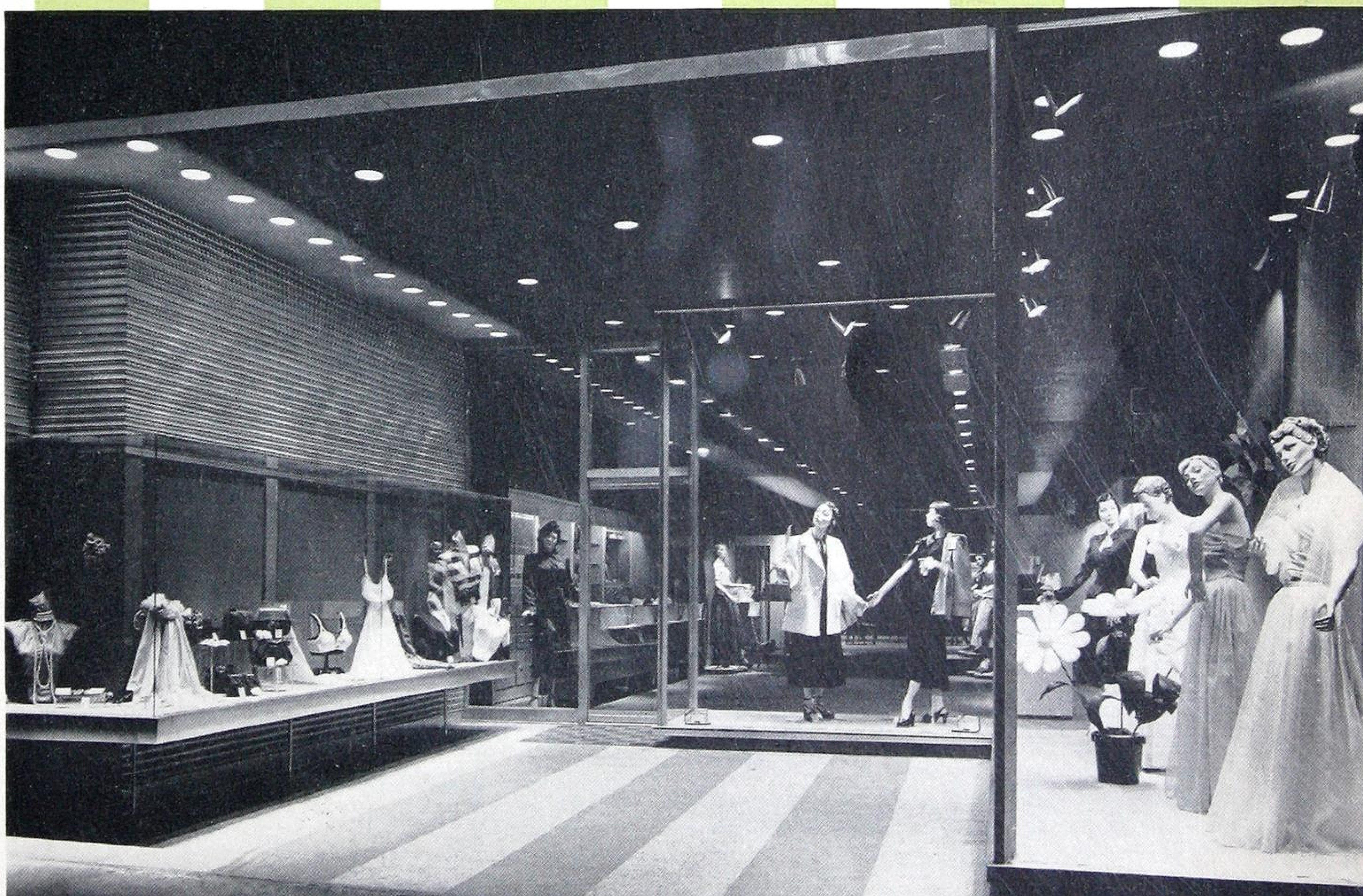
LS-158

1956

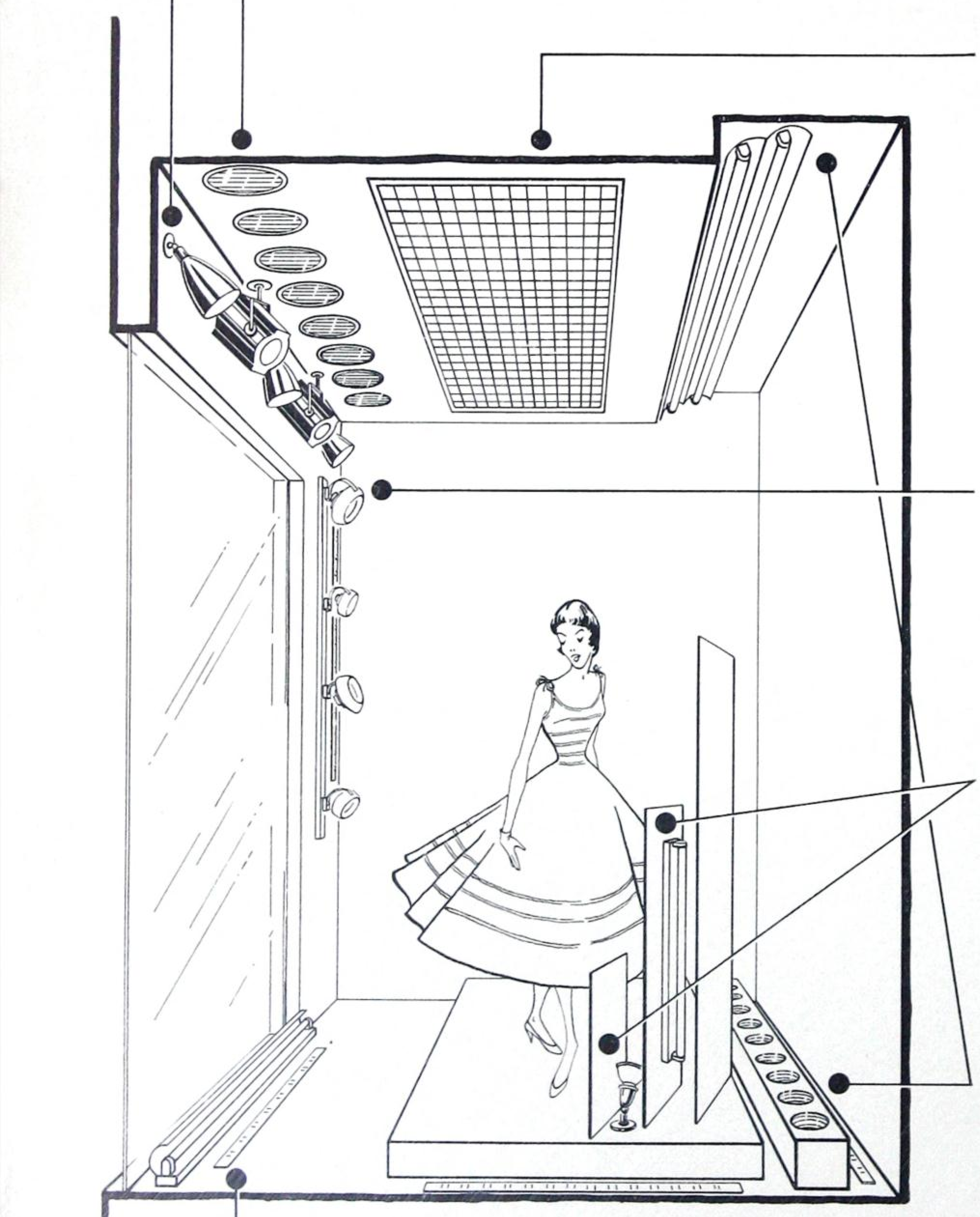
# LIGHTING FOR SHOW WINDOWS
## AND OPEN-FRONT STORES



# COMPONENTS OF SHOW WINDOW LIGHTING

***spotlighting*** — Provides adjustable, high-intensity directional lighting — Builds up brightness of feature areas — Is most effective in combating window reflections, particularly in the daytime — Creates small, bright highlights, dramatic contrasts, shadows — and emphasizes texture.

***general filament lighting*** — Is usually necessary to provide adequate foundation lighting — Gives most light output per unit of ceiling area — Offers several choices of light distribution pattern — Produces small, bright highlights on shiny merchandise.



***general fluorescent lighting*** — Supplies additional foundation lighting — Generates less radiant heat per footcandle — Gives soft shadows and low brightness highlights — Is available in a variety of "whites" and efficient colors.

***side strip lighting*** — Supplements spotlighting or general lighting — May consist of filament spots or floods, or fluorescent lamps in strips — Is often used as a means of adding colored light.

***portable supplementary lighting*** — Is highly desirable to create high brightness within display at close range with excellent control and relatively low wattage — May consist of lamps built into the display fixtures — Affords opportunity of using localized colored light.

***background lighting*** — May be fluorescent or filament — Adds brightness, often color, to background for dramatic contrast with display and better daytime visibility.

***footlighting*** — Provides "fill in" light for vertical surfaces — Reduces shadows — Is useful for modeling effects, lighting signs. Should be used sparingly to avoid unnatural effects.

# THE SHOW WINDOW

By CHARLES N. CLARK
Application Engineering
Large Lamp Department
General Electric Co.

is the visual "on-the-spot" link between the merchandise inside the store and the hundreds or thousands of potential customers who walk or ride past. It occupies the most valuable and strategic space in the store; many merchants charge 25% or more of their first floor rent to show windows. If the window is to pay its way, as many customers as possible must be made to look, stop, look some more, enter the store, and buy. Lighting is a key factor in attaining this result.

The *objectives* of window display lighting are to:

ATTRACT ATTENTION OF MORE PASSERS-BY. Typically, only about one-third of the passers-by look at a poorly lighted window. Tests show that this proportion can be more than doubled by improved lighting.

HOLD ATTENTION LONG ENOUGH TO STOP PEOPLE. If a window display stops 10% of the passers-by when inadequately lighted, it can stop over 20% of them when well lighted.

LEAVE A FAVORABLE IMPRESSION OF THE GOODS DISPLAYED. More shoppers will remember the merchandise if it is well lighted — tests prove it.

CREATE A DISTINCTIVE APPEARANCE. Bright, attractive windows can do it—and they identify the alert, progressive merchant.

INVITE THE SHOPPER INTO THE STORE. What better way to suggest a pleasant interior atmosphere, than to make the window as appealing as possible?

Modern show window lighting techniques and equipments make it entirely practical to realize these objectives, by providing:

*Large bright areas* to attract attention to the window, both by day and by night, and to help overcome reflections in the windowpane . . .

*Accents of very high brightness* where needed for dramatic composition and effective display, for competing with surrounding distractions — and, again, for breaking through window reflections.

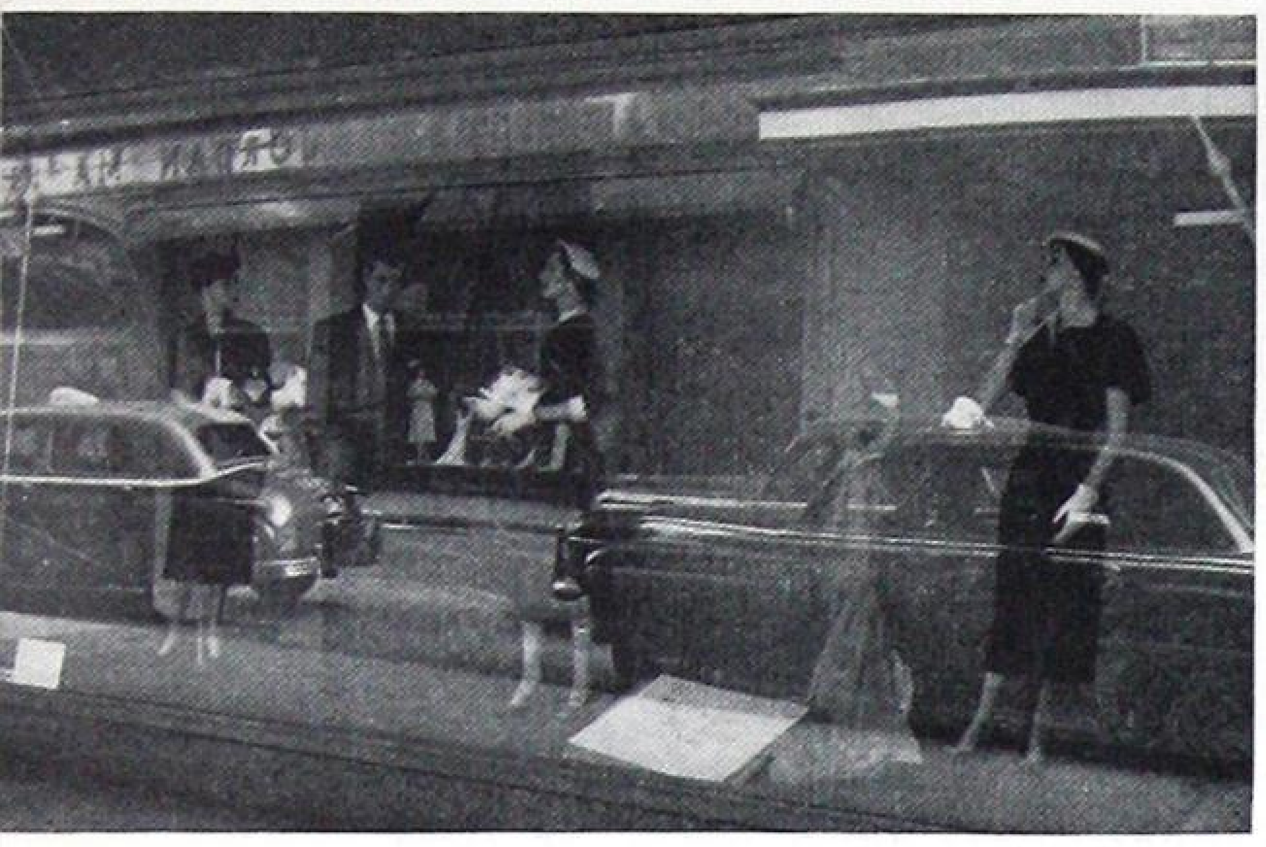
*Strong contrasts, modeling, and color* to vitalize the display . . . By such means, high visibility can be achieved, even where light goods are shown against light backgrounds.

*True color rendition* to give accurate impressions of the merchandise . . .

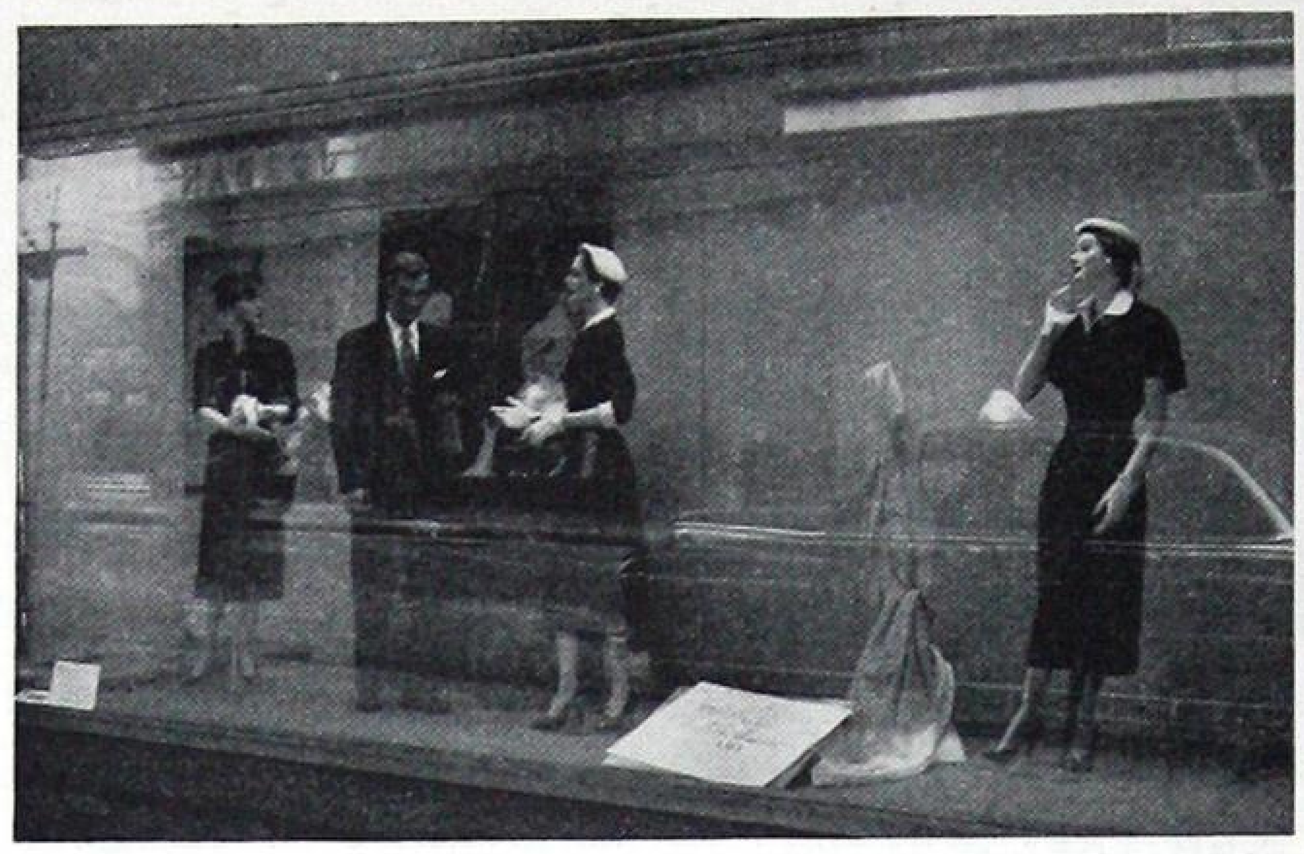
These are the elements of effective show window lighting. This booklet tells how to put them to work, so that

**Good Lighting Multiplies the Selling Power of the Show Window**

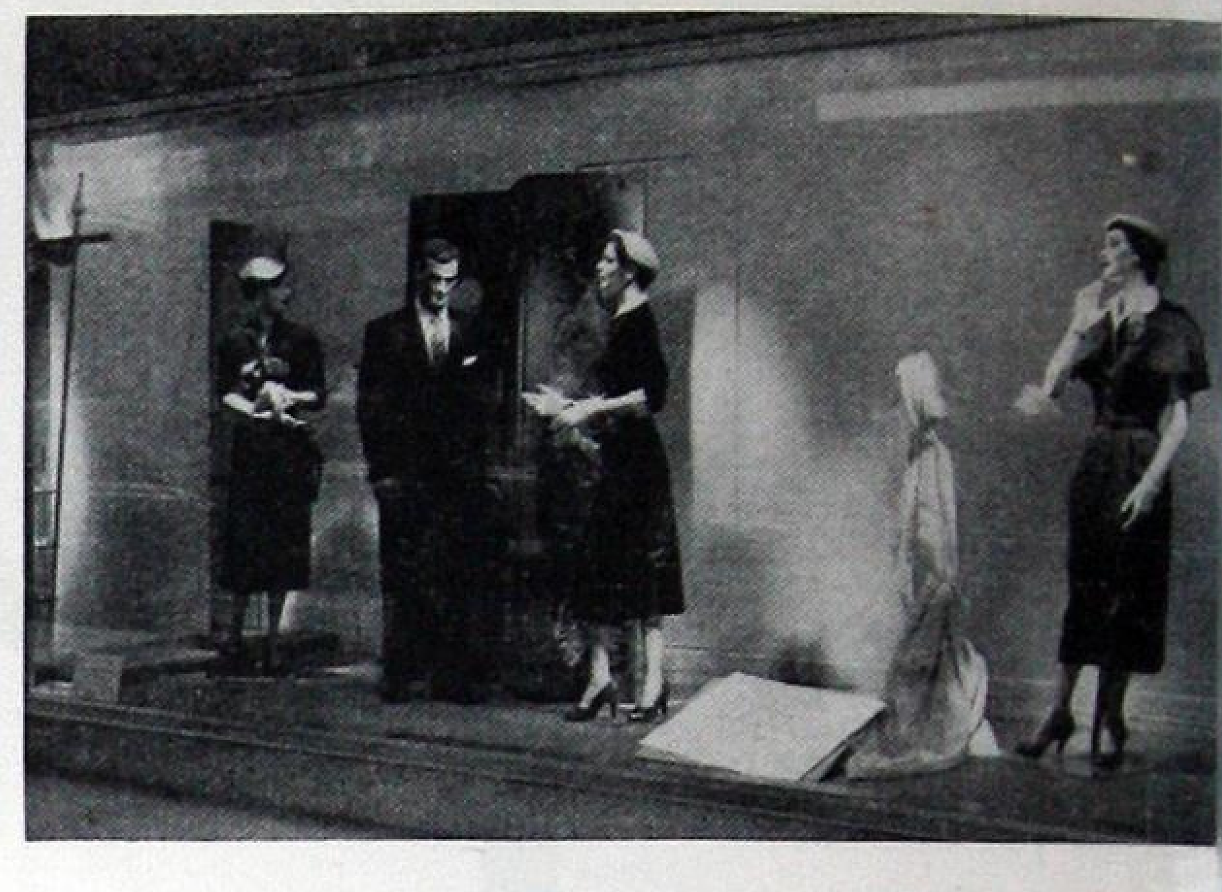
During the day, with no artificial light, the window display is lost behind a veil of distracting reflections of moving traffic and the buildings opposite. The reflected image of a display across the street is a prominent part of the shopper's view of the window.



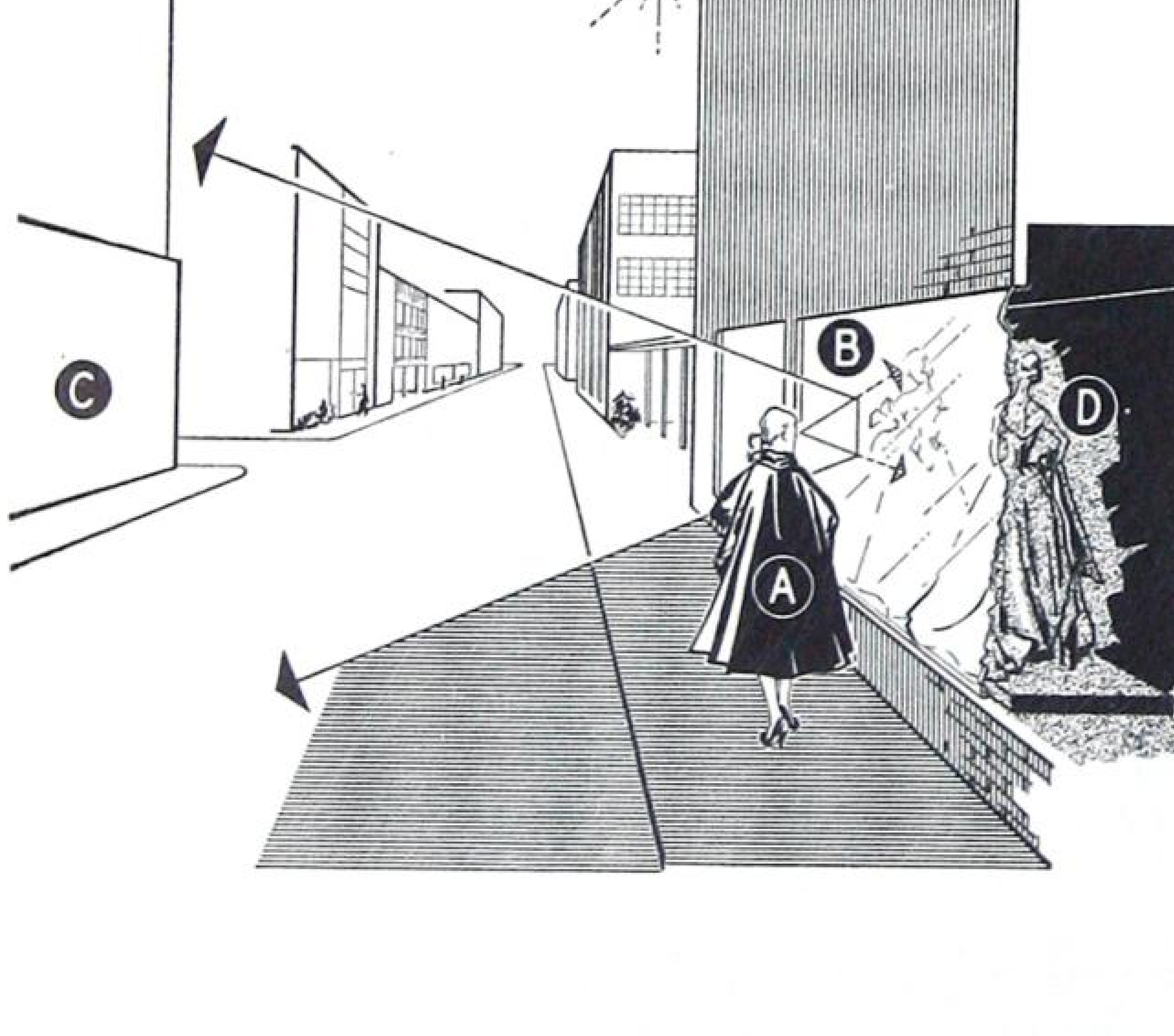
Six rows of 96-inch T-8 slimline fluorescent lamps reduce the effect of window reflections somewhat, but do not provide enough light to eliminate them completely. Merchandise appears flat and uninteresting in the highly diffused illumination.

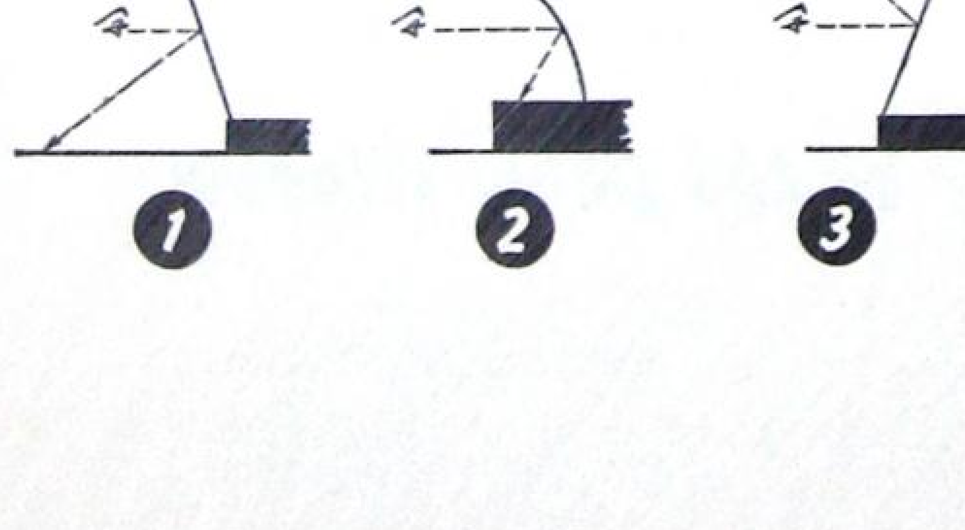


Merchandise is dramatized when PAR-46 spotlamps are added, bringing the illumination level to 1000-1500 footcandles on the mannequins. Distracting reflections are further minimized.



# COMBATING DAYTIME WINDOW




The selling force of a show window is particularly valuable during the usual daytime shopping hours, when the customer can enter and buy immediately after being attracted by the display. Daylight, however, creates severe competition for the shopper's attention, but this can be minimized with modern lighting equipment and techniques.

In the sketch, left, a shopper (A) looks at a show window (B) on the shady side of the street. The window glass acts as a mirror, reflecting images of (C) the sky, buildings across the street, pavement, street traffic, etc. Measurements show that these objects, in direct sunlight, have a typical brightness of 1000 footlamberts*. The window reflects about 10% of this brightness, or 100 footlamberts. These bright reflected images are seen super-imposed on the window display (D), and without adequate lighting will be many times brighter than the display itself. In this case, **reflected brightness** makes it difficult or impossible for the shopper to see **into** the window.

On the sunny side of the street, an equally unfavorable situation exists. But here the windows must compete with higher **surrounding brightness.** Sunlight striking light-colored building and pavement surfaces adjacent to the window can create brightnesses of 1000 footlamberts. In comparison with these areas of high brightness, the unlighted windows appear to be dark recesses in the store front, unless direct sunlight is allowed to fall on the display.

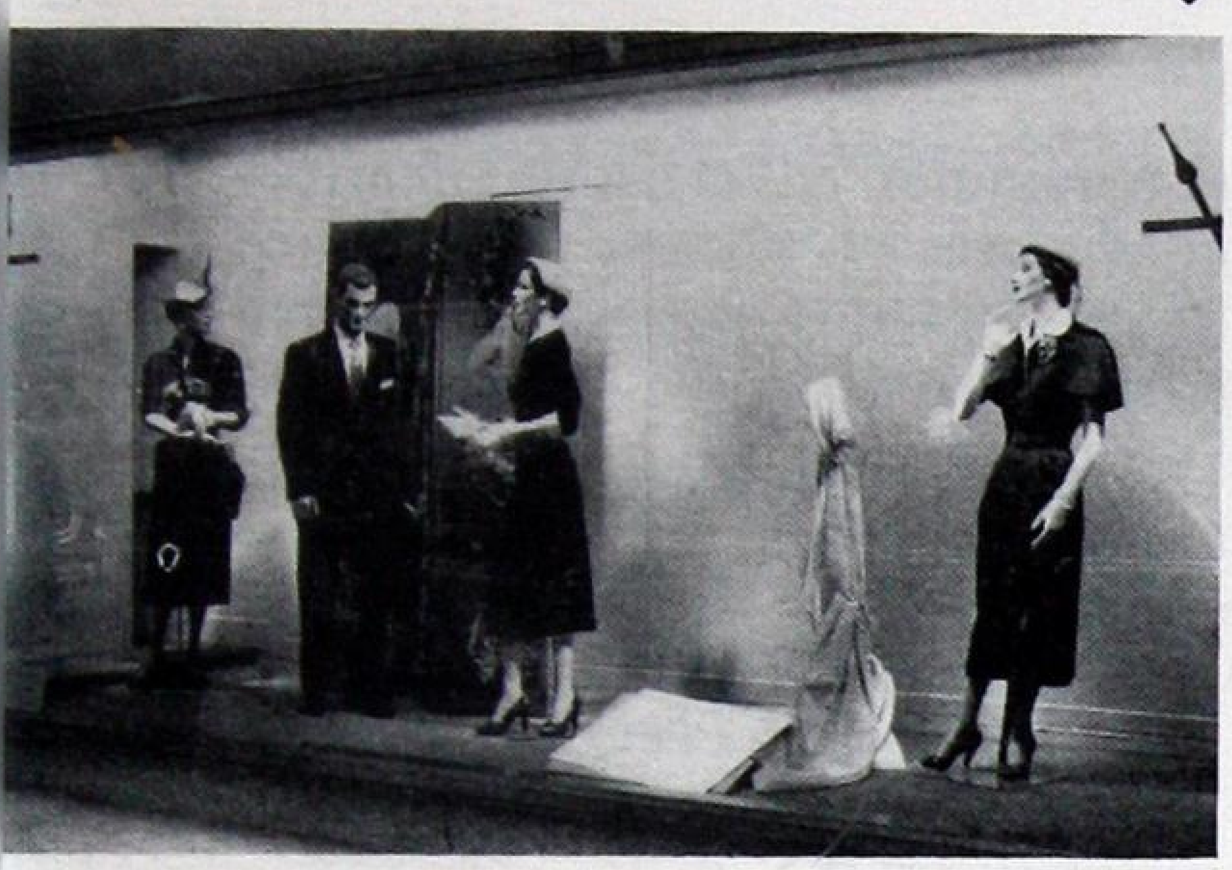
Under certain conditions, slanted or curved glass windows can help eliminate reflected veiling glare. Glass that slants inward from top to bottom (1) reflects the sidewalk. If this is in shade, or a canopy is used, reflections are reduced. Curved glass (2) can almost completely eliminate reflections, by reflecting a dark "well" in front of the window. Glass that slants outward from top to bottom (3) can be arranged to reflect the dark underside of a canopy. If there is no canopy, this last arrangement may be worse than when the glass is vertical, because of the bright image of the sky.

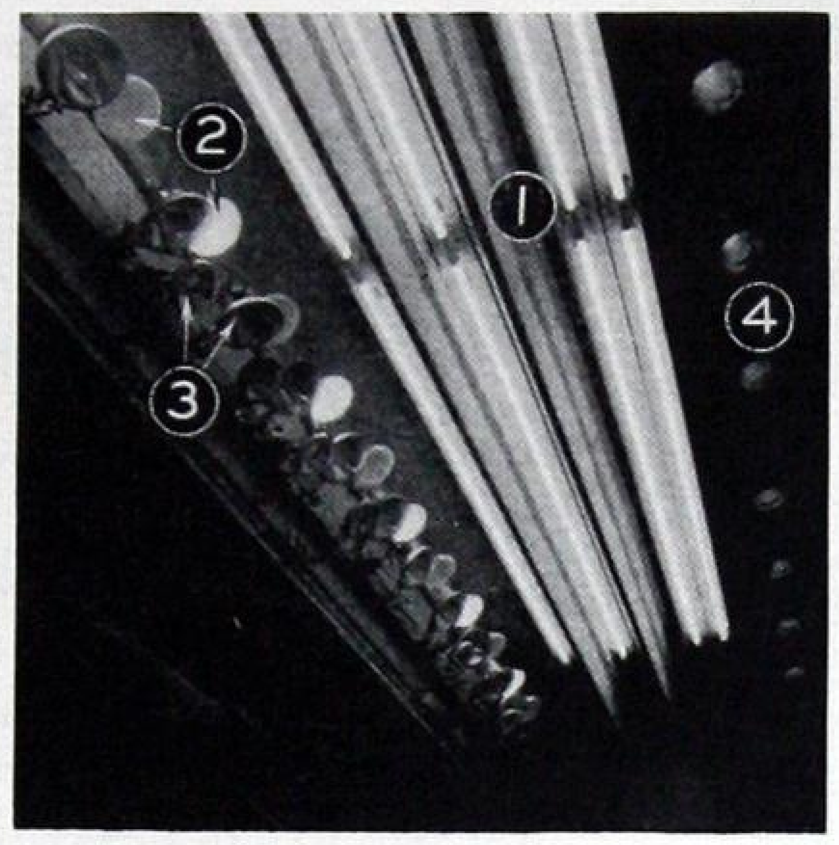
The first two techniques reduce valuable display area, while the third makes it difficult to position lighting equipment with favorable aiming angles. In any event, adequate lighting is necessary to make the display effective when compared to brightly lighted adjacent exterior building surfaces.

* The footlambert is a unit of brightness and is equal to footcandles multiplied by reflectance of a diffusing surface. Therefore, if we assume that 5000 footcandles of sunlight fall on a diffuse surface of 20% reflectance, the resulting brightness is 1000 footlamberts.

Addition of 150-watt, R-40 floodlamps on 1-foot centers brings the general lighting level to 200 footcandles. With a light-colored background, this is sufficient to eliminate reflections in the window and provide a clear view of the merchandise.

The lighting components of this versatile window are shown here: a combination of slimline fluorescent (1) and reflector filament lamps (2) for general illumination; narrow-beam spotlamps (3) for high-intensity feature lighting; and three circuits of 150-watt R-40 spotlamps with colored spread lenses (4) for background lighting.



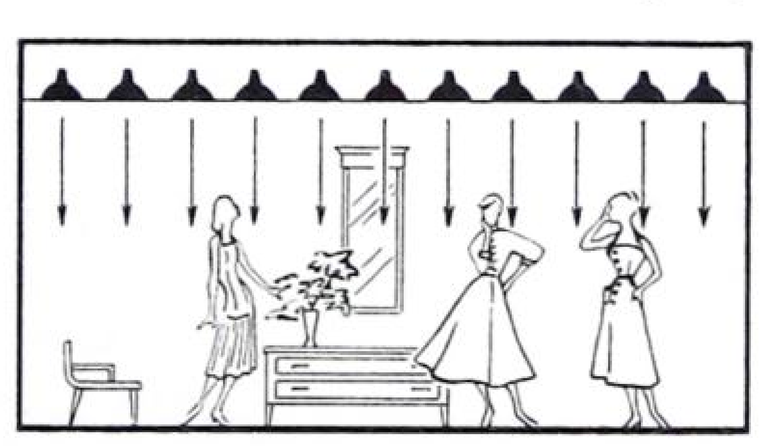


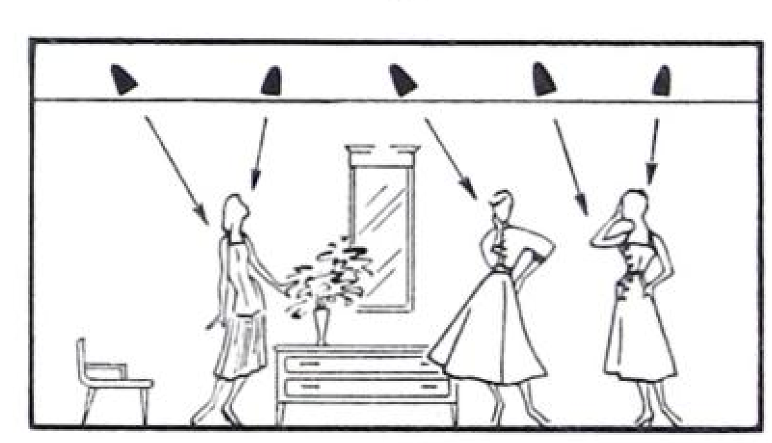

# REFLECTIONS

Studies have shown that in order to "see through" reflected images in the window glass, surfaces inside the window must be at least as bright as the reflected images, preferably several times as bright. Thus, when reflections have a brightness of 100 footlamberts, vertical display surfaces should also have a brightness of at least 100 footlamberts. With light-colored displays and backgrounds (averaging 50% reflectance), 200 footcandles of general illumination on vertical surfaces will produce this brightness. For darker-colored displays, or for greater effectiveness, even higher levels of illumination (1000 or more footcandles) are necessary. Spotlighting is effective in achieving these higher levels necessary for seeing into the window, and for dramatizing featured parts of the display by making them several times brighter than surrounding display elements.

Here, then, is what is usually required: (subject to modification to fit the particular situation)

***general lighting*** — to provide about 200 footcandles on light-colored vertical display surfaces and backgrounds.



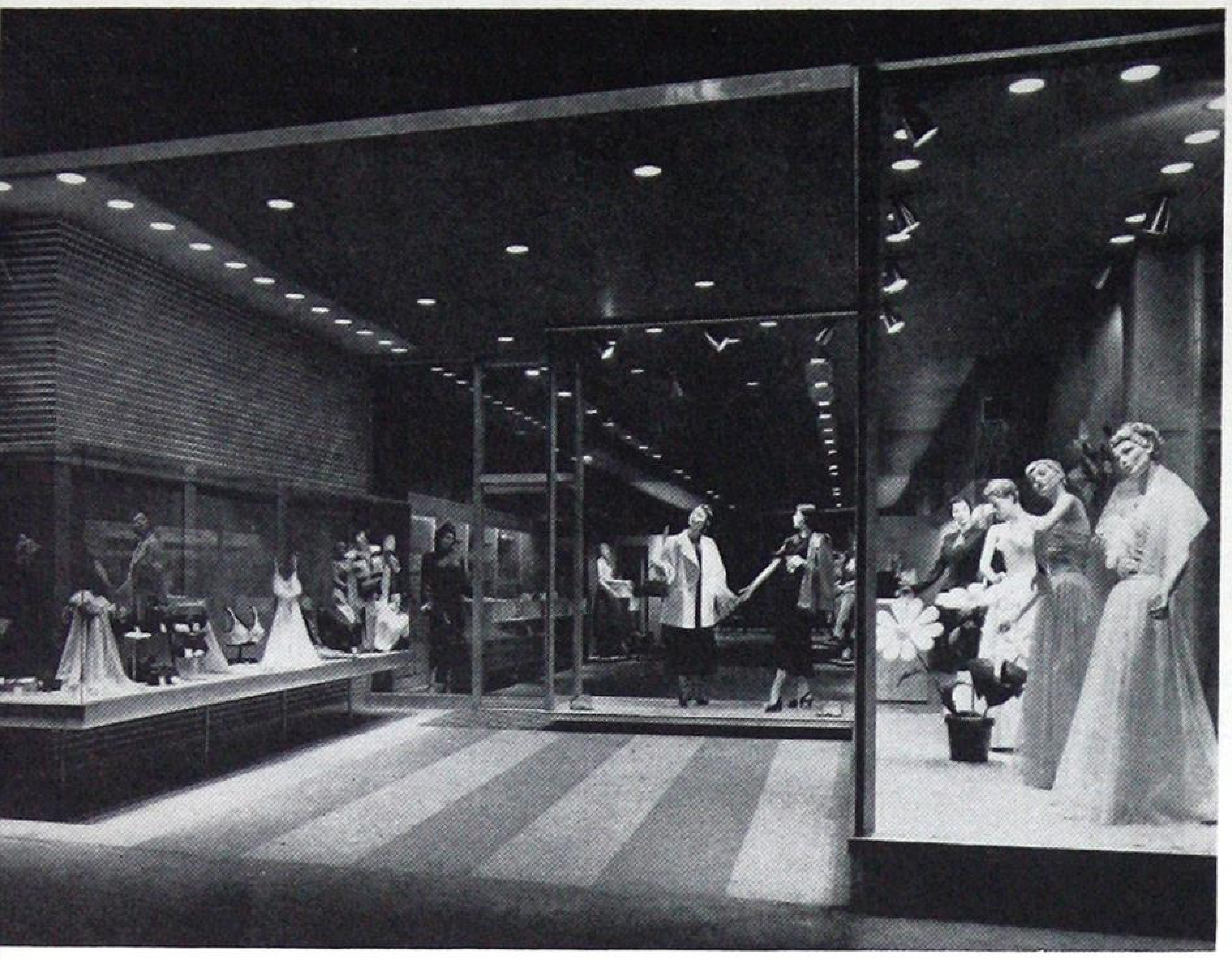


**GENERAL** **SPOTS**

***spotlighting*** — to provide 1000 or more footcandles on featured parts of the display.

***supplementary lighting*** — to create high brightnesses on selected surfaces. Light-colored backgrounds and a supplementary background lighting system, perhaps with color, are recommended for all closed-back windows or where portable screens become backgrounds.

**In open front stores,** the whole store is, in effect, a window display. The same levels of illumination needed for conventional windows should be provided on vertical surfaces inside the store by such means as valance lighting, spotlighting, luminous panels, bright niches, showcases and wall displays. (See Pages 8 and 9)



Opportunities for additional night-time advertising include not only exterior show windows, but also spotlighted interior feature displays and supplementary lighting in floor and wall cases. This is particularly true in open-front stores, as illustrated here. The interior general lighting system need not be used, since it contributes relatively little to the brightness of vertical surfaces as seen from the street.

# NIGHT-TIME SHOW WINDOW EFFECTIVENESS

While lighting for maximum advertising effectiveness of the show window is of utmost importance during the daytime shopping hours, evening operation offers additional opportunities.

The value of well-lighted show windows during evening store operation is obvious. But even after closing hours, pedestrian traffic is often heavy, and in a leisurely "window-shopping" mood. In today's sharp competition, the additional advertising value of effective after-hours display can be an important factor in successful merchandising.

Levels of show window illumination comparable to those used during the daytime for overcoming reflections are very often required at night. This is particularly true where signs, floodlighted buildings, street lights, or the lighted windows of other stores are mirrored in the glass. These light sources, as well as moving automobile lights, compete for the attention of the passerby. Their competition can be successfully overcome only by providing adequate brightness, contrast, and color in the window.

The small additional cost of operating the show window lighting after dark enables the merchant to secure a maximum return on his investment in window space, displays, and lighting equipment.

FOR EXAMPLE: a window 16 feet long and 6¼ feet deep has 100 square feet of floor area. A typical well-lighted window of this size will use about 80 watts per square foot, or a total load of 8 kilowatts. Assuming an electrical energy cost of 2 cents per kilowatt hour, the hourly operating cost of the lighted window is 16 cents. Adding 4 cents per hour for lamp and maintenance cost brings the total to 20 cents per hour.

If the average traffic past the window is 800 people per hour during the evening hours, and 25 per cent of them look at the window when there is inadequate lighting or no lighting at all, the result is 200 lookers per hour. Increasing the attraction power of the window with high-intensity lighting may well cause twice as many of the passers-by to look — or an additional 200.

These 200 additional lookers have cost 20 cents, or $1.00 per thousand advertising impressions. This figure compares very favorably with other advertising media costs.

Colored lighting, especially on the background, is a particularly potent night-time attraction, since there is no tendency for the color to be diluted by daylight coming in the window. Many merchants arrange for a time switch to add colored circuits after dark. The switch can also be used to reduce the lighting level automatically after midnight or when traffic past the window becomes too low to warrant full operation.

**Good Lighting Multiplies the Selling Power of the Show Window**

*In any show window, the designer must face these*

# PRACTICAL CONSIDERATIONS

**wattage requirements**

Show window lighting, to be effective both day and night, requires capacity of 50 to 100 watts per square foot of ceiling. This is usually divided about equally between the general lighting and all other lighting equipments. In shallow windows where light is utilized relatively inefficiently, greater capacity may be needed.

Lighting facilities should be adequate for any type of display likely to be used, although not all equipments may be needed at any one time. In both new and relighted windows adequate wiring should be installed, to insure full voltage for efficient operation of the lamps. It is well to provide extra wiring or conduit capacity to allow for future load increases. Circuit protection by fuses or circuit breakers is a "must."

**circuiting**

To insure flexibility and to save time and effort in adjusting the lighting as displays are changed, it is desirable to circuit lighting equipment in small groups on individual switches. Several circuits for spotlights will allow the displayman to light only the ones required, without having to unplug the units or unscrew the lamps.

For maximum convenience, switches for individual circuits may be mounted within the window, and a master switch installed outside the window. The master switch can be controlled by a timer, so that the lighting is automatically turned on and off at pre-selected times. A time switch could also be used to add circuits of colored light on backgrounds, etc., after dark, when colored lighting is often most effective.

**ventilation**

Most windows need some provision for removing heat so as not to subject either merchandise or lighting equipment to excessively high temperatures. A substantial part of the heat comes from sunlight, and the remainder is added by the lighting equipment. In some stores, the warm air is exhausted into the store to supplement the heating system in the winter. In the summer it is exhausted outside.

To insure against overheating of lamps and lighting units, only well-designed equipment should be used, with lamps of no higher wattage than specified for each fixture. Porcelain sockets provide maximum resistance to failure under high temperature conditions. The use of fluorescent lamps as a part of the general lighting will help minimize heating because of their low heat content per footcandle. Locating fluorescent lamp ballasts remote from the window avoids exposing them to high temperatures.

**fading**

Many articles fade or discolor upon prolonged exposure to light. Tests show that:

1. For a given footcandle level, the rate of fading under fluorescent and incandescent lamps is the same. Natural daylight generally causes fading about twice as fast as artificial light sources at the same level of illumination.
2. Fading depends on intensity of light and length of exposure. For example, equal fading is produced in 500 hours under 100 footcandles and in 50 hours under 1000 footcandles. The "exposure" in both cases is 50,000 footcandle-hours.
3. Materials vary greatly in susceptibility to fading. Some textiles begin to show perceptible discoloration after an exposure of 50,000 footcandle-hours.

Many articles show no appreciable fading after normal display exposures. Others do fade, but if displays are changed frequently, fading is minimized. Where fading does occur, losses commonly are written off as a part of the display or advertising budget.

**maintenance**

A regular schedule for cleaning reflectors and other optical equipment will help to insure maximum efficiency of the lighting system. Replacement filament lamps should have the same voltage rating as the voltage at the sockets with all the lighting turned on. This will insure that lamps will give their rated light output and life.

If lamps are replaced individually as they burn out, failures will occur during the time the display is lighted. When this happens, it usually is inconvenient to enter the window to replace the lamps; if the maintenance man does enter the window, the display may be disturbed, or dust and dirt may fall on it. And if the burned out lamps are not replaced, the effectiveness of the display is reduced.

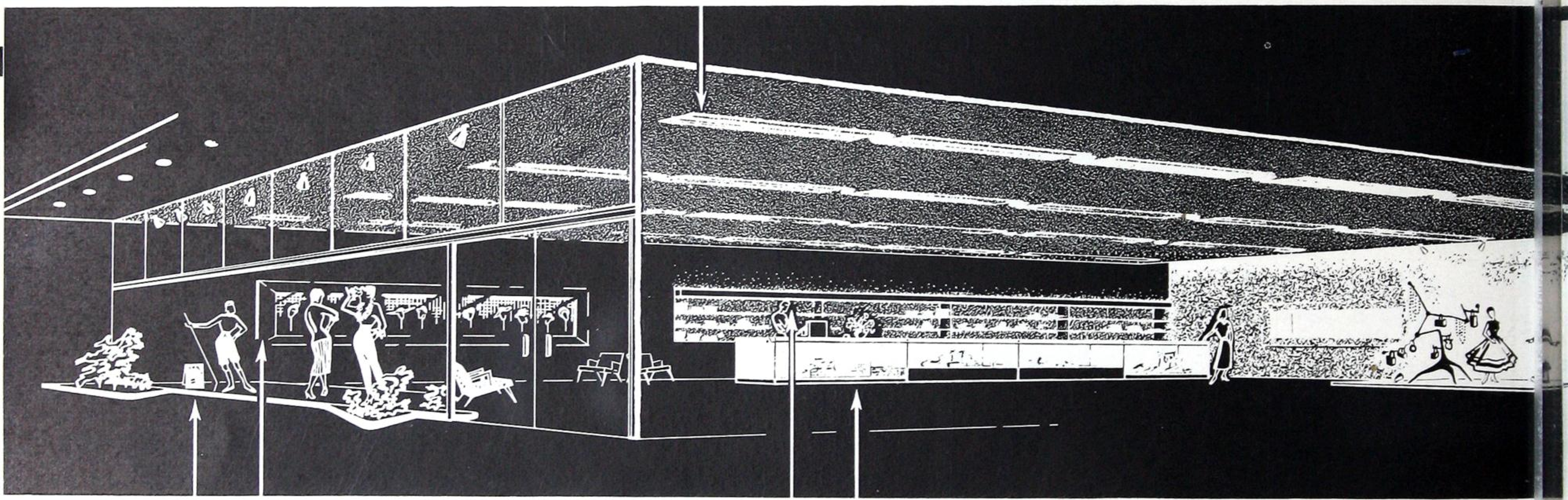
This can be minimized by group relamping. With this system, all lamps of the same life rating are replaced at the same time, at 70% to 80% of rated life. All PAR and R lamps are rated at 2000 hours and would be replaced at 1500 hours. Display spotlights that are rated at 500 hours would be replaced at 400 hours, and fluorescent lamps rated at 7500 hours would be replaced at 6000 hours. Group relamping results in more effective displays, greater convenience, higher average output of lamps, and reduced lamp-changing labor costs.

Open-front store design aims to make the whole interior an effective "window display," attracting shoppers when the store is open, and drawing attention after store hours. The most effective open-front stores are those that have bright displays and interiors. With an open front, it is particularly advantageous to leave displays throughout the interior lighted after store hours. Displays are often set in the front part of the store and special lighting facilities may be needed for them.

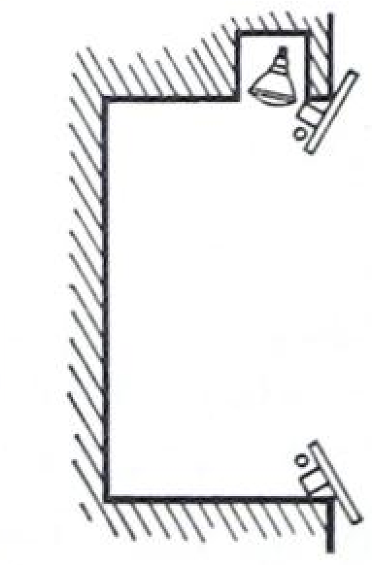
However, in some open-front stores, the glass front, instead of removing visual barriers, has become a mirror for exterior surroundings during the daytime when the heaviest traffic is passing by. The principles for reducing the effect of these reflections are the same as for closed-back show windows: (1) use light finishes on interior room surfaces; (2) provide about 200 footcandles on the vertical surfaces of displays and walls, particularly around the perimeter of the store; (3) provide about 1000 footcandles on spotlighted feature and niche displays at several locations within the store. The drawing below shows some of the lighting elements that contribute to making open-front stores effective traffic-pullers during daylight hours.

**General lighting** luminaires on the ceiling contribute to the basic brightness pattern of the area, and are often easily visible from the street. Many pleasing arrangements of luminaires are possible: lengthwise or crosswise rows, geometric designs, or patterns fitted to the layout of display cases. However, excessive brightness in the overhead zone is undesirable — the main emphasis should be on the goods in the display and selling areas.

# THE OPEN-FRONT STORE

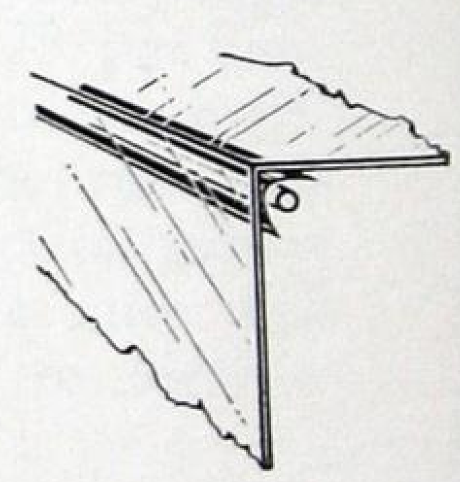


**Lighted niches** are centers of attraction that compel the attention of shoppers by brightness created with concealed fluorescent or filament lamps. They may be built into shelf areas or mounted separately on side or rear walls. High brightness and modeling effects can be obtained by spotlighting the items in the niche, either with built-in compact spots, or by spots aimed into the niche from outside locations.

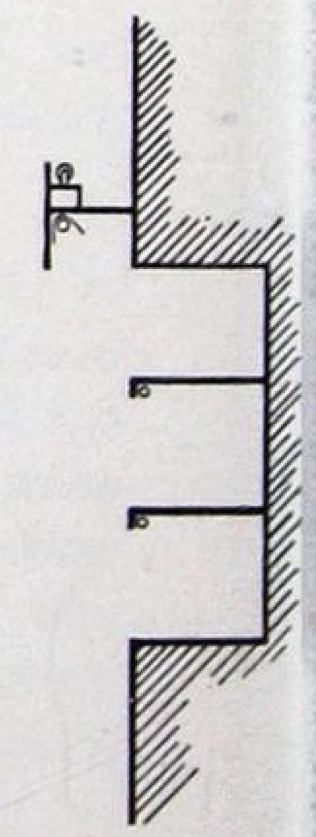


**Window displays** are used up close to the window-front by many stores. One or more rows of adjustable spotlamps above the inside of the window provide a versatile means of lighting such displays and of building up the brightness at the front of the store. Equipment may be attached to the ceiling for convenience, or recessed for smoother appearance. Lamps should be shielded with louvers or baffles, if necessary, to reduce glare in the eyes of shoppers inside the store.

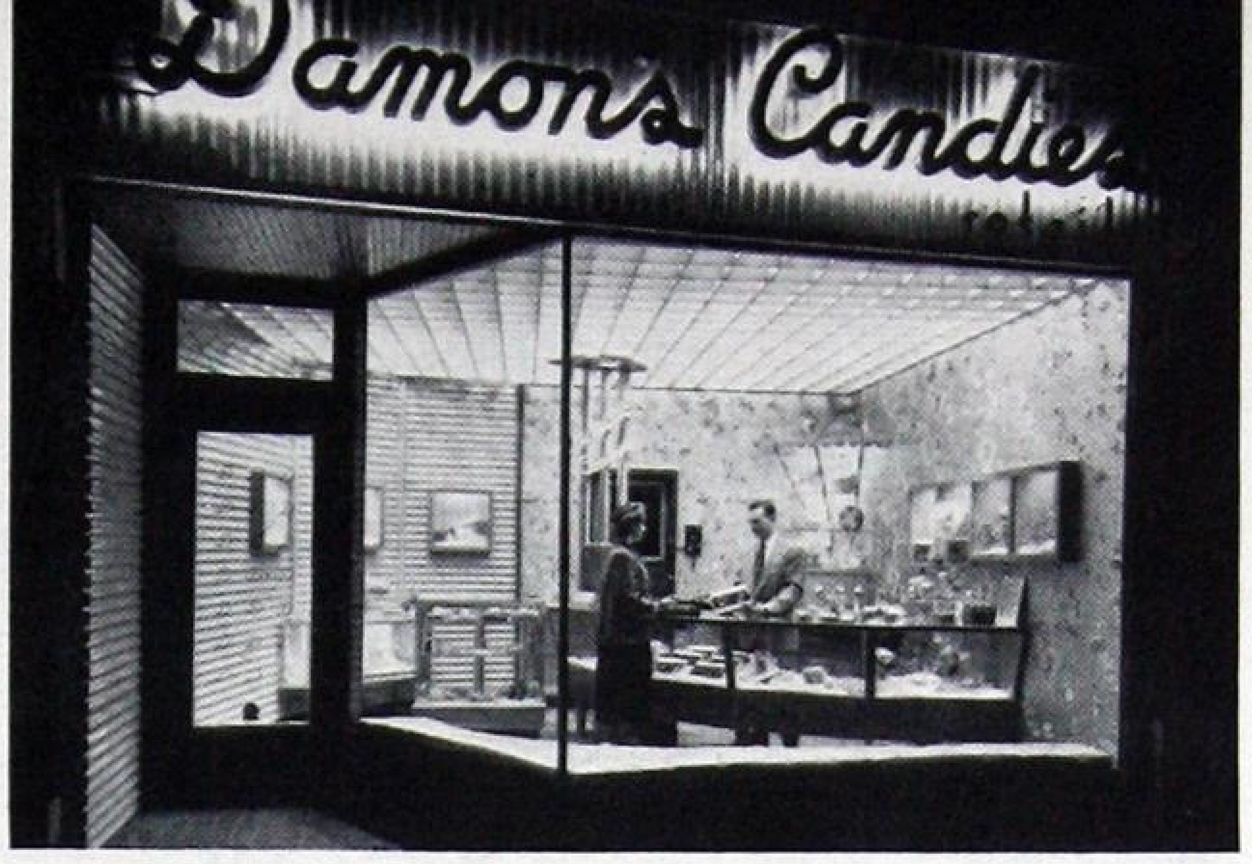
**Showcase lighting** inside the cases may be accomplished with small-diameter fluorescent or filament showcase lamps. Increased brightness of the items displayed is effective not only in attracting attention from the street, but also in overcoming reflections which sometimes occur in the glass top of the cases. Lighting design data for showcases are given on page 23.



**Valance lighting** provides downward light, usually from fluorescent lamps, to illuminate merchandise on shelves and in floor or wall cases. It may also direct light upward to increase the brightness of upper walls and ceilings, thus reducing objectionable brightness contrasts and contributing to a more cheerful, spacious atmosphere. The most effective way to distribute light over the display area is to place a reflector over the lamps and use a separate row of lamps to provide the upward light. Design data for calculation of vertical surface illumination from valances are given on page 23.

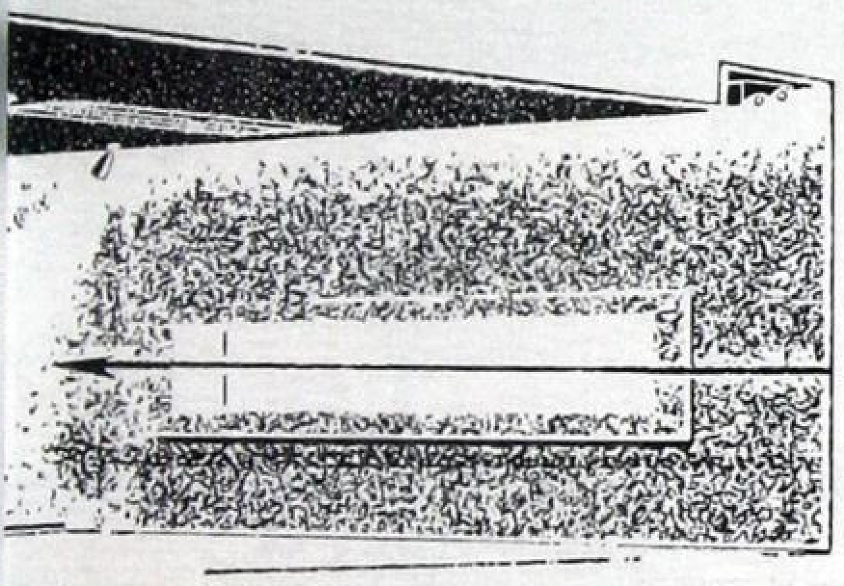


**Shelf lighting**, using small-diameter fluorescent or tubular filament lamps concealed in the front edge of individual shelves, will generally produce 200 or more footcandles. It gives each shelf an equal chance to sell its merchandise and contributes to the brightness pattern that allows shoppers to see through window reflections from outside the store.




The bright chartreuse-tinted cells of this louverall ceiling help gain the attention of passing motorists and pedestrians. The ceiling also spreads its light diffusely to brighten the walls. Accents of brightness provided by lamps in the wall displays cut through window reflections in the daytime. Deluxe warm white fluorescent lamps are appropriately used here for lighting the candies.

Concealed fluorescent lighting in the floor and wall cases attracts attention from the street. For customers within the store, it also overcomes the visual barriers of reflections from glass case-fronts, and distance from the displays.



***Spot-lighted interior feature displays*** within the merchandising area, lighted to about 1000 footcandles, are highly effective in attracting the shopper's attention from outside the store and in promoting customer circulation toward the spot-lighted area.

Displays at the rear wall may be treated in much the same manner as displays in a closed-back show window. Brightness and color can be created on the wall through the use of fluorescent or filament strips at the top and bottom of the wall, supplementing the general lighting already present in the area. High-intensity spotlighting for the feature can be provided by adjustable ceiling units or by portable spots.


Several elements contribute to the daytime effectiveness of this open front: the shielded fluorescent units mounted out from the wall around the perimeter aimed to light shelves and display cases; the spotlighted mannequins near the glass, with special emphasis on the feature displays at either end; the light finishes used throughout the store; and the interesting pattern of recessed luminaires in the ceiling.

PRISMATIC

MIRRORED ▶

R-40

PAR-38 ▶

***Filament*** ▶

Filament general lighting units are virtually a necessity in most show windows, even where fluorescent lighting is also used. The compactness of filament lamps makes it possible to obtain 200 or more footcandles on display zones by utilizing a relatively small part of the ceiling area.

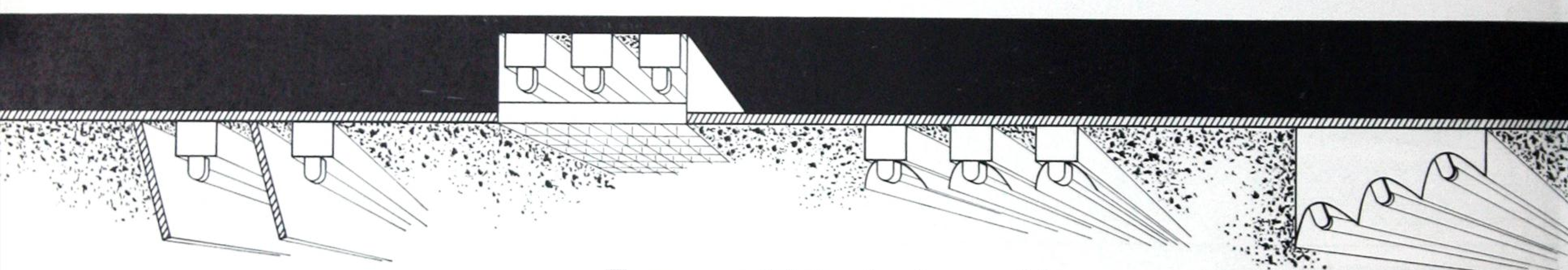
Mirrored glass, prismatic glass, and metal reflectors for general lighting are made in a range of sizes and shapes, for surface or recessed mounting, often with provision for louvering. Units have various light distribution patterns specifically designed for most efficient utilization in shallow, medium, or deep windows. Sizes are available to use general service lamps up to 500 watts. Clear lamps produce the smallest, brightest reflected highlights on shiny finishes. Inside frosted lamps produce a softer effect.

Projector (PAR) and Reflector (R) floodlamps, combining compactness with good light control, are also appropriate for general lighting. When they are replaced, clean new reflectors are automatically provided, restoring the system to maximum efficiency with a minimum of maintenance work.

PAR and R lamps are available in sizes up to 300 watts, with the latter also made in a 500-watt size. Side-prong PAR-38 lamps are particularly useful where lamps must be recessed in a shallow cavity or thin canopy.

See Pages 18-21 for filament lamp general lighting design data.

# GENERAL LIGHTING



***fluorescent*** ▶

Fluorescent lighting is often useful as a supplement to the filament general lighting system. Because of the comparatively low light output of fluorescent lamps per unit of ceiling area, it is not ordinarily possible to use them exclusively to provide the 200 footcandles of general illumination usually required to minimize reflections. However, because of their high efficiency and low heat radiation per footcandle, fluorescent lamps are desirable as a part of the general lighting. Their illumination is diffuse and uniform, and areas lighted by them lack high-brightness reflected highlights. But the long, low-brightness reflections of fluorescent lamps are often desirable to emphasize the shape of shiny merchandise.

A choice of "white" fluorescent lamp colors gives the flexibility required for distinctive effects by setting the overall tone of a window. Generally, the choice is between warm or cool tones. In windows where a substantial part of the light is from incandescent lamps, the efficient standard cool white or standard warm white color is appropriate. Where the lighting is mostly fluorescent, and good rendition of colors is essential, "deluxe" white fluorescent lamps should be used — deluxe warm white to blend with incandescent lighting, deluxe cool white for interesting contrast.

Polished metal reflectors, parabolic in cross-section, provide the highest light utilization and best coverage of vertical surfaces by reducing spill light and directing the light toward display zones. Optimum reflector width is about 4 times the lamp diameter.

Of all fluorescent systems, T-6 lamps operated at 300 milliamperes in 3-inch parabolic reflectors provide the greatest display-plane illumination from a given ceiling area.

Units comprising a bank of 3 or 4 reflectors, tilted for best coverage of display surfaces and for shielding, are available for surface or recessed mounting. Other methods of shielding include baffles between lamps and louver elements below lamps.

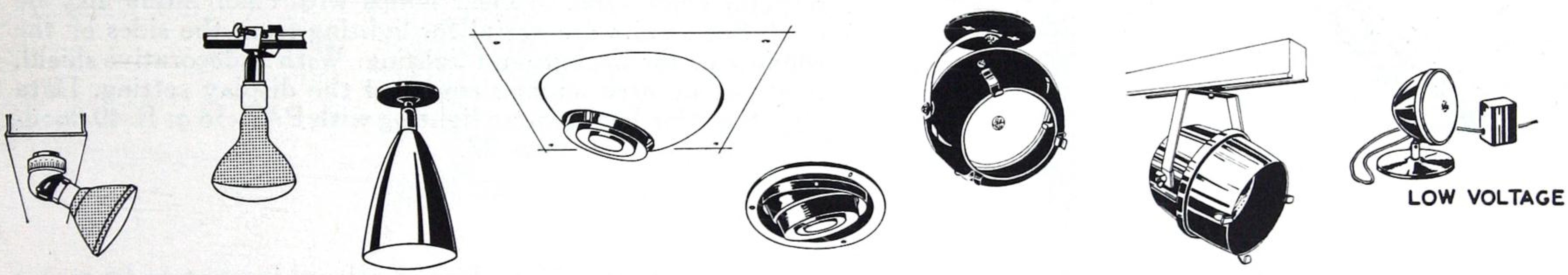
See Pages 18-19 for fluorescent general lighting design data.

Modern spotlights make it easy and practical to provide 1000 or more footcandles on important areas of a display. Such levels of illumination are vital during the daytime, to reduce the distracting reflections in the glass, and to compete with high exterior brightnesses. Day and night, they enhance the attractiveness of the display by calling attention to its featured elements, and give the designer opportunities to create the desired composition.

It is most effective to spotlight objects with two or more units mounted at different locations. Typical stage-lighting techniques apply, such as providing major illumination from one side in white light, and secondary "fill" light from the other side in white or colored light. Flexibility for a variety of display arrangements can be had by providing extra spotlamps that can easily be mounted and plugged into electrical outlets, in case more units are needed to cover large or unusually-shaped objects.

Lighting equipment used for spotlighting includes theatrical-type spots and a variety of reflectorized lamps (Page 17). Units are commonly mounted at the top front of the window, and often at the sides as well. Flexibility in aiming is an important consideration. Several types of mounting are shown in the illustrations. Other techniques include the use of a ceiling grid to support clamp-on units, and metal channels that combine mechanical support and electrical connections for the units wherever they may be attached.

Projector (PAR) spotlamps have molded glass bulbs with an accurately-positioned filament and sealed-in reflector. Because of their rugged construction of heat resisting glass, louvers or color caps can be attached directly on the bulb, and the lamps may be mounted by their rims. Their compactness, particularly that of the side-prong 150- and 200-watt lamps, facilitates recessed mounting. Simplicity and ease of maintenance are other advantages.




# SPOT LIGHTING

Among the most important lighting tools for really effective spotlighting are the 200-watt PAR-46, 300-watt PAR-56, and 500-watt PAR-64 narrow spots, which combine high intensity with relatively small size. With typical aiming, each provides about 1000 footcandles on vertical display surfaces at distances of 5, 7, and 10 feet respectively. Their potency makes it easy and practical to combat daytime reflections successfully, and to create dynamic displays. Also available in the same wattages and bulb sizes are the medium floodlamps, which provide smooth coverage over a useful area about twice as great as that covered by the narrow spots. Their oval beams are especially suitable for lighting an entire mannequin, or other elongated display.

Two 6-volt 30-watt sealed-beam type lamps, one with a PAR-36 bulb (#4515), and one with a PAR-46 bulb (#4535), have been adapted for show window use by means of a stepdown transformer. Their extremely narrow "pin-point" beams with little spilled light are ideal for lighting small featured details of a display to very high brightness.

Reflector (R) spotlamps are made of blown-glass bulbs (in some cases of heat-resistant glass) and have sealed-in reflectors. In general, their beam patterns are broader than those of PAR lamps, and maximum candlepower is less for a given wattage. Color caps, louvers, etc., should be supported by fixtures or lampholders, rather than by the bulbs themselves.

Fresnel-lens theatrical-type spots in sizes up to 1000 watts are widely used. They have the advantage of being adjustable for a wide or narrow beam. Candlepower of typical 500-watt units at spot focus is about 35,000.

Another theatrical-type spot utilizes a paraboloidal reflector and a shielded lamp that can be adjusted to produce a very narrow, intense beam with little spilled light. Typical 1000-watt units produce more than 2000 footcandles at 13 feet, when focused for minimum beam spread.

# SUPPLEMENTARY LIGHTING

Supplementary lighting, like spotlighting, offers opportunities to create a more dramatic display, as well as to increase the brightness and attracting power of the window. The high brightness necessary for good daytime visibility may be efficiently obtained by using lamps close to display surfaces and backgrounds, built into display fixtures, or concealed within the display. Background lighting is especially desirable when dark-colored merchandise is displayed and it is impractical to light it brightly enough to make it stand out. The bright background adds to the attracting power of the window, and silhouettes the displayed items for dramatic contrast.

The small-size fluorescent lamps, PAR and R type filament lamps, and general service filament lamps all lend themselves to easy concealment within the display. In some cases, lighted floor and table lamps or wall brackets may form part of the setting. Colored light used on backgrounds or within the display can create compelling and dramatic effects.

In laying out the lighting and wiring for show windows, an adequate number of electrical outlets on the floor, sides and ceiling should be provided to accommodate portable supplementary lighting units and other electrical display equipment.

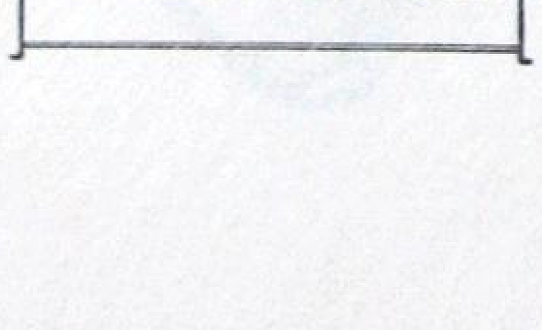
## filament strips

Filament strips of various types accommodate general service lamps, PAR, or R lamps. Colored lamps such as the reflector color type, or clear lamps with color filters may be used. Such units are useful for lighting from the sides of the window or for background lighting. With a decorative shield, they can be used as an element of the display setting. Data for estimating background lighting with PAR-38 or R-40 floodlamps are given on Page 22.

## fluorescent strips

Fluorescent strips, for white or colored lamps 6 to 96 inches in length, have many uses—background lighting, footlighting, and sign, merchandise, or prop lighting within the display. A stock of channels and suitable reflectors in several lengths will enable the display designer to provide effective close-up lighting in all types of display settings. Data for estimating background illumination from fluorescent lamps are given on Page 23.

## background lighting







In addition to the use of fluorescent or filament strips, other techniques for introducing adequate brightness in the background include luminous panels of diffusing glass or plastic lighted from behind, usually by fluorescent lamps. For uniformly bright appearance, spacing between lamps should not exceed 1½ times their distance behind typical diffusing panels. For example, 96-inch T-12 slimline lamps on one-foot centers in a white cavity, 8 inches behind a diffusing panel, will produce a uniform maintained brightness of about 150 footlamberts. Lamps may also be concealed in recesses between panels to provide brightness on adjacent panels or background.

Although white light (or a very pale tint) is generally desirable on the merchandise in a display in order to avoid distortion, colored light offers an opportunity to heighten the dramatic quality of the window. For example, modeling lights at the sides or from below can be used to fill in shadows with color; or backgrounds lighted with color can provide eye-catching contrast with the merchandise displayed. Tests of the "stopping power" of windows in which a substantial part of the usual white light was replaced with colored light have indicated increases as great as 40% in the number of people stopping to look at the window.

PAR-38, COLOR CAP

R-40 REFLECTOR COLOR

COLOR-CHANGING SPOT

Red, pink, gold, green, and blue fluorescent lamps are available in sizes interchangeable with white lamps. As compared with filtered filament lamps producing the same color, colored fluorescent lamps have an efficiency advantage ranging from 2 to 1 for yellow, to 15 to 1 for blue, and 20 to 1 for green. However, the relatively large size and low brightness of fluorescent lamps restricts the total amount of colored light that can be delivered from a given area and makes accurate directional control of the light difficult. Therefore, fluorescent lamps are most useful for flooding large areas with colored light.

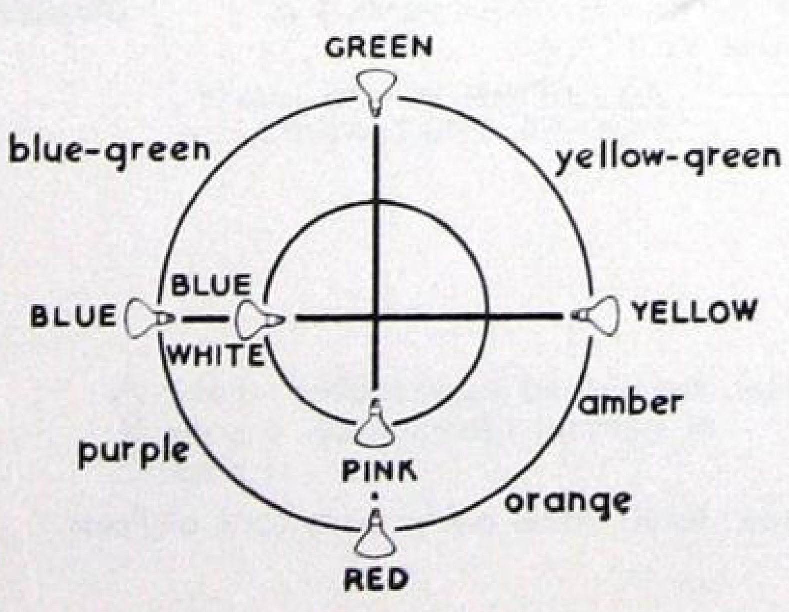
There are several methods of producing colored light with filament lamps. Colored glass filters or spread lenses may be used over reflectorized lamps or filament strips. Glass or gelatine color filters can be used on theatrical-type spotlights.

Reflector color lamps are convenient and effective sources of colored light. These 150-watt R-40 spot-type lamps each have a permanent, baked-on color filter. Six colors are available: saturated red, yellow, green, and blue, and lighter tints of pink and blue-white. These colors are designed for maximum effectiveness, both singly and in combination with each other. (See diagram below.) The pink and blue-white lamps give the whole display a warm or a cool tone with relatively little color distortion. The pink lamps are complimentary to complexion tones; the blue-white lamps are particularly suitable for lighting such displays as jewelry, silverware and home appliances, or wherever cool highlights are desired.

# COLORED LIGHTING

Separately-switched circuits of red, green, and blue-tinted filament lamps or pink, green, and blue fluorescent lamps provide a high degree of flexibility in tinting backgrounds or the whole window. By using various combinations the area may be "painted with light" in different colors. Practical equipment is now available for dimming fluorescent, as well as filament lamps. If the color circuits are on dimmer control, a nearly infinite variety of hues and tints can be created. Automatic dimming on a time cycle introduces striking mobile color effects. Cyclic variation of color can also be conveniently produced by a color-changing spotlight.

Red, green, and blue light combined in appropriate amounts produce white light. So do blue and yellow. The use of such combinations on a display often creates interesting colored shadows, while the over-all effect on the merchandise is that of white light.




## COLOR MIXING with reflector color lamps

Outer circle represents deep hues; inner circle, tints. Mixing adjacent colors creates intermediate hues. Red plus blue makes purple; red plus yellow makes amber or orange; etc. Deep hues, or their mixtures, diluted with white light produce tints. Colors also form complimentary pairs. Yellow and blue (or blue-white) combined in proper proportion produce white light, as do green and red (or pink).

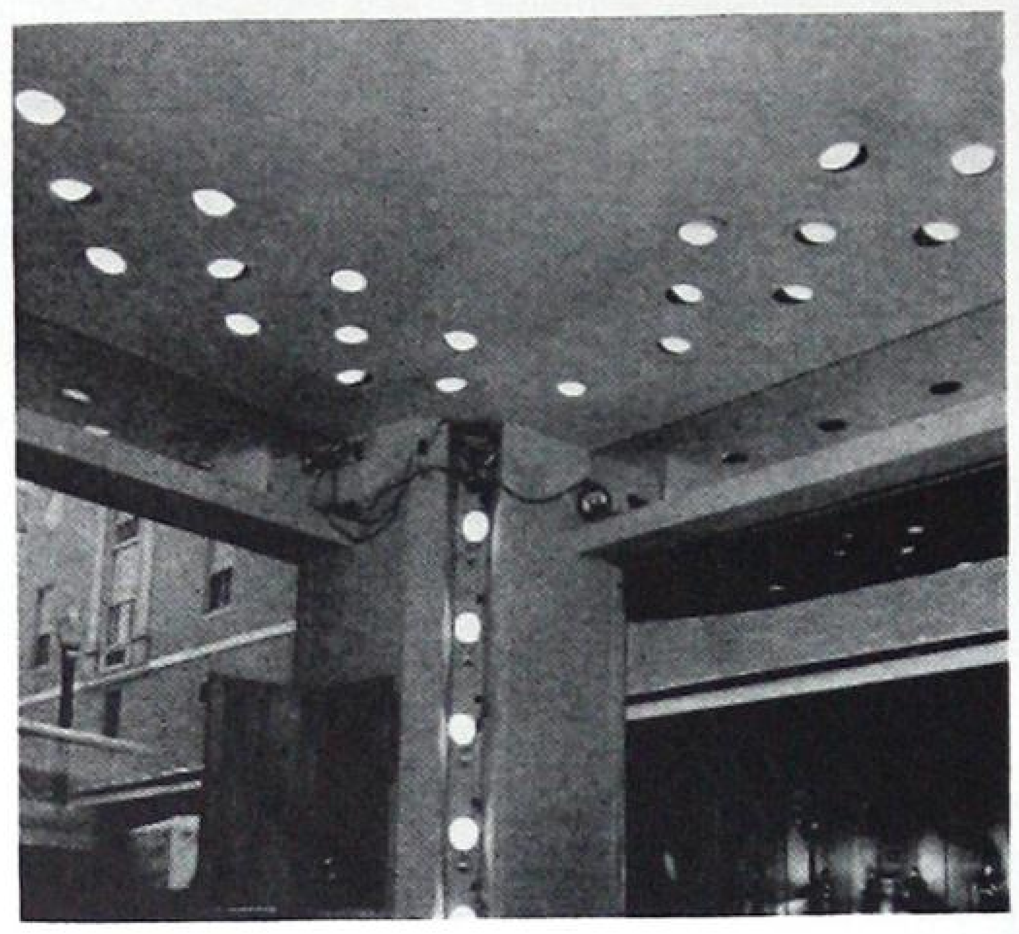
These relationships apply specifically to reflector color lamps, but will apply, approximately, also to colored fluorescent lamps and to filament lamps with other filter media.

1

2

3

4



**1** A very deep window often requires a second row of general lighting units halfway back. Asymmetric filament lamp reflectors are used here. Lighted portable lamps and adjustable spotlamps accentuate certain parts of the display.

**2** A total of 22 300-watt PAR-56 spot and medium floodlamps are used in this corner window. High-level illumination and very light surface-finishes contribute to good daytime visibility.

**3** Adjustable-beam fresnel-lens spots and high-intensity paraboloidal spots at top front of window, together with adjustable 200-watt PAR-46 narrow spotlamps at sides, provide high-level, dramatic accent lighting. Colored background lighting from above, below, and sides is by shielded strip units with filtered 150-watt R-40 floodlamps.

**4** A corner window often presents problems of concealing the lighting equipment. Here, three rows of adjustable 200-watt PAR-46 narrow spotlamps are recessed in the ceiling to provide high-level lighting. Brightness contrasts between lamps and ceiling are reduced by upward light from the cove. Note mirrors on cove walls to eliminate "hot-spots" near the lamps and to reflect more light onto the ceiling.

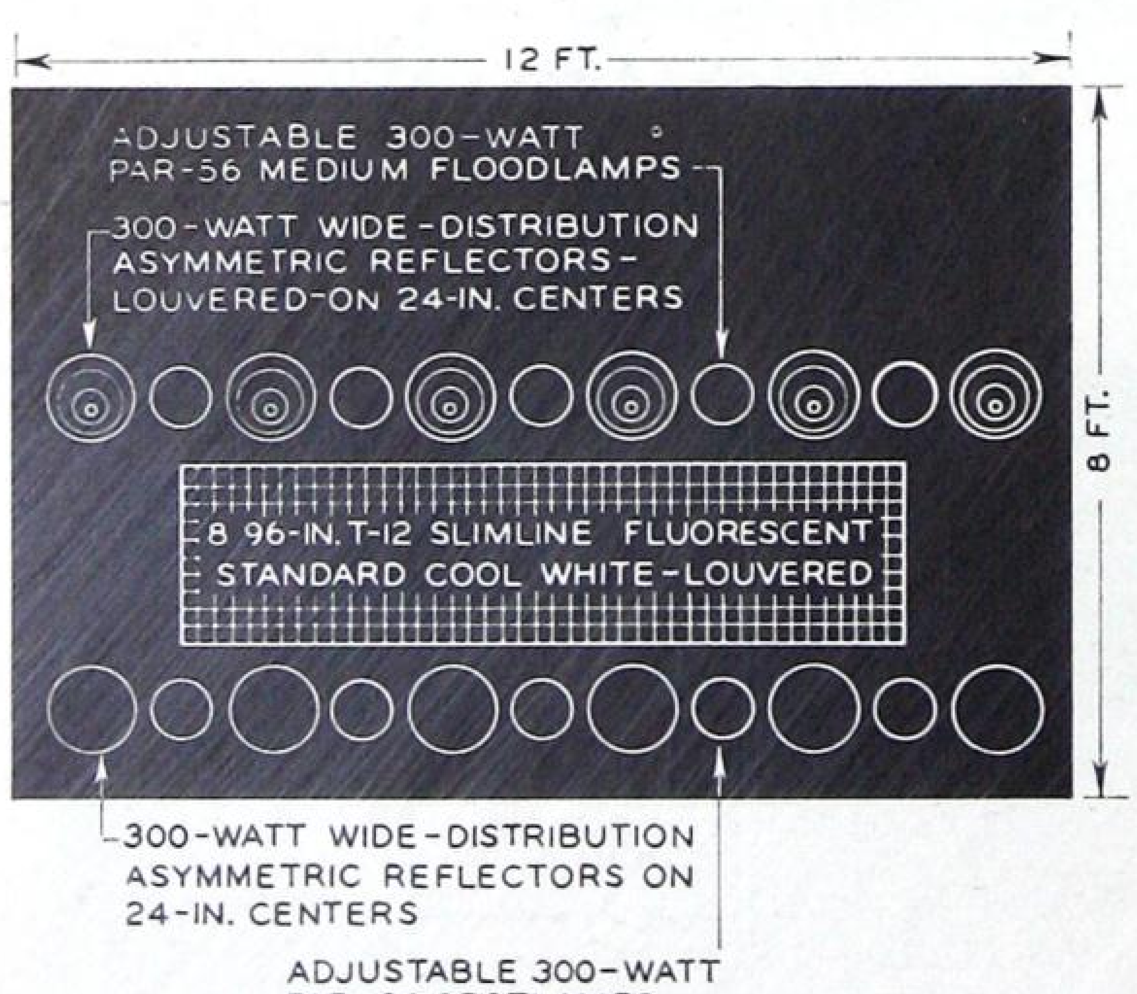
## relatively deep window

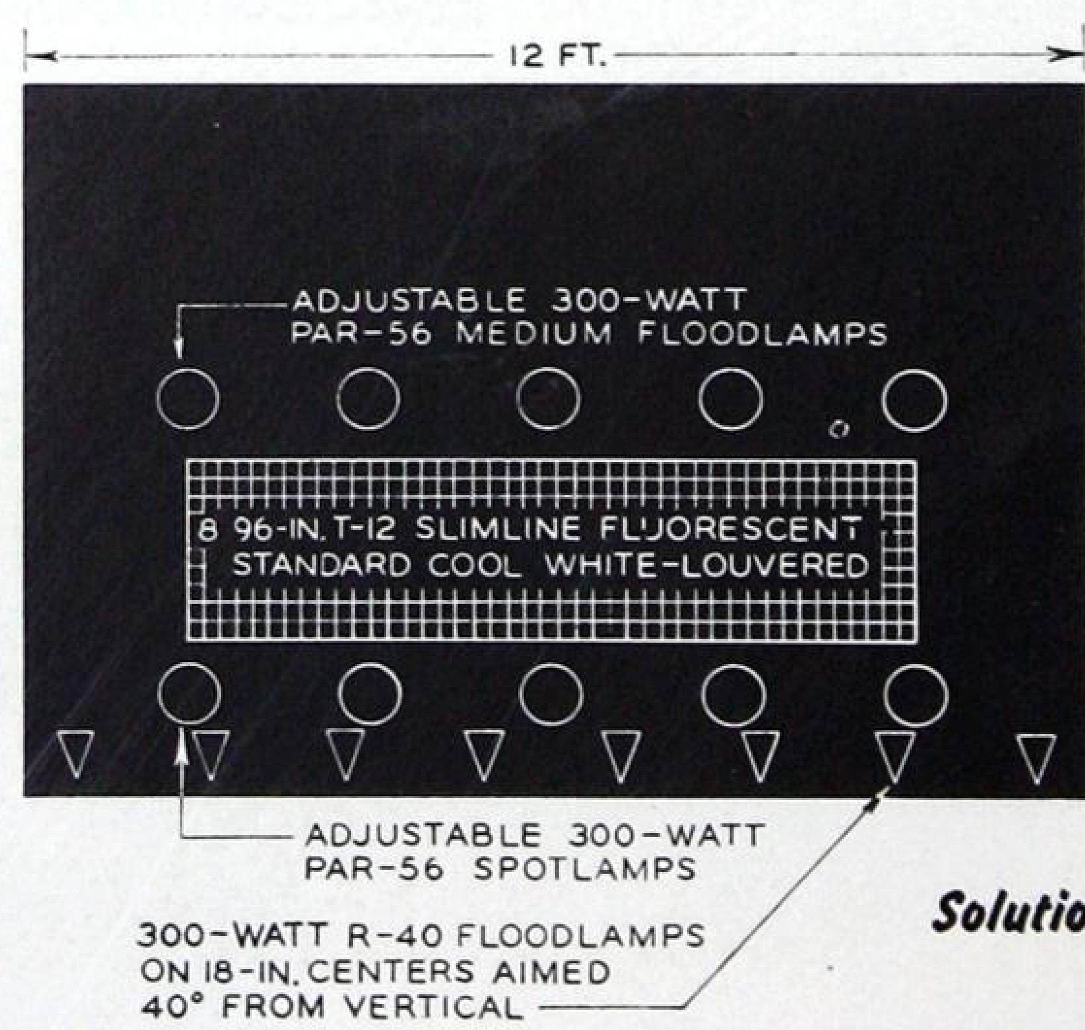
In this relatively deep window, filament and fluorescent general lighting are combined. Where asymmetric filament units are used (Solution 5), two rows are usually required for uniform illumination. Louvering is desirable on the units in the second row, and also the first row if the glass extends all the way to the ceiling. Where R-40 floods are used instead (Solution 6), one row close to the glass will give adequate uniformity.

Either the asymmetric units or the R-40 lamps provide about 150 footcandles in the B-zone, with good distribution in all zones. The fluorescent lamps add about 70 footcandles, softening shadows and lending long, low-brightness reflected highlights. The 300-watt PAR-56 spotlamps each provide maximum illumination of more than 1000 footcandles in parts of zones A or B. The PAR-56 medium floodlamps each supply maximum illumination of about 600 footcandles in parts of zone B.

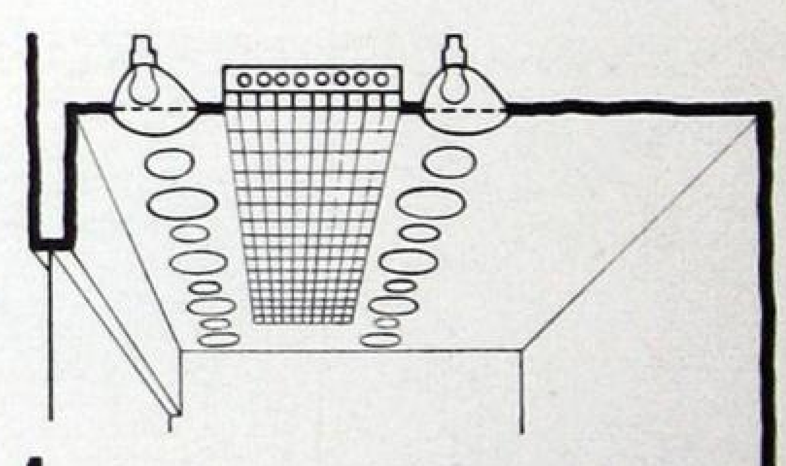
| | | Solution 5 | Solution 6 |
|---|---|---|---|
| Approx. maintained footcandles of general illumination | zone A | 200 | 200 |
| | zone B | 220 | 220 |
| | zone C | 120 | 120 |
| Approx. total watts per square foot of floor. | | 75 | 65 |

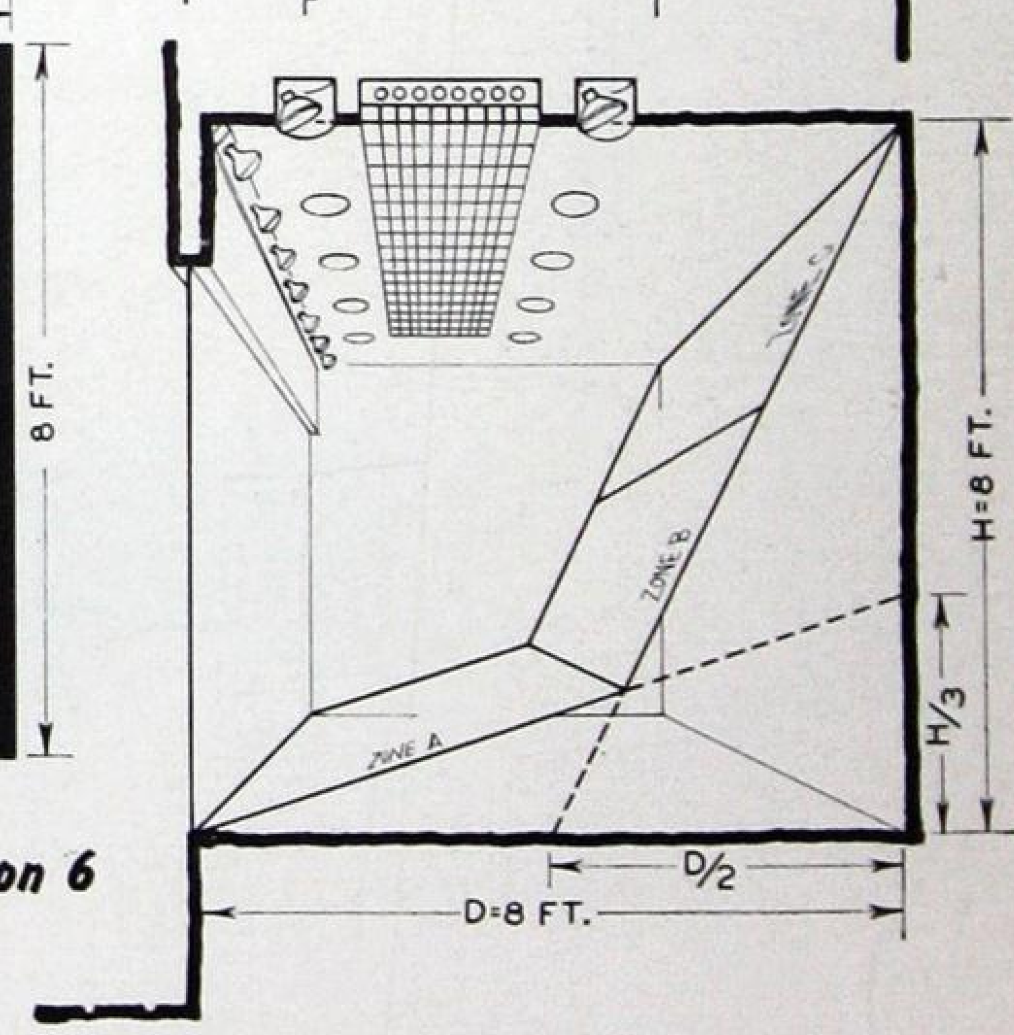
Solution 5




Solution 5






Solution 6

## General service lamps

| WATTS | | BULB | LT. CTR. LGTH.(in.) | LUMENS |
|---|---|---|---|---|
| 100 | medium base | A-21 | 3⅞ | 1630 |
| 150 | | A-23 | 4⅝ | 2700 |
| 150 | | PS-25 | 5¼ | 2550 |
| 200 | | A-25 | 5¼ | 3700 |
| 200 | | PS-30 | 6 | 3700 |
| 300 | | PS-30 | 6 | 5950 |
| 300 | mogul base | PS-35 | 7 | 5650 |
| 500 | | PS-40 | 7 | 9900 |
| 750 | | PS-52 | 9½ | ①17100 |
| 1000 | | PS-52 | 9½ | ①23400 |
| 1500 | | PS-52 | 9½ | 33000 |

NOTE: The above lamps are available either clear or inside frosted.
① New Bonus Line lumen values.

## Showcase lamps

| BULB | | WATTS | DIA. (In.) | FINISH | LGTH. (In.) | LUMENS |
|---|---|---|---|---|---|---|
| T-6½ | intermediate base | 25 | 13/16 | Clear | 5½ | 240 |
| T-10 | medium base | 25 | 1¼ | Clear | 5⅝ | 260 ① |
| | | 40 | 1¼ | Clear | 5⅝ | 430 ① |
| | | 60 | 1¼ | Clear | 5⅝ | 730 |
| T-10 Reflector | medium base | 25 | 1¼ | Reflector | 5⅝ | 215 |
| | | 40 | 1¼ | Reflector | 5⅝ | 400 |
| T-8 Long | medium base | 40 | 1 | Clear | 11⅞ | 410 ① |
| T-10 Long | | 75 | 1¼ | Clear | 11⅞ | 800 |

① With inside frost finish, these lamps are rated at 5 fewer lumens.

## Reflector color lamps

| BULB | WATTS | COLORS | |
|---|---|---|---|
| R-40 | 150 | Saturated Colors: Red, Yellow, Green, Blue | Tints: Blue-White, Pink |

## Lumiline lamps

| BULB | | WATTS | DIA. (In.) | LGTH. (In.) | LUMENS |
|---|---|---|---|---|---|
| T-8 | disc base | 30 | 1 | 17¾ | 250 |
| T-8 | | 40 | 1 | 11¾ | 370 |
| T-8 | | 60 | 1 | 17¾ | 560 |

NOTE: Lumiline lamps are available clear, inside frosted, and colored.

## Spot and flood lamps

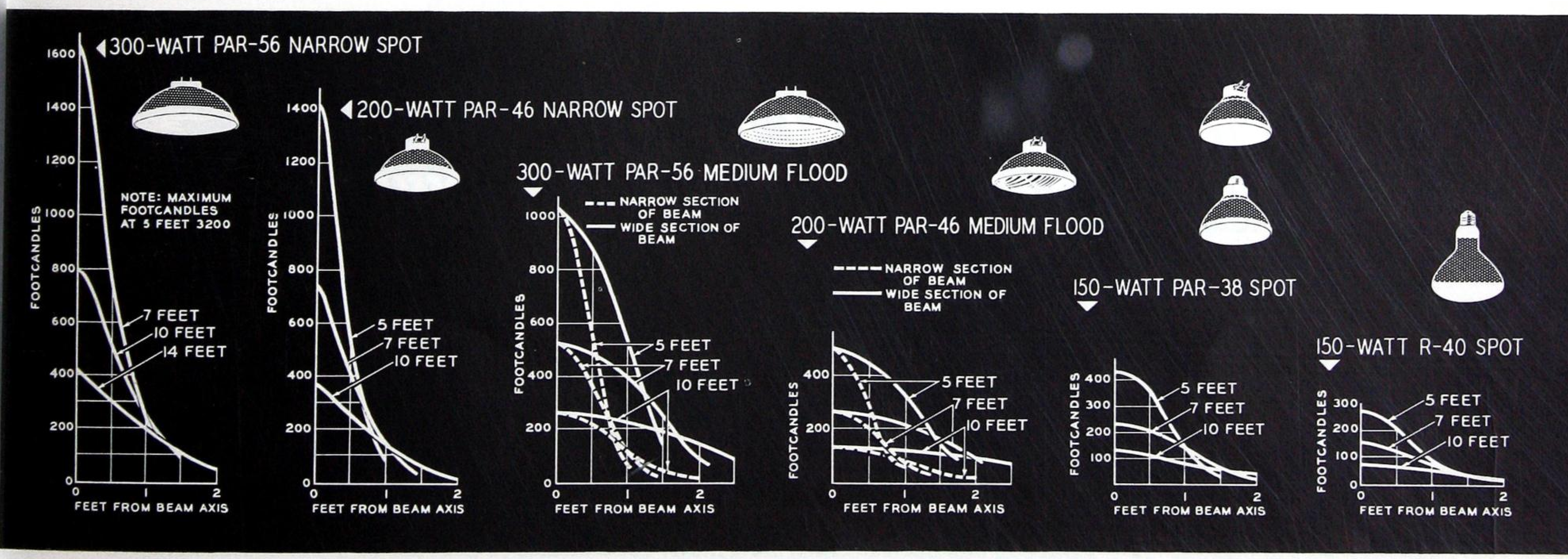
| BULB | WATTS | BEAM SPREAD① Spot | BEAM SPREAD① Flood | AV. CANDLEPOWER IN 10° CONE Spot | AV. CANDLEPOWER IN 10° CONE Flood |
|---|---|---|---|---|---|
| R-30 | 75 | 55° | 130° | 1,900 | 430 |
| R-40 | 150 | 40° | 110° | 6,000 | 1,250 |
| R-40 | 300 | 40° | 115° | 13,500 | 2,600 |
| R-40 | 500 | 45° | 115° | 20,000 | 5,200 |
| PAR-36 4515② | 30 | 4½° x 5½° | .... | 50,000③ | .... |
| PAR-38 | 150 | 30° | 60° | 10,500 | 3,400 |
| PAR-46 | 200 | 17° x 23° | 20° x 40°⑤ | 30,000④ | 11,000⑤ |
| PAR-46 4535② | 30 | 4° x 5½° | .... | 95,000③ | .... |
| PAR-56 | 300 | 15° x 20° | 20° x 35°⑤ | 70,000④ | 22,000⑤ |
| PAR-64 | 500 | 13° x 20° | 20° x 35°⑤ | 110,000④ | 35,000⑤ |

① To 10% of maximum candlepower.
② Step-down transformer is used with this 6-volt lamp. Holder and transformer units commercially available.
③ Value is for maximum candlepower.
④ Values for central 5° cone.
⑤ Medium Flood.

# LAMP DATA

Lumen data on this page are average initial values; individual lamps may vary from them. All lamps listed are available for standard voltages, except where noted. Technical data are subject to change without notice.

For technical information, lumen outputs, etc. of fluorescent lamps, consult G. E. Large Lamp Catalog or folder LS-101, "Fluorescent Lamps and Auxiliary Equipments"




The curves above show footcandles produced on surfaces at right angles to the light beam, for various lamp types and distances from the display. The PAR-46 and PAR-56 spotlamp beam patterns are shown by one average curve. Actually the beams are somewhat oval, so that by properly orienting the beam, maximum effectiveness can be obtained for rectangular areas. The widest dimension of the beam is horizontal when the monogram on the face of the bulb is upright. The PAR-38 and R-40 lamps have essentially circular beams.

## MULTIPLYING FACTORS FOR LAMPS IN EXTERNAL REFLECTORS

### TABLE I — for filament lamps

**Ia — K Factors**

| Cross Section H/D | Zone A Wide | Zone A Semi-Conc. | Zone A Conc. | Zone B Wide | Zone B Semi-Conc. | Zone B Conc. | Zone C Wide | Zone C Semi-Conc. | Zone C Conc. |
|---|---|---|---|---|---|---|---|---|---|
| 4.0 | 4.2 | 3.4 | 2.0 | 6.8 | 5.5 | 3.9 | 1.6 | 2.0 | 3.0 |
| 3.5 | 3.6 | 3.0 | 1.8 | 6.0 | 5.0 | 4.1 | 1.8 | 2.3 | 3.6 |
| 3.0 | 3.2 | 2.6 | 1.7 | 5.5 | 4.6 | 4.5 | 2.0 | 2.8 | 4.1 |
| 2.5 | 3.0 | 2.4 | 1.7 | 4.6 | 4.0 | 5.0 | 2.4 | 3.7 | 5.0 |
| 2.0 | 2.9 | 2.3 | 1.7 | 4.3 | 3.7 | 5.5 | 3.1 | 5.1 | 6.1 |
| 1.5 | 3.0 | 2.4 | 1.9 | 4.1 | 3.6 | 6.3 | 4.1 | 8.3 | 9.4 |
| 1.0 | 3.3 | 2.9 | 2.3 | 4.6 | 4.1 | 7.5 | 7.5 | 20.3 | 20.0 |

(Table based on typical commercial equipments. A maintenance factor of 0.75 has been assumed.)

**Ib — P (Length) Factors**

| Type of Equipment | Window Length Divided by Height (L/H) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.5 | | 1.0 | | 1.5 | | 2.0 | |
| | 1 Glass End | Solid Ends | 1 Glass End | Solid Ends | 1 Glass End | Solid Ends | 1 Glass End | Solid Ends |
| Wide | 1.40 | 1.25 | 1.10 | 1.05 | 1.00 | 1.00 | 1.00 | 0.95 |
| Semi Conc | 1.30 | 1.20 | 1.05 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 |
| Conc | 1.20 | 1.10 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

**Ic — Q (Shielding) Factors** (Factor for Unlouvered Lamps = 1.00)

| H/D | Louvers at Right Angles to Plate Glass Zone A | Zone B | Zone C | Louvers Parallel to Plate Glass Zone A | Zone B | Zone C | Eccentric Ring Louvers Zone A | Zone B | Zone C |
|---|---|---|---|---|---|---|---|---|---|
| 4.0 | 1.3 | 1.4 | 1.4 | 1.2 | 1.4 | 2.2 | Not Usually Employed | | |
| 3.5 | 1.3 | 1.4 | 1.4 | 1.2 | 1.4 | 2.3 | Not Uusally Employed | | |
| 3.0 | 1.3 | 1.4 | 1.5 | 1.2 | 1.5 | 2.6 | Not Uusally Employed | | |
| 2.5 | 1.3 | 1.4 | 1.6 | 1.2 | 1.6 | 3.0 | Not Usually Employed | | |
| 2.0 | 1.4 | 1.4 | 1.6 | 1.2 | 1.8 | 3.7 | 1.4 | 1.6 | 2.9 |
| 1.5 | 1.4 | 1.5 | 1.7 | 1.2 | 1.9 | 4.6 | 1.4 | 1.8 | 3.3 |
| 1.0 | 1.4 | 1.5 | 1.8 | 1.3 | 2.1 | 5.3 | 1.4 | 2.2 | 4.0 |

### TABLE II — for fluorescent lamps

**IIa — K Factors**

| Cross Section H/D | Zone A Wide | Zone A Semi-Conc. | Zone A Conc. | Zone B Wide | Zone B Semi-Conc. | Zone B Conc. | Zone C Wide | Zone C Semi-Conc. | Zone C Conc. |
|---|---|---|---|---|---|---|---|---|---|
| 4.0 | 4.9 | 5.7 | 4.2 | 11.3 | 10.3 | 7.6 | 2.7 | 1.5 | 1.7 |
| 3.5 | 4.6 | 5.2 | 3.9 | 9.2 | 9.2 | 6.8 | 2.3 | 1.6 | 1.9 |
| 3.0 | 4.2 | 4.2 | 3.4 | 7.9 | 6.9 | 5.6 | 2.5 | 1.8 | 2.2 |
| 2.5 | 4.1 | 3.9 | 3.0 | 6.2 | 5.0 | 4.7 | 2.8 | 2.2 | 2.7 |
| 2.0 | 4.1 | 3.8 | 2.7 | 5.7 | 4.3 | 3.7 | 3.3 | 2.8 | 3.7 |
| 1.5 | 4.0 | 3.6 | 2.4 | 5.2 | 4.4 | 4.1 | 4.3 | 4.1 | 5.7 |
| 1.0 | 4.3 | 3.6 | 2.3 | 5.0 | 5.0 | 6.8 | 7.6 | 7.6 | 15.1 |

(Table based on equipments of typical distribution. Efficiencies: Wide 65%; Semi-Concentrating 85%; Concentrating 80%. A maintenance factor of 0.75 has been assumed.)

Note: This simplified table is based on four rows of fluorescent lamps in reflectors of typical widths at typical angles of tilt. Some variation in results is to be expected depending on type of equipment selected, number of rows, and mounting angle. As the number of rows is increased, rear rows contribute progressively less light to the A and B zones, and more to the upper background.

**IIb — P (Length) Factors**

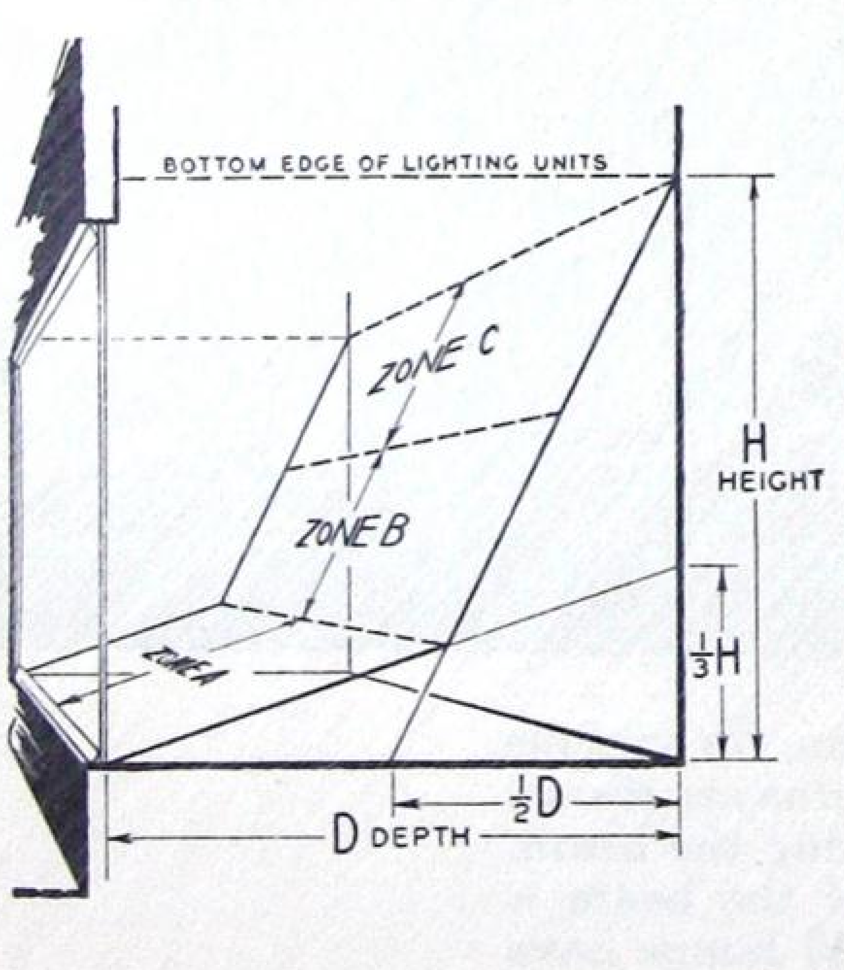
| Window Length Divided by Height (L/H) | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.5 | | 1.0 | | 1.5 | | 2.0 | |
| 1 Glass End | Solid Ends | 1 Glass End | Solid Ends | 1 Glass End | Solid Ends | 1 Glass End | Solid Ends |
| 1.55 | 1.45 | 1.20 | 1.10 | 1.00 | 0.95 | 0.95 | 0.90 |

**IIc — Q (Shielding) Factors** (Factor for Unlouvered Lamps = 1.00)

| H/D Ratio | Shielding Factors (S) — Eggcrate Louvers (Matte White) Shielding Lamps to 45° Crosswise and 25° Lengthwise: Zone A | Zone B | Zone C |
|---|---|---|---|
| 4.0 | 1.11 | 1.20 | 1.14 |
| 3.5 | 1.11 | 1.20 | 1.14 |
| 3.0 | 1.11 | 1.18 | 1.14 |
| 2.5 | 1.11 | 1.18 | 1.14 |
| 2.0 | 1.11 | 1.18 | 1.16 |
| 1.5 | 1.09 | 1.15 | 1.19 |
| 1.0 | 1.09 | 1.10 | 1.27 |

# DESIGNING THE GENERAL LIGHTING —
## FILAMENT AND FLUORESCENT LAMPS IN EXTERNAL REFLECTORS

(Data for PAR and R lamps are given on Pages 20 and 21.)




Display Zones A, B, and C, shown in the drawing at the left, are used as representative planes of typical window trims. They provide reference location for measurement of illumination on display surfaces. Zones B and C are equal divisions of the upper plane.

The usual procedure is to **select the zone** that is likely to be most important. This selection, of course, is based on the nature of the merchandise that will be displayed, and on the kind of back (open or closed) that the window has. In most cases, either Zone A or Zone B is regarded as the most important zone.

Once it has been decided how many footcandles to provide in a particular zone, the type of lighting equipment and its spacing must be determined. The procedure is as follows:

**STEP 1** Find how many lamp lumens per linear foot of window must be provided.

**Lamp lumens needed per foot = Footcandles desired x Height in feet x K x P x Q**

Where K = a constant that takes into account the height-to-depth (H/D) ratio of the window, and the light distribution;

P = length factor (introduces the effects of the length-to-height (L/H) ratio and of the kinds of ends the window has);

Q = shielding factor (adjusts for the effects of type and orientation of louvering used).

The K, P, and Q factors for filament and fluorescent lamps are found in Tables I and II, respectively, on Page 18. For each H/D ratio, **the lowest K factor** in the selected zone identifies the reflector distribution that will provide the desired illumination most efficiently.

## STEP 2 — a. for filament lamps

Make tentative selection of lamp size. One way to do it is to choose the **smallest** lamp size that has a lumen output rating **higher** than the lamp lumens needed per foot, found in Step 1 (see "General Service Lamps" box on Page 17). Then:

$$\textbf{Lamp spacing in inches} = 12 \times \frac{\textbf{Rated lumens per lamp}}{\textbf{Lamp lumens needed per foot}}$$

If spotlighting equipments are to be mounted between the general lighting units, the spacing found from this formula may not always be great enough to accommodate them. In this case, select the next-higher-wattage lamp, and recalculate the spacing.

## — b. for fluorescent lamps

Find the lumens per foot of window produced by a single row of fluorescent lamps of the size, type, and color selected:

$$\textbf{Lumens per foot for one row} = \frac{\textbf{Total lamp lumens for one row}}{\textbf{Length of window}}$$

$$\text{Then, }\textbf{Number of rows needed} = \frac{\textbf{Lamp lumens needed per foot, from Step 1}}{\textbf{Lumens per foot for one row}}$$

Sometimes, in shallow windows, there is not enough ceiling space for the required number of rows of fluorescent lamps. T-6 slimline lamps at 300 milliamperes in three-inch parabolic reflectors generally give maximum display-zone illumination from a given ceiling area. Their use should be considered when difficulties are encountered in obtaining high footcandle levels from fluorescent lamps.

## EXAMPLE

In a window 9 feet long, 6 feet high, and 4 feet deep, with solid ends, assume that we wish to illuminate Zone B to 200 footcandles — 150 footcandles from filament lamps, and 50 footcandles from standard cool white fluorescent lamps. Then, $H/D = \frac{6}{4} = 1.5$; $L/H = \frac{9}{6} = 1.5$.

For the 150 footcandles of **filament** lighting, refer to:

*Table Ia* — In Zone B, for H/D = 1.5, semi-concentrating reflectors give the lowest K factor (3.6).

*Table Ib* — For semi-concentrating equipments, window with solid ends, and L/H = 1.5, the length factor P is 1.0.

*Table Ic* — Shielding parallel to the glass is desirable to keep glare from the eyes of people standing close to the window and looking upward; so for Zone B, when H/D is 1.5, the shielding factor Q is 1.9

Now, from Step 1: Lamp lumens needed per foot = 150 x 6 x 3.6 x 1.0 x 1.9 = 6156

From the "General Service Lamps" box on Page 17, it is found that the **smallest** size lamp that has a lumen output rating **higher** than 6156 is the 500-watt lamp, with an output of 9900 lumens.

Then, from Step 2a: Lamp spacing in inches $= 12 \times \frac{9900}{6156} = 19.3$ inches.

For the 50 footcandles of **fluorescent** lighting, refer to:

*Table IIa* — In Zone B, for H/D = 1.5, concentrating reflectors give the lowest K factor (4.1).

*Table IIb* — For a window with solid ends, and L/H = 1.5, the length factor P is 0.95.

*Table IIc* — In Zone B, for H/D = 1.5, the shielding factor Q is 1.5.

From Step 1: Lamp lumens needed per foot = 50 x 6 x 4.1 x 0.95 x 1.15 = 1344

Assume that two 40-watt standard cool white lamps are used in each row. Then, from Step 2b,

Lumens per foot for one row $= \frac{2 \times 2500}{9} = 555$, and,

Number of rows needed $= \frac{1344}{555} = 2.42$, call it 3 to be safe.

## DESIGNING VERTICAL-SURFACE ILLUMINATION

### PAR-38 and R-40 floodlamps

Effective illumination of vertical surfaces such as show-window backgrounds can be accomplished with PAR-38 or R-40 floodlamps. Greater background illumination is possible with these lamps than with fluorescent lamps, because of the higher lumens-per-foot available from incandescent lamps.

In the charts below, the vertical surface to be lighted is divided into one-foot sections. A row of 150-watt PAR-38 or R-40 floodlamps on 8-inch centers, at various distances from the surface, is assumed. The lamps are aimed parallel to the surface. Average illumination and vertical uniformity will be somewhat increased if the lamps are slightly tilted and aimed at the far edge of the surface. Footcandles in the center of each one-foot section, well in from the edges of the surface, are shown for the PAR-38 lamps (upper figures) and the R-40 lamps (lower figures). A 75% maintenance factor is assumed.

If the lighting is to be from above, rather than from below, the charts may simply be inverted. Illumination for other center-to-center lamp spacings can be calculated:

$$\text{Illumination for any lamp spacing} = \frac{\text{footcandles from chart x 8}}{\text{lamp spacing in inches}}.$$

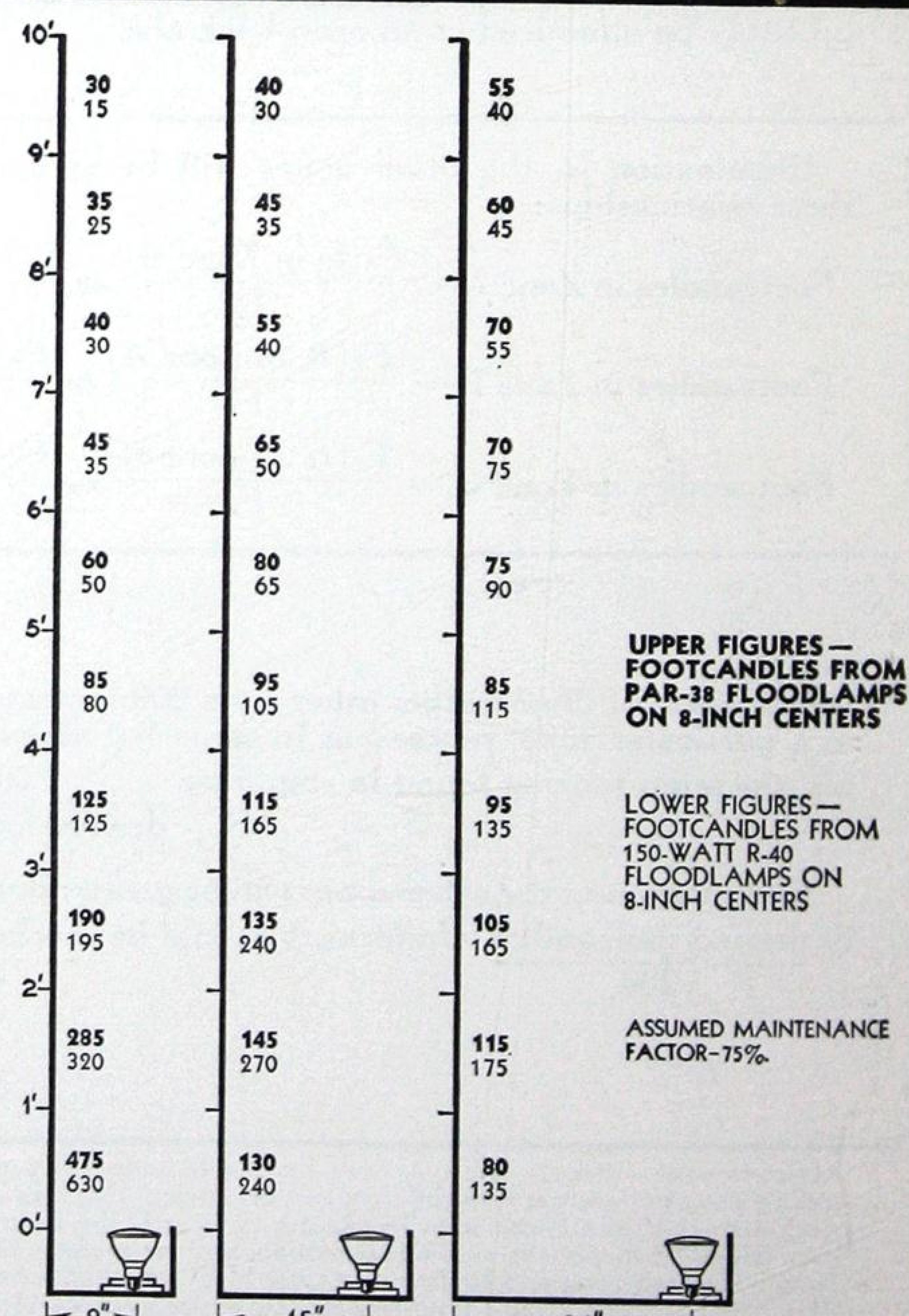
For estimating results from other wattages of reflector flood lamps, footcandle values for the R-40 flood should be multiplied by the following factors:

| Lamp | Factor |
|---|---|
| 500-watt R-40 flood | 3.1 |
| 300-watt R-40 flood | 2.0 |
| 75-watt R-30 flood | 0.4 |

Some considerations in designing vertical-surface illumination:

1. *Uniformity of brightness along the surface close to the row of lamps.* When used without shielding media between them, R-40 flood lamps will give good uniformity if the distance between lamps is not greater than their distance from the surface. If the lamps are in housings, some "scalloping" effect may result. PAR-38 flood lamps will also produce some scalloping at this spacing because they emit little light at wide angles. The scalloping effect can be minimized by painting the background a dark color near the lamps or by suitable shielding. Lighting units are available with spread-lenses to increase uniformity. The smoothest effects can usually be obtained with general service lamps in reflectors designed specifically for this use. When color circuits are used, the spacing relationships indicated above should be observed for each color, in order to provide smooth mixtures.
2. *Uniformity of brightness across the surface from top to bottom.* As can be seen from the charts, this depends on the distance from the row of lamps to the surface, the light distribution of the lamps, and the distance to be covered. A convenient rule of thumb is to locate the lamps at least one foot away from the surface for every 4 to 5 feet of its height. Following this rule with PAR-38 floods, the variation in brightness from bottom to top of the surface will be about 2 to 1. When there is an opportunity to locate lamps farther away from the background, higher brightness and better uniformity can be obtained. The R-40 floodlamp is recommended when lamps can be placed out from the surface at a distance equal to ½ its height.

**EFFECTIVE**



## fluorescent lamps

Vertical surfaces of merchandise on shelves or garment racks, wall surfaces at the perimeter of the store, and backgrounds of show windows can be effectively lighted by properly placed fluorescent lamps. Show-window background lighting is usually more effective from below, than from above. The charts at the left can be applied to lighting from below simply by inverting them.

In the charts, a continuous single row of fluorescent lamps mounted at various distances from a vertical surface is assumed. For each 6-inch strip of the surface, at distances up to four feet from the source, values of $K_V$ are given. To find footcandles on the vertical surface (well in from its edges), multiply $K_V$ by the lumens per foot of the lamp used.

The upper of each pair of figures is the $K_V$ for a continuous row of fluorescent lamps shielded by a cornice painted white inside. The lower figures are for the same lamp fitted with a polished concentrating reflector aimed at the bottom of the 4-foot vertical plane. The figures assume a 75 per cent maintenance factor. They also assume that the lighted area is wider than it is tall. For areas of lesser width, values of $K_V$ will be somewhat lower.

Where the height of the vertical surface is less than four feet, the reflector would be aimed higher, and some increase in the footcandles over the values calculated would result. The charts and the procedure may be applied to vertical surfaces of other height if all distances are multiplied by $\frac{\text{Height in feet}}{4}$ and all $K_V$'s are multiplied by $\frac{4}{\text{Height in feet}}$. To obtain higher illumination, multiple rows can, of course, be used.

### K FACTORS FOR VERICAL SURFACES

| Strip (distance below source) | 3" | 6" | 9" | 12" | 18" |
|---|---|---|---|---|---|
| 0–6" | .450<br>.256 | .302<br>.119 | .202<br>.031 | .154<br>.023 | .101<br>.021 |
| 6"–1' | .139<br>.091 | .119<br>.094 | .131<br>.102 | .124<br>.072 | .097<br>.060 |
| 1'–1'6" | .020<br>.046 | .045<br>.071 | .064<br>.073 | .074<br>.071 | .074<br>.063 |
| 1'6"–2' | .008<br>.021 | .021<br>.042 | .033<br>.058 | .043<br>.065 | .051<br>.068 |
| 2'–2'6" | .005<br>.012 | .014<br>.026 | .020<br>.038 | .026<br>.047 | .035<br>.058 |
| 2'6"–3' | .003<br>.008 | .008<br>.021 | .013<br>.027 | .017<br>.033 | .024<br>.044 |
| 3'–3'6" | .002<br>.006 | .005<br>.013 | .008<br>.020 | .012<br>.025 | .017<br>.036 |
| 3'6"–4' | .002<br>.005 | .004<br>.010 | .006<br>.015 | .009<br>.023 | .014<br>.028 |

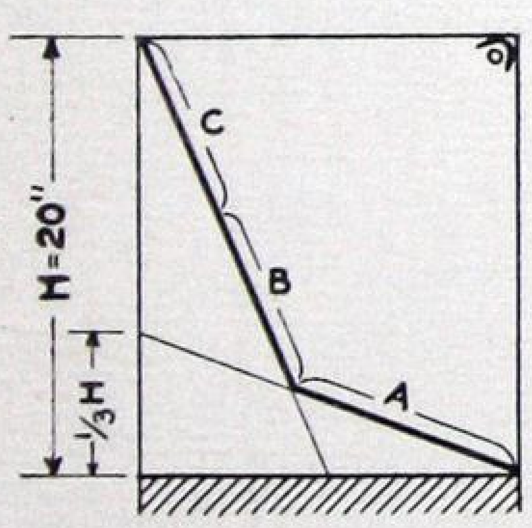
VERTICAL FOOTCANDLES = $K_V$ (Shown above) x Lumens-per-foot of light source.

Values of $K_V$ { **Upper figures — fluorescent lamp, no reflector, cornice mat-white inside.**
Lower figures — fluorescent lamp, concentrating reflector aimed at bottom of 4-foot section.

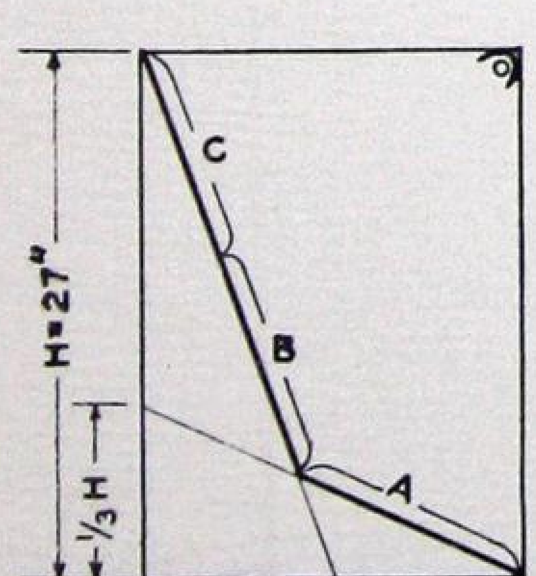
# DISPLAY LIGHTING

### K FACTORS FOR SHOWCASES


| ZONE | Fluorescent Lamp: in white diffusing Reflector | Fluorescent Lamp: in concentrating Reflector | Filament Lamp: clear T-10 in semi-diffusing Reflector | Filament Lamp: T-10 Reflector Showcase |
|---|---|---|---|---|
| A | .199 | .241 | .164 | .267 |
| B | .091 | .148 | .103 | .269 |
| C | .038 | .070 | .071 | .096 |




| | | | | |
|---|---|---|---|---|
| A | .128 | .124 | .107 | .170 |
| B | .103 | .144 | .089 | .250 |
| C | .061 | .104 | .091 | .138 |




| | | | | |
|---|---|---|---|---|
| A | .097 | .092 | .081 | .134 |
| B | .084 | .109 | .070 | .178 |
| C | .071 | .113 | .091 | .155 |

## DESIGNING SHOWCASE ILLUMINATION

When lighting is supplied from within the showcase by lamps at the top front edge, footcandles in each of three typical trim-planes can be estimated. Plane A extends from the lower front edge to a line at 1/3 the height of the case. Plane B-C runs from the top rear edge to a line at 1/2 the case depth on the bottom. Zones B and C are equal. Any or all of these zones may be of prime importance, depending on the method of displaying merchandise.

In the accompanying charts, typical glass showcases 20 inches deep are assumed. Constants (K) are given for each zone, for three typical case heights, and for four lighting methods. The values of K are based on an assumed maintenance factor of 75%.

When lamp and reflector have been selected, the footcandles in any zone can be estimated:

**footcandles = K x (lumens-per-foot of case length)**

The lumens-per-foot value for a continuous row of fluorescent lamps running the entire case length will be the lumens-per-foot of the lamps used. Otherwise, lumens-per-foot of case length for either fluorescent or filament lamps will be:

$$\textbf{Lumens-per-foot of case length} = \frac{\textbf{lumens per lamp x number of lamps}}{\textbf{length of case (feet)}}$$

LARGE LAMP DEPT.

GENERAL ELECTRIC

CLEVELAND 12, OHIO

APPLICATION ENGINEERING

LS-158 MARCH, 1956