LIGHT

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LIGHT

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COVER AND FRONTISPIECE
The light bright colorful architect-designed wall shown on the front cover is a use of light as an architectural element. The frontispiece is a dramatically lighted flower built by a sculptor and is installed in the perpetual-evening mood created by lighting designers for a display garden. The two installations effectively demonstrate that light is a rewarding medium for visually creative designers.
The wall of light is in the Indianapolis Power and Light building in Indianapolis. The flower and garden are in the Lighting Institute at Nela Park.
Cover photograph is by Dave Ulrich, frontispiece is by Don Stang; both of Nela Photographic Section.

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The current 205,000 square feet of floor space in the new Electric Building of Indianapolis Power & Light Company consists of 105,000 square feet of remodeled space in a fifty-year-old structure, plus 100,000 square feet in the new structure. Of the seven window sections in the building face, the three at left are in the new structure. Careful planning for uniformity of floor levels also makes detection of new/old demarkations inside difficult.

STATE OF THE LIGHTING ARTS

...at Indianapolis Power and Light

by **Norman F. Schnitker**, *Dir., Comm'l Lighting Sales, Indianapolis Power & Light Co.*

The 1930's were primitive times in terms of the lighting arts as we know them today. In fact, considering the environmental factors — visual, thermal, sonic, aesthetic, — to which lighting bears important relation today, the lighting of the 1930's might almost be considered prehistoric. Until the late 1930's, vital environmental influences such as fluorescent lighting and air conditioning had not yet been marketed. The best-known technique for controlling the heat from lighting in the 1930's was to turn off the lights and open the windows. The concept of collecting, storing, and recovering lighting heat on demand was almost unheard of.

Since the 1930's we have brought many technological firsts to the Indianapolis community. In the 1940's we were among the first to use then-new fluorescent lamps for a new kind of lighting environment with twice the illumination level of incandescent lamps; we were among the first to use fluorescent street lighting extensively; among the first to reach toward visual environments of 150 footcandles for general lighting; among the first to demonstrate to our customers that many working situations require 300 footcandles, which our Senior Vice President-Sales, Mr. Richards, challenged us to exceed for his work situation.

We have found, however, no important practical value in simply bringing technological firsts to the community. Being first has given our Lighting Department a good fix on available lighting technology and ways to apply it, but getting the technology into service has been another matter. Back through the 1940's, lighting specifiers were being somewhat less than objective about the seeing task. Their primary enthusiasm was directed to their principal interest among environmental influences: decorators recommended lighting suitable to decorating schemes; architects applied lighting to enhance architectural lines; lighting equipment suppliers keyed recommendations to the tops of their own equipment lines; air conditioning engineers recommended lighting systems on the basis of heat loads. The heart of the problem lay not in a lack of good conscience or good judgment among the various specifiers; it was in the lack of readily available objective resource in application of the lighting arts.

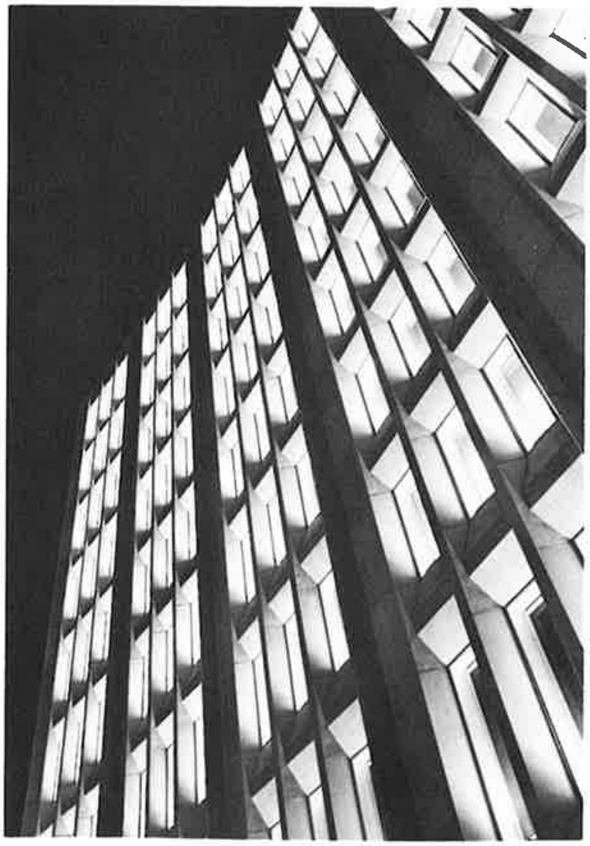
We acted to establish ourselves as that resource, but not without some resistance. Some specifiers resented us on the basis that we were load-building. We were, but more important, we had become keenly aware that increasing complexities in the use of electric energy had made our customers dependent on us not just for energy, but for a complete capable utility service in the use of electric energy. As we broadened our service policy, our Lighting Department people became *the* experts in lighting in the area we serve. We encouraged customers and specifiers to use the services of our Lighting Department freely. And, over the years, we have built confidence among consultants and specifiers and have successfully convinced them we are not intruding upon their fields, but are filling important gaps as lighting specialists to help make them more expert in their own specialties. And we've enjoyed a natural and healthy load growth which we haven't had to force. As a result of establishing ourselves as a useful lighting resource, we find great cooperation between customers, specifiers, suppliers and ourselves. In the past, those who should have been interested in a new idea or a trial installation were not. Now, even the cost of a trial job isn't a barrier. The interested parties willingly agree on problems worth solving, willingly agree that costs, shared equitably, are secondary to the solution.

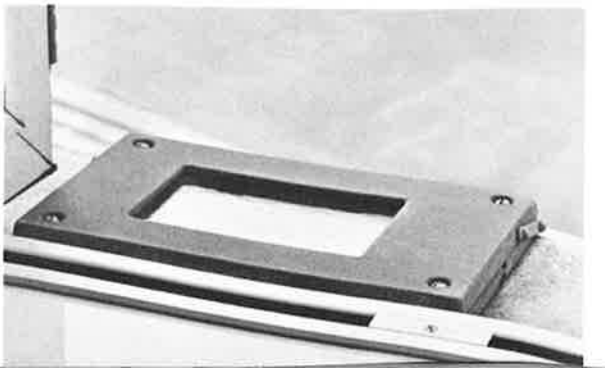
For years we lacked facilities of our own for demonstrating to customers how coordination of expert skills could work to their benefit on a practical basis. Our Board of Directors solved that for us in 1963 when they decided to increase our office space. After the Building Committee selected the architect for the new building, the Lighting Department found itself playing exactly the role it had established for itself; offering consultation, and liaison to the architect on behalf of the customer. In this case, the customer was our own Management.

Acting on our recommendation, the staff of architect Mr. Richard Lennox established 300 to 350 footcandles as the requirement for areas where visual work is intensive. Later calculations indicated the heat load from a system meeting that lighting level would be adequate to heat the building. Management accepted both the footcandle level and the electrical space-conditioning* concept. When preliminary construction estimates were submitted by the architect, there was concern that the costs were too great and consideration was requested for possible reduction. The key to reduction would have been the lighting level, since it influenced electrical and mechanical costs. The architect calculated a million dollar reduction in construction costs if lighting levels were reduced to 150 footcandles, but recommended strongly against such action due to the nature and use of the building. We documented lighting trends in our area to prove that reduction would put the environment-control influences of lighting, heating and air handling in our building below many other buildings locally, whereas, we should be a show-place at least five years ahead of the times in the efficient use of electric energy. We resold the 300 footcandle level and the electrical space-conditioning concept.

The design of lighting for our building was, of course, a major accomplishment in cooperation within our established pattern of liaison. The architect made design decisions. We fed his people ideas and technical assistance, and supported their relations with suppliers.

**See explanatory schematic diagram inserted in this issue.*





Window apertures each have an enclosed unit for one 500-watt Quartzline® lamp recessed into bottom outer sill. Unit's reflector and spread-lens system for light distribution disperses illumination to sides and top of each window recess. The slightly-warm grey coloration of the Indiana limestone facing is enriched by the color of Quartzline lighting after dark.

Exterior floodlighting was one of the notable accomplishments. The Management decided that our present site in the heart of Indianapolis would be enlarged and occupied by one building. That meant removing the face from our existing building, tearing down the adjacent building, erecting a new section, then facing both buildings uniformly to create one apparent structure. The architect recommended that the building have a new architectural treatment, and that it be selected with respect to a new kind of exterior lighting treatment. We worked with his staff and the General Electric Outdoor Lighting Department building full-scale section mock-ups on which we worked out the new lighting effects and details. And, incidentally, we successfully worked out some "bugs" that we know would have been costly to correct later.

For the building interiors, the architect also took our lighting-treatment ideas and expanded on them. He wanted to use light as an architectural element and one of the areas singled out for special treatment was the elevator lobby on the first floor. The entire wall opposite the elevators is a giant indicator panel and spectrum display wall combined. (See front cover illustration.) An animated light pattern traverses the wall from top to bottom in sequence with elevator ascents and descents. The effect is unique. A Chicago display firm helped work out new mechanics, and General Electric supplied a special lamp type.

In all the services we offer, we have the problem of balancing service rendered against load-growth. If we do the job right, the two blend together — when we effectively demonstrate a productive use of energy to a customer, our load-growth follows naturally.

In this building we feel that we have defined for the Indianapolis area the state of the lighting art and set the pace in the environmental control field for several years hence. Lighting trend data compiled during the building planning stage showed that 7 installations in our area were over 300 footcandles; 68 were over 150 footcandles. Newer data, as of early 1967, shows comparative counts of 16 installations over 300 footcandles and 128 over 150 footcandles. Roughly doubled, the numbers indicate an accelerating trend toward higher lighting levels and better-controlled environment suggesting that we've rendered a useful and profitable service by broadening the scope of technological resources that we have available for our customers.

GENERAL OFFICE AREAS

Among 1935's best, this Indianapolis Power & Light Company office boasted leadership with 30 footcandles using incandescent lamps in indirect units to meet the then-current I.E.S. recommendation.

Luminaires with four 40-watt rapid-start lamps and prismatic glass covers are recessed in the mechanically functional ceilings in general office areas. Luminaire size is 2′ x 4′; spacing is one foot between rows, two feet between units. Basic design module is 4′ x 5′. Luminaire fills 40% of module, 60% remains for acoustical treatment, so all suspension rigging is concealed for maximum acoustical effect. Footcandle level is 300 maintained.

CUSTOMER SERVICE AREAS

Distinctive lighting treatments distinguish two customer service desks: over cashier's desk, panel fluorescent lamps concealed in deep-shielding boxes deliver more than 200 footcandles. Over customer interview desk, visually dark parabolic wedge louvers conceal high output fluorescent lamps delivering a maximum above 300 footcandles.

The second-floor auditorium area, lighted with a combination of fluorescent and incandescent systems has a maximum level of 120 footcandles. System is variable with dimmers and by zones; audience zone is controllable separate from presentation area; fluorescent and incandescent systems are separately controlled.

Slots between circular light units are typical of air supply system used where fixtures are not of air handling type. Square louvered ceiling areas in background, which correlate typically with display windows, can deliver 550 footcandles in display area. Light level is controllable by dimmer which is connected with half the lamps in the system — a unique idea that gives full system variability, above or below half intensity. This system, because it is half-dimmer-controlled, requires some operating manipulation, but reduces cost of dimming equipment — a practical savings where smooth maximum-to-zero dimming is not a requirement, as in display window set-ups.

CONVENIENCE AREAS

Visual variety and unity of purpose are served in elevator lobbies by wood framings, configurated plastics, luminous wall panels, ceiling louver sections, incandescent downlights, fluorescent colors with dimming and mixing controls. Circuiting also interconnects with elevator controls to energize incandescent lamps, brightening overhead panel at door of next available elevator car.

PRIVATE OFFICE AREAS

Luminous panel ceiling section, ceiling-mounted wall lighting strips, luminous back wall, selective switching, dimmer controls, color light effects, all of which equip the Senior Vice President — Sales, Mr. W. T. Richards, to express his enthusiastic conviction about the benefits of good lighting to key customers with practical and meaningful on-the-spot demonstrations. He has played a definite part in many major lighting improvements in the Indianapolis area such as the relighting of a 1,700,000 square foot industrial plant from 22 to 100 footcandles average for the working benefit of 5,000 employees.

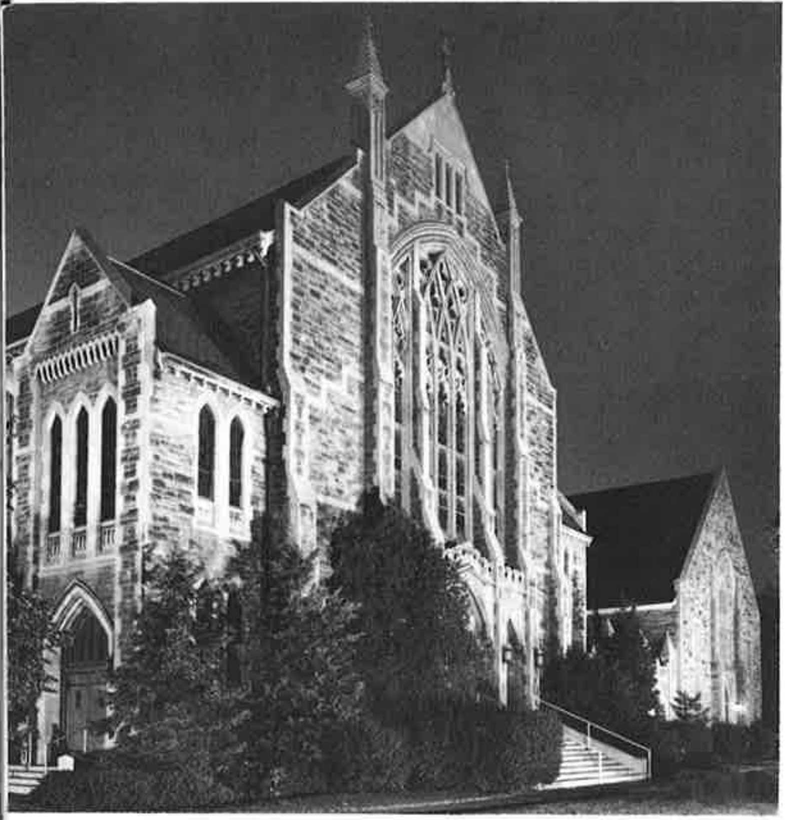
As early as 1947 Mr. Richards became accustomed to working in the 100-and-over footcandle range. This office of the late forties and early fifties had 100 footcandles from four-lamp, 40-watt units.
Before his present lighting system was installed, Mr. Richards' office lighting included twelve 5-lamp troffers compacted over his desk, plus a pattern of 3-lamp troffers surrounding, plus incandescent downlighting, plus drape-lighting cornice — all on separate dimmer controls, allowing Mr. Richards almost infinite variability for demonstrations up to a maximum well over 500 footcandles.

Basic air-handling luminaires are set into wood framing that simulates exposed joists to serve executive reception and secretarial areas with added visual interest of texture, shadow contrast. Incandescent downlighting also adds variety. Incandescent area is over 80 footcandles; fluorescent area is over 160 footcandles.

Excutive offices, guest reception, and executive secretarial spaces are individualized with custom wood treatments, diverse fixture selections, varied unit mountings and custom fixtures.

The Board of Directors' meeting room has configurated ceiling section with louvers concealing incandescent downlighting and general fluorescent system. Suspended ceiling surrounding louvered section has fluorescent cove. Pull-out panel for Board Chairman puts lighting switching and dimming at his choice. Luminous panel accommodates large business charts or rear-screen projections. Maximum footcandle level is 170.

Conference-demonstration room with contrasting louvering and adjustable incandescent wall lighting can demonstrate principal effects from 600 footcandle system. Fan coil unit on lower wall at right is typical of temperature controlling air distribution units in old section of building where structural limitations prohibit installation of the hot/cold air mixing and distributing equipment used for electrical space-conditioning in the new section of the building.



Lighting Progress

THE MARK OF LEADERSHIP IN INDIANAPOLIS

Lucalox® lamps, one of the newest of light sources, makes maximum use of potential for color enhancement of stone facade of the North Methodist Church.

Accurate print reading and machining to close tolerances for profitable manufacture of precision automatic equipment are the reasons behind this installation ranging to 300 footcandles in selected areas.

Five hundred and fifty footcandles for 100% in-line inspection of engine block castings helps to make possible the manufacturer's 5-year / 50,000-mile warranty.

Ahead-of-the-times 400-footcandle lighting in the American Fletcher National Bank encompasses a 35,000 square foot area; serves five data processing systems, handling facilities for 225,000 checks daily, checking and savings accounting departments, automated customer services, and other operations. The lighting system, in use 24 hours a day, provides all the heat required for normal heating purposes to and beyond the -10°F thermal-control design basis.

Industrial operation where fifty footcandle level for roughest operations graduates to four hundred footcandles as additional man-hours and machine time are invested in parts, and provides better visibility as needed for finishing, inspection and assembly.

Quality lighting to serve a quality market — 150 footcandles of general lighting, 200 to 300 footcandles in selection and fitting areas, color rendering sources — all aid the customer's discriminatory judgments. Footcandle level of 500 in final alterations work room helps to keep handwork quality high.

Working mock-up illustrates a revolutionary approach to surgical lighting via industrial lighting techniques which has provided Dr. Robert Heimberger of the Indiana University Medical Center and the industrial lighting specialist of Indianapolis Power & Light Company with data for a basic assessment of specifications for improved techniques for meeting the critical seeing task requirements of brain surgery. Lighting levels were nearly 2,000 footcandles from fluorescent units in the general table area, 6,000 footcandles in the surgeon's working area from 6-volt very-narrow spot lamps, 400 to 500 footcandles of wall washing fluorescent lighting. Current research is directed toward the design of a complete unitized lighting system and toward development of new air handling techniques to be built into the system for disposal of lighting heat load to suit thermal parameters of the operating room.

Simplicity, beauty, utility, justifiable investment, are all important considerations in lighting designed for tax-supported properties like this office of the Mayor in Indianapolis. A typically simple utilitarian plastic panel system uses F40 lamps on a dimmer system for general lighting. Embellishment has been added with wood and perforated metal border trim topped with continuous rows of Power Groove fluorescent lamps for wall lighting, indirect perimeter lighting, and to brighten decorative perforations. Lighting levels permit existing-light TV pickup for coverage of Mayor's news conferences.

New at
Nela
Park

It's Evening in the Garden–Always

by **Rose Coakley**
Lighting Institute, Nela Park
and **Nancy Evans**
Residential Sales, Product Planning and Application, Nela Park

Here's a small garden that challenged the lighting designer in an unusual way. He was called on to create a full range of garden lighting effects; and he also had to create, indoors with light, a perpetual evening-in-the-garden setting within which the effects can be demonstrated.

The garden is in the General Electric Lighting Institute at Nela Park. It's a very small garden. The space is only 12 x 29 feet - smaller than many living rooms, certainly narrower than most. And this garden incorporates typical complicating factors often present in small patio or dooryard gardens: a much-used path connects spaces adjoining the garden on either side; garden access is from three points; the restricted size requires that an illusion of spaciousness be created.

Being a display garden, the lighting plan incorporates as many lighting effects as possible. Thirty-three lighting fixtures are combined with twelve types of light sources. Circuiting is for fifteen control switches. In some cases commercial fixtures were modified for lighting effects otherwise unattainable. The garden demonstrates lighting for two different viewing situations: for walk-through

Daylight never reaches this indoor garden. It was planned that way using mostly artificial plants, shrubs, and trees for the purpose of demonstrating lighting effects that can be employed in gardens of any size. This particular garden plan, confined to a small area, emphasizes the fact that tiny outdoor spaces can have charm as captivating as that of very large gardens.

viewing, and for viewing from indoors. Both are typical for patio gardens.

Aside from being in an artificial indoor evening-in-the-garden setting, this garden typifies the kind that can be installed on any patio, in any dooryard, or on any small city or suburban lot. The first step in creating this garden was the landscaper's plan. To that was added a preliminary lighting plan, envisioning lighting in relation to plantings. The third step was the addition of a wiring plan. With planning accomplished, wiring was installed first; plantings were put in second; and last, the fixtures were carefully located, aimed, and securely mounted in place.

The lighting equipment has been selected in keeping with the size and scale of the garden. Some circuits are standard-voltage, others are 12-volt. The 12-volt circuiting makes available more small lamps, adding to the light distribution patterns that standard-voltage lamp lines offer.

The lamps on the roof overhang are 12-volt, 25-watt, PAR36 floods, a perfect choice for uniform illumination without spill of light on the window glass. Small low-voltage-lamp units accent low plantings from hidden locations in trees. Another 12-volt lamp, semi-concealed in a small clump of ground cover, casts a sharp graceful shadow of a yucca plant on the fence. A Mugo pine is lighted by two unconcealed 12-volt, 25-watt, PAR 36 spots, using their perfect beam control to avoid discomforting brightness in a visually critical location. Small low-wattage downlights at the top of the fence are unobtrusive and add a decorative pattern of highlights and shadows on the fence.

Standard-voltage 150-watt floods at ground level also light the fence. So do blue fluorescents which create a background for tree silhouettes. Other lighting effects from standard-voltage lamps are: modeling and highlighting on hemlock trees with 50- and 100-watt blue-white and 100-watt mercury lamps; moonlight effects with shadows and highlights on ground covers and paths created by 75- and 150-watt blue-white reflector lamps tree-mounted, or pole-mounted in small unsupporting trees; up-lighting from a ground-recessed waterproof incandescent lamp housing at the foot of a birch tree.

The curving path, the wooden panel screens, the mirrored walls, the artificial-sky lighting effects, the carefully balanced illumination brightnesses, the careful choices of fixtures and lighting effects—these all add up to an authentic picture of an apparently-spacious lighted garden. It serves as a model for the kind of garden lighting effects that can be created with careful planning and designing. And it demonstrates a large selection of lighting techniques to brighten the natural evening anywhere.

Visual drama from downlighting units recessed in roof overhang.

Leafy sparkle and brightness is from tree-mounted reflector lamp.

Lacy foliage tracery silhouetted against lighted-fence texture.

Brightness emphasis from reflector lamps in the trees, low-voltage lamps on the fence.

Unconcealed unit with narrow-beam shielded-filament spot lamp highlights a pine shrub.

Low-voltage spot-unit beam weaves leaf and shadow arabesques among static lines.

A grazing beam of up-light highlights tree trunk's surface texture.

New at Nela Park

Two offices. Two color-decorating schemes. Two types of light sources. Source in picture at left is Deluxe White mercury lamps; at right, Deluxe Cool White fluorescent lamps. Color rendering by both sources is acceptable. Which is preferred? Numerous similar comparisons are being test evaluated for source-color preference ratings.

A Preference for Color

by **W. Glenn Pracejus**
Advanced Planning Studies, Nela Park

Two identical offices have been installed at Nela Park to explore the way in which color quality of various light sources relates to their application in general lighting systems. Room sizes and shapes, and the furnishings in both offices are identical. Both were test - evaluated with a warm-colored decorating scheme, and evaluations were repeated with cool-color decorations.

Lighting is variable. Light-source color comparison choices available include several types of fluorescent and high-intesity discharge lamps. Brightness patterns with both high-intensity discharge and fluorescent sources are similar.

The objective in these test facilities is to score color-quality preferences based on visual comparisons of many paired combinations of light-source colors in the practical full-scale situation of a typical working environment. Most previous color preference comparisons were made with look-in booths which usually subject observers to abnormally high brightnesses and inappropriate conditions of observer adaptation for color viewing. Thus, the small - booth tests often tended to confuse and mislead observers.

With today's wide choice of high efficiency light sources, characteristics of color are becoming increasingly important to designers of lighting and interiors. So, many hundreds of visitors to Nela Park have been given the opportunity to spend time in these rooms and express their views on the relative appeal of pairs of sources in identical settings. Also a "control group" of local observers evaluated all of these source-pair combinations under both color decorating schemes. Their choices have been evaluated in an effort to establish statistical correlation to the mass testing. In this way, it is hoped that a reliable relative preference scale can be established.

Results to date indicate an apparent preference by observers for the excellent color properties of deluxe Cool White fluorescent lamps. Standard fluorescent colors and newer high-intensity discharge lamp types are represented in a fairly closely spaced group of secondary preferences.

Light source color is currently measurable on the basis of spectral energy data. Light source color-rendering effects can be predicted by computing the effect of measured spectral energy data on objects of specific spectral reflectances. The resultant computations are used to arrive at the General Color Rendering Index, as recently adopted by Illuminating Engineering Society and Commision Internationale D'Eclairage. The Color Rendering Index is an effective measure of the effects of light sources on object colors for precise discriminations such as those involved in color matching and color grading. It does not, however, satisfactorily relate to the broader area of less-critical human color preference that generally prevails in general lighting applications.

Nela Park engineers hope the subjective studies under way in these new comparison rooms may lead to a numerical approach to color acceptability — one that can readily be calculated by computers, using spectral energy source-color data, and that also will correlate well with Color Rendering Index values for critical color evaluations.

Such a system for evaluating color acceptability would move lamp color selection one important step beyond the present intuitive-choice basis, increasing the certainty that tomorrow's lighting will meet users' needs in color — just as today's techniques for predicting illumination levels and visual comfort probabilities have helped to assure user satisfaction in those areas.

H.I.D. Lamps in Food Stores...a Panacea?

by **F. A. Dickey**
Lighting Development, Nela Park

Commercial lighting is being affected by some of the many significant developments of the past several years in the high intensity discharge (H.I.D.) lamp field. And it seems likely the effects will soon reach major proportions.

The current activity grows out of the combination of a new phosphor with an existing tried-and-proven performer, the Bonus Line mercury vapor lamp. The Deluxe White mercury lamp, as the new version is known, has stimulated interest in downlighting with open-bottom reflector type luminaires, especially in food stores. Downlighting, a distinctive design style, traditionally incorporating incandescent lamps, has never been widely used in food stores. Fluorescent lighting proved far more economical than incandescent for reaching the illumination levels commonly used in the industry.

Deluxe White lamps today help create dramatic downlighting effects with added advantages: fewer fixtures are needed, fewer lamps to be replaced, and Deluxe White lamps have extremely long life. These new lamps increase the range of lighting variations available to store owners and operators who ask often for new and different kinds of visual environments for mass merchandising.

Appearance Factors

In lighting terms, "appearance" can refer to a variety of factors and it seems useful to outline some of these factors as they relate to downlighting.

Exposed fluorescent lamps in ceiling mounted units radiate their energy almost equally in all directions. Approximately half the energy tends to light the upper walls and ceiling, and gives the space a bright, open feeling. For the observer, however, the effect of spatial brightness is often destroyed by the uncomfortably high brightness of the lighting system itself.

Downlighting systems, in contrast, radiate a much greater percentage of their energy within 45° from the fixture's distribution axis, which usually is vertical to the ceiling — so, the wall and ceiling brightness depends on reflected light. The visual comfort resulting from such fixtures makes the overall brightness of the space and merchandise more obvious to the viewer since he isn't forced to adapt to overly-bright luminaires.

Other appearance factors are: more impressive reflected highlights on glass and metal packaging, and a visually dramatic increase in contrast between

This newly opened supermarket uses 400-watt Deluxe White mercury lamps in suspended semi-indirect luminaires. Combined with appropriate and well-designed display lighting, this general lighting system gives the store an appearance tailored to the tastes and expectations of the modern shopper.

Suspended fluorescent soffit in foreground produces 200 footcandles for fast accurate check-out. Recessed luminaires in background are appropriate for low ceilings. This Deluxe White mercury general lighting combines well with soffit for comfortable, bright, visually stimulating store environment.

Cool-Beam incandescent display lighting gives the meat a rich sparkling and appealing appearance. Light is reflected from the high-reflectance floor onto the underside of the soffit and back wall of this meat department giving it an adequate overall brightness.

highlight and shadow areas. These factors give better modeling to merchandise, display fixtures, shoppers, and the space itself, putting a more pleasing emphasis on three-dimensional quality.

Color and Color Rendition

Color is always a key element in designing merchandise lighting systems. The color of light from previous H.I.D. lamps has severely limited their application in the merchandising field. The very good acceptance of the color effects from the new Deluxe White mercury lamps on food store merchandise and on the complexions of people has brought about a full reversal of that limitation.

One factor in the good color acceptance of Deluxe White mercury lamps is that they appear to be whiter than other H.I.D. lamps — such as Color-Improved mercury with its greenish yellow cast. It has to be said, however, that good color acceptance does not imply the best color rendition. No form of currently available H.I.D. lamp can equal in color rendition the deluxe-type fluorescent lamps, they are still the best all-around lamps for color-rendition of merchandise.

Geometry

One of the most important aspects of designing downlighting systems for supermarkets is reconciling the essentially vertical light distribution to the vertical orientation of the visual task — that of seeing the vertical faces of grocery items stacked on gondolas. If the package is on the top shelf, the viewing angle is horizontal and the viewing plane is 90° from the plane of the lighting system. The seeing tasks on lower shelves involve downward viewing angles that are more advantageous in relation to the lighting system plane.

The importance of reflecting downlighting illumination from the floor onto the bottom shelf can not be over-emphasized; floor surface should be neutral in color with as high a reflectance as practical.

The biggest geometry problem in food store downlighting is the spacing of luminaires. Typical spacing ratios range from 1.2 to 1.3 times the mounting height above the seeing task. Given a ceiling height of 13 feet, and a height of 6 feet from the floor to the average top-shelf package, the effective mounting height is 7 feet. Hence, the maximum spacing between luminaires is 9.1 feet (7 x 1.3 = 9.1). Greater spacings will produce noticeable variations in illumination on the top shelves.

These spacing considerations apply primarily to the lighting fixtures in the rows parallel with aisle centerlines. Where necessary, from an appearance standpoint, between-the-rows spacing across aisles can be greater since minor variations in illumination on the centers of gondola tops is not necessarily critical. In areas where lower display merchandisers such as dump tables are used, lighting unit spacings should be in a square or otherwise uniform modular pattern using the 1.3 to 1 ratio to develop uniform illumination on the horizontal surfaces.

Economics

Certainly the cost of appropriate lighting levels is also a factor in any food store lighting system, and bears careful consideration. Following are some typical costs for food store lighting, given in terms of dollars per million lumen hours delivered (5,000 sq. ft. x 200 fc = 1,000,000 lumens).

LAMP AND MOUNTING TYPES	$ per million lumen hours delivered @ 2¢ per KWH
*F40CW, 4-lamp strip	.87
*F40CWX, 4-lamp strip	1.33
*F96T12/CW, 3-lamp strip	.78
*F96T12/CW, 4-lamp strip	.73
*F96T12/CWX, 4-lamp strip	1.13
*F40CW, 4-lamp, suspended & louvered	1.02
*F40CWX, 4-lamp, suspended & louvered	1.56
*F40CWX, in troffers	1.50
*F96T12/CW, 4-lamp, suspended & louvered	.84
*F96T12/CWX, 4-lamp, suspended & louvered	1.34
*F96T12/CWX/HO, 4-lamp, suspended & louvered	1.42
*500PS40/IF, in open-bottom luminaires	2.31
H400 Deluxe White mercury downlighting group relamped at 7,000 hours (most economic life)	1.06
H400 Deluxe White mercury downlighting group relamped at 16,000 hours	1.14

*Costs based on spot relamping.

Specular can tops and housewares glitter and sparkle under downlighting.

In general, shielded luminaires, fluorescent or H.I.D., are shown to be more expensive to own and operate than most forms of strip lighting. Shielded fixture lighting with Cool White lamps is somewhat less expensive than Deluxe White mercury, but where Cool White lamps are used the lower cost is somewhat critically offset by sacrifices in color rendering. Downlighting with H.I.D. lamps is less expensive than most shielded-fixture lighting with Deluxe fluorescent lamps.

Field Measurements

Field measurements of typical store general lighting systems show the following values:

WITH FIXTURE ON AISLE CENTERLINES	TYPICAL FOOTCANDLE VALUES	
	Fluorescent	Deluxe White Mercury
Aisle centerline, horiz. fc	200	200
Gondola top, vert. fc	140	90
Gondola bottom, vert. fc	100	65
Gondola bottom, 45° - angle fc	140	100

Fluorescent lighting values show, from gondola top to bottom, a 1:1 ratio for typical viewing angles. For Deluxe White mercury downlighting, the ratio is nearly 1:1 from top to bottom as far as the visual task is concerned. To get 90 footcandles of seeing-task illumination, a downlighting system must produce 200 footcandles of horizontal illumination, while an exposed-fluorescent-lamp system need only produce 120 footcandles of horizontal illumination. The 80 footcandles additional in light output requirement for equal seeing-task illumination from downlighting systems is a costly addition and has to be equated with some intangible factors that are not read on a footcandle meter — different and improved store appearance, greater customer comfort in terms of fixture brightness in the field of view, sparkling attraction brightness of merchandise — and it also has to be equated with the comparative cost factors for other types of lighting systems.

One important aspect of mercury downlighting systems that has been factored into the economic picture should be pointed out: that is, the ease of lamp maintenance. Fewer mercury lamps are needed, than fluorescent, for a given illumination level. And mercury lamps are easily replaced *from the floor* with pole-type lamp changers.

Downlighting systems, like any other general lighting systems, work better for merchandising when combined with good display lighting that gives variation to the store luminance patterns. It helps, for instance, to have perimeter fluorescent lighting in coves, soffits, or valances — that increases the brightness of perimeter walls. Selective selling locations such as gondola ends are more obvious to the shopper when spotlighted. Meat displays look more appealing with additional incandescent lamp lighting — a reason for the great acceptance of Cool-Beam PAR lamps for meat department lighting in newer stores.

The check out stand presents a particular dilemma — reflections on the specular cans and bottles tend to obscure the price marks, making the seeing task more difficult for the clerks who must work speedily and accurately. The solution is to use the softer more diffuse lighting of a fluorescent luminous element over the checkout stand.

The supplementary systems recommended here have an additional functional value. Since the mercury lamp requires up to 5 minutes to relight after a momentary power interruption, the fluorescent and incandescent lighting used for displays will provide sufficient standby lighting for safety and security.

Summary

H.I.D. lamps are certainly not in any case a panacea for all aspects of food store merchandising: neither in any case are they the wrong prescription necessarily. Obviously, they are eminently useful in treating specific aspects of lighting for merchandising. H.I.D. lamps will revolutionize the food store downlighting application mainly because they produce lighting effects similar to those of the less efficient incandescent sources, and because recent technological developments have made them practical from a color rendering standpoint. Also because they are economical, and competitive with other lighting systems.

Combined, Deluxe Cool White fluorescent and 150PAR38 Cool-Beam floods create a distinctive environment for this meat department. Deluxe White mercury lamps and Deluxe Cool White fluorescent lamps mix well together.

NEW LIGHTING using an overall ceiling of multi-layer polarizing plastic panels opens the working space visually, eliminates relatively dark spaces between benches, and ends rigid limitations on orientation of benches as shown under the old lighting system at right above.

OLD LIGHTING system, of higher quality than many new installations, suspended over work benches gave 250 footcandles. At left above, is a new 350 footcandle system that replaced it. Dahlberg Electronics proved their need for better lighting by their own tests.

Where Seeing Aids Hearing

by **M. Christensen** *and* **William B. DeLaney**
Lighting Development, Nela Park

Sounds of course, can't be seen; nor can sight compensate for lost hearing sensitivity. Indirectly, however, sight proves to be an important key to hearing when tiny parts and tiny subassemblies are combined into tiny hearing aids that can be hidden in the ear, behind the ear, or in eyeglass frames.

The management of Dahlberg Electronics, manufacturer of the world-famous Dahlberg hearing aids, well aware of the value of sensory aids, has long insisted on good visibility and carefully planned visual comfort to meet the exacting visual requirements involved in their processes.

Dahlberg's present new lighting system was developed using the same precision testing and retesting that goes into their products. Lighting tests were conducted over a two-year period to determine the most desirable amount and quality of lighting for their new plant.

The old lighting system, which has been replaced, gave 250 footcandles of general lighting from louvered, up-light fixtures—a lighting quality standard that many manufacturing plants today do not nearly approach. Because of the small size of the visual tasks at Dahlberg Electronics, and in spite of the use of microscopes and magnifiers equipped with circular fluorescent lamps for supplemental illumination, Dahlberg's own tests showed that they needed better general lighting.

Their lighting currently consists of an over-all-ceiling lighting system that provides 350 footcandles of general lighting controlled with multi-layered radially polarizing panels. The illuminated microscopes and magnifiers, still used, add light for magnified viewing of tiny parts and fine details.

Dahlberg Electronics is currently conducting productivity studies to determine the actual return on their investment in the new lighting system. They have already determined that absences due to headaches are fewer, and that employees have shown considerably less fatigue.

Several advantages accrue to the production areas from the overall ceiling of multilayer panels. The panels act like diffusers in that they shield (hide) and diffuse (reduce) the brightness of the lamps when viewed from below. When used in an over-all ceiling, the brightness and brightness variations of the ceiling are reduced. This minimizes objectionable bright reflections from shiny tasks, and, in turn, reduces eye strain and fatigue resulting in fewer headaches. The panels reduce the brightness (and thus direct glare) of the ceiling when viewed at angles near parallel to the ceiling—as when a worker looks up from his task and sees the fixtures some distance away. This, too, reduces fatigue since the eyes need only make small adjustments to brightness variations as they view the various surfaces.

Veiling reflections (subtle reflections that occur in non-specular tasks reducing task visibility) are usually not obvious. But, they can measurably reduce visibility and force the eye to work harder to see. This adds to eye fatigue. It can be demonstrated that polarized light such as that passing through the multi-layer panels can reduce veiling reflections as well as the brighter more obvious specular re-

A soldering operation involving hair-fine wire and parts so small they have to be positioned with tweezers — a typical seeing task for employees at Dahlberg Electronics, where a fine lighting system is considered an economical production tool.

In the foreground, production workers. In the background, factory office workers. Overhead, the same lighting system for both which shows this working space is adaptable to many kinds of tasks, many kinds of equipment, other work flow plans, or other arrangement of production equipment.

A large luminous ceiling panel lights the reception area at Dahlberg Electronics. It is somewhat different in design from the plant's polarized panel ceilings, a difference suitable to the room's decorative design.

In the general office areas, large ceiling sections are the same as the overall ceiling in the production areas, except that the lighting level has been modified to an average of 125 footcandles suitable to the seeing task.

flections occurring in most tasks. However, task surfaces of metallic electrically conductive material tend to depolarize the light, defeating the purpose of polarized light. When put together, the beneficial effects of polarization add up to a lighting system that makes seeing easy.

All too often the designer of a manufacturing space overlooks two major kinds of refinements: brightness control, and the proper use of color. Here the excellent control of light source and general surface brightnesses produce a comfortable working environment. The lightness of colors chosen for the floors and work surfaces also contributes greatly to an overall, comfortable visual environment. The use of accent colors on the standard supporting columns adds much to the pleasantness of the space. This is a dramatic example of good industrial design which shows that a manufacturing area does not have to be a dull, dismal place in which to work.

One of the major advantages of this type of manufacturing space, as pointed out by Plant Manager Edward S. Nash, is its flexibility. Benches and work stations can be rearranged without changing the lighting. The electric power distribution system is also flexible permitting changes in the work setups without changing the distribution system. They have already had occasion to convert some manufacturing area to secretarial office space. The only change necessary was to remove benches and move in desks.

The same design considerations that were applied to the manufacturing area were used in the general and private office to provide delightful and pleasant work areas. In these spaces, color, texture, brightness control, and light have been used to advantage.

The efficient design of this facility includes electrical space conditioning features. Ventilation facilities in the lighting cavity permit lighting heat to be recovered and utilized or exhausted as needed. This heat source is supplemented by in-the-floor heating when required. The installation is an excellent example of how lighting heating and cooling features can be combined with the visual stimulation of color to create efficient, pleasant, profitable working space.

A Visit to Montreal

by **Robert Lewis**
Canadian General Electric Co., Toronto, Ontario, Canada

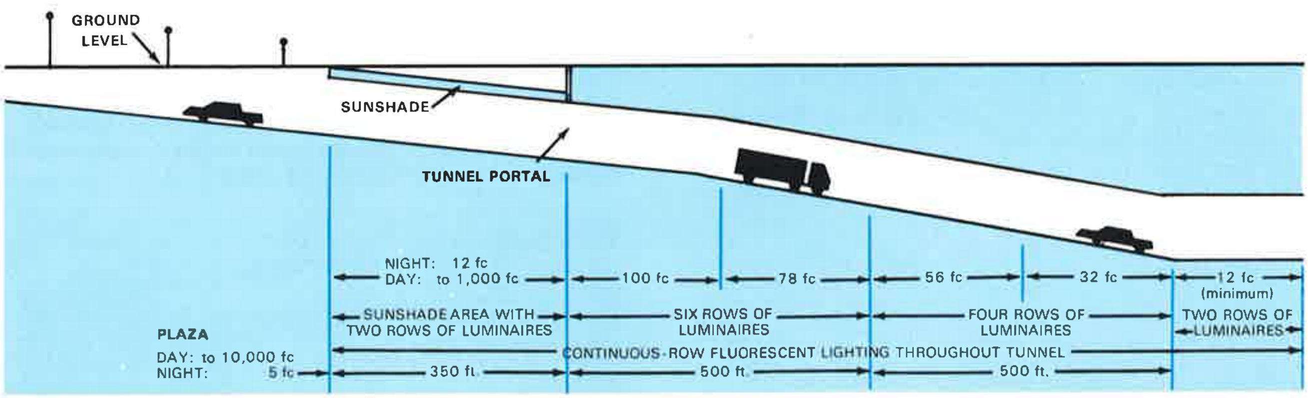
Montreal is a lighting showplace. The heavily publicized show at Expo '67 temporarily eclipsed the interesting lighting features of the city's many major developments. Some of those developments have been widely reported in the general press and trade journals: the renewal complex Place Ville Marie, the new Hotel Chateau Champlain, the Stock Exchange Tower skyscraper, the Canadian Imperial Bank of Commerce building, and Place Bonaventure which is Canada's new unfinished international trade center. All are impressive and justly deserve the focus of attention, but visitors interested in lighting have found there's even more to see in Montreal.

Originality and skill in lighting are evident underground in Montreal's handsome new subway, the Metro. Another worthwhile visual treat is the civic theatre lighting at La Place des Arts. The Louis-Hippolyte LaFontaine highway-tunnel to suburban Boucherville has some first-on-this-continent features. And Steinberg's new supermarket in Boucherville exemplifies many fine commercial lighting installations in Montreal.

The following pages take you backstage and into the wings to demonstrate that the most-publicized lighting shows in Montreal are not the only good lighting performances.

Tunnel Louis-Hippolyte LaFontaine

by **A. Couture** *and* **M. Provost**
Societe' d' Ingenieurs Conseils de Boucherville, Montreal P. Q.
(A joint venture of Per. Hall & Associates, Brett & Ouellette, Lalonde & Valois.)



The Trans-Canada highway, across Montreal and under the St. Lawrence River, connects the island city with its suburban neighbors, the towns of Boucherville and Jacques Cartier on the Canadian mainland to the south. Tunnel planning and engineering has been sharply focused on drivers' visibility and general automotive-tunnel safety. The tunnel's lighting was designed, installed, and is being operated under the direction of Montreal engineers Marcel Provost, electrical, André Longpré, operational supervision.

The following article has been translated from the French-language journal L'INGÉNIEUR, Vol. 53, No. 218, in which it was originally published. Technical editing of the English-language translation was by R. L. Paugh, Street and Outdoor Lighting Specialist, General Electric Large Lamp Department, Nela Park, Cleveland, Ohio—Editor's note.

General Description

The tunnel Louis-Hippolyte LaFontaine consists of two tubes for one-way traffic, each with three lanes. The tubes are separated by a third tube used for ventilation. Vertical clearance throughout the tunnel is 15 feet. The center lane is 12 feet wide, side lanes are 13 feet. Total length of the tunnel is 4,561 feet entrance-to-entrance. Maximum speed limit is 60 MPH, or 88 ft per second.

The materials used on the interior surfaces of the tunnel have been selected to satisfy its specific requirements for lighting, soundproofing and aesthetics. The walls have 8″ x 16″ egg-shell color ceramic tiles. The ceiling has dark grey perforated asbestos tile to diminish sound waves.

Study Of The Lighting System

Good lighting in the tunnel is made up of two components: 1) Proper lighting levels inside the tunnel and, 2) transition zones allowing comfortable eye-adaptation from an outside lighting level of 10,000 footcandles to the interior lighting levels. To achieve these we considered the speed of adaptation of the human eye, and the normal speed of the vehicles in the tunnel.

In many tunnels the walls and ceilings are used as reflectors to increase the efficiency of the luminous source. On the other hand, in some tunnels lighting is concentrated on walls and roadways. In both cases upper-wall portions tend to be brighter than lower walls. When the ceiling is illuminated, the brighter upper-wall and ceiling areas fill 50% of the driver's field of view, drawing his attention to those brighter surfaces. The apparent dimensions of the tunnel, as seen by the driver, seem then to get considerably smaller by perspective effect.

Our studies indicated that only the walls and the roadway should be lighted and that we should avoid lighting the ceiling. This conclusion, although different from the normal practice of a few years ago, is now being tried in many European tunnels with good results. To control upper-wall brightness, the tunnel sidewalls are designed with a double slope. The lower portion of wall tilts outward to a height of 6 feet, thus increasing the angle of incidence of the light rays and the brightness of the walls in that area. The upper 10 feet of wall tilts toward the interior, decreasing the angle of incidence and thus reducing the upper-wall brightness. This special wall contour helps also from an accoustical standpoint in that the non-parallel surfaces do not maintain stationary sound waves. The slanted walls tend to direct traffic sounds toward the accoustical ceiling.

Minimizing adaptational effects at tunnel entrances during daytime requires a lighting transition from exterior to interior within 10 to 15 seconds, depending upon eye conditions of motorists. We have selected a transition distance allowing 15 seconds of adaptation at 60 MPH. This transition from high to low lighting level, ideally, should be a gradual change. In practice such a gradual change in lighting is not feasible and a stepped variation has been adopted. Each lighting step is limited to 10% of the previous level because the eye can not clearly and quickly distinguish objects within its field of view when lighting levels exceed a 10 to 1 ratio. Day-lighting outside the tunnel can be as high as 10,000 footcandles; hence, to be within the prescribed ratio, the first light reduction step must be to a possible-level of 1,000 footcandles. For obvious economy reasons this first transition is made by using natural light filtered through a honeycomb patterned sunshade overhead rather than by artificial lighting.

The sun shades are designed to allow no direct light from the sun at road level, and they cover a pre-portal area of 350 ft. approaching the tunnel entrance.

For nighttime lighting of the sun shaded portion, two rows of luminaires light the roadway with about 12 footcandles — a step up from the 5-footcandle level on the plaza so that motorists can enter the tunnel swiftly, safely, and confidently.

Lighting Levels

Since the sunshades reduce the maximum natural ambient light intensity to 1/10th, or approximately 1,000 footcandles, we must provide 100 footcandles from artificial sources at the tunnel entrance to stay within the required 10 to 1 ratio. (NOTE: Footcandle values are theoretical; actual values with clean luminaires and walls are higher by factors of 1.5 to 1.7.) The minimum value at the center of the tunnel is 12 footcandles, therefore we reduce the 100 footcandles at the entrance in four successive steps of equal length in the first 1,000 feet of the tunnel. So, if we look at the cross section of one traffic tube we have the following lighting configuration starting from the entrance and progressing toward the interior of the tunnel:

From 0 to 250 ft. (100 fc)
: Six rows of fluorescent luminaires; two rows with one 800 mA lamp per unit, and four rows with two 1500 mA lamps per unit.

From 250 to 500 ft. (78 fc)
: Six rows of fluorescent luminaires; two rows with one 800 mA lamp per unit, two rows with two 1500 mA lamps per unit, and two more rows with one 1500 mA lamp per unit.

From 500 to 750 ft. (56 fc)

Four rows of fluorescent luminaires; two rows with one 800 mA lamp per unit, and two rows with two 1500 mA lamps per unit.

From 750 to 1000 ft. (32 fc)

Four rows of fluorescent luminaires; two rows with one 800 mA lamp per unit, and two rows with one 1500 mA lamp per unit.

From 1000 ft. through tunnel (12 fc minimum)

Two rows of fluorescent luminaires with one 800 mA lamp per unit.

The above mentioned lighting levels are necessary only for the sunshine period, when the ambient outdoor lighting level is near 10,000 footcandles. The lower the outside light level, the lower the artificial light level required in the tunnel. Therefore, at each entrance four light-sensitive cells control automatic circuits and relays to adjust the various light levels in the first 1,000 feet of the tunnel. In addition, a time clock, programmed on a seven day basis, reduces the twelve-footcandle level to 4 footcandles on the whole length of the tunnel during the night. The control system also permits manual operation of the various circuits. The continuous rows of 800 mA luminaires bordering the sunshade are four feet from each tunnel wall and extend the entire length of the sunshade.

Power Failure

In the event of a power failure, various groups of static converters supplying part of the lighting circuits will insure lighting levels of 34 footcandles from 0 to 250 ft., 12 footcandles from 250 ft. to 500 ft., and 2 footcandles for the rest of the tunnel. This allows a minimum of lighting during the starting-time period required by the diesel generators. When the generators are in function, the levels become 56, 34 and 4 footcandles respectively.

Luminaires

A total of 3,500 luminaires have been installed, a quantity large enough to permit special design features specific to the conditions of the tunnel. To produce wall and roadway brightnesses within a 5 to 1 ratio, 80% of the luminaires have been designed for controlled distribution that directs no light toward the ceiling. The remaining 20% of the luminaires direct as much light as possible toward the roadway and a minimum toward ceiling areas near the tunnel entrances, in the light transition zones.

Before manufacturing the luminaires, two prototype units were submitted to the following complete tests:

(1) Light distribution curves
(2) Luminaire efficiency
(3) Luminaire output at temperatures between -20° and +90°F with a wind of 10 MPH
(4) A check of water tightness when exposed to a water jet
(5) Structural strength under vertical load
(6) Ease of tube replacement at an ambient temperature of -20°F.

Conclusion

On Saturday, March 11, 1967, the tunnel was inaugurated. Use to late October totaled 9 million vehicle passages — averaging 1.2 million passages each for seven-and-one-half months. The count was an unplanned traffic-pressure test attributable to heavy traffic generated by Expo '67. The single-day peak was 70,000 passages completed at the average rate of six vehicles (one in each of six traffic lanes) every 7.4 seconds for twenty-four hours — well within the tunnel's designed capacity.

The Tunnel Louis-Hippolyte LaFontaine now permits motorists to drive the 500 miles between Quebec City and Toronto on a divided highway featuring high-speed travel and controlled access.

In the Louis-Hippolyte LaFontaine tunnel the operating supervisor has under constant surveillance the lighting, heating, ventilating and traffic-control systems as well as sequential TV pictures of traffic flow through both traffic tubes.

The Metro

The less-than-one-year old Montreal Metro is the world's only subway with all train wheels rubber-tired — but rubber-tired comfort is not the Metro's only distinction. Among subway designs, the Metro's lighting and architecture are surpassingly handsome. Designs of the twenty-six stations along Metro's 16.1 miles of route are each by a different architect. Trains are amply lighted with 50 footcandles for seated readers. Car aisles have 30 footcandles at floor level. Platforms, concourses and entrance areas range from 20 to 150 footcandles.

Two-lamp box troffers with lenticulated plastic covers have been widely used approximating systematized utility lighting, but the system is so often varied and broken through with visually interesting detailing that systematic patterns function efficiently almost unnoticed.

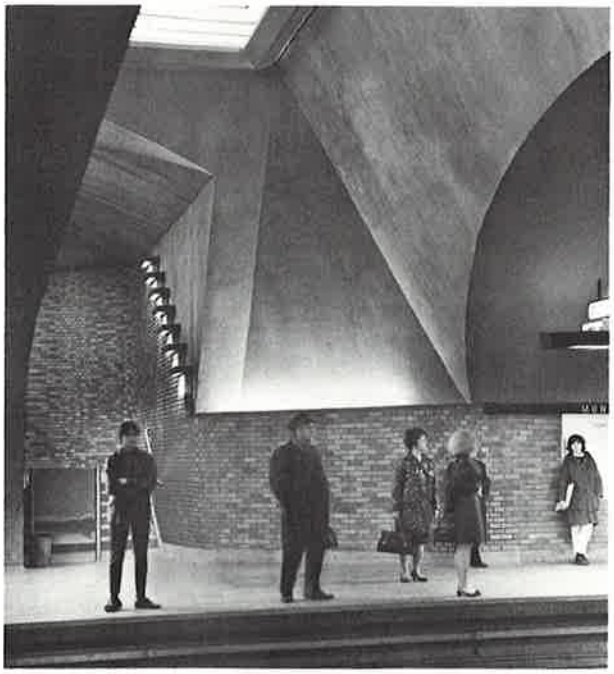
At the heart of the city, in the Berri-deMontigny station, the Metro entrances connect with shopping arcades that are, but hardly seem to be, underground. And the separation between shopping arcades and subway entrances would not be apparent except for the turnstile area enclosures.

The generous use of lighting within more-spacious-than-usual underground structures creates for commuters the illusion that the Montreal Metro is not really underground. Lighting and architectural design can be fully credited with the illusion.

Entrance to Berri-deMontigny station has 125 footcandle average from F20-, F40-lamp rows centered above 12" x 12" egg-crate pattern of 42-foot square louver. Background mall has 30 footcandles from F40 lamps on 6-foot centers in cavities 6 feet apart.

Design proportions of typical box troffers are applied to wall valance in Peel station entrance tunnel (background) and concourse area (foreground). Valance delivers 10 to 15 footcandles in tunnel; F40's in 2-lamp troffers increase concourse area lighting to 40-to-50 footcandle range.

Typical 2-lamp box troffers light stairs, far platform, and track crossover. For design variety, spacious main platform area incorporates 400-watt mercury downlighting in 18"-diam. cans 4 feet deep, with prismatic reflectors and concentric-ring shielding. Lamps are 16 feet up, on 12-foot centers.



Step lighting, wall washing, ceiling dome lighting in Mont-Royal station typify careful detailing of Metro lighting. Ceiling cove has 2-lamp F40 strips, step lights have single F20 lamps. Wall washers are fluorescent. Illumination generally is in 30 to 50 footcandle range.

The Berri-deMontigny station, hub of the Montreal Metro, has 20 footcandles on platforms from square six-lamp units on 8' x 10' centers 30 feet overhead. Detail lighting for waiting bench is from two continuous fluorescent rows in shielded troffers.

Metro's casual platform readers have 45 to 50 footcandles.

Luminous ceiling in Sherbrook station gives 70 footcandles on turnstiles from F40 lamps in continuous rows on 2-foot centers. In general, Metro turnstile areas range 40 to 60 footcandles.

Steinberg Supermarket

Several stores of the Steinberg chain bear the distinct stamp of progressive lighting planning which is current in Montreal. This store in suburban Boucherville, neither Steinberg's largest nor smallest, is typical: wall lighting emphasizes wall colors and textures for interior attractions beyond large windows; work lighting is at footcandle levels for working efficiency and accuracy; interior brightnesses are comfort controlled; areas of customer-traffic congestion have higher lighting levels.

The general ceiling lighting system is with General Electric F96T12 High Output lamps bare in continuous 2-lamp strips set in 1-foot deep cavities with sloped reflecting sides. This system provides a general lighting level of 150 footcandles at shopping-cart height between gondolas. Feature and display lighting levels exceed 200 footcandles in several areas; work lighting at critical points exceeds 300.

In the meat-cutting room 4-lamp strips in edge-of-ceiling cavities on two sides put 350 footcandles on meat-cutting bench and conveyor directly beneath, while center work area gets 190 footcandles. 4-lamp strip in high ceiling cavity outside cutting room lights upper wall, aisle behind meat counter, and meat supply conveyor.

Outside, parking lot lighting is multi-purpose: assures safe parking, identifies the store, and attracts customers. High-mounted multiple-lamp units minimize, within practical limits, the numbers of obstructions that need be erected in the parking area.

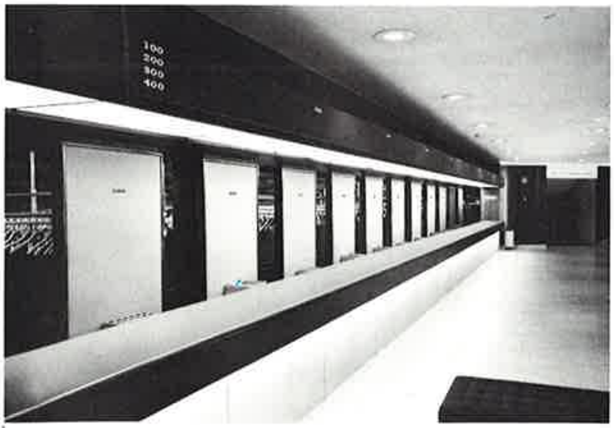
The produce case has supplementary single-lamp continuous strip behind a valance 2½ feet above merchandise display for total of 210 footcandles. Uplight on wall behind produce case is from 2 F40-lamp rows in continuous strips; downlighting is from 4-lamp continuous strips in edge-of-ceiling cavity.

La Place des Arts

The 3,000-seat Salle Wilfrid Pelletier of La Place des Arts, Montreal's civic theatre, is designed for staging a variety of performances: solos, chamber music ensembles, full-scale orchestral and operatic performances, even including major dramatic and musical productions and road shows.

The erection of La Place des Arts, was through the combined efforts of the City of Montreal and the Government of Quebec. The entire facility, housing three complete theatres, was leased to Expo for the exhibition's six-month run. With Expo past, La Place des Arts will continue operating as planned — being Canada's international cultural center presenting world famous performing artists on the stages of its finely appointed continental style theatres.

Auditorium lighting in the Wilfrid Pelletier theatre is all incandescent, all on dimmers. Geometric ceiling construction over orchestra seating completely conceals house downlighting; also conceals many stage lighting units. Indirect lighting is built into balcony rails.



Check room foyer has 150-watt R40 downlighting. Recessed, louvered over-counter units have four F72T12 Deluxe Warm White lamps; 115 footcandles. Counter edge has F40-lamp row, continuous. Back of counter: 3 rows on 6-foot centers light coat rack area with F40 lamps 10-foot centered in rows, 70 footcandles; fourth row lights service aisle.

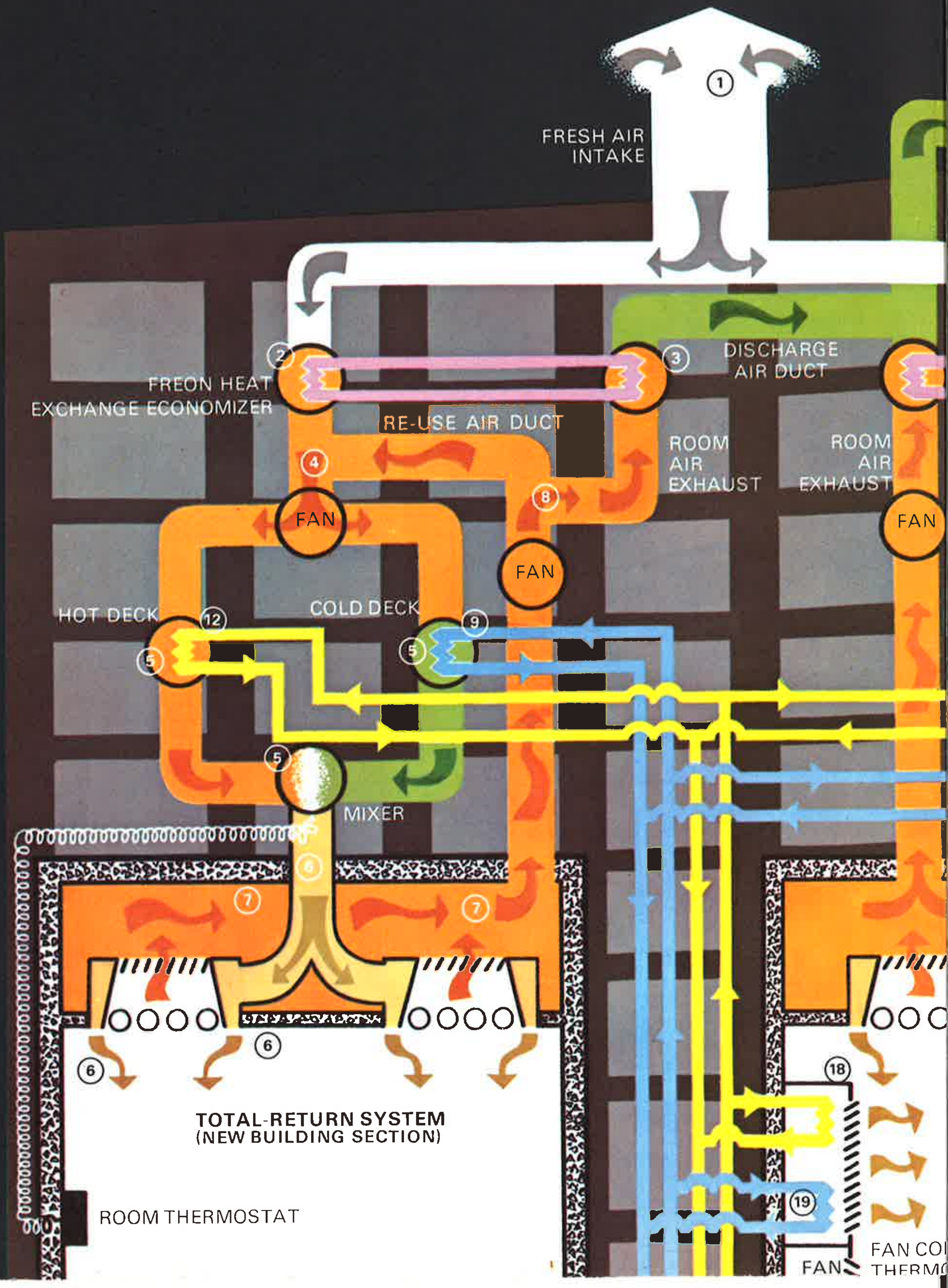
High ceiling area has 3 semi-circular rows of recessed R40 300-watt lamps. Additional in the same pattern, 8 well-shielded directional PAR-lamp units supply dramatic stairway lighting as needed. Large crystal chandeliers each sparkle with 175 15-watt clear incandescent lamps.

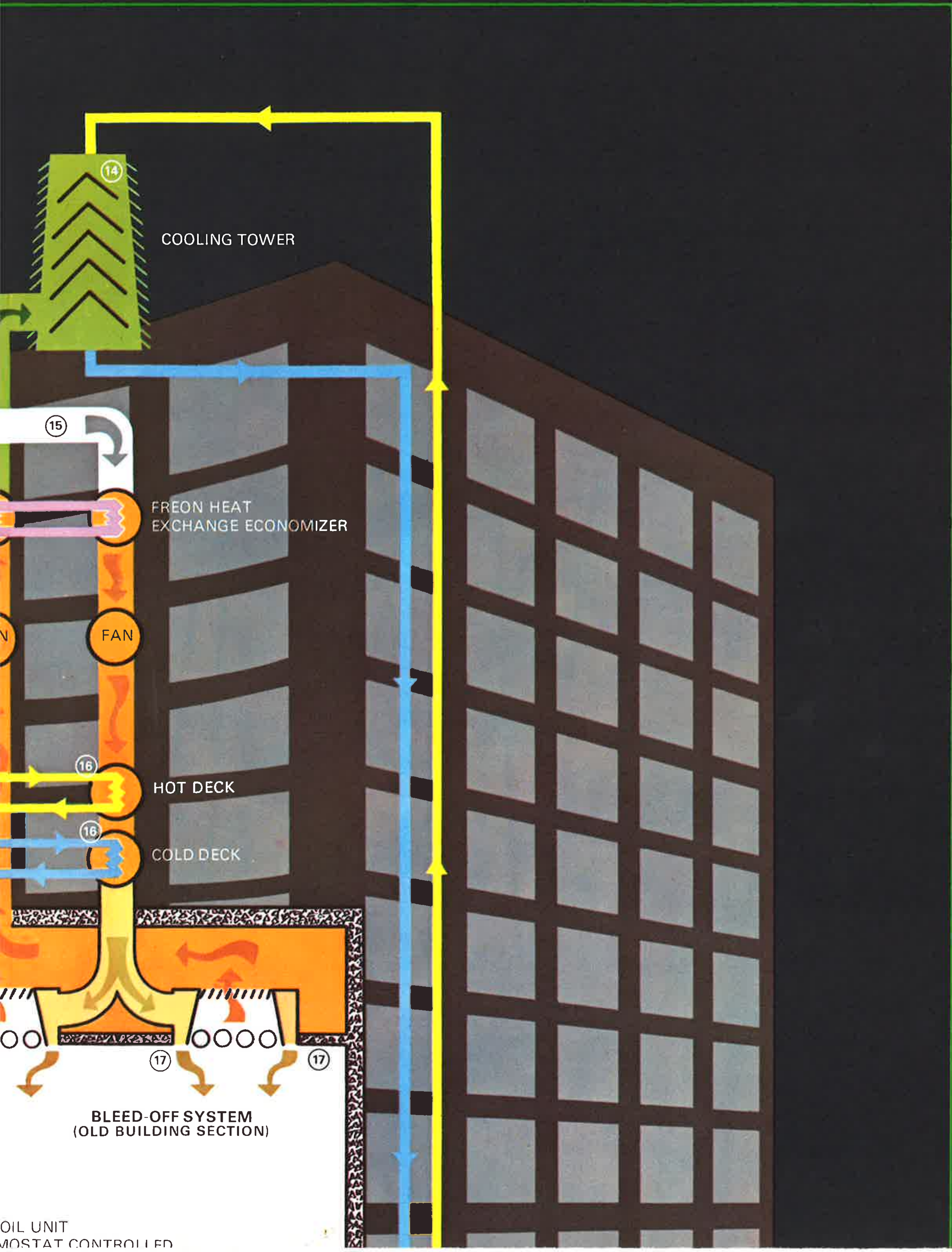
Ideas and New Products

Two essential ingredients of accomplishment — ideas and new products — GE excels in both, but especially in new and better products to fulfill lighting design ideas.

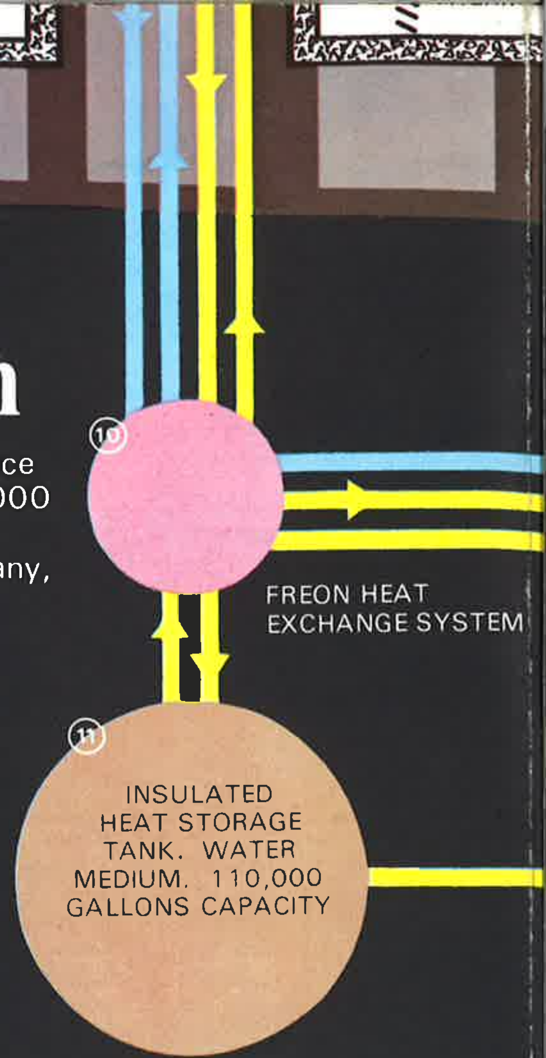
New GE Lucalox® lamps add a sparkling touch of warmth to the austere grandeur of the Indiana World War memorial in Indianapolis. General floodlighting is with GE Multi-Vapor® lamps — a better product of General Electric.

8900


FRESH AIR
INTAKE
DISCHARGE
AIR DUCT
FREON HEAT
EXCHANGE ECONOMIZER
RE-USE AIR DUCT
ROOM
AIR
EXHAUST
ROOM
AIR
EXHAUST
FAN
FAN
FAN
HOT DECK
COLD DECK
MIXER
TOTAL-RETURN SYSTEM
(NEW BUILDING SECTION)
ROOM THERMOSTAT
FAN



14
COOLING TOWER
15
FREON HEAT
EXCHANGE ECONOMIZER
FAN
16
HOT DECK
16
COLD DECK
17
17
BLEED-OFF SYSTEM
(OLD BUILDING SECTION)
OIL UNIT



Electrical Space Conditioning System

This is a simplified schematic diagram of the electrical space conditioning system as installed and serving the total 205,000 square feet of floor space in the Electric Building, a commercial property of the Indianapolis Power and Light Company, Indianapolis, Indiana.

- Heated air circulation
- Chilled air circulation
- Tempered-air circulation at 75° F. approximately, or at temperature meeting room thermostat demand.
- Freon 11 circuit systems for heat transfer
- Water circulation for chilling effect
- Water circulation for heating effect
- Air circulation at outdoor temperatures

NEW BUILDING SECTION

(1) Air is taken into ventilating-heating-cooling system at temperature of outdoor air.

(2) Intake air passes through Freon® heat exchange economizer where it absorbs heat that has been extracted at point (3) from the warm room air exhaust before it enters the discharge air duct.

(4) Fresh intake air is combined with re-use air to make supply air. Fan forces supply air through hot/cold decks and mixer box (5). Circulation through the hot/cold decks is automatically controlled in response to demand from room thermostat. The hot deck adds heat to supply air; the cold deck extracts heat from supply air.

(6) Air, tempered to satisfy room thermostat, passes through low-velocity duct system to enter room through slots in sides of light fixtures.

(7) Room exhaust air traverses main body of lighting fixture, picking up heat from lamps and ballasts, and then enters ceiling plenum chamber and exhaust duct.

(8) Room exhaust air stream is divided into discharge and re-use ducts. Discharge air gives up its heat at point (3) as described above. Re-use air combines with fresh intake air for circulation through hot/cold decks and mixer.

(9) When supply air is too warm to satisfy cold duct temperature setting, heat is extracted at cold deck and carried away by circulating water.

(10) Freon heat exchange system extrac fers it for storage into an insulated h required at hot decks, as at (12) and heat in other building areas, heat is shun of into storage tank.

Hot deck function is to heat ventilatin during nighttime hours so that lightin where heat is needed as in colder perimet

(13) Water heater operates only in em lighting heat supplies building heat nee tures) for a minimum of four consecutiv is in use to supply additional heat.

(14) Cooling tower comes into operatio all building heat requirements are bei completely charged with storage heat.

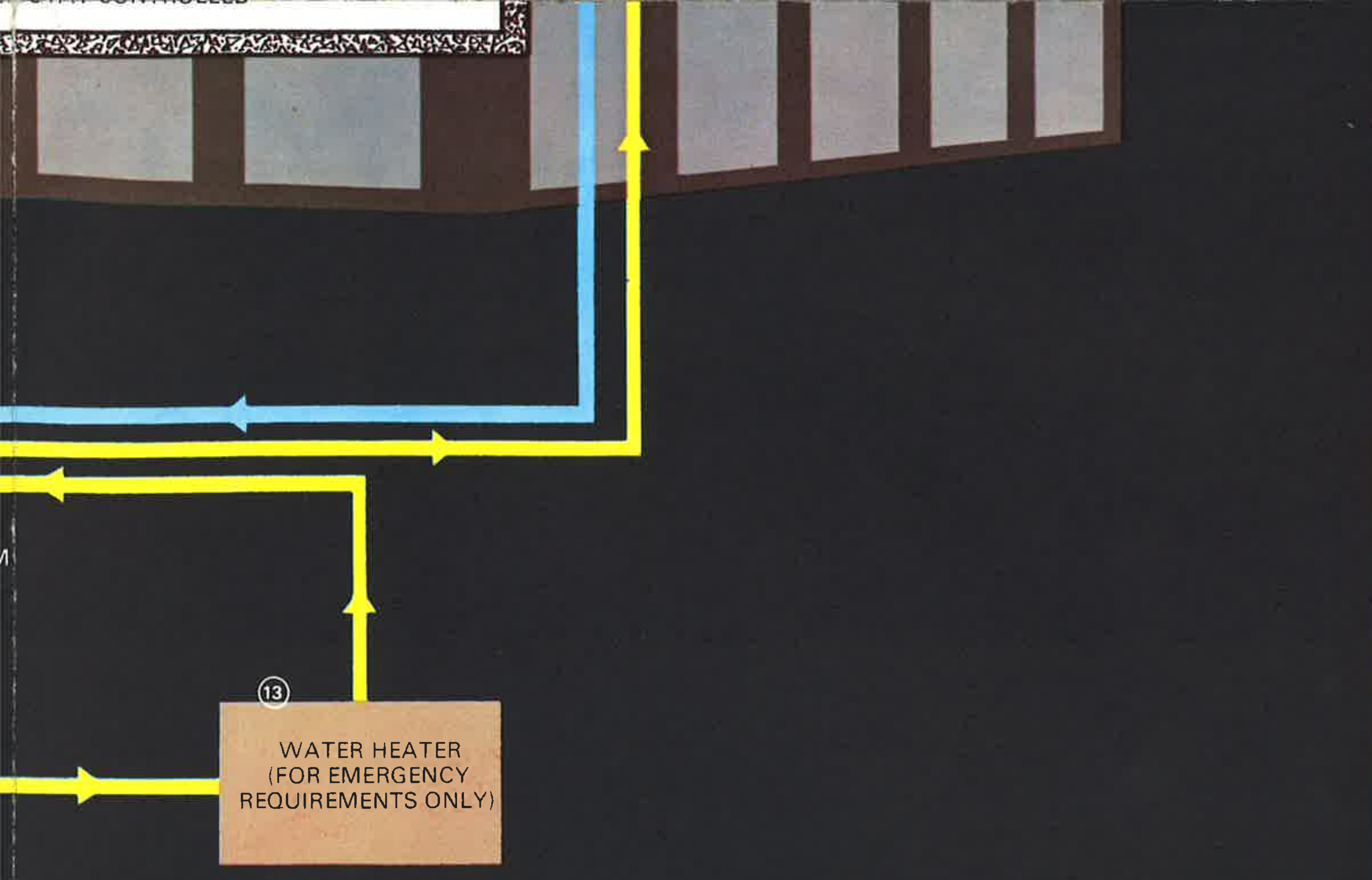
OLD BUILDING SECTION

(15) The portion of fresh intake air en heat from a Freon heat exchange econ section — that is, by transfer from the disc

(16) Hot/cold decks in line in a sing heat as necessary to temper ventilation ai

GENERAL

LARGE LAMP DEPART



acts heat from circulating water and trans- heat storage tank (11) for future use as d (16). In case of immediate demand for unted to hot decks in those areas instead

ting air when, for example, lights are off ting heat is not directly available; or neter areas of the building.

emergencies. Normal capacity for storing needs fully (in sub-zero, outdoor tempera- tive non-operational days when no lighting

tion to dispose of excess heat only when eing met and when storage tank (11) is

entering the old building section receives onomizer in the same way as in the new ischarge air.

ingle intake-air duct either add or extract air to 75°F.

(17) Ventilation air enters through lighting fixture slots in volume sufficient to accomplish approximately one air-change per hour. Air circulation volume is restricted by old building structural limitations on duct work; hence heat handling by the bleed-off system used here is less efficient than by the total-return system in the new building section.

(18) The function of the fan coil unit, wall mounted in rooms of the old building section, is to add heat or extract it from the room air as it is circulated through the unit. The heat handled by the fan coil unit is mainly lighting heat, but also includes the heat gained from room occupants and operating equipment. Excess heat is transferred to water and carried off for storage, or for use in cooler building areas; similarly, when additional heat is needed it is transferred from circulating hot water taken from the storage tank or brought from other building areas having an excess of heat.

(19) (9) and cold deck (16) are typical heat collecting points at which heat is taken from circulating air by transfer to the circulating water system for conservation in the heat storage tank to meet future heat demands, or for conservation by redistribution to parts of the building where heat losses exceed heat gain. The transfer is accomplished by the chilling-effects water circuit which absorbs heat from the circulating heated air and carries it to the Freon heat exchange system where it is transferred into the heating-effects water circuit for redistribution, storage, or discharge to atmosphere.

ELECTRIC

TMENT, CLEVELAND, OHIO