

Detroit Warplant Uses 3KW Units. See page 6.

THE MAGAZINE OF

LIGHT

PUBLISHED BY GENERAL ELECTRIC

1943 * NUMBER 5

18 War Production Men report what happened *when lighting was improved*★

GREATER ACCURACY

SHELL FUSE manufacturer: Production increases of from 25 to 50 per cent as result of better inspection and more efficient machine operation.

MOTOR TRUCK manufacturer: Workmen read micrometers and scales more accurately.

TEXTILE manufacturer: Better Lighting a great aid in color matching.

LESS SPOILAGE

ROLLER BEARING manufacturer: Grinder operators spot improper grinder performance more quickly and can correct it before work is spoiled.

ELECTRICAL EQUIPMENT manufacturer: Better lighting accompanied by five per cent reduction in errors.

FACTORY OFFICE: Reduction in office errors as result of lighting.

FASTER SEEING

HEAVY MACHINE TOOL BUILDER: Better lighting reduces time required to rebuild a machine.

ELECTRICAL EQUIPMENT manufacturer: Time required for machine set-ups reduced.

AIRCRAFT PARTS manufacturer: Less time lost by workmen hunting for tools.

EASIER SEEING

LAMP manufacturer: Time for training new women operators greatly reduced.

SMALL MACHINE PARTS: Men can read scales and blueprints more easily at night than by daylight.

FACTORY OFFICE staff: Unable to keep up with increased work under old lighting, but now work is done without undue effort.

INCREASED SAFETY

ORDNANCE PLANT: Increased safety, especially when breaking in new labor.

SHIP BUILDER: New lighting reduced blinding effect of flashes from welding torches.

TEXTILE manufacturer: Decreased fire-hazard.

DECREASED FATIGUE

MACHINE PARTS manufacturer: Men on night shift gained weight.

AIRCRAFT PARTS manufacturer: Morale improved; fewer yard fights.

AIRCRAFT PARTS manufacturer: Fewer headaches; aspirin tablet consumption decreased from 1000 to 600 tablets per month.

War Production Executives!

The 18 comments summarized on this page are typical of the wide range of benefits resulting from lighting improvements.

Lighting may seem like the least of your problems. But it may be the answer to some of your *other* problems. We'd like to take the lighting problem off your shoulders, by sending a Wartime Lighting Counselor to check your lighting and show you how it can be improved with the least possible use of critical materials. Call your nearest G-E lamp office. Or see your G-E lamp supplier or your electric service company. General Electric, Nela Park, Cleveland, Ohio.

★ *These reports are the result of a survey of warplants made under the direction of a special committee of the Illuminating Engineering Society, a non-profit professional organization of the nation's leading lighting authorities. Interviews were made by teachers of illuminating engineering of five leading technical colleges.*



G-E MAZDA LAMPS

GENERAL  ELECTRIC

A Summary of Limitation Order L-78 as Amended

August 18, 1943—By DON JULIEN



L-78 AMENDED IN IMPORTANT RESPECTS

An Amended L-78 Order was approved, and is now in the hands of the printer. In due time it will be sent to those people on WPB's mailing list and will be available at WPB Field Offices, but in the meantime, here are the important changes incorporated in the Amended Order.

SALE WITHIN THE INDUSTRY

After September 1st, manufacturers may not sell to wholesalers or dealers, or wholesalers may not sell to dealers except pursuant to properly rated orders. This stops the uncontrolled flow of fluorescent equipment within the industry, which heretofore has been permitted to help move frozen stocks. These stocks are now practically liquidated, so after September 1st the "lid" goes back on. After that date, wholesalers can maintain stocks on PD1X applications under the procedure set up by L-63.

MANUFACTURE OF COMMERCIAL UNITS TO BE RESUMED

Until December 1, 1943, manufacturers may make "non-industrial" fluorescent fixtures only upon written authorization of WPB. After December 1st, no distinction between "industrial" and "non-industrial" will be made and consequently the so-called commercial fixtures can be made without any authorization and sold on orders bearing A-1-J, or higher, ratings. Since there is no distinction, commercial fixtures obviously will have to comply with L-78 limitations as to weights of metal, types of fixtures, etc. Setting the date at December 1st is to give manufacturers who want to make commercial type fixtures ample time in which to tool up, etc.

METAL FOR CLOSED ENDS

Manufacturers may apply by letter in duplicate to WPB for permission to use metal for ends, baffles, shields, louvers, etc. (Formerly application was made to Director General.)

But no such authorization is needed in these cases: (1) Fixtures specially designed and constructed for use on board ship, (2) or in hazardous locations as defined by Par. 5005 and 5006, Art. 500, N. E. Code 1940 edition, (3) or for operation of 400-watt and 3000-watt mercury vapor tubes, or (4) for industrial portable equipment.

FURTHER RESTRICTIONS ON METAL WEIGHTS

Except for the uses and types of fixtures described in the preceding paragraph, a 4-lamp, 40-watt fixture may not use more than 6 pounds of ferrous metal. This type of fixture was not included in previous orders.

CERTAIN TYPES OF FIXTURES ELIMINATED

After September 8th, and in the absence of written authorization from WPB, no one shall use any ferrous metal in the manufacture of the following types of fixtures: (1) A single-lamp, unit fixture using 30-watt tubes or larger, (2) four or more tubes of any wattage, except 40 watts, arranged in parallel, (3) a continuous row of single tubes of any wattage, (4) two or more tubes arranged in parallel continuous rows using any tubes other than 40 and 100 watts.

PD 556 APPLICATION ELIMINATED

On the assumption that retail stocks of "frozen" units have been cleared out, the use of Form PD 556 requesting permission for unrestricted sale at retail has been discontinued. If such permission is desired, an appeal by triplicate letter may be filed with WPB, Building Materials Branch, Washington.

NOTE: The foregoing interpretations are our own, based on a full discussion of the order with WPB representatives. In short, the purpose of the Amended Order is to recognize, (1) that the emergency conditions created by large frozen inventories are over, (2) that "commercial" fixtures have an "essential" application in the war effort, and that therefore, (3) there is no further need for distinctions between industrial and non-industrial units, either as to manufacture or sale.

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What's AHEAD in LIGHTING

UNDER this title S. B. Williams, editor of *Electrical World*, has offered the results of a searching study on the prospects for the renewal of lighting development after the war. This thoroughgoing study, first appearing in the issue of July 24, has been reprinted as a separate text, and, in this handy form will doubtless be the reference basis for many plans to be prepared during the next twelve months.

The inclusive nature of Mr. Williams' views on What's Ahead in Lighting can be realized by a listing of some of the fields he has discussed with a word or two of his expectations about them. For real consideration of problems and opportunities coming soon, a careful reading of the complete analysis by Mr. Williams is recommended.

Design: Trend towards simplicity . . . great forests of large hanging fixtures do not harmonize.

Practice: Comfortable lighting is the criterion, layout adapting standardization to the specific job.

Education: Not only lighting salesmen, but everyone who is a party to new installations needs a better appreciation of what to sell and what to buy in lighting, and why.

Wiring: From the war . . . new ideas on wiring and voltages for lighting circuits. Inertia that coupled 110 volts to lighting so long as filament lamps were used appears to be broken.

Sources: Light source of the future is definitely fluorescent with continuous improvements.

Markets: Virtually everything prewar is obsolete, or will be by the time we get around to it.

Filament Lamps: Still offers much for relighting to new design . . . still important in home uses.

Cold Cathode: Winning friends and influencing design features. High voltage is a major hurdle.

Fluorescent Improvements: Starters, Ballasts, Life, Output, Sizes—all these elements may be expected to record advances.

Tomorrow's Recommendations: Higher foot-candles achieving new standards of comfort in all fields. Quality considerations will be met before advances are relevant.

Tomorrow's Utilization: Higher and with regard for regular maintenance, and psychology of color distribution.

Effect of War Limitations: Encouragement of better and advancing standards. Little chance that conservation for war purposes will develop a postwar trend.

Commercial Lighting: Small stores including gasoline service stations will present immense demand. Larger stores, of course, will return to former emphasis on lighting with keener interest.

Industrial Lighting: Warplant standards will revise postwar practice upwards as millions of workers now regard lighting conditions as definite job factor.

Home Lighting: New ideas on housing and home building offer strong encouragement to new design.



Figuring Horizon Distances

How far can your friend in the Air Forces see from 25,000 feet up? Pilots as well as airline passengers often wonder how far they can see from upstairs. Distances at altitudes are even more deceiving than on the surface at sea level.

Clipper pilots, attempting to answer queries from passengers, and to justify or deny such claims of long-range visibility from various heights, came across the surprising fact that practically no one knows how far you can really see. With that fact in hand, the Pan American Clipper captains got together, went through the research files and produced the scientific answer. They call it the Clipper Captain's "vision-range" formula.

The actual curvature of the earth for the first mile is about nine inches, and increases thereafter at a rate approximately equal to the square of the distance in feet. If approximate curvature of the earth for any distance is wanted, multiply the square of the distance in miles by .67. The answer will tell you how much the earth has curved under at that point. For example, the surface of the earth 10 miles from where you are standing is 67 feet lower than you are.

On the surface of the sea, at eye level, the range of vision is only 2.9 miles. On land, since the earth itself varies in altitude, the range of vision is always at least the same 2.9 miles plus the distance reflected by altitude of the individual and the object's altitude.

With that background, the Clipper Captains finally worked out the following "vision-range" formula to tell how far the average person can see from various heights.

The range of vision is equal to the square root of the altitude multiplied by 1.225 miles. For example, at 1,000 feet, you can see for 38.8 miles. From 10,000 feet you can see for 122.5 miles. And for those who are somewhat rusty on their mathematics, the Clipper Captains compiled a table:

From 1,000 feet—you can see—	39 miles
From 2,000 feet—you can see—	55 miles
From 3,000 feet—you can see—	67 miles
From 4,000 feet—you can see—	77 miles
From 5,000 feet—you can see—	87 miles
From 10,000 feet—you can see—	123 miles
From 15,000 feet—you can see—	150 miles
From 20,000 feet—you can see—	173 miles
From 25,000 feet—you can see—	194 miles

Science News Letter, June 5, 1943

U. S. DEPARTMENT OF LABOR

Endorses American Standards Association Recommendations on Lighting

REPRODUCED on this page is the cover of the Department of Labor's edition of the American Standards Association's Recommendations on Industrial Lighting. The first inside page of the publication is also reproduced showing the remarks of the Department of Labor official transmitting the text to the Secretary of Labor. Most actively engaged lighting men are familiar with the A. S. A's Recommended Practice. As one of the more than twenty national scientific business and government organizations comprising the Association, it was a natural consequence that the Department of Labor would endorse this reference in the cause of improved working conditions and better production for the war effort.

Letter of Transmittal

UNITED STATES DEPARTMENT OF LABOR,
DIVISION OF LABOR STANDARDS,
Washington, June 15, 1943.

MADAM: Good lighting speeds production. It is essential to the health, safety, and efficiency of workers. Without it eye damage may occur, accidents and spoilage of material will increase, and production will slow down. But if each job is lighted to make vision clear and easy, then better and faster production will result and vital manpower will be conserved.

Management is becoming increasingly aware of this fact. But until recently the answer to the question "What is good lighting?" was not available in precise and tangible terms.

The Illuminating Engineering Society, through many months of work in which the Division of Labor Standards collaborated, developed detailed lighting standards which have now been adopted as a revised code of the American Standards Association, under the title "American Recommended Practice of Industrial Lighting."

The Division has reprinted this American standard so that it will be generally available to the thousands of plants now in need of this practical guidance. The application of these recommendations will protect workers and increase their efficiency while speeding production.

Verne A. Zimmer, Director.

Hon. FRANCES PERKINS,
Secretary of Labor.

INDUSTRIAL HYGIENE AND PLANT EFFICIENCY THROUGH GOOD LIGHTING

A Reprint of
American Recommended Practice
of Industrial Lighting
Approved by AMERICAN STANDARDS ASSOCIATION

UNITED STATES DEPARTMENT OF LABOR
FRANCES PERKINS, Secretary
DIVISION OF LABOR STANDARDS
VERNE A. ZIMMER, Director

1943

Practically every phase of sound, contemporary industrial lighting practice is covered in this edition of the A. S. A. manual. Lighting men everywhere will find this official Labor Department aid on lighting a helpful reference in their work.

The MAGAZINE of LIGHT

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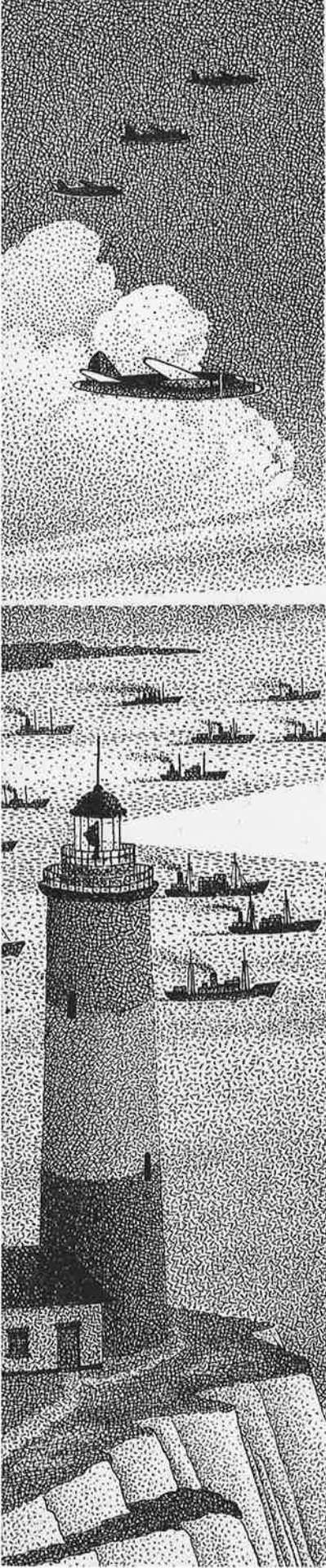
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Cross Gear & Machine Company

Adopts 3KW Units in Main Plant Area

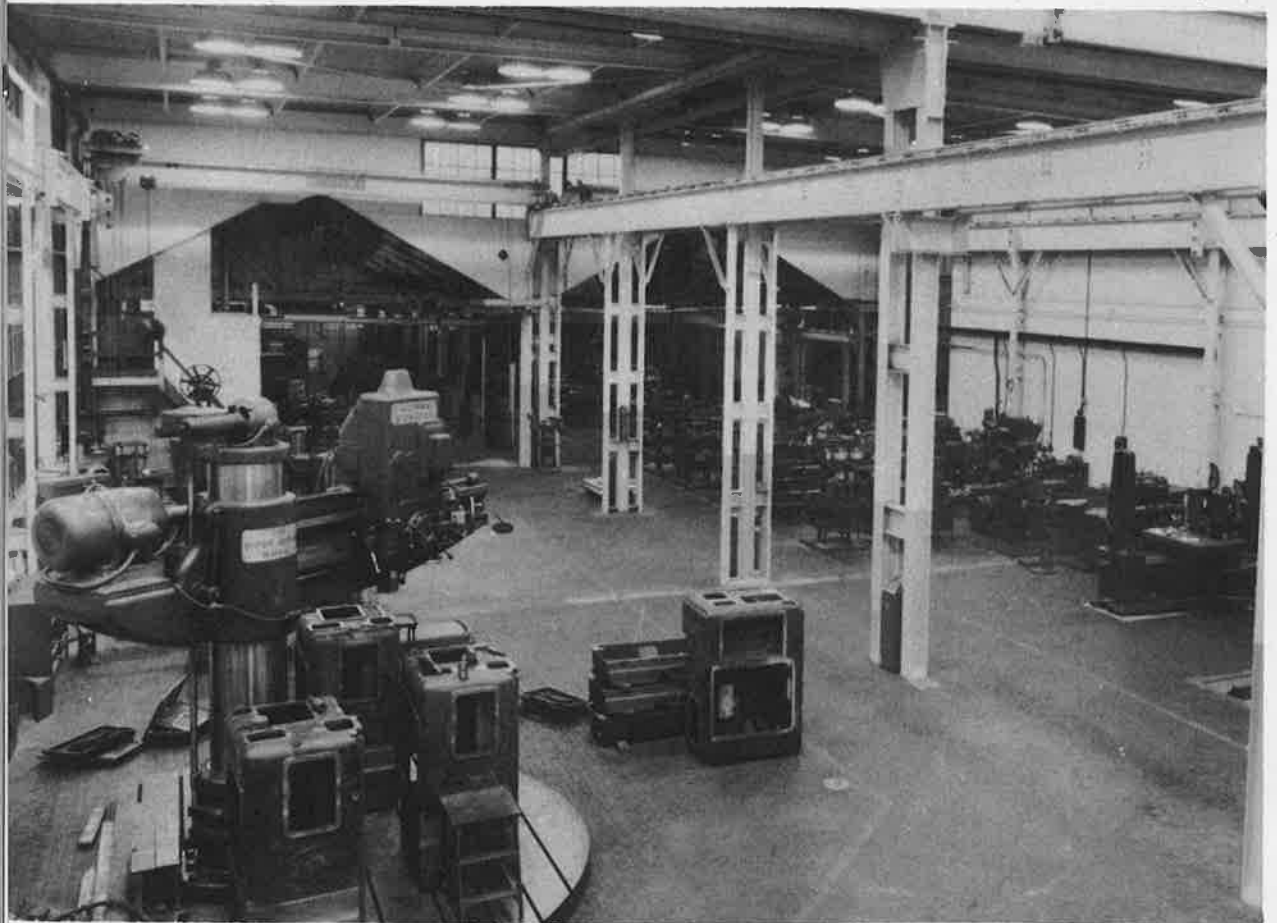
By T. P. BROWN, Engineer, Michigan Division

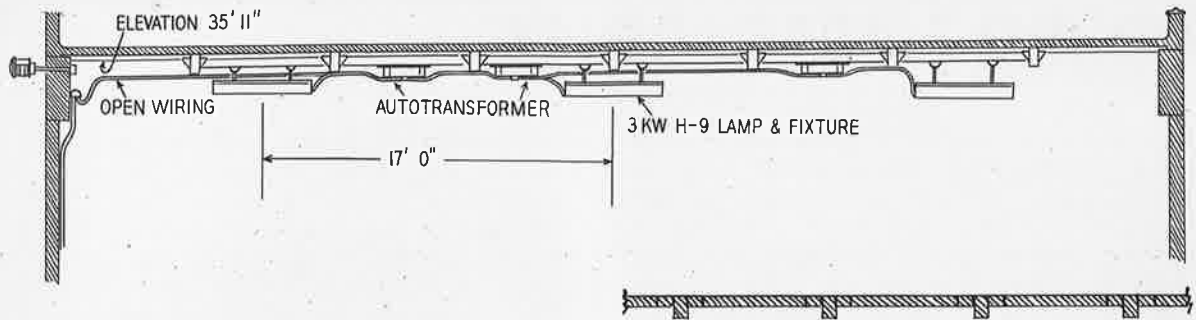
THE cover illustration for this issue shows an outstanding industrial lighting installation of the war period. In the last three years advanced industrial lighting practice has won more acceptance than in the twenty years before 1940. Many of the best installations of the war expansion have been in the great production center of Detroit. In this metropolis of mass production the H. E. Beyster Corporation has counseled and built for industry some of the most completely integrated warplants in the nation.

The plant of the Cross Gear & Machine Company, Detroit, is a good example of this company's recognition of advanced industrial lighting and the effective work of their engineer-architect counsel.

The main area is 53 feet by 266 feet and the ceiling is 35 feet high. The area of industrial floor space which is devoted to vital high-precision war work, required much better than standard practice levels of illumination to do the work with the highest efficiency of manpower, materials and machines. A general lighting system of special characteristics in terms of quantity and quality with a minimum maintenance responsibility was what the situation needed as Beyster representatives and Cross Company officials concluded their studies.

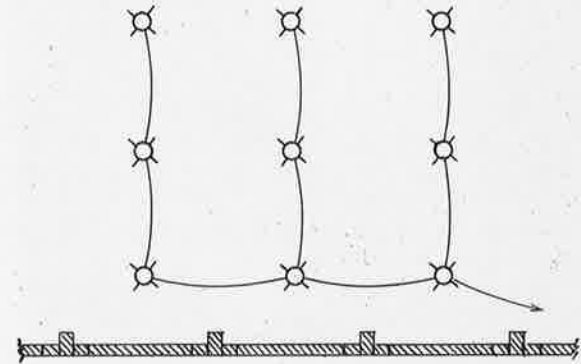
A combination system was used in this low-bay area with a 400-watt H1 and three 200-watt filament lamps in each pair of reflectors.





The sketch above shows a section of the main area, indicating the location of lighting units with reference to the disposition of transformers. The sketch, right, shows a plan of the main area lighting for one bay.

Lamps are controlled in banks of 3 to 5 through this compact panel (below) of switches.

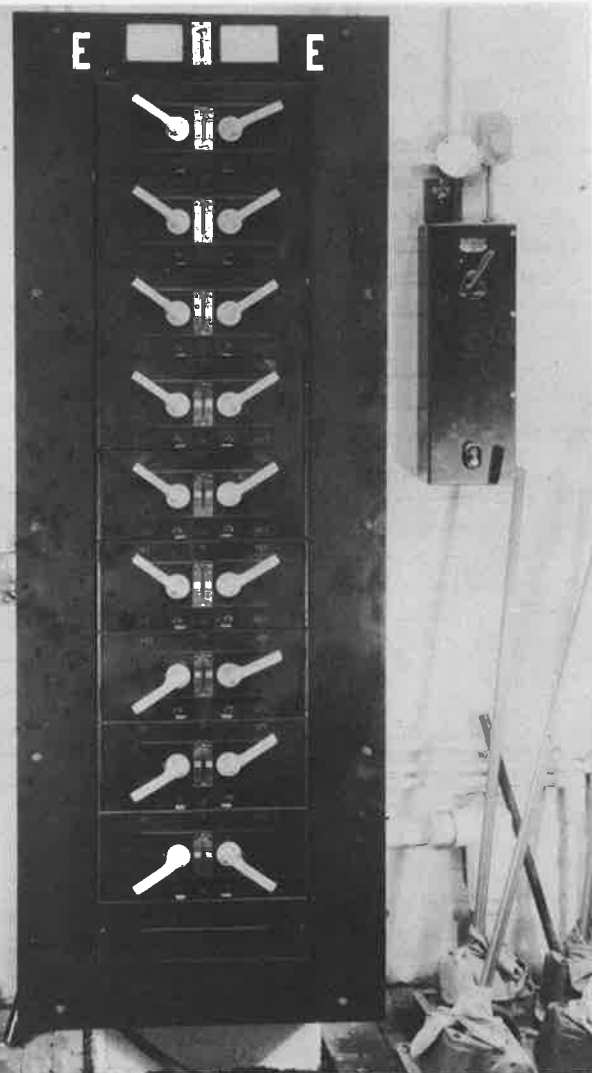


The result was the installation shown on the cover. There are 39 units employing 3000-watt G-E lamps.

The lighting load with ballasts adds up to 122,850 watts which averages out to nearly 9 watts per square foot. The footcandles on the work level after eight months measure 110. Day Brite fixtures with a cutoff of 28 degrees were used.

Electrical service is 480 volts, 3-phase, 3-wire. The transformers are 480 volts primary winding. Lamps are controlled in banks of 3 to 5 through switches shown in the accompanying photo of the panel. All lamps are "phased out" to minimize stroboscopic effect.

Cross Gear & Machine Company executives, Ralph E. Cross and C. R. Parsons, have long been convinced of the necessity of advanced lighting for the most efficient plant operation. Wartime conditions have emphasized their convictions. When the architects and engineers of H. E. Beyster Corporation were consulting on the lighting of the plant they found a very sympathetic and understanding client. L. W. Saltz of the latter organization, had charge of the design specifications and the installation of the electrical work. The completed job in operation is a special satisfaction to him, because his own organization and the client's officials and personnel are agreed that they have what it takes in lighting to make the maximum war effort.



COLOR in FACTORIES*

CERTAINLY one postwar development in progress for industry is a matter of color in plant housekeeping. Its aim is efficiency through satisfying distributions of color. The conviction that quietly cheerful combinations of hues, shades and tints evoke a more substantial effort by workers on the job, is growing with plant managers. The addition of large numbers of women to industrial payrolls has emphasized the potentialities of color techniques. Now the steps to be taken are the perfection of such techniques, with the head, rather than the heart, dictating the process. Preferences in color are often one's own choice for what we think others should have. However, color in industry, on a practical basis, avoids the romancing of home decoration.

The primary objectives of color applications in industry are the conservation of energy and minimizing of hazards. The resulting appear-

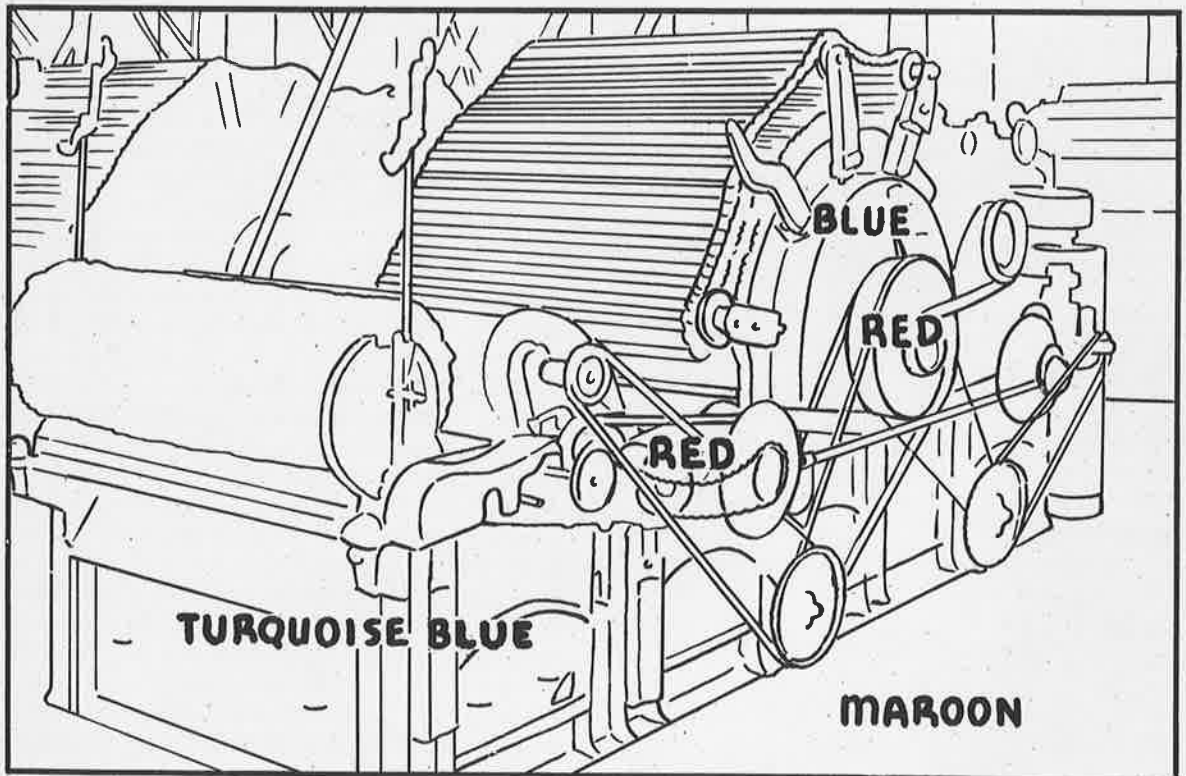
ance should be attractive with such aims, but it is not the express purpose of the project.

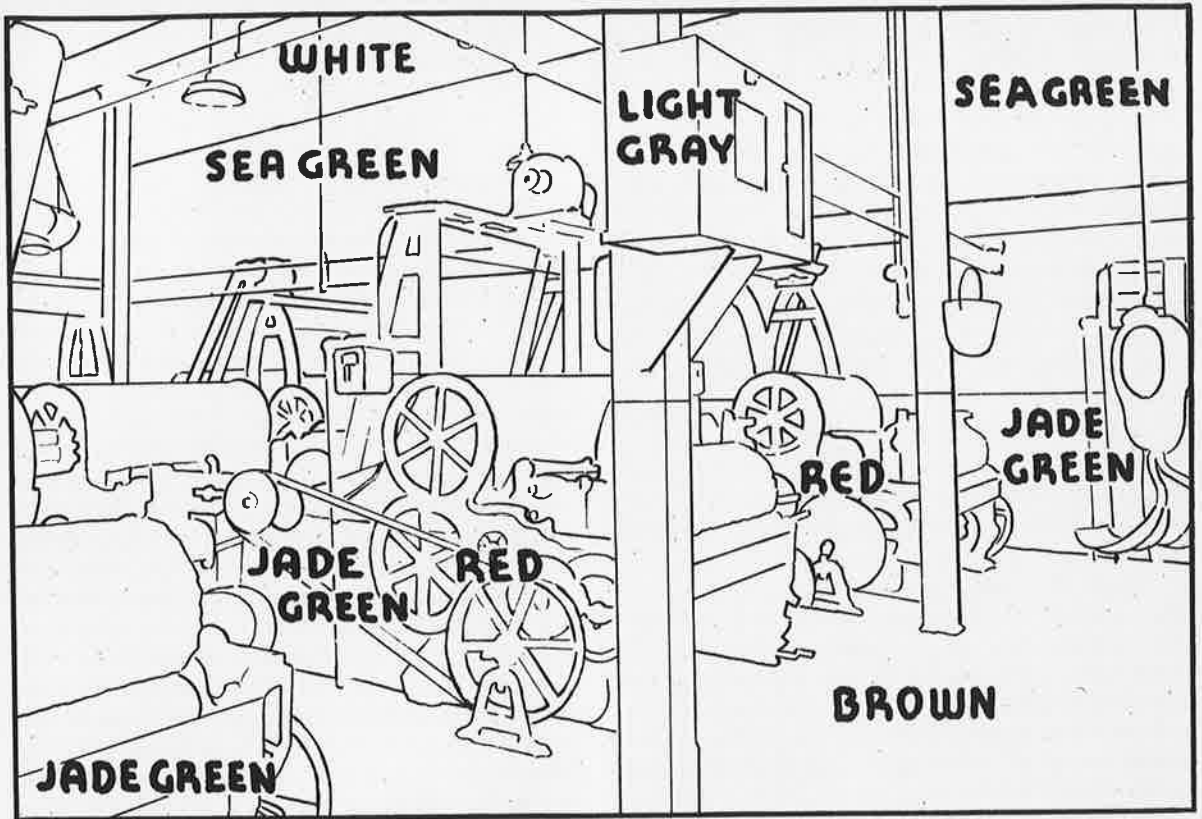
Colton in a recent article by its editor, Robert W. Philip, cited a number of well-known textile mills which have successfully applied color for industrial efficiency. Some of the natural color photographs reveal a trend which may come to be one of the best expressions of the rising standard of working conditions in this industry.

It takes an advanced industrial society to produce workers capable of making so substantial a response to eye-satisfying conditions that extra production absorbs the expense of the project. Yet this is a development which was probably bound to follow the policy of superior lighting in advanced textile plants. Good lighting shows up dirt and grime. A plant cleanup is the next step. To insure maintained cleanliness a lot of white paint is the next event in sequence. From this stage the move to utilize distribution of color as a complement to good lighting is natural.

The repetitious character of most industrial jobs argues the case for color to minimize the

* An article which presents a detailed analysis of this subject was presented recently in the *Sight Saving Review*, Vol. XIII, Number 1. The article is based on a paper by Faber Birren, well-known industrial consultant specializing in color. His paper, "Color in Industry," was given at the Greater New York Safety Conference.





The outline illustrations were derived from full-color reproductions of scenes in the Lafayette plant of the Avondale Mills as printed in the June, 1943, issue of "Cotton." Recent practice in the latest warplants has emphasized the advantages of white cement floors. This very desirable factor would pose a problem in older industrial plants.

effect of job monotony. So in the same spirit that music-on-the-job has been adopted in some plants, we turn at last to color.

"It is apparent," says Editor Philip, "that only by the use of interior finishes having a fairly high reflection factor (60 per cent or higher) that a satisfactory utilization of light can be attained.

"Machines must not be overlooked in any light-salvage program, for the average machine in the average factory absorbs 94 per cent of the illumination thrown upon it, reflecting only 6 per cent.

"White—with a reflection factor of 85 per cent—has been found both experimentally and in actual use to be the most satisfactory ceiling finish. It reflects a maximum amount of light from natural or artificial sources. Because the ceiling represents the most important light-reflecting surface of any industrial interior, and is not continuously in the line of vision of the

employee, it should be finished with a paint with extremely high reflection power.

"Wall areas from the dado to the ceiling call for specially designed hues. Color tones providing a cool color of high light-reflecting qualities and reducing severe brightness contrasts are recommended in these areas. The dado color may be darker in shade but should provide a complementary contrast to the upper wall color. Accident hazards are identified strikingly in bright red—as a supplement to mechanical safeguards, in revolving pulleys and wheels, fire-fighting equipment, etc.—in fact, anywhere to emphasize cautious preventive action."

Mr. Philip encourages the choice of a high-visibility yellow to identify objects that need to stand out on moving equipment that must be avoided by the employee. Electric trucks and boxes moved through the mill are other examples of equipment he recommends painted in this color. For controls or starter handles he suggests either red or a high-visibility yellow to emphasize their importance to the employee, thus minimizing errors in starting and stopping machinery. For the colors selected for upper walls, dados and machinery, he urges "cool" colors, i.e., blues and greens, to create the illusion of space and airiness.

In many mills, Mr. Philip observes, a well-designed lighting system is robbed of its full effectiveness by dull colors in ceilings, walls and floors. As an antidote there are many color combinations which may be used to yield dividends in terms of better light, better sight, and better morale. The combinations used, for instance, by the Avondale Mills in the Lafayette, Alabama plant, are good examples of textile industry progress. Plant executives have found the results of their preliminary program so satisfactory that more extensive applications are being made in other units in the group. A two-tone blue-green wall combination, in the Callaway Mills, LaGrange, Ga., is reported to have won much employee appreciation in connection with a general program of color distribution.

While the changes of the business cycle produce a cycle of changing influence from different departments of management, the sum of each era of experience in the U. S. has been a rising standard of working conditions. Who would have surmised 30 years ago that a day would come in industry when it would be seriously contended that the use of color in production would be an element of "self-liquidating" plant conditions in the interest of profitable

operation? But 30 years ago no one could have estimated the all-around advances in technical perfection, and the tendency of industrial maturity to find that product approval begins with the production processes.

The most modern plants in America, born of the war effort, are not only capable of turning out fine industrial products, but their operation is designed to utilize the maximum energies of equipment and personnel. Industrial lighting programs have been undertaken with understanding of the several ways in which they bear upon successful plant operation. The maintenance policies which have gone along with so many warplant lighting jobs speak for the thoroughness with which the visual side of the work-world is getting recognition. Beauty of design is a regular feature of our impressive industrial skill. We appreciate that clean efficient design will eventuate in good looking products. Where such products are made to extremely close tolerances, as is often the case, it cannot be permitted to encourage less than the highest critical regard for the steps in the production process. Clean, skillful distribution of color is not an effeminizing reflection upon the environment of honest work. It is simply one of those ultimate refinements of the advanced industrial process.

If you see a Shattered Soldier—

By H. F. BARNES

I TALKED with a shattered* soldier yesterday . . . a soldier whose broken body is here, but whose future may be buried in the muck and heat and stench of the Solomons.

It was hard to get him to talk about the war . . . about whether he thought we business men were doing our share.

He seemed hesitant about criticizing or complaining . . . Yes, he thought war production was going along marvelously. No, he believed there wasn't much he could suggest.

But I kept trying to see whether, down under the surface, there were any things which rankled him . . . things that a soldier, who has looked into the eyes of death, might feel were queer—or out of place—in a business world at war.

He smilingly fended off my questions until I asked him—

"Do you think that every business man is going to be proud of his record of service when this war is over?"

"Well, I don't know," he said—and the smile left his face. He leaned forward in his chair, and nervously opening and clenching his hands, remarked:

"I'll say this—and then I'll shut up. I was a salesman . . . when I came back, I naturally visited my own company. I was proud to see the war work they were doing.

"But when I found out that one of the big shots didn't seem to care too much about helping end the war sooner, or what the cost in life and happiness was going to be . . . I wasn't so proud—I was burned up.

"You know when you have been down on your knees wiping the blood off the face of a dying buddy . . . and holding his hand, trying to help him through it . . . you

* shell-shocked, crippled, malaria victim

wonder why there would be anybody in the world who wouldn't be giving every ounce of his energy to getting this mess over—and quickly.

"And yet, some men seem to be mainly concerned over their sales figures. You find others who are 'post-war planning,' not with the idea of making jobs for the boys who'll come back, but with the thought of making it tough for competitors. And, I've met plenty who are doing a lot less than they really could. Yet, how they love to talk about the few things they are contributing.

"It's . . . well . . . I guess they just don't understand."

I shall never forget this shattered soldier. He had already done far more than his share. He made me search my soul to see if I was doing all I could. Not a matter of doing a little—or even quite a lot—but a matter of doing *all* I can.

A matter of helping increase production to the limit . . . a matter of helping get out more . . . at less cost . . . a matter of keeping at it day in and day out . . . a matter of living with one's self, when this war is over.

So, if you see a shattered soldier, perhaps you will say to yourself, "I have reason to be proud of that soldier . . . I wonder if he has reason to be proud of me?"

* * *

Nobody knows how long the war will last. It can last a long time.

Isn't our job, in the lighting industry, to see to it that light is helping end the war sooner? It's a day-in and day-out job.

It's a job that won't be done—till the hour of the final Armistice.

LIGHT SOURCES and UTILIZATION *

By WALTER STURROCK, Nela Park Engineering Dept.

THE War Production Board today controls the distribution as well as the manufacture of lamps. You are all familiar with their plan of priority ratings to control the distribution of manufactured products and this makes the supply of approved types of lamps and approved designs of lighting equipment available for a controlled distribution. The three light sources which are of most concern today for lighting war production areas are filament lamps in the usual range of wattage sizes, fluorescent F type lamps in 15 to 100-watt sizes, and mercury Type H lamps in the 400- and 3000-watt sizes. An example of curtailment for industrial use is the elimination of the Type RF fluorescent lamp for new installations. This lamp can, of course, be obtained for replacements in existing circuits.

General Lighting

If one visits the architects and consulting engineers who have designed the lighting for many large war production plants he will hear many lengthy discussions and review masses of figures, all of which have to do with an honest effort to make the best choice of lighting system including the light source, type of reflector, size of branch circuit wire, switches, panel boards, weight of transformer, and other items for specific areas when all the conservation suggestions are carefully considered. It is, however, recognized that the 400- and 3000-watt high-intensity mercury lamps, having an efficiency of 40 lumens per watt, are essentially for high mounting, and that to improve the color quality of the light as well as protect against periods of darkness or semi-darkness these mercury lamps should preferably be used in combination with the higher wattage (20 lumen-per-watt) filament lamps so that the latter provides about half the total lumens.

But what about fluorescent lamps?—Should they be mounted 40, 50 or more feet above the floor? Opinion in Washington now appears to look with some disfavor toward such high mounting of fluorescent lamps because the maintenance of such a lighting system with a great many units is less simple than if a few high lumen output units are used. However, in

those high-bay areas as well as in low-bay areas where it is desirable to reduce to a comfortable degree the specular reflections from the work, it may be to advantage to install large-area low-brightness lighting units. In this respect I want to emphasize one of the outstanding contributions from fluorescent lamps, the low bulb brightness. Fluorescent lamps with their inherent low brightness are a "natural" for use in those areas where specular reflections from polished surfaces are encountered. Moreover, since a 40-watt lamp together with its auxiliaries has an efficiency of 42 lumens per watt—more than double that for a filament lamp—it isn't at all surprising to find the 40-watt fluorescent lamp at the top of the list of light sources used in low-bay production areas, and in order to get the most light from an existing wiring system, one would certainly consider the use of fluorescent lamps.

Supplementary Lighting

With the more general acceptance of illumination levels of 25, 30 or 40 footcandles in production areas, we often fail to give proper consideration to some of the more critical seeing tasks which may be found within a given area. The I.E.S. American Recommended Practice of Industrial Lighting as approved a year ago by the American Standards Association, specifies a minimum of 100 footcandles for such tasks as extra fine bench and machine work, and it suggests the most economical way to provide such lighting is by general illumination plus supplementary lighting at the work point. Have we forgotten to build up the illumination at these most important locations? The War Production Board recognizes that supplementary lighting units are often required in order to satisfactorily solve some of the wartime lighting problems, and I am sure the intent of the Limitation Orders on both filament and fluorescent equipment is not to limit the use of supplementary lighting where needed in war production areas. In several manufacturers' catalogs we, therefore, find industrial portable lighting units of various designs for both filament and fluorescent lamps. Such units should be properly designed not only to control the light effectively as to amount and direction but also for shielding to eliminate

* From a paper given at the East Central Regional Conference of the I.E.S., June 9, 1943.

glare. Large-area low-brightness supplementary units are the answer to many local lighting problems involving the inspection of shiny surfaces on machines, tables, and workbenches. For these applications fluorescent units are rapidly becoming the first choice and in my opinion their use will be greatly expanded under postwar conditions. On the other hand, there are certain conditions where a high level of illumination must be carefully directed toward the work surface and for this purpose a choice can be made from many available designs of low-wattage filament units which can be located close to the work. If, however, the lighting units are to be located at a distance from the work, they should be of the spotlight or floodlight design. Low-cost units of these designs, utilizing a minimum of critical materials, are found in the R-40 and the PAR-38 type lamps which have been available for several years.

The R-40 reflector lamp is for indoor use only, while the PAR-38 projector with its pressed, hard glass bulb will withstand rugged weather conditions. These two lamps of different designs find many applications both indoors and out-of-doors around an industrial plant. Direct glare can be minimized by use of louvers which in the case of the projector lamp can be attached directly to the bulb, but for the reflector lamp a special louvered lamp-holder is necessary. With this variety of available equipments we readily can provide several hundred footcandles at the point of work when required, and when such lighting is used with a well-designed general lighting system we know from studies of brightness distributions that the result will be comfortable lighting.

Ballasts and Starters

Fluorescent lamps for general lighting or supplementary lighting as the case may be, require ballasts and starters. The past year has brought important developments in these auxiliaries which are of particular interest in connection with the conservation of critical materials.

A few months ago a new three-lamp ballast was announced for operating three 40-watt lamps on 208 (199-216) and 236 (220-250) volt alternating current circuits. This new ballast has already made a substantial saving in critical materials because it is the same size and same weight as the standard two-lamp ballast. It is recommended for all fixtures where three 40-watt lamps are used and can be operated on one of the two voltages—208 or 236.

Another development of note is the single ballast for operating four 100-watt fluorescent lamps on circuits having a voltage of 265 (250 to 280 volts). This new unit is the same size as the standard two-lamp ballast for 100-watt lamps but it is slightly heavier (17½ pounds instead of 14½). It makes use of the split-phase circuit and thereby has a high power factor. Two 100-watt lamps are operated in series on each leg of the two circuits and this is known as the sequence starting circuit. It has several advantages which include cutting the critical material nearly in half; one-half the ballast cost; over-all reduction of 25 per cent in fixture cost and an increase of about 8 per cent in light output per watt consumed.

These advantages may seem rather trivial, but when applied to a large installation, it indicates rather big savings. For example, the new Douglas aircraft company plant has 55 foot-candles in the main assembly area where they use continuous rows of 100-watt lamps with Forlamp ballast. The use of this ballast instead of the conventional Tulamp type made possible a saving of approximately 50 tons of transformer iron and 30 tons of other critical materials, principally copper. About one-third of the copper saving was in the ballast and two-thirds in reduced wire sizes which were acceptable with the higher voltage distribution. While quoting big figures I might also mention that 170 tons of steel were saved in this one large Douglas plant by use of the new non-metallic reflectors instead of the open end porcelain enameled steel reflectors as originally considered.

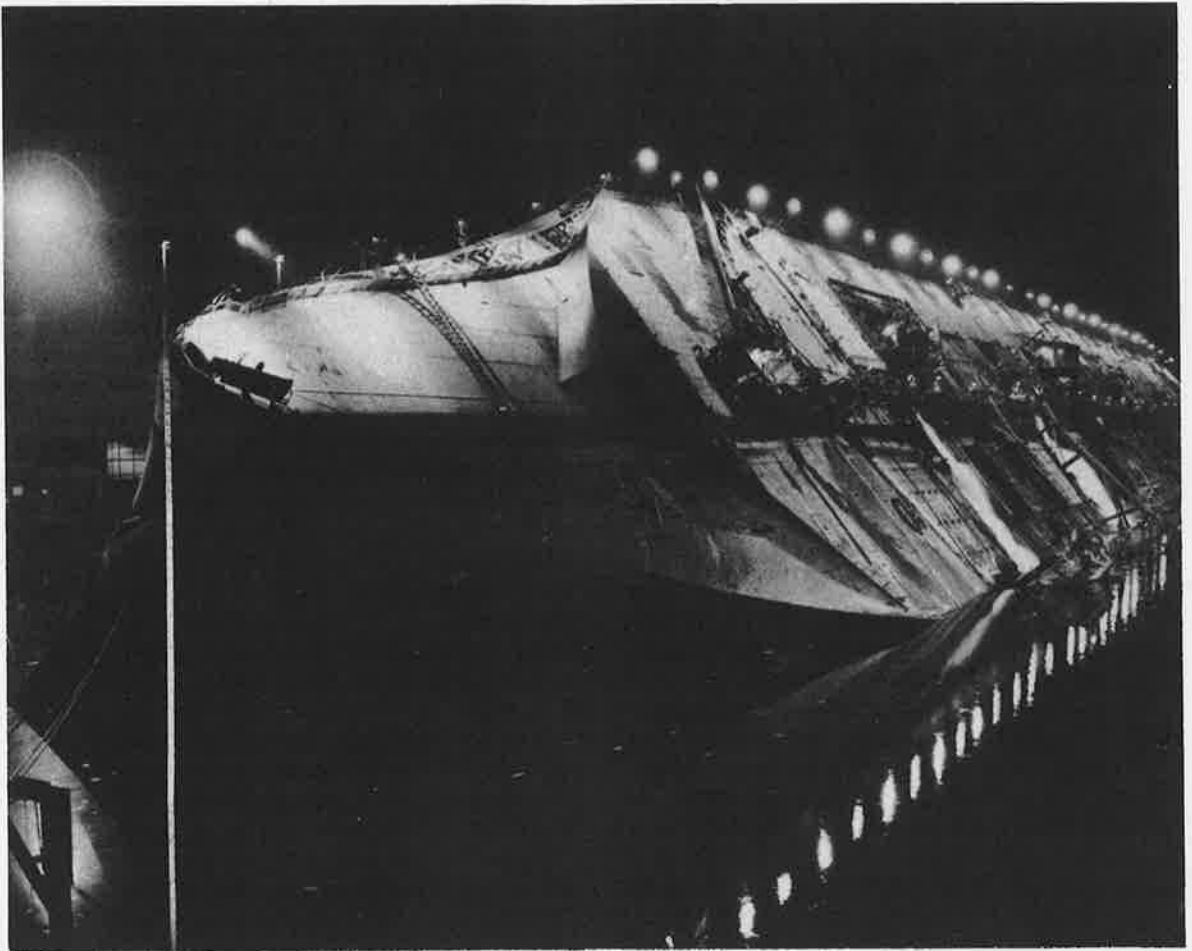
Although the new four-lamp ballasts show marked savings when used in circuits having 265 volts, it should not be concluded that similar savings will be experienced on lower voltage circuits (such as 208 volts) where extra step-up transformers are required to obtain the desired higher potential. These extra transformers increase the cost and also increase the weight of the critical materials. A better solution would usually be, where possible, to use the three 40-watt unit, unless the lamps are mounted at a considerable height so that the fewer number of 100-watt lamps to maintain becomes an important factor.

The third new development is the Watch Dog "No-Blink Starter" as announced early this year. This new design has several advantages over its predecessor. These advantages include (a) much simpler design, (b) more positive action, (c) greater reliability, and (d) when the starter switch is mounted so that

one can see the top of it, there is visible evidence as to whether or not the switch is tripped. This new design is designated as the FS-40 and FS6NB respectively for the 40- and 100-watt lamps.

Some of you are now, no doubt, thinking that although we have these new developments and substitutions in designs to bring about a conservation in critical materials, yet we cannot use them to any extent because WPB Limitation Orders prevent us from doing so. This, of course, is true to a small extent but the essential industries are granted a priority rating on artificial lighting equipment sufficient to conservatively meet the seeing requirements. Old buildings which are remodeled to house

war production can also get additional lighting equipment if better lighting is required for the particular work carried on. In this connection, I might mention that only recently a War Production Board press release stated among other things that in the future "no purchase of new machine tools, machinery or equipment, or erection of buildings will be authorized until it has been conclusively proven that the work cannot be done by existing facilities." This release definitely indicates that more influence will be directed along the lines of obvious wisdom that less money and critical materials are involved in giving old plants new usefulness with lighting than in erecting new buildings.



INS Photo

One of the outstanding engineering jobs of the war is the raising of the once proud Atlantic liner, Normandie, now the Lafayette of the U. S. armed forces. Floating of the immense ship from its sunken position at a New York pier is progressing rapidly now, and this night scene of the pumping operations shows how lighting plays a part in this round-the-clock job.

BALLAST AIR CONDITIONING

By A. B. ODAY, Nela Park Engineering Dept.

IT OFTEN proves to be the case that when necessity dictates, ways and means are found to do a job which turn out superior to the original method.

Thus when materials for fluorescent lighting fixtures became scarce, and restrictions made it necessary to limit the amount of steel used in the lighting systems, the first move was to eliminate the rather spacious and bulky channels that were employed to house the wiring and the ballast. This meant that the ballast was brought out into the open and not enclosed in a special housing. To many in the industry it had seemed illogical to take a piece of equipment like a fluorescent lamp ballast which is made with a very substantial metal housing and enclose it in another metal housing. The ballast housing itself is sufficiently strong to conform to any reasonable mechanical requirements. A further advantage which accrues through bringing the ballast out in the open is the potential lowering of ballast operating temperature. This is most important.

Dissipation of heat from fluorescent lamp ballasts is a problem that we probably will always have. MAZDA F lamps being electric discharge or arc type require some ballasting equipment. All such equipment absorbs wattage, and through this absorption generates heat. During the normal operation of lamps this energy and generation of heat is of a constant quantity. When lamps fail due to cathode deactivation this absorption of wattage and generation of heat often increases unless the so-called No-Blink type of starter is used, in which case the starting mechanism is open circuited and no additional heat problem is created.

Auxiliary specifications which have been developed establish maximum safe operating values* for all of the auxiliary equipment, and particularly for the essential parts of the auxili-

* When operated continuously in an ambient air temperature of 40° C (plus or minus 5), at rated primary voltage and frequency, and with the starter switch short-circuited, the maximum temperature rise on any exposed part of an open-type ballast shall not exceed 60° C, nor shall the maximum temperature rise on the case of an enclosed type ballast exceed 50° C, nor shall the maximum temperature on any capacitor exceed the maximum safe operating temperature for that type of condenser, nor shall this temperature rise in any case exceed 35° C.

ary, such as the ballast coils and capacitors. (Values below these are still more preferable.) These limiting temperature specifications must of necessity apply to the temperature of the ballast itself when operated under a specified set of conditions. Tests conducted by the Electrical Testing Laboratories in connection with certification of Fleur-O-Lier equipment show very conclusively that a ballast of suitable design to conform to specifications will only operate at a safe temperature when properly installed in a specific lighting fixture. These tests prove very conclusively that whenever a ballast is enclosed additional problems of heat dissipation are introduced.

Dissipation of heat from fluorescent lamp ballasts is accomplished in one of three general ways, namely, conduction, convection and radiation. A brief consideration of these three methods leads very definitely to the conclusion that the best, most practical and safest method for installing ballasts, in order to insure minimum interference from temperature, is to install the ballast in the open.

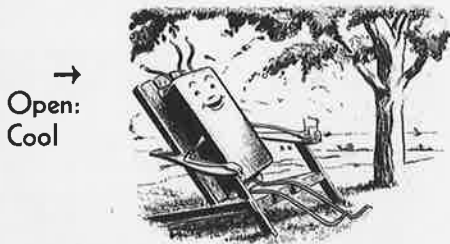
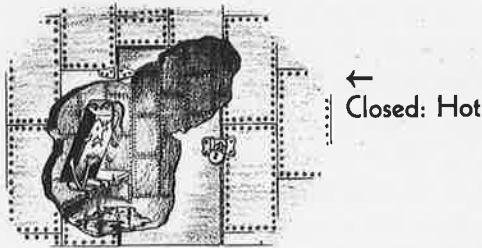
Conduction

This method of taking heat away from the ballast consists in contacting the ballast with some cooler surface. In order to get the maximum value from such a method conductors should be in contact with as much area of the ballast as possible, such as, bottom, sides and top. To be effective such conductors must have good contact with the ballast and they must involve considerable area. It is obvious, of course, that such contact surface to be effective must be able to dissipate any heat that is transferred to them. Metal surfaces, of course, are always preferable. Such a method of heat transfer presents many complications often leading to ineffective results. Generally speaking, the secondary contacting surface means transferring the problem of getting rid of the heat from the ballast surface to some other surface.

Convection

Such a method of transferring heat away from the ballast depends quite largely on air current or more specifically, the circulation of

relatively cooler air around the ballast itself. If the ballast is enclosed in a wireway or some similar enclosure, this means that more complicated ventilating problems are encountered. It is a well-known fact that a layer of still, dead air around a hot body is of little use in dissipating heat. To get good circulation, design is required which provides an intake and outlet, which will bring a constant washing effect with cool air on the ballast. It is obvious that placing the ballast in an enclosure presents much more difficult problems if we depend upon convection to take heat away.



Radiation

This method of transferring heat away from the ballast involves several features. First of all the ballast itself must be built with a large enough area to permit the heat to be radiated at a sufficient rate over the exterior surface.

In addition to having sufficient area the ballast container itself should be finished with non-metallic pigment paint, this being more suitable from a heat transfer standpoint than metallic surfaces or paints having metallic pigments. After the manufacturer has provided a ballast that is capable of radiating heat away, the remaining problem is to locate the ballast so that the heat can be transferred from the exterior surface.

In considering the problems of taking care of the heat generated by a ballast it seems indeed logical, if not essential, that the industry adopt the principle of locating ballasts in the open. It seems unnecessary, and in fact quite undesirable, to place ballasts in special containers or wireways, for in such cases the problem of dissipating heat becomes more and

more complicated. It is believed that the following points are highly important:


1. Design the fluorescent lamp ballast properly and sufficiently generous in size so that it is capable of dissipating the heat energy at a rate sufficient to maintain a suitable and safe operating temperature.
2. Finish the exterior of the ballast in a manner conducive to rapid and effective radiation.
3. Secure the ballast in the fixture assembly so that it will be in good physical contact with an efficient radiating surface that is not in itself heated by other radiators and is capable of transferring the heat away from the fixture assembly.
4. Do not place ballasts in confined areas where they will be surrounded by dead air space. Each layer of dead air presents an additional problem, and, generally speaking, placing the ballast in enclosures complicates this problem. (Today the problem of enclosure is further complicated because of the difficulty of meeting metal limitations consistent with design requirements for sufficient radiating surface.)
5. Provide for free circulation of air around and over the ballast. This is usually much more easy of accomplishment if the ballast is not confined in small specific enclosures such as wireways. To provide free circulation of air, merely means the skillful location of inlets and exits of circulating air.

It is quite obvious that the ballast assembly consisting of coils and condensers is the most critical permanent part of all fluorescent lighting installations. Generally speaking, this ballast assembly becomes a much less critical part if adequately designed and suitable provision made for keeping its temperature at a satisfactory minimum. These safe temperatures can best be realized if the ballast is kept as much in the open as possible, that is, when not confined in small space.

It is believed that the user and the industry will be best served if all future installations employ the open ballast location policy. And in this connection an additional opportunity should not be overlooked in considering the appearance of the exposed ballast. This is not a primary problem, but if we take care of the main items of air conditioning ballasts we have a chance to do something for customer appeal at the same time.

Postwar Tourists on Pan-American Will Find Argentina Auto Club

FOUR years of war have long since reduced international travel to the movements of troops and individuals on missions connected with the conflict. Such neutral countries that remain out of the orbit of the war have been finding this period has developed keen interest in travel at home. Thus Argentina's Automobile Club has been busier than ever recently responding to the interest of local tourists in itineraries in their own country and neighboring nations. A new building with ample capacity for all present service to Argentine motorists is also planned to take care of even busier days when the Pan-American Highway is ready for travel from Alaska to Buenos Aires.



A complete ten-story building of modern, functional design is provided throughout with fluorescent lighting. This interesting photograph of the building at night shows the architectural features are appropriate to the mood of Argentina's motor travel enthusiasts.



The troffer lighting in the ground floor lounge heightens the simplicity and tasteful appearance of appointments in this room. The lovely mural decorations, symbolizing the variety of scenic features the motorist may choose in his native land, are well illuminated by the troffer system.

an Highway Ready

The Tourist's Information office has the sleek, smooth lines of a smart motor car of the future. Speaking of the future, note the expectancy of Buenos Aires for the postwar development of international motor travel on the Pan-American Highway. The route of the highway and historic scenes invite the tourist to know the Americas, North, South and Central. Troffer lighting, of course.



This drafting room is just one of many work areas in the building where specialists in one or another of the professions contributing to travel enjoyment and safety, carry on for the motorists of Buenos Aires and Argentina.

Electrical installation was by E. Lix Klett & Co., S.A. Main contractors and technical directors were the architectural firms of Antonio U. Vilar; Sanchez, Lagos y de la Torre; Jorge Bunge; Jacobs, Gimenez y Falomir and Hector C. Morixe.



LIGHTING for EASY SEEING

Paragraphs from an article written originally by Dr. Matthew Luckiesh for "Architectural Record." The full article in eight pages with 11 illustrations is available in reprint form through G-E Lamp Department Sales Division offices.

BEWARE of the limitations of footcandles. They are a measure of the *level of illumination* but they alone do not determine the *brightness*. And brightness is a controlling factor in lighting for comfortable seeing.

Note a white cuff projecting from a dark coat sleeve. Cuff and sleeve differ greatly in brightness even though they receive the same amount of light. If an illuminating engineer talks footcandles and ignores brightness, his approach is inadequate. He belongs to the dark age of yesteryear before certain aspects of the science of seeing were available for specifying light and lighting on a brightness basis for easier seeing. He belongs in one of the dark-walled, dark-floored—and sometimes dark-ceilinged—dungeons along with the shades of those who designed those dark-stained areas.

No practical lighting installation can produce satisfactory seeing conditions if the reflection-factors of great areas of walls, floors and ceilings are low. Even desktops, office equipment, machinery and other things in interiors occupy a large portion of the visual field. Their reflection-factors should not be as low as they generally are.

To provide good seeing conditions the architect must deal with the whole interior, not just the work plane. Science emphasizes the brightness of light sources and backgrounds and brightness-contrasts between the work and its surroundings.

Footcandles and Reflection-Factor

Consider this printed page as a visual task. A white paper reflects about 80 per cent of the incident light. Assume this paper does, and that it is illuminated with 10 footcandles. Paint a portion of this page with black India ink and let it dry. The diffuse reflection-factor of the ink-smear area will be relatively low—say 8 per cent. Now to make it as bright* as

* Brightness is measured in footlamberts. The product of the footcandles and the diffuse reflection-factor results in footlamberts. For example, on a perfectly diffusing white surface having a (theoretical) reflection-factor of 100 per cent, each footcandle of illumination results in a brightness of one footlambert.

the white page the footcandles must be increased ten-fold; that is, to 100 footcandles. But in the latter case the brightness-contrast between the "black" print and the background of low reflection-factor is much lower than that of the black print on white paper. To make up for this, in addition to maintaining the brightness, requires a total of 300 footcandles to maintain the visibility of the one task equal to the other.

The visibility of this printed page—or of any object or task—depends upon the *size* of the critical details, their *contrast* with their immediate background, and the *brightness* of the background or entire task.

In Fig. 1 is shown a living room in which the reflection-factors of the large areas are reasonably high. Even that of the carpet is rather high, for a floor-covering. By balancing the amount of light emitted upward by the open-top portable lamps and the localized light emitted downward, good seeing conditions for any purpose are achieved. There are soft contrasts which provide variety and interest, but they are not harsh.

Compare the conditions illustrated in Fig. 2. Here critical tasks are performed for hours. Regardless of the footcandles in the tasks the



Fig. 1—In the author's living room, large areas—walls, carpet, furnishings—have relatively high reflection factor; upward and downward light is balanced; thus contrasts are subdued.

brightness-contrast between the page of the book, for example, and the rest of the room is tiring. The seeing conditions are very poor for critical seeing. What light can do is illustrated in Fig. 3. By the addition of a proper



Fig. 2—Brightness-contrasts of the work (sewing or reading) and the background cause eyestrain and fatigue. This lighting may be satisfactory for conversation, but not for critical seeing.

floor lamp and by substituting a suitable table lamp the seeing conditions are greatly improved even if no more footcandles illuminate the visual tasks.

Reducing Glare

The old bug-a-boo—preventable glare—aids in emphasizing the desirability of reasonably bright surroundings. Visualize a lighting fixture of bare bulbs seen against dark-stained walls. Whether or not one is fully aware of it, these glaring sources are doing their work. They are distractions which bid for the attention of the eyes and mind. The struggle goes on continually. The tenseness produced has actually been measured. The effect is cumulative, and results not only in localized eye-fatigue but also in fatigues throughout the entire muscular, neural and mental realms of the human being.

If the background against which these glaring sources are seen is increased in reflection-factor (and therefore in brightness) the glare is reduced. Actually the brightness-contrast is reduced and the distraction is proportionately diminished. Hold a lighted bulb at a window in the daytime. It becomes almost glareless against the bright background of sky. This is an extreme case but it demonstrates the undesirability of dark surroundings. Actually the brightness of interior backgrounds cannot be sufficiently increased to eliminate glare from sources as bright as tungsten-filament lamps. But high reflection-factors help materially.

In Fig. 4 is illustrated a modern lighting system with especially designed troffers containing fluorescent lamps. The contrast between these lighting units and the ceiling is not high

and, therefore, the glare is not noticeable. However, this photograph was made in the daytime when some daylight helped to illuminate the ceiling, directly and by reflection from the white work sheets. At night the ceiling is less bright compared with the lighting units, but these troffers do provide good lighting for easy seeing.

Brightness of Surroundings

The most subtle, far-reaching and neglected aspect of lighting for seeing is the brightness-contrast between the actual visual task and its surroundings. The motion picture screen, relatively bright amid almost dark surroundings, is a good example of extremely undesirable seeing conditions. Eyestrain and fatigue of which one is sometimes conscious is commonly attributed to the motion, or flicker, of the picture. Actually these are largely due to the abominable seeing condition—the dark surroundings which constantly bid for attention. The only reason the public has not rebelled against these abominable seeing conditions is that viewing a motion picture is not really critical seeing. If one were reading fine print on the screen for two hours, the strain, tense-



Fig. 3—Seeing conditions are greatly improved by different types of lamps, and more of them, to illuminate the surroundings, even though providing no more light on the visual task.

ness and resulting fatigue would be decidedly obvious—and the dark surroundings would be the chief cause.

Suppose this page is being read on the usual dark-finished desktop in an office. It will commonly be 10 or 15 times as bright as its surroundings.

Now suppose this page is being read at home under the light of a nearby portable lamp.

The page is relatively bright compared with its background or apparent surroundings. Actually the surrounding field may be clothing, or floor-covering of low reflection-factor. Besides, this page is probably receiving more light than the surroundings. At any rate it is not uncommon for a page to be a hundred times brighter than its surrounding field.

Must we have white floor-coverings, white clothes, white desktops, white surroundings in general? Even if these were ideal they would be impractical or "unnatural." All complex practices involve compromises. Furthermore, most visual tasks outside of offices and schools involve reflection-factors averaging far less than those of so-called white papers. In addition to this, a brightness-contrast between the central field (the visual task) and the surroundings of ten to one has been shown to be within reasonable bounds. In other words, the reflection-factors of surroundings might be 20 per cent, 35 per cent, or 50 per cent, or 75 per cent depending upon the particular surface and area involved.

Practical Recommendations

All equipment in offices such as desks, filing cabinets, and machines should have reflection-factors at least between 20 and 30 per cent.



Fig. 4—Brightness-contrast, between lighting units and ceiling is low; glare is minimized. Work sheets happen to be large, thus surroundings of the task are bright and seeing conditions good.

This is a large increase above the reflection-factors of common metal and dark-stained office furniture and the customary black of typewriters and other machines. The walls

should have reflection-factors at least between 35 and 50 per cent. In large rooms where occupants are not as "intimate" with them the reflection-factors may be still higher, actually approaching white. The ceilings should be white or just off the white.

The same applies to classrooms in schools, and everywhere that critical seeing is done for prolonged periods.

In factories one finds much more freedom. Walls can be nearly white, as the ceilings should be. There is no excuse for low reflection-factors of machinery and other large equipment. As in offices these may well have reflection-factors of 20 to 30 per cent. Large sheet metal equipment, ducts and the like, may logically be painted with aluminum paint. Certain surfaces of the machinery or equipment might even be coated with white paint to aid seeing.

Floors in large factories, particularly if they are of cement, can very readily be of high reflection-factor. Such floors have been advocated because they send light upward to under surfaces of machines and work. That is desirable, but the best reason is that they provide better seeing conditions by reducing the contrast between the visual task and its surroundings. The floor is commonly the "surroundings" of a visual task.

Color is Desirable

Everything we see is reducible to two fundamentals—brightness and color. Of these, brightness is generally far more important than color. However, there is no excuse for "penitentiary" grays. Environments even in factories have a right to subdued—grayed—colors. Every factory in every part of the country is worthy of some study as to color. Only one generalization can be made. Work is associated with sweat. It is generally easy for a worker indoors to keep warm; to keep cool is far more common a problem. From this viewpoint a color scheme of grayed greens, particularly bluish greens, has more to commend it than other color schemes. Of course, there are many exceptions.

Suffice it to state here that there is no mysterious magic in color. Its place in the work-world should be determined by the same considerations as elsewhere. Certainly we would soon tire of a brass band. Color should not be used any more garishly where one must work with it than where one lives with it.

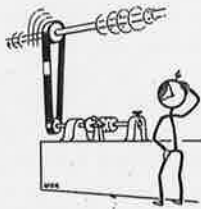
OBSERVATIONS at EYE LEVEL

By J. P. DITCHMAN, Nela Park Engineering Dept.

It is possible for workers sitting at assembly benches along an aisle to be disturbed by people walking up and down the aisle, particularly if they intercept daylight on an operator's work. This traffic has a tendency to make the worker turn to look. It is this reaction of the eye which enables us to keep alive with fast moving traffic today. Motion of a car or any quickly moving object makes the eye turn to see what is coming.

An industrial company in the Middle West had a striking example of this in a mended machine belt. The maintenance man had repaired this by adding a new segment to the old belting. This little segment was very light in color compared to the old belt. It was even more noticeable when the power was turned on and the motor started to turn that this small segment of belting seemed to fly through space. The contrast of this small light piece against the dark background created in effect a small flashing light that was very disturbing to the workers in the vicinity.

A white patch on a rapidly moving belt is an obstacle to comfort on the eye level.



An elderly man who had bought a new I.E.S. study lamp placed it on the table, took off the shade, and faced the lamp while he was reading his newspaper. When questioned as to why he was breaking all rules of good lighting he said that normally he had to hold his paper at a great distance from his eyes to see the print legibly. He discovered that by facing the lamp he was able to focus and see the print legibly at normal reading distance. Although he was unable to adjust his eyes normally to read the paper within focus, by putting a light source directly in front of his eyes the pupils contracted for protection from the glare. Obviously he was trying to cure one evil by means of another. What he really needed was the services of an eyesight specialist.

Special consideration must be given to older employees' eyes. Because of the normal changes in eye accommodation with age more light and higher brightness are required by older eyes to function well. The seeing conditions should also be such as to avoid unnecessary pupil contraction and expansion.

The eye cannot see objects that are too large without extra fixations. It is surprising how little one can see at one time. A simple test is to take two objects, pencils or pens, and hold them in front of a person's eye with the two objects at the same distance. You will notice that the eyes focus first on one object, then on the other, in an effort to determine their length. If the objects are brought closer you will find

The accompanying sketches by W. D. Riddle were created to depict ordinary obstacles to comfort at eye level in the work-world.

that when they are approximately an inch or so apart, then, and only then, can one detect any slight difference in length. This is proof that a person can see only approximately 1 degree at a time—and while focusing only on one thing.

Did you ever notice a barber giving a haircut? You will see that when the barber has trimmed the hair that he will step back from the head to look at it, or he will turn to face the mirror to see if the trim was made symmet-

The careful barber checks his "head" work by taking a new perspective on the job.



rically. He does this because his eyes were too close to see the entire head. He is applying this very simple fundamental of the eye to practical use.

Goggles and safety glasses should be designed so as not to interfere with normal eye functions. For instance, goggles with opaque sides

prevent the eye's periphery from seeing moving objects. This may cause accidents simply because the goggles have interfered with the function of the eyes to protect against motion at wide viewing angles. Operators at grinding wheels or buffing operations should not be allowed to go away from their wheels without first removing their goggles. If goggles must be worn while the operators are moving, they should be of such a design as to admit light into the eye at wide angles of viewing.

Safety derives from comfort in the view a worker has on his job.



The eye always tends to focus on the brightest thing in the line of vision. A very simple test is to close one's eyes and then open them, paying particular attention to the object that first comes into view. It will be noted that in an industrial plant invariably it will be the bare lamps, windows, and lighting fixtures which are seen first. This is most undesirable because the eye must go through a severe accommodation from the brightness of the window or lamp to the job at hand many times an hour.

You have noted that in going into a neighborhood show, particularly one without a lobby, that you are blind upon entering and blind upon leaving. This happens because the eye hasn't had time for accommodation from one brightness to another. So, in a factory one can say that whenever the worker is blinded he loses time, or he loses about the time it takes a man to walk through the lobby. Whenever he looks at a glaring light source in the plant and then looks back at the machine, the eye still must go through this accommodation period. During part of the period the operator is actually blind. If he tries to do any precise work during the blind period he is guessing.

A matte surface viewed at any angle appears bright to the eye, whereas a polished or specular surface, such as a mirror, appears dark to the eye at all angles except those in which the mirror is reflecting some brightness to the eye. Between these two extremes of perfect matte and perfect reflection there are varying degrees of reflection.

Many materials may be considered as types

The character of surfaces on the working plane may include a combination of difficulties if the light source has not been carefully considered.



of mirrors. (So far as the eye is concerned we must remember that when looking at a polished surface at 14 or 15 inches the eye may actually be focusing on the fixture, lamp and ceiling.) Some are perfect, which means they reflect images of things as they are—or they may be imperfect such as a shattered mirror in which the image would be very blurred and distorted and one could not recognize the actual object being imaged in the mirror.

Low-brightness sources simplify many problems involved in reconciling factors on the work level.



Many accidents have been caused by men stumbling over stock piled on the floor as well as in stock bins and boxes. These boxes and bins, if painted with a contrasting color to that of the floor, would be less cause for accidents.

Working surfaces, benches, stockrooms, stock piles, storage of materials—all of these various problems should be studied from the standpoint of creating a proper shape and proper orientation so that light from the overhead system can readily fall in the proper direction on the object to be seen.

This means that stock bins should be cut away at the top and be wider at the bottom to provide for this. Instead of boxes being stacked horizontally they should be stacked so that the light will fall on every one of the boxes, making them easier to see. The interiors of many stock bins should be painted matte white to help diffuse the light.

NEW HORIZONS

In an early issue the "Magazine of Light" will present an article by H. F. Barnes, Manager of the Nela Park Sales Promotion Division, which scans the shapes of some good things on the U. S. postwar horizons.

Voluntary Conservation for Utility Industry*

A Special Task Committee, designated by Mr. J. A. Krug, Director, Office of War Utilities, to develop a program for voluntary conservation of electric energy by all electric consumers, met in Washington July 1 and 2, and again on July 13, 1943. This program is designed to effectuate the electric utility industry's participation in the broad conservation program which has been adopted by the War Production Board to effect savings in critical resources—manpower, material, equipment, and fuel—which are present in domestic, commercial, and industrial use of coal, petroleum products, electricity, gas, water, communications, and transportation. The following outline of program development lists the aims of the industry in the voluntary cooperation on conservation.

Development of Program by Individual Utilities

Each utility will be expected to advise its customers of specific steps which they should take in cooperating in the program. The four fields of electric energy use within which the conservation program should be particularly urged are the commercial, white way street lighting, residential, and industrial fields. These are further broken down below into classes of use.

The term "nighttime" as used in the following numbered subparagraphs may be defined as the period starting at dusk (30 minutes after sunset) and ending at dawn (30 minutes before sunrise).

It should be made clear to customers that the desired savings in lighting should be obtained primarily by the turning off of lights which are not necessary and by replacement at renewal time when lamps are burned out, with lower wattage lamps.

1. Indoor and Outdoor Advertising, Promotional and Display Sign Lighting

- (a) Daytime: Eliminate completely.
- (b) Nighttime. Reduce burning hours so far as practicable but in no case burn for an interval exceeding two hours and only during the period from dusk until 10 p. m., in terms of local time.
- (c) Electric signs necessary for direction or identification of places of public service, such as

public restaurants, public lodging establishments, transportation terminals, etc., may be operated during nighttime but only while the establishment is open for business.

- (d) Reduce lamp wattage of all signs by the maximum practicable amount.

2. Decorative and Ornamental Lighting Including Decorative Floodlighting

- (a) Exterior lighting: Eliminate completely at all times.
- (b) Interior lighting: Eliminate all non-essential lighting, reduce the balance by the maximum practicable amount.

3. Show Window Lighting which does not provide essential interior illumination

- (a) Daytime: Eliminate completely.
- (b) Nighttime: Reduce burning hours so far as practicable but in no case burn for an interval exceeding two hours and only during the period from dusk until 10 p. m., in terms of local time.
- (c) Reduce wattage by maximum practicable amount.

4. Lighting of Marquees (other than advertising signs) and Building Entrances

- (a) Daytime: Eliminate completely.
- (b) Nighttime. Reduce in intensity by maximum practicable amount consistent with public safety consideration.
- (c) Eliminate completely when establishment is not open for business except for amount necessary for protection.

5. Lighting of Outdoor Business Establishments

- (a) Daytime: Eliminate completely.
- (b) Nighttime: Reduce in intensity by maximum practicable amount.
- (c) Eliminate completely when establishment is not open for business except for amount necessary for protection.

6. General Interior Illumination and Show Case Lighting

- (a) Eliminate all non-essential lighting.
- (b) Reduce remainder by the maximum practicable amount consistent with public safety consideration and eyesight conservation.

7. General Conservation by Commercial Customers

- (a) Turn off lights and appliances when not actually needed.
- (b) Eliminate unnecessary use.

8. Air Conditioning

Adopt more moderate margins of reduction in temperature and relative humidity.

9. White Way Street Lighting

Reduce wherever practicable to lower levels consistent with public safety.

10. Residential

- (a) Eliminate all waste in the use of various electric appliances such as refrigerators, radios, ranges, space heaters, water heaters, etc.

(Continued on page 27)

* The report is signed by eleven leading utility executives and a representative of the War Production Board. It has the unanimous approval of the 39 members of the Informal Electric Advisory Committee, all leaders of the utility industry and representing every section of the nation.

Straws in the POSTWAR LIGHTING TREND

By MARY WEBBER, Nela Park Engineering Dept.

THE women of America are being asked to tell the manufacturers of the nation how they would like to have their postwar world equipped in terms of shelter, furnishings, conveniences, and all appurtenances to living. The situation is somewhat analogous to the amazing things that were shown a wise man at the gates of heaven. He was told he might have what he wanted in three easy wishes. So, being a wise man, he chose first to know what he ought to want. The rest was easy after that.

The postwar world is pretty much an untouched piece of future, and most people's thinking on it is not limited by facts and past experience; therefore, it appears to offer rich-

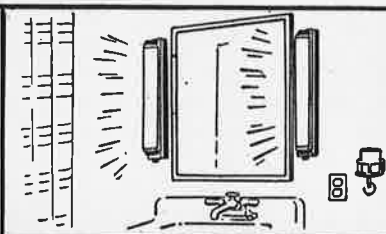
ness absolutely without parallel. In the respect that we find out how we ought to choose we shall give several generations the benefit of a measure of our wisdom.

Perhaps the simplest, surest field for knowing what we want lies in the place our families call home. If we can begin shaping our future out of the strength of character and the imaginative maturity of our wishes for the home, we may have made the wisest beginning. Toward that end the *Small Homes Guide* has started some exploratory suggesting. With respect to the results that developed about lighting improvements in the home, we have some data and some straws in the postwar trend which will



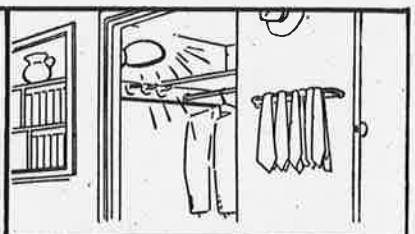
Light that illuminates your doorstep, marks your home for strangers, welcomes friends

1 659 or 84%



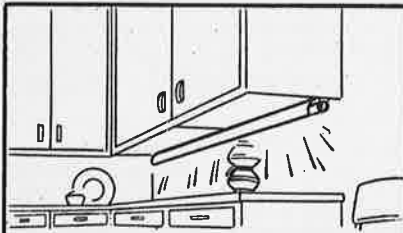
Fluorescent shaving light with its length gives light to fit both short and tall.

2 607 or 78%



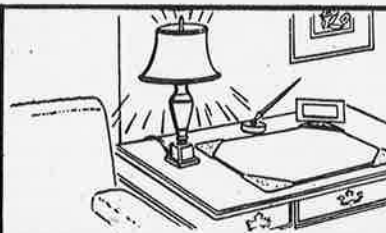
Light to help you find things in closets directs the light where you need it.

3 521 or 67%



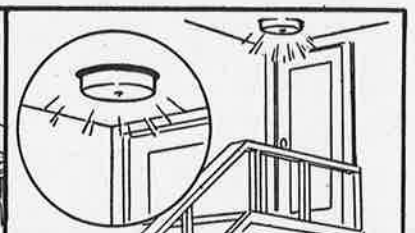
Generous light on work areas make food preparation easier and the whole top usable.

7 385 or 50%



Sight-saving lamps wherever eye work is done ... to make writing or study easier.

8 377 or 49%



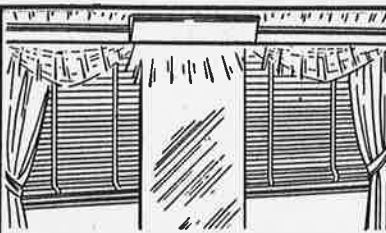
Light that guides and guards your steps up and down the cellar stairs.

9 372 or 48%



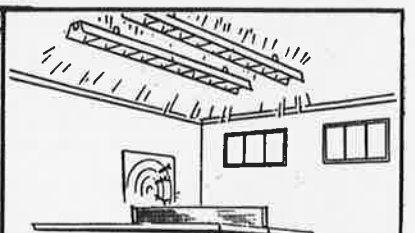
Plenty of light over laundry tubs to help you see dirt and get clothes cleaner.

13 319 or 41%



Even light for full length mirror ... that can let you see how you look by "daylight."

14 317 or 41%



Generous, uniform, diffused light to make games more fun ... cover the whole table top.

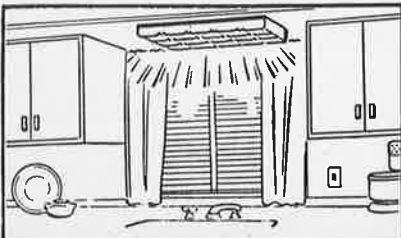
15 298 or 38%

bear further study and work. We have in the *Guide's* editorial experiment a suggestive pattern for aiding prospective home builders to know more about what they "ought to want."

The *Small Homes Guide*, published twice a year by the National Homebuilders' Bureau, Inc., has a circulation of approximately 300,000, and is distributed through lumber dealers and newsstands to prospective builders of small, moderately-priced homes. The Spring Issue, 1943, devoted entirely to the illustration and discussion of possible postwar developments in home design, construction, equipment, and decoration, was treated editorially with persuasive urging of the reader to "Tell Us What Kind of Postwar Home You Want." A simplified tear sheet was included which summarized all the items on which the reader could express his preference or vote. By mid-July there were nearly 1000 (938 to be exact) reader returns. Sixty-one per cent of these said

Essence of the Evidence

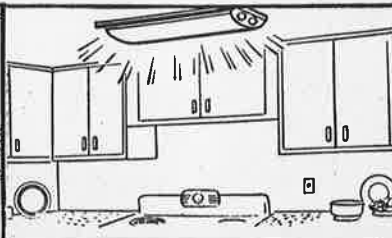
1. Most hopes about lighting refer to single, simple improvements bearing on such commonplace difficulties as finding the right blue dress in the clothes press.
2. People have had too little experience with home lighting refinements to organize their expectations about developments in this line.
3. The initiative in forming an intelligent demand in lighting still rests with industry leaders.
4. The small homeowner may be expected to be conservative, to accept refinements as he becomes convinced of their need.
5. The advances in modern housing coming in the postwar period challenge the creative energies of the leaders in lighting. To share a proportionate part in this powerful influence on the home, improved lighting must develop its progressive advances in harmony with other elements of design.



Light that makes hard-to-see dirt stand out on dishes; helps you wash them clean faster.

4

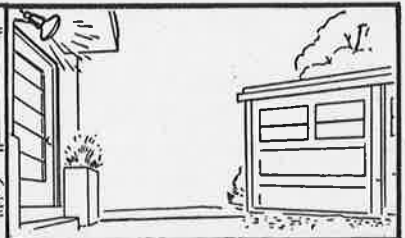
453 or 58%



Center ceiling light for the kitchen, to supplement work area light. "Daylight" if you like.

5

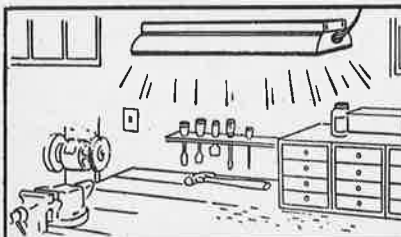
440 or 57%



Light that lets you see the yard at night, or floods your path to the garage.

6

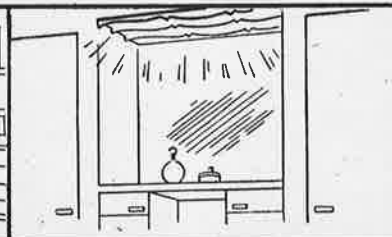
402 or 52%



Light that covers your work bench from end to end, makes it all usable.

10

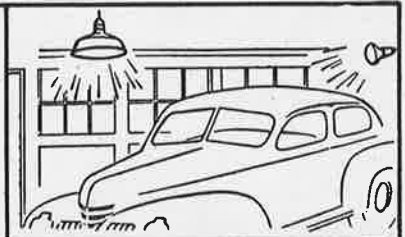
347 or 45%



"Make-up" light that is soft and even. Fluorescent supplies it and it's compact too.

11

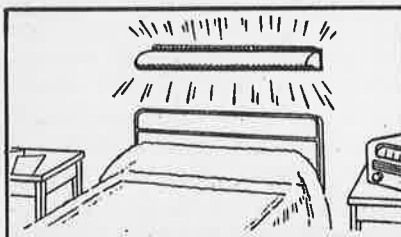
346 or 44%



Light that helps you see under the hood or into the back deck of your car.

12

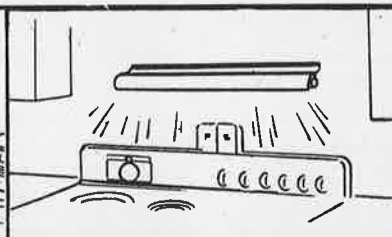
328 or 42%



Good reading light no matter where you put your head, with fluorescent's pleasing light.

16

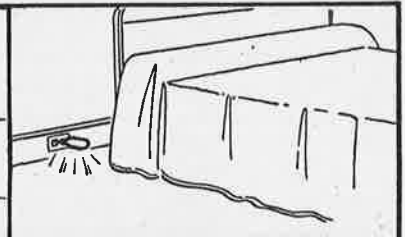
290 or 37%



Smooth light over the whole range top to simplify tasks there.

17

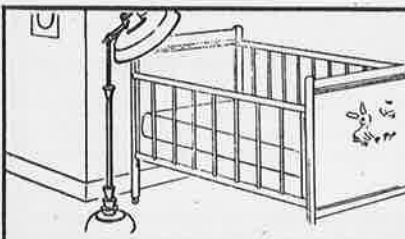
266 or 34%



Low-intensity night light to guard you against stumbling; handy in halls and bathrooms too.

18

253 or 33%



Health-giving ultra-violet light for baby and the whole family. Brings "sunlight" indoors.

19

231 or 30%



Sewing light that is convenient and flexible. Sight-saving swing arm offers one answer.

20

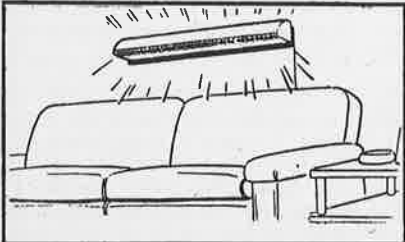
224 or 29%



Pleasing light for the dinette . . . planned for double use with light enough for eye-work.

21

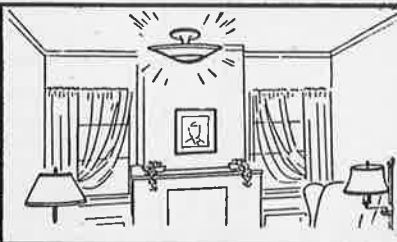
223 or 29%



Reading light for the full length of your davenport . . . thanks to fluorescent.

22

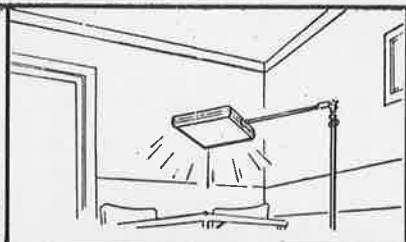
213 or 27%



Cheery, overall light for the living room. Note larger scale center ceiling unit.

23

173 or 22%



Plentiful light for cards or games . . . from a wall-mounted unit that's flexible.

24

151 or 19%

a \$4000 to \$6000 house was contemplated; 14 per cent less than \$4000; and 25 per cent over \$6000. Forty-three per cent indicated they would consider prefabricated construction; 21 per cent said they would not consider it; and the remainder were undecided. The question regarding the style of furniture desired was answered in 94 per cent of the returns with 60 per cent expressing the wish for modern; 30 per cent for traditional; and the remaining 10 per cent preferred to combine the two styles. Of the 938 reader returns, 777 or 83 per cent expressed their wishes on lighting.

The double-page spread on lighting discussed the benefits of good lighting and included very simplified line sketches, with brief user-benefit copy, of 24 specific lighting features, on which the reader was asked "How Many of These Lighting Features Do You Want in Your Future Home?" The average return asked for ten of the features, and the number of times each of the features was mentioned is shown under each of the sketches, which are reprinted here, rearranged in their order of mention. Thus the combination entrance fixture and lighted house number was mentioned by 659 persons; it is not to be interpreted as a first choice since the questionnaire form gave no opportunity to express order of choice. No single feature, you will note, was mentioned by everyone.

Obviously no profound conclusions for a

broad development of future equipment or future promotion can be drawn from this first experimental sampling. Reader returns are being received daily and a later analysis of the total returns may truly be representative of the country's future homeowner's lighting wishes. The expression of these first 777 voters is in the meantime nonetheless worthy of consideration and perhaps provocative of a more realistic analysis of future educational and commercial efforts on the part of the lighting profession.

Unquestionably it is a bit disconcerting to find the age-old recipes of a lighted house number, light at both sides of the mirror, in the closet and over the sink receiving the highest votes for "Must have's" in the dream home after Victory! You'll note, however, that the eight features receiving the greatest mention involved important eye-use locations *common to every home*, and locations which have been notoriously neglected in prewar homes. Ignorance, indifference, or economies in wiring on the part of small home builders have made it almost impossible to obtain lighting in most of these locations. The wise builder will feature wiring outlets for these locations. And the wise equipment manufacturer will note the importance of increasingly effective merchandise to accomplish the best possible lighting results at these much-used areas.

The strong vote for these particular features

may be more expressive of "pet peeves" or resentment against present lack or inadequacy of light at these daily-used spots than of any studied or informed preference for these over the other features sketched. It certainly indicates an encouraging awakening to the function of light as a necessary partner of sight—a rewarding assurance of the effects of the Better-Light—Better-Sight Movement. But with victory, the scope of its educational program must be broadened and its pace quickened to familiarize more homeowners with the newer development in lighting, if Tomorrow's Homes are to enjoy the fuller benefits of Better Lighting.

This first opportunity for the homeowner to "speak up" indicates not only a demand for more specific and satisfactory kitchen lighting but also a demand for fluorescent sources there. Three of the "first eight" features are for the kitchen. The request of 57 per cent of the voters for a "center ceiling light for the kitchen" must point to the desire to change to the newer fluorescent source, since it is well known that more homes had bought kitchen fixtures than any other equipment then recommended.

It should not be overlooked that the light for over the sink received the highest vote of any kitchen feature. Actually in point of use, it is the most needed by the homemaker, and the fact is that no center ceiling fixture will produce satisfactory lighting at local work areas. No matter how efficient or advanced the central fixture may be, its light is cut off by the user at the presently located wall work surfaces. Is the industry's thinking on kitchen unit campaigns so fixed that it cannot encompass the homeowner's expressed needs? Can it not find a practical means of merchandising a kitchen lighting package which recognizes those local lighting requirements that are after all paramount to the attainment of easier seeing?



Voluntary Conservation

(Continued from page 23)

- (b) Turn off lights and appliances when not actually needed.

11. Industrial

Many economies can be achieved in the use of electric energy by industrial plants, both large and small, without adversely affecting volume of production. By proper publicity these economies should be called to industrial plant managers' attention. Utilities should utilize services of their power engineers and other personnel to assist industrial customers to effect more economical use of electric energy, keeping in mind the necessity of maintaining or improving maximum production levels.

Sight-saving lamps, wherever eye work is done, are recognized as a requirement by half the voters. Despite the increasingly discussed fact by some designers that the ideally lighted home of the future will not need portable lamps, they will remain for some years to come the most practical means of obtaining local light and charm in other than utility rooms of the low-cost home. The I.E.S. Specification lamp was the first step toward attaining eyesight-conserving light. It need and should not be considered the last step by any means.

This report is obviously not the last step in judging the help the postwar homeowner is going to give the lighting industry. The numbers of persons involved in this first effort are by no means representative of the 8,500,000 new homeowners in the \$4000 to \$6000 class, which are currently projected for the ten-year period of postwar building. To many industry leaders throughout the country, this small sampling will not seem adequate for appraising local situations. Therefore, the most helpful aspect of this experiment is its challenge to the lighting industry leaders in every locality. The technique for assembling the first straws can be developed and adapted in specific territories. There is little question that equipment manufacturers and lighting specialists would profit greatly from greater attention paid to early returns on polls about consumer attitude. However tentative the first balloting may prove to be in specific localities, we can see already that we are finding corroboration for some things we might have expected. There are probably many helpful hints for the way the lighting industry must plot its future course by studying and refining the methods of polling public opinion. This conclusion pairs with the plain obligation to offer the public the means of knowing what can be provided.

12. Exceptions

The Committee wishes specifically to direct attention to the fact that no effort should be made to curtail necessary military, aviation and police lighting, lighting essential to public health, including eyesight conservation and safety, plant protection, transportation, and production purposes. As outdoor recreational activities are considered essential for wartime morale, the use of electric energy necessary for this purpose should not be discouraged.

Of course, to the extent that economies can be achieved in the above fields without impairment of function, they should be urged and encouraged.

The reasons for the above exceptions should be made clear to the public.

DESIGN GUIDE for Interior Electric Lighting and Wiring for Wartime Construction

IN THE interest of conservation, but without sacrifice of adequate seeing conditions, interior lighting installations shall be incandescent, high-intensity mercury (mercury H) or fluorescent light sources in accordance with the following:

1. Fluorescent lighting* may be used only as follows:
 - a. In production areas only, where fixtures are mounted not higher than 20 feet above the general working plane and where, as an alternate or an addition to incandescent lighting, fluorescent installation is deemed advantageous for exacting visual tasks in the following categories of skilled operations:
 - (1) Assembly, inspection and calibration of instruments, or precision equipment.
 - (2) Operation of fine weaving and cutting machines.
 - (3) Precision tool and metal work of fine detail.
 - (4) Other factory production work with tools or machines, including setting and repair of the machines and inspection incident to such manufacturing processes.
 - (5) Minute color, contour or shade discrimination, or color matching.

* Fluorescent lighting as used herein includes only sources utilizing a fluorescent coating in the production of light.



Discussion by Walter Sturrock, Nela Park Engineering Dept.

A revised copy of the WPB Conservation Division "Design Guide for Interior Electric Lighting and Wiring for Wartime Construction," dated May, 1943, is reprinted above. It is now circulated by the government as a part of a Critical Construction Materials Design Guide, dated June 26.

Please keep in mind that while this is a document of the War Production Board it does not apply to all structures for which lighting is supplied. Buildings under the jurisdiction of various government groups come under the various regulations as follows:

1. *Privately owned new buildings and pri-*

- (6) Floor drafting or similar work in such areas as moulding lofts.
 - b. In offices or other rooms where, because of ceiling conditions or excessive radiant heat, incandescent lighting will be unsatisfactory for such tasks as accounting and auditing, business machine operations and tabulations and drafting and designing.
 - c. In buildings operating mainly for the War Effort and which are supplied in whole or in part from an isolated electric generating plant where installation of fluorescent lighting for essential higher intensities will immediately prevent an addition to such generating capacity.
 - d. In buildings being converted, altered or modernized for war production and which would have to be substantially re-wired if incandescent lighting were installed to obtain the necessary higher intensities.
2. High-intensity mercury lighting (mercury H) may be used only where it is deemed advantageous for such areas and purposes as: high-mounting heights referred to in paragraph 3; plating and pickling rooms and such areas where other light sources would be affected by fumes, or where color correction is necessary with incandescent lighting.

vately owned buildings which are remodeled and/or relighted.

The priority applications to permit the use of materials for these buildings must be submitted to the WPB either locally or in Washington depending upon the size of the job. In either case, the WPB representative who reviews the plans for lighting will presumably base his decision on the limitations given in the WPB "Design Guide for Interior Electric Lighting and Wiring for Wartime Construction."

2. *Buildings financed by the Defense Plant Corporation.*

3. For production areas where fixture-mounting heights are in excess of 20 feet above the working plane, the lighting system shall be incandescent or a combination of incandescent and high-intensity mercury (mercury H) units, except that where work is to be performed on large specular reflecting surfaces such as airplane wings, fluorescent lighting may be employed.
4. Incandescent lighting shall be used in all areas and for all purposes except where, as permitted herein, fluorescent lighting or high-intensity mercury (mercury H) lighting may be used either as an alternate for incandescent lighting or in combination with it.
5. All lighting fixtures and accessories shall be constructed in accordance with the applicable L and M orders of WPB.
6. The maximum average lighting intensities in service shall not exceed the minimum footcandles recommended by the American Recommended Practice of Industrial Lighting, 1942, issued by the Illuminating Engineering Society and approved by the American Standards Association. The attached supplementary table, which is consistent with the I.E.S. publication above, may be taken as illustrative of maximum intensities for the more prominent wartime seeing tasks.
7. Wherever possible, appropriate colors (lighter shades) of non-critical paints or other finishing materials on walls, ceilings, floors, and machines, should be used to improve reflecting surfaces and reduce the wattage of lighting systems.
8. Electric wiring and conduit systems for interior lighting installations shall, in general, conform to the following:
 - a. Such systems shall be designed to utilize minimum amounts of critical materials, such as copper, rubber and steel, without provisions for future extensions, making maximum use throughout of the common neutral wire in both alternating and direct current systems, using as high standard voltage as is consistent with the design of the installation.
 - b. All wiring shall be open wiring on insulators, concealed knob and tube work, or other types of wiring approved for wartime construction in accordance with War Production Board Limitation Order L-225 or other applicable WPB orders or directives.
 - c. Rubber insulation is permitted only on electrical conductors in buildings and, where necessary, in underground installations, but not for open wiring in dry locations or for solidly grounded conductors. The grades of the insulation used shall be in conformity with those listed in the table set forth in War Production Board Order M-15-B-1, List 27, Items (1) to (3) (c), inclusive.
 - d. Conductor sizes, except as may be necessary to secure the proper operating voltage at the lamps, shall be the minimum permitted by the 1940 National Electrical Code, with amendments thereto issued by the Emergency Committee of the National Fire Protection Association. Proper operating lamp voltage shall, as far as possible, be obtained by selecting the proper supply voltage



It is my understanding that the majority and perhaps all of these buildings can be considered as owned by DPC. For this reason the DPC has a keen interest in all the details of design and construction. The design of such buildings is usually handled by architect engineers selected jointly by the DPC and by the manufacturing company who will operate the plant. In general, the WPB Design Guide controls the construction and the lighting of these buildings. In some specific instances, however, where the War Department or the Navy have a very close interest in the product to be made, it is quite apparent that their respective design departments have some influence on certain features regarding the construction

of the building and in this case the War Department or Navy Department limitation orders may govern.

3. *Buildings which are owned and built by the War or Navy Departments.*

The War Department Circular Letter No. 2122 (Nov. 2, 1942) and the Navy Department Circular Letter 304-42 (Oct. 17, 1942) give the specifications and limitations on lighting which will usually govern their respective buildings, but not always, for in some, 50 footcandle installations have been made.

The principal difference between these very brief Army and Navy Munitions Board limitations and those established by WPB is in the

rather than by increasing the conductor sizes.

NOTE: The availability of the various materials employed in lighting and wiring varies from time to time, and the limitations governing their use change accordingly. These limitations are set forth in detail in the Critical Construction Materials Design Guide, the latest issue of which must be consulted when a specific project is being considered, to obtain information on such details then in effect.

SUPPLEMENTARY TABLE OF WAR PRODUCTION LIGHTING INTENSITIES IN MAXIMUM FOOTCANDLES IN SERVICE

Airplane Manufacturing	
Stock Parts—	
Production.....	35
Inspection.....	A*
Parts Manufacturing—	
Welding, Drilling, Riveting and Screw Fastening..	30
Spray Booths.....	30
Sheet Aluminum Layout and Template Work, Shaping and Smoothing of Small Parts for Fuselage, Wing Sections, Cowling, etc.....	A*
Sub-assembly—	
Landing Gear, Fuselage, Wing Sections, Cowling and other large Units.....	30
Final Assembly—	
Placing of Motors, Propellers, Wing Sections and Landing Gear, Mounting of Guns and other large Equipment.....	30
Inspection of Assembled Ship and its equipment..	A*
Machine Tool Repairs.....	A*
Artillery Manufacturing	
Forging and Casting of Gun Barrels and Mounts.....	10
Machining and Grinding of Gun Barrels, Breeches, Mounts and Carriages.....	30
Measuring and Testing of Parts; Barrel Boring, Machining and Assembly of Range Adjusters, and Firing Mechanisms.....	A*
General Assembly.....	35-50



attitude towards fluorescent lighting. The ANMB state that

“Generally all lighting shall be incandescent or when mounting heights are in excess of 24 feet, a combination of incandescent and mercury H types. Because of the criticalness of certain materials, fluorescent lighting is only permissible in industrial or production areas where mounting heights are 24 feet or less . . .”

In comparison the WPB state that

“Interior lighting installations shall be incandescent, high-intensity mercury or fluorescent light sources in accordance with the following: (1) fluorescent lighting may be used only as follows: (a) in production

Tank Manufacturing

Assembly Line.....	40-50
Frame Assembly.....	20
Body Manufacturing—	
Parts.....	20
Assembly.....	20
Finishing and Inspecting.....	A*

Construction—General

Excavation.....	2
Exterior.....	5
Indoor.....	10

Explosives

Hand Furnaces, Boiling Tanks, Stationary Driers, Stationary and Gravity Crystallizers.....	5
Mechanical Furnaces, Generators and Stills, Mechanical Driers, Evaporators, Filtration, Mechanical Crystallizers.....	10
Tanks for Cooking, Extractors, Percolators, Nitrators..	15

Precision War Equipment

Assembly and Adjustment of Range Finders, Binoculars, Periscopes, Timing Equipment, Gun Sights, Electronic Devices, Torpedo Mechanisms, etc.....	A*
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Shell Loading Plants

Fuse and Booster Manufacturing.....	50
Inspecting, Cleaning and Spraying of Shell Forging... ..	30
Loading of Shells, Bombs, Mines and Depth Charges—	
Hand.....	A*
Automatic.....	30
Cleaning and Inspection.....	30
Assembly of Shells, Bombs, Mines and Depth Charges.....	30-40
Packing and Boxing—Storage.....	10

Shipyards

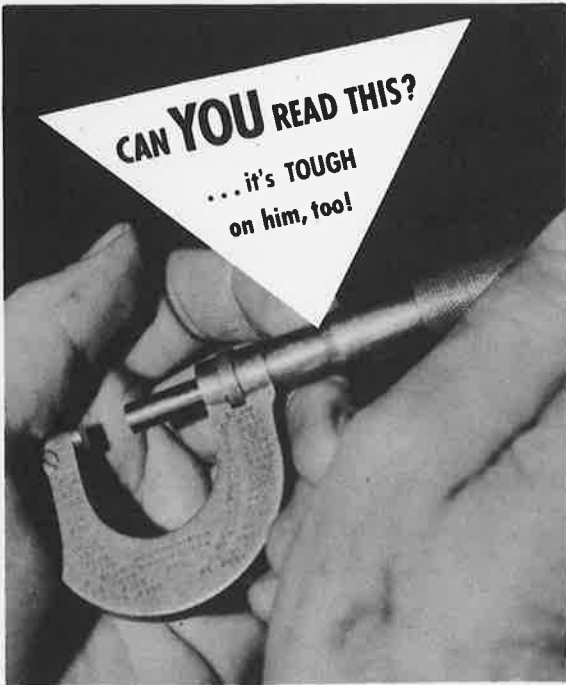
General.....	5
Ways and Fabricating Areas.....	10

A* These are critical, sustained seeing tasks, frequently occurring in small areas or rooms, and call for lighting intensities frequently as high as 50-100 footcandles. To conserve critical materials as well as effect other economies, a combination of general illumination (20 footcandles) with supplementary or localized lighting directly over working surfaces will generally suffice. Good results have been achieved by hanging standard industrial type fixtures 3 to 5 feet directly over the benches or objects, where practicable, or attaching portable type fixtures of lower wattage much closer to the working surfaces.

areas only where the fixtures are mounted not higher than 20 feet above the general working plane and where, as an alternate or an addition to incandescent lighting, fluorescent installation is deemed advantageous for exacting visual tasks, etc. . . .”

It will be noted that WPB permit fluorescent lighting where the fixtures are mounted no higher than 20 feet above the *work plane*, while the ANMB state that fluorescent lighting is permitted if the fixtures are mounted not over 24 feet *above the floor*. WPB restrictions will permit fluorescent lighting for difficult seeing tasks where the mounting height may be as high as 35-40 feet above the floor, because the work plane may be 15-20 feet high as in bomber plants.

3917



PROBLEM: *Night Production*



"I don't know what more we can do to balance the efficiency of all three shifts," growled the Personnel Director of a large warplant. "We've put in portable canteens, music and rest periods to cut down night-shift fatigue. We've added more experienced workers. But we're still off about 15% at night."

What about light, Mr. Director?

You may think that you haven't got a lighting problem. Perhaps you're right . . . yet there may be simple, practical things you can do—especially where critical seeing is involved—that will help reduce fatigue, accidents and waste. And that

doesn't necessarily mean new equipment; *it may be a matter of getting more light out of the equipment you now have.*

That's where the G-E Wartime Lighting Consultant comes in.

He may be able to help *you*—by applying G-E's practical knowledge of lighting for production. If you run a warplant, no matter what size, it costs you nothing to find out.

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BUFFALO . . .	LAFayette 7194 . . .	Genesee Bldg.	MINNEAPOLIS	GRanville 7286 . . .	Northwestern Terminal
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DENVER . . .	MAIn 6141 . . .	Merchandise Mart	PITTSBURGH . . .	FAirfax 7911 . . .	601 E. General Robinson St.
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