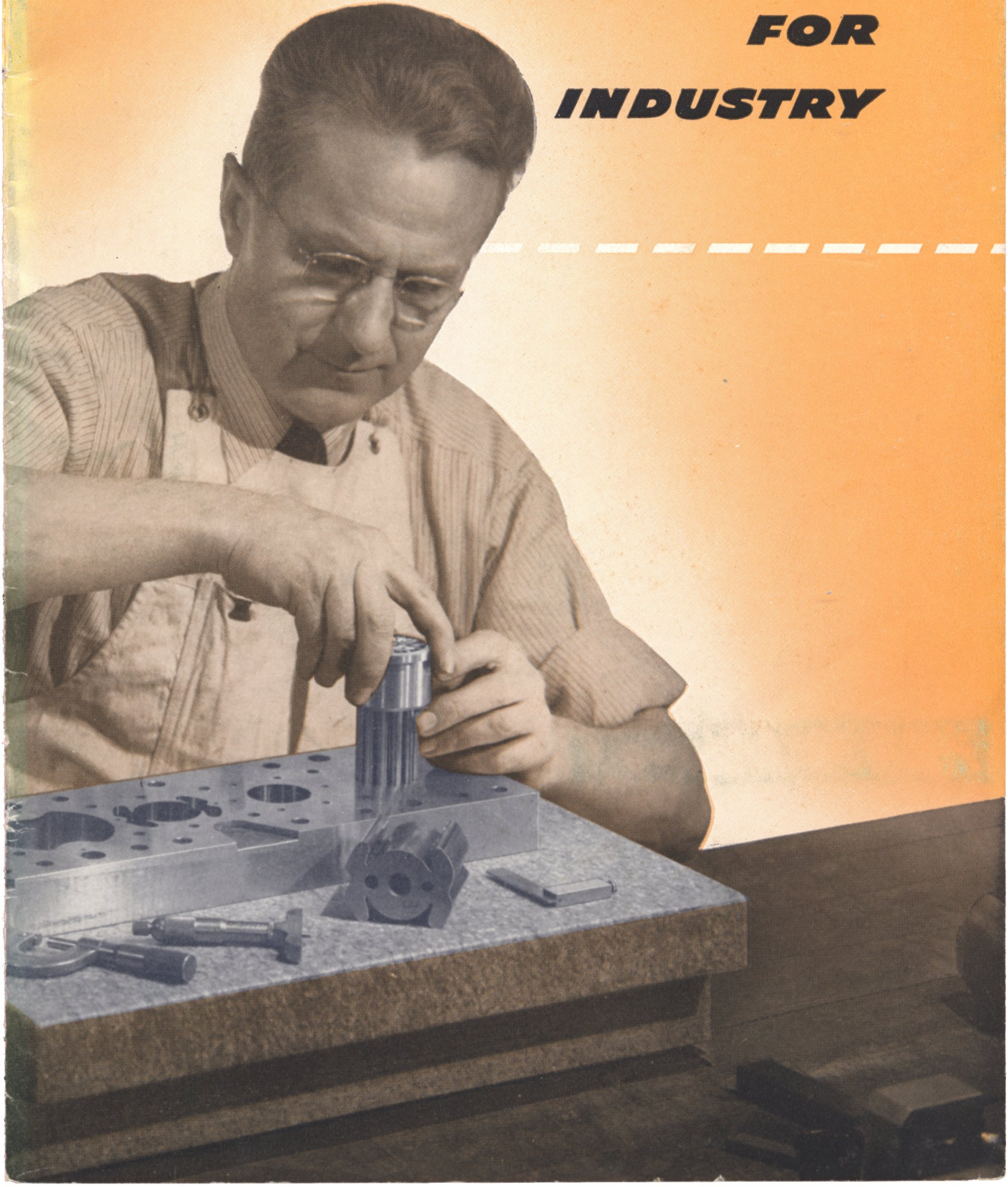
Daylight FOR INDUSTRY



INSULUX Glass Block

Controlled Daylight for Industry

In the past fifteen years much progress has been made in the improvement of seeing conditions in all types of buildings. While most of the original work was in the artificial lighting field, the last ten years have produced a notable improvement in the daylighting field.

American Structural Products Company (a subsidiary of Owens-Illinois Glass Company), in conjunction with the University of Michigan, has played a major role in developing methods and products for the efficient control of daylight.

Outstanding in daylight research has been the development of light-directing prismatic glass block and its application to school classrooms. These light-directing blocks have proved themselves so satisfactory for controlling daylight that they have become the standard "window" in schools throughout the country. While light-directing block are not new to industry, early types having been used as far back as 1939, so much progress has been made in their development in the past two or three years that it was felt an explanation of their performance would be of interest to industrial users. This booklet has been prepared with that need in mind.

A Product of Owens-Illinois Glass Company • Toledo 1, Ohio

Glaring headlights at night make it hard to see while the same lights during the day cause no problem. Narrow windows in out-of-date factories like the one below produce little light, and like headlights at night, are so bright in comparison to surrounding dark walls that workers find it difficult to see. Large glass areas in newer industrial buildings transmit more daylight but must be designed to distribute and control daylight or "glare" will still be a problem.

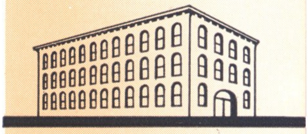
Extremes in Industrial Lighting

Until the invention of the incandescent lamp, very little thought was given to the lighting of industrial buildings. Windows were small and artificial illumination was almost non-existent. The introduction of the incandescent lamp started engineers thinking about better lighting. Originally it was thought that the more light on the work, the better the seeing condition, and the greater efficiency of the worker. This thinking led to the use of higher and higher intensities of artificial illumination, larger and larger windows, until many industrial buildings became virtually sheet glass enclosures. Although these larger glass areas and brighter lamps provided more light on the working surface, they created new seeing problems as serious as the low illumination levels in the 1890 buildings. These problems have, over the years, changed the emphasis in lighting from quantity to quality, with the result that the elimination of "glare" and of high lighting contrasts are now considered highly important for comfortable seeing and efficient production.

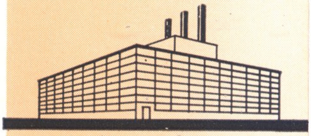
While the new thinking in lighting has had considerable effect on the design or selection of better type industrial lighting fixtures, little attention is being given to the control of daylight in the design of many industrial buildings. Thus, the operators of many plants must resort to make-shift devices, such as the painting or shading of glass areas, to protect the worker from glare and disagreeable high lighting contrasts.

The use of these devices does not improve the quality of the daylight, but merely excludes it and necessitates the use of artificial lighting during practically all of the daylight hours.

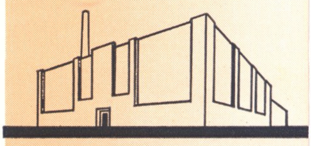
Daylighting problems are an important factor in influencing the designers of some industrial buildings to give up the use of free daylight and build blackout buildings, using costly artificial illumination one-hundred per cent of the time.



Circa 1890—Building with narrow windows—too little light.



Circa 1920—Large window areas with no light control.



Circa 1940—Blackout buildings—no use of free daylight.

high contrast

The worker's face is hard to see because of "glare" from sky.

How Contrasts Affect Seeing

The picture above shows the serious effect high brightness contrasts (glare) can have on one's ability to see, while the picture on the opposite page illustrates how easy seeing is when contrasts are low. Both pictures were taken in the same room at the same time of day and with the same interior illumination. The picture on Page 6 is indistinct because of the extreme difference in brightness between the sky and the worker. The picture on Page 7 is clear because extremes in brightness have been eliminated by drawing the shade to exclude sky glare.

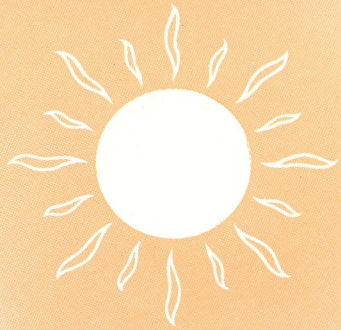
A camera can be adjusted manually to compensate for too little or too much light with no harm done. Our eyes, however, must make their adjustments automatically, quickly, and continually to facilitate correct vision at all times. Even though the eye adjusts itself automatically to varying conditions of illumination and brightness contrast, continual adjustments produce fatigue and eventually damage. In like

The worker's face is easy to see because shade cuts out "glare".

manner, any sustained visual adjustment to brightness contrast conditions far above the optimum level (approximately 3 to 1) will bring with it gradual decrease of visual acuity and a sense of nervous and physical exhaustion at the completion of a day's work.

For older workers the importance of proper lighting, both natural and artificial, is even greater. Speed and degree of visual accommodation to glare conditions decrease sharply with age, and in industries employing a high percentage of older skilled workers, the loss of efficiency resulting from uncorrected glare conditions will be larger.

Since acuity and ease of seeing bear a close relation to quality of work, it has become a cardinal principle of progressive management to make industrial seeing conditions as comfortable as possible. In actual industrial cases where extreme glare conditions have been corrected, accident rates, absenteeism, and reported cases of eyestrain have shown a sharp drop. It follows, then, that fullest use of daylight in industry is only possible when some method of brightness control is included in the daylighting scheme.



Standards for Good Lighting

In the course of a twenty-seven year study, the Committee on Daylighting of the Illuminating Engineering Society has established standards of performance for various seeing tasks. These standards establish illumination levels and maximum allowable brightness ratios between working surfaces, light sources, and the more remote parts of the room.

These standards require that the lighting fixture shall not be more than twenty times as bright as the ceiling above it, and that the window shall not be more than twenty times as bright as the surface adjacent to it. Light levels should be varied according to task, but brightness ratios between source and adjacent surface should not exceed the 20 to 1 standard in industrial or office buildings, where performance is dependent upon good seeing.

A Glare Test

Here is an experiment you can try to prove how extremes in brightness make seeing difficult. Open the flap. Hold the book with the flap open at arm's length against the window. Note that you cannot read the printing silhouetted against the bright sky, but that you can read the printing shielded from the sky by the book. Seeing is easy with a moderate, uniform light, but is difficult under extreme contrasts.

Seeing Conditions in Many Factories

The building above is typical of thousands of factory interiors where illumination levels fall far below standard, and extreme brightness contrasts (glare) go uncorrected.

In this example, the unshaded window has a brightness of 2024 while the surface immediately adjacent has a brightness of 20. This is a light source-to-adjacent surface brightness ratio more than five times as great as the allowable maximum of 20 to 1, established by the Illuminating Engineering Society. For the worker, the effect of these extreme contrasts is a constant difficulty in properly seeing the work at hand as well as the necessity for complete visual readjustment to his work when glancing from the window to his task. Older workers find this readjustment slower and more difficult.

The brightness figures shown on the photograph are foot-lamberts. The measurements were taken on an overcast day. If taken on a bright day, extremes would have been greater and seeing conditions worse.

A worker seated in poor light tilts his head so that his brow shields his eyes.

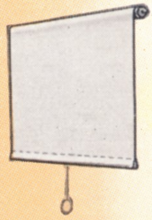
The same worker seated in good light sits erect, his body free from stress and free to do his work.

Light, Posture, and Fatigue

Studies by independent investigators indicate a close relationship between lighting, seeing, and posture. Where task illumination is insufficient, the worker will attempt to remedy the deficiency by bringing his eyes closer to the work. The existence of glare sources or high brightness contrasts within the visual field will cause the worker to assume an unnatural and uncomfortable position in order to protect his vision. Either or both of these illumination conditions force a posture adjustment largely involuntary on the worker's part. The worker does not realize his posture is unnatural until muscular tension causes acute physical discomfort. Such discomfort can result in poor work and loss of production. The studies also show that a worker seated in a room lighted according to best standards uses his energy to perform the task at hand, and does not have to waste his energy in trying to adjust his body to compensate for inequality in lighting.

Methods for Daylight Control

Lighting authorities say that natural daylight produces the best seeing environment. While conditions in many factories do not permit operation by daylight alone, many designers of industrial buildings say that daylight should be utilized to the fullest extent, provided adequate methods for controlling direct sunlight can be incorporated into the design of the building:

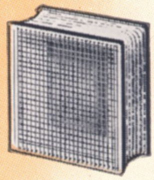


SHADES Adjustable shades are among the most commonly used devices for daylight control. Surveys show that shades are not adjusted with respect to varying exterior illumination. Their use tends to exclude daylight and require a more extensive use of artificial illumination. Their high initial cost and high cost of maintenance usually limit their use to office buildings and a few manufacturing operations.

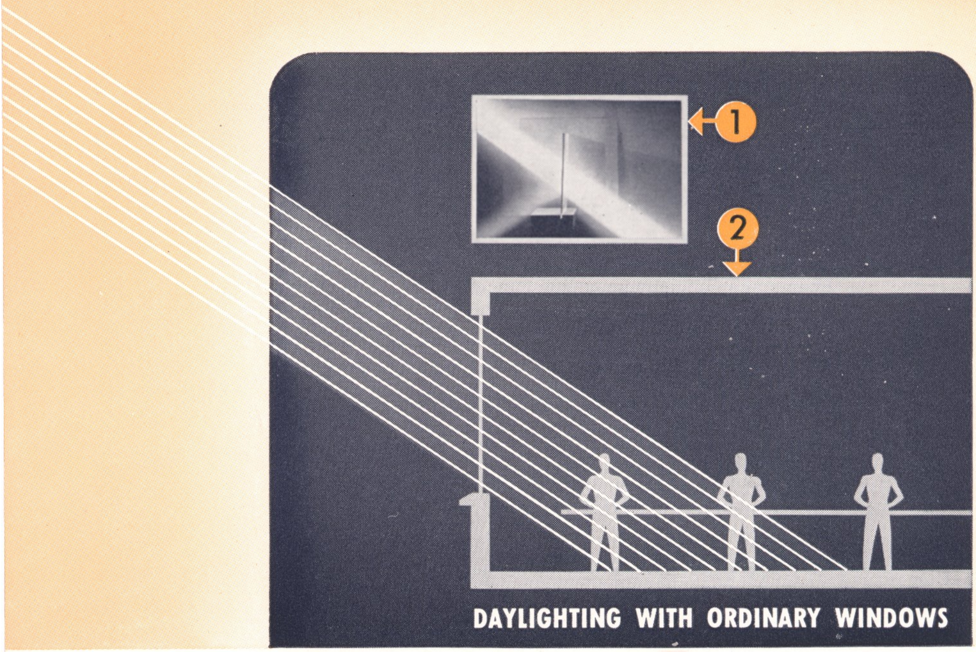
GLASS DESIGN Various figured glasses are used in industrial buildings in an effort to control light. While some designs are more effective than others, the patterns available today do not adequately control light on direct sun exposures.

Color introduced in glass offers opportunity for light control, but sufficient coloration to handle direct sunlight will seriously reduce the ability of the glass to transmit light adequately.

GLASS PAINTS Glass paints to reduce brightness represent an emergency method of brightness control where none was provided in the original design. While such paints reduce sky brightness, they do so at the expense of light transmission, and artificial illumination must be used. Glass once painted presents a never-ending maintenance problem and results in an unsightly appearance.

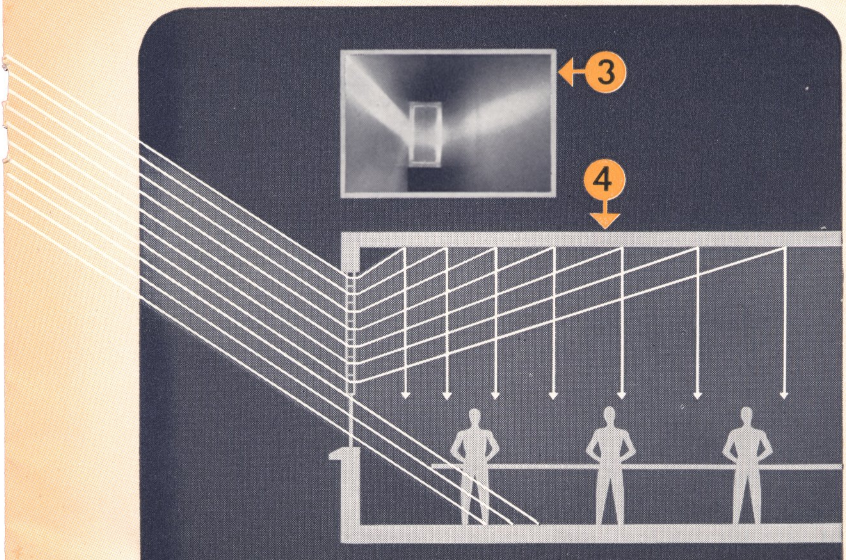


GLASS BLOCK Glass block was introduced to the industrial building field in the late thirties. It is widely accepted because of its superior insulation qualities, and lower maintenance costs. The fact that glass block is hollow, and offers four surfaces on which light controlling designs are impressed, gives the manufacturer a greater opportunity to produce a more efficient light-controlling medium than is possible with sheet glass.



How Daylight Is Transmitted

The diagram and light beam pictures on these pages show how light is transmitted through clear glass and through light-directing glass block. The photograph (1) on this page shows how a beam of light is transmitted through a sheet of clear window glass. The glass has little effect on the light—it does not diffuse it, or change its direction. The drawing (2) shows how clear glass admits light to a building. The direct rays from the sun strike the floor, machines, and the workers seated near the outside wall. Dark clothing and machines make poor light-reflecting surfaces, so a substantial part of the light is absorbed, and not reflected back into the room. More serious, the workers seated near the outside wall are faced with uncomfortable brightness on their work.



DAYLIGHTING WITH LIGHT-DIRECTING GLASS BLOCK

The photograph (3) on this page shows how a beam of light is transmitted through a light-directing glass block. The two sets of unlike prisms on the two inside faces of the block change the direction of the beam, turning it upward.

The diagram (4) shows how the glass blocks light a room. The blocks, used above a clear vision strip, direct the light to the ceiling, which acts as a huge reflector, sending it down onto the work areas. (Where continuous vision and ventilation are not required a light-diffusing block may be used below the light-directing block to replace the vision strip.) Because the light-directing glass block turns the major portion of the light upward above the workers' heads, its brightness is low when viewed from below eye level. Light is distributed deep into the room and shades over the glass block panel are not needed.

Remodeling for Good Seeing

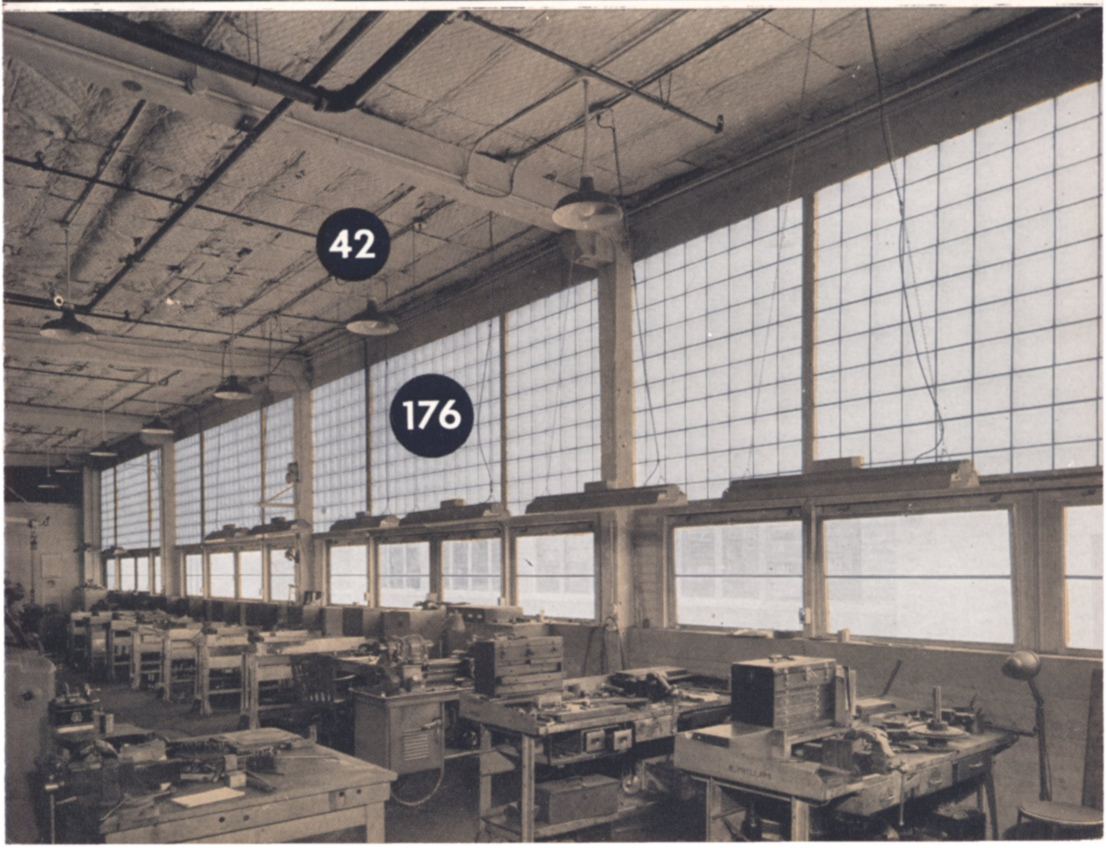
The top picture on the opposite page shows the interior of a 20 year old industrial building and the lower picture a recent addition to the same building.

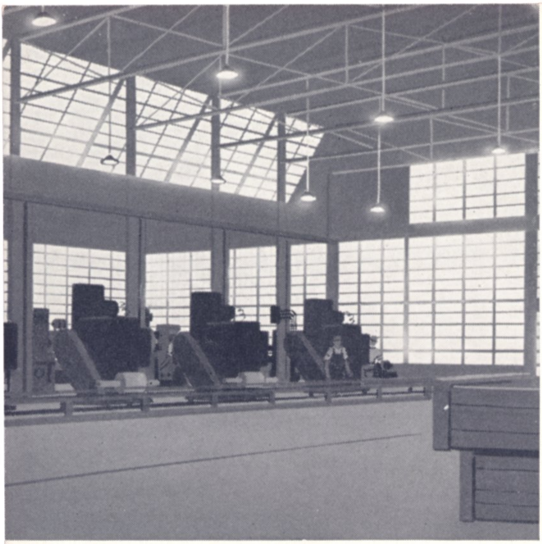
In the new addition everything within the limitations of remodeling was done to make the new plant as efficient as possible. Effort was made to provide a pleasant interior for the worker and to give him the best possible seeing condition. When the preliminary studies were made for the new addition architects and owners decided to make the greatest possible use of daylight, and knowing that the use of daylight and daylight control cannot be separated, the decision was made to use a panel of light-directing glass block above windows for vision and ventilation.

In the original building sources of glare exist and contrasts are extremely high. The figures on the picture show that the sky has a brightness of 2024 whereas the surface adjacent to it has a brightness of 20, a ratio of more than 100 to 1, five times greater than that considered acceptable by lighting standards. A worker in this room, glancing up from his work in the general direction of the window, is faced with the same difficulty that the camera had "seeing" the workman before the unshaded window on Page 6.

The new addition meets the modern standards for good daylighting. Glare is no problem, light is more uniform, no shades, paint or other light-controlling devices are required for the glass block panel. The panel has a brightness of only 176 and the surface near it a brightness of 42, a ratio of 4 to 1, well within the 20 to 1 standard. A worker seated in this room "sees" as easily as did the camera in taking the picture of the worker standing in front of the shaded window on Page 6. Had this been a completely new building and the designer not restricted by design of the original building, lighting conditions could have been further improved. A smoother and more reflective ceiling might have been incorporated in the design.


20
2024


42
176

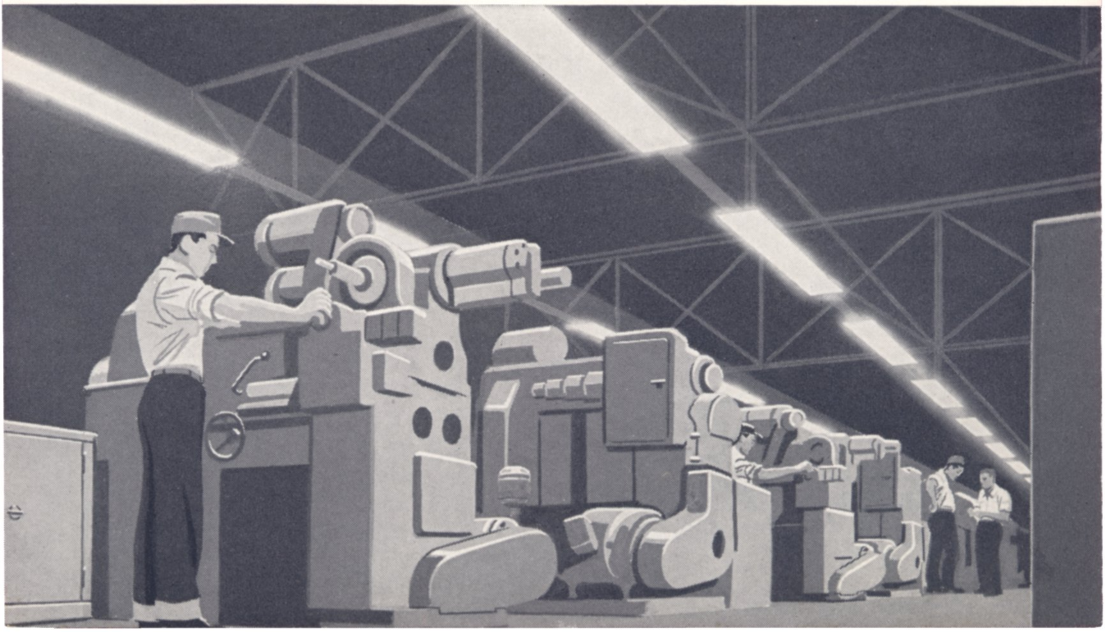


All Window Factory

Large glass areas on sun exposures in factories where close work is being done, such as in offices, precision manufacturing, and product and machine inspection require a supplementary method of light control if worker efficiency and accuracy is to be maintained. Devices used for glare reduction and daylight control, such as shading and painting of glass, are merely light reducers and cause high maintenance expense.

Blackout Factory

While this type of building does eliminate the problem of sun and sky glare, experience indicates that it creates other and more serious problems for both management and worker. The most important to management is cost. Buildings of this type must be completely air-conditioned and artificially lighted. From the viewpoint of both worker and management, buildings from which daylight is excluded are cheerless places to work, causing high labor turnover and loss of efficiency. If artificial light is the only source of illumination throughout the working day, high-quality, high-priced artificial lighting fixtures must be used to meet the seeing standards set by the Illuminating Engineering Society.



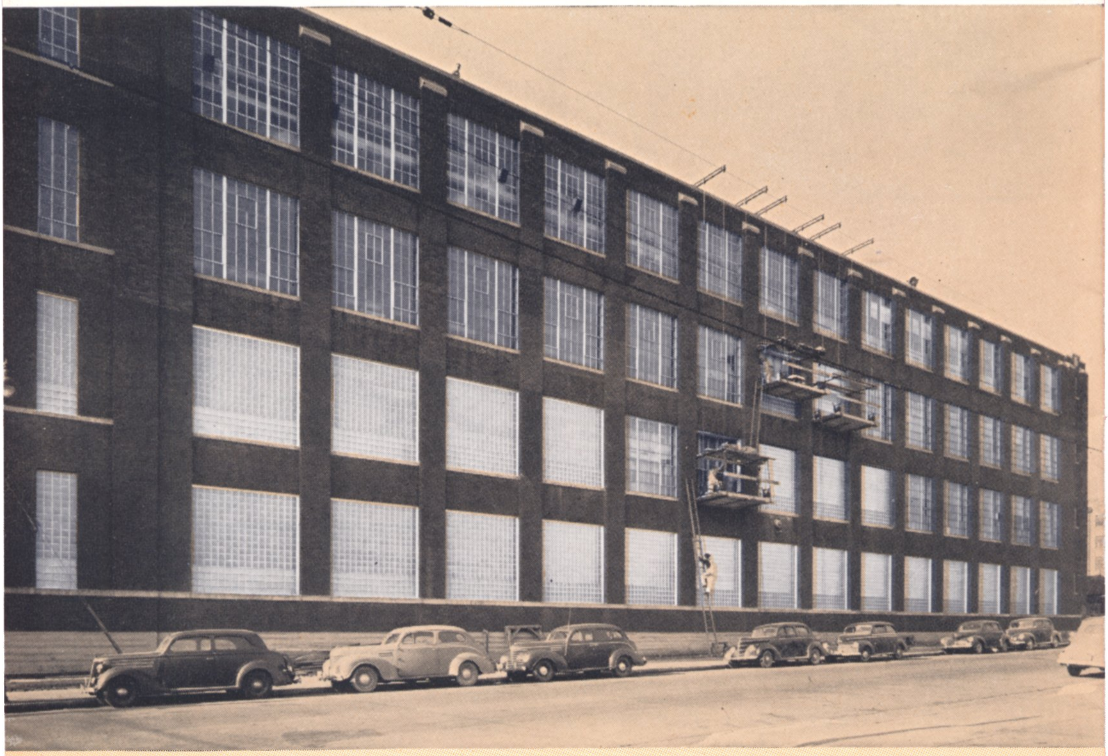
The Daylight-Engineered Factory

The Daylight-Engineered factory puts controlled daylight to work for more efficient production and reduced worker fatigue. Insulux Fenestration Systems (light-directing glass block for daylight control installed above horizontal transparent windows) meet every requirement of good daylighting—low surface brightness, low brightness contrasts, excellent light distribution, and adequate allowance for vision and ventilation.

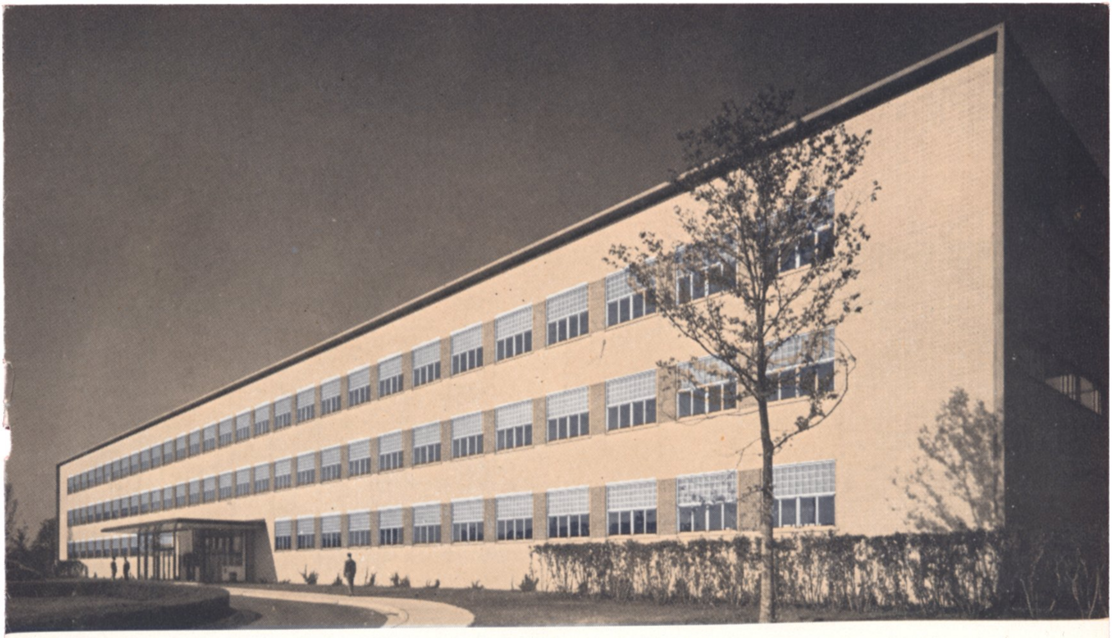
Insulux light-directing glass block is designed so that the major portion of the light is directed upward at an angle sufficiently acute to penetrate the building interior to a considerable depth, thus providing adequate daylight illumination for buildings of moderate depth during many working hours. (*Continued on Page 18*)

Although advocates of blackout buildings may say that the large area manufacturing plant cannot be adequately lighted by daylight alone without the use of monitors, perimeter daylighting such as provided by the use of Insulux Fenestration has three advantages to offer:

1. Adequate glare-free daylight illumination in areas adjacent to exterior walls (penetration depends upon ceiling height).
2. The upward beam of light emerging from the light-directing block provides enough supplementary illumination to light ceilings in areas at considerable distance from outside walls, thus reducing contrasts between low-cost, direct-light luminaires and ceilings to acceptable standards.
3. Insulux Fenestration makes a glare-free daylight wall which helps to create a pleasant, cheerful place to work, a necessity to modern industry if full worker efficiency and maximum production are to be attained.



Davenport Hosiery Mills, Chattanooga, Tennessee



Standard Oil Company of Indiana, Whiting, Indiana
Architects: Holabird & Root & Burgee, Chicago

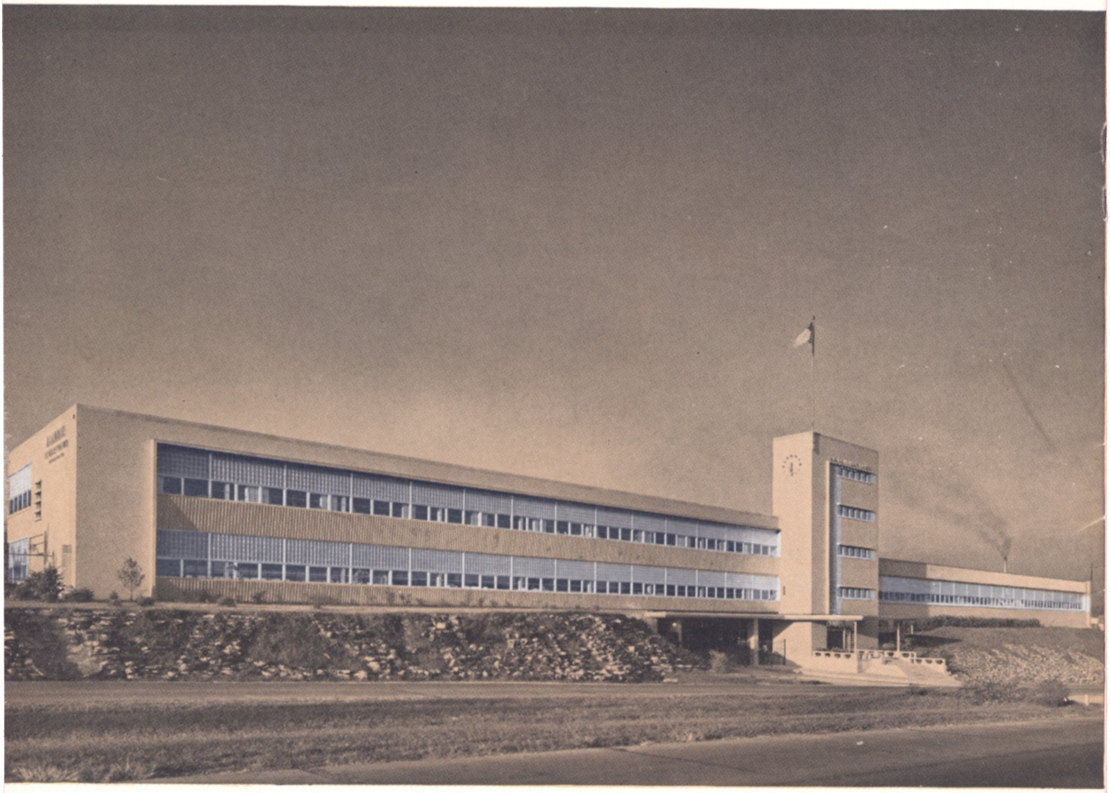
Office Buildings

Seeing conditions in industrial office buildings—owing to the nature of the work to be done—are even more critical than in industrial buildings. Here, the use of high-quality natural light is more important than in manufacturing areas. Fortunately the very nature of the average industrial office building—its limited depth, its better interior reflecting surfaces—offers a greater opportunity for efficient use of daylight than the larger and deeper factory. Here Insulux Fenestration (light-directing block above clear glass) offers maximum use of daylight, elimination of objectionable glare, vision to the outside, natural ventilation and elimination of shades. Where shades over the vision strip are needed they may be used with little or no effect on room illumination.

←Modernization

Many owners of existing industrial buildings have taken advantage of the light-controlling characteristics of glass block in replacement of worn-out windows. In the building at left maximum insulation and elimination of metal are more important than vision to the outside, and a light-diffusing block, design No. 365 was used below the light-directing type to replace the vision strip. In similar installations inset windows have been used to provide vision and ventilation.

Aladdin Industries, Nashville, Tennessee
Architects: Spencer J. Warwick & Associates, Cincinnati



Principles for the Most Efficient Use of Insulux Glass Block

Light-controlling Insulux Glass Block is made in two types—the prismatic light-directing type Design No. 63 is available in both the 8″ square block (No. 363) and the 12″ square block (No. 463)—the light-diffusing type Design No. 65 is also available in 8″ and 12″ sizes (Nos. 365 and 465).

Both types of glass block are equipped with azimuth-correcting exterior vertical ribs, an exclusive Insulux feature which enables these blocks to transmit light more uniformly for a greater variety of sun positions than other blocks and makes them especially efficient in transmitting light from "glancing" sun angles. Various combinations of blocks and windows may be made to answer most industrial lighting and ventilating requirements. (See page 8.) For most efficient performance of light-controlling blocks the following rules for their use should be observed:

1. Light-directing types Nos. 363 and 463 should always be used above eye level (approximately 6′0″ above floor).

2. Light-diffusing types 365 and 465 are similar in appearance to the light-directing types and may be used below eye level in combination with the 63 design or in panels by themselves where lower levels of illumination are satisfactory.

3. Ceilings (including trusses and beams) and upper walls should be painted in light colors, preferably white. Some roof deck materials such as Kaylo Roof Tile have high reflectivities and require no paintings.

4. Fenestration should be as nearly continuous as practicable, with piers cut to a minimum. Heads of panels should be as high as practicable above the floor for maximum penetration of light into the building.

5. Artificial lighting fixtures near outside walls should be switched independently for conservation of power when exterior illumination conditions permit the use of daylight alone.

for Industrial Construction

In preparing the above suggestions technical details such as construction methods and illumination data were omitted. This information is available and can be obtained on request. American Structural Products Company also maintains an engineering staff and an illumination laboratory to supply architects and engineers with technical data. Such information can be secured by writing the Daylighting Laboratory, American Structural Products Company, Toledo 1, Ohio.

Additional Advantages of INSULUX GLASS BLOCK

While the subject of this booklet is daylight control, and Insulux light-directing glass block, this material has other basic advantages. It is manufactured in three sizes and a wide variety of face designs. The No. 63 and the No. 65 designs offer maximum daylight control but all glass block affords high insulation value, resistance to corrosion, sound reduction, and extremely low maintenance cost.

1 EASE OF MAINTENANCE

The thousands of square feet of fenestration area in today's industrial plants constitute a substantial drain on plant maintenance accounts. Panels of Insulux Glass Block cut window maintenance by as much as 80 per cent. They need no painting, reputtying, or reglazing. Washings are infrequent, usually little more than a matter of hosing down.

2 RESISTANCE TO CORROSION

Pickling plants, electroplating units, chemical factories, and others face the troublesome problem of corrosive vapors which cause tremendous damage to exposed metal fittings. Panels of Insulux Glass Block, containing no exposed metal, are ideally suited to such operations. Glass and cement-lime mortar, the two chief panel elements, are resistant to nearly all industrial acids and caustics.

3 RESISTANCE TO HUMIDITY

Slower-acting, but just as effective a destroyer of industrial fenestration, is the high-humidity condition occurring in paper mills, textile mills, food processing plants, and other operations requiring the use of free steam or water. The extremely low condensation point of Insulux Glass Block coupled with imperviousness to humidity guarantees indefinite fenestration life under these conditions.

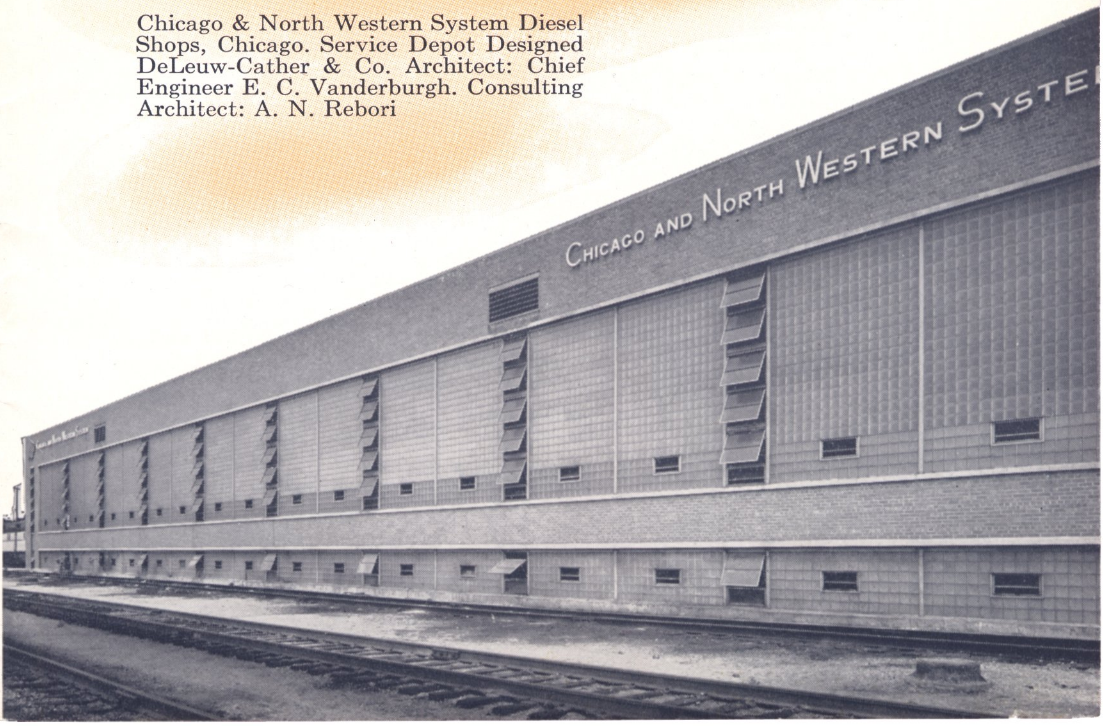
4 INSULATION

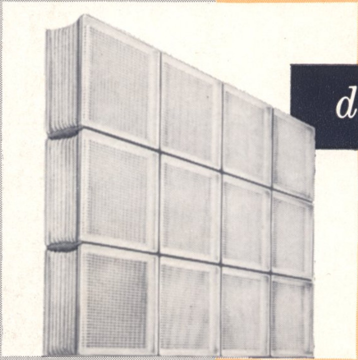
With an insulation value roughly equivalent to that of an eight-inch brick wall and far superior to that of single-glazed windows, panels of Insulux Glass Block effect important fuel savings, particularly in temperate and cold weather climates. Conversely, in the warmer months this same insulation value contributes toward cooler interiors, reduces loads on air-conditioning systems.

5 PERMANENCE

Once installed, panels of Insulux Glass Block become an integral part of the industrial building, sealing it against moisture, weather, and infiltration. Sturdy enough to withstand blows that shatter ordinary windows and impervious to nearly all the elements which limit the life of ordinary fenestration, panels of Insulux Glass Block can be counted upon for indefinite and trouble-free service.

Chicago & North Western System Diesel Shops, Chicago. Service Depot Designed DeLeuw-Cather & Co. Architect: Chief Engineer E. C. Vanderburgh. Consulting Architect: A. N. Rebori





district offices

Atlanta, Georgia
1010 Whitehead Building......CYpress 7801

Boston, Massachusetts
1206 Statler Office Building......HUbbard 2-9085

Buffalo, New York
1542 Marine Trust Building......WAshington 6-7867

Chicago, Illinois
1555 LaSalle-Wacker Building......STate 2-3120

Houston, Texas
River Oaks Building, 5, Rm. 2......JUstin 3737

Kansas City, Missouri
1120 Board of Trade Building......HArrison 1686

Los Angeles, California
3465 West Eighth Street......DUnkirk 2-3475

Milwaukee, Wisconsin
639 Empire Building......MArquette 8-0760

Minneapolis, Minnesota
760 Rand Tower......ATlantic 2217

New York City, New York
604 Chrysler Building......MUrray Hill 6-4300

Philadelphia, Pennsylvania
1931 P. S. F. S. Building......WAlnut 2-0432

Pittsburgh, Pennsylvania
1808 Clark Building......EXpress 1-1467

St. Louis, Missouri
1503 Continental Building......NEwstead 9682

Seattle, Washington
1482 Dexter-Horton Building......SEneca 0775

Toledo, Ohio
Ohio Building......FAirfax 6543

Washington, D. C.
1627 "K" Street NW......NAtional 8412

AMERICAN STRUCTURAL PRODUCTS COMPANY

Subsidiary of Owens-Illinois Glass Company