Probably the single most important factor in the purchase of an aircraft is the financial arrangements made with the manufacturer. Many factors are involved and many include the negotiated price, loan provisions, trade-in considerations, buy-back agreements, guarantees, and concession services.

Concessions may include spare parts agreements, product support, airport planning assistance, retrofit with higher technology equipment, etc. Douglas has recently been able to work out satisfactory lease/purchase agreement with some airlines instead of outright purchases. The company has found these arrangements to be beneficial to both parties.

Airport and aircraft noise is becoming an increasingly important factor for airlines to consider. Some domestic airports will only allow newer, quieter aircraft, such as Douglas' MD-80, to use their facilities. The John Wayne and Burbank Airports in California are examples.

Often, airline image or a country's prestige or politics will dictate the purchase of certain aircraft irrespective of an air carrier's needs.

Outlook

What is going to happen in the future? It is not at all clear yet where the air transportation industry is headed. Because of deregulation, the competition between airlines is extremely severe and while larger existing airlines are experiencing financial problems, new small ones seem to be created almost daily. As a result, trip and seat-mile costs are taking on a new significance for some airlines while others purchase old, less fuel-efficient models. There is no doubt that some airlines will not be able to survive. Airport requirements are going to become more important in the future. As aircraft are changed to improve their efficiency, longer wingspans may influence runway, taxiway, apron, and gate clearance requirements. Noise considerations and operating slots may also limit aircraft selection.

Conclusion

In the near term, airline efforts to increase profits will determine the size of aircraft they pruchase. Only the larger, more sophisticated airlines will be able to include detailed economic airport terminal considerations in their aircraft selection analysis. Airlines will consider other alternatives at length before accepting an increase in direct operating cost to alleviate aircraft terminal problems.

APRON AND RAMP LIGHTING AT CHICAGO-O'HARE INTERNATIONAL AIRPORT

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Abstract

The apron and ramp lighting at Chicago-O'Hare International Airport, which served the concourse aprons and service areas for twenty years, has become obsolete due to the traffic of larger aircraft and the need for more complex ground service operations. The low-mounted fluorescent system produces a limited lighting pattern and has become a burden in maintenance service costs. A new lighting system now being installed will overcome these inadequacies and satisfy O'Hare's modern-day visibility requirements for pilots and ground crews.

High-mounted 1000 kw. high-pressure sodium cut-off luminaires are supplemented with low-mounted 150 kw. high-pressure sodium units.

Introduction

The apron and ramp lighting at Chicago's O'Hare Airport, which served the concourse aprons and service areas for twenty years, has outlived its usefulness. Over the years, as larger aircraft, heavier traffic, and greater need for more complex ground service operations developed, the original lighting system has become obsolete due to high operating costs and inadequate performance.

The present system consists of fluorescent luminaires mounted on davit-type poles located on the rooftops of the concourse buildings. Each luminaire contains four 72-inch long, very high output fluorescent lamps, enclosed in a wraparound acrylic lens. The luminaire is inclined at 50° above the horizontal and is approximately 36 feet above the apron.

The illumination levels are very low and fall off rapidly to 0.2 footcandles at a distance of only 100 feet away from the concourse buildings. (See Figure 1) These lighting levels are further reduced during Chicago's severe winter weather due to the effects of low temperatures on fluorescent lumen output.

Another objection has been the direct glare to pilots who approach the terminal gate area with jumbo jets with cockpit eye level at the fixture mounting height. (See Figure 2) There is no directional control of the light output; and the low mounting height, compared with the larger airplanes, causes shadows in the service areas where the visual tasks include baggage handling, refueling, and access to power pit connections.

Extensive fixture maintenance has been necessary due to the dimensional instability of the gasket-mating surfaces with the plastic lenses. Leaks at the ends of the fixtures collect dirt and insects, which results in substantial reduction of luminaire efficiency. Rain and snow enter the fixture, short-circuiting and destroying lamp sockets, ballasts, and other components. Frequent servicing must be performed by a full crew of electricians using special aerial trucks that must occupy the apron areas. This interferes with ground service operations and the aircraft movement.

Proposed Lighting System

A "Lighting Study of Aprons and Ramps" was commissioned to investigate new technological developments, to increase efficiency of the ground service operations, and to enhance safety.

During the course of the study, numerous other airport lighting arrangements, both in the United States and abroad, were examined, and a literature search was made.

The study suggested

(a) relighting program for replacement of the rooftop fluorescent lighting that uses the latest state of the art in lighting design to provide adequate illumination, and

(b) prototype, or experimental, installation of three sets of poles and luminaries to be evaluated prior to proceeding with the final design of the construction contract documents (this would insure acceptable solutions to all the diverse requirements for the final design).

Figure 1. Area of work for apron and ramp lighting and its relationship to control tower line of sight visibility to runways and taxiways, Chicago-O'Hare International Airport.

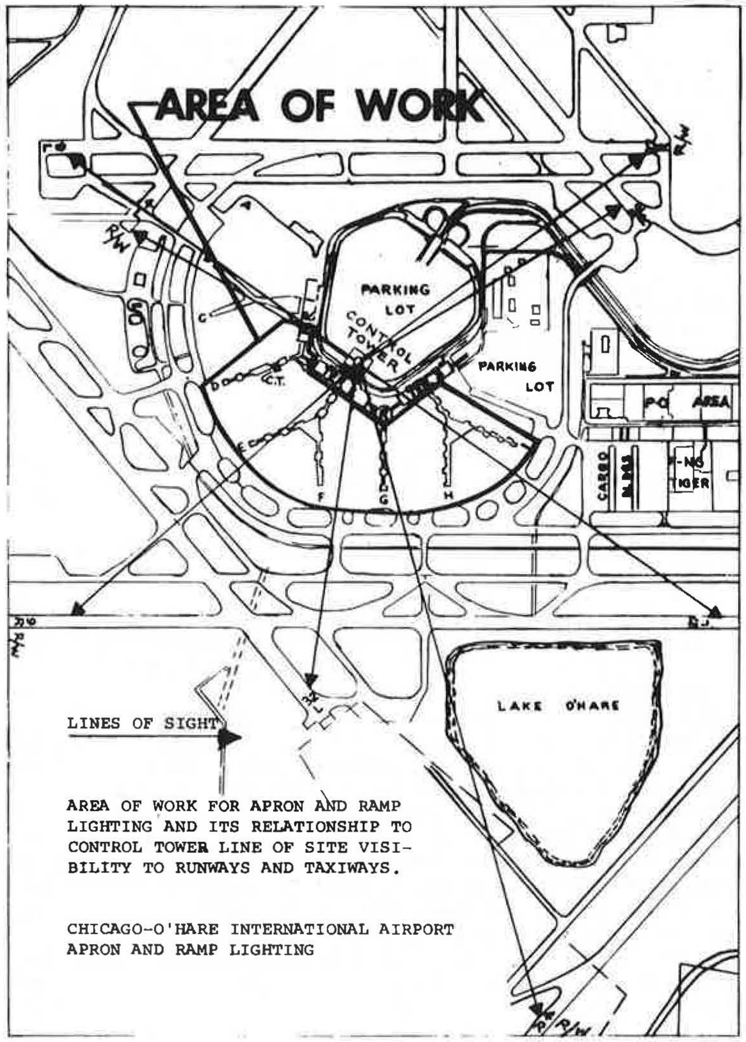
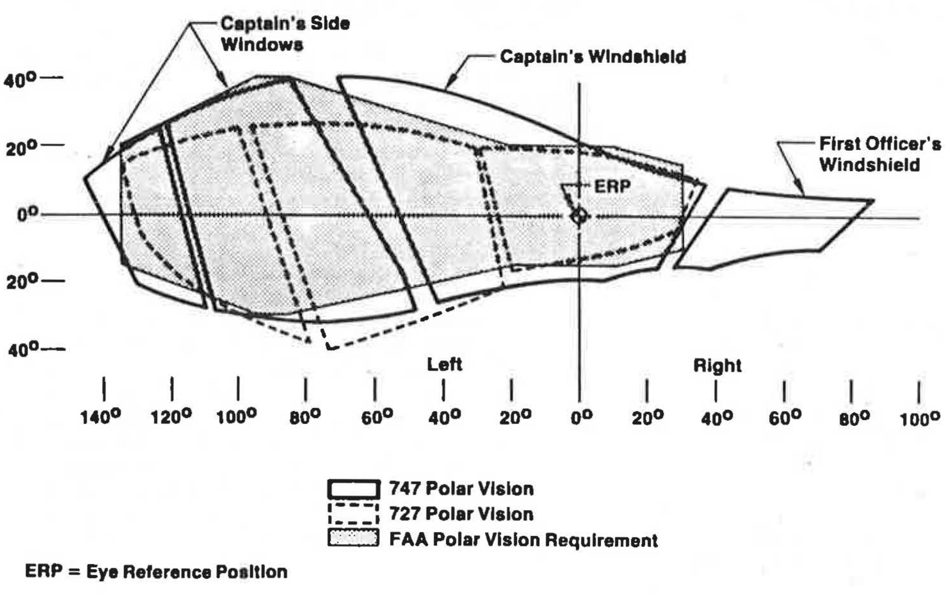


Figure 2. Polar vision comparison, Chicago O'Hare International Airport.



The Illuminating Engineering Society's "Recommended Practice for Airport Service Area Lighting" (RP-18, July 1960), which recommends minimum illumination values and provides definitions and the principles for achieving adequate illumination, was used as a design guide. This standard practice is currently being updated and modernized to reflect the advancements in lighting technology and to accommodate larger aircraft and new airport configurations. According to the standard practice,

> "The term 'service area', 'loading ramp', or 'apron' is understood to be an all-inclusive one. The terms refer to every operational outdoor area not directly involved in aircraft landing and taxiing operation. These are areas into which aircraft would normally be expected to move under power or by towing for docking at a gate for loading, servicing, and refueling. Adequate lighting of these functional and service areas must be provided for the various visibility tasks and to minimize ground traffic accidents, through the safe passage of aircraft and movement of vehicles. The apron and ramp area is determined largely by the diameter of the aircraft parking circle of the largest aircraft and by additional space required for passing or taxiing aircraft."

The luminaire poles should be mounted at or near terminal or finger buildings to avoid obstructions to aircraft ground traffic. The floodlighting of the apron area is accomplished by projection of illumination outward to 300-400 feet from essentially one direction.

To achieve an acceptable quality of lighting, another dimension must be added. This quality factor is that of higher mounting height, which produces a balance between horizontal and vertical illumination.

Greater height, high mounting, or HiMasts, then overcomes two major design problems. The first is the ability to spread the lighting for greater distances and the second is to keep the light source well above the pilot's line of sight. In principle, the minimum ratio of mounting height to pilot's level should be 2 to 1, and the projection distance to mounting height ratio should not be greater than 8 to 1.

Although both horizontal and vertical surface illumination is essential at the service areas, vertical illumination is the most important at greater distances. It helps silhouette vehicles in the areas between finger buildings and enhances visibility with increased pavement luminance.

The O'Hare study recommended the following illumination level values:

Distance From Loading Ramp (ft.)	Horizontal Foot-candles	Vertical Foot-candles	Uniformity
1st 50	10	20	4:1
50-100	5	10	4:1
100-200	1	5	4:1
200-300	0.01-1.0	1.0	-

Prototype Lighting Layouts

The first prototype lighting layout consisted of single 1000 kw. metal halide luminaires using 20-foot poles, with resultant 44 feet mounting height. These poles used the existing rooftop pole foundations, which are spaced 40 feet apart. This arrangement would be very economical and a natural conversion, since the use of existing foundations permitted the reuse of existing conduits and wiring. However, the foundations were of limited structural capability, restricting our selections of mounting height, and luminaire size, due to wind load considerations. The nighttime measurements of this limited trial of three units were acceptable for only a limited area.

The second prototype lighting installation included the use of 30-foot poles, with a luminaire height of 55 feet. This increased height permitted the use of the larger and more efficient 1000 kw. high-pressure sodium lamps and satisfied the pilot's vision and quality-of-projection requirements. However, due to the higher mounting height and the greater projected area of the luminaire, new pole mounting foundations were required. These consisted of structural steel brackets anchored to the face of the reinforced concrete building columns by using malleable-iron anchors.

The new luminaire is of controlled output and cut-off distribution; and excellent lighting performance was achieved. The choice of the 1000 kw. high-pressure sodium lamps of 140,000 lumens, with its high efficacy, resulted in higher illumination values, and will generate savings in maintenance costs, due to its 24,000-hour-rated life, which results in less frequent relamping.

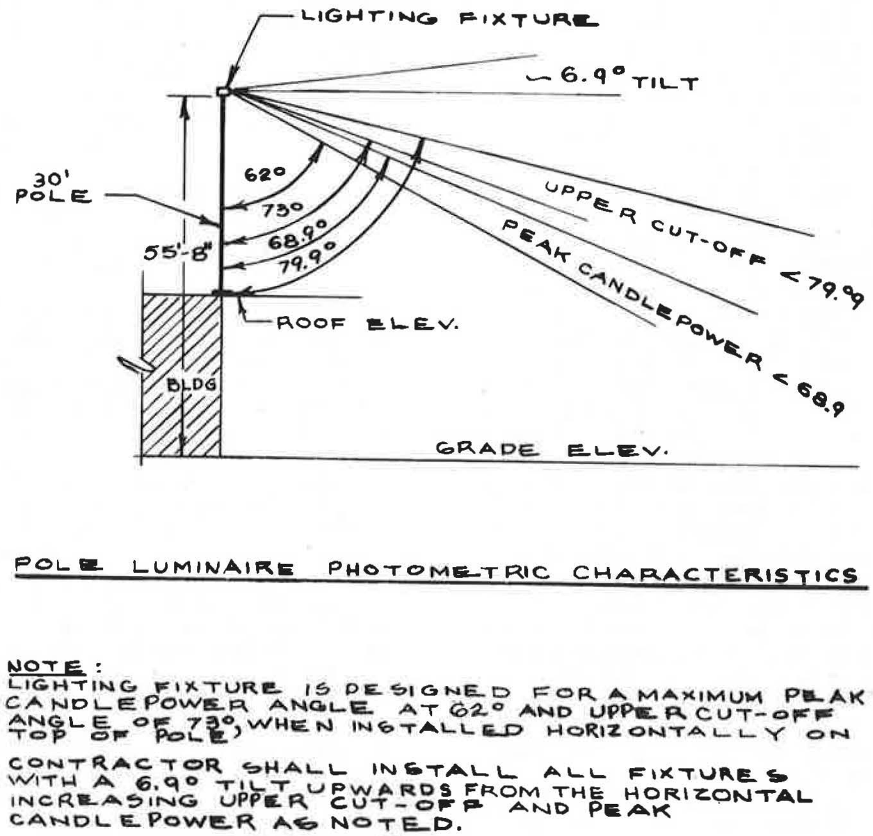
Further economies in maintenance would be realized by the use of hinged poles and a lowering device, both of which are accessible from the building roof. This eliminates the need for an aerial tower truck and large maintenance crews.

The required photometric characteristics of the luminaire selected are described in Figure 3. Although the fixture's maximum beam occurs at 62°, with an upper cut-off at 73°, an upward luminaire tilt of 6.9° is needed to achieve optimized illumination to the outer reaches of apron and ramp areas. The lamp is positioned horizontally within the elliptical-parabolic alzak reflector area to achieve cut-off distribution without the use of refractors, louvers, or visor shields, thus assuring maximum luminaire efficiency. A flat, clear, tempered glass seals this luminaire, the specular, reflector, and the lamp from dust, dirt, and insects.

These high-mounted lights satisfy only that portion of the illumination requirements that are adjacent to the aircraft standing areas and outward to the taxiing areas. The close-in areas and underside service areas are provided with additional low-mounted wall packs of 150 kw. high pressure sodium lamps, which produce 16,000 lumens. Mounted at a height of 12 feet, these fixtures have a maximum intensity of 65°, with cut-off at 75°. Such illumination is especially needed to enhance ground traffic, baggage cart operations, and refueling.

A major area of concern with the high-mounted floodlight installation was to avoid obscuring the FAA control tower's line-of-sight visibility to the runways and taxiways. Possible airspace penetration necessitated the filing of a "Notice of Proposed Construction of Alterations" (FAA-7460-1) in order to satisfy FAA regulations. Part 77 of these regulations required that the locations and elevations of the proposed 300 poles and lights be indicated. Due to the complexities of predicting the visual impact of a luminaire and pole to the line of sight extending outward thousands of feet away, tentative approval was allowed for these locations.

Figure 3. Pole fixture photometric characteristics, apron and ramp lighting, Chicago-O'Hare International Airport.



As far as visual impact is concerned, the new prototype lighting, which was installed with the cooperation of American Airlines, has made a dramatic difference at Gate K-8. The ground crews are enthusiastic, stating that they went without accidents and can pursue their tasks readily since the new lighting was placed in service.

After six months of continuous operation of the lights, no complaints were received from the pilots and no real problems regarding day or nighttime visibility are anticipated from the air traffic or ground controllers. Requests for similar lighting at the remaining gates are now being made.

MATHEMATICAL MODEL OF RUNOFF FROM GROOVED RUNWAYS

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Abstract

A conceptual model of runoff from grooved runways based on a hydraulically equivalent ungrooved surface has been investigated for its capability to simulate flow depths on a runway surface. The specific objective of model development is to predict runoff characteristics for uniform rainfall rates on a 100-foot wide concrete runway, grooved and sloping traversely at 1-1/2 percent. A FORTRAN IV computer program is used to solve the kinematic wave approximation to the shallow water equations which are central to the model. The kinematic wave approximation is employed for various hydraulic roughnesses as predicted from another study using a typical maxrotexture range of 0.01 inch to 0.03 inch. A rectangular groove shape with fixed dimensions is considered at five different spacings. The computer simulation results show that grooving enhances the drainage from the pavement in the form of decreased surface depths. The maximum depth reduction due to grooving is about 19 percent for all rainfall intensities, including the 6 inch per hour maximum in this study. These results are tentative, since an experimental study involving equipment that simulates rain on an indoor slab is presently underway. Qualitative observations of early experimental runs seem to indicate that depth reductions based on computer model runs may be too small.

Introduction

The landing aircraft is brought to a quick stop by the combined forces of aerodynamic drag, reverse engine thrust, and wheel braking. The stopping distance can vary widely depending upon the friction level available at the tire-runway interface. When this interface is dry, the friction level is high and the aircraft can be brought to a stop quickly; however, the presence of water at the interface reduces the available friction level significantly, and potentially hazardous conditions of overrun and hydroplaning exist.