DEVELOPMENT OF INTERIOR PAINTING AND LIGHTING FOR CAA FACILITIES

By

H J Cory Pearson and Marcus S Gilbert

Airport Development Division

Technical Development Report No 76

CIVIL AERONAUTICS ADMINISTRATION

TECHNICAL DEVELOPMENT

INDIANAPOLIS, INDIANA

March 1949

TABLE OF CONTENTS

Manuscript received, December 1947

DEVELOPMENT OF INTERIOR PAINTING AND LIGHTING FOR C. A. A. FACILITIES

SUMMARY

The work under this project was done to demonstrate the effect produced by a set of painting and lighting specifications, prepared for recommendation as a standard

Fluorescent lighting was selected for the Control Center and Communications Station Several shades of green paint were used on walls, trim and equipment, with gray for the tower ceiling and white for the other ceilings.

Although the walls and ceilings were covered with acoustic materials, the application of oil base paints apparently made little difference in the acoustic properties of such materials.

The general effect of the lighting and painting proved to be pleasing to the station personnel and satisfactory in general. Airport tower lighting, which is not discussed here, will be treated in detail in a separate report.

INTRODUCTION

In line with the policy of the Civil Aeronautics Administration to standardize on equipment, methods, materials, and general practices wherever possible, the Office of Federal Airways requested the Office of Technical Development to make specific recommendations for use in the preparation of standard specifications for the interior painting and lighting of various Federal Airways facilities.

Since the appearance of any painted surface varies widely under different qualities of illumination, it is very important to consider this factor.

If the natural light is north light, which is deficient in reds and yellows and rich in blues, the color selected should compensate for this cold light. Where natural light is from the south, where direct sunlight is to be expected, the colors should be colder, or contain more blue and less red and yellow

It is also important to balance the color of the paint with the color tone and quality of the artificial light used. For this purpose any proposed standardization of painting must include standardization of artificial lighting. As incandescent lamps are warm in color tone and differ materially from natural daylight, fluorescent lighting, with which color qualities of different color temperatures are available, is more flexible and more easily adapted

One point in the selection of artificial lighting color quality must be kept in mind While it is possible to reproduce the color quality of any selected type of daylight (north light or direct sunlight) by means of artificial light, it is not practical in general illumination to reproduce the quantity of daylight The psychological reaction to the color quality of daylight with the quantity of light which it is practical to furnish, is a definite feeling of gloom and inadequacy, even if the artificial lighting is built up to 100 foot-candles. This effect is overcome by using a warmer light with more reds and yellows producing a more cheerful atmosphere with a much lower level of illumination.

Another factor which had to be considered was the undesirability of using any paint which had a finish sufficiently glossy to produce surface or specular reflections Such a surface reflecting light into the eyes produces fatigue and eye strain. At the same time, the surface must be smooth enough to be easily cleaned

After consultation with various paint manufacturers, preliminary specifications were prepared to cover the painting of the Civil Aeronautics Administration facilities at the Allegheny County Airport at Pittsburgh, Pennsylvania. Specifications for the lighting were based upon the authors' experience and upon generally accepted practice in the field of illuminating engineering.

PAINTING

In planning painting, the problem is to provide a color scheme that will be pleasing in appearance with a minimum amount of specular reflection and light absorption

Much has been written on the subject of the psychology of color and a discussion on this subject is beyond the scope of this paper. Color preferences are quite general, a majority of people preferring certain color schemes while disliking others. The use of red for walls must be avoided, especially for interiors where the occupants spend protracted lengths of time. Colors that approach natural surroundings seem to be the most generally accepted

In the case of control towers there is the additional problem of avoiding reflected sunlight. Particularly vexing is the reflection of sunlight from the ceiling immediately after sunrise and shortly before sunset The use of gray paint was adopted in solving this problem.

Discussions were held with representatives of several paint manufacturers, as a result of which, the following specifications were prepared In these specifications the colors and code numbers employed in various applications and shown in Table I refer to commercial nomenclature and codes applying to products of the Pittsburgh Plate Glass Company, although similar and equal paint and color formulations can be obtained readily from any reliable paint manufacturer.

Furniture All furniture shall receive two coats of Lavax Machinery Enamel, Vista Green, Code #23-76, or equal, air dry finish.

New Equipment (Teletypes, racks, and similar devices with exposed metal surfaces) Use Lavax Machinery Enamel, Vista Green, Code #23-76, or equal, with a low sheen, hard and durable wrinkle finish

The baking time and temperature for equipment enamel shall be specified by the equipment manufacturer and the manufacturer of the paint used, as variations are necessary, depending upon whether the finish is baked on by use of infrared lamps or other drying ovens, and on the chemical composition of the paint

Air Traffic Control Center and Communications Station

Wall Finish Pittsburgh Wallhide PBX wall paint, or equal, shall be used for the finish coat. The color shall be the same as that obtained by mixing equal parts of the following two colors Code #24-121 Eye Rest Green and Code #24-6 White

In cases where separate rooms are exposed to north and south lighting, the north room shall use a warmer green, known as Seafoam Green, Code #24-116, let down with one part White, Code #24-6, or equal.

An undercoat should be applied. This shall consist of Pittsburgh Wallhide First Coater #26-1, or equal, applied according to the manufacturer's directions.

The use of varnish type primers shall be prohibited for wall areas

Wood Trim Doors and Frames--Metal Doors and Frames (except baseboards) Pittsburgh Lavax PBX Enamel, or equal, shall be used. The color shall be the same as that obtained by mixing equal parts of Code #23-21 Eye Rest Green and Code #23-23 White, or Seafoam Green Code #23-16 with White Code #23-23, where north light is involved.

Baseboards Same color and quality as Pittsburgh Plate Glass Company Lavax Machinery Enamel Vista Green Code #23-76 Undercoater shall be applied as specified for communications stations and centers.

On old work, one or two coats of finish shall be applied as needed. On new work apply one coat of PBX Enamel undercoater #23-85, or equal (to which has been added one pint of the Finish Coat mixture for each gallon of Undercoater) before applying the final coat.

Ceilings Only For old work, use paint similar and equal to Pittsburgh Wallhide Flat Wall Paint Code #26-72 Soft White. Apply one or two coats as needed

On new work apply one coat of Primer #26-1, or equal, before final coat of flat wall paint.

TABLE I

MUNSELL COLOR NOTATIONS AND REFLECTION FACTORS

The color effects obtained through use of the paints specified in the foregoing can be described approximately by the following Munsell color notations. Reflection factors for the various paints are given also.

Paint Description	Manufacturer's Code No.	Munsell Notations	Reflection Factor
1. Lavax Machinery Enamel Vista Green	#23-76	10 GY 4.5/4	19%
2 Wallhide PBX Eye Rest Green and Wallhide PBX White (Equal Parts)	#24-121 #24-6	7.5 GY 8/2	41%
3 Wallhide PBX Sea Foam Green Wallhide PBX White (Equal Parts)	#24-116 #24-6	2.5 GY 8/4	69%
4. Wallhide Flat Wall Paint Soft White	#26-72	N 9+ /	85 5%
5. Wallhide Flat Wall Paint Stratosphere Gray	#24-120	N 6 5/	37%

Control Tower

Walls and Trim Same color and quality as Pittsburgh Plate Glass Company Lavax Machinery Enamel Vista Green Code #23-76. Undercoater shall be applied as specified for communications stations and centers.

Ceilings The same specifications shall apply as for ceilings of communications stations and centers, but the final color of the ceiling shall be Pittsburgh Plate Glass Company or equal Stratosphere Gray Code #24-120

On the basis of these specifications, the First Regional Office of the Civil Aeronautics Administration drew up a contract with a local contractor for painting the Pittsburgh facilities.

Prior to completion of the painting, it was noted that the Venetian blinds would need some treatment. Accordingly they were taken down and sprayed with two coats of the same paint as was used for the trim. New tapes of a Burgundy color were used to replace the old tapes

LIGHTING

Fluorescent lighting fixtures of the URC-4/40-watt type with 3500-degree Kelvin color temperature were selected to give general illumination on the order of 40 foot-candles. These were installed wherever possible on existing outlets with the bottoms just above door level height. Although the ceilings were somewhat low, there was sufficient room to suspend the luminaires to take advantage of the indirect lighting effect. The mounting height of the fixtures will vary in different locations, being dependent upon the ceiling height. Consequently, every installation will require individual study and engineering Fig. 1 gives candlepower distribution data for a typical URC luminaire and Figs. 2 and 3 show the luminaires installed

For the repair shop several industrial fixtures of the 2/40-watt size were purchased for suspension above the work bench.

The following specifications prepared by the authors cover the purchase of luminaires

General All lighting units furnished under this specification shall be Underwriters' Laboratories Approved.

Contractor shall furnish a sample of the lighting unit for inspection or furnish a list of existing installations of these lights to be seen in . . . . . (city).

A. Four-Lamp Semi-Indirect Fluorescent Lighting Unit The lighting unit shall be similar and equal to Westinghouse Type LW-160, Cat. No. 1373702.

The lighting unit shall be complete with Westinghouse No. 1371816, or equal, twin stem hangar for individual suspension mounting and shall be furnished with rigid metal "egg-crate" louvers. The design shall be such that lamps can be removed without removing any other part.

The body assembly shall consist of rugged sheet chassis, decorative steel end covers and glass side panels of ribbed diffusing glass.

The lighting unit shall be designed to use four 40-watt T-12 Mazda F fluorescent lamps and shall be furnished complete with 3500-degree white lamps, sockets, standard FS-4 starters and twist-turn "button" type lamp holders.

High power factor (95 - 99 per cent) ballasts of Underwriters' Laboratories approved design for 60-cycle, 120-volt operation shall be furnished as a part of each lighting unit The lighting unit shall have stroboscopic correction.

Each lighting unit shall be delivered completely wired ready for connection to line leads.

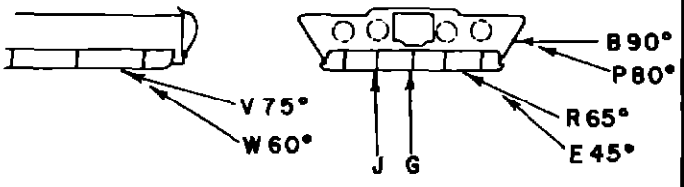
Luminaire body and ceiling brackets shall be furnished in baked white enamel.

B. Two-Lamp Industrial Type Fluorescent Lighting Unit The lighting unit shall be similar and equal to "Mitchelite" Model No 2084 Industrial Type.

The lighting unit shall be complete with open end heavy gauge steel reflector

LUMINAIRE WESTINGHOUSE TYPE LW-160 FLUORESCENT LUMINAIRE
S#1373702 WITH LOUVER AND GLASS SIDE PANELS

LAMPS FOUR-40 WATT, WHITE (3500°K) FLUORESCENT, 48"
T-12 BULB, 2320 RATED LUMENS, MED BIPIN BASE,
OPERATED AT 118 VOLTS INPUT TO BALLAST



AVERAGE REFLECTIVITY OF WHITE ENAMEL 83 1%

LUMINAIRE DISTRIBUTION DATA

AVERAGE OF THREE PLANES

MID-ZONE ANGLES	CANDLE-POWER AT 25 FT	ZONAL LUMENS	MID-ZONE ANGLES	CANDLE-POWER AT 25 FT	ZONAL LUMENS
180°	1318		90° HOR	96	
175°	1299	123	85°	100	105
165°	1294	367	75°	166	176
155°	1242	575	65°	259	257
145°	1254	725	55°	440	395
135°	1033	800	45°	681	527
125°	889	797	35°	928	583
115°	637	633	25°	1113	515
105°	362	383	15°	1282	364
95°	160	175	5°	1367	130
			0° NADIR	1386	

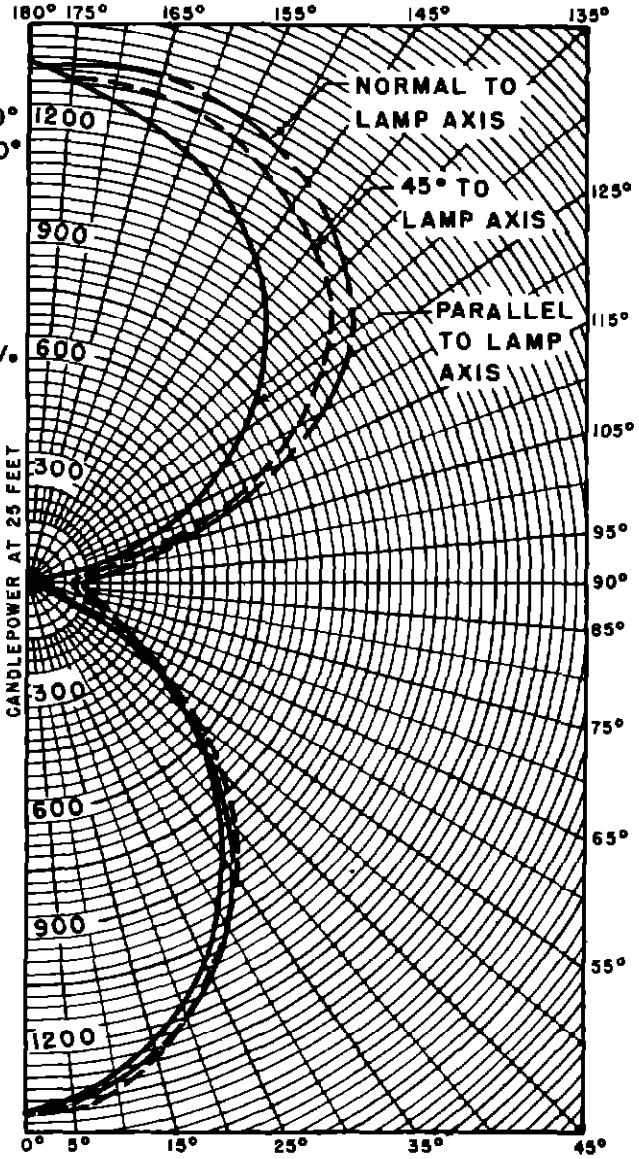
LIGHT FLUX VALUES

ZONE	LUMENS		PER CENT TOTAL LUMENS BARE LAMP	PER CENT LIGHT OUTPUT
	LAMP	LUMINAIRE		
0°-60°		2514	27 1	82 2%
0°-90°		3052	32 9	
90°-180°		4578	49 3	
0°-180°	9280	7630	82 2	

LUMINAIRE BRIGHTNESS

ARROWS INDICATE LOCATION AND ANGLE OF VIEW
CANDLEPOWER PER SQUARE INCH

B		E		P		G	R	V		J		W
9		31		9		1	14	10		42		25



COURTESY OF ENGINEERING DEPARTMENT WESTINGHOUSE ELECTRIC
& MANUFACTURING CO, EDGEWATER PARK, CLEVELAND, OHIO

Fig 1 Candlepower Distribution Data for URC Type Luminaire

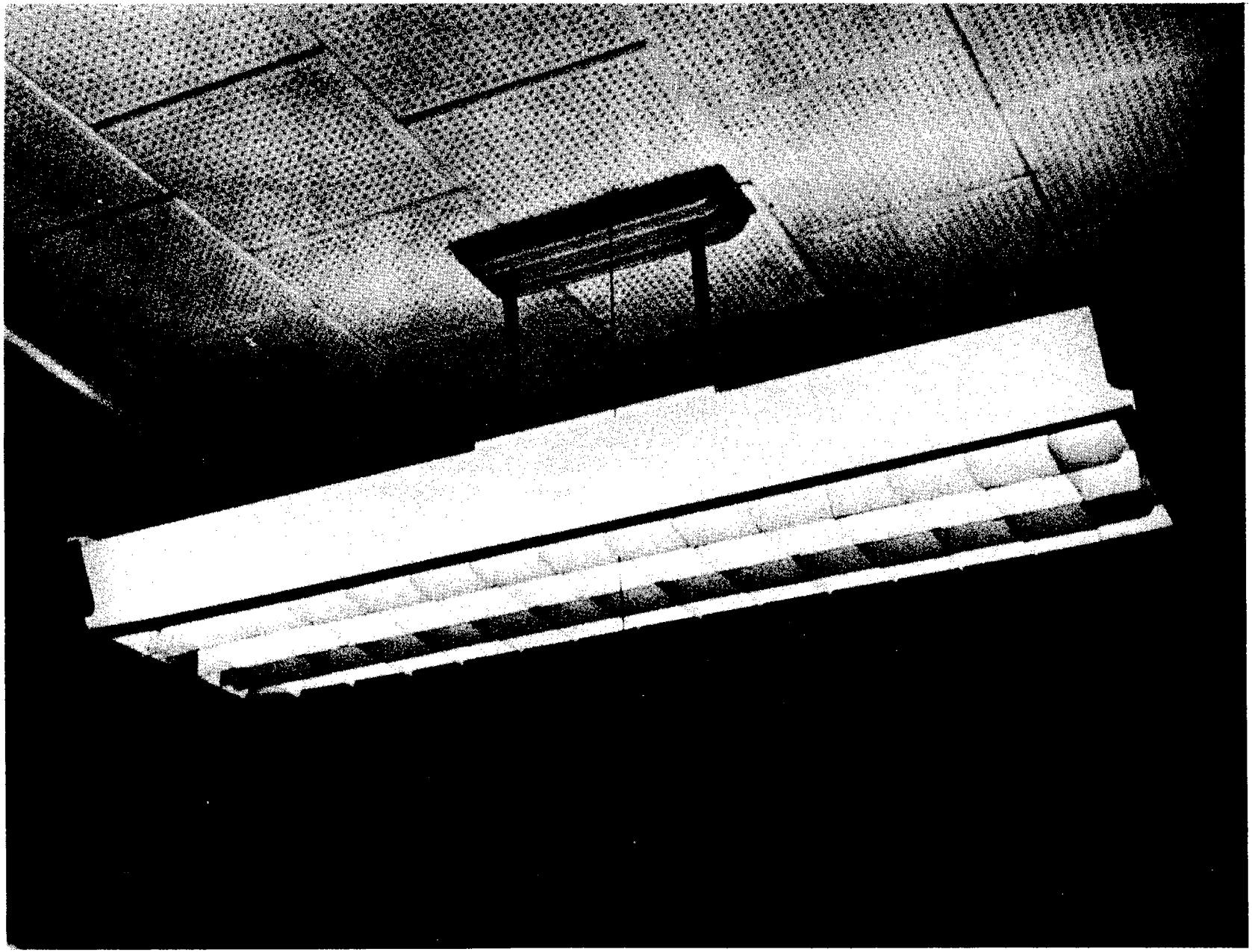


Fig. 2 Typical URC Luminaire

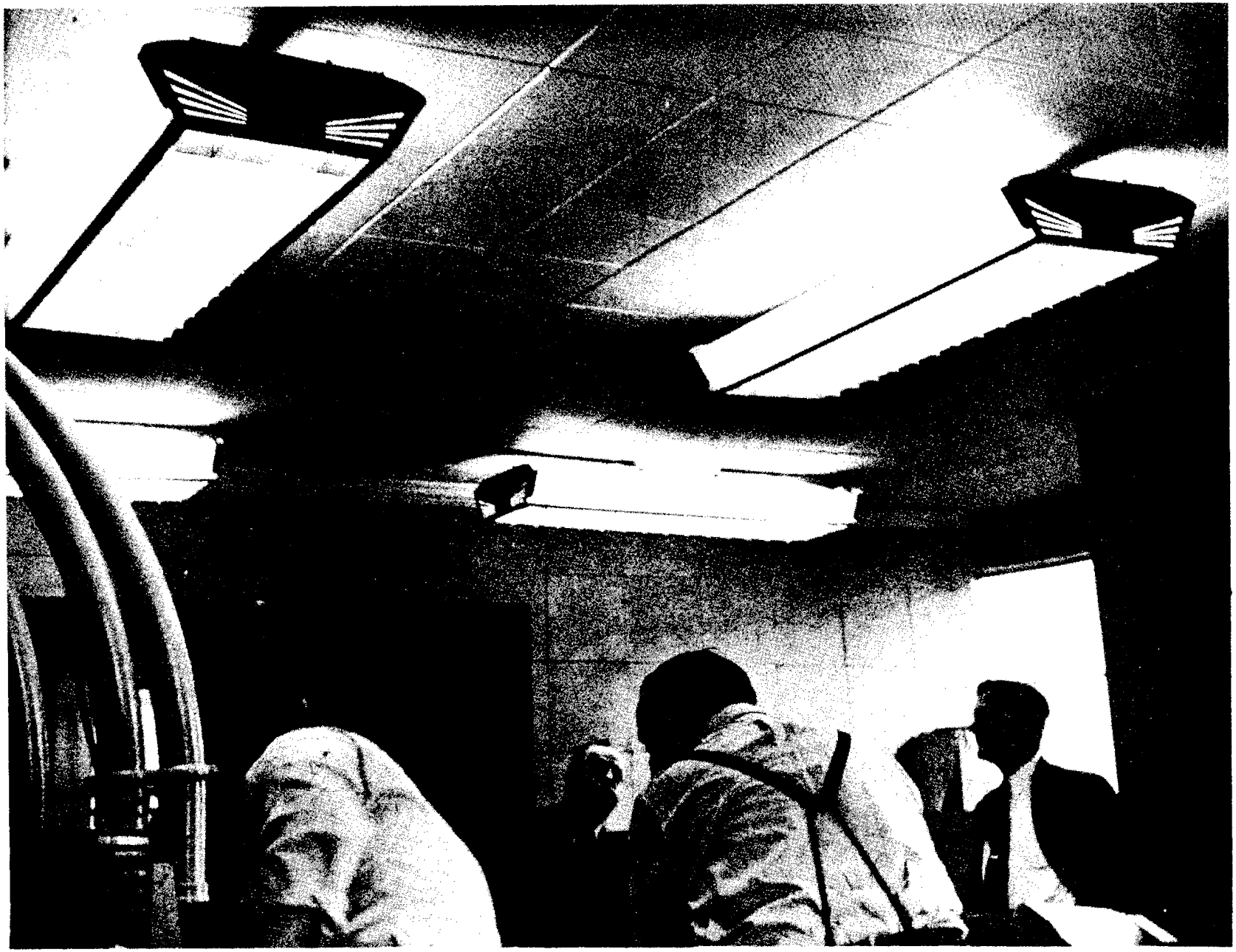


Fig. 3 Interior View of Civil Aeronautics Administration Communications Station at Alleghany County Airport, Pittsburgh, Pennsylvania, Showing Installation of URC Type Luminaires

having porcelain enamel finish and with heavy gauge steel wireway channel.

The lighting unit shall be designed to use two 40-watt T-12 Mazda F fluorescent lamps and shall be furnished complete with 3500-degree white lamps, sockets and standard FS-4 starters.

A Tulamp Ballast of Underwriters' Laboratories approved design for 60-cycle, 120-volt operation shall be furnished as a part of each lighting unit Stroboscopic correction as well as power factor exceeding 90 per cent is required.

Each lighting unit shall be delivered completely wired and ready to hang.

GLARE

Although lighting modernization, through the installation of general fluorescent lighting to replace existing incandescent fixtures, has as its purpose the improvement of seeing conditions, unsought-for results frequently are obtained. The increase in either the number of luminaires, or the luminous output at existing outlets, also serves on many occasions to increase the number of glare points or sources of misplaced light and to point up those already existing. As a result, many new lighting programs are rendered ineffective through neglect in considering the elimination of glare sources.

One of the greatest offenders among glare sources in commercial lighting has been the "executive" type of plate glass top frequently placed on office desks. Such a surface reflects most of the light incident to it, much of this light being redirected into the eyes of unsuspecting workers who are inclined to blame their headaches and eyestrain on the new lights. Other glare sources are picture frame glass, bookcase doors, and business machines with their glass windows or shields and bright chrome trim.

In CAA Communications Stations the glass in teletype machines, clocks and map cases, and the chromium plating on the operating shelf trim often are very annoying glare sources. While it is regrettable that manufacturers of office devices have not entirely eliminated the need for glass in their products, much has been done toward the elimination of shiny surfaces from office equipment because of the increasing consciousness of glare sources on the part of the general public.

In CAA Air Traffic Control Centers the Flight Progress Boards frequently have glare sources in the form of chrome trim or other highly reflective material. It is recommended that, wherever possible, glare sources such as those mentioned above be rendered less objectionable by careful positioning of equipment and operators with respect to the luminaires. Sometimes apparatus can be placed between luminaires rather than directly beneath an individual lighting fixture, thus eliminating objectionable glare. Shiny trim can be removed or painted black, while glass often can be removed from machines without lowering their efficiency.

A careful study of glare conditions frequently will bring forth adequate remedies and consequent relief from eyestrain due to glare. Relocating of luminaires sometimes can be as effective as repositioning of occupants. This is not generally recommended due to the fact that the general illumination will thus become less uniform and because it is usually less trouble and less expensive to move a desk than a luminaire. In a number of cases, however, relocating of the luminaires may be the only means left for correcting glare conditions

In recent years the use of glass blocks instead of window panes has added another glare source to many rooms. As in the case of windows, Venetian blinds over glass block areas can eliminate much discomfort Occupants of a room should never be seated to face bare glass block outer walls, nor should occupants wearing spectacles be placed with their backs to such glass walls, as the spectacles frequently reflect light back into the eyes of the wearer

For a complete discussion of glare and related subjects, reference is made to the booklet "Recommended Practice of Office Lighting" published by the Illuminating Engineering Society, 51 Madison Avenue, New York City.

AUXILIARY OR LOCAL LIGHTING

In many instances general lighting which is adequate for most working positions in a room is not sufficient for a special operation

or for a position not advantageously placed with reference to ceiling luminaires, as, for example, the back of a rack or operating shelf. In such cases it is advisable to supplement the general lighting with auxiliary or local lighting.

There are available on the market adjustable or "floating" auxiliary light fixtures that can be moved to almost any desired position. One unit of this type consists of a reflector and three 6-watt fluorescent lamps with a magnifying glass which is very useful in maintenance work on teletype and other delicate or finely adjustable equipment.

Caution should be exercised in selecting fluorescent auxiliary light fixtures to avoid purchasing single tube units as these have an objectionable stroboscopic effect caused by the lamp going out for an instant every time the current passes through the zero point of its cycle. This condition is minimized in multiple lamp fixtures by operating the individual lamps out of phase with each other through the use of capacitors.

Because the life of the lamp is greatly reduced, the use of fluorescent lighting fixtures on direct current outlets is to be avoided, even though such use is possible by means of resistors.

CONCLUSIONS

The general opinion of personnel working in the facilities at the Allegheny County Airport is that the painting and lighting are pleasing.

The color is easy on the eyes and provides satisfactory working surroundings. The surfaces are smooth enough to be cleaned easily but are not so glossy as to cause uncomfortable specular reflection.

The oil base paint, contrary to the predictions of several painting contractors, has not affected the acoustic qualities of the special walls and ceilings. Water color paints may be more easily applied to the acoustic materials and may be less expensive, but the painters experienced no difficulty in doing this work. Costs will vary in different localities and under other conditions, although there is very little difference in the cost of good paints, regardless of the colors chosen. It should be emphasized that since the cost of labor is such a large proportion of the total costs, any possible savings accrued by purchase of inferior paints would be too small to justify the reduction in quality.

The type of lighting fixture selected is one that has been widely used and is generally accepted by lighting engineers and designers. It is made by many manufacturers and is generally available. The reactions to their use at Pittsburgh were uniformly favorable. Although little was done toward removing glare sources, except to point out such sources to the occupants of the areas relighted, none of the occupants complained of discomfort from glare. Most of them expressed approval of the lighting and felt that it was adequate.

ACKNOWLEDGMENT

Acknowledgment for assistance is made to the following:

The management of the Allegheny County Airport for hanging the lighting fixtures.

Personnel of the Civil Aeronautics Administration First Region for their work in connection with the issuance of contracts.

Messrs. Porter, Davis, and Fraley of Pittsburgh for cooperation in expediting this experimental work at their facilities.

Messrs. Joe C. Thompson, Jr., N. A. Mason, and H. D Bishop for their help in the selection of the color schemes