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SURVEY OF VISUAL GROUND AIDS AT O'HARE INTERNATIONAL AIRPORT

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INTERIM REPORT

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Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SYSTEMS RESEARCH AND DEVELOPMENT SERVICE
Washington DC 20591

LIST OF ILLUSTRATIONS

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1. INTRODUCTION

During the period June-July 1974 a survey of Visual Ground Aids was conducted at O'Hare International Airport in Chicago, Illinois. The purpose of this survey was to identify equipment currently installed to aid in providing visual guidance to pilots in traversing various sections of the airport and to identify certain technical and maintenance-oriented characteristics associated with these installations.

Visual Guidance Equipment (VGE) functions as a navigational aid for aircraft both airborne and on the surface and vehicles traveling on the field. Airborne VGE consists of approach lighting, obstruction marking and lighting, lighted wind tees, segmented circle systems, beacon towers, and so forth; airborne VGE aids are usually the FAA's direct responsibility. Surface VGE consists of runway and taxiway lighting systems, markers, signs, and pavement surface markings. Surface VGE aids are usually the responsibility (subject to FAA approval) of the airport authority and are maintained by this authority. At O'Hare the City of Chicago, Department of Aviation, is responsible for these surface VGE systems.

Previous discussions with personnel responsible for operating and maintaining the airport indicated that the requisite information for this survey was documented and could be readily extracted from various files. Upon initiating the survey effort, an attempt was made to identify the necessary drawings, etc., to be used in establishing the data base for this survey. This consisted of researching a number of listings of various projects associated with the evolution of the airport to its present configuration.

Airport construction activities were initially identified by RB (Revenue Bond) numbering systems and subsequently by PW (Public Works) number assigned schemes. It soon became apparent that there was a number of difficulties inherent in attempting to derive information for this study from the records, including:

1. No direct relationship between the time a PW or RB number was assigned to a project and actual installation date.

2. Actual installation differed from information contained in project documentation as originally proposed, i.e., as-built drawings were generally not available.

3. Projects usually were comprehensive in nature and included many items not relevant to this survey.

4. Equipment details were generally insufficient to permit identification of manufacturer, nomenclature, or model number.

5. Details relative to installation (e.g., taxiway edge lights) varied sufficiently from one set of plans to another that consistent, uniform information was not attainable.

6. Records indicating sign information and installation locations did not exist.

7. Cost data for equipment and installations were not accessible. We were advised that equipment and construction costs have increased to such an extent recently that any relationship developed on the basis of the original costs would be meaningless.

Consequently, it became necessary to develop the requisite information to the best extent possible by means of physical surveys, research of scattered listings and drawings, and through conversations with various airport personnel. Here, too, while many inconsistencies and discrepancies were encountered, these were for the most part resolved through discussions with the staff of the maintenance section.

Table 1-1 is a listing of personnel who provided reference information in the performance of this survey.

In view of the extended and unanticipated duration of the visit of CSC personnel conducting the survey and the amount of information that had to be gathered from and questions answered by these people, their cooperation in assisting to the best of their ability is sincerely appreciated.

TABLE 1-1. LISTING OF PERSONNEL PROVIDING REFERENCE INFORMATION

Contact	Position	Telephone*	Information Category
John Carr	Assistant Airport Manager	686-2234	Administrative-General
James Donovan	Airport Operations Supervisor	686-2206	Administrative-General
Jim Reid	Chief Electrician	686-2224	Lighting, Electric Signs, Maintenance
Ed Snider	Electrical Foreman	686-2224	Lighting, Electric Signs, Maintenance
Lee Herrick	Electrical Foreman	686-2224	Lighting, Electric Signs, Maintenance
Willy Rieger	Painting Foreman	686-2224	Non-electric signs
Ray Humbad	Landscaping Foreman	686-2247	Pavement Markings
Paul Shaver	Planning-Dept of Aviation	744-6896	Cost Data-Installation
Joseph Kohopka	Parts Foreman	686-2254	Cost Data-Spare Parts

*Area code: 312

2. FIELD LIGHTING SYSTEMS

2.1 LIGHTING CONTROL VAULT

The airport is fed through four separate 34.5 kV, 3-phase, high tension feeder lines from Commonwealth Edison (CE) Company. CE operates many substations at the airport to drop the 34.5 kV feeders to 4160 Vac, etc., for local distribution to terminal facilities and field lighting circuits.

At present all taxiway and runway lighting circuits are fed from a single lighting control vault located off the service road opposite Concourse "F" on the field. An adjacent CE substation supplies two separate 4160 Vac, 3-phase power circuits to the vault from two 34.5 kV feeder lines. Future plans are to locate a second lighting control vault and substation near the AAL hangar to the North along the scenic taxiway to serve the north area of the airfield. Bids for this installation are expected later this year.

The present lighting control vault is a one-story building. The basement area houses the 4160 Vac power source breakers and disconnects. The main floor is divided into the Taxiway Room (see Figure 2-1), the Runway Room (see Figure 2-2), and an additional section contains the emergency diesel generator. In the event of commercial power failure, this emergency power system can be connected to either Runway 14R or Runway 9R including the associated taxiway circuits to permit continued airport operations during the power failure period. The vault houses all taxiway and runway constant current regulators and control circuits for the entire field lighting system.

Figure 2-3 shows a closeup view of the taxiway regulator serving the 9R-27 turnoff area. Figure 2-4 shows the automatic primary power disconnect units serving several adjacent taxiway regulators.

In the runway room, the two separate, 3-phase 4160 Vac power sources called "normal" and "standby" connect to an automatic transfer switch. The output 4160 Vac "normal" from the transfer switch supplies power to the runway room

Figure 2-1. Taxiway Lighting Room

Figure 2-2. Runway Lighting Room

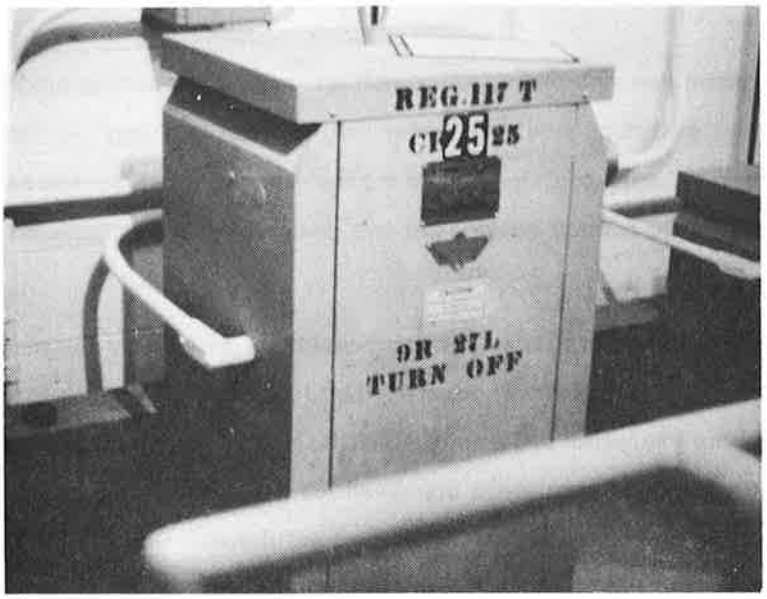

Figure 2-3. Typical Taxiway Regulator

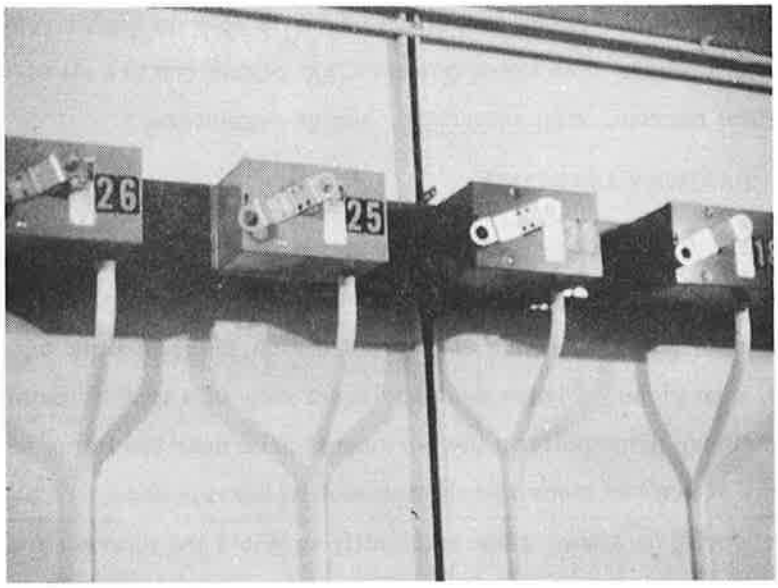

Figure 2-4. Typical Taxiway Disconnect Units

and taxiway room power busses. This voltage-sensing, quick-transfer (one second or less) switch will automatically switch from "normal" to "standby" when the "normal" voltage drops below a preset value. Ten series regulators are connected to the runway room 4160 volt power bus through automatic disconnects.

Table 2-1 lists these runway regulators as well as the pertinent data on the runway circuits which are identified by letters. All runway regulators, with the possible exception of Runway 4L-22R, are constant current series regulated 20 amp maximum regulators approved for airport lighting use. Table 2-1 also shows the area served for each lettered regulator. Runway 18-36 has modified Air Force edge lights that operate on a parallel 110 Vac circuit using standard 10-watt incandescent lamps. Instead of having a remotely controlled regulator, this circuit is operated by a time clock activated transformer.

In the Taxiway Room the 4160 Vac power bus connects 41 series regulators through automatic disconnects. Table 2-2 lists these regulators and their associated taxi circuit number as well as pertinent data on each circuit including the area being served. The lower powered taxi regulators are all 6.6 amp maximum, constant current, step adjustable, series regulators.

2.2 TAXIWAY LIGHTING

At O'Hare Airport all taxiway areas are provided with edge lighting. The majority of the edge lighting installations use standard taxiway edge lights, type L822, base mounted, with a standard 6.6 amp, 30-watt lamp housed in a symmetric, blue globe. Figure 2-5 provides a view of a typical installation. At several locations, principally in the peripheral area near the Ramp area at the intersections of taxiway stubs and the automotive service road, the blue globe has been replaced with an amber globe to identify to pilots the intersection of the service road. The basic fixture remains unchanged at these locations.

TABLE 2-1. RUNWAY LIGHTING CIRCUITS

Circuit Number	Area Served	Lighting Function	Regulator Mfgr/Current (amps)	Rated Power (kW)
B	9L-27R	Runway Edge	GE/20	30
C	4L-22R	Runway Edge	HD/NA	7.5
D	14L-32R	Runway Edge	HD/20	50
E	9R-27L	Runway Edge	HD/20	30
G	4R-22L	Runway Edge	HD/20	50
J	14L-32R	Runway C/L	HD/20	70
K	14R-32L	Runway Edge	HD/20	50
L	14L	Runway TDZ	HD/20	50
M	14R	Runway TDZ	HD/20	50
N	14R-32L	Runway C/L	HD/20	70
18-36	18-36	Runway Edge	(110V Transformer)	NA

Abbreviations

HD = Hevi Duty

GE = General Electric

NA = Not Available

TDZ = Touchdown Zone

C/L = Centerline

TABLE 2-2. TAXIWAY LIGHTING CIRCUITS

Circuit Number	Area Served	Lighting Function	Regulator Mfgr	Rated Power (kW)
1	Ramp B-C	Edge	HD	15
2	Parallel - 32L		HD	15
3	T-T2 Parking		HD	7.5
4	S. Scenic		HD	4
5	N. Scenic		HD	4
6	Parallel 9L-27R		HD	15
7	Hold Apron 9L		HD	7.5
8	Outer Circular Ramps D to G		HD	7.5
9	Hold Apron 32L		HD	7.5
10	Hangar Area Taxiway A		HD	7.5
11	Hangar Area Taxiway B		HD	7.5
12	Cargo Taxi		HD	7.5
13	Cargo Aprons		HD	4
14	Ramps C-D-E-F-G		HD	7.5
15	H-K Ramps		HD	4
16	Parallel 22		HD	4
17	14L Parallel		GE	7.5
18	Taxi to 9R		HD	7.5
19	Cargo Taxi to 27L		HD	4
20	Warm-up 27L		HD	4
21	Outer Circular East		GE	7.5
21A	Cargo Taxiway		HD	4
22	Taxi to Bridge	Edge	HD	7.5
23	Bridge	C/L	GE	7.5
24	32R Holding Area	Edge	HD	4
25	Parallel to 27L	Edge	HD	7.5

TABLE 2-2. (CONTINUED)

Circuit Number	Area Served	Lighting Function	Regulator Mfgr	Rated Power (kW)
26	Parallel to 27L	Edge	HD	7.5
27	Not Assigned			
28	Not Assigned			
29	T6B By Pass	Edge	HD	4
30	Not Assigned			
31	Parallel 14L	Edge	HD	7.5
32	Parallel 14L	Edge	HD	7.5
33	Not Assigned			
34	Not Assigned			
35	Not Assigned			
36	4R Warm-up	Edge	HD	7.5
37	27L Turn Off	Edge	HD	7.5
38	4R-22L	Edge	HD	7.5
39	4R Turnoff	C/L	HD	4
40	22L Warm-up	Edge	HD	7.5
AF 1	Army Side N.W.	Edge	HD	4
AF 3	Army Side East	Edge	HD	7.5
AF 9	Army Side Alert-Hangar	Edge	HD	4
Spare	Not Assigned		HD	4
Spare	Not Assigned		HD	7.5
Spare	Temporary Ckt #20		HD	7.5

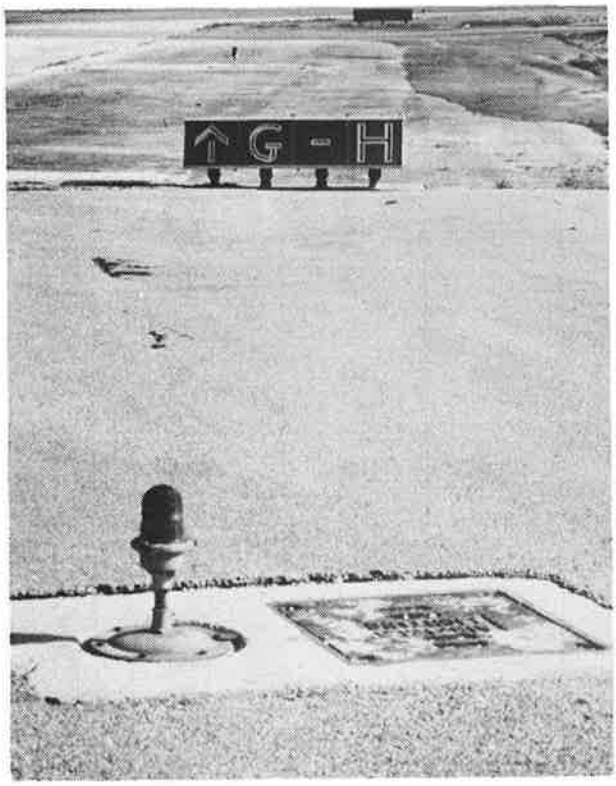

Figure 2-5. Typical Taxiway Edge Light Installation

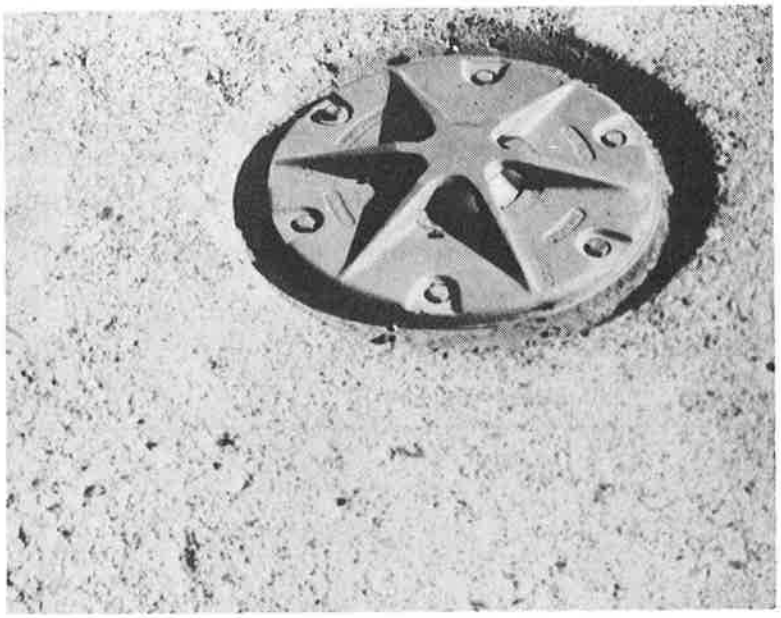

Figure 2-6. Installed Class B3 Taxiway Marker Light

In a number of locations, again especially in the periphery of the Ramp area, where past history has indicated the susceptibility to fixture damage by frequent vehicular activity, the standard taxiway edge light fixture has been replaced with a semi-flush, medium intensity, omni-directional fixture. This fixture is manufactured in accordance with MIL-L-26202D, Class B3, and contains a 6.6 amp, 45-watt lamp with a clear screen. Approximately 84 of these fixtures are currently in place including the bridge as described below. Figure 2-6 shows a typical installation of this fixture.

Taxiway edge lighting on the bridge spanning the entrance roadway to the airport which provides aircraft access between the terminal area and the 32R warm-up pad is also equipped with the Class B3 fixture. Figure 2-7 provides a view of a portion of the bridge taxiway (left side of photograph) and a raised curb (denoting the outer edge of the taxiway) containing the taxiway edge lighting. The reason for installing this type of fixture here is that the increased elevation resulting from the curb construction would increase the height of the standard fixture beyond allowable limits. The opposite side of the bridge is similarly constructed and also contains this type of fixture.

Also included under the category of taxiway lighting are two circuits serving the bridge centerline and Runway 4R-22L, high-speed turnoff centerline lighting systems. The bridge C/L fixtures are the L852, Type I bidirectional designed for bonding into existing taxiway pavement. These fixtures are equipped with 45-watt lamps and provide a narrow beam light output in both directions. Figure 2-8 shows a segment of this installation.

The high-speed turnoff C/L fixtures are the L852, Type II fixtures designed for shallow base installations. In this case, the lamp rating is 65 watts and the light output is widebeam and unidirectional. Figure 2-9 provides a view of the L850 Type II fixture mounted on the shallow base (top) as well as an assembly view of the optical housing and lamp holder. Both the bridge and turnoff C/L fixtures are equipped with green filters for guidance purposes.

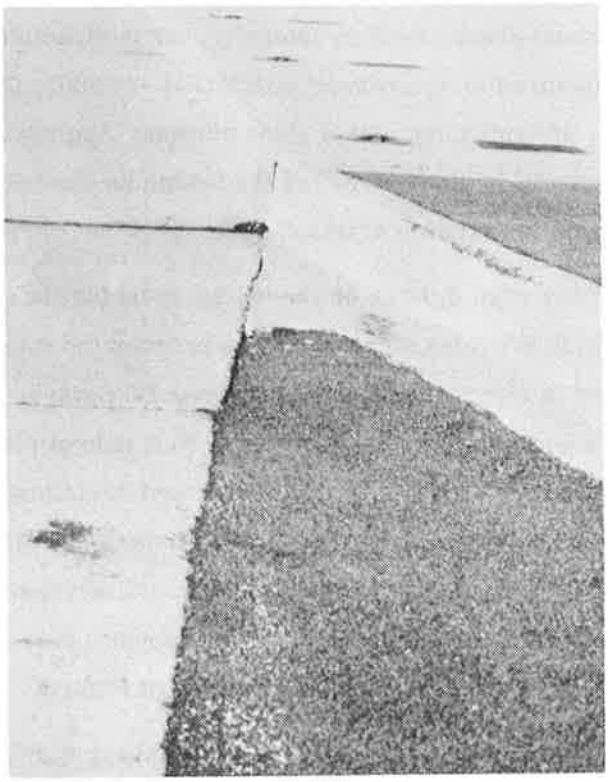

Figure 2-7. View of Bridge Taxiway Edge Lighting

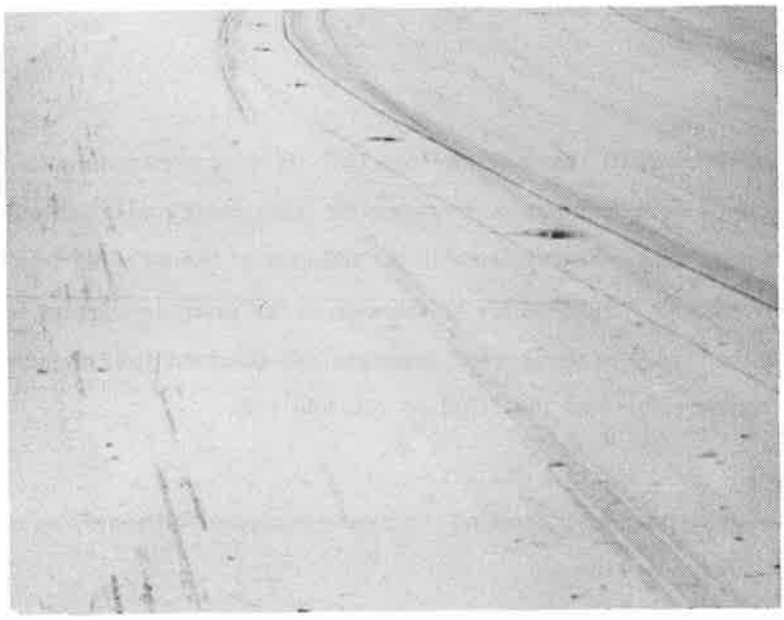

Figure 2-8. Centerline Lighting Installation on Bridge

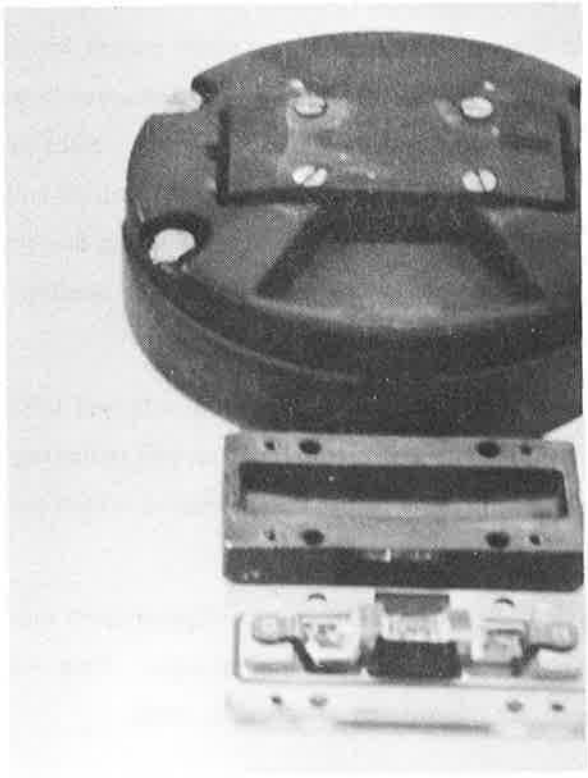

Figure 2-9. L-852, Type II Centerline Fixture and Assembly Breakdown

Figure 2-10 shows the bridge C/L lighting arrangements and numbering scheme used by maintenance personnel in identifying and troubleshooting defective fixtures. Note the variation in the number of lamps tying into the different transformer pots or manholes for connection to the primary circuit feeding these lamps. Similar types of numbering schemes are used for the touchdown zone and centerline lighting systems installed on 14L and 14R.

An airport map showing the areas equipped with taxiway edge lighting is shown in Figure 2-11.

2.3 RUNWAY LIGHTING

All of the major runways at O'Hare, except runway 4L-22R, are equipped with high-intensity edge lighting. These base-mounted fixtures are in accordance with Specification L-819 having fixed focus, bidirectional globes housing 6.6 amp, 200-watt quartz lamps. The globes are clear except for some of the fixtures on Runways 14L-32R and 14R-32L. These are discussed below in connection with the centerline and touchdown zone lighting systems. Runway 4L-22R is equipped with medium intensity, L-802 base-mounted fixtures equipped with 30-watt lamps in the center section of the runway and alternating 30-watt and 45-watt lamps at both end sections to indicate touchdown and takeoff portions of the runway.

Figures 2-12 and 2-13 are photographs of typical L-819 and L-802 fixtures, respectively, showing the differences in construction and mounting details as well as the power plugs for connection to the transformers which are contained within the base.

As previously mentioned, Runway 18-36 is edge-lighted with modified Air Force edge lights operating in parallel from a 110 Vac source. This runway is used infrequently and is not used for takeoffs or landings at night.

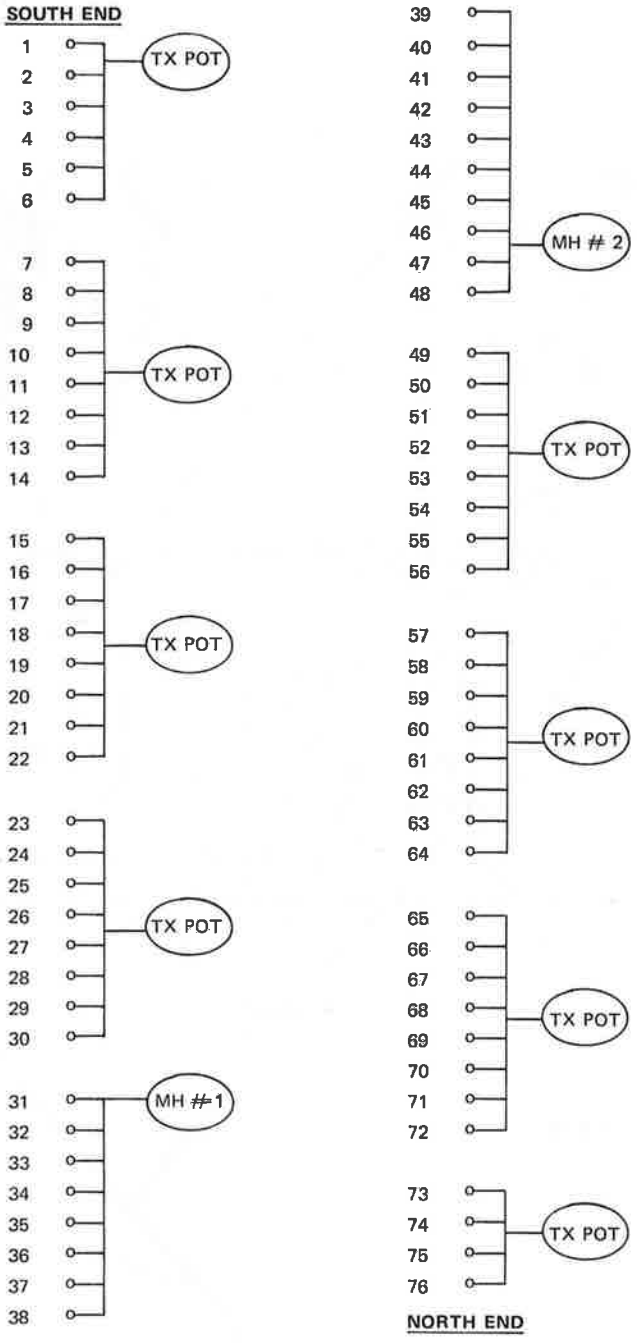

Figure 2-10. Bridge C/L Lighting Arrangement

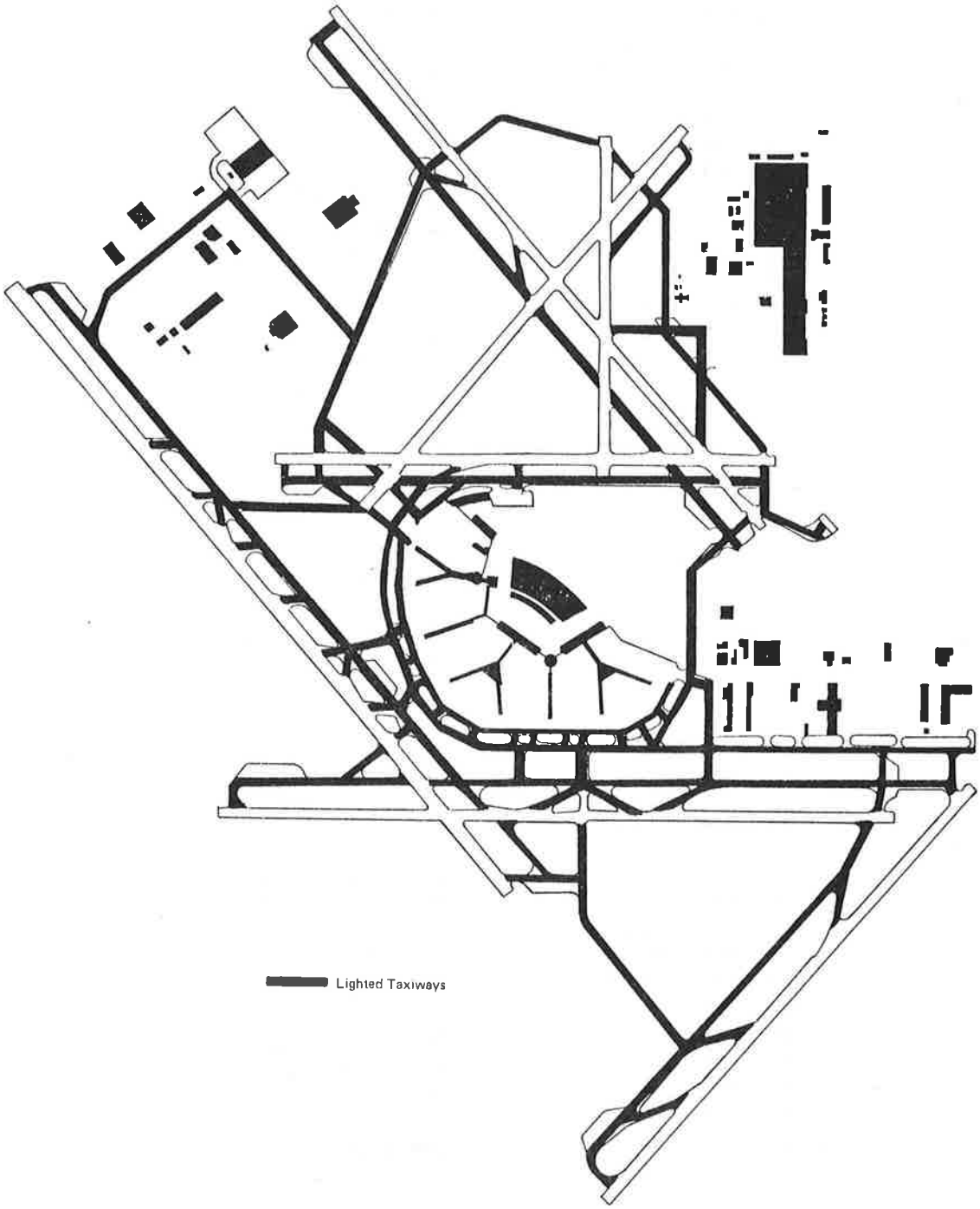

Figure 2-11. Areas of the Airport With Taxiway Lighting Installed

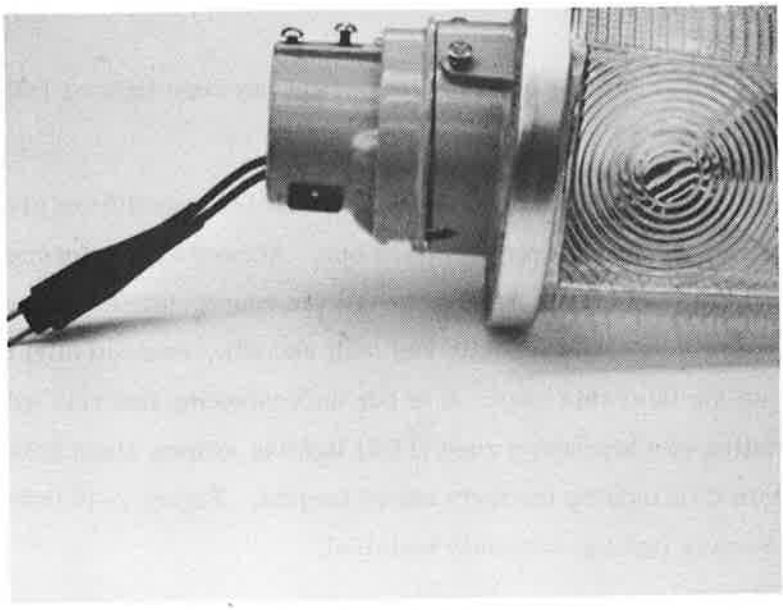

Figure 2-12. Typical L-819 Fixture

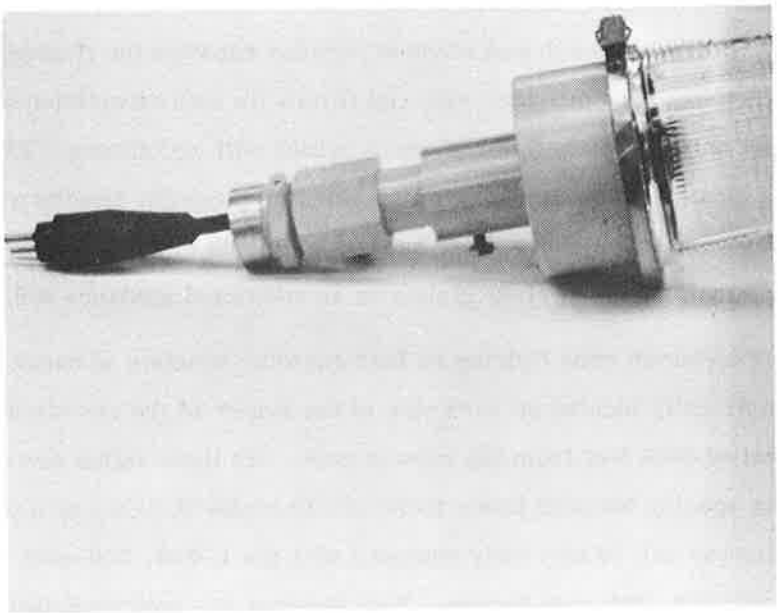

Figure 2-13. Typical L-802 Fixture

Figure 2-14 identifies the types of runway edge lighting installed for the various runways.

At present, only two runways--14L and 14R--at O'Hare are equipped to handle aircraft during Category II conditions. According to information provided during the survey it is planned to install the appropriate facilities to permit Category II operations at the opposite end (32R and 32L, respectively) of these runways sometime later this year. It is our understanding that this will only entail installation of a touchdown zone (TDZ) lighting system since both runways already contain C/L lighting for their entire lengths. Figure 2-15 indicates the Category II Runway lighting currently installed.

Centerline lighting on both of these runways utilizes the L-850A, 200-watt, bidirectional fixtures. These fixtures are installed at 50-foot intervals resulting in a total of 198 fixtures on 14L-32R and 230 fixtures on 14R-32L. Figure 2-16 provides a view of the basic fixture while Figure 2-17 provides an assembly view showing the lamp and lens mounting arrangement. Note also the slots available at the outer side of the lens holders which are provided for insertion of color filters. At each end of these parallel runways the fixtures located in the first 1000 feet are provided with red filters (in both directions) while in the next 2000 feet only alternate fixtures are provided with red filters. The use of these filters aids the pilot in determining remaining runway lengths available to him. Runway edge lights above these runway segments are provided with yellow globes rather than the usual clear globes as an additional guidance aid.

Touchdown zone lighting on both runways consists of banks of three lights symmetrically located on each side of the center of the runway and extending for a total of 3000 feet from the runway ends. As these lights are installed with 100-foot spacing between banks there are 30 banks of lights or a total of 180 fixtures. Runway 14L is currently equipped with the L-843, 200-watt fixture and 14R with the L-850, 200-watt fixture. Both fixtures are unidirectional.

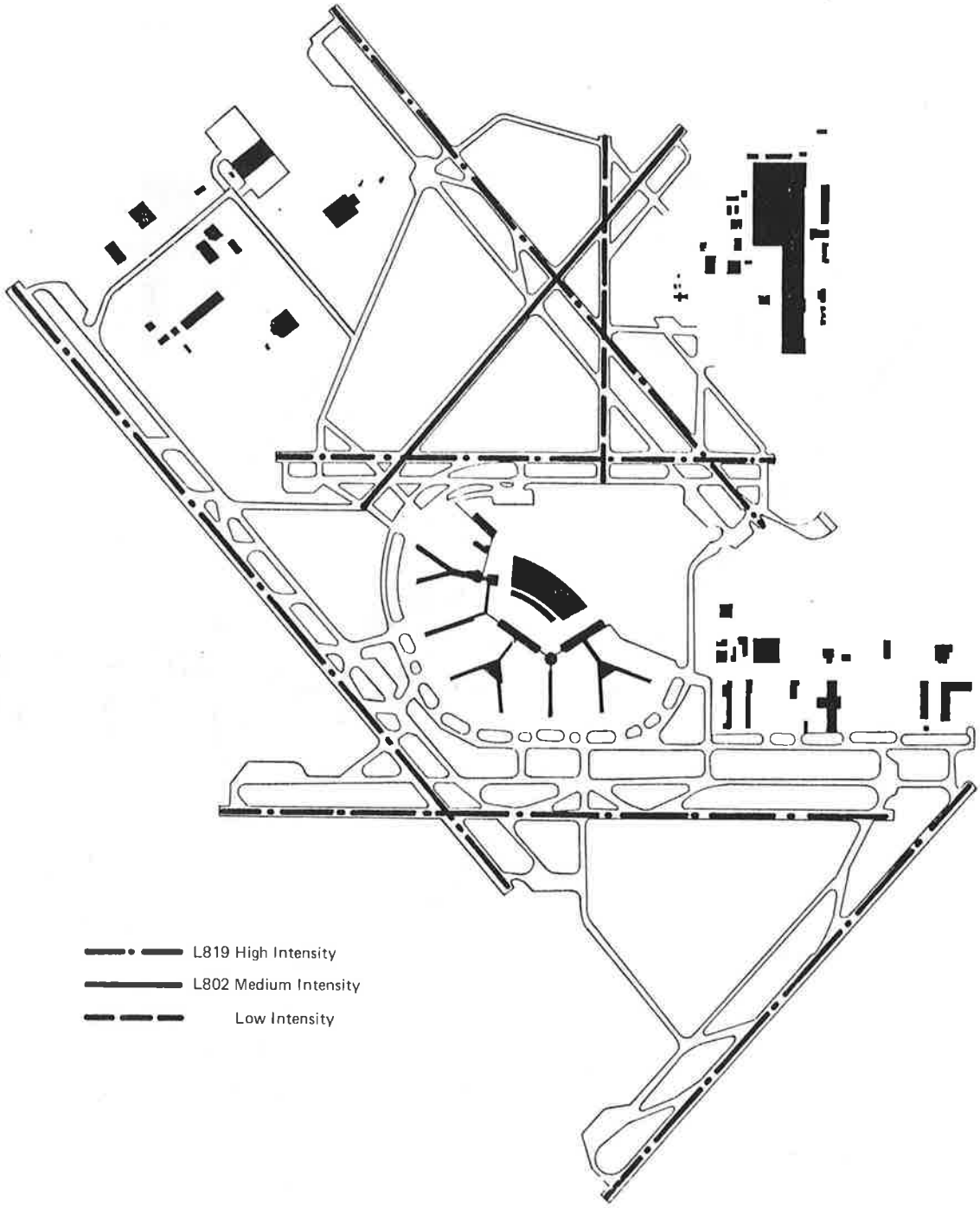

Figure 2-14. Runway Edge Lighting

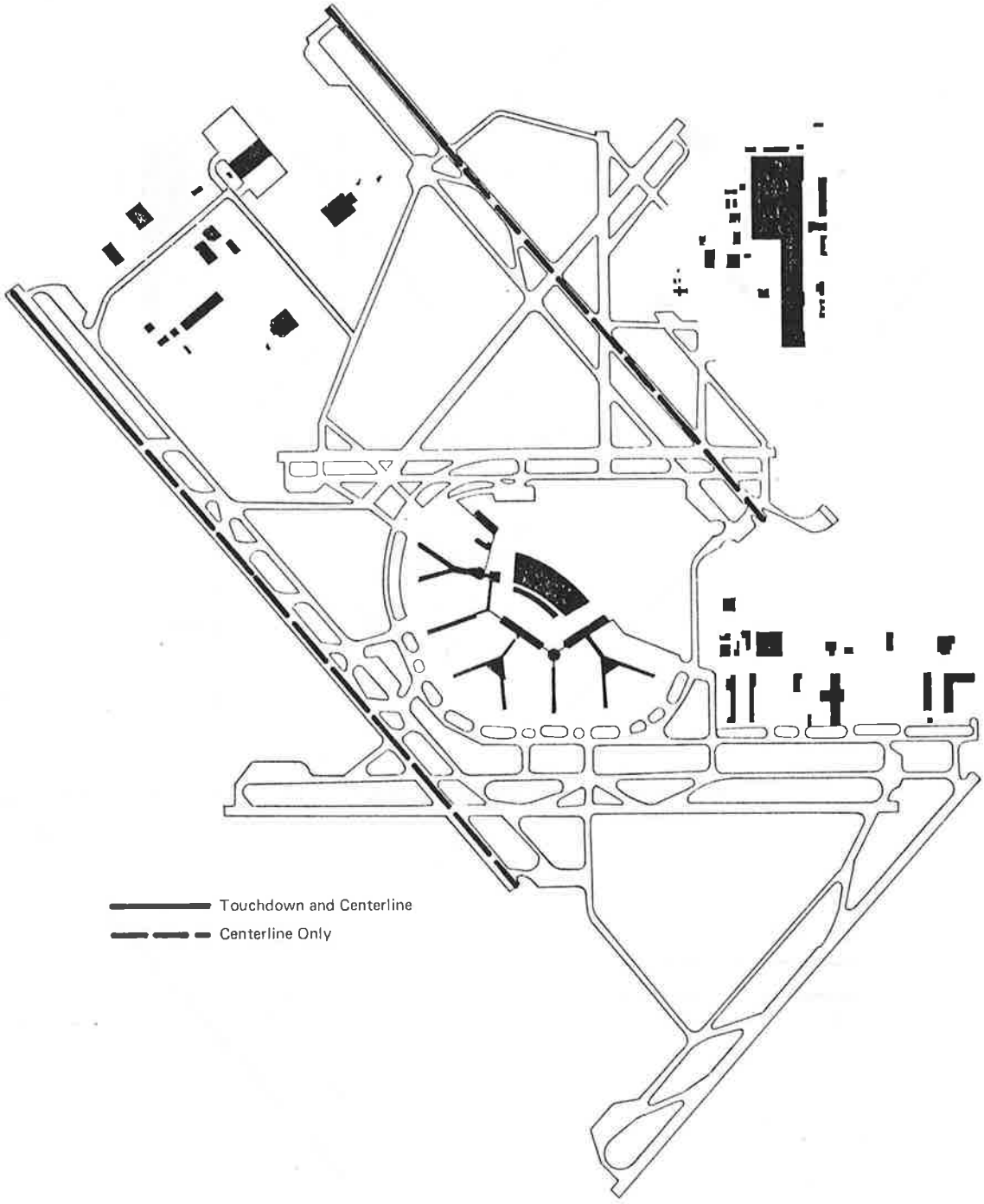

Figure 2-15. Category II Runway Lighting

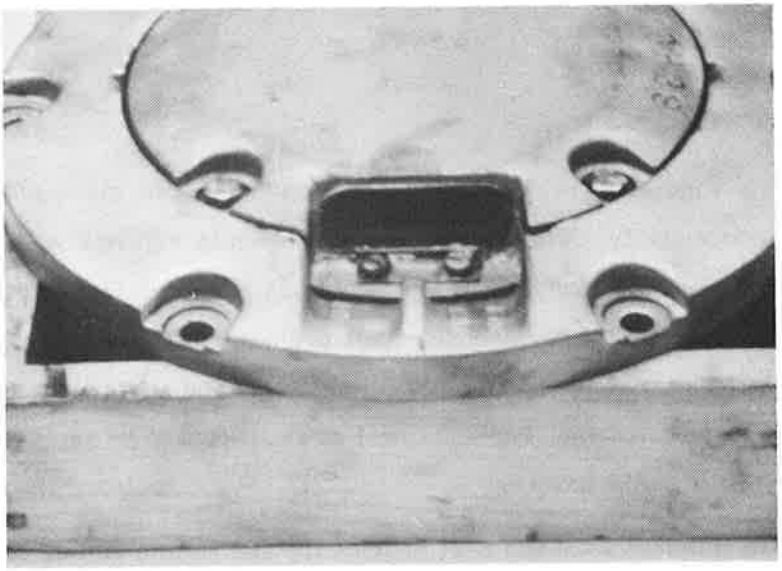

Figure 2-16. View of L-850 Fixture

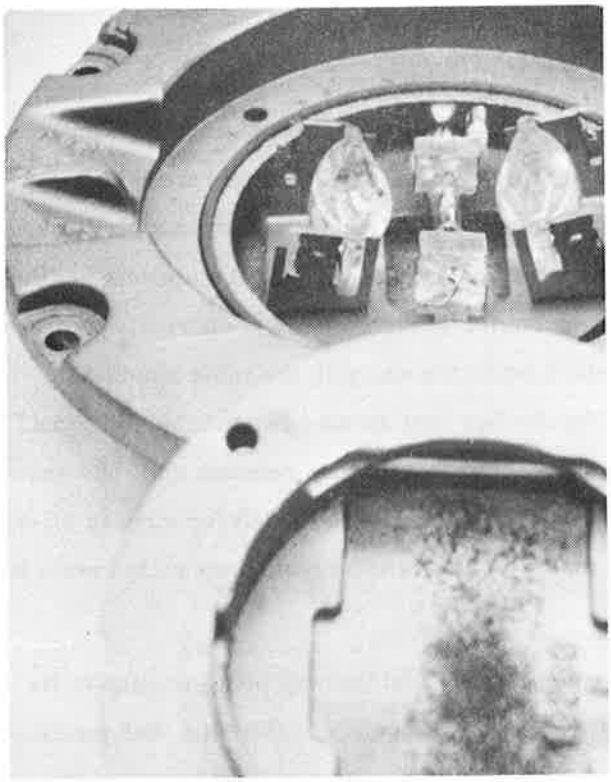

Figure 2-17. Assembly View L-850 Fixture

Figures 2-18 and 2-19 provide top and bottom views of the L-843 fixture, respectively. The metallic contacts seen in Figure 2-19 provide a mechanical pressure contact with the terminals housed in the installed base assembly. There have been considerable problems with this arrangement as a result of annealing of the copper/beryllium strips and subsequent arcing and pitting of these contacts. These fixtures are expected to be replaced in the near future with the L-850 fixture.

Figures 2-20 and 2-21 provide top and bottom views, respectively, of the L-850 touchdown zone fixture. Note the differences in the construction of this fixture compared to the L-843. The lamp for this fixture is a bayonnet-mounted type (see lamp detail in Figure 2-21), and the socket has wire pigtails for direct connection to the contact posts located in the installed base for this fixture.

2.4 LIGHTING INSTALLATION DATA

Table 2-3 has been prepared to provide an indication of the approximate numbers of fixtures installed at O'Hare. Included also are the major suppliers of these fixtures. The data were extracted from a list dated 8 May 1972 and therefore do not necessarily agree in all respects with the current configuration. For example, the physical inventory of sign locations currently indicates that only 179 lighted signs are in place while the entry in the table shows 210. This discrepancy can be explained by the fact that an unknown number of signs have been blown or knocked down or removed for various reasons and thus were no longer in place when the survey was taken. It is known that for runway 4R-22L alone eight signs are no longer in place. There are no plans currently known for re-installation of these signs.

The evolution of the airport runway and taxiway configuration to its present capabilities has been via a series of expansions, additions, and modifications to the former existing layout. Consequently, dates of installation of the accompanying lighting systems are quite varied for different sections of the airport.

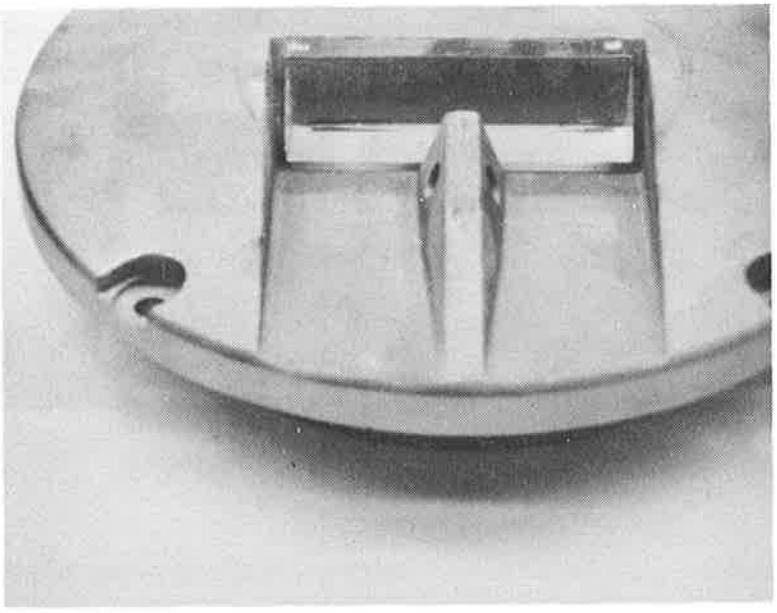

Figure 2-18. Top View of L-843 Fixture

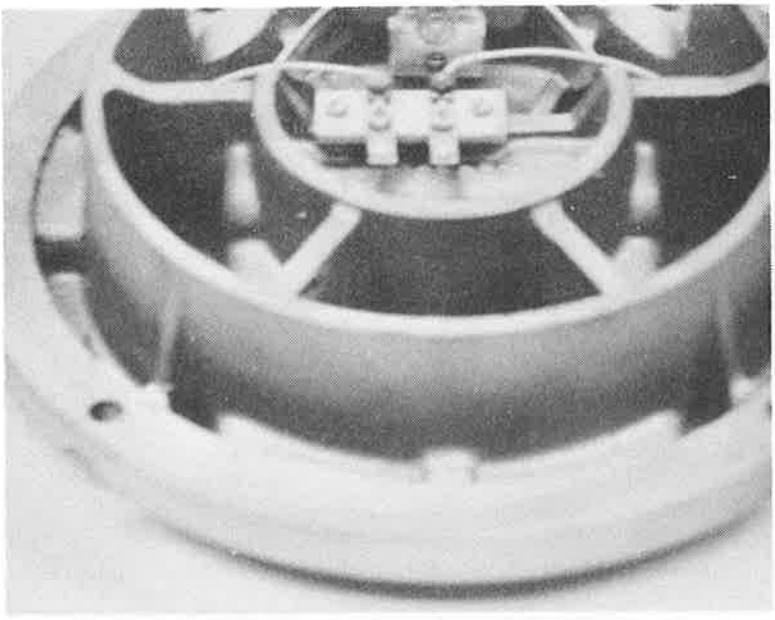

Figure 2-19. Bottom View of L-843 Fixture

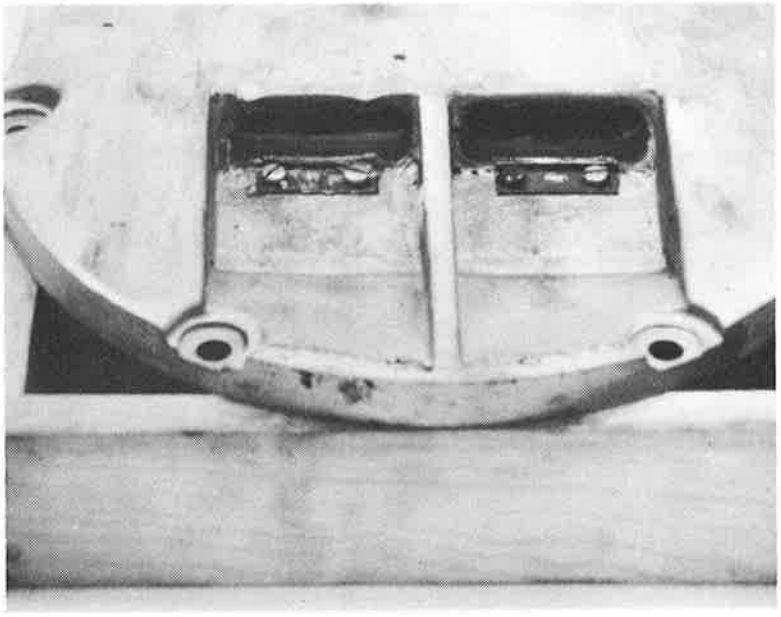

Figure 2-20. Top View of L-850 TDZ Fixture

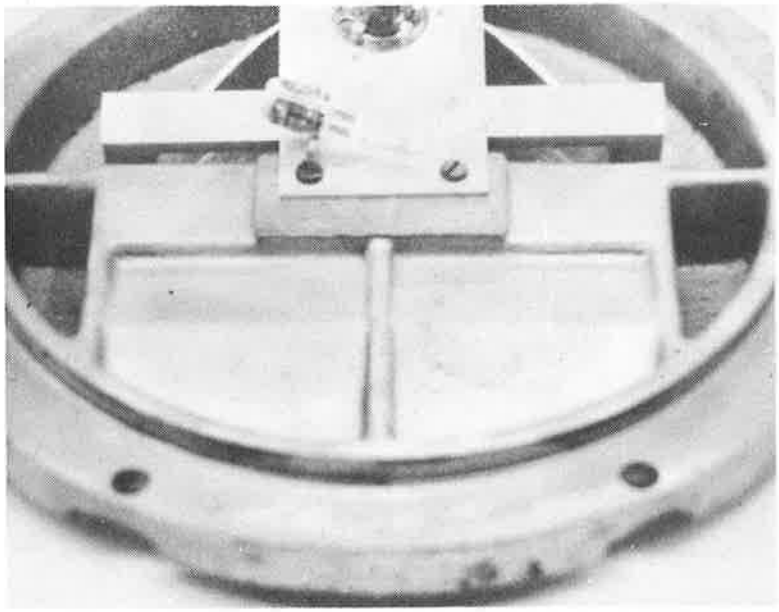

Figure 2-21. Bottom View of L-850 TDZ Fixture

TABLE 2-3. SUMMARY OF FIXTURE DATA*

Fixture	Approximate Number Installed	Supplier
C/L Taxiway - 45W	80	Sepco
C/L Taxiway - 65W	80	Sepco
C/L Runway - 200W	428	Sepco
TDZ Runway (14R) - 200W	180	Sepco
TDZ Runway (14L) - 200W	180	Crouse-Hinds
Edge Lighting Runway 200W	1225	Crouse-Hinds
Edge Lighting Taxiway 30W	2580	Crouse-Hinds
Edge Lighting Taxiway Flood 45W	84	Crouse-Hinds
Taxi Guidance Signs (1-8 sections)	210	Crouse-Hinds

*See text.

Based on data researched from various drawings and revisions thereto, most of these installations were accomplished in the early and middle 1960 period.

The most recent installation is runway 4R-22L with its associated taxiway systems which was completed in 1971. Touchdown zone and centerline lighting was installed in 1967 for runway 14L-32R and in 1968 for 14R-32L. Standby power was added to the lighting control vault in 1970.

Information as to installation costs for the various types of fixtures was sought from the Department of Aviation in Chicago. As mentioned earlier, we were advised that any attempt to develop cost reference data based on installation work completed at various times over the years at O'Hare would be futile. Consequently, these data were not made available. However, some typical post data were provided for a number of different fixture types as shown in Table 2-4 based on recent quotations submitted for these types of installation both for O'Hare Airport and some unidentified activity in Indiana.

TABLE 2-4. TYPICAL INSTALLATION COSTS

Fixture Type	Approximate Installed Unit Cost	Remarks
Taxiway Edge Light	$ 150	Plus power
Runway Edge Light	$ 300	Plus power
Lighted Signs		
3-Panel	$ 400	Plus power
5-Panel	$ 700	Plus power
7-Panel	$1000	Plus power
Touchdown Zone Lights	$1000	Includes power
Runway Center Line Lights	$1000	Includes power

These figures reflect two major categories of installation. The first category consists of fixtures to be mounted along the edges of runways and taxiways and costs are exclusive of power. The second category consists of fixtures that are mounted into runway pavement and requires that sawkerfs be cut into the pavement to allow for installation of the power cables to each of the fixtures. In addition, the installation of touchdown zone or centerline lights requires independently controllable power sources so that cabling must be extended from the actual installation site to a power control vault for connection to separate regulators for each circuit. The prorated costs include these additional requirements.

Several observations may be made concerning the apparent differences in the indicated costs. These are described below.

1. With the exception of the sign installation costs, the indicated installation cost for all fixtures is approximately four times the basic cost of the fixture. This is in excellent agreement with an approximate rule of thumb provided by a fixture manufacturer which is that the total installation cost (including the fixtures) is five times the basic cost of the fixture.

   In a specific example cited, the total cost for the installation of approximately 200 centerline lights and 180 touchdown zone lights inclusive of preparation, wiring, parts, regulators and labor would be approximately $475,000 to $500,000. The basic fixture price was approximately $250 average for the two fixtures cited.

2. In the case of runway and taxiway edge lighting it is believed that the cost is based on modification of existing pavements. As a result minimal additional cost to power the fixtures will be incurred since the existing circuits are simply extended to include the new fixtures and no new "home runs" or regulators are required.

3. The installation costs shown for the three sizes of signs are approximately 1.33 to 1.5 times the basic cost of the sign. This slight variation is not very significant. As in the case of edge lighting, power may be assumed to be an extension of existing circuits so that the cost to do this is again not expected to be significant.

Finally, variations in installation costs can be expected as a result of many influencing factors, some of which are listed below:

- Size of installation and quantity of accessories and parts such as cable ducts, wiring, regulators, etc.
- New installation versus modification or extension of an existing installation
- Geographic Location - Climate
- Geographic Location - Labor Costs
- General Business Climate - Competition

2.5 LIGHTING MAINTENANCE

Maintenance of the lighting systems at O'Hare is performed by the electrical maintenance group. A considerable stock of spare parts is maintained for the various types of fixtures used on and adjacent to runways and taxiways.

Typical repairs required for edge lights are replacement of burned out lamps and cracked globes (especially for runway edge lights) resulting from loose pebbles kicked up by the jet blast from passing aircraft.

A major maintenance item is the upkeep of touchdown zone and centerline lighting fixtures on the 14L and 14R runways. The workload is especially difficult during the winter months when fixtures are subject to physical damage by snowplow blades. An additional problem is occasional damage to the optical assemblies from the considerable hydrostatic pressure resulting from the compression of water and or slush by aircraft tires passing directly over the fixture.

The specific criteria for in-runway lighting which must be satisfied in order to maintain the Category II rating for runways 14R and 14L include the following:

1. No more than ten percent of the lights of the Centerline Lighting System shall be inoperative.

2. No more than ten percent of the lights on either side of the Touchdown Zone Lighting System shall be inoperative.

3. No more than four consecutive lights of the Centerline Lighting System shall be inoperative.

4. No more than one bar (three-light fixture) of the Touchdown Zone System may be inoperative; however, two adjacent bars on the same side of the system shall not be inoperative. A bar is considered inoperative when all of its lights are out.

As long as these requirements are met the general maintenance policy is not to close down the runway to effect repairs. Thus when a repair crew is sent out, the number of fixtures relamped or replaced represents failures occurring over varying periods of time. For example, on 6/12/74 eleven of the 198 centerline lights were burned out on runway 14L. However, it could not be determined over what period of time these failures took place.

It should be recognized that the basic fixtures used are subject to continued improvements by the manufacturers as ways are found to alleviate common causes of failure. Since the damaged fixtures are normally brought back to the maintenance shop for complete cleaning and refurbishing the improvements offered by the modified fixtures are only obtained when the original part is actually replaced.

Unlike many other airports, O'Hare has found it more expedient to do all of the required repairs and replacement of parts in house. In addition to the quicker turnaround time achieved, considerably fewer of the basic fixture components are required to be in the inventory.

Figure 2-22 shows a maintenance man operating a blasting machine used in removing rubber deposited by aircraft tires on touchdown and rust which has accumulated on various parts of the touchdown or centerline fixtures. Small glass beads are sprayed under pressure against the fixture which has had all glass components removed or covered before the refurbishing process is begun. Failure of the O-ring seals or the previously mentioned breakage of the optical assembly

Figure 2-22. Maintenance Man Using Blasting Machine

seals are the most common failures which allow water to enter the housing and quickly erode the various internal parts.

After the fixtures have been cleaned and broken lenses, optical assemblies, and electrical contacts replaced or cleaned, the fixtures are relamped and stored either in the shop or in a trailer. The trailer is towed to the field when lamps or fixtures are to be replaced. Sufficient stock is maintained in the trailer to meet the needs of normal replacement activities which are performed during the midnight shift when airport operations tend to be at minimum levels.

Another type of problem encountered with the L-843 touchdown zone fixture is with the two copper beryllium spring contacts used to establish the electrical connection between the lamp housed in the fixture and the electric contact posts housed in the shallow base which is epoxy bonded to the runway surface. The spring contacts tend to soften through an annealing process thus eventually causing arcing and subsequent failure.

Furthermore, if the lead-in wire to the shallow base fails the repair process is difficult. The epoxy-mounted base cannot readily be removed since it takes approximately 24 hours for the epoxy of the newly mounted base to harden. In addition, the temperature must be maintained above 40°F. This type of repair, therefore, would require complete shutdown of runway 14L for at least 24 hours after the repair is completed. Generally, in the instance of input cable failure to this base, the epoxy in the slot containing the lead-in wire is chipped out, a hole is drilled into the side of the still mounted base and then a new wire for connection to the contact posts is pulled in. The slot is then sealed with epoxy and the fixture is ready to be returned to service.

The budget for the electrical maintenance shop indicates a crew of 66 men; however, the actual number of employees is normally less than sixty. Approximately 1/3 of the crew is assigned to runway/taxiway lighting and sign maintenance while the remaining 2/3 are assigned to various maintenance functions throughout the airport buildings. This represents an annual cost of approximately $1.3 million.

The data collected on the cost of spare parts and the number of units ordered were limited to typical significant elements. A complete listing would be impractical undertaking due to the extremely large number (more than 5000) of items involved in the electrical maintenance inventory. Table 2-5 represents some typical data collected during the survey.

TABLE 2-5. TYPICAL REPLACEMENT/COST DATA*

Part Designation	Function or Use	Approximate Yearly Qty	Approximate Unit Cost ($)
18929/19265	C/L Optical Assembly	100	47.23
200W-6.6A/T4 CDR	TDZ Lamp	500	7.50
200W-6.6A-19258	Prefocused Assembly	500	15.55
200W-6.6A/T14P	Runway	2000	2.40
45W-6.6A/T10P	Runway/Taxiway	2000	1.05
30W-6.6A/T10/1P	Runway/Taxiway	2000	0.98
30W-6.6A/T10/4P	Taxiway External Shield	300	3.70
45W-PAR 56/5	Taxiway Marker Light	100	3.40
ML 331	Blue Globes	600**	6.11
ML 47	Green Globes	200	11.75
---	Amber Globes	50	6.11
ML 48	Clear Globes	20	5.90
19088	L850B TDZ Fixtures	13	128.00

*Quantity and unit costs based on 1973-1974 costs including quantity discounts to varying extents.

**Four year average quantity.

3. SIGNS

No records are kept at O'Hare of sign installations, locations, and information content. Consequently, the information provided as part of this survey was obtained by physically traversing the entire airport at various times of the day and night. Due to the general level of aircraft activity and the need for a maintenance vehicle and driver to gain access to the various parts of the airport runway and taxiway system, it was necessary to conduct this survey activity over an extended period of time.

There are two basic types of signs installed, namely, internally lighted, elevated taxi guidance signs, and non-lighted, elevated billboard type informational signs. Of the 179 internally lighted signs identified in the survey, approximately 150 are the standard L-829 type signs as depicted in Figure 3-1. These signs are constructed with various numbers of sections depending on the information content to be displayed. The number of sections ranged from 1 to 8 with an average being approximately 4 sections per sign.

Each section of the sign contains a 45-watt lamp which can illuminate both sides of the sign, if necessary. All lighted runway and taxiway signs at O'Hare are connected to the existing taxiway circuits. None are connected to runway circuits of any type.

Approximately 85 percent of the sign messages are directional guidance information for the pilot. An example would be "K-Ramp → " where the arrow, if used, will indicate the direction to go for the K ramp. About 10 percent of the sign messages are location guidance for the pilot. An example would be "T3" or "STUB" that indicates a specific unique spot on the field such as the T3 exit taxiway off runway 14R. The other five percent of the sign contents are control or precautionary. Examples like "CAT 2" or "RNWY" are used to indicate the position of critical CAT 2 and runway hold lines painted on taxiway surfaces. Such lines are difficult to see at night or when snow covered.

Figure 3-1. Internally Lighted Type L-829 Taxi Guidance Sign

Sign information is orange-yellow on a black background. There are two basic construction methods for the sign inset panel:

1. Solid metal sheet with cutouts for letters or other information. A piece of colored plastic then is attached on the inside surface of the sheet.

2. All plastic sheet with cutout and colored plastic backing on inside surface.

In both cases the basic inset panel is opaque with light passing only through the cutouts.

The remaining internally lighted signs were developed by one of the electrical maintenance foremen at O'Hare. Figure 3-2 is a picture of one of the installed signs on the bridge taxi route near the K ramp. This type of sign, called a "TRI-PAC" sign, provides upward slanted panels which serve a dual purpose since they are more nearly perpendicular to the viewing line of the cockpit crew of an aircraft and also are more capable of withstanding the effects of jet blast from aircraft passing by. Variations of this sign have been installed at O'Hare for several years and recently have gained formal approval from the FAA. Patents are pending for the design features of this sign as well as the name.

In addition to the lighted signs discussed above, there are 16 unlighted wooden billboard signs of various sizes. These sizes, most of which are located in the northeast section of the airport, provide mandatory control information such as "747 NO STOP ON BRIDGE" and "DO NOT TAXI BEYOND THIS POINT", as well as directional and other information such as "ALTIMETER CHECKPOINT RAMP ELEV 645.0 MSL".

These signs are constructed by personnel in the carpenter's shop and the painting and lettering is done by personnel in the painter's section. The background of these signs is black and the lettering is white except for the "747 NO STOP ON BRIDGE" sign which has a red background with white lettering. A typical sign installation is shown in Figure 3-3.

Figure 3-2. Internally Lighted "TRI-PAC" Taxi Guidance Sign

Figure 3-3. Typical Billboard Sign Installation

As previously mentioned, there was not documentation which permitted identification of sign installation dates. However, it can be assumed that sign installations were accomplished at the time of runway/taxiway construction or modification.

Based on the information collected during the survey, the locations and content, respectively, of the various signs are shown in Figure 3-4 and Table 3-1. In order to assist the personnel who may have a further requirement for more detailed location information the numbering scheme has been selected to key to the page numbers of the "Composite Utilities Drawings" for Chicago-O'Hare International Airport. These drawings are arranged to depict various airport details on a sectionalized or grid basis. Thus, for example, a sign identified as 22-15 would indicate that the grid depicting the area where the sign is located is found on Page 22 and that the sign is the fifteenth sign in that section.

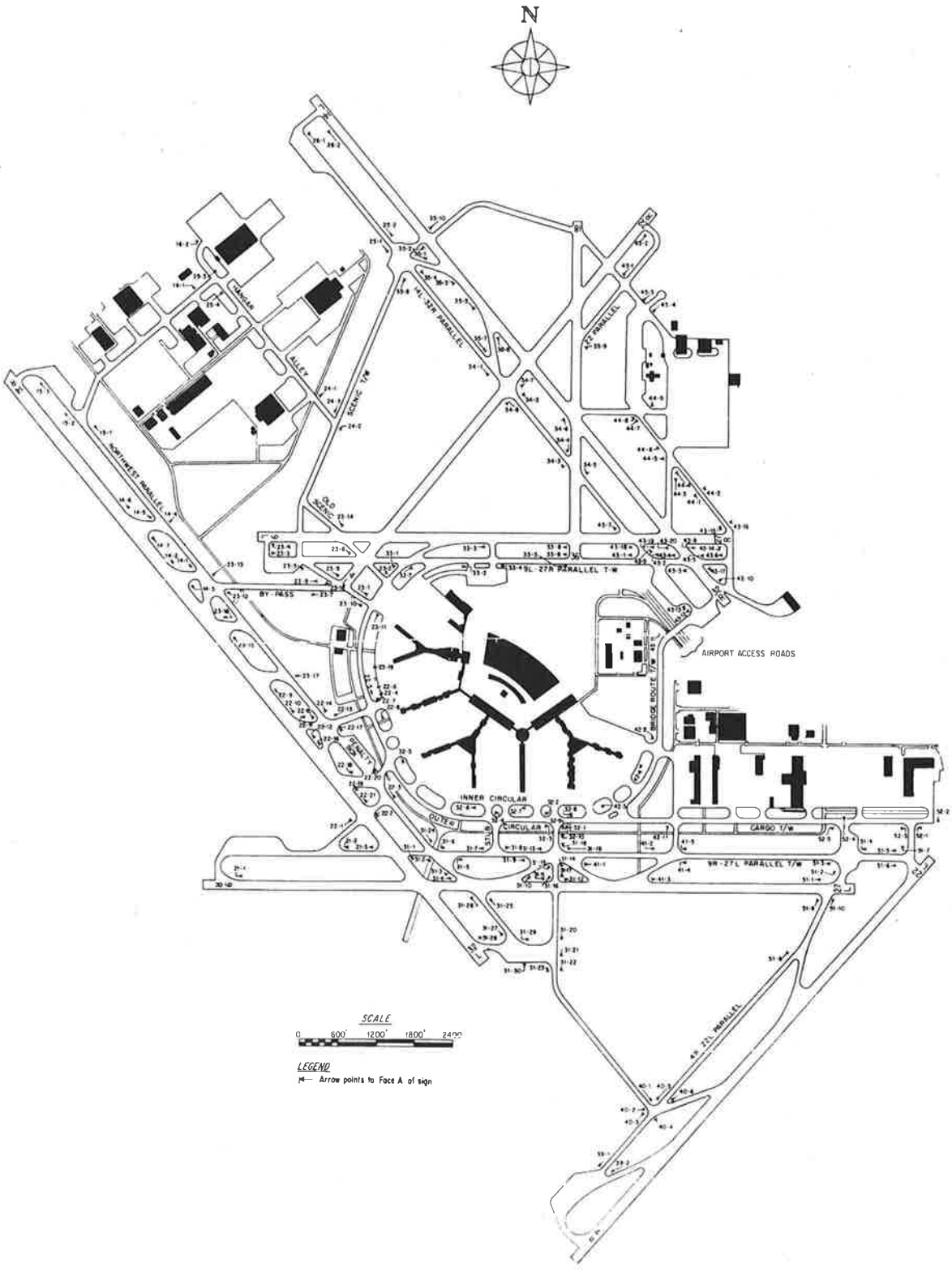

Figure 3-4. Visual Ground Aids at O'Hare International Airport

TABLE 3-1. SIGN LEGEND (SHEET 1 OF 12)

Sign Identification No.	Face A	Face B	Remarks
14-1	T7	T6	
14-2	T6	T7 ↑	
14-3	T6	T5 ↑	
14-4		RAMP →	
14-5	T7	T7	
14-6	T7	↑T8	
14-7	T7	↑T6	
15-1	HGR →	↑ RAMP	
15-2	↑ T8	← HGR	
15-3	CAT-2		
16-1		← 14R	
16-2	← →		

TABLE 3-1. SIGN LEGEND (SHEET 2 OF 12)

Sign Identification No.	Face A	Face B	Remarks
21-1		RAMP →	Sign blown down
21-2	↖-E	TAXI	
21-3	32L	↑9R	
22-1	14R-32L	↑9R	
22-2	←RAMP	T1	
22-3	32L ↑	T1	
22-4	←B-C	↑14R	
22-5	←B-C	B-C→	
22-6	←RNWY→		
22-7	T3		
22-8	←D	D→	
22-9	↑T5	T4	
22-10	T3	↑T4	
22-11	T3	T3	
22-12	T3	T4 ↑	
22-13		RAMP→	
22-14	←RAMP	T4 ↑T8	
22-15	T2 ↑	T3	
22-16	T2	T3 ↑	
22-17	←RAMP	RAMP→	
22-18	T2	T2	
22-19	T1 ↑	T2	
22-20	RAMP	14R→	
22-21	T1	T2 ↑	

TABLE 3-1. SIGN LEGEND (SHEET 3 OF 12)

Sign Identification No.	Face A	Face B	Remarks
23-1		↑OLD	
23-2		↖OLD	
23-3	9L →		
23-4	9L		
23-5	↑RAMP	↖9L	
23-6	RNWY	↑14L	
23-7	14R ↗	RAMP ↗	
23-8	RAMP ↗	14R ↑9L ↗	
23-9	RAMP ↑	↑9L	
23-10	↑RAMP	4L ↑9L	
23-11	B →	NEW →	
23-12	14R ↗	BYPS ↖	
23-13		RAMP →	
23-14	9-27	↑14L	
23-15	↑T6	T5	
23-16	T5	T5	
23-17		RAMP →	
23-18	↑9L	↑RAMP	
23-19	← →		

TABLE 3-1. SIGN LEGEND (SHEET 4 OF 12)

Sign Identification No.	Face A	Face B	Remarks
24-1	See Note	See Note	
24-2	RAMP ↑	← HGR	
24-3	HGR →	14L ↑	
	NOTE Faces A and B are the same VE ← NO | HI TU | CL RNS | ES → | 4 section sign Reduced letter size		
25-1	RAMP →	↑ 14L	
25-2		CAT 2	
25-3	14L →		
25-4	←	←	
26-1	CAT 2		
26-2	← RAMP		

TABLE 3-1. SIGN LEGEND (SHEET 5 OF 12)

Sign Identification No.	Face A	Face B	Remarks
31-1	RNWY		
31-2	TAXI	RNWY	
31-3	↑32L	TAXI	
31-4	↖EXIT	RNWY	
31-5	TAXI	RNWY	
31-6	↑27L	TAXI	
31-7	STUB	TAXI	
31-8	STUB	TAXI	
31-9	TAXI	↑9R	
31-10		RNWY	
31-11	←RAMP	EXIT→	
31-12	RAMP→	←EXIT	
31-13	4R→	TAXI	
31-14	4R→	TAXI	
31-15	TAXI		
31-16	EXIT	RNWY	
31-17	↑32L	EWTX	
31-18	↑G-H	↑32L	
31-19	N-S	←H	
31-20	TAXI	RNWY	
31-21	32L→	RAMP↑	
31-22	4R ↑	TAXI	
31-23	4R ↑	←32L	
31-24	EWTX		
31-25	9L-27L		
31-26	RNWY	4R ↑	

TABLE 3-1. SIGN LEGEND (SHEET 6 OF 12)

Sign Identification No.	Face A	Face B	Remarks
31-27	TAXI	↑ RAMP	
31-28	32L		
31-29	←RAMP	TAXI	
31-30		← ← 4R	
32-1	← 32L	↑ CRGO	
32-2	←	→	
32-3		32L →	
32-4	← STUB	STUB →	
32-5	← E	E →	
32-6	← F	F →	
32-7	← G	G →	
32-8	← H	H →	
32-9	↑ 32L	CARGO →	
32-10	AIRCRAFT DO NOT BLOCK SERVICE ROAD		Wooden sign, non-electric

TABLE 3-1. SIGN LEGEND (SHEET 7 of 12)

Sign Identification No.	Face A	Face B	Remarks
33-1	32 ↗	RAMP ↑	
33-2	↖ RAMP		
33-3		↖ EXIT	
33-4	↑ INTL		
33-5	← 18-36		
33-6	RAMP →	← RAMP	
33-7	32 ↑ 27	RAMP ↑	
33-8	RAMP →	← RAMP	
34-1	4-22	14L ↑	
34-2	4-22	RAMP	
34-3	18-36	14L ↑	
34-4	TAXI		
34-5	RAMP ↑	36-18	
34-6	← 36	36 →	
34-7	← RAMP	RNWY	
34-8	TAXI	RAMP →	

TABLE 3-1. SIGN LEGEND (SHEET 8 OF 12)

Sign Identification No.	Face A	Face B	Remarks
35-1	TAXI	TAXI	
35-2	14L		
35-3	EXIT ↗	TAXI	
35-4	↑14L		
35-5	TAXI	↖EXIT	
35-6	RNWY		
35-7		14L ↑	
35-8	CAT-2	RAMP ↑	
35-9	18-36	22R ↗	
35-10	CAT-2		
39-1	4R ↑	RAMP ↑	
39-2	RAMP →		

TABLE 3-1. SIGN LEGEND (SHEET 9 OF 12)

Sign Identification No.	Face A	Face B	Remarks
40-1	TAXI	RAMP ↑	
40-2		RAMP →	
40-3	TAXI	4R ↑	
40-4		4R →	
40-5	TAXI	← RAMP	
40-6	↑4R	CARGO ↑	
41-1	← 4R	↑ 27L	
41-2	← CRGO	TAXI	
41-3	EXIT		
41-4	↑ 27L		
41-5	← CRGO	TAXI	
42-1	← RAMP		
42-2	K-RAMP →	27R-32R ↑	
42-3	H-RAMP →	27R-32R ↑	
42-4	← K	K →	

TABLE 3-1. SIGN LEGEND (SHEET 10 OF 12)

Sign Identification No.	Face A	Face B	Remarks
43-1	TAXI		
43-2	RAMP →		
43-3	32R		
43-4	↑27R		
43-5		32R	
43-6	← 27R		
43-7	27R-9L	14L ↑	
43-8	RAMP →		
43-9	TAXI	↑14L	
43-10	32R	↖27R	
43-11	747 NO STOP ON BRIDGE		Wooden sign, non-electric, white letters on red background
43-12	32R	↑RAMP	
43-13		RAMP →	
43-14	NO PARKING BEYOND THIS SIGN		Wooden sign, non-electric
43-15		DO NOT TAXI BEYOND THIS POINT UNTIL CLEARED BY TOWER	Wooden sign, non-electric
43-16		DO NOT TAXI BEYOND THIS POINT UNTIL CLEARED BY TOWER	Wooden sign, non-electric
43-17		RAMP	
43-18	TAXI		
43-19	RAMP →		
43-20		← RAMP	

TABLE 3-1. SIGN LEGEND (SHEET 11 OF 12)

Sign Identification No.	Face A	Face B	Remarks
44-1		NO PARKING BEYOND THIS SIGN	Wooden sign, non-electric
44-2		NO PARKING BEYOND THIS SIGN	Wooden sign, non-electric
44-3		ALTIMETER CHECK POINT RAMP ELEV. 645.0 MSL	Wooden sign, non-electric
44-4	AIR FORCE RAMP		Wooden sign, non-electric
44-5		SOUTH TAXI	Wooden sign, non-electric
44-6		SOUTHEAST TAXI	Wooden sign, non-electric
44-7	SOUTHEAST TAXI		Wooden sign, non-electric
44-8	WEST TAXI		Wooden sign, non-electric
44-9		TAXI CLOSED	Wooden sign, non-electric

TABLE 3-1. SIGN LEGEND (SHEET 12 OF 12)

Sign Identification No.	Face A	Face B	Remarks
45-1		22 ↑	
45-2	RAMP →		
45-3		ALTIMETER CHECK POINT RAMP ELEV. 645.0 MSL	Wooden sign, non-electric
45-4		TRANSIENT AIRCRAFT	Wooden sign, non-electric
51-1	← RAMP		
51-2	RAMP ↑	27L	
51-3	TAXI	↑TAXI	
51-4	22L ↑	TAXI	
51-5	← CARGO		
51-6	22L →	RAMP ↑	
51-7	TAXI	22L ↑	
51-8	RAMP ↑	4R ↑	
51-9	9R-27L	4R ↑	
51-10	RAMP ↑	4R ↑	

4. MARKERS

There are no permanent markers used at O'Hare Airport in the context of the visual ground aids definition. In the event sections of the airport must be closed as a result of an emergency or for maintenance reasons, various types of highway barricades, flags, and/or flashers are deployed at suitable locations to indicate the closed areas.

5. MARKINGS

Runway and taxiway pavement markings at O'Hare are in accordance with the standards provided in AC 150/5340-1. In general, all standard runway markings are accomplished with white paint while taxiways and closed or hazardous areas are marked with yellow paint. In certain cases, especially on light colored pavements, the standard markings are outlined with black borders in order to increase the contrast levels.

In the apron areas, pavement marking consists of a solid yellow centerline between adjacent fingers and dashed white lines in proximity to each finger to indicate the confines of the gate area. Aircraft parked at gates are restricted to the area between the finger and the dashed line so as to permit free movement of other aircraft taxiing to or from their assigned gates without danger of collision.

A typical view of the standard apron area markings may be seen in Figure 5-1. Any additional pavement markings within these so-called "lease lines" or between the centerline and the gate for nosewheel tracking are the responsibility of the individual tenant airlines. Typical of such markings are guidance lines to assist the pilots in approaching the specific gates and for docking purposes.

Pavement areas are repainted twice per year, once in the Fall and once in the Spring, by an outside painting contractor. The following is an indication of the approximate surface area that is painted with the indicated colors.

Runways: 844,000 sq ft - white
323,000 sq ft - black
101,000 sq ft - yellow

Taxiways: 150,000 sq ft - yellow

Included in the above taxiway figure are approximately 60 Hold Lines which are distributed at various taxiway/runway intersections throughout the airport.

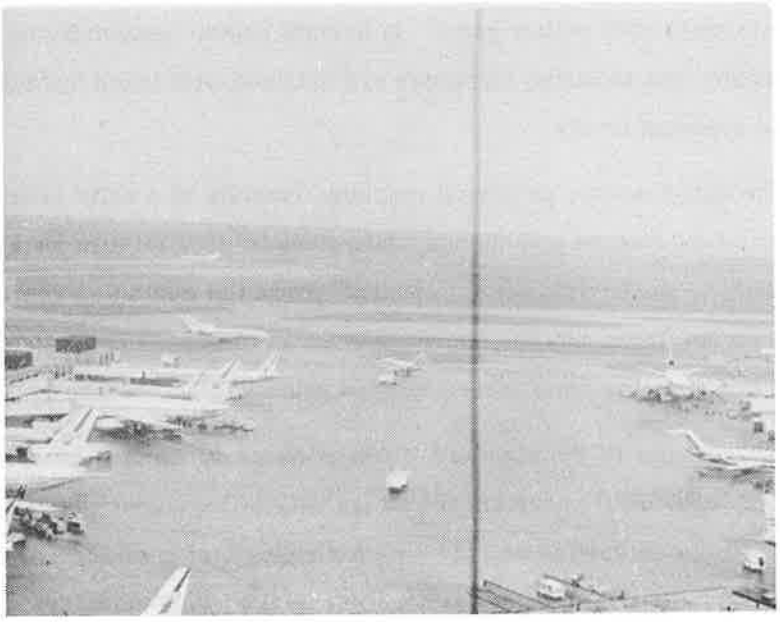

Figure 5-1. Typical View of Pavement Marking in Apron Area

In the process of applying the paint to the pavement surface, tiny glass beads are deposited on top of the fresh paint to provide a degree of reflectivity to the painted surface. In highway applications where there is a continual wearing down of the paint due to tractional forces applied by the drive wheels of automobiles, the beads, if used, are premixed with the paint so that new levels are exposed as the paint wears. In airport applications, however, aircraft tires only roll on these surfaces (except for braking) and thus no tractional forces are applied to the painted surface. Hence, the pellets need only be near the top of the paint. The most recent cost information available indicates a total cost (material and labor) for repainting as follows:

Color Paint	Cost per Square Foot
White	$.26 (including glass beads)
Yellow	$.26 (including glass beads)
Black	$.15

6. LIGHTING CONTROLS

Field lighting circuits are controlled from two lighting panels installed in the cab of the control tower. Photographs of the taxiway and runway circuit control panels are provided as Figures 6-1 and 6-2, respectively. To provide greater legibility of the switch identification and other pertinent material, drawings of these panels are provided in Figures 6-3 and 6-4 for the respective panels.

All circuits are actuated by means of toggle switches. Taxiway switches have OFF-HI-LO positions for intensity control with normal settings maintained at the low position. Only on rare occasions are any of these circuits ever set to the high position.

Runway circuits have ON-OFF toggle switches for edge, centerline, and touchdown zone lighting activation. Each of these circuits have an associated five-step brightness control capability except for the runway 4L-22R edge lighting circuit which only has a three-step control capability. In this latter instance a standard taxiway regulator is used to provide regulation for this runway circuit. The intensity is normally maintained at mid-level by tower personnel.

In all cases 110 volt (ac) control voltages are used to actuate control relays located beneath the tower cab. These relays, in turn, operate on 48 volts (dc) over standard telephone cables to the lighting control vault where another set of control relays are actuated to control the individual runway or taxiway regulators.

Operation of any given tower lighting control switch will activate a specific number of circuits serving the area designated for that switch. It is of interest to note that specific circuits may be activated by more than one tower lighting control switch. Table 6-1 illustrates the specific circuits that are actuated by each of the control tower taxi circuit switches. Here it may be seen, for example, that taxi circuit #4 (So. Scenic Taxi) is actuated by any of the following switches:

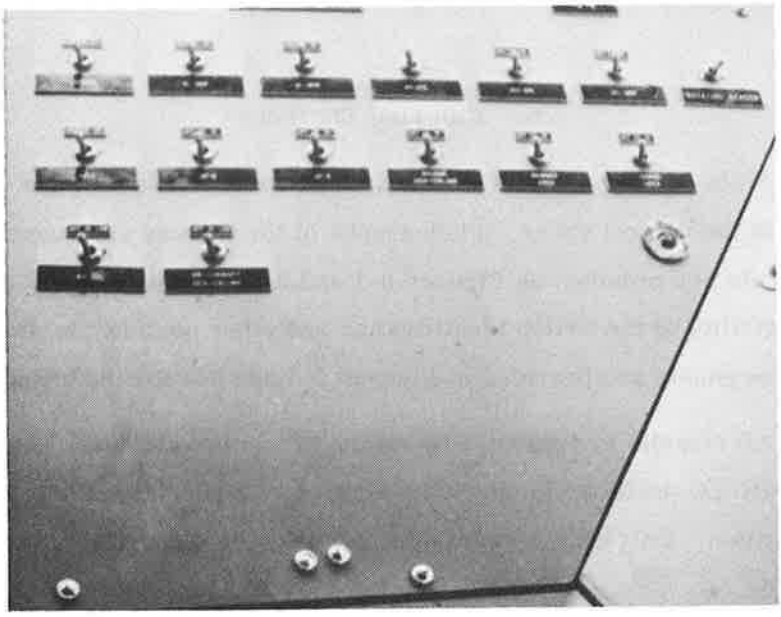

Figure 6-1. Taxiway Circuit Control Panel

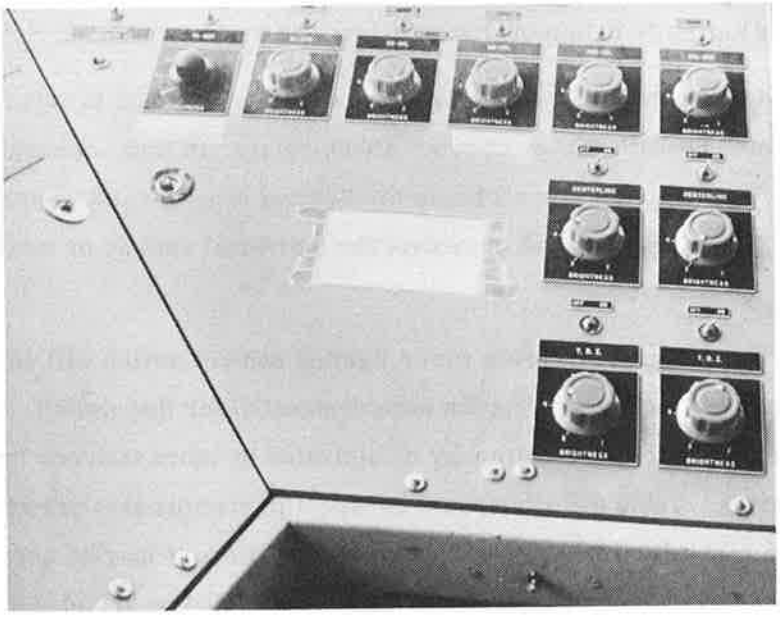

Figure 6-2. Runway Circuit Control Panel

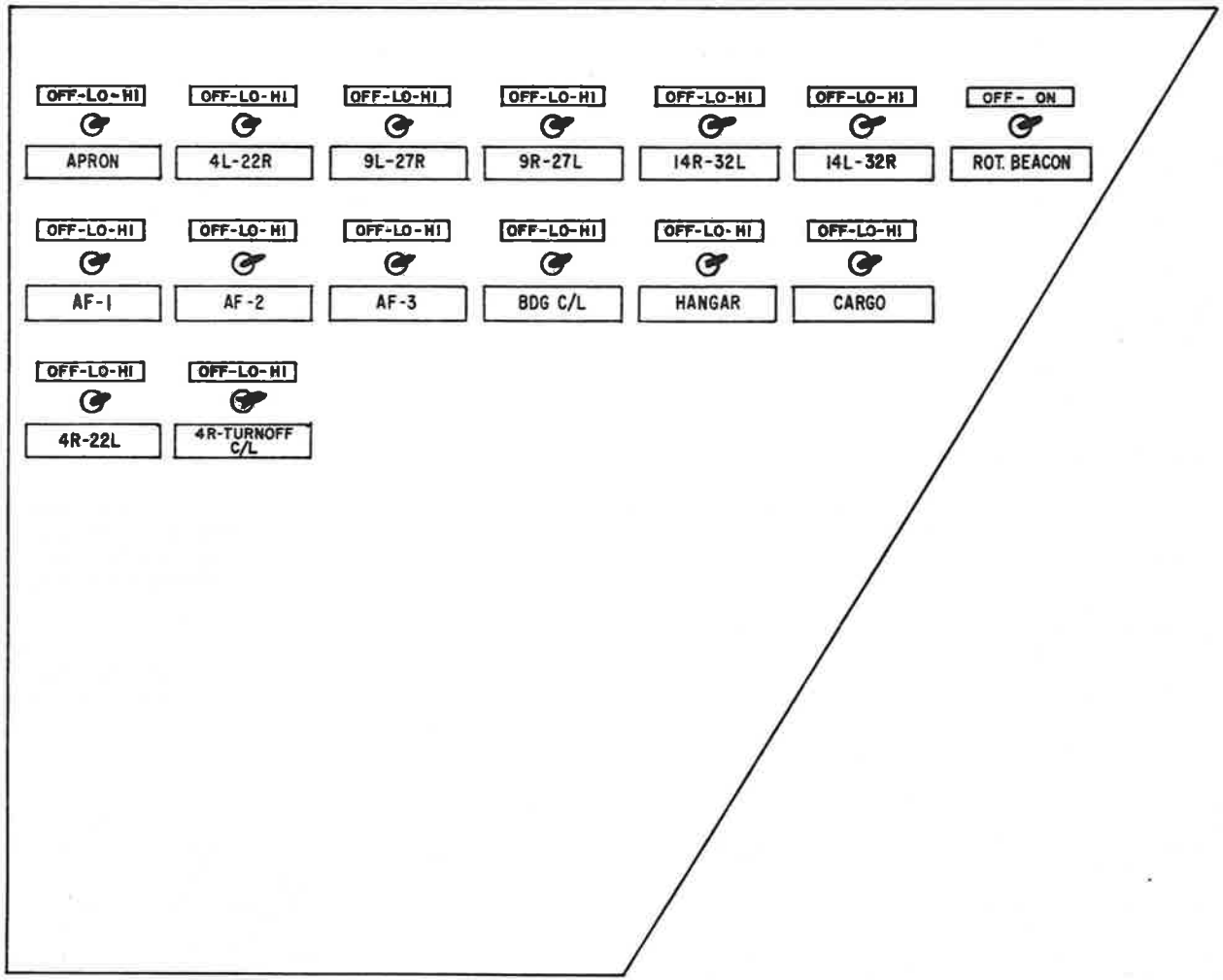

Figure 6-3. Taxiway Lighting Panel

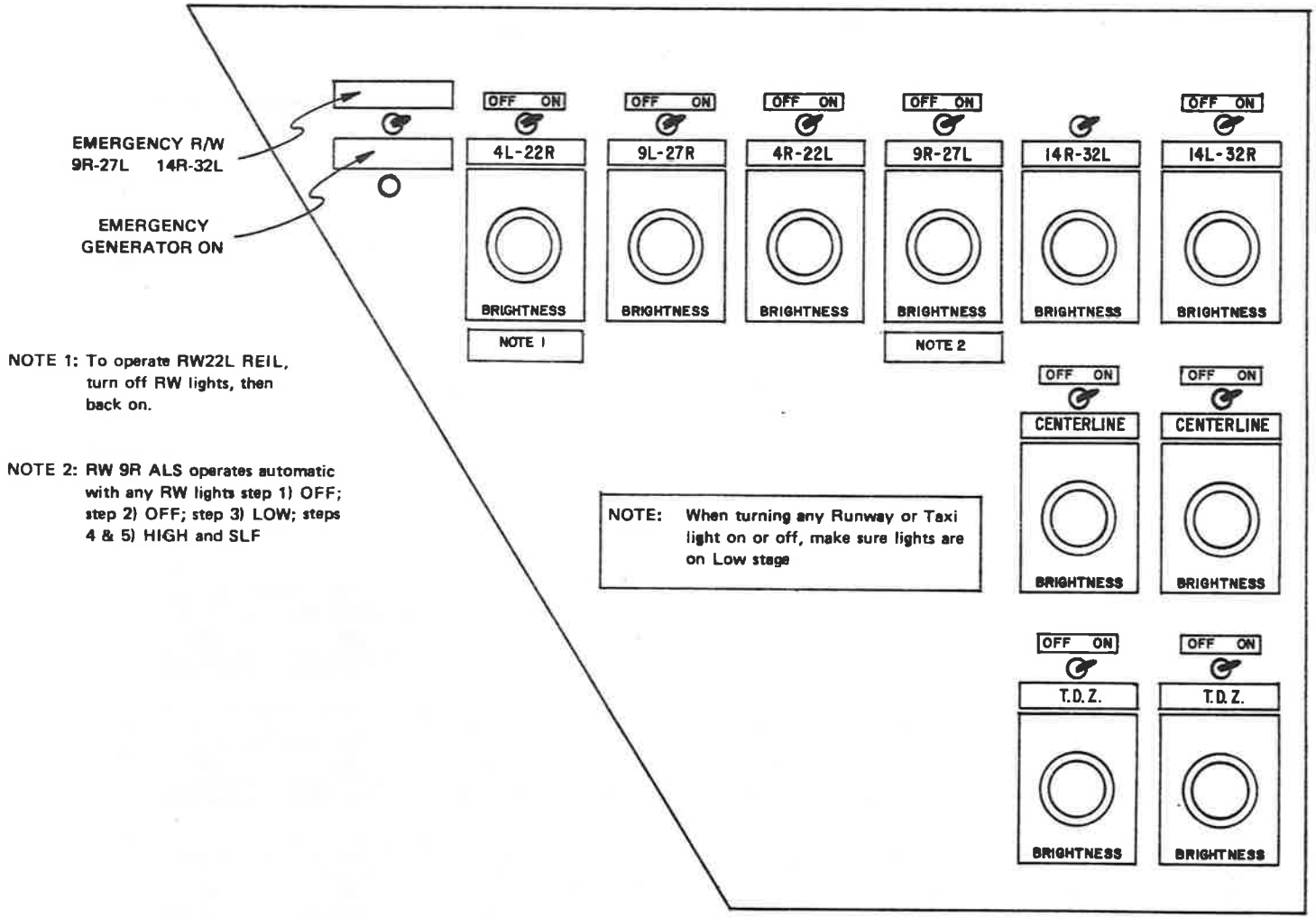

Figure 6-4. Runway Lighting Panel

TABLE 6-1. FAA CONTROL TOWER CONSOLE - TAXI CIRCUIT SWITCH

Tower Switch	Taxi Circuit Number	Area Served
14R-32L	2	Parallel to 14R
	3	T1-T2 - Park Apron
	4	So. Scenic Taxi
	7	Hold Apron 9L
	9	Hold Apron 32L
	10	Hangar Area Taxi
	11	Hangar Area Taxi
14L-32R	4	So. Scenic Taxi
	5	No. Scenic Taxi
	7	Hold Apron 9L
	17	Parallel to 14L
	22	Taxi Bridge
	24	Hold Apron 32R
	29 T6B	T6B By Pass
	31	Parallel 14L
	32	Parallel 14L
Cargo	12	Cargo Taxi
	13	Cargo Aprons
	21A	Cargo Taxi
Hangar	10	Hangar Area Taxi
	11	Hangar Area Taxi
Apron	1	B-C Ramp
	8	D-E-F-G Ramp - Outer Circular
	14	D-E-F-G Ramp - Inner Circular
	15	H-K Ramp
	21	Outer Circular-Taxi-East
4L-22R	AF 1	Air Force Taxi-North
	4	So. Scenic Taxi
	5	No. Scenic Taxi
	7	Hold Apron 9L
	16	Parallel - 22R
9L-27R	AF 3	Army East Side
	4	So. Scenic Taxi
	6	Parallel-Taxi-9L-27R
	7	Hold Apron-9L
	22	Taxi Bridge
	24	Hold Apron 32R

TABLE 6-1. (CONTINUED)

Tower Switch	Taxi Circuit Number	Area Served
9R-27L	3	T1-T2 - Park Apron
	12	Cargo Taxi to 27L
	18	Taxi to 9R
	19	Cargo-Taxi to 27L
	20	Hold Apron 27L
	25	Parallel to 27L
	26	Parallel to 27L
AF 1	AF 1	Army Taxi N.W. Side
AF 2	AF 3	Army Taxi East Side
AF 3	AF 9	Army Taxi Alert - Hangar
Bridge C/L	23	Bridge Center LTS
4R-22L	36	4R Warm-up
	37	27L Turnoff
	38	4R-22L
	40	22L Warm-up
4R Turnoff C/L	39	Hi-Speed Turnoff

14R-32L
14L-32R
4L-22R
9L-27R

These control panels were installed at the time the control tower was built in 1967 and subsequent modifications were made, both to the panels and the associated control circuitry, as additional lighting systems came into being. Specific information as to panel manufacturer, model number, cost, etc., was not available.

No major maintenance problems were identified. However, it was pointed out that, if tower personnel failed to follow the standard procedure reducing brightness control settings to minimum value prior to turning the runway circuits on or off, the regulators are subject to fail as a result of overloading. We understand that this potential problem area will be eliminated in the near future by providing brightness controls with an "OFF" position which will ensure that the minimum intensity level will be set immediately before or after turning lights off or on.

7. AIRCRAFT DOCKING AIDS

In addition to the previously described visual ground aids, some further information was obtained relative to aids to pilots in approaching and docking at the gate area. A survey of the various gate areas revealed that only American and United Air Lines provided any means of self guidance for their pilots in this operation. The remaining airlines rely on a mechanic (or other personnel) to provide guidance information to their pilots in the docking operation.

American has two types of systems in use. The first consists of two painted panels displaced from each other both in depth as well as in actual elevation, depending on the particular combination of aircraft type and gate configuration. Figures 7-1 and 7-2 provide photographs of two installations at the same gate (K-2). In the first figure an aircraft has just about completed docking using the two panels mounted on a boom which extends from the jetway serving that gate. It may be noted that this set of panels is used for 707 as well as 727 aircraft as indicated on the rear panel.

The pilot steers his aircraft into the gate area by keeping the vertical lines (painted on both panels) in line with each other. This ensures the correct alignment of the aircraft. His forward progress is halted when the padded end portion of the boom rests against the front of the aircraft windshield. Note also the traffic light mounted on the boom which permits a mechanic to signal the pilot to halt in the event of a potential ground hazard not visible to the pilot. Once the plane has stopped, the jetway operator raises the boom to a vertical position and then proceeds to bring the jetway into position for emplaning/deplaning.

Figure 7-2 shows the set of panels used when a DC-10 is to dock at that gate. Similar procedures to those above are used with the exception of the stopping procedure which is accomplished by means of a mechanic actuating the red portion of the traffic light mounted adjacent to the panels.

Figure 7-1. Docking Aid for 707 and 727 Aircraft at Gate K-2

Figure 7-2. Docking Aid for DC-10 Aircraft at Gate K-2

Figure 7-3 shows the second type of system, mounted at gate K-5. We were advised that this system is due to be replaced as a result of pilot dissatisfaction with its operational characteristics. Consequently the methods of docking were not pursued; however, it may be noted that forward movement of the aircraft will cause a vertical shift in the relative location of the horizontal light bar. Alignment of the light bar with the painted dash adjacent to aircraft type indicates the correct stopping point.

United Air Lines utilizes a system called ACCU-PARK at their gates to provide self-docking capability. The system is comprised of two separately mounted units--one to provide directional guidance and the other to indicate the correct stopping point.

Figure 7-4 shows a close-up view of the directional guidance unit as installed at gate F-6. The neon tubes located near the building and at the opposite end (red and green, respectively) are to be kept superimposed on each other by the pilot as the aircraft enters the gate area. Figure 7-5 shows the approximate viewing angle for the pilot.

The second unit consists of vertical red neon tubes (front and back) with a small horizontal bar at the rear tube and aircraft identifications for use in correctly locating the stopping point for each type of aircraft. A photograph of a typical installation is shown in Figure 7-6. This unit is displaced laterally from the directional guidance unit by differing distances depending on the physical terminal construction in the gate area. As may be seen in the figure, 737 and 720 aircraft come to a stop when the forward neon tube appears to touch the left tip of the horizontal bar while 8-61 and 727-222 aircraft come to a stop when the forward neon tube is aligned with the right tip of the horizontal bar. All other aircraft are stopped when the vertical bars are superimposed.

Figures 7-7 and 7-8 are photographs taken from the cockpit of a parked aircraft to indicate the relative view of the parking aids to the crew of the aircraft.

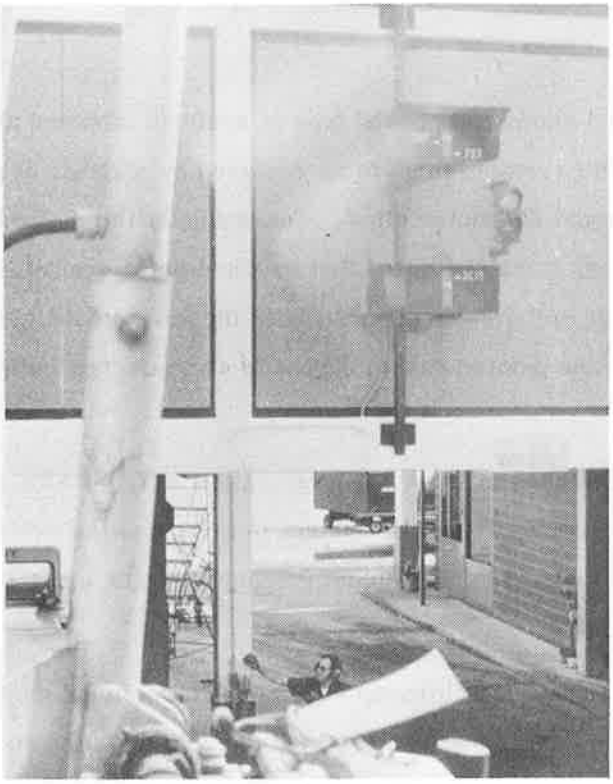

Figure 7-3. Docking Aids at Gate K-J

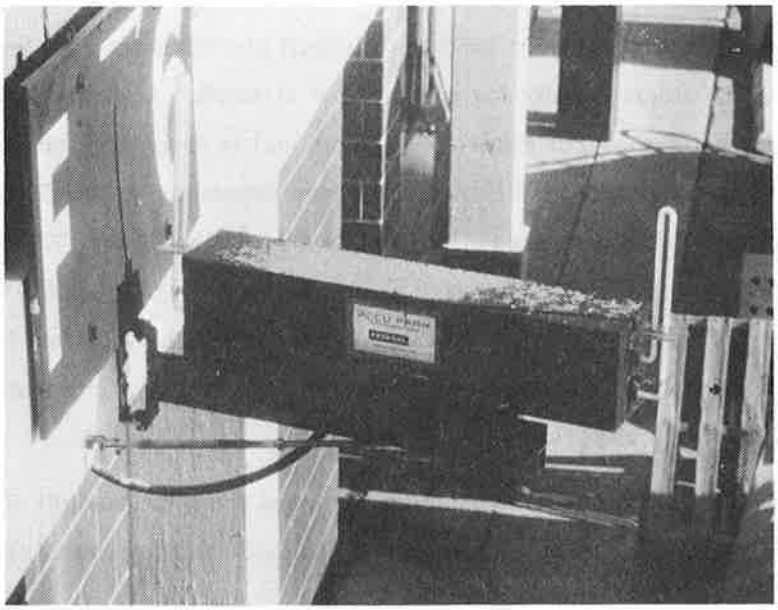

Figure 7-4. Directional Guidance Unit of the ACCU-PARK System Installed at Gate F-6

Figure 7-5. Directional Guidance Unit at Gate F-5

Figure 7-6. "Stop" Alignment Unit at Gate F-5

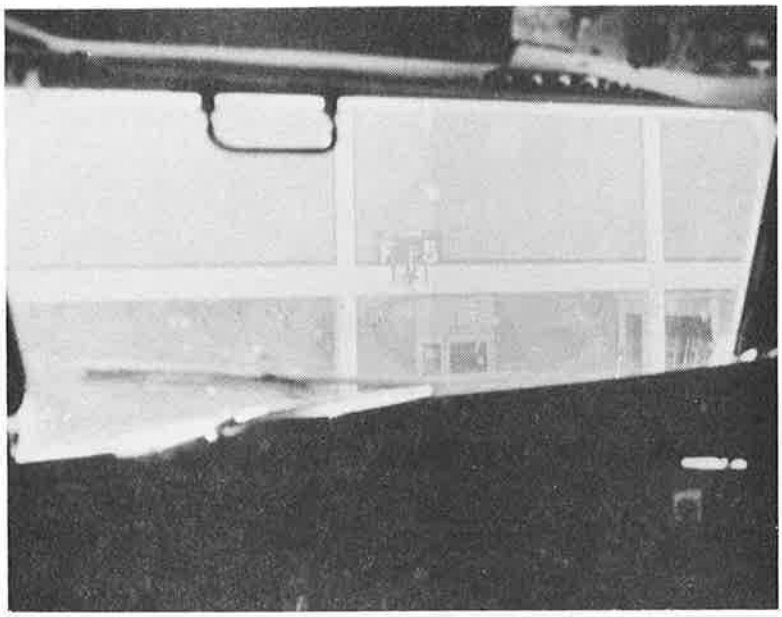

Figure 7-7. Pilot's View of Directional Alignment Unit

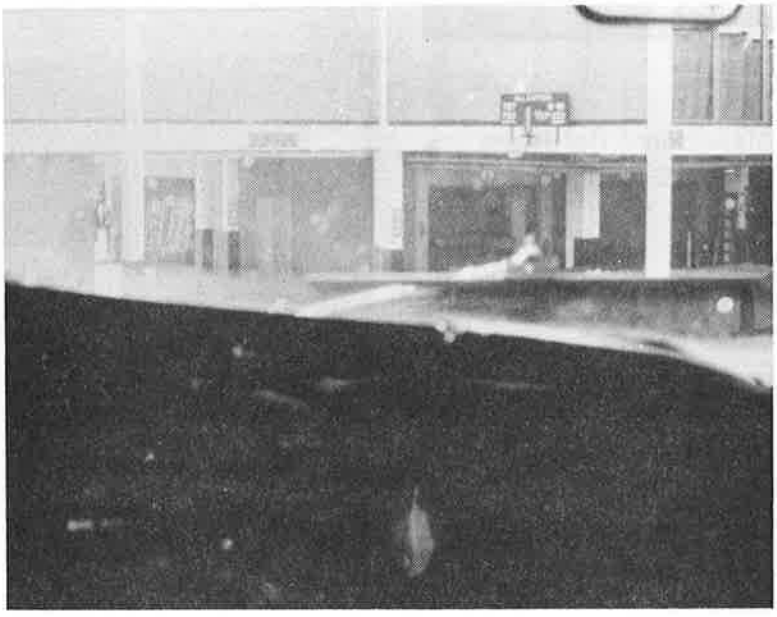

Figure 7-8. View Through Co-Pilot's Windshield of Stopping Guide

This system appears to be well liked by United's pilots according to information obtained from one of the pilots.

APPENDIX - REPORT OF INVENTIONS

A diligent review of the work performed under this contract has revealed no new innovation, discovery, improvement or invention.