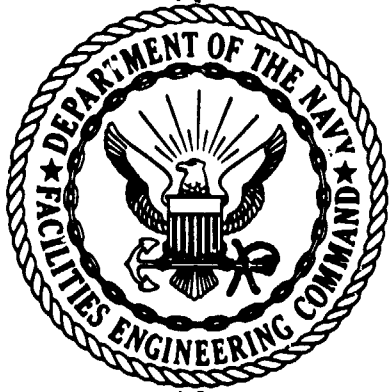


ADA 119 525-



**NAVFAC DM-23.1
JULY 1981**

APPROVED FOR PUBLIC RELEASE

AIRFIELD LIGHTING

DESIGN MANUAL 23.1

**DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
200 STOVALL STREET
ALEXANDRIA, VA. 22332**

82 09 23 087

DISTRIBUTION: (1 copy each unless otherwise specified)

| | | | | | |
|------|--|---------|---|----------|---|
| SNDL | | FF38 | | FT2 | |
| 23A1 | (COMNAVFORAZORES only) | FG2 | (Balboa, Harold Holt, Nea Makri, Thurso, Stockton, and Ponce only) | FT6 | |
| 24J1 | | | | FT13 | (Less Millington) |
| 27C | | | | FT18 | |
| 39B | | FG3 | (Cheltenham and East Machias only) | FT19 | (San Diego only) |
| 39C1 | | | | FT22 | |
| 39E | | FG6 | (Wahisawa and Norfolk only) | FT27 | (Idaho Falls only) |
| 42A3 | | FH3 | (Beaufort only) | FT28 | |
| 45B | | FH6 | (Bethesda only) | FT31 | |
| 49 | | FH8 | (Cairo only) | FT37 | |
| 51A | | FH25 | (Philadelphia, Portsmouth VA, Camp Lejeune, Oakland, Newport, Great Lakes, and Long Beach only) | FT55 | |
| 51B1 | | | | FT64 | |
| 51B3 | | | | FT73 | |
| B2A | (JCS, NSA, DLA, and DNA only) | FJ5 | | FT74A | (MIT and Texas only) |
| B5 | (USCG only) | FKA6A1 | | FT74B | (California, Illinois, Rensselaer, Georgia Tech only) |
| C34 | (Holy Loch, Souda Bay only) | FKA6A2 | | | (2 copies) |
| C37D | (Port Hueneme only) | FKA6A3A | | FT78 | |
| E3A | | FKA6A3B | | V2 | |
| FA6 | (Bermuda, Brunswick, Cecil Field, Key West, Jacksonville, Virginia Beach only) | FKA6A9 | | V3 | |
| FA7 | (Guantanamo, Keflavik, Brooklyn, Panama Canal, Mayport, Roosevelt Roads only) | FKA6A12 | | V5 | |
| FA10 | | FKA6A15 | (Code 521) | V8 | |
| FA18 | | FKA6A16 | | V12 | |
| FA23 | (Antigua, Brawdy, Buxton, Lewes only) | FKA9 | | V14 | |
| FA32 | | FKM8 | | V15 | |
| FB6 | | FKM9 | | V16 | (less Camp Smith) |
| FB7 | (Alameda, Fallon, Lemoore, Oak Harbor, Miramar, North Island, Moffet Field only) | FKM12 | | V17 | |
| FB10 | | FKM13 | | V23 | |
| FB21 | | FKM15 | (Philadelphia only) | V25 | |
| FB31 | (Guam only) | FKN1 | (West and Lant only (85 copies each)) | | |
| FB34 | (Kadena, Sasebo only) | FKN' | (South and North only (50 copies each)) | Copy to: | (One copy each unless otherwise indicated) |
| FB36 | (Big Sur, Coos Head, Ferndale, and Pacific Beach only) | FKN1 | (Pac only, 25 copies each) | 21A | |
| FB41 | | FKN1 | (Ches only, 25 copies each) | A2A | (ONR only) |
| FB48 | | FKN1 | (Ches, FPO-1 only) | A3 | |
| FC3 | (London only) | FKN2 | | A4A | |
| FC4 | (Sigonella only) | FKN3 | (6 copies each) | A5 | |
| FC5 | | FKN5 | (5 copies each) | A6 | (Code LFF) |
| FC7 | | FKN8 | | C7 | (Brazil and Chile only) |
| FC12 | | FKN10 | | FD1 | |
| FD2 | | FKP1B | (less Concord) | FE1 | |
| FE2 | | FKP1B | (Concord only, 3 copies) | FG1 | |
| FE4 | (Adak, Edzell, Hanza, Galeta Island, Homestead, Winter Harbor, Sabana Seca, and Sonoma only) | FKP1J | | FKA1A | |
| FF1 | (Washington only) | FKP1M | | FKA1B | (2 copies) |
| FF5 | | FKP3A | | FKA1C | (Code 043 - 50 copies) |
| FF6 | | FKP7 | | FKA1F | |
| FF19 | (New Orleans, Seattle only) | FKP8 | | FKN2 | (Port Hueneme (Code 156) only) |
| | | FKP11 | | FR1 | |
| | | FKQ3 | | | |
| | | FKR1A | | | |
| | | FKR1B | (2 copies) | | |
| | | FKR2A | (Dallas only) | | |
| | | FKR3A | | | |
| | | FKR3H | | | |
| | | FKR4B | | | |
| | | FKR5 | | | |
| | | FKR7E | (3 copies) | | |
| | | FR3 | | | |
| | | FR4 | | | |
| | | FT1 | | | |

Additional copies are available from:

Commanding Officer
 Naval Publications and
 Forms Center
 5801 Tabor Avenue
 Philadelphia, PA 19120

ABSTRACT

Design criteria are presented for Category Code 136 and are intended for use by experienced architects and engineers. The contents include approach lighting, runway lighting, taxiway lighting, and helipad lighting.

A



FOREWORD

This design manual is one of a series developed from an evaluation of facilities in the shore establishment, from surveys of the availability of new materials and construction methods, and from selection of the best design practices of the Naval Facilities Engineering Command, other Government agencies, and the private sector. This manual uses to the maximum extent feasible, national professional society, association, and institute standards in accordance with NAVFACENGCOCM policy. Deviations from these criteria should not be made without prior approval of NAVFACENGCOCM Headquarters (Code 04).

Design cannot remain static any more than can the naval functions it serves or the technologies it uses. Accordingly, recommendations for improvement are encouraged from within the Navy and from the private sector and should be furnished to NAVFACENGCOCM Headquarters (Code 04). As the design manuals are revised, they are being restructured. A chapter or a combination of chapters will be issued as a separate design manual for ready reference to specific criteria.

This publication is certified as an official publication of the Naval Facilities Engineering Command and has been reviewed and approved in accordance with SECNAVINST 5600.16.



W. M. Zobel
Rear Admiral, CEC, U. S. Navy
Commander
Naval Facilities Engineering Command

COMMUNICATIONS, NAVIGATIONA AIDS, AND AIRFIELD LIGHTING DESIGN MANUALS

| <u>DM Number</u> | <u>Chapter superseded in Basic DM-23</u> | <u>Title</u> |
|------------------|--|-------------------------------|
| 23.1 | 5 | Airfield Lighting |
| 23.2 | 3&4 | Navigational and Traffic Aids |

Note: Chapters 1 and 2 of the basic design manual, DM-23, will be incorporated in a new design manual, DM-12, Electronic Facilities Engineering, to be issued at a later date.

CONTENTS

| | <u>Page</u> |
|---|-------------|
| Section 1. PRELIMINARY DATA | 23.1-1 |
| 1. SCOPE | 23.1-1 |
| 2. CANCELLATION | 23.1-1 |
| 3. RELATED CRITERIA | 23.1-1 |
| a. Definitive Designs | 23.1-1 |
| b. Other Publications | 23.1-1 |
| 4. COMMON CRITERIA | 23.1-1 |
| a. Light Colors | 23.1-1 |
| b. Lighting Fixture Height | 23.1-3 |
| c. Light Intensity | 23.1-3 |
| d. Equipment Characteristics | 23.1-3 |
| 5. AIRFIELD LIGHTING, GENERAL REQUIREMENTS | 23.1-3 |
| a. Lighting Systems Integration | 23.1-3 |
| b. Airfield Lighting Control | 23.1-3 |
| c. Airfield Lighting Vaults | 23.1-4 |
| d. Direct Burial Cable | 23.1-7 |
| Section 2. AIRFIELD LIGHTING SYSTEMS | 23.1-7 |
| 1. APPROACH LIGHTING | 23.1-7 |
| a. System Elements | 23.1-7 |
| b. Electrical Requirements | 23.1-8 |
| c. Control Requirements | 23.1-8 |
| 2. RUNWAY EDGE LIGHTING | 23.1-9 |
| a. Description | 23.1-9 |
| b. Location | 23.1-9 |
| c. Variations | 23.1-9 |
| d. Electrical Requirements | 23.1-9 |
| e. Control Requirements | 23.1-10 |
| 3. THRESHOLD, RUNWAY END, AND RUNWAY IDENTIFICATION LIGHTING | 23.1-10 |
| a. System Elements | 23.1-10 |
| b. Electrical Requirements | 23.1-11 |
| c. Control Requirements | 23.1-11 |
| 4. RUNWAY CENTERLINE LIGHTING | 23.1-11 |
| a. Description | 23.1-11 |
| b. Location | 23.1-15 |
| c. Alinement | 23.1-15 |
| d. Electrical Requirements | 23.1-15 |
| e. Control Requirements | 23.1-15 |

CONTENTS

| | <u>Page</u> |
|--|-------------|
| 5. TOUCHDOWN ZONE LIGHTING | 23.1-15 |
| a. Description | 23.1-15 |
| b. Location | 23.1-15 |
| c. Alinement | 23.1-15 |
| d. Electrical Requirements | 23.1-15 |
| e. Control Requirements | 23.1-15 |
| 6. SIMULATED CARRIER DECK LIGHTING | 23.1-15 |
| a. Description | 23.1-15 |
| b. Location | 23.1-16 |
| c. Alinement | 23.1-16 |
| d. Electrical Requirements | 23.1-16 |
| e. Control Requirements | 23.1-16 |
| 7. WHEELS-UP LIGHTING AND RUNWAY WAVE-OFF LIGHTING | 23.1-16 |
| a. System Elements | 23.1-16 |
| b. Electrical Requirements | 23.1-19 |
| c. Control Requirements | 23.1-19 |
| 8. TAXIWAY LIGHTING | 23.1-19 |
| a. System Elements | 23.1-19 |
| b. Electrical Requirements | 23.1-27 |
| c. Control Requirements | 23.1-27 |
| 9. HELIPAD LIGHTING | 23.1-27 |
| a. System Elements | 23.1-27 |
| b. Electrical Requirements | 23.1-29 |
| c. Control Requirements | 23.1-30 |
| 10. PARKING AND SERVICE AREA LIGHTING | 23.1-30 |
| a. Description | 23.1-30 |
| b. Electrical Requirements | 23.1-31 |
| c. Control Requirements | 23.1-31 |
| References | Reference-1 |
| APPENDIX A: Metric Conversion Factors | A-1 |

FIGURES

| <u>Figure</u> | <u>Title</u> | <u>Page</u> |
|---------------|--|-------------|
| 1 | Typical Threshold Lighting Configuration | 23.1-12 |
| 2 | Threshold Configuration with Approach Lighting | 23.1-13 |
| 3 | Displaced Threshold Configuration | 23.1-14 |
| 4 | Touchdown Zone Lighting | 23.1-17 |
| 5 | Simulated Carrier Deck Lighting | 23.1-18 |

CONTENTS

| <u>Figure</u> | <u>Title</u> | <u>Page</u> |
|---------------|--|-------------|
| 6 | Taxiway Edge Lighting, Longitudinal Spacing | 23.1-21 |
| 7 | Taxiway Edge Lighting, Spacing on Curves | 23.1-22 |
| 8 | Taxiway Edge Lighting, Entrance-Exit Details | 23.1-23 |
| 9 | Taxiway Centerline Lighting | 23.1-24 |
| 10 | Taxiway Centerline Lighting, High-Speed Exit | 23.1-26 |
| 11 | Helipad Lighting | 23.1-28 |

TABLES

| <u>Table</u> | <u>Title</u> | <u>Page</u> |
|--------------|--------------------------------------|-------------|
| 1 | Definitive Drawing Numbers | 23.1-2 |
| 2 | Lighting System Components | 23.1-5 |

AIRFIELD LIGHTING

Section 1. PRELIMINARY DATA

1. SCOPE. This manual contains data and information comprising standards for the following lighting systems used for aircraft guidance from approach to parking:

- (1) Approach lighting.
- (2) Runway edge lighting.
- (3) Threshold, runway, and runway identification lighting.
- (4) Runway centerline lighting.
- (5) Touchdown zone lighting.
- (6) Simulated carrier deck lighting.
- (7) Wheels-up lighting and runway wave-off lighting.
- (8) Taxiway lighting.
- (9) Helipad lighting.
- (10) Parking and service area lighting.

All installations of the above lighting facilities shall comply with these standards. Where local conditions necessitate deviations, prior approval must be obtained from NAVFAC HQ.

2. CANCELLATION. This manual, Airfield Lighting, NAVFAC DM-23.1, cancels and supersedes Chapter 5 of NAVFAC DM-23, Communications, Navigational Aids, and Airfield Lighting, of August 1971.

3. RELATED CRITERIA. Design criteria related to the subject matter of this chapter may be found in NAVFAC P-272 and in other NAVFAC publications.

a. Definitive Designs. The data in Definitive Designs for Naval Shore Facilities, NAVFAC P-272, are an integral part of the Naval Facilities Engineering Command's design program and are listed in Table 1. Definitive designs associated with this design manual can be used for guidance in acceptable design principles related to specific functional layouts and operational requirements.

b. Other Publications. Design criteria, not covered in this chapter, may be found in the following publications:

| <u>Subject</u> | <u>Source</u> |
|---|---------------------|
| Airfield Pavements | NAVFAC DM-21 series |
| Facilities Planning Factors for Naval Shore Activities | NAVFAC P-80 |
| Navigational and Traffic Aids | NAVFAC DM-23.2 |

4. COMMON CRITERIA. The following criteria are applicable to all airfields described in Section 2.

a. Light Colors. For colors of lights, see Color, Aeronautical Lights and Lighting Equipment, General Requirements for, MIL-C-25050.

TABLE 1
Definitive Drawing Numbers

| Title | NAVFAC Dwg. No. |
|---|-----------------|
| Airfield Lighting, Schematic Plot Plan | 1291766 |
| Centerline Approach Lighting System | 1068473 |
| Centerline Approach Lighting System | 1068474 |
| Centerline Approach Lighting System | 1068475 |
| Centerline Approach Lighting System | 1068476 |
| Centerline Approach Lighting System | 1068477 |
| Centerline Approach Lighting System | 1068478 |
| Centerline Approach Lighting System | 1068479 |
| Direct Fueling Station, Helicopter and Fixed Wing Aircraft, Plan and Installation Details | 1403042 |
| Runway Distance Marker, Plan and Installation Details | 894982 |
| Runway Lighting, Edge Lights and Distance Markers | 1068480 |
| Runway Lighting, Circling Guidance, Narrow Gauge and Centerline | 1068481 |
| Runway Lighting, Identification and Edge Lights | 1068482 |
| Runway Lighting, Circling Guidance and Edge Lights | 1068483 |
| Runway Lighting, Narrow Gauge and Threshold Lights | 1068484 |
| Runway and Taxiway Lighting | 1068485 |
| Runway Lighting, Ductline Plan Handhole Details | 1068486 |
| Runway Lighting, Field Lighting Vault and Schematic Wiring | 1068487 |
| Simulated Carrier Deck Lighting Plan and Wiring Diagram | 1291793 |
| Simulated Carrier Deck Lighting Details | 1291794 |
| Wheels-Up and Runway Wave-Off Lighting Plan and Details | 1068471 |
| Wheels-Up and Runway Wave-Off Lighting, Wiring Diagram and Details | 1068472 |

b. Lighting Fixture Height. Lighting fixtures are semiflush or elevated depending on use as follows:

(1) Semiflush fixtures include all fixtures projecting up to 1 inch above the surface on which installed. One-inch-high fixtures are used where it is not intended that aircraft traffic pass over the fixture but when an occasional encounter will not damage aircraft or fixture. In active pavement areas, the maximum fixture projection is $\frac{1}{2}$ inch.

(2) Elevated fixtures include all fixtures in excess of 1 inch in height. They are used in areas where aircraft do not normally operate. However, where an inadvertent encounter is possible, elevated fixtures are mounted on frangible couplings to minimize damage to aircraft. In areas involving ground movement of aircraft, the maximum fixture height is 14 inches.

c. Light Intensity. The brightness steps associated with five levels of lamp intensity, achieved by varying the current in the lighting circuit, are as follows:

| Brightness Step | Current 20-Ampere Circuit | Current | Current | Approximate Percent Rated Intensity |
|-----------------|---------------------------------|---|---|--|
| | | 6.6-Ampere Circuit 200-500 Watt Lamp | 6.6-Ampere Circuit 30-45 Watt Lamp | |
| 1 | 8.5 | 2.8 | 3.4 | 0.16 |
| 2 | 10.3 | 3.4 | 3.8 | 0.8 |
| 3 | 12.4 | 4.1 | 4.4 | 4.0 |
| 4 | 15.8 | 5.2 | 5.3 | 20.0 |
| 5 | 20.0 | 6.6 | 6.6 | 100.0 |

d. Equipment Characteristics. See Table 2, Lighting Systems Components.

5. AIRFIELD LIGHTING, GENERAL REQUIREMENTS. Each lighting system is presented individually in this chapter, but should be considered part of the overall lighting system. The purpose of the system is the safe and expeditious transition of aircraft from ground to air and return. The components are designed to be complementary, and to have integrated control. The design of each new component must consider all other lighting categories to insure compatibility.

a. Lighting Systems Integration. Installation requirements for the various airfield lighting systems are established in NAVFAC P-80. For relative locations of lighting systems in the overall airfield lighting plan, see NAVFAC P-272.

b. Airfield Lighting Control. The control system for airfield lighting consists of control panels, relaying equipment, accessories, and circuits to energize, deenergize, select lamp brightness, and otherwise control various airfield lighting circuits in accordance with operational requirements. Control of any one airfield lighting system is normally provided at two points only: the control tower and the vault which powers that system. Exceptions are Simulated Carrier Deck Lighting, which is controlled from the Landing

Signal Officer (LSO) station only; optical landing system, which is controlled from the tower and/or LSO station; and runway wave-off lights which are controlled from the LSO station, the wheels-watch position, and the control tower.

A transfer relay assembly is provided at the vault to transfer control from the remote location to the vault when necessary. Attention is called to the following:

(1) Power Requirements. Because of the distance between control tower and vault(s) and in order to integrate the systems, a 120-volt control system utilizing low burden pilot relays (pilot relay assembly) is used to actuate the power switches, contactors, and relays controlling the regulators and transformers supplying the airfield lighting circuits. For a detailed layout of the control system, see NAVFAC P-272.

(2) Pilot Relay Assembly. The pilot relay assembly shall be circuited to insure the following:

(a) Lighting on intersecting runways cannot be energized simultaneously.

(b) All circuits supplying the lights for any one lighting system (for example, runway edge lighting) are energized simultaneously and are operated at the same brightness step.

(c) Taxiway lights are on the brightness step compatible with associated runway brightness.

(d) Touchdown zone lighting (TDZL) cannot be energized unless the runway centerline lights are energized.

c. Airfield Lighting Vaults. All vaults require a primary service of 4160/2400-volt, 3-phase, 60 Hertz power. An emergency generator or other power source shall be provided at each vault to insure continuous operation in the event of principal power source failure. For details of power vault construction and equipment, layout, see NAVFAC P-272, and consider the following:

(1) The main airfield lighting vault houses power distribution and control equipment for runway and taxiway lighting circuits and any other airfield lighting that can feasibly use this source. Auxiliary vaults may be required for other systems depending upon airfield configuration. Vaults are located above grade at locations most suitable as supply points. The maximum horizontal distance from tower to vault is 7,350 feet to keep the control cable length within limits for proper functioning of the pilot relay assembly.

(2) The approach lighting vault houses power distribution and control equipment primarily for the approach lighting and sequenced flashers, but other lighting systems nearby may also use this vault as a power source. The vault is located adjacent to the approach zone at a sufficient distance to satisfy obstruction criteria, but as close as possible to minimize cable lengths.

TABLE 2
Lighting System Components

| Lighting | Fixture Type or Class | Fixture Specification | Lamp | Size | Transformer MIL STD DMC or FAA No. | Regulator Type and Specification |
|--|--------------------------------|-----------------------------------|--|---|--|---|
| 1. Approach: | | | | | | |
| (a) ALS-elevated, white (1000' - 2000') | MB-2 | MIL-L-26764 or FAA-E-982(a) | 200W/Q6.6A/PAR56/2 | 200W, 20/6.6A | MS27286 or FAA L-830-7 | FAA L-828, 30KW or 50KW (Replaces RGU-5/F) |
| (b) ALS-elevated, white and all elevated red (2100' - 3000') | MB-2 | MIL-L-26764 or FAA-E-982(a) | 200W/Q6.6A/PAR56/2 500W/Q20A/PAR56/1 500W/Q20A/PAR56/1 | 200W, 20/6.6A 500W, 20/20A 500W, 20/20A | MS27286 or FAA L-830-7 MS27302 or FAA L-830-13 MS27302 or FAA L-830-13 | |
| (c) ALS-semiflush, white | B-25(b) or L-850E(b) | MIL-L-26202 or FAA-AC-150/5345-46 | 200W/Q6.6A/PAR56/3 | 200W, 20/6.6A | MS27286 or FAA L-830-7 | |
| ALS-semiflush (red only)(c) | | FAA-E-2491 | 200W/Q6.6A/T4/DCR 500W, 20A(c) | 200W, 20/6.6A 500W, 20/20A | MS27286 or FAA L-830-7 MS27302 or FAA L-830-12 | |
| (d) SPL-elevated | | MIL-L-26311 | | | | |
| 2. Runway edge: | | | | | | |
| (a) HIRL-elevated | C-1 or L-862(d) | MIL-L-5904 or FAA-AC-150/5345-48 | 204W/6.6A/T14/2P 204W/6.6A/T14/2P | 200W, 20/6.6A 200W, 20/6.6A | MS27286 or FAA L-830-7 MS27286 or FAA L-830-7 | FAA L-828, 30KW or 50KW (Replaces RGU-5/F) |
| semiflush | B15 or L850C(e) | MIL-L-26202 or FAA-AC-150/5345-46 | 499W/Q20A/PAR56/3 200W/Q6.6A/T4/DCR | 500W, 20/20A 200W, 20/6.6A | MS27302 or FAA L-830-13 MS27286 or FAA L-830-7 | |
| (b) Distance marker | NAVFAAC | Dwg 8949b2 | 75W/120V (6 or 8 lamps)(f) | 200W, 20/6.6A (f) | MS27286 or FAA L-830-7 | |
| (c) Arresting Gear Sign | NAEC | Dwg 620217 | 75W/120V (8 lamps) | 200W, 20/6.6A (2 XPHRS) | MS27286 or FAA L-830-7 | |
| (d) Circling guidance | | MIL-L-22252 | 500W/20A/T-20 | 500W, 6.6/20A | MS27136 or FAA L-830-12 | FAA L-828, 15KW, 2400V, 6.6A (Replaces RGU-4/F) |
| 3. Runway centerline (bidirectional) | L852N-2 Type V or Type VI(g) | FAA-AC-150/5345-46 | 45W/6.6A(h) | 200W, 20/6.6A per 4 lamps | MS27286 or FAA L-830-7 | FAA L828, 30KW (Replaces RGU-5/F) |
| 4. Simulated carrier deck (unidirectional)(i) | L852N-2 Type V or Type VI(g) | FAA-AC-150/5345-46 | 45W/6.6A(h) | 200W, 6.6/6.6A per 4 lamps | MS27288 or FAA L-830-6 | FAA L828, 4KW (Replaces Type CI) |
| 5. Wheels-up, Wave-off: | | | | | | |
| (a) Wheels-up | MB-2 | MIL-L-26764 or MIL-L-81015 | Q500PAR56/MFL Q1000PAR64/NSP | 15KVA, 2400/120V 2400/120V, 5kW | | Multiple System Multiple System |
| (b) Wave-off | | | | | | |
| 6. Taxiway: | | | | | | |
| (a) Edge-elevated | M-1 | MIL-L-7082 | 30W/6.6A/T-10 | 30/45W, 6.6/6.6A | MS27289 or FAA L-830-1 | FAA L828, 15KW, 240V, 6.6A (Replaces RGU-4/F) |
| Semiflush | B-3 L-852N-2 Type I or Type II | MIL-L-26202 or FAA-AC-150/5345-46 | 45W/6.6A/PAR56/5 65W/6.6A/T-2-1/2 CL(h) | 30/45W, 6.6/6.6A 300W, 6.6/6.6A per 4 lamps | MS27289 or FAA L-830-1 FAA L-830-10 | |
| (b) Centerline | L-852N-2 Type I or Type II | FAA-AC-150/5345-46 | 45W/6.6A/T-2-1/2 CL(h) | 200W, 6.6/6.6A per 4 lamps | MS27288 or FAA L-830-6 | |
| (c) Guidance signs | L-829 | FAA-AC-150/5345-4 | 30W/6.6A/T-10 | 30/45W, 6.6/6.6A 100W/6.6/6.6A 700W, 6.6/6.6A | MS27289 or FAA L-830-1 L830-4 MS27288 or FAA L-830-6 | |
| 7. Touchdown zone: | | | | | | |
| (a) Semiflush | BR-25(j) | MIL-L-26202 | 200W/Q6.6A/PAR56/3 | 200W, 20/6.6A | MS27286 or FAA L-830-7 | FAA L828, 50KW (Replaces RGU-5/F) |
| (b) Semiflush | L-850B(j) | FAA-AC-150/5345-46 | 200W/Q6.6A/T4/DCR | 200W, 20/6.6A | MS27286 or FAA L-830-7 | |

TABLE 2 (Continued)
Lighting System Components

| Lighting | Fixture Type or Class | Fixture Specification | Lamp | Size | Transformer MIL STD DMC or FAA No. | Regulator Type and Specification |
|--|--|--------------------------------------|---|---|--|-----------------------------------|
| 8. Threshold (High Intensity): | (a) Unidirectional elevated (Grn) | MIL-L-26764 or FAA-E-982(a) | 500W/Q20A/PAR56/1 | 500W, 20/20A | MS27302 or FAA L-830-13 | R/W Circuit |
| | (b) Bidirectional elevated (R/G) | MIL-L-26990 | 500W/Q20A/PAR56/1 503W/Q20A/T-20/3 | 500W, 20/20A 500W, 20/20A | MS27302 or FAA L-830-13 MS27302 or FAA L-830-13 | R/W Circuit R/W or ALS Circuit |
| | (c) Bidirectional semiflush (R/G) | MIL-L-26202 or FAA-AC-150/5345-46 | 499W/Q20A/PAR56/3 200W/Q6.6A/T4/DCR | 500W, 20/20A 200W, 20/6.6A 2 XFMRs REQ'D | MS27302 or FAA L-830-13 MS27286 or FAA L-830-7 | ALS Circuit ALS Circuit |
| | 9. Displaced Threshold and Runway End: | (a) Unidirectional elevated (Grn) | MIL-L-26764 or FAA-E-982(a) | 500W/Q20A/PAR56/1 | 500W, 20/20A | MS27302 or FAA L-830-13 |
| (b) Unidirectional semiflush (Grn) | MIL-L-26202 | 499W/Q20A/PAR56/3 | 500W, 20/20A | MS27302 or FAA L-830-13 | R/W | |
| (c) Bidirectional elevated (R/R) | MIL-L-26990 | 200W/Q6.6A/T4/DCR 503W/Q20A/T20/3 | 500W, 20/20A | MS27286 or FAA L-830-7 MS27302 or FAA L-830-13 | R/W R/W | |
| 10. RIL (Runway Identification Light): | (a) Rotating beacon type | MIL-L-21703 | 200W/30V/PAR56 | 500W, 20/20A | MS27302 or FAA L-830-13 | R/W |
| | (b) Strobe type (1) (a) | FAA-AC-150/5345-14 | (2 lamps in series) Depends on mfg of light assembly | (m) | | R/W or Multiple System |
| 11. Helipad: | (a) Perimeter | FAA-AC-150/5345-2 | 116A21/TS(116W) | (Requires yellow omnidirectional globe) | | Multiple System |
| | (b) Landing Direction | FAA-AC-150/5345-2 | 116A21/TS(116W) | (Requires yellow omnidirectional globe) | | Multiple System |
| | (c) Approach Direction | FAA-AC-150/5345-2 | 116A21/TS(116W) | (Requires clear omnidirectional globe) | | Multiple System |
| 12. Parking Area | | | USE COMMERCIALLY AVAILABLE FIXTURES | | | |

NOTES: (a) Authorized substitute for MB-2.
 (b) Class B25 fixture to be used for replacement only. For new installations use FAA-L-850E Fixture.
 (c) FAA-E-2491 only used for ALS-CAT I at the 200 ft. centerline bar. Replacement lamp has a special base and can only be obtained from manufacturer of the light fixture.
 (d) Authorized substitute (with 204 watt lamp) for the C-1 fixture.
 (e) Authorized substitute for the B15 fixture. L-850C has two 200 watt lamps and requires two isolation transformers.
 (f) Single digit sign uses 6 lamps and requires one XFMR. Two digit sign uses 8 lamps and requires two XFMRs.
 (g) L852N-2 Type V is a specially hardened version of the L852N-2 Type I fixture and is designed to be resistant to impact of aircraft tail hooks. Similarly the type VI fixture is a hardened version of the L852N-2 Type II fixture. Type VII and Type VIII fixtures are also hardened versions of the L852N-2, and are designed for can-mounting.
 (h) Replacement lamp has special terminals and must be ordered from manufacturer of the light fixture.
 (i) To procure the unidirectional fixture order the bidirectional fixture with a blank plate covering one window.
 (j) Class BB-25 fixture to be used for replacement only. For new installations use FAA L-850B
 (k) Used for ALS CAT I & II fill in. B15 fixture to be used only for replacement. For new installations use FAA L-850D. L-850D has two lamps and requires two XFMRs.
 (l) L-849 strobe light is an optional substitute for the rotating beacon. When ordering the L-849, the procuring activity must specify 3 step (not fixed) brightness.
 (m) When ordering the L-849 for installation in the runway edge circuit, the procuring activity must specify that the manufacturer is to also provide the special isolation transformer which is required.

d. Direct Burial Cable. The use of direct earth burial cable for airfield lighting systems shall be kept to a minimum or consideration should be given to direct buried duct. Where possible, individual installations should consider future duct requirements. For details of a typical duct system, see NAVFAC P-272.

Section 2. AIRFIELD LIGHTING SYSTEMS

1. APPROACH LIGHTING. Approach lighting enhances the pilot's ability to acquire the runway environment visually when making an approach for landing during periods of reduced visibility. Visual cues for directional and roll guidance are provided to the pilot for operations at night and in marginal weather conditions by day.

a. System Elements. The principal elements of approach lighting systems are the approach lights which burn steadily and the sequenced flashing lights which flash in periodic sequence. The Approach Lighting System (ALS) with sequenced flashing lights (SFL), Category I (ALS/SFL CAT I) and Category II (ALS/SFL CAT II) are 3,000 feet long unless a shorter system is authorized for installation by NAVAIR.

(1) Approach Lights. The approach lights are mounted in horizontal barrettes arranged symmetrically about the runway centerline extended, starting at the runway threshold and extending outward into the approach zone. All barrettes shall be installed perpendicular to the centerline of the approach lighting system which shall be common with the centerline of the existing or future runway centerline lights (see Runway Centerline Lighting in paragraph 4, below). The configuration for ALS/SFL CAT I and ALS/SFL CAT II shall be as shown in NAVFAC P-272. All lights in the 1,000 foot overrun except the three-light red barrettes shall be semiflush fixtures. The lights in the red barrettes shall be frangibly mounted and shall not exceed 14 inches in height. At the 1,000-foot crossbar and beyond, the overrun lights up to 6 feet in height shall be mounted on frangible couplings. For heights greater than 6 feet, the lights must be installed on frangible supports. When rigid towers, trestles, etc., are required, the light unit shall be at least 20 feet above the rigid structure and the support between the two shall be frangible.

(a) Location-Plan. The nominal spacing between light barrettes in both ALS/SFL CAT I and II systems shall be 100 feet. The spacing of lights within individual barrettes shall be 3 feet 6 inches for bars along the centerline and 5 feet for all others.

(b) Location-Elevation. The longitudinal and transverse gradients of the semiflush lights in the overrun shall conform with the finished grades of the overrun as specified in NAVFAC DM-21 series. There shall be no change of longitudinal grade of the semiflush lights within the overrun except to change from semiflush fixtures at the 900 foot barrette to elevated fixtures at the 1,000-foot crossbar. Here the plane of the lights for the remainder of the system may be raised a distance not to exceed 2 feet. The plane of lights from the 1,000-foot crossbar to the 3,000-foot barrette should preferably be horizontal. The gradient of the plane, however, may be varied not to exceed plus 2 percent or minus 1 percent if necessitated by terrain or obstructions.

(c) Alinement. All lights shall be alined in azimuth with beam axes parallel to the approach lighting system centerline. Elevated lights shall be aimed vertically at a point on the glide path 1,500 feet in advance of the light with the angular elevation of each light calculated as shown in NAVFAC P-272. Semiflush lights have a preset vertical aiming angle and require alinement in azimuth only.

(d) Obstruction Clearance. No objects shall protrude through the plane which passes through the centers of the approach lights. In plan, the plane is rectangular in shape, 400 feet wide, originating at the 1,000-foot crossbar and extending 200 feet beyond the end of the system. For light plane clearance approach purposes, all roads, highways, vehicle parking areas, and railroads shall be considered as vertical solid objects. The clearance required above interstate highways is 17 feet; railroads, 23 feet; and all other roads, highways, and vehicle parking areas, 15 feet, measured from the crown of the road or top of rail as applicable. Airport service roads or rail spurs, where all traffic is under tower control, are not considered obstructions. For additional system visibility requirement from flight path envelopes, see NAVFAC P-272.

(e) Variations. When a permanent obstacle such as a highway exists in the approach zone, the longitudinal spacing of the light barrettes may be adjusted. If a barrette is displaced, adjacent barrettes shall be adjusted to maintain essentially equal spacings as near 100 feet as possible. Within the first 1,500 feet of the threshold, the spacings shall not vary by more than 10 feet. The 1,000-foot crossbar, 1,500-foot barrette, and 3,000-foot barrettes, however, shall not vary from position by more than 50 feet.

(2) Sequenced Flashing Lights. Sequenced flashers are installed on a line with the approach light barrette and 1 foot 9 inches to the right of the centerline when viewed from the approach end. The flashing light shall be mounted in accordance with paragraph 1.a.(1) of this manual for frangible requirements. For installation details, see NAVFAC P-272.

b. Electrical Requirements. The approach lights operate on 20-ampere series circuits with constant current regulators. Primary power requirements are 3-phase 2400/4160-volt service with a peak demand of about 100 kilowatts. A separate circuit shall be used for the red barrettes in the Category II system. Sequenced flashing lights require 240/480-volt, 3-wire, single-phase, multiple circuits so arranged that they cannot be operated unless the approach lights are operating. The sequenced flashing lights shall flash in sequence toward the runway at 1/60-second intervals between adjacent units. The sequence shall be repeated at 1/2-second intervals. For wiring diagram and vault layout, see NAVFAC P-272.

c. Control Requirements. The control voltage is 120-volt, single-phase service. The steady burning approach lights shall be provided with a five brightness step intensity control. An audible resettable alarm shall be provided to indicate continued operation on system brightness step 5. The alarm shall activate after 15 to 30 minutes of continuous operation on step 5. The alarm shall not be turned off by resetting or by switching to brightness step 4. Approach lighting brightness with independent on-off control from the sequenced flashing on-off control shall be available at the remote

control panel in the control tower and at approach light vault. In addition, a monitor shall be provided in the control tower which automatically signals when one or more sequenced flashers are inoperative. For time meters, warning buzzer, and other monitor details, see NAVFAC P-272.

2. **RUNWAY EDGE LIGHTING.** The runway edge lighting system consists of two straight lines of high-intensity lights defining the lateral limits of the runway.

Circling guidance lights are also installed along the edge of the runway and are used to enable the pilot to locate the runway from a circling approach and establish the proper traffic pattern.

a. Description.

(1) Runway edge lights are bidirectional white lights. They are elevated, except at intersections and at arresting gear locations where semi-flush lights are used in maintaining uniform spacing. Frangible couplings are provided for the elevated lights.

(2) Circling guidance lights are elevated 180-degree white lights mounted with frangible couplings. Circling guidance lights are aligned to emit light away from the runway.

b. Location. See NAVFAC P-272, and as follows:

(1) Runway edge lights shall extend the full length of the usable runway and shall be spaced at even 200-foot intervals from each end toward the midpoint. For runway lengths not evenly divisible by 200 feet, light spacing at the midpoint shall be not less than 100 feet. Where an interval of less than 100 feet may occur, it is averaged with the adjacent space(s) to attain a lighting configuration symmetrical about the midpoint of the runway. Each pair of lights shall be installed on a common transverse line across the runway. Elevated lights shall be placed in the shoulder on each side of the runway on a line approximately 2 feet outside the edge of full strength pavement. Semiflush lights at intersections, and at arresting gear locations, shall be installed along the same line.

(2) Circling guidance lights shall be located approximately 1,000 feet apart, 50 feet outboard of the edges of single runways and the outer edges of parallel runways. They shall be located adjacent to the runway distance markers (see Runway Distance Markers in NAVFAC DM-23.2).

c. Variations. For edge lights located on displaced thresholds, see paragraph 3.a.(1)c.

d. Electrical Requirements. The electrical characteristics of the edge lighting and circling guidance lights are as follows:

(1) High-intensity runway edge lighting systems operate on 20-ampere series circuits with a constant current regulator capacity consistent with the number of lights and circuits and the proximity of the vault. Usually a 37.5 kilowatt regulator is used. The primary voltage is 2,400-volt, single-phase power.

(2) Circling guidance lamps are 20 amperes but are served from a 6.6-ampere circuit through 6.6/20.0-ampere transformers because of the small capacity required. Circling guidance lights are maintained at essentially full intensity.

(3) All runway edge light and circling guidance light circuits shall be installed in ducts. For handhole and duct system details, see NAVFAC P-272.

e. Control Requirements. The control voltage is 120-volt, single-phase service. On-off and brightness control for runway edge lights shall be available at the remote control panel in the control tower and at the field lighting vault. Circling guidance lights shall be controllable from the lighting panel in the control tower and from the field lighting vault. For simultaneous control of brightness on both runway and taxiway lights, see paragraph 8.c.

3. THRESHOLD, RUNWAY END, AND RUNWAY IDENTIFICATION LIGHTING. Threshold and runway end lighting systems define the ends of the runway surface usable for landings. Runway identification lights enable a pilot to identify the runway during night and reduced visibility operations.

a. System Elements. The following constitute threshold and runway end elements:

(1) Threshold and Runway End Lights. Threshold and runway end lights are provided on the approach ends of all runways with runway edge lighting. Threshold lighting consists of two groups of elevated lights, one group at each edge of the runway. In each group, seven lights form a wing bar outboard of the runway edge lights. Six inboard lights are provided at each edge of the runway. All lights show green in the approach direction. Runway end lights are provided on the rollout end of all runways with runway edge lighting. The runway end lights consist of 2 groups of inboard lights and show red in the direction of the runway. Except in the case of displaced thresholds, the function of threshold and runway end lights shall be combined into a single fixture. For typical configuration, see Figure 1.

(a) Location. The light units shall be installed on a line which is perpendicular to the runway centerline and is approximately 2 feet beyond the end of the runway surface usable for landing. All lights are located on 5-foot centers. The outermost inboard light shall be in line with the runway edge lights.

(b) Alignment. The inboard lights are aligned with the principal beams toed-in toward the runway centerline producing equal angles of 3.5 degrees with a line through the light fixture parallel to the runway centerline. The wing bar lights are aligned in azimuth with the beam parallel to the runway centerline.

(c) Variations. Threshold and runway end lights may be varied as follows: (1) The gap between the two groups of threshold lights in the threshold bar varies depending on runway width. Where the gap is excessive, all inboard lights may be spaced nominally on 10-foot centers, and additional elevated lights are installed until the gap approximates the gage of the touchdown zone markings. (2) Additional lights shall be added to the

threshold lighting configuration when an approach lighting system is installed (see Approach Lighting in paragraph 1). Inboard lights are added in the gap between the two groups with nominal spacings between lights of 10 feet for ALS/SFL CAT I and 5 feet for ALS/SFL CAT II. The added lights are bidirectional, elevated fixtures except within the touchdown zone limits where semi-flush fixtures are used. For threshold configuration used with approach lighting, see Figure 2. (3) Displaced threshold lighting is employed if a portion of the pavement is unusable for landing but is available for rollout and takeoff.

The configuration for a displaced threshold is as shown on Figure 3. The runway edge lights shall be provided with 180-degree color filters as shown in Figure 3. If the unusable portion of the pavement is unavailable for rollout or takeoff, the runway edge lights and runway end lights shall be removed, that part of the pavement shall be marked as shown in Figure 6-5 in NAVFAC DM-21 series, and a standard threshold shall be installed at the new location.

(2) Runway Identification Lights. Identification lights have a rotating mechanism which rotates two high-intensity lamps inside a clear glass cover at a constant speed of 40 revolutions per minute. The fixtures are elevated and mounted on a frangible coupling. The runway side of these lights is shielded to prevent glare from blinding pilots of approaching aircraft. A runway identification light is installed 50 feet outboard from each side of the runway edge in line with the threshold lights, as shown in Figure 1.

b. Electrical Requirements. Threshold, runway end, and runway identification lights are electrically an integral part of the runway edge lighting system. For criteria, see Runway Edge Lighting in paragraph 2. When an approach lighting system is installed, the additional lights described in 3.a.(1)(c) of this manual may be connected electrically to the runway approach lighting circuit or to a separate regulator which is connected so that it is energized with the approach lights. Runway identification lights are operated from the runway edge lighting circuit or, preferably, on an auxiliary circuit. Intensity of the runway identification lights shall remain almost constant regardless of the runway edge lighting brightness step. Runway end lights and lights serving as both threshold and runway end lights shall be connected to the runway edge lighting circuit.

c. Control Requirements. Threshold and runway end lights are varied in intensity through the five brightness steps with the runway edge lights and are controlled with the runway edge lights. Runway identification lights shall have an on-off control which may operate from the runway edge lights or, preferably, from a separate circuit.

4. RUNWAY CENTERLINE LIGHTING. Runway centerline lighting is used as a visual aid for centering the aircraft during nighttime and reduced visibility takeoff and landing operations.

a. Description. Runway centerline lights are semiflush, bidirectional lights installed along the runway centerline. They are designed for installation in either rigid or flexible pavements, both new and existing, using methods shown in NAVFAC P-272. Centerline lights shall be white from threshold to the point 3,000 feet from the runway end; alternated red and white from 3,000 feet to 1,000 feet from the runway end, and red from 1,000 feet to the runway end.

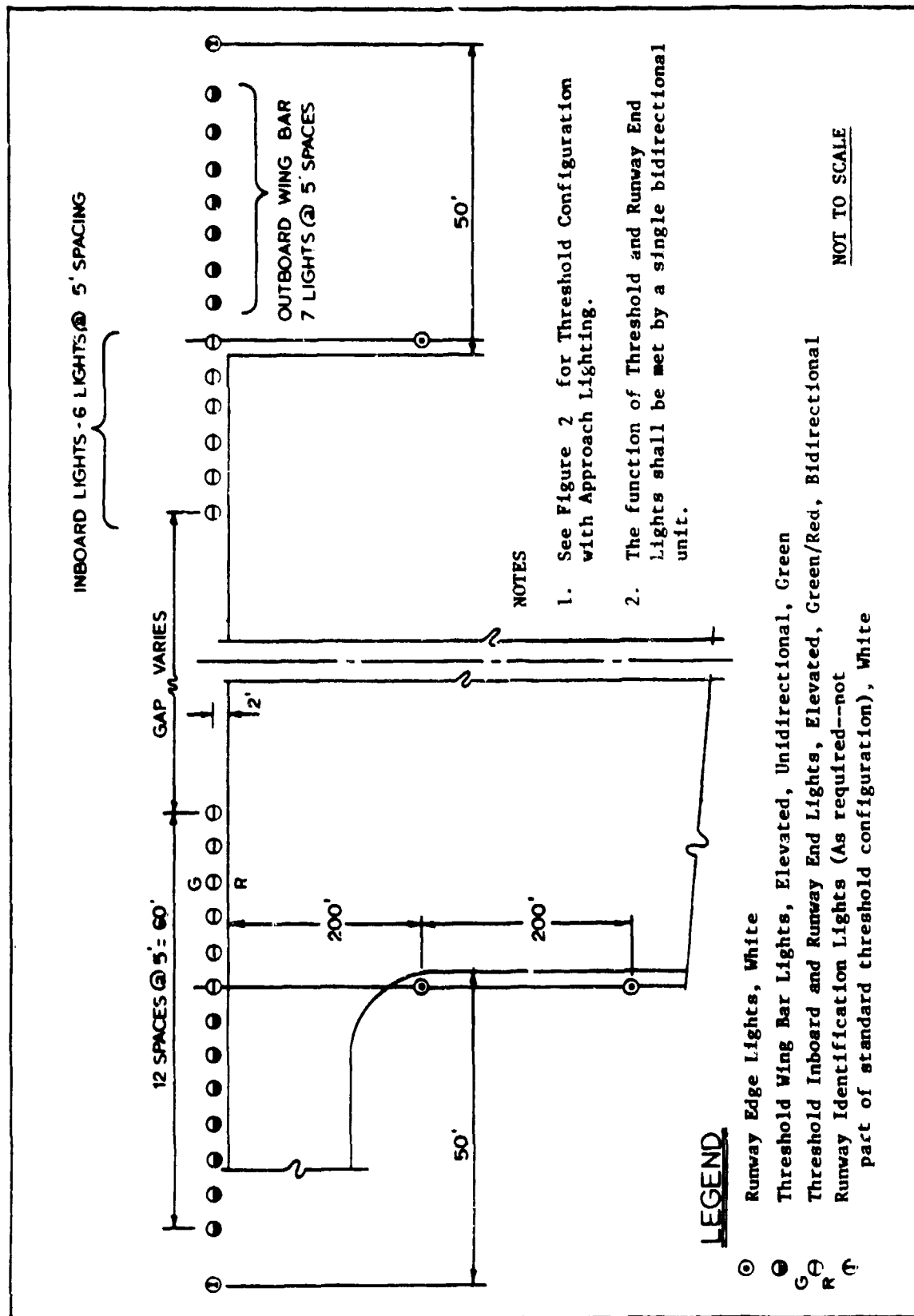


FIGURE 1
Typical Threshold Lighting Configuration

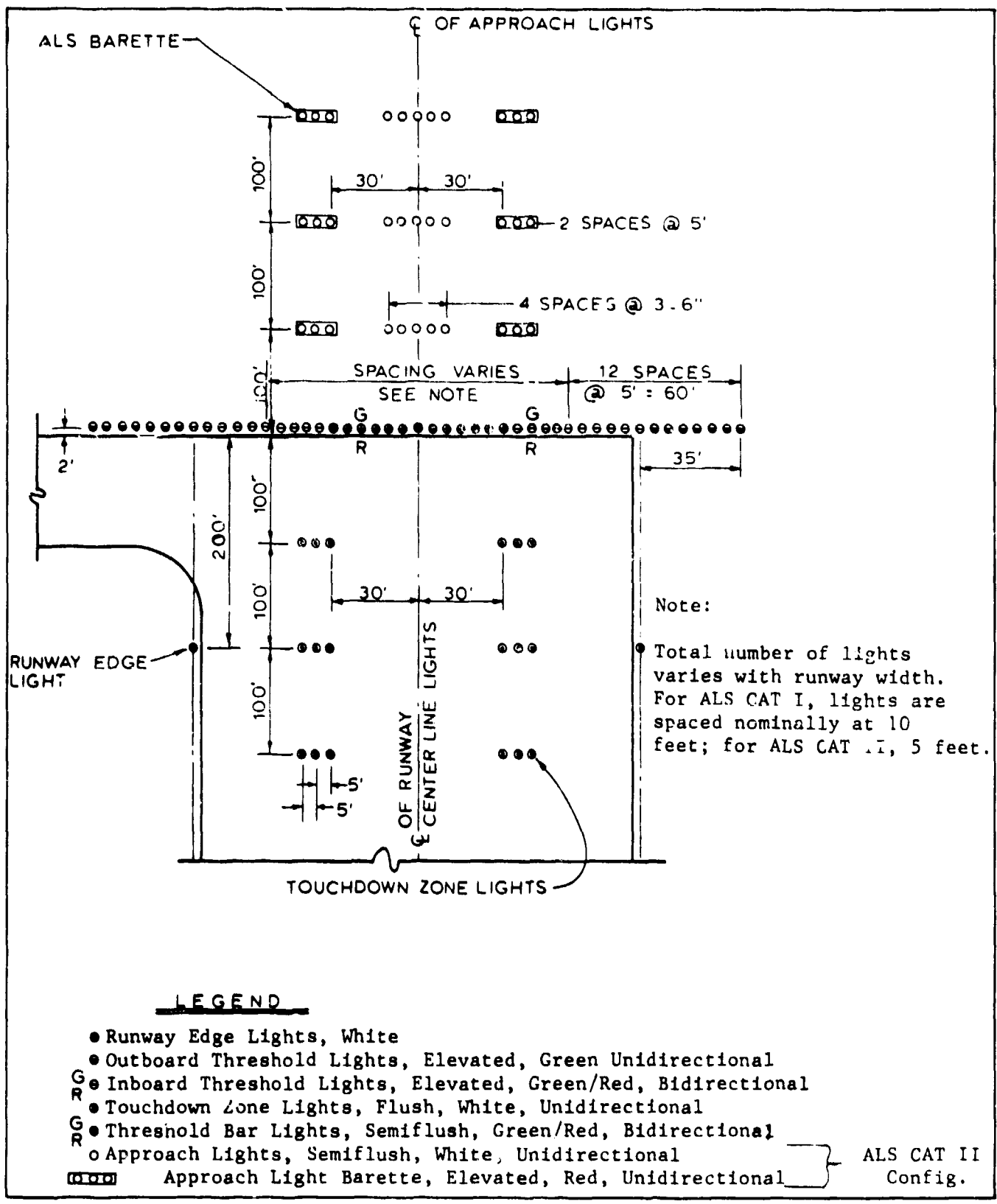
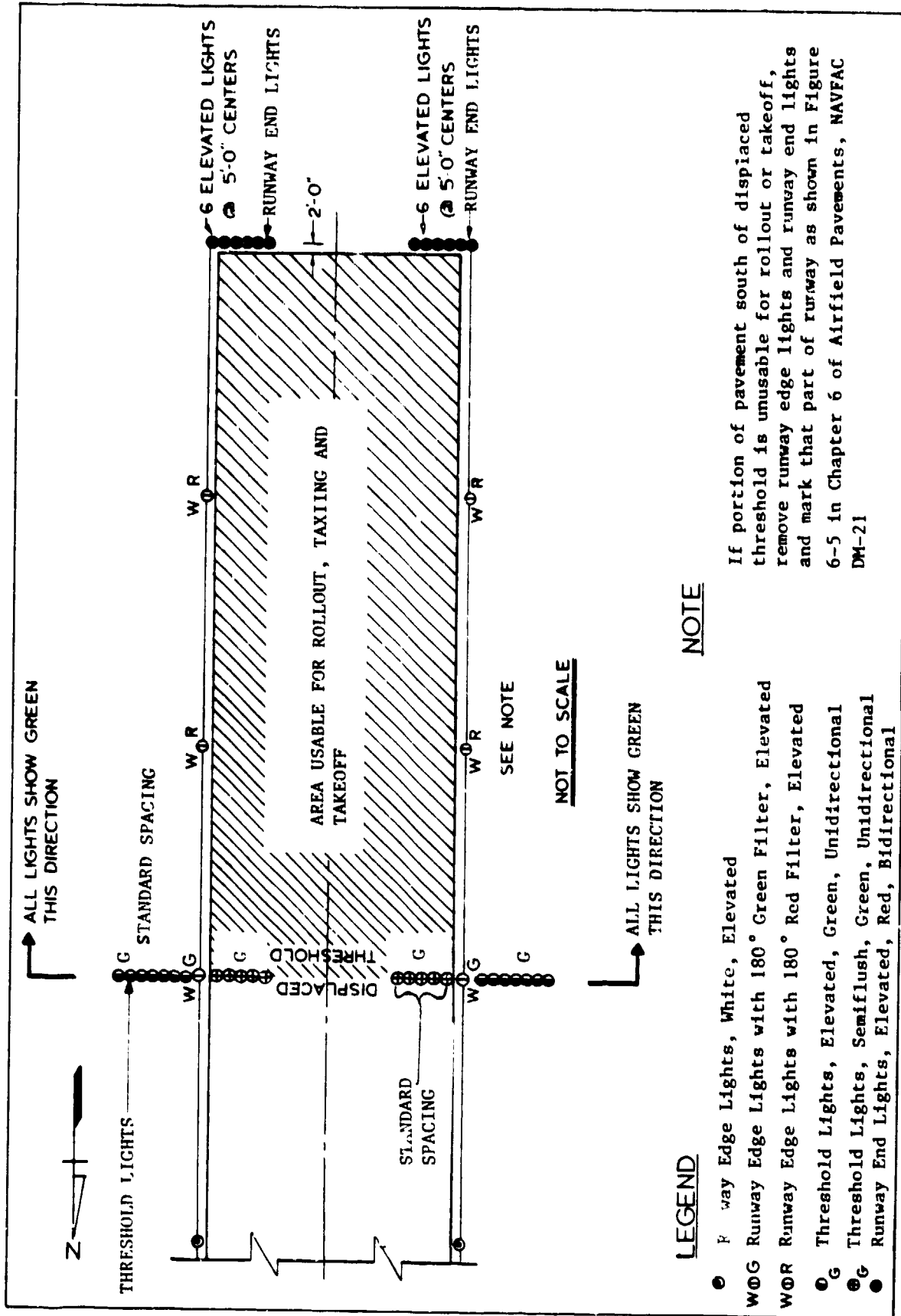


FIGURE 2
Threshold Configuration with Approach Lighting



LEGEND

- F Way Edge Lights, White, Elevated
- WOG Runway Edge Lights with 180° Green Filter, Elevated
- WOR Runway Edge Lights with 180° Red Filter, Elevated
- G Threshold Lights, Elevated, Green, Unidirectional
- ⊙ G Threshold Lights, Semiflush, Green, Unidirectional
- Runway End Lights, Elevated, Red, Bidirectional

NOTE

If portion of pavement south of displaced threshold is unusable for rollout or takeoff, remove runway edge lights and runway end lights and mark that part of runway as shown in Figure 6-5 in Chapter 6 of Airfield Pavements, NAVFAC DM-21

SEE NOTE

NOT TO SCALE

FIGURE 3
Displaced Threshold Configuration

b. Location. The nominal spacing between light fixtures shall be 25 feet. Installation tolerances are as shown in NAVFAC P-272.

c. Alinement. Runway centerline lights are alined with the light beams parallel in azimuth to the runway centerline.

d. Electrical Requirements. Runway centerline lighting systems are designed to operate on a 20-ampere series circuit. The series circuit is supplied from constant current regulators having an adequate capacity. The regulator primary voltage is 2,400-volt, single-phase.

e. Control Requirements. The control voltage is 120-volt, 60-Hertz, single-phase service. Brightness and on-off control shall be provided at the field lighting vault and on a remote panel located in the control tower cab.

5. TOUCHDOWN ZONE LIGHTING. Touchdown zone lighting (TDZL) delineates the touchdown zone on the runway and provides directional and roll guidance for aircraft approaching the threshold and preparing for touchdown.

a. Description. Touchdown zone lights are semiflush, unidirectional white lights arranged in bars of three and placed on each side of the line of runway centerline lights. The system may be installed in new runway construction or in existing pavements, as shown in NAVFAC P-272.

b. Location. Light bars shall be placed at nominal 100-foot spacings for 3,000 feet from the runway threshold as shown in Figure 4. Bars shall be spaced laterally with a 60-foot gage between inboard lights. Installation tolerances are as shown in Figure 4. Each pair of light bars shall be on a common line perpendicular to the runway centerline. They may be on a transverse line with runway edge lights or runway centerline lights, but in any case, the three systems should be developed to utilize a common handhole and duct system with a minimum of handholes.

c. Alinement. Light units shall be aimed parallel to the runway centerline and toward approaching aircraft.

d. Electrical Requirements. Touchdown zone lighting systems operate on a 20-ampere series circuit using a constant current regulator having an adequate kilowatt capacity (normally 37.5 kilowatts). The regulator primary voltage is 2,400-volt, single-phase service.

e. Control Requirements. The control voltage is 120-volt, single-phase service. Brightness and on-off control shall be provided at the field lighting vault and on a remote panel located in the control tower. The pilot relay assembly is used to insure that the touchdown zone lighting cannot be operated unless the centerline lights are turned on.

6. SIMULATED CARRIER DECK LIGHTING. A simulated carrier deck is used to train pilots ashore for landing aircraft on carrier decks. Simulated carrier deck lighting permits training at night.

a. Description. The simulated carrier deck lighting system includes edge lights along the sides of the simulated carrier deck, ramp, and forward

athwartship lights at the ends, and a line of centerline lights along the center. The simulated carrier deck is located on the left side of the runway, as viewed from landing aircraft. All lights are white, unidirectional, and semi-flush.

b. Location. Simulated carrier deck lighting shall not be installed on primary runways, but will have the spacings and configurations as shown in Figure 5. For installation details, see NAVFAC P-272. For pavement design requirements and markings, see NAVFAC DM-21 series.

c. Alinement. All lights are alined parallel in azimuth to the runway centerline and are directed toward the nearest runway threshold.

d. Electrical Requirements. Simulated carrier deck lighting systems are designed to operate on a single 6.6-ampere series circuit. Four fixtures connected in series are supplied from an isolation transformer located at the edge of the runway. With the use of selector switches, one regulator can serve two or more systems. For a typical wiring diagram, see NAVFAC P-272.

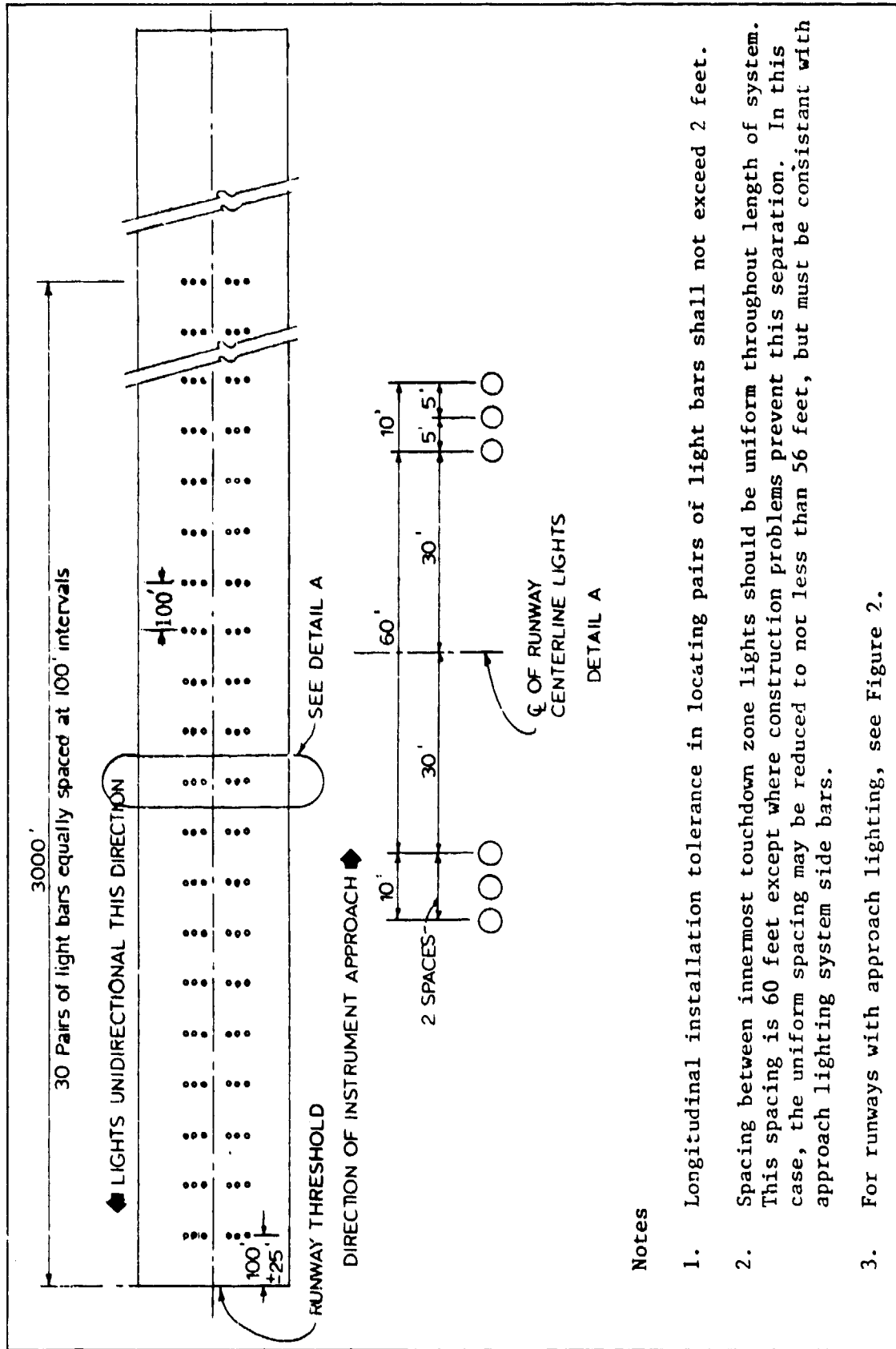
e. Control Requirements. Five step brightness and on-off control shall be provided at the Landing Signal Officer (LSO) station of the Optical Landing System (OLS). Utilizing the pilot relay assembly in the field lighting vault, the simulated carrier deck lighting system shall be so circuited that, when energized during normal operating conditions, no other lighting associated with that runway is energized. An emergency override capability shall be provided, however, that will allow immediate energizing of the other lighting systems on this runway of the LSO.

7. WHEELS-UP LIGHTING AND RUNWAY WAVE-OFF LIGHTING. The purpose of wheels-up lighting and runway wave-off lighting is to signal the pilot preparing to land if the landing gear of his aircraft has been lowered. It consists of two lighting systems, wheels-up lighting and runway wave-off lighting. Wheels-up lights illuminate the underside of aircraft, enabling a wheels watch stationed in the approach zone to determine at night if the landing gear is fully lowered. Runway wave-off lighting signals the pilot by day and by night to execute a missed approach if the landing gear is not lowered.

a. System Elements. Lighting shall be installed as shown in NAVFAC P-272.

(1) Wheels-Up Lights. The wheels-up lights shall be located in the approach zone and project a beam of white light upward and toward the runway threshold as follows: the three lights nearest the runway throw the light beam 30 degrees above the horizontal and 25 degrees toward the runway centerline; the remaining 17 lights throw that light beam 30 degrees above the horizontal and 30 degrees toward the runway centerline.

(2) Runway Wave-Off Lights. The runway wave-off lights are equipped with red filters. They shall face landing aircraft, be turned in toward the runway centerline 7 degrees from a line parallel to the runway, and be elevated 4 degrees above the horizontal.



Notes

1. Longitudinal installation tolerance in locating pairs of light bars shall not exceed 2 feet.
2. Spacing between innermost touchdown zone lights should be uniform throughout length of system. This spacing is 60 feet except where construction problems prevent this separation. In this case, the uniform spacing may be reduced to not less than 56 feet, but must be consistent with approach lighting system side bars.
3. For runways with approach lighting, see Figure 2.

FIGURE 4
Touchdown Zone Lighting

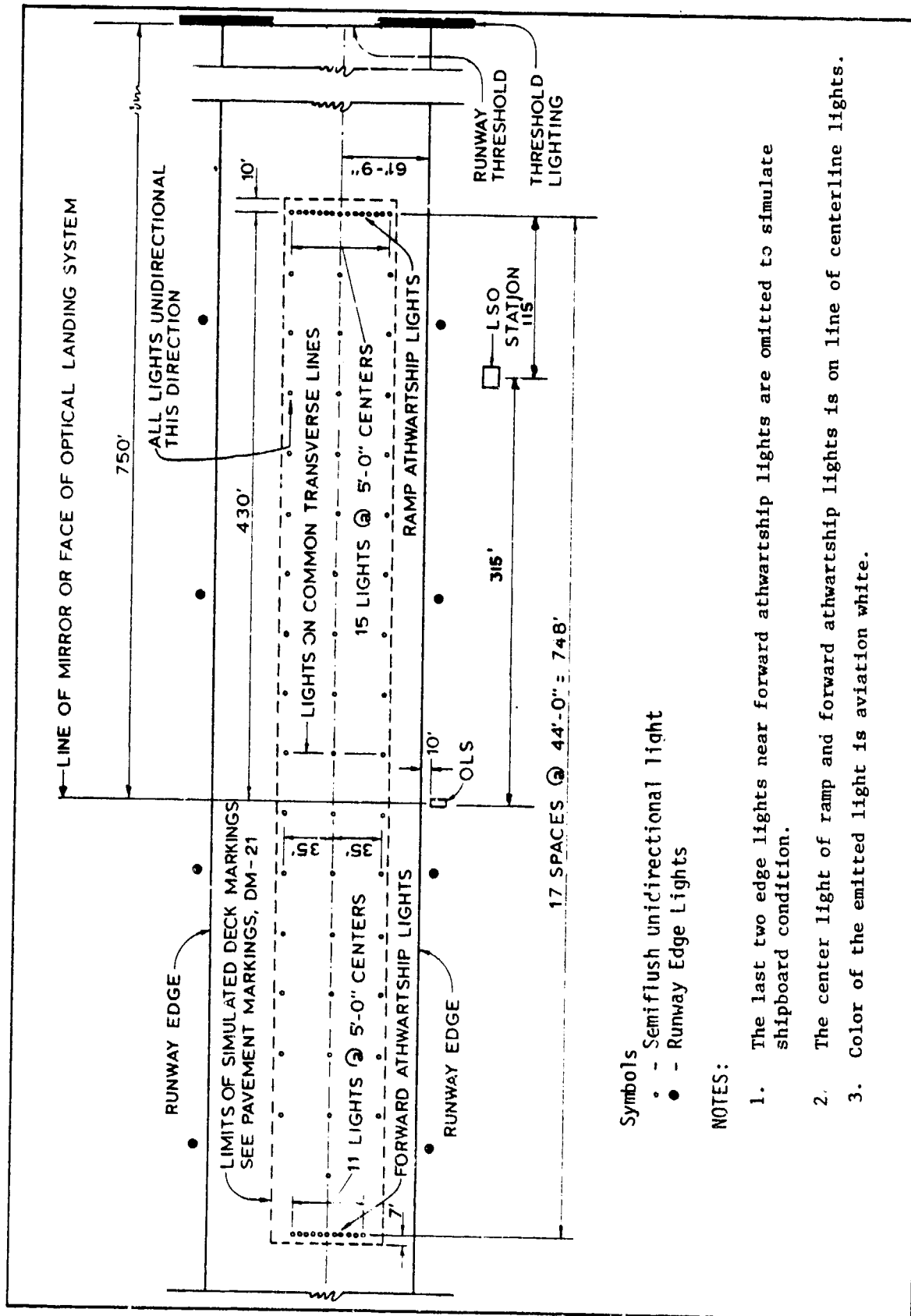


FIGURE 5
Simulated Carrier Deck Lighting

(3) Wheels-Watch Shelter. The wheels-watch shelter shall be located in immediate proximity to the wheels-watch handhole. It shall have a maximum size of 8 feet square and 8 feet high with the upper half of the shelter made of transparent material. It should be portable and, preferably, wheel mounted. It shall be marked as an obstruction (see Obstruction Lighting in NAVFAC DM-23.2 and Obstruction Marking in NAVFAC DM-21 series).

b. Electrical Requirements. For wiring diagram, see NAVFAC P-272 and the following:

(1) Wheels-Up Lights. The wheels-up lights require 10 kilowatts at 120 volts and shall be served from the nearest available power source. The power transformer and all controls shall be located so that the surface mounting will not create an obstruction.

(2) Runway Wave-Off Lights. Runway wave-off lights may be served from the optical landing system (OLS) power vault, where installed on the same runway. A stepdown transformer 2400/120 volts, used with each set of three lights, is located in a handhole adjacent to the lights. The lights shall flash at 90 flashes per minute, half the time on and half the time off. The normal condition of the flashing device shall be off.

c. Control Requirements. The wheels-up lights shall have continuous brightness control from 10 to 100 percent of total brightness and an on-off control at the wheels-watch handhole only. The runway wave-off lights shall be circuited so that they can be controlled by a hand-held "pickle" switch at the Landing Signal Officer (LSO) station, at the wheels-watch handhole, and at the control tower. Wherever an OLS is installed on the same runway, the OLS wave-off control circuit shall be designed to energize the runway wave-off lights simultaneously with the OLS wave-off lights on the OLS. For installation details, see Naval Air Engineering Center (NAEC) Drawing No. 621285.

8. TAXIWAY LIGHTING. Taxiway lighting outlines the taxiways and marks routes to and from runways, parking areas, maintenance areas, fueling areas, and other locations.

a. System Elements. Taxiway lighting includes taxiway edge lights, centerline lights, high-speed exit lights, hold lights, and guidance signs.

(1) Taxiway Edge Lights. Taxiway edge lighting consists of a line of blue lights along each side of the taxiway. They are elevated or semiflush depending upon location. Semiflush lights are used at turns and in paved areas such as aprons where elevated lights might be damaged by aircraft or vehicles.

(a) Location. Lights shall be located at a uniform distance, preferably 2 feet outside the paved or marked edges of taxiways. Examples of the spacing criteria for taxiway edge lights are shown in Figures 6 and 7. The spacing for each straight section is calculated by dividing the taxiway into sections. The ends of the sections are: the nearest points of tangency (PT), corners, changes from the parallel straight sections to single straight sections or to curved sections, changes in width of taxiways, the necks of curved sections, or the intersections of extended centerlines of the taxiway with the line of lights on the far side of an intersecting taxiway. A

light shall be placed on each PT. The lights on straight sections normally are spaced uniformly at intervals not exceeding 200 feet. For single straight edges, the maximum spacing is 100 feet. For all sections less than 300 feet, the maximum spacing shall be 50 feet. An additional light shall be installed 40 feet from each PT on all straight sections or single edges in excess of 300 feet. Light spacings on curves depend on the curve radius and shall be spaced as shown in Figure 7. A neck in a taxiway is divided into two sections at the narrowest point, and the spacing is determined for each section independently.

Where a taxiway intersects but does not cross another taxiway, an edge light shall be located on the far side of the intersection on the extended centerline of the intersecting taxiway. This light shall be the dividing point between two sections for spacing the edge lights on the far side of the intersection. Unnecessary fillet lights may be omitted at taxiway-runway crossings as shown in Figure 8.

(b) Alinement. Elevated taxiway edge lights should be shielded and alined to allow light to be emitted only in directions where taxiway guidance is needed. Shielding may be accomplished by hoods.

(c) Variations. Taxiway lights are also installed in the following cases: (1) The use of runways as taxiways should be avoided. Where this is required, separate taxiway fixtures and circuits shall be provided. Lights shall be located at a uniform distance, preferably 5 feet, outside the paved or marked edges but not closer than 2 feet to the line of the runway lights. (2) Towways shall be provided with edge lights in accordance with criteria for taxiways. (3) Taxiway edge lights shall be installed on both sides of the taxiway. On the apron side of the taxiway bordering an apron, semiflush lights shall be used.

(2) Taxiway Centerline Lights. Taxiway centerline lighting is used as a supplement where the edge lights alone do not furnish the desired guidance. Taxiway centerline lights are green, semiflush, and unidirectional or bidirectional as required by the taxiing pattern.

(a) Location. On straight sections, centerline lights shall be placed on the taxiway centerline. On curves, centerline lights shall be installed along an arc located one-half the normal width of the taxiway from the outside edge of the taxiway. At intersecting taxiways the line of lights shall be installed along an arc drawn tangent to the axes of taxiways with the largest radius of curvature that will retain a minimum clearance to the inner edge of the taxiway equal to one-half the width of the narrower taxiway. Lights shall be spaced as shown on Figure 9. Centerline lighting is discontinued where taxiways intersect with or cross a runway.

(b) Alinement. Centerline lights along straight sections of the centerline shall be alined with the horizontal axes of the beams parallel to the axis of the taxiway. On curved sections, the lights shall be alined with the horizontal axes of the beams parallel to the tangents of the arc of curvature at the light.

(3) High-Speed Exit Lights. Lighting for high-speed exits consists of both blue edge lights and green centerline lights. The centerline lights are unidirectional.

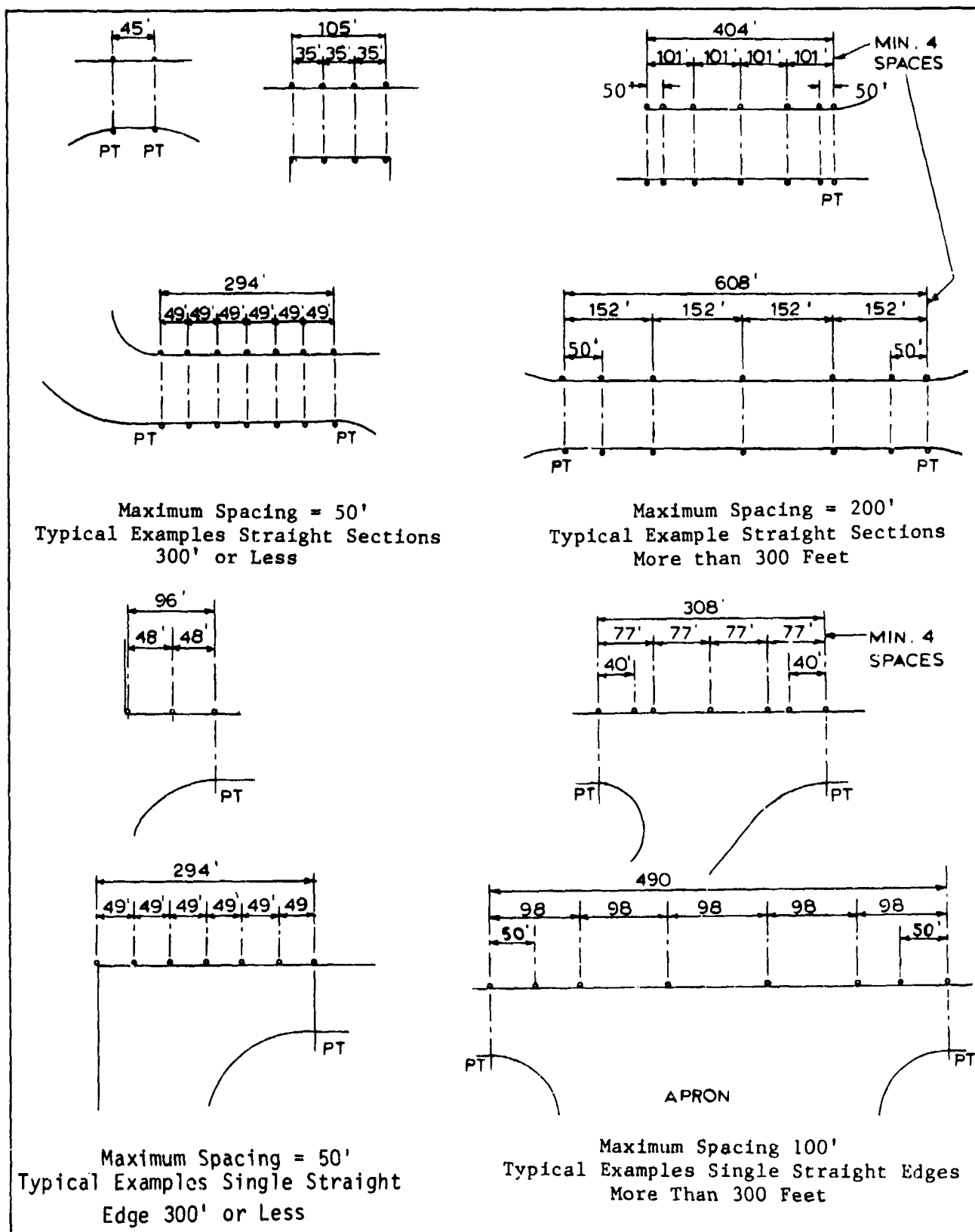
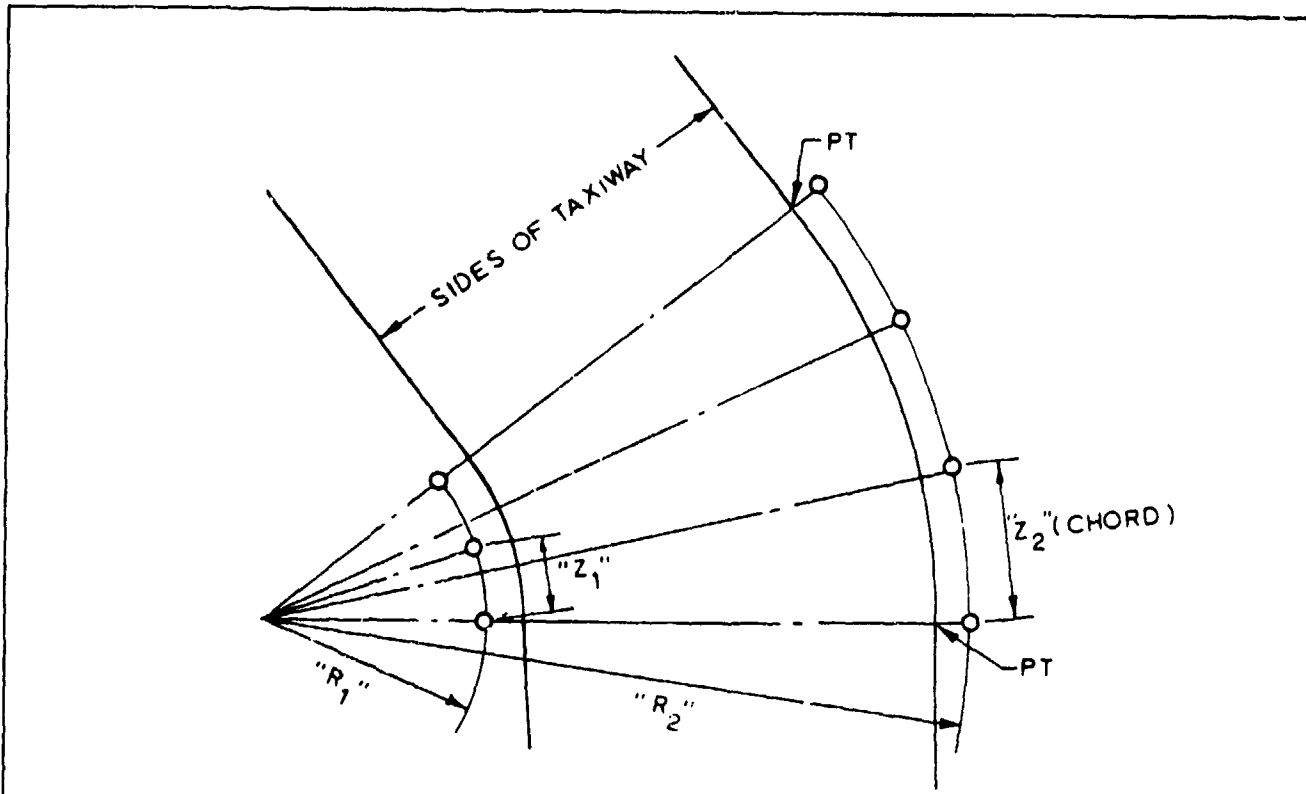


FIGURE 6
Taxiway Edge Lighting, Longitudinal Spacing



| RADIUS "R" OF CURVE IN FEET | DIMENSION "Z" IN FEET |
|-----------------------------------|-----------------------------|
| 25 | 17.3 |
| 50 | 24.5 |
| 75 | 30 |
| 100 | 34.5 |
| 150 | 42.5 |
| 200 | 49 |
| 250 | 55 |
| 300 | 60 |
| 400 | 69 |
| 500 | 77 |
| 600 | 85 |
| 700 | 91.5 |
| 800 | 98 |
| 835 & over | 100 |

Notes

1. Space lights uniformly on both sides of taxiway between points of tangency (PT). Determine spacing by dividing total arc into equal increments approximating "Z". Actual spacing shall not exceed "Z" by more than 5%.
2. On curves of radii not listed, interpolate spacings from values given.
3. On all curves in excess of 30 degrees of arc, there shall be a minimum of three edge lights including those at PT's.

FIGURE 7
Taxiway Edge Lighting, Spacing on Curves

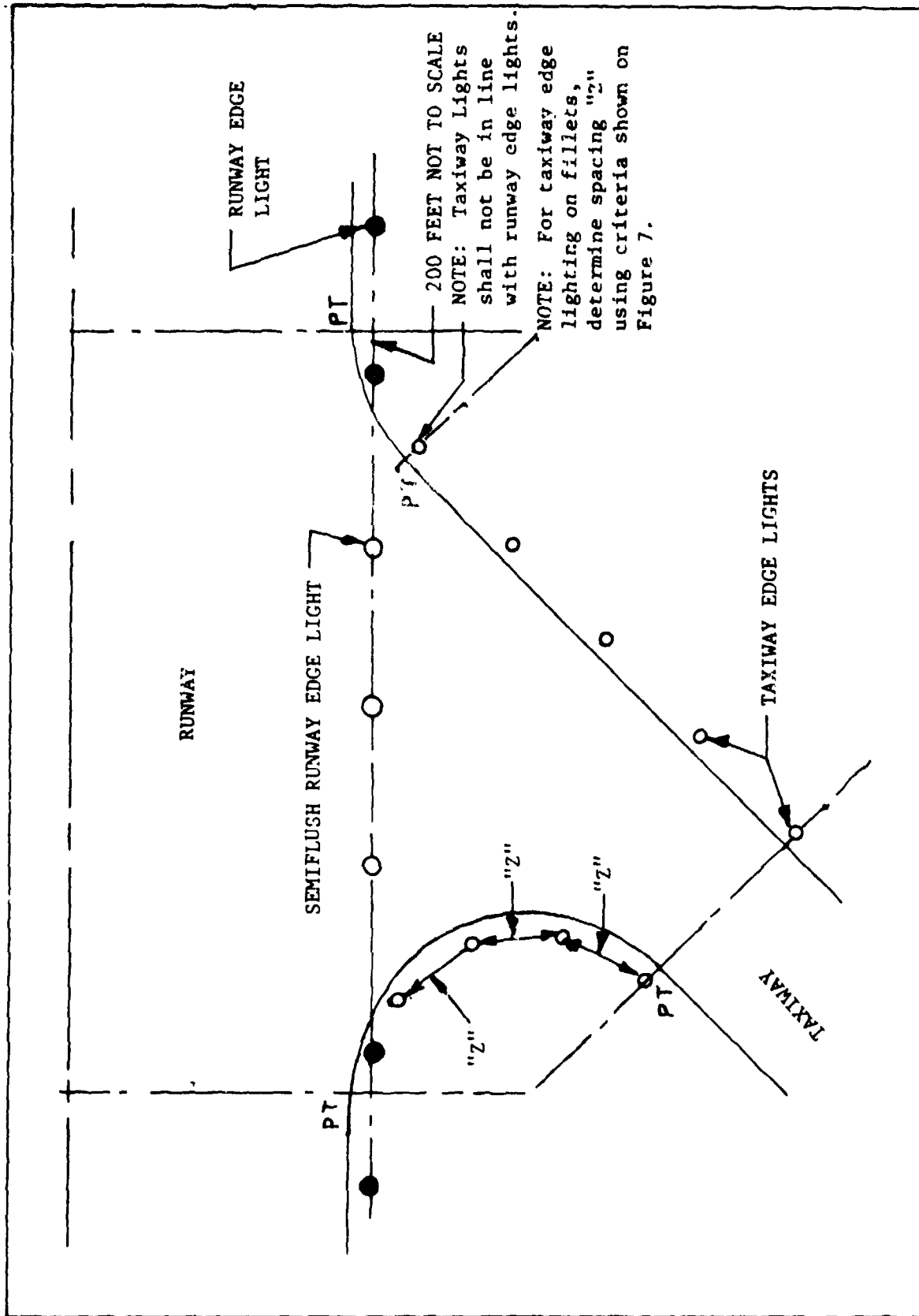
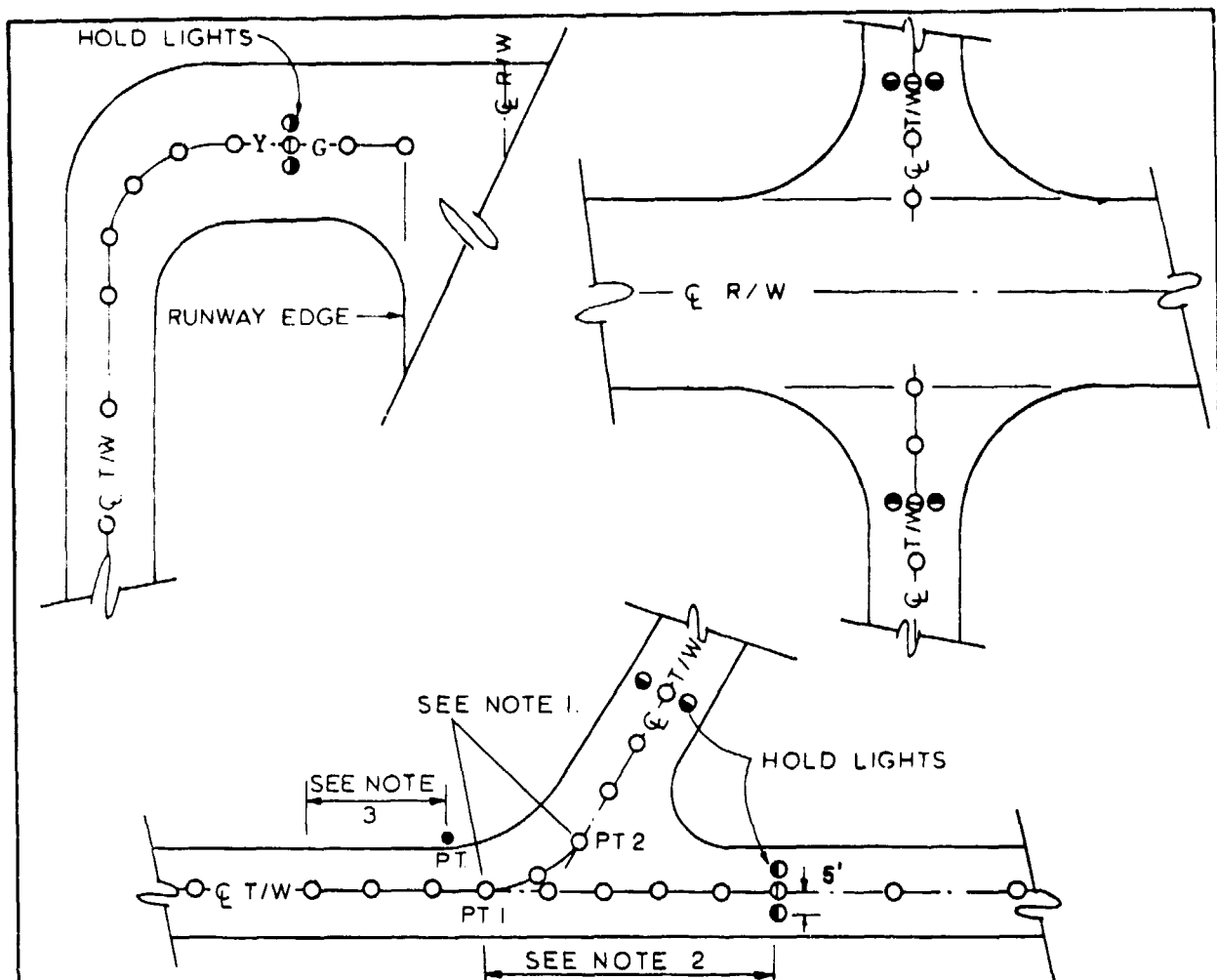


FIGURE 8
Taxiway Edge Lighting, Entrance-Exit Details



LONGITUDINAL SPACING CRITERIA

| | Cat. II IFR | All Other |
|-----------------------------------|----------------|--------------|
| Nominal | 50' | 100' |
| At Intersections (See Note 2) | 50' | 50' |
| Curves Radius Less Than 400' | 12.5' | 25' |
| (See Note 1) Radius 400' to 1200' | 25' | 50' |
| Radius Greater Than 1200' | 50' | 100' |

LEGEND

- ⊙ Bidirectional, Green and Yellow
- Bidirectional, Green
- Unidirectional, Yellow, Direction of light ↑

NOTES:

1. Locate lights at PT1 and PT2, and space intermediate lights equally along selected curve in compliance with spacing criteria.
2. Space lights equally between PT1 and "Hold" lights.
3. Continue centerline lights for at least 100 feet beyond PT of taxiway edge or the beginning of the taxiway edge lights.
4. Runway and taxiway edge lights not shown.

FIGURE 9
Taxiway Centerline Lighting

(a) Location. Edge lights shall be located and spaced as for other taxiway sections but spacing shall not exceed 50 feet. Centerline lights shall be located and spaced as shown on Figure 10.

(b) Alinement. Edge lights shall be alined as for other taxiway sections. The centerline lights in the line parallel to the runway shall be alined parallel to the runway centerline and the beams directed toward the threshold. For centerline lights in the curved portion, the axes of the beams shall be alined in azimuth towards the approaching aircraft to intersect the taxiway centerline at a point approximately 500 feet ahead of the light.

(4) Hold Lights. Hold lights are three semiflush lights used to mark the hold positions. The lights are unidirectional yellow except when installed with taxiway centerline system in which case the center light is bidirectional yellow and green.

(a) Location. The center light is located on the taxiway centerline with the other two fixtures located 5 feet outboard on a line perpendicular to the taxiway centerline. Examples of the use of hold lights are shown on Figure 9.

(b) Alinement. Hold lights are alined with beam axes parallel in azimuth to the taxiway centerline.

(5) Taxiway Guidance Signs. Taxiway guidance signs are internally lighted with white lamps and emit aviation yellow light through a colored plastic window. The elevation of the top of the sign shall be not greater than 24 inches above that of the adjacent edge of the full strength pavement. Guidance signs are built in one to six sections with one lamp per section. Taxiway guidance signs are the following types: destination signs, which indicate the direction to taxi; location signs, which identify the observer's location; and instruction signs, which convey instruction such as "no entry." Legends consist of combinations of short words, contractions, abbreviations, and runway numbers for destinations and special instructions; arrows for directions; dots for separating more than one destination in the same direction; and blanks to provide spaces and to blank out unused sections of signs. Holding position signs shall spell out "HOLD" and identify the runway. The arrow for direction to destination should be an open chevron without a shaft. Arrows marking the far limit of runway turnoffs should include shafts. The following words and abbreviations are for use on destination signs:

| | |
|---|-------|
| General parking, servicing, and loading areas | RAMP |
| Aircraft parking only areas | PARK |
| Civilian areas of joint-use airports | CIVIL |
| Military areas of joint-use airports | MIL |
| Freight or cargo handling areas | CARGO |
| International areas | INTL |
| Runup areas | RUNUP |
| Altimeter check point | ACP |
| VOR check point | VCP |
| Operations area | OPS |
| Visitors area | VSTR |
| Refueling area | FUEL |
| Holding point at intersection with runway | HOLD |

(RUNWAY NUMBER)

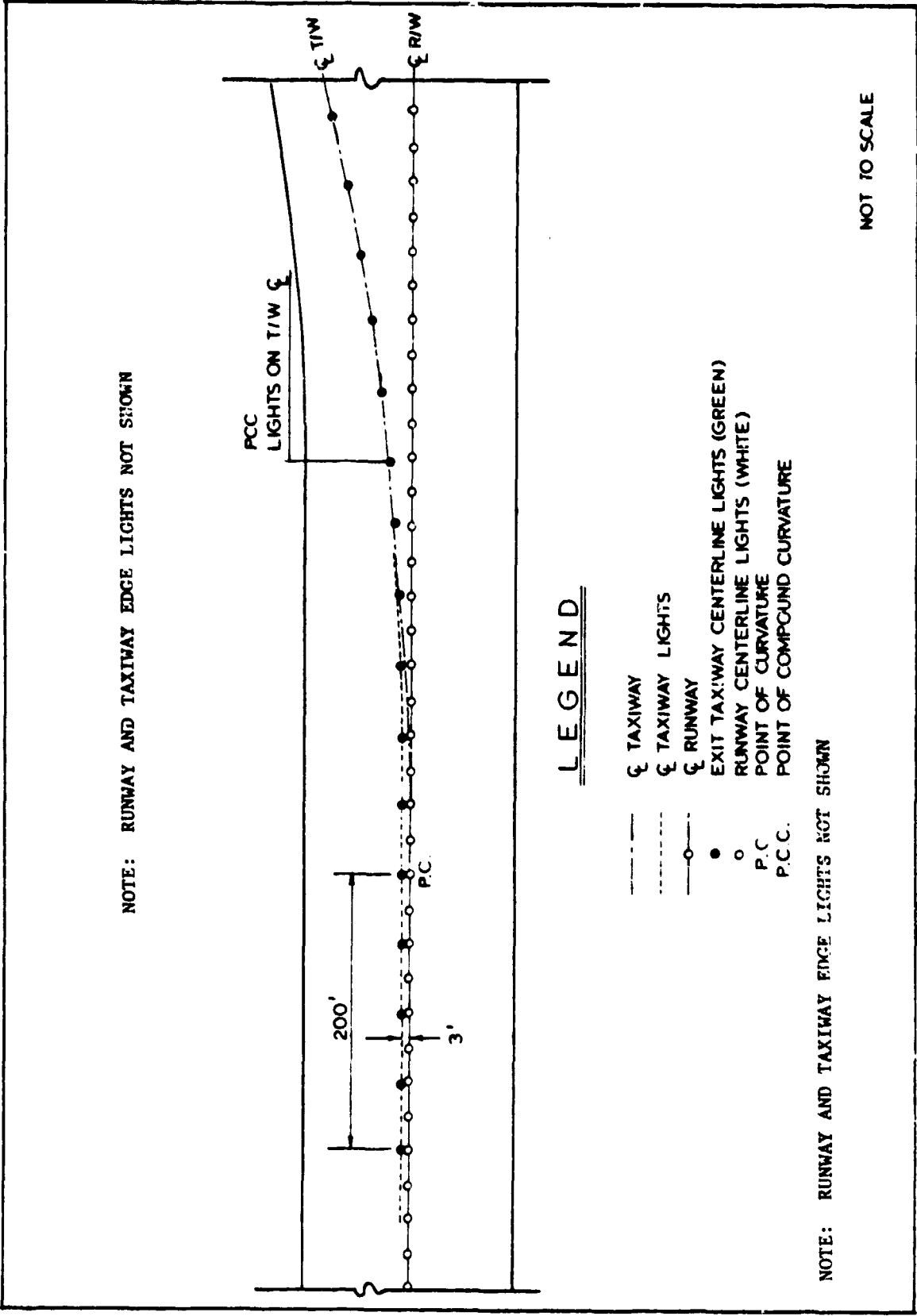


FIGURE 10
Taxiway Centerline Lighting, High-Speed Exit

(a) Location. The inboard edge of the signs shall be 25 feet from the edge of the full strength pavement or designated edge of the taxiway, runway, or apron. Location or instruction signs are located on the left hand side of the taxiway for easier visibility by the pilot. Destination signs should be located on the side of the taxiway in the direction to be followed. Destination or routing information signs shall be placed on the near sides of the intersections on the radius through the point of tangency of the fillet. "HOLD" signs at entrances to runways shall be located in line with the taxiway holding position markings.

(b) Alinement. Signs shall be alined with the face of the sign perpendicular to the axis of the taxiway or runway from which the sign will be observed.

b. Electrical Requirements. In general, separate taxiway lighting circuits should be installed to light taxiing routes (not sections of taxiways) from the parking apron to the runways. A sufficient number of separate circuits should be used to permit flexible and safe taxiing operations. In the interest of economy, however, the number of circuits should be kept to a minimum. Taxiway lighting circuits are supplied by constant current regulators with a 6.6-ampere output. Taxiway edge lights, centerline lights, hold lights, and guidance signs may all be on common circuits as long as system flexibility is maintained. Isolated guidance signs may use 120/240-volt multiple primary circuits.

c. Control Requirements. The intensities used for the taxiway lighting system are brightness steps 5, 4, and 3. The setting should be controlled by the brightness selected for the runway lights. For example, for brightness steps 1, 2, 3, 4, and 5 of high intensity runway lights, the taxiway lights are at brightness step 3, 4, 4, 5, and 5, respectively. Remote on-off control and brightness control shall be provided locally in the main vault and at a remote panel located in the control tower.

9. HELIPAD LIGHTING. Helipad lighting is a system of lights which define the helicopter landing pad for operations at night and during periods of poor visibility. It is used for single helicopter landing pads when authorized as an operational requirement at isolated locations. Helipad lighting and pavement markings must be compatible.

a. System Elements. All lighted helipads require perimeter lighting. Local conditions and usage may require the addition of landing direction, approach direction, and depth perception lighting. For layout of helipad lighting system, see Figure 11.

(1) Perimeter Lighting. Perimeter lights are aviation yellow, omnidirectional lights, normally in elevated fixtures. Semiflush fixtures are used only on helipads where taxiing of wheeled helicopters is required. Elevated perimeter lights are installed on frangible supports and shall not exceed 18 inches above ground and preferably not over 14 inches and placed as follows:

(a) Perimeter lights are normally placed at the edge of the helipad pavement and shall not be more than 7.5 feet outward from that edge. For sizes and details of helipad marking, see NAVFAC DM-21 series.

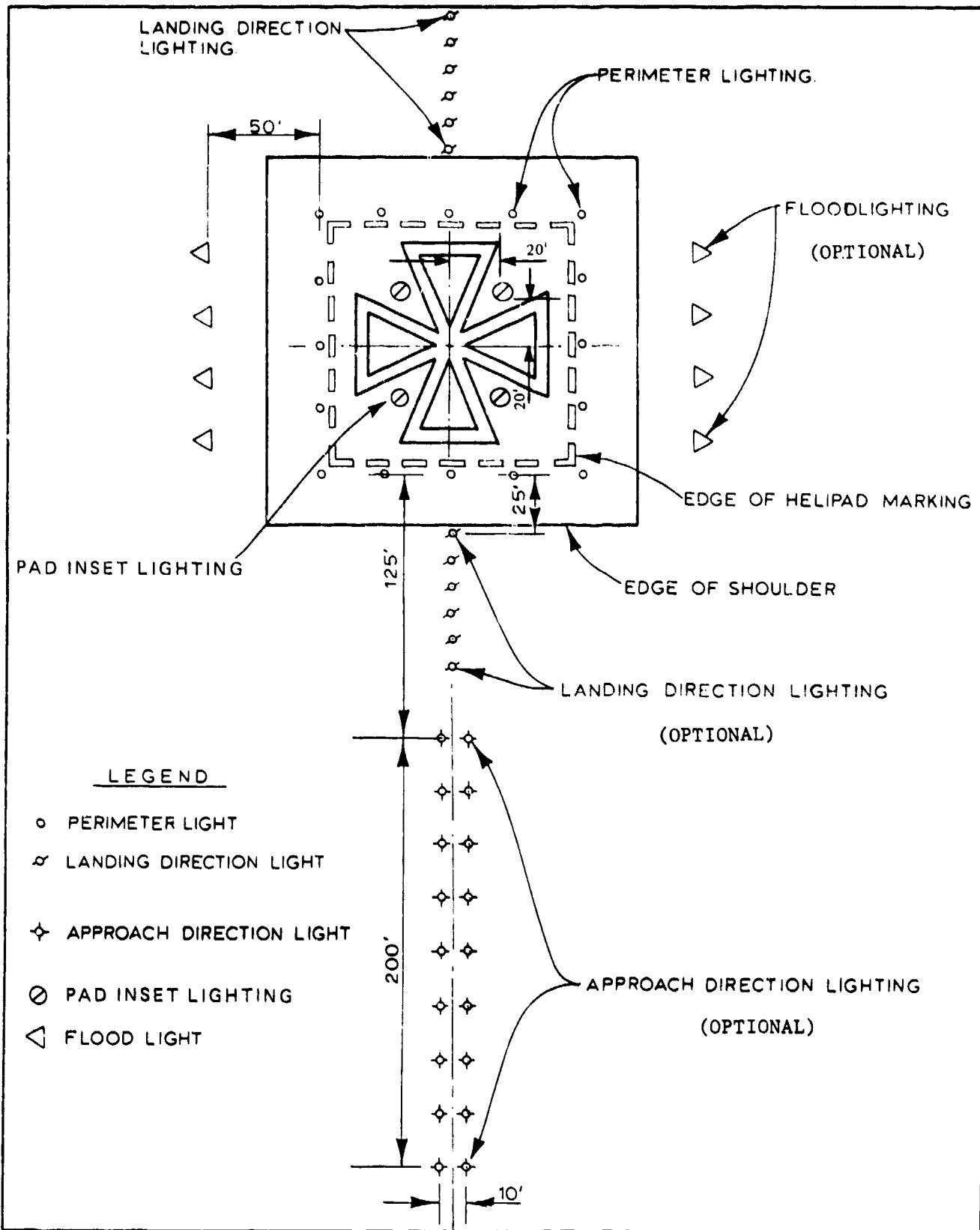


FIGURE 11
Helipad Lighting

(b) Lights shall be placed at each corner of the helipad with three additional lights equally spaced between the corner lights. Lights on opposite sides of the helipad shall be opposite each other and equidistant and parallel to the centerline of the helipad extended.

(2) Landing Direction Lighting. Where a preferred landing direction has been established, landing direction lights shall be installed. They are aviation yellow lights normally in elevated fixtures and are installed at the same height as the perimeter lights.

(Semiflush fixtures may be used under the same conditions as for perimeter lighting.) Six landing direction lights shall be spaced 15 feet apart with the first light located 25 feet from the centerline of the row of perimeter lights. They shall be in a straight line along one or more of the centerlines of the helipad extended. Lights are normally in a horizontal plane with a tolerance of +2 or -1 percent in longitudinal slope.

(3) Approach Direction Lighting. Where additional guidance is required and landing direction lights have been installed, approach direction lights shall be installed. Approach direction lights are aviation white, omnidirectional lights on elevated fixtures. They shall be installed in two rows of nine lights each with the rows spaced 5 feet on each side of the helipad centerline extended in the direction of approach. The first pair of lights shall be placed 125 feet from the centerline of the row of perimeter lights, and subsequent lights, 25 feet apart. The slope established for the landing direction lights shall be continued for the approach direction lights.

(4) Depth Perception Lighting. Additional lighting may be required to assist in depth perception for operations at certain helipad locations. This lighting includes pad inset lights and/or floodlights described as follows:

(a) Pad inset lights may be installed on pads 60 feet per side and larger. They are aviation blue omnidirectional lights in semiflush fixtures. The four lights shall be installed at the corners of a 40-foot square as shown on Figure 11.

(b) Floodlighting of the helipad may be required for landing safety under adverse weather conditions and to assist ground operations. Where installed they shall be located in two rows 50 feet beyond the edges of the helipad on opposite sides and parallel to the normal approach direction. The floodlights shall be mounted on frangible couplings and not over 4 feet above the grade of the helipad. A small obstruction light shall be mounted on top of each floodlight, visible from any direction around and above the light. The entire light output of the floodlight shall be directed below the horizontal. 500-watt lamps are used in the floodlights.

b. Electrical Requirements. Perimeter, landing, and approach lights are installed on 6.6-ampere circuits. Floodlights are supplied from multiple circuits. Regulator and transformer equipment shall be located in an enclosure at a suitable site near the helipad but where it will not be an obstruction.

c. Control Requirements. On-off control of each of the lighting systems shall be provided at the power source and at the location where approaches to the helipad are controlled. In addition to on-off control, approach direction lights require variable intensity control for brightness steps 1 through 5.

10. PARKING AND SERVICE AREA LIGHTING. Parking and service area lighting enables a pilot to guide his aircraft into position for loading, servicing, or parking and provides illumination to perform functions such as fueling, maintenance, loading, and unloading.

a. Description. Parking and service area lighting systems should be in accordance with the recommended practices for these lighting systems as published by the Illuminating Engineering Society, and with the following specific requirements:

(1) Control of Glare. Light distribution shall be controlled to prevent glare toward the control tower or operating aircraft. Disability and discomfort glare shall be kept to a minimum by proper location of lights and direction of beams and by appropriate selection of light source and luminaire type. In addition, positive shielding of any "spill light" above the horizontal level should be accomplished using louvers, louver grids, or baffles. Means shall be provided to adjust luminaires to change light direction.

(2) Illumination Levels. Aprons and service areas in which aircraft are only maneuvering shall have an average maintained horizontal illumination level of not less than 0.5 footcandle for a distance of 200 feet from buildings or structures. Parking aprons and other areas where aircraft servicing requires higher illumination levels should be provided. The service equipment parking area shall be illuminated to an average horizontal level of 1 footcandle. Where higher illumination levels in localized areas are required, portable lighting equipment should be used instead of increasing the illumination levels of the general area. The areas specified above shall be lighted uniformly within a 4 to 1 uniformity range (average to minimum). A two-part system may be utilized to attain the separate lighting requirements of maneuvering of aircraft and servicing.

(3) Supports, Mounting Heights, and Spacing. Illumination is accomplished using high-intensity discharge lamps in fixtures mounted on buildings or poles. Within obstruction clearances, fixtures shall be mounted as high as possible and not less than 50 feet for floodlights and 30 feet for roadway-type luminaires. For obstruction clearance criteria, see NAVFAC DM-21 series.

(4) Peripheral Lighting. The periphery of aprons not illuminated from buildings or structures may be marked by blue taxiway lighting.

(5) Direct Fueling Station Lighting. A typical lighting system for a direct fueling station is shown in NAVFAC P-272. Lighting for maneuvering aircraft is provided by blue taxiway edge lights (see Taxiway Lighting in paragraph 8). Direction is provided by taxiway guidance signs positioned at the entrance to each lane. Illumination in the fueling area is provided by surface-mounted floodlights.

b. Electrical Requirements. Electrical distribution for parking and service area lighting should be 277/480-volt multiple service. Three circuits, one on each phase, should be used to balance the load. The light connections to these circuits should be staggered to promote uniformity in lighting levels and to reduce stroboscopic effects.

c. Control Requirements. On-off control for area lighting shall be provided at the vault and in the control tower. Direct fueling station lighting shall be so circuited that when the fuel pumps and floodlights are turned on, the taxiway lights at the entrance and exit of the fueling lanes shall be maintained on. On-off control shall be provided at the fueling lanes.

REFERENCES

IES Publications, Illuminating Engineering Society, New York, N.Y. 10017.
Lighting Handbook.

Military Specifications, Military Standards and NAVFAC Guide Specifications
(TS), available at U.S. Naval Publications and Forms Center, 5801 Tabor
Ave., Philadelphia, PA 19120. Telephone number: Autovon 442-3321;
commercial 215-797-3321.

MIL-C-25050

Color, Aeronautical Lights and
Lighting Equipment, General
Requirements for

NAVFACENGCOCM Design Manuals and P-Publications

Government agencies may obtain Design Manuals and P-Publications from the U.S. Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120. TWX: 710-670-1685, AUTOVON: 442-3321. The stock number is necessary for ordering these documents and should be requested from the NAVFACENGCOCM Division in your area.

Non-Government organizations may obtain Design Manuals and P-Publications from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

DM-21 series

Airfield Pavements

P-80

Facilities Planning Factors
for Naval Shore Activities

DM-23.2

Navigational and Traffic Aids

P-272

Definitive Designs for Naval
Shore Facilities

Naval Air Engineering Center (NAEC) Drawings, available at Naval Air Technical
Services Facility, 700 Robbins Ave., Philadelphia, PA 19111.

Drawing No. 621285

Installation Details for Simultaneous
operation of Wave-off Lights and Runway
Wave-off Lights

APPENDIX A

METRIC EQUIVALENTS

The following metric equivalents are approximate and were developed in accordance with ASTM E 621. These units are listed in sequence as they appear in the text.

| | |
|--------------------------|---------------------------|
| ½ inch = 12 mm | 61 feet 9 inches = 18.8 m |
| 1 inch = 25 mm | 69 feet = 21 m |
| 14 inches = 350 mm | 75 feet = 23 m |
| 18 inches = 490 mm | 77 feet = 23.5 m |
| 1 foot 9 inches = 550 mm | 85 feet = 25.9 m |
| 24 inches = 600 mm | 91.5 feet = 27.9 m |
| 2 feet = 600 mm | 96 feet = 29 m |
| 3 feet = 900 mm | 98 feet = 30 m |
| 3 feet 6 inches = 1.07 m | 100 feet = 30.5 m |
| 4 feet = 1.2 m | 101 feet = 30.75 m |
| 5 feet = 1.5 m | 105 feet = 31.8 m |
| 6 feet = 1.8 m | 125 feet = 38 m |
| 7 feet = 2.1 m | 150 feet = 45 m |
| 7.5 feet = 2.25 m | 152 feet = 46.25 m |
| 8 feet = 2.4 m | 200 feet = 61 m |
| 10 feet = 3 m | 250 feet = 76 m |
| 12.5 feet = 3.75 m | 294 feet = 90 m |
| 15 feet = 4.5 m | 300 feet = 91 m |
| 17 feet = 5 m | 308 feet = 94 m |
| 17.3 feet = 5.3 m | 400 feet = 122 m |
| 20 feet = 6 m | 404 feet = 123 m |
| 23 feet = 7 m | 430 feet = 131 m |
| 24.5 feet = 7.5 m | 490 feet = 150 m |
| 25 feet = 7.5 m | 500 feet = 152 m |
| 30 feet = 9 m | 600 feet = 183 m |
| 34.5 feet = 10.5 m | 608 feet = 185 m |
| 35 feet = 10.6 m | 700 feet = 213 m |
| 40 feet = 12 m | 750 feet = 230 m |
| 42.5 feet = 13 m | 800 feet = 244 m |
| 45 feet = 13.75 m | 835 feet = 255 m |
| 48 feet = 14.5 m | 900 feet = 280 m |
| 49 feet = 15 m | 1000 feet = 300 m |
| 50 feet = 15.25 m | 1200 feet = 370 m |
| 55 feet = 16.8 m | 1500 feet = 450 m |
| 56 feet = 17 m | 3000 feet = 915 m |
| 60 feet = 18 m | 7350 feet = 2240 m |