TECHNICAL MANUAL

ORGANIZATIONAL

GENERAL REQUIREMENTS FOR

SHOREBASED AIRFIELD MARKING AND LIGHTING

This manual is prepared by NAWCADLKE, Lakehurst, NJ

This manual supersedes NAVAIR 51-50AAA-2 dated 1 May 2003 and all changes thereto.

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NUMERICAL INDEX OF EFFECTIVE WORK PACKAGES/PAGES

List of Current Changes

Original....0.......28 June 2022

Only those work packages/pages assigned to the manual are listed in this index. If changed work packages or pages are issued, insert the changed work package/pages and dispose of the superseded work package/pages, including classified date, in accordance with applicable regulations. The portion of text affected in a change is indicated by change bars in the outer text margin. Changes to illustrations are indicated by pointing hands or the use of the words "MAJOR CHANGE" enclosed in a box, as applicable. A change bar adjacent to an illustration figure title indicates that only the title of the illustration has changed.

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LIST OF TECHNICAL PUBLICATION DEFICIENCY REPORTS INCORPORATED

SHOREBASED AIRFIELD MARKING AND LIGHTING

Identification Number/ QA Sequence Number	Location
NONE	

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WARNINGS APPLICABLE TO HAZARDOUS MATERIALS

SHOREBASED AIRFIELD MARKING AND LIGHTING

1-1. INTRODUCTION.

1-2. Warnings in this manual are provided through the use of the Hazard Icons listed below. Consult the “HAZARDOUS MATERIALS WARNINGS” below or Safety Data Sheets (SDS) Navy Safety and Occupational Health Program (SOH) for specific information on hazards, effects, and protective equipment requirements. If you do not have an SDS for the material involved, contact your supervisor or the base Safety or Bioenvironmental Engineering Office.

1-3. Icons are used in this manual to identify dangers associated with hazardous materials. The icons used and their definitions are identified under the heading “EXPLANATION OF HAZARDOUS MATERIALS ICONS”.

1-4. The hazardous materials used in this manual are identified under the heading “HAZARDOUS MATERIALS WARNINGS”. Each icon represents a certain hazard as described. Beneath the icon or group of icons are the hazardous material name and reference number, and a description of the hazardous material. Only the icons, material name, and reference number are used in the text of the manual. If a full description of the hazardous material is required while performing procedures in this manual, use the reference number to locate the appropriate description below.

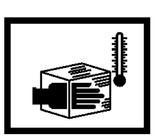
EXPLANATION OF HAZARDOUS MATERIALS ICONS

Biological

The abstract bug symbol shows that material may contain bacteria or viruses that present a danger to life or health.

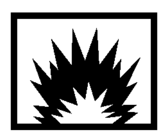
Chemical

The symbol of drops of liquid onto a hand shows that the material will cause burns or irritation of skin and tissue.



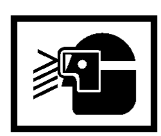
Cryogenic

The symbol of a hand in a block of ice shows that the material is extremely cold and can injure human skin or tissue.



Explosion

The rapidly expanding symbol shows that the material may explode if subjected to high temperatures, sources of ignition, or high pressure.



Eye Protection

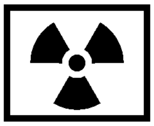
The symbol of a person wearing goggles shows that the material will injure eyes.

Fire

The symbol of a flame shows that the material can ignite and burn.

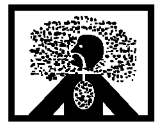
Poison

The symbol of a skull and cross-bones shows that the material is poisonous or a danger to life.



Radioactive

The symbol of three circular wedges shows that radioactive energy is emitted which can injure tissue and organs.



Vapor

The symbol of a human figure in a cloud shows that material gives off vapors that are a danger to life or health.

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SHOREBASED AIRFIELD MARKING AND LIGHTING

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ORGANIZATIONAL

INTRODUCTION

SHOREBASED AIRFIELD MARKING AND LIGHTING

1-1. PURPOSE AND SCOPE.

1-2. PURPOSE. The purpose of this manual is to provide the general requirements for airfield visual landing aids for approaches, landings, takeoffs, taxiing, and surface maneuvering of aircraft on Navy and Marine Corps shore-based airfields. Refer to the Expeditionary Airfields (EAF) NATOPS Manual NAVAIR 00-80T-115, and all subordinate documents, for EAF lighting and marking requirements. This manual should not be used for designing or planning of EAF or forward operating areas and combat fields. The standard configurations and permitted variations are described. Installation requirements affecting the configurations and expected performance are discussed. The types of equipment which are currently approved for use in new installations are indicated. It is not the intent of this manual to direct or request implementation, but to establish guidance information for use when implementation is directed.

1-3. SCOPE. This manual provides information and requirements for designing and installing the various visual landing aids systems used for shore-based Navy airfields and heliports. Visual landing aids include lighting, signs, and markings. Typical installations are described indicating the configurations and equipment that comply with current Navy requirements. This manual is a requirements guide to be used for new installations and for improving existing installations. It is divided into sections of visual aids intended to support different phases of aircraft operations at airfields. Each section of the manual is composed of one or more Work Packages (WP) describing the configurations and requirements for a particular visual aid system. The first WP of each section identifies each type of visual landing aid system included in the section. The visual aids sections of the manual are as follows:

- Approach Visual Aids (WP 003 00)
- Runway Visual Aids (WP 004 00)
- Taxiway Visual Aids (WP 005 00)
- Special Lights and Markings Visual Aids (WP 006 00)
- Helipad Visual Aids (WP 007 00)
- Auxiliary Landing Fields Lighting and Markings (WP 008 00)
- Electrical Power and Control for Visual Aids (WP 009 00)

1-4. PRECEDENCE. This manual supersedes and replaces Technical Manual, NAVAIR 51-50AAA-2, General Requirements for Shorebased Airfield Marking and Lighting, 1 May 2003, with Change 3 of 1 November 2017, in its entirety.

2-1. PROCEDURES FOR RECOMMENDING CHANGES TO THE MANUAL.

2-2. TECHNICAL MANUAL UPDATES.

2-3. Obtaining and Identifying Manuals.

2-4. To automatically receive future changes and revisions to this manual, all activities shall submit their automatic distribution requirements on the Automatic Distribution Requirements Listings software from the Naval Air Technical Services Facilities (NATSF) Technical Publications Library (TPL). The TPL program is available from the NATSF technical publications specialist in your area or from NATSF (215) 697-4879 or DSN 442-4879. Additional copies of this manual and any changes may be procured by submitting a MILSTRIP Form DD 1348 to Navy Publications and Forms Center (NPFC), 5801 Tabor Avenue, Philadelphia, PA 19120. Refer to NAVSUP Publication 2002 to obtain Federal Stock Numbers. Use of this form will not place you on automatic distribution.

2-5. Change and Revisions of Manuals.

2-6. Visual Landing Aid manuals are periodically brought up-to-date, when procedures and other important information are added. Manuals are current per the revision or change data on the title page. The following information applies:

- A manual CHANGE is not a complete publication; only changed or added pages are issued. The title page of the change contains a change notice and a change data. A complete list of changed pages with their change date is given on the A-page following the title page. The portion of the text affected by the current change is indicated by a vertical line in the outer margins of the page.
- A manual REVISION is a completely new manual and supersedes the entire preceding issue and its changes. The revision data appears only on the title page. For later changes, the revision date is retained on the title page, with the change noted underneath.

2-7. Refer to NAVAIR 00-25-100 for additional information about NAVAL AIR SYSTEMS COMMAND TECHNICAL PUBLICATION LIBRARY MANAGEMENT PROGRAM (see TMAPS website at: mynatec.navair.navy.mil).

3-1. BACKGROUND.

3-2. HISTORY. The requirement for visual aids has existed from the first flight of an aircraft. As aviation progressed to flying at night and in low visibility, more complex visual aids have been required. The present status of air operations is such that new developments in visual landing aids and standardization have increased. Standardization of visual aids facilities is essential for promoting operational safety and makes it possible for a pilot to rapidly interpret and react to guidance information with a minimum amount of mental concentration. The visual landing aids for both military and civilian airfields are nearly standard, except for the differences in mission and operational procedures.

3-3. INTERNATIONAL MILITARY STANDARDS. The Navy and other U.S. military agencies have agreements with the North Atlantic Treaty Organization (NATO) and the Air and Space Interoperability Council (ASIC) to develop standardization of airfield visual aids. The requirements of the Air Standards of ASIC and the Standards Agreements (STANAG) of NATO have been considered in developing the requirements for the visual landing aids in this manual.

3-4. RELATED DESIGN MANUALS. This technical manual provides the general requirements for the visual landing aid standards. For other publications which have details about the design and installation of visual aids, refer to the following:

- FAA AC 150/5340-30, Design and Installation Details for Visual Aids
- UFC 2-000-05N, Facility Planning Factor Criteria for Navy and Marine Corps Shore Installation
- UFC 3-260-01, Airfield and Heliport Planning and Design
- UFC 3-535-01, Visual Air Navigation Facilities
- UFC 3-535-02, Design Drawings for Visual Air Navigation Facilities

4-1. APPLICATION.

4-2. USE OF MANUAL. The criteria contained in this manual shall be followed in planning, budgeting, and installing visual aids. The requirements of this manual shall apply for all new and replacement visual landing aids installations at Navy and Marine Corps shorebased airfields except when:

- International agreements require differences.
- Only part of an installation is configured to prior standards and giving satisfactory performance is to be replaced but differences in configuration or equipment would not be compatible,
- Where it is impractical to make a standard installation and the request for waivers is approved.

4-3. DEVIATIONS AND APPROVALS. This manual contains the requirements for visual aid installations. Any deviations from the requirements must be authorized by Naval Air Systems Command. Any requests for waivers or deviations shall be submitted to NAVAIR Code AIR 7.10 for approval. Any deviations from the requirements in this manual shall be clearly defined with specific reasons justifying the deviations before approval will be considered.

4-4. JUSTIFICATION FOR INSTALLATIONS. This Manual recommends the requirement level for each type of visual aid to be provided for each category of operations. These recommendations are as a general class for Navy airfields. The mission demands; frequency of use of a visual aid; cost of making the installation; the availability of other aids to provide the guidance; and the availability of funding are other factors considered when authorizing the installation of a specific visual aid for an airfield. This manual neither approves nor justifies requests for installing a particular visual aid. However, it may be one factor, among others, to be considered when requesting approval for an installation.

4-5. AIRFIELD SAFETY CLEARANCES. The visual aids installations shall comply with the requirements of UFC 2-000-05N and Title 14 Combined Federal Regulation (CFR) Part 77. Certain visual aids are exempt from waiver requirements.

4-6. EXISTING FACILITIES. Existing visual landing aids installed per requirements in effect at the time of installation may continue to be used and maintained if they provide satisfactory performance for the particular mission requirements of the airfield. If only a minor part of the system requires replacement, the configurations and equipment may be in accordance with that of the original system. If an appreciable part of the visual aids requires replacement, upgrading to the requirements of this manual should be considered. If the major part of the installation must be replaced, the entire installation shall conform to the requirements of this manual.

4-7. METEOROLOGICAL FLIGHT RULES. Each runway of an airfield shall be provided with visual landing aids that will satisfy the requirements for the minimum meteorological conditions for approach, landing, and takeoff operations under the authorized visibility category. It should be noted that OPNAV Inst. 3721.1 establishes the criteria for categorizing Naval Airfields with a category letter based on equipment and services required. This manual re-defines the “runway” categories with a numerical rating for precision IFR conditions and lists the “visual landing aids” required for each category. For other related equipment requirements (approach minima) refer to OPNAV Inst. 3721.1 and OPNAV Inst. 3722.16 (TERPS).

4-8. Visual Flight Rules (VFR).

4-9. Rules that govern the procedures for conducting flights under visual conditions. The term “VFR” is also used in the United States to indicate weather conditions that are equal to or greater than minimum VFR requirements. Internationally, the conditions for these operations are referred to as Visual Meteorological Conditions (VMC), which is expressed in terms of visibility, distance from clouds, and weather ceiling equal or greater than the specified minima. The minimum conditions in which VFR operations are permitted is a minimum cloud ceiling of 1000 feet and ground visibility of 3 miles.

4-10. Instrument Flight Rules (IFR).

4-11. Rules governing the procedures for conducting instrument flight. (Also a term used by pilots and air traffic controllers to indicate a type of flight plan.) IFR flight operations are dependent upon a pilot’s use of instrument guidance. Internationally, the conditions for these types of operations are referred to as Instrument Meteorological Conditions (IMC). IMC is expressed in terms of visibility, distance from clouds, and ceiling less than the minima specified for VMC, i.e., low ceiling and/or poor visibility. As the ceiling becomes lower or the visibility more restrictive, the more the precision for electronic and visual guidance is required.

- NON-PRECISION IFR. IFR operations that use non-precision electronic aids (TACAN, VORTAC, etc.) to provide directional guidance for straight-in approaches to a Minimum Descent Altitude (MDA) as low as 260 feet and one mile visibility or 5000 feet RVR.
- PRECISION IFR, PAR. Requires precision approach radar and visual aids for approach minimums of not less than 100 feet decision height (DH) and 1600 feet runway visual range (RVR). (Use ALSF-1.)
- PRECISION IFR, CATEGORY I. Require precision electronic aids (ILS or MLS) and visual aids for approach minimums of 200 feet Decision Height (DH) and 2400 feet runway visual range (RVR). (Use MALSR.)
- PRECISION IFR, CATEGORY II. Requires precision electronic aids (ILS or MLS) and visual aids for approach minimums of 100 feet DH and 1200 feet RVR.
- PRECISION IFR, CATEGORY IIIA. Requires precision electronic aids (ILS or MLS) and visual aids for approach minimums of 0 feet DH and 700 feet RVR.

- PRECISION IFR, CATEGORY IIIB. Requires precision electronic aids (ILS or MLS) and visual aids for approach minimums of 0 feet DH and 150 feet RVR.
- PRECISION IFR, CATEGORY IIIC. Requires precision electronic aids (ILS or MLS) and visual aids for approach minimums of 0 feet DH and 0 feet RVR.

4-12. APPROACH MINIMUMS. Approach minimums are defined as, the minimum visibility required for landing an aircraft while utilizing instrument approach procedures. The minimums apply (with other limitations in 14 CFR Part 91) to Minimum Descent Altitude (MDA) or Decision Height (DH) in instrument approach procedures as follows:

- Straight-in landing minimums - A statement of MDA and visibility, or DH and visibility, required for straight-in landing on a specified runway.
- Circling minimums - A statement of MDA and visibility required for the circle-to-land maneuver.

4-13. The minimums depend on several factors including the following:

- Type of instrument approach.
- Aircraft approach category.
- Controlling obstacles.
- Local terrain.
- Airport lighting (runway and approach lighting systems).
- Runway visual range.

4-14. For the method to determine the approach minimums for an approach to a given runway, refer to OPNAV Inst. 3722.16.

4-15. RUNWAY VISUAL RANGE (RVR). Runway Visual Range (RVR) is the horizontal range over which the pilot of a moving aircraft positioned on the centerline of a runway can see, from the approach end, the runway surface markings or the lights delineating the runway. The RVR is a computationally derived value expressed in feet (or meters) that is based on inputs from instruments that measure: the visibility; background luminance; and runway light intensity that is determined from runway edge light brightness settings. A typical RVR system consists of the following: a visibility sensor; an ambient light sensor; a runway light intensity sensor(s); a data processing unit; and air traffic control tower displays.

4-16. RVR is a critical component in the determination of what the minimum values will be for each landing category in paragraph 20b and is most often reported in hundreds of feet. The locations of RVR equipment is typically at the runway threshold (near the touchdown point) and, in some cases, at the runway midpoint.

4-17. DECISION HEIGHT (DH). The DH is height above the runway in an IFR approach at which a missed approach shall be initiated if the required visual references have not been observed. The DH is specified in feet above mean sea level. The DH applies only where an electronic glide slope, such as PAR, ILS, or MLS, provides an electronic reference for descent. The DH shall be established with respect to the obstacle clearance requirements for the approach.

5-1. OTHER FACTORS.

5-2. SAFETY. Visual aids installations shall be designed to provide safety considerations for both aircraft and personnel. The configurations in this manual include safety requirements as well as performance for the design. Although exemptions and waivers are permitted for several types of visual aids, the installation of visual aids shall always satisfy safety requirements. The safety considerations should include (but not be limited to) the following:

- The height of elevated lights and other visual aids equipment shall be kept to a minimum (see UFC 3-535-01 and FAA AC 150/5340-30 for mounting heights).
- All elevated lights and signs near traffic areas shall be mounted on frangible supports and be of frangible construction (see FAA AC 150/5345-44 and AC 150/5345-46 for frangible support requirements).
- Elevated approach lights shall use frangible or low-impact-resistant supports (see FAA AC 150/5345-45).
- The tops of concrete bases and foundations shall be at ground surface level.
- Concrete bases and foundations within 50 feet of runways and taxiways should be designed to prevent or reduce damage to the landing gear and aircraft.

- Provide safe clearance in the lighting equipment vault, around generators and other equipment for maintenance and servicing.
- Identify and clearly label all electrical cables at all points where they may be available for connections or inspection.

5-3. MAINTENANCE. Design visual landing aids for easy access and rapid servicing or replacement when performing maintenance in order to reduce down time for a runway or taxiway. A complete guide to maintaining airfield equipment can be found in FAA AC 150/5340-26, (Maintenance of Airport Visual Aid Facilities) and Table 1 for allowable outages.

Table 1. Navy Lighting Tolerance Chart

NO.		LIGHTING SYSTEM	COMPONENT TYPES	ALLOWABLE OUTAGES	NOTES
1.	a.	**ALSF-1 with Sequence Flashing Lights (SFL)**	Overall System	15% lamps out (random) – 2 lamps out; in 5-light bar – light bar out	1, 2, 3, 4
	b.		Centerline bars	2 lamps out in 5 lamp bar	1
	c.		Pre-threshold bar	2 lamps out	1
	d.		Threshold bar	5 lamps out	1
	e.		Terminating bar	2 lamps out	1
	f.		1000-foot bar	5 lamps out	1
2.	a.	**ALSF-2 with SFLs**	Overall System	15% lamps out (random) – 2 lamps out; in 5-light bar – light bar out	1, 2, 3, 4
	b.		Centerline bar inner 1500 ft	2 consecutive light bars out, 20% random lamps out	1
	c.		Centerline bar outer 1500 ft	2 consecutive light bars out, 20% random lamps out	1
	d.		Centerline bar	2 lamps out in 5 lamp bar	1
	e.		Side row bars	2 consecutive light bars out, 20% random lamps out	1
	f.		Side row	1 lamp out in 3 lamp bar	1
	g.		Threshold bar	3 adjacent lamps out, 20% random lamps out	1
	h.		500-foot bar	3 adjacent lamps out, 20% random lamps out	1
	i.		1,000-foot bar	3 adjacent lamps out, 20% random lamps out	1

Table 1. Navy Lighting Tolerance Chart (Cont)

NO.		LIGHTING SYSTEM	COMPONENT TYPES	ALLOWABLE OUTAGES	NOTES
3.	a.	**MALSR, SALS and SSALR**	Overall System	15% lamps out (random) – 2 lamps out; in 5-light bar – light bar out	1, 2, 3, 4
	b.		5-lamp bar	2 lamps out	1
	c.		Threshold bar (where existing)	3 lamps out	1
	d.		1000-foot bar	3 lamps out	1
	e.		Terminating bar	2 lamps out	1
	f.		Centerline bars	2 lamps out in 5 lamp bar	1
4.	a.	**Glide Slope Indicator Lamps**	Precision Approach Path Indicator (PAPI)	1 lamp out in a 3-light box and no lights out for a 2-light box.	1, 2, 3
5.	a.	**Runway End Identifier Lights** (REIL)	Operational	None	1, 2, 3, 4
6.	a.	**Obstruction Lights:** Fixed	Operational	None	1, 2
7.	a.	**Runway/Taxiway Systems and Airfield Beacons**	Threshold lights	25% lights out	1, 2, 3, 4 **Note:** 25% lights out is for VFR or non-precision IFR runways. For precision runways, use Approach Lighting System allowable outage.
	b.		End lights	25% random lights out	1, 2, 3 **Exception:** Do not turn off lights if they are collocated (same fixtures) with the opposite end threshold lights).
	c.		Edge lights	15% random lights out	1, 2, 3, 4, 5, 6
	d.		Edge Lights Cat II and III	5% random lights out	1, 2, 3, 4, 5, 6
	e.		Centerline lights	5% lights out	1, 2, 3, 4
	f.		Touchdown Zone (TDZL)	10% lights out	1, 2, 3, 4 **Note:** Two adjacent bars on the same side of the system shall not be inoperative. A bar is considered inoperative when all light are out.
	g.		Sequence flashing lights	20%	1, 2, 3, 4

Table 1. Navy Lighting Tolerance Chart (Cont)

NO.		LIGHTING SYSTEM	COMPONENT TYPES	ALLOWABLE OUTAGES	NOTES
8.	a.	**Taxiway**	Edge lights	15% on	1, 2, 3, 4 For CAT III – Taxiway edge lights, taxiway edge reflectors and taxiway centerline lights along low-visibility route – no two adjacent lights or reflectors unserviceable. Taxiway clearance bar lights – no more than one light at a location unserviceable.
	b.		Centerline lights (CAT II)	10% lights out	1, 2, 3, 4, 5, 6 **Exception:** If 8.a. is in service for the same taxiway, disregard note 6. For CAT III - Taxiway edge lights, taxiway edge reflectors and taxiway centerline lights along low-visibility route - no two adjacent lights or reflectors unserviceable. Taxiway clearance bar lights - no more than one light at a location unserviceable.
	c.		Elevated Runway Guard Lights	No more than one light in a fixture	1, 2, 3
	d.		In-pavement runway guard lights	No more than 3 lights per location nor 2 adjacent unserviceable.	1, 2, 3
	e.		Runway stop bar lights	No more than 3 lights per location nor 2 adjacent unserviceable.	1, 2, 3
9.		**Rotating Beacon**		None	1, 2
10.	a.	**Runway Distance Markers (Lighted)**	Arresting gear marker (lighted)	None	1, 2

NOTES: When allowable outages are exceeded, airfield maintenance personnel must take the following actions:

1. Document and report outage to Public Works electrician for correction.
2. Send a NOTAM according with OPNAV Inst. 3721.20D
3. Turn off affected lighting system. Notify OPSO/AFM as necessary. **Note**: Installation Commander is the waiver authority for leaving the system on.
4. Notify NAVFIG to determine impact to instrument procedures.

Table 1. Navy Lighting Tolerance Chart (Cont)

NO.	LIGHTING SYSTEM	COMPONENT TYPES	ALLOWABLE OUTAGES	NOTES
5.	Turn off REILs only when they are not connected with the opposite end threshold light.			
6.	Prohibit fixed-wing aircraft operations during night or low-visibility operations.			
7.	NAVAIR 51-50AAA-2/ FAA AC 150/5340-26. Any deviation from these requirements must be authorized by Naval Air Systems Command. Any request for waivers or deviations shall be submitted to NAVAIR Code AIR 7.10 for approval. Any deviations from the requirements of this manual shall be clearly defined with specific reasons justifying the deviations before approval will be considered.			

5-4. EQUIPMENT. The visual aids equipment designated in the equipment schedule of the individual WP were the approved items at the time of the manual preparation. If the type of equipment is optional, any approved type may be used. However, to reduce the amount of spares that must be maintained, some equipment commonality is essential. This is particularly true for airfield light fixtures. Ideally, all light fixtures should be from the same manufacturer to minimize differences in presentation to pilots.

6-1. ABBREVIATIONS, SYMBOLS, NEW AND UNUSUAL TERMS.

6-2. A list of abbreviations, symbols, and terms is as follows:

6-3. ABBREVIATIONS.

ABBREVIATION	DEFINITION
AC	Advisory Circular
ALSF	Approach Lighting System with Sequence Flashing Lights
ALSF-1	Approach Lighting System with Sequence Flashing Lights for Category I Meteorological Conditions
ALSF-2	Approach Lighting System with Sequence Flashing Lights for Category II Meteorological Conditions
ASCC	Air Standardization Coordinating Committee
ASIC	Air and Space Interoperability Council
AWG	American Wire Gauge
CGL	Circling Guidance Light
DH	Decision Height
DM	Design Manual
EAF	Expeditionary Airfield
FLOLS	Fresnel Lens Optical Landing System
HDBK	Handbook
HIRL	High-Intensity Runway Edge Lights
IFLOLS	Improved Fresnel Lens Optical Landing System
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LSO	Landing Signal Officer
MALS	Medium-intensity Approach Light System
MALSR	Medium-intensity Approach Light System with RAIL
MDA	Minimum Descent Altitude
MLS	Microwave Landing System
MOVLAS	Manually Operated Visual Landing Aid System
NATO	North Atlantic Treaty Organization

ABBREVIATION	DEFINITION
OLA	Optical Landing Aid
OLS	Optical Landing System
PAPI	Precision Approach Path Indicator
PAR	Precision Approach Radar
RAIL	Runway Alignment Indicator Light
RCL	Runway Centerline Light
RDM	Runway Distance Marker
REIL	Runway End Identification Light
RIL	Runway Identification Light
RRP	Runway Reference Point
RVR	Runway Visual Range
SALS	Short Approach Light System
SFL	Sequence Flashing Light
STANAG	Standards Agreement
TDZL	Touchdown Zone Light
TERPS	Terminal Instrument Procedures
UFC	Unified Facilities Criteria
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional Range

ORGANIZATIONAL

CONSOLIDATED LISTS OF TECHNICAL DIRECTIVES, SUPPORT EQUIPMENT, MATERIALS, AND REFERENCES

SHOREBASED AIRFIELD MARKING AND LIGHTING

1-1. RECORD OF APPLICABLE TECHNICAL DIRECTIVES.

1-2. The Historical Record of Applicable Technical Directives is a list of all technical directives that have ever been in this manual. Current technical directives now affecting this manual are listed in the Record of Applicable Technical directives of each work package. When a technical directive is rescinded the before configuration is removed from the manual and the technical directive entry is removed from each work package. Each WP title page also contains a list of technical directives applicable to the equipment covered in that work package.

Historical Record of Applicable Technical Directives

NONE

2-1. SUPPORT EQUIPMENT REQUIRED.

2-2. This list identifies all equipment required to support the procedures contained in the manual. When an item of support equipment is not available, an approved alternate identified in the activity's Individual Material Readiness List (IMRL) may be substituted. Each WP title page also contains a list of support equipment required applicable to the equipment covered in that work package.

Support Equipment Required

Nomenclature	Part Number	CAGE Code
–	–	–

3-1. MATERIALS REQUIRED.

3-2. The list identifies all materials required to support the procedures contained in the manual. Each WP title page also contains a list of materials required applicable to the equipment covered in that work package.

Materials Required

Nomenclature	Specification/Part Number	HMWS Index Number
Glass Spheres, Type III or Type I, gradation A.	TT-B-1325	–
Paint, Black	TT-P-1952, SAE AMS-STD-595, chip No. 27038	1
Paint, White	TT-P-1952, SAE AMS-STD-595, color chip No. 17875	2
Paint, Yellow	TT-P-1952, SAE AMS-STD-595, chip No. 23538	3
Paint, Red	TT-P-1952, SAE AMS-STD-595, chip No. 12197	4

4-1. REFERENCE MATERIAL.

4-2. The list identifies all reference material required to support the procedures contained in the manual. Each WP title page also contains a list of reference material required applicable to the equipment covered in that work package. Advisory Circulars (AC) may be viewed or downloaded from: www.faa.gov. Unified Facilities Criteria (UFC) Publications are available on the Whole Building Design Guide website https://www.wbdg.org/.

Reference Material

Aeronautical Ground Light and Surface Marking Colors .... ICAO, Annex 14, Vol. 1, App. 1
Airfield and Heliport Planning and Design .... UFC 3-260-01
Airfield and Heliport Marking .... UFC 3-260-04
Airport Lighting Equipment Certification Program (lists sources of qualified
equipment) .... FAA AC 150/5345-53
Air Traffic Control Facilities Manual .... OPNAV Inst. 3721.1
Base and Accessories, Airport Marker Lights, General Specification for MIL-B-8954
Beads (Glass Spheres); Retro-Reflective .... FED TT-B-1325
Circuit Selector Switch .... FAA AC 150/5345-5
Colors, Aeronautical Lights and Lighting Equipment, General Requirements For .... SAE International SAE AS25050
Colors, Use in Government Procurement .... SAE AMS-STD-595
Department of Defense Notice to Airmen (NOTAM) System .... OPNAV Inst.3721.20D
Design Drawings for Visual Aid Navigation Facilities .... UFC 3-535-02
Design and Installation Details for Airport Visual Aids .... FAA AC 150/5340-30
Dual Mode High Intensity Approach Lighting System (ALSF-2/SSALR) FAA-E-2689a
E-28 Shore-Based Emergency Arresting Gear .... NAVAIR 51-5-31
Engine Generator Sets (EGS) Diesel and Propane Fueled – 10 KW To 1500 KW FAA-E-2204
FAA Specification for L-823 Plug and Receptacle, Cable Connectors .... FAA AC 150/5345-26
Facilities Planning Factors Criteria for Navy and Marine Corps Shore Installations
.... UFC 2-000-05N
Four-Box Precision Approach Path Indicator FAA-E-2756
General Operating and Flight Rules .... 14 CFR Part 91
General Requirements for Lighting System, Airport Approach, Condenser
Discharge Sequence Flashing MIL-L-26311
Generic Visual Glideslope Indicators (GVGI) .... FAA AC 150/5345-52
Isolation Transformers for Airport Lighting Systems .... FAA AC 150/5345-47
Isolation Transformer (1500 Watt) for High-Intensity Approach Light Systems FAA-E-2690
Light Sources Other Than Incandescent and Xenon for Airport and Obstruction
Lighting Fixtures .... FAA EB 67D
Lightweight Approach Light Structure .... FAA AC 150/5345-45
Light, Markers, Airport, Semiflush, General Specifications for MIL-L-26202
Light, Marker, Airport Approach, High Intensity, Type MB-1 .... MIL-L-26990
Light, Marker, Portable, Emergency, Airfield, Battery Operated, General
Specification for MIL-L-19661
Light, Navigational, Beacon, Beacon Obstacle for Code, Type G-1 .... MIL-L-6273
Light Sources Other Than Incandescent and Xenon for Airport and Obstruction
Lighting Fixtures .... FAA
Engineering Briefs Engineering Brief 67
Light, Wave-off, Flashing, Capacitance-Discharge MIL-L-29575
Low-Impact-Resistant Structures FAA-E-2702
Low Visibility Taxiway Lighting Systems .... FAA AC 150/5340-28
Manually Operated Visual Landing Aids System MK 2 MOD 2 .... NAVAIR 51-40ACA-3
Medium Intensity Approach Lighting System with Runway Alignment Indicator
Lights (MALSR) FAA-E-2980
Navy Precision Approach Path Indicator Certification Requirements .... NAEC-91-8082 (PAPI)
Obstruction Marking and Lighting .... FAA AC 70/7460-1
Paint, Airfield Marking, Solvent Base FED-TT-P-85
Paint, Traffic and Airfield Marking, Waterborne .... FED SPEC TT-P-1952F
Painting, Marking and lighting of Vehicles Used on an Airport .... FAA AC 150/5210-5
Panels, Airport Lighting Control, General Specification for MIL-P-8944
PAR-56 Lampholder FAA-E-982

Reference Material (Cont)

Portable Shore-Based Fresnel Lens Optical Landing System MK 8 MODs 0 and 1	NAVAIR 51-40ABA-14
Portable Shorebased Improved Fresnel Lens Optical Landing System MK14 MOD 0	NAVAIR 51-40ABA-24
Precision Approach Path Indicator (PAPI) Systems	FAA AC 150/5345-28
Precision Approach Path Indicator (PAPI) Type L-880, Style A, Class II	NAVAIR 51-50AAA-4
Runway End Identifier Light System (REIL)	FAA-E-2159
Safe, Efficient Use, and Preservation of the Navigable Airspace	14 CFR Part 77
Sequenced Flashing Lighting System, Elevated and Semi-Flush with Dimming and Monitoring	FAA-E-2628b
Specification for Airport and Heliport Beacons	FAA AC 150/5345-12
Specifications for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories	FAA AC 150/5345-42
Specification for Constant Current Regulators and Regulator Monitors	FAA AC 150/5345-10
Specification for Discharge-Type Flashing Light Equipment	FAA AC 150/5345-51
Specification for L-821 Panels for the Control of Airport Lighting	FAA AC 150/5345-3
Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits	FAA AC 150/5345-7
Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits	FAA AC 150/5345-13
Specification for L-854, Radio Control Equipment	FAA AC 150/5345-49
Specification for L-893, Lighted Visual Aid to Indicate Temporary Runway Closure	FAA AC 150/5345-55
Specification for Obstruction Lighting Equipment	FAA AC 150/5345-43
Specification for Portable Runway and Taxiway Lights	FAA AC 150/5345-50
Specification for Runway and Taxiway Light Fixtures	FAA AC 150/5345-46
Specification for Taxiway and Runway Signs	FAA AC 150/5345-44
Specifications for Wind Cone Assemblies	FAA AC 150/5345-27
Standards for Airport Markings	FAA AC 150/5340-1M
Standards for Airport Sign Systems	FAA AC 150/5340-18
Standards for Specifying Construction of Airports	FAA AC 150/5370-10
Star-of-Life Ambulance	FED KKK-A-1872
Transformer, Power, Distribution	FED W-T-631
United States Standard for Terminal Instrument Procedures (TERPS)	OPNAV Inst. 3722.16
Visual Air Navigation Facilities	UFC 3-535-01
Visual Guidance Lighting Systems	FAA JO 6850.2B

ORGANIZATIONAL

DESCRIPTION

APPROACH VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. Approach visual aids enhance the pilot's ability to acquire the runway visually and to accurately position the aircraft for landing by furnishing direction and roll guidance as well as distance and approach angle information. The approach visual aids are a continuation of the guidance initially furnished by electronic navigational aids and complete the transition to a safe landing.

1-3. SCOPE. The approach visual aids section of this technical manual contains the configuration requirements, applications, equipment, and basic design and installation criteria required for U.S. Navy shore-based airfields. The requirements specified in the Work Package(s) (WP) for each visual aid system are to be used for new installations. Existing installations of similar systems may be used and maintained as long as the mission essential guidance is provided. Major modifications and upgrading of existing installations shall comply with the requirements of the applicable WP.

1-4. STANDARDIZATION. The requirements of the WP for each visual aid system establishes the standard to be used for most Navy airfields. Standardization of visual aids on a nation-wide basis is essential to safe and efficient landing operations. When deviations from standard installations are necessary, changes shall be authorized per the approval procedures in WP 002 00. To provide national standards, the Navy coordinates with the Air Force, Army, and Federal Aviation Administration (FAA) about the requirements for approach visual aids. Internationally, the Navy coordinates visual aids requirements with the Air Force Interoperability Council (AFIC) and the Standards Agreements (STANAGs) of the North Atlantic Treaty Organization (NATO).

2-1. FLIGHT RULES.

2-2. GENERAL. The types of approach visual aids required for an airfield depend on the kind of flight operations that will be performed. Flight operations are separated into visual flight rules operations and instrument flight rules operations (WP 002 00). Major airfields usually have both types of operations. The approach visual aids associated with the different flight rules are indicated in Table 1.

2-3. VISUAL FLIGHT RULES (VFR). The minimum meteorological conditions, for which VFR operations are permitted, are weather ceiling height of 1000 feet and visibility of 3 miles. To permit flight operations at the VFR minimums, certain approach and runway visual aids are required. See WP 002 00 for the criteria.

2-4. INSTRUMENT FLIGHT RULES (IFR). For flight operations in IFR conditions the landing aids must be of types approved for the IFR category. The approach light system shall be designed to meet the requirements of the assigned runway approach category. For a given runway approach, the IFR approach minimums are determined per the methods in OPNAV Inst. 3722.16. The authorized approach minimums and the required Runway Visual Range (RVR), Minimum Descent Altitude (MDA), and Decision Height (DH) values are determined from the information in OPNAV Inst. 3722.16.

2-5. IFR CATEGORIES. The approach minimums for the IFR categories are found in WP 002 00.

3-1. SELECTION OF APPROACH VISUAL AIDS.

3-2. The type of approach visual aids required depends on the mission and the approach minimums which may be necessary. Table 1 is a guide for determining the aids to be provided. The design requirements are found in the WP for each type of approach aid. For installation details refer to UFC 3-535-01, UFC 3-535-02, and FAA AC 150/5340-30.

Table 1. Approach Visual Aids Requirements

Visual Aids System	Authorized Operations						
		IFR Category					
	VFR	Non-Prec	I	II	IIIA	IIIB	IIIC
Identification Marking (WP 003 01)	C	C	NR	NR	NR	NR	NR
Airport Beacons (WP 003 02)	R	R	–	–	–	–	–
Wind Indicators (WP 003 03)	OPT	OPT	–	–	–	–	–
REIL (WP 003 04)	C	C	–	NR	NR	NR	NR
ALSF-1 (WP 003 05) (see note)	NR	NR	NR	NR	NR	NR	NR
ALSF -2 (WP 003 06)	NR	RS	NR	R	R	R	R
SALS (WP 003 07)	NR	RS	NR	NR	NR	NR	NR
Obstruction Markings (WP 003 08)	R	R	–	–	–	–	–
Obstruction Lights (WP 003 09)	R	R	R	R	–	–	–
PAPI (WP 003 10)	RS	RS	RS	–	–	–	–
Optical Landing Aid (OLA) (WP 003 11)	RS	RS	RS	–	–	–	–
MALSR (WP 003 12) (see note)	RS	RS	R	–	–	–	–

C - Recommended

R - Required (These visual aids are required for operating in the IFR Category, but other factors may negate approval for installation. See Justification for Installation, WP 002 00.)

RS - Required under special conditions. *An example: Only if high-speed exit is installed.

OPT - Option as recommended by air station commander and approved by NAVAIR.

– - No entries are made where requirements have not been determined or where the system would have limited usefulness under the particular category.

NR - Not Required.

NOTE For CAT I approach systems use MALSR. See WP 002 00.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems. A complete listing of certified light fixtures and manufacturers may be found in FAA AC 150/5345-53, Appendix 3 (Certified Airport Lighting Equipment). See “Advisory Circulars” at www.faa.gov/airports.

2. LEDs are recommended for new installations, or as a complete replacement for an existing incandescent system. Do not intersperse LED light fixtures in a system with incandescent light fixtures. In addition, do not mix rows of LED light fixtures on runways or taxiways with incandescent light fixtures. Example: one side of a runway with incandescent light fixtures and the other with LEDs. See UFC 3-535-01 and FAA AC 150/5340-30 for additional information about LED light fixtures.

3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot’s ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

ORGANIZATIONAL

AIRFIELD IDENTIFICATION MARKING

APPROACH VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for Airfield Identification Marking. These requirements are a guide for developing a suitable marking instead of providing standardization of airfield identification markings. The airfield identification marking is used only if the airfield does not have sufficient means of visual identification for air operations during daylight conditions. The requirements for airfield identification marking apply for new installations. For existing installations, these requirements should be considered for improving identification. If the airfield identification marking is to be installed, the actual design and location should be the responsibility of the airfield authority.

1-3. JUSTIFICATION REQUIREMENTS. The justification for installing an airfield identification marking depends upon the need for improving identification and the increased effectiveness that such a marking can provide. Past experience is usually the source that indicates a need for improved identification. The local situation must be evaluated to determine if an effective improvement in identification is a practicable solution.

1-4. RELATED FACILITIES. The airfield identification marking serves an independent function for special conditions during daytime operations. A runway marking (WP 004 01) may provide some or adequate airfield identification and wind indicators (WP 003 03) assist in providing airfield identification. For airfield identification at night, the airport rotating beacon and identification code beacon (WP 003 02) provide the airfield identification.

2-1. DESCRIPTION.

2-2. The airfield identification marking shall be the name of the airfield located in a prominent position. The marking should ensure maximum visibility from all approach directions. The color should contrast with its background. White or light-colored markings are used for dark backgrounds, and orange or black are effective against light backgrounds. The airfield name may need to face in opposite directions to be legible from different approach directions.

2-3. LOCATION. The airfield identification marking shall be located where it will be prominent and most effective. Preferably, the site should be on the airfield, but a site near the airfield that is more prominent may be used. The following sites may be considered in selecting the location of this marking.

- Runways.
- An embankment on or near the airfield built for this specific purpose provided it is not an obstruction.
- The roof of a large building or structure such as a hangar on or near the airfield.
- A water tower or other structure on or near the airfield.
- Natural terrain features such as a hillside or mesa near the airfield.

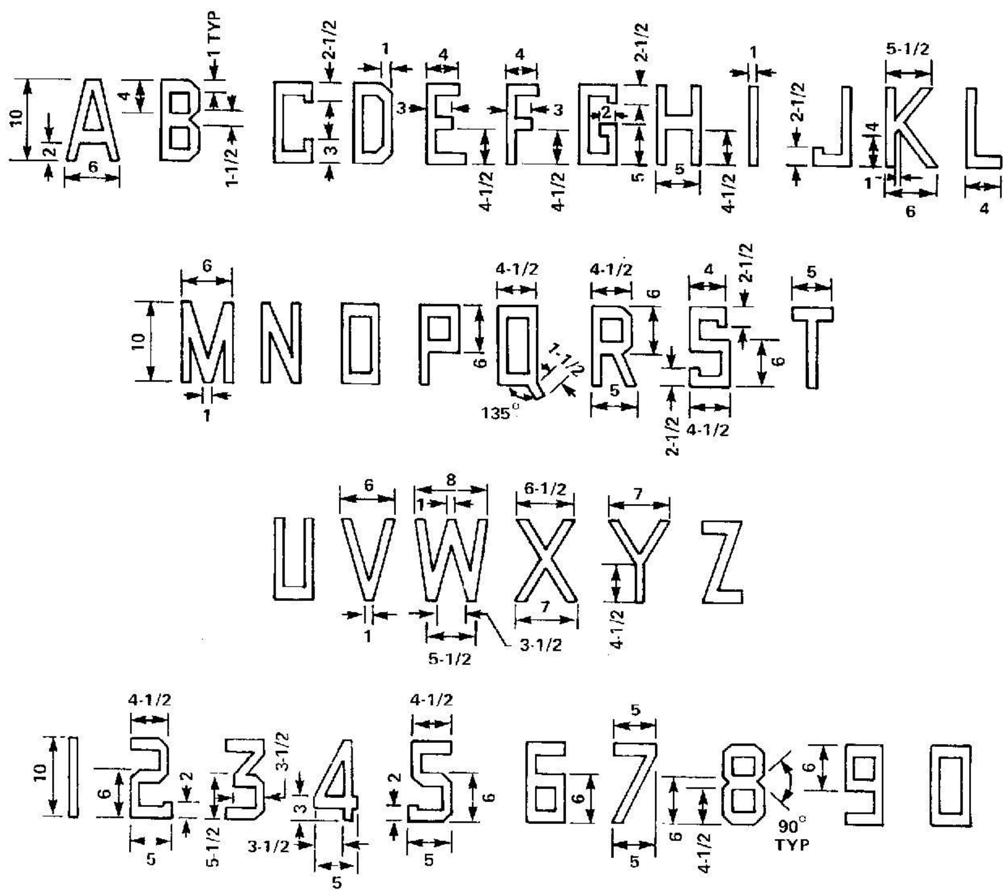
3-1. INSTALLATIONS.

3-2. METHODS OF INSTALLATION. The methods of installing an airfield identification marking will vary with the design of the markings and the type of support. Painting is the common means of marking, but sometimes colored stones, plants, or other natural materials may be used. The method of painting shall provide a top-quality product for continuous exterior service and provide several years' service in the environment. Black borders or outlines of the characters can be used to improve the contrast with the background.

3-3. DIMENSIONS. The airfield identification markings should use block type letters and numbers. The characters (Figure 1) shall be 10 feet tall minimum. The size of the characters used depends on the distance at which the marking should be readable and the projected height of the marking from the viewing direction.

3-4. MATERIALS. The materials required for the airfield identification markings will vary with the design for the particular airfield. The types of materials are optional but must be suitable for the purpose and the environmental conditions. The materials frequently used are:

- Paint. The paint shall be of high quality, exterior type, suitable for the surfaces to which it will be applied. The color should provide good contrast with the background.
- Surface. The surface for the characters will depend on the design for the markings. Surfaces for painting may be plywood, sheet metal, roofing, stones, or other materials.
- Supports. The supports for the marking will vary with the location and design but shall provide stability for several years of service.
- If the marking is to be floodlighted, commercial type floodlights may be used. The floodlights should have an adequate number of fixtures, properly located and aimed to illuminate the marking uniformly and at an acceptable brightness for reading. The input power for the floodlights may be 120 or 240 Volts. The controls may be automatic photoelectric switches or manual switching.



VERTICAL STROKES ARE 1 UNIT WIDE. INCLINED STROKES ARE 1 UNIT WIDE. HORIZONTAL STROKES ARE 1-1/2 UNITS WIDE. NUMBERS SHALL BE 8 UNITS O.C. EXCEPT “1” IN CONJUNCTION WITH “1” TO BE 4-1/2 UNITS O.C. AND “1” IN CONJUNCTION WITH ANY OTHER NUMBER TO BE 6-1/4 UNITS O.C. LETTERS SHALL BE 10 UNITS O.C. EXCEPT “T” OR “I” WITH ANY OTHER LETTER TO BE 8 INITS O.C.

NOTE:

DIMENSIONS FOR NUMBERING AND LETTERING ARE GIVEN IN UNITS PROPORTIONALLY APPLICABLE FOR ANY HEIGHT NUMBER OR LETTER. ALL CHARACTERS SHALL BE 4-1/2 UNITS WIDE UNLESS OTHERWISE INDICATED.

EXAMPLE:

FOR LETTERS OR NUMBERS 50 FT. HIGH, MULTIPLY EACH DIMENSION BY 5.

Figure 1. Characters for Airfield Identification Marking

ORGANIZATIONAL

AIRPORT BEACONS

APPROACH VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for airport beacons. Airport beacons are high-intensity flashing lights that provide a visual signal to pilots to assist in locating and identifying the airfield or a hazardous obstruction at night or in restricted visibility conditions. Airport beacons may be rotating or fixed but shall provide a signal 360º in azimuth. Airport beacons with different visual signals are used for the following functions.

- Airfield rotating beacons.
- Identification or code beacons.
- Heliport beacons.
- Obstruction or hazard beacons.

1-3. These requirements are to be used for new installations of airport beacons. Existing installations may continue to be used and maintained, but major replacements or upgrades shall comply with the applicable requirements of this WP.

1-4. JUSTIFICATION REQUIREMENTS. Justification for providing each type of airport beacon is as follows:

1-5. Airfield Rotating Beacon.

1-6. Navy airfields authorized for operations at night shall use an airfield rotating beacon, except if two or more airfields are closely located where one beacon serves more than one airfield.

1-7. Identification or Code Beacon.

1-8. An identification beacon is required if the rotating beacon is more than one mile from the runway or where one rotating beacon serves more than one airfield.

1-9. Heliport Beacon.

1-10. A helipad or heliport intended for operations at night that is not located at an airfield should have a heliport beacon. See WP 007 06 for details about heliport beacons.

1-11. Hazard or Obstruction Beacon.

1-12. Any structure or natural feature on the airfield that is 150 feet or more above the airfield surface elevation and, in some cases, objects near the airfield that are 150 feet or more above the ground surface shall be marked with red hazard or obstruction beacons. For details about hazard or obstruction beacons see WP 003 09.

1-13. Deviations.

1-14. If deviations from these requirements are necessary, follow the procedures of WP 002 00 for obtaining approval.

1-15. RELATED FACILITIES. Airfield rotating beacons and identification or code beacons are usually used only for airfields lighted for flight operations at night. Several types of approach and runway lights may be required for a particular airfield. The types of lighting systems that may be used are discussed in WP 003 00 for approach lights and WP 004 00 for runway lights.

2-1. DESCRIPTION.

2-2. AIRFIELD ROTATING BEACON. Each lighted Navy airfield, except where one rotating beacon serves more than one airfield in close proximity or for auxiliary landing fields (WP 008 00), shall use a high-intensity military type beacon (FAA Type L-802M or equivalent). See FAA AC 150/5345-12 for additional information about L-802M military airport beacon requirements.

2-3. IDENTIFICATION OR CODE BEACON. The identification beacon is used only at airfields where the airfield rotating beacon is located more than 5000 feet from the nearest runway or where the airfield rotating beacon serves more than one airfield. The identification beacon is a nonrotating flashing omnidirectional light visible through 360º. This beacon flashes a green coded signal at approximately 40 flashes per minute. The signal is an assigned code of characters to identify the particular airfield. The identification beacon shall be operated whenever the associated airfield rotating beacon is operated.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. General design and installation requirements for airfield beacons are discussed below and in FAA AC 150/5340-30. For installation details refer to the manufacturer's instruction book.

3-3. METHODS OF INSTALLATION. Airport beacons may be mounted on existing structures or separate towers. Typical structures for mounting the beacons are elevated water tanks, hangar roofs, and other existing buildings. The beacons shall be permanently mounted on a stable, level platform. Safe access for maintenance shall be provided. Usually the beacon will be equipped with double obstruction lights. The beacon and its supports should be grounded to reduce damage arising from lightning strikes.

3-4. LOCATION. The standard location for the airfield rotating beacon or the identification beacon shall be:

- Visible through 360º of azimuth if possible.
- Not less than 1000 feet from the centerline or the extended centerline of the nearest runway.
- Not in the line of sight from the control tower to the approach zone of any runway or to within 75 feet vertically over any runway.
- 750 feet or more from the control tower.
- Not more than 5000 feet from the nearest point of usable landing area, except if surrounding terrain will restrict visibility of the beacon through an appreciable angle in some directions or the beacon will serve more than one airfield. If terrain restricts viewing the beacon, the distance of the beacon from the nearest runway may be increased to not more than 2 miles.

- The base is not less than 20 feet higher than the elevation of the floor in the control tower cab.
- If the airfield rotating beacon is located more than 5000 feet from the nearest point of a usable landing area, an identification beacon shall be installed per paragraphs a through f and not more than 5000 feet from the nearest point of usable landing area.

NOTE

Under certain conditions, the beacon may be mounted on the air traffic control tower. The beacon and its supporting structure must be below the 7:1 transition surface. If atmospheric conditions create glare and flashback in the air traffic control tower, the beacon must be relocated to satisfy the requirements listed above. This change will only impact new construction and demolition of structures that support airfield rotating beacons. Air stations should be prudent in the selection of the tower mount option so as not to incur the additional cost of having to relocate the beacon if local atmospheric conditions create a glare problem.

3-5. AIMING. The vertical aiming of the beacons should be properly focused and aimed when manufactured and leveling should be all that is required for aiming during installation. The axes of the beams vertically should be approximately five degrees above the horizontal for the rotating beacon. For the identification beacon, the center of the beam shall be approximately three degrees above horizontal. See FAA AC 150/5340-30 for additional installation information.

4-1. EQUIPMENT.

4-2. FIXTURES. The airfield rotating beacon and the identification beacon equipment shall be per Table 1. The identification beacon shall be provided with keying equipment to flash the assigned code.

Table 1. Schedule of Lighting Equipment for Airport Beacons

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	POWER TRANSFORMER	
		RATING	TYPE
Airfield rotating beacon.[1] L-802M	Per manufacturer	Per manufacturer	Commercial
Identification or code beacon.[2] Light, beacon, MIL-L-6273, type G-1, green	700W 120V AC[3]	2KVA, 120V AC output.	Commercial

NOTES:

1. Usually one beacon per airfield but some beacons may serve more than one airfield.
2. Only used if rotating beacon is more than 5000 feet from any runway or if the rotating beacon serves more than one airfield.
3. Two lamps operating simultaneously for each beacon.

5-1. PHOTOMETRIC REQUIREMENTS.

5-2. The photometric requirements for the airfield rotating beacon and the identification beacon shall be:

- Colors. The color of the emitted light for United States based airfield installations shall be per FAA AC 150/5345-12. For international airfield installations (North Atlantic Treaty Organization (NATO, et al)) the chromaticity of emitted light shall be per ICAO, Annex 14, Vol. 1, Appendix 1.
- Airfield rotating beacon. Per FAA AC 150/5345-12.
- Identification beacon. With the beacon operating steadily (not flashing) at rated voltage, the intensity of the green light shall be not less than 1500 candelas for a distribution through 360 degrees horizontally and 2 degrees vertically. The areas of the beam where the support rods are located may be less than these required intensities.

6-1. POWER AND CONTROLS.

6-2. POWER. The electrical power requirement for the airfield beacons is 120 volts alternating current (AC). The source of power may be from the airfield lighting vault or from a local source that is continuously available. If the distance from the power source causes a large voltage drop, the transmission of power at a higher voltage and step-down to 120 volts at the site may be desirable. The step-down transformer should be rated at not less than 3 KVA for the rotating beacon or 2 KVA for the identification beacon. Emergency power is not required for the airport beacons, but should be used if it is available (WP 009 01).

6-3. CONTROLS. The controls for the airport beacons are only those required to energize and switch off the beacon and its drive motor or keying equipment. Preferably, airfield beacons should be remotely controlled from the lighting control panel (WP 009 05) in the air traffic control tower or the airfield lighting vault. Control may also be furnished by an automatic photoelectric switch or a clock-driven timer.

ORGANIZATIONAL

WIND INDICATORS

APPROACH VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for wind indicators (or wind cones) to be used at Navy airfields. The purpose of the wind indicator is to provide visual information about the surface wind direction and a general indication of the wind speed to pilots. Wind information is most useful during takeoff; for orientation to make an approach; and in the final phase of approach prior to touchdown. These requirements apply for all new installations of wind indicators. Existing installations may continue to be used and maintained. Existing installations may include wind tees or tetrahedrons as well as wind cones. Replacements of wind indicators shall use the requirements in this WP.

NOTE

The wind indicators in this WP do not provide the data for the wind information used and reported by air traffic control.

1-3. JUSTIFICATION REQUIREMENTS. Navy airfields shall be provided with one or more wind indicator. The wind indicator is usually located at a central position on the airfield. If the runways are long, wind cones should be installed near the thresholds of the runways. One wind cone may serve two runway thresholds to both reduce costs and hazards to aircraft. If the runway is authorized for flight operations at night, the wind indicator shall be internally or externally lighted. Helipads shall be provided with wind cones unless they are located near an existing wind indicator. Approval for deviations from these requirements shall follow the procedures in WP 002 00.

1-4. RELATED FACILITIES. The use of wind indicators is not directly related to other visual aids, but they may be associated with the following :

- One may be located at the identification marking (WP 003 01) if this marking is located on the airfield.
- The wind indicator may use the runway edge light circuit (WP 004 05) as a source of power for illumination and obstruction lights.

- The wind indicators shall be lighted if runway visual aids (WP 004 00) and approach visual aid (WP 003 00) are lighted.
- Wind indicators may be used to provide wind information for helipads (WP 007 06) and auxiliary landing fields (WP 008 00).

2-1. DESCRIPTION.

2-2. The standard wind indicator (wind cone per FAA AC 150/5345-27, FAA Type L-807, Style I-A (externally lighted), or Style 1-B (internally lighted), Size 2 (12 feet)) is used for Navy airfields. The wind indicator materials and construction shall be per the requirements in FAA AC 150/5345-27. The FAA Type L-807 wind cone support shall be hinged at its base or near its middle so both the wind cone and any light fixtures may be serviced from the ground. If the airfield or runway has lighting facilities for flight operations at night, the wind cone shall be illuminated.

2-3. EIGHT-FOOT WIND INDICATOR (CONE). An 8-foot wind cone per FAA AC 150/5345-27, FAA Type L-806 (low mass supporting structure), Styles I-A, 1-B, or Style II (unlighted), Size 1) may be approved for use on small secondary airfields, helipads, or if necessary, to locate the wind cone closer than the standard distance to the runway. The wind cone support structure may be hinged for ease of maintenance. FAA Type L-806, Size 1 wind cones may be lighted for night operations or unlighted if used in daytime only.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. General design and installation requirements for wind cones are given below. For installation details, refer to the manufacturer's instruction book. An obstruction light (WP 003 09) shall be provided if the wind cone penetrates any runway clearance surface or is considered a possible hazard to aircraft. The wind cone supporting structure shall be electrically grounded.

3-3. LOCATION. The 12-foot wind cone should be located as follows:

- Near the runway threshold not less than 400 feet from the runway centerline.
- Preferably between 500 feet and 1500 feet down the runway from the threshold.
- In an area free from the effects of local air disturbance. This may require clearing of brush and vegetation.
- One wind cone may serve the ends of two runways if the distance from either runway centerline is not more than 1000 feet.

3-4. Eight-foot wind cones, if approved for use at small secondary airfields or near the runway, should be installed as follows:

- At a central site for small airfields without lights.
- Not less than 150 feet from the runway edge where clearance space or wind disturbances are not suitable for the 12-foot wind cone. If the wind cone is less than 300 feet from the runway edge, the support shall be low-mass or light-weight type. Additional information is located in FAA AC 150/5340-30H.

4-1. EQUIPMENT.

4-2. The wind indicator equipment shall be per Table 1.

Table 1. Schedule of Equipment for Wind Indicators

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	POWER TRANSFORMER		
		RATING	TYPE	ADAPTER
12-foot wind cone.[1]				
FAA AC 150/ 5345-27, type L-807, style I or II, size 2	(4) 200W 120V, type 200 PS 30/45	120V output 1000VA if needed	Commercial	If on series circuit, 20A or 6.6A/120V, 1000VA
8-foot wind cone.[1]				
FAA AC 150/ 5345-27, type L-806, style I or II, size 1	(4) 150W 120V type 150 PS25	120V output 1000VA	Commercial	If on series circuit, 20A or 6.6A/120V, 1000VA

NOTES:

1. The number of wind cones varies with the size and configuration of the airfield.

5-1. PHOTOMETRIC REQUIREMENTS.

5-2. If lighted, wind cone photometric requirements shall be per FAA AC 150/5345-27. If installed, obstruction lights shall meet the requirements for steady-burning red obstruction lights (WP 003 09).

6-1. POWER AND CONTROLS.

6-2. POWER. The electrical power required for the wind cones is only for the internal or external illumination lights and the obstruction lights if required. This power shall be 120 volts and not more than 1000 VA. Emergency power is not required for wind indicators, but it is desirable if it is available (WP 009 01). The sources for power may be from the airfield lighting vault, a local source of continuous power, or for runway ends, from the runway edge light circuit (WP 004 05). If power is provided by the runway edge high voltage series light circuit, a power adapter (WP 009 04) is required that will not reduce the illumination of the wind cone to less than 50 percent of full intensity for any runway intensity step setting is required.

6-3. Use caution when using series lighting circuit power adapters. The power adapter may cause an excessive power factor that will prevent the startup of some series lighting circuit constant current regulators. Check with the manufacturer of the power adaptor for power factor data.

6-4. CONTROLS. The only controls required are switches to turn the wind cone internal and external lights to either ON or OFF. For power sources from the lighting vault or local sources, the preferred arrangement is for remote control at the lighting control panel (WP 009 05) in the control tower and alternate control at the airfield lighting vault. If remote control for power from local sources is not practical, the switching can be provided by photoelectric switches or time clocks. If power is obtained from the runway edge lights, the wind cone lights are controlled via the intensity step setting of the runway lights.

ORGANIZATIONAL

RUNWAY END IDENTIFICATION LIGHTS (REIL)

APPROACH VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the Runway End Identifier Lights (REIL) consisting of two flashing lights, one on each side of the runway, at the runway threshold. The purpose of the REIL is to provide the pilot with rapid and positive identification of the runway threshold during an approach for landing. The REIL assists the pilot in making landings in Visual Flight Rules (VFR) conditions and in non-precision instrument approaches in Instrument Flight Rules (IFR) conditions (WP 002 00 and WP 003 00). The requirements in this WP are to be used for new installations of REIL. The existing installations of REIL or Runway Identification Lights (RIL) may continue to be used and maintained, but replacement or upgrading of either type of light shall require a new REIL installation.

1-3. JUSTIFICATION REQUIREMENTS. The REIL is not considered to be a precision approach aid. Approaches to runways provided with approach lights usually are not provided with the REIL, but the runway threshold for approaches from the opposite direction may require REIL. The approval for an installation or for deviations from these requirements shall follow the procedures of WP 002 00.

1-4. RELATED FACILITIES. The following airfield visual aids are required with the use of the REIL:

- High-Intensity Runway Edge Lights (HIRL) (WP 004 05),
- Runway threshold lights (WP 004 02) or displaced threshold lights (WP 004 03),
- Runway Markings (WP 004 01).
- Precision Approach Path Indicator (PAPI) system (WP 003 10) may be an associated visual aid.

2-1. DESCRIPTION.

2-2. The REIL consists of two flashing light fixtures (strobe lights), located on each side of the runway threshold. The REIL lights are usually unidirectional but omnidirectional lights may be used for special operational conditions. The lights flash simultaneously. The REIL shall have a minimum of three intensity settings. There should be provisions for shielding the light to prevent objectionable glare. Each REIL light fixture may have its own power unit, but the light (flasher head) shall be capable of separation from the power unit. See FAA AC 150/5345-51 for more information about REIL configurations and performance requirements.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details about REIL, refer to UFC 3-535-01 and UFC 3-535-02. For general design and installation requirements, see FAA AC 150/5340-30.

4-1. EQUIPMENT.

4-2. The REIL equipment shall be per Table 1. The lights, power units, and power adapters, if used and are elevated, shall be mounted on frangible couplings. If required, REIL light shields or baffles may be installed.

Table 1. Schedule Of Lighting Equipment For REIL

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	POWER UNITS	
		RATING	TYPE
Runway End Identifier Lights (REIL) system.[1]			
Light, flashing, unidirectional, FAA AC 150/5345-51, type L-849, style E.	Capacitor-discharge, type as determined by manufacturer.	120/240V or 20A/120-240V	Separate source, or Series circuit power adapter, type as determined by manufacturer.
Light, flashing, omnidirectional, FAA AC 150/5345-51, type L-849, style F.	Capacitor-discharge, type as determined by manufacturer.	120/240V or 20A/120-240V	Separate source, or Series circuit power adapter, type as determined by manufacturer.

NOTES:

1. Two lights, flasher head and power unit, one is the master light and one is the slave light.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of certified light fixtures and manufacturers is in FAA AC 150/5345-53. See www.faa.gov/regulations_policies/advisory_circulars/.
2. For LED based light fixtures, the last letter after the FAA Type number will have an (L) in parentheses to denote the use of an LED light source. Example: L-849V(L).
3. LED based lamps are recommended for new installations or complete replacement.
4. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

ORGANIZATIONAL

APPROACH LIGHTS, CATEGORY I - ALSF-1

APPROACH VISUAL AIDS

Reference Material

Introduction	WP 002 00
Approach Visual Aids, Description	WP 003 00
Approach Visual Aids, Approach Lights, Category II and Category III - ALSF-2	WP 003 06
Approach Visual Aids, Obstruction Lights	WP 003 09
Approach Visual Aids, Medium-Intensity Approach Light System with Runway Alignment Indicator Lights (MALSR)	WP 003 12
Runway Visual Aids, Runway Markings	WP 004 01
Runway Visual Aids, Runway Threshold Lights	WP 004 02
Runway Visual Aids, Displaced Threshold Lights and Markings	WP 004 03
Runway Visual Aids, Runway End Lights	WP 004 04
Runway Visual Aids, High-Intensity Runway Edge Lights (HIRL)	WP 004 05
Runway Visual Aids, Runway Centerline Lights (RCL)	WP 004 06
Electrical Power and Control for Visual Aids, Description	WP 009 00
Electrical Power and Control for Visual Aids, Auxiliary Power and Power Transfer Equipment	WP 009 01
Electrical Power and Control for Visual Aids, Constant-Current Regulators	WP 009 02
Electrical Power and Control for Visual Aids, Special Power Supplies	WP 009 04
Electrical Power and Control for Visual Aids, Airfield Lighting Control Panels	WP 009 05
Aeronautical Ground Light and Surface Marking Colors	ICAO, Annex 14, Vol. 1, App. 1
Colors, Aeronautical Lights and Lighting Equipment, General Requirements For	SAE International SAE AS25050
Design Drawings for Visual Aid Navigation Facilities	UFC 3-535-02
Isolation Transformers for Airport Lighting Systems	FAA AC 150/5345-47
Isolation Transformer (1500 Watt) for High-Intensity Approach Light Systems	FAA-E-2690
PAR-56 Lampholder	FAA-E-982
Light, Markers, Airport, Semiflush, General Specifications for	MIL-L-26202
Light, Marker, Airport Approach, High Intensity, Type MB-1	MIL-L-26990
Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures	FAA Engineering Brief 67D
Low-Impact-Resistant Structures	FAA-E-2702
Sequenced Flashing Lighting System, Elevated and Semi-Flush with Dimming and Monitoring	FAA-E-2628b
Specification for Runway and Taxiway Light Fixtures	FAA AC 150/5345-46
Specification for Discharge-Type Flashing Light Equipment	FAA AC 150/5345-51

1-1. INTRODUCTION.

1-2. This Work Package (WP) should be used for installations for CAT I conditions where the approach minimums are 100 DH and 1600 RVR. See MALSR at WP 003 12 for 200 DH and 2400 RVR.

1-3. PURPOSE. This Work Package (WP) contains the requirements for the Approach Light System with Sequence Flashers (ALSF-1) required for airfield operations in Category I conditions. The requirements in this WP are to be used for new installations and for upgrading existing installations. Category I conditions require Instrument Flight Rule (IFR) operations (WP 002 00). The ALSF-1 is the standard high-intensity approach light system to provide visual guidance for precision IFR approaches. This system provides the visual guidance for alignment of the aircraft with the runway and final corrections before landing at night and during low visibility weather conditions. Approval of plans or requests for deviations shall be processed as directed in WP 002 00.

1-4. JUSTIFICATION REQUIREMENTS. Any runway that is equipped with a precision electronic approach aid such as an Instrument Landing System (ILS), Microwave Landing System (MLS), or Precision Approach Radar (PAR) should qualify for an ALSF-1 (WP 003 00). The exceptions are approaches with an ALSF-2 for Category II conditions (WP 003 06) or if it is not feasible to install an ALSF-2. Criteria to be considered for obtaining approval for an ALSF-1 include:

- Mission requirements for operations in Category I conditions.
- The frequency of occurrence of IFR conditions.
- Terrain features in the approach areas that do not provide adequate visual guidance or produce misleading or deceptive cues to the pilots.
- Fixed objects or hazards near the approach path or runway end that could endanger aircraft deviating from the approach or undershooting the runway.

1-5. ASSOCIATED FACILITIES. In addition to the ILS, MLS, or PAR electronic aids, other airfield facilities required for use with the ALSF-1 for operations in Category I conditions should include the following:

- The runway should be paved and not less than 150 feet wide. The runway length shall not be less than 6000 feet, but shorter runway lengths may be approved for special operating conditions.
- The runway should be equipped with the following:
    - Precision approach runway markings (WP 004 01),
    - High-intensity runway edge lights (HIRL) (WP 004 05),
    - High-intensity threshold lights (WP 004 02),
    - Runway end lights (WP 004 04).
- The approach should have a paved or stabilized end zone area extending 1000 feet into the approach area and not less than the width of the runway. The first 300 feet of this paved or stabilized area should have the same slope as the first 1000 feet of the runway. The remainder of the paved or stabilized area may have a slope of not more than ±1.5 percent.
- The runway should have an RVR system.
- Air traffic control should be provided during normal operating hours.

1-6. TYPE OF PROJECT. The requirements for the ALSF-1 are for new installations; however, these requirements can apply for projects that replace or upgrade existing approach light systems. Existing equipment that is in excess of these requirements may be removed. As an example, remove the flush-type sequence-flashing lights in the end zone area.

2-1. GENERAL INFORMATION.

2-2. See UFC 3-535-01 for a detailed ALSF-1 system description and installation criteria. See UFC-3-535-02 for a detailed plan view of the ALSF-1 system.

2-3. Unified Facilities Criteria (UFC) Publications may be downloaded free of charge at: https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc.

2-4. See also FAA JO 6850.2B for system installation details.

2-5. The FAA Joint Order may be downloaded free of charge at: www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.information/documentID/321004.

2-6. See the ALSF-1 system manufacturer's installation instructions.

2-7. SYSTEM DESCRIPTION. The ALSF-1 is a system of light bars and barrettes in the approach zone immediately ahead of the runway threshold. The standard length of an ALSF-1 system is 3000 feet unless terrain or other local conditions prevent a full length installation. Then the length may be shortened to not less than 2400 feet. The plan view of the ALSF-1 system is per UFC 3-535-02, Figure 50 and the lighting equipment is in Table 1. The ALSF-1 consists of centerline light barrettes, sequence flashing lights, 1000-foot crossbar, terminating bar, pre-threshold wing bars, and threshold lights.

NOTE

A barrette is three or more lights closely spaced in a transverse line so that from a distance they appear as a single short illuminated bar.

2-8. OBSTRUCTION CLEARANCES. The following restrictions apply:

2-9. No object will be permitted to obstruct the visibility of any approach light from the viewing window. Per Figure 2, the viewing window is a rectangular area 100 feet above and below and 250 feet left and right of the ideal glide path at 4500 feet before the runway threshold.

2-10. A light plane or planes (Figure 3), in which the lights of the system are located, are used for determining the obstruction clearances of the approach lights. The side boundaries of the light plane are 200 feet on either side of the extended runway centerline.

2-11. The end boundaries of the light plane are at the runway threshold and 200 feet before the start of the approach light system. All lines in the plane perpendicular to the runway centerline are level. The ideal light plane is a single horizontal plane that passes through the runway threshold.

2-12. If the 1000 feet of runway at the threshold end is sloped, the first 300 feet of the paved or stabilized area of the runway end zone and light plane for this area shall continue with the same slope.

2-13. The final 700 feet of the paved or stabilized area may have a slope of not more than 1.5 percent up or down.

2-14. From the 1000-foot crossbar to the beginning of the approach light system, the preferred light plane is horizontal and will include the 1000-foot crossbar lights.

- If the clearance of obstructions or terrain prohibits using a horizontal light plane, this plane may be sloped. The slope of this plane shall not exceed 2 percent up or 1.5 percent down.
- The preferred light plane in the area beyond the 1000-foot crossbar is a single plane, but changes in the slope of the plane are permitted.
- All light planes shall start and end at a light station and shall contain not less than three light stations.

2-15. No objects, except the elevated lights of the ALSF-1 in the runway end zone, should be permitted to extend above the light planes within their boundaries.

- All railroads are considered as objects that extend 23 feet above the rails.
- Interstate highways are considered as objects that extend 17 feet above the highest point of the road surface.
- Other highways, public roads, and parking areas are considered as objects that extend 15 feet above the highway surface. Private or military roads are considered as objects that extend 10 feet or higher.
- Airport service roads are excepted from the preceding requirements. The service road exception only applies when all vehicular traffic is controlled by the airport control tower, or the road has signs that require a complete stop and visual clearance for aircraft before proceeding. Parking or stopping between signs is prohibited.

2-16. Every effort must be made to remove or relocate objects that penetrate the light plane. For objects that cannot be moved, such as an ILS localizer, the height must be kept to a minimum and shall be located as far from the runway threshold as possible.

2-17. For objects that are not feasible to remove, lower, or relocate and cannot be cleared by the permitted slopes, a waiver may be granted (WP 002 00) to exceed the slope limits.

2-18. Obstruction lights (WP 003 09) are required on all objects protruding through the ALSF-1 light plane with the exception of the frangible mounted elevated lights of the approach light system.

2-19. INSTALLATION REQUIREMENTS. For details about the design and installation of the ALSF-1, refer to UFC 3-535-01 and UFC 3-535-02. General requirements for installation are given in this WP under the discussions of each type of light.

2-20. TOLERANCES. The approved tolerances for positioning steady-burning ALSF-1 lights are as follows:

- Lateral tolerance of a bar is ±3 inches.
- Distance between individual light centers is ±1 inch.
- Height for light centers up to 6 feet is ±1 inch.
- Height for light centers between 6 and 40 is ±2 inches.
- Height for light centers over 40 feet is ±3 inches.
- Tolerance for vertical aiming of light units is ±1.0 degree.
- Tolerance for horizontal aiming of light unit is ±5 degrees.
- Length of a barrette shall not exceed 15 feet and the center-to-center spacing of the lights shall not exceed 5 feet.
- Longitudinal tolerance for the light bar from the designated station is ±10 feet, except light bars may be displaced 50 feet to avoid omitting a barrette where obstructions cannot be removed or cleared by acceptable clearance planes.
- Where barrettes must be located more than 10 feet from the usual station position, the nearby barrettes may be located to provide more uniform spacing between barrettes.

2-21. LIGHT LOCATION IDENTIFICATION (STATION LOCATION). Positions of the ALSF-1 system lights may be identified by the station or distance. Stations are the longitudinal distances in feet into the approach zone starting from the runway threshold. The runway threshold is station 0+00. An item located 745 feet from the threshold would be at station 7+45. This item may be located on or off the centerline. Lateral, vertical, and longitudinal distances are given in feet and inches.

2-22. AIMING CRITERIA. The beams of all approach lights shall be aimed into the approach and away from the runway threshold (Figure 1). Some approach threshold lights are bidirectional and will have the red beam (as runway end lights) aimed along the runway.

2-23. All lights, except bidirectional lights with toe-in, shall be aimed in azimuth with the beam axes parallel to the extended runway centerline. Some elevated threshold lights and some existing semi-flush threshold lights have 3.5 to 4 degrees toe-in toward the runway centerline which shall be allowed in aiming.

2-24. The vertical aiming of the elevated, unidirectional, steady-burning lights of the approach lighting system shall be aimed with elevation angles per Table 2. Aiming angles are based on a glide-slope angle of 3.0 degrees. If other glide-slope angles are used, the vertical aiming of the lights shall be adjusted for the difference. The semi-flush lights and the elevated bidirectional runway threshold lights have fixed elevation angles for the beams.

2-25. ACCESS FOR SERVICING. Provisions for servicing the ALSF-1 system should be provided by such facilities as access roads, footpaths, and catwalks.

2-26. LIGHTING EQUIPMENT. The lighting equipment for the ALSF-1 shall be per Table 1 .

3-1. CENTERLINE LIGHTS.

3-2. DESCRIPTION. The centerline lights are white, incandescent, steady-burning lights located in 5 light barrettes along the projected centerline of the runway. In the runway end zone, semi-flush type lights are used in paved areas but elevated lights may be used in unpaved areas. In the outer approach area, including those at station 10+00, elevated type lights are used.

3-3. LOCATIONS. (See UFC 3-535-02, figure 50.) The centerline lights are located at 100-foot intervals from station 1+00 to the outer end of the system

3-4. The barrettes are each perpendicular to the extended runway centerline.

3-5. The middle light of each barrette shall be centered on the extended runway centerline, except if the runway has or will be equipped with runway centerline lights.

3-6. The middle barrette light will be on a line with the runway centerline lights (WP 004 06). The line may be offset a maximum of 24 inches to either side of the runway centerline.

3-7. The barrettes may be located ±10 feet from its base station to avoid local installation problems.

3-8. To avoid major obstructions such as roads, buildings, railroads, and large objects that cannot be removed, the barrette may be displaced up to 50 feet from its station. Omit the barrette if larger displacement is necessary.

NOTE

Never omit more than one barrette in sequence.

3-9. If displacement greater than the 10-foot tolerance is necessary, the adjacent barrette ahead of and behind this station may be relocated to obtain more uniform spacing.

3-10. INSTALLATION. The light fixtures within the centerline barrettes shall be uniformly spaced between 40 and 42 inches apart.

3-11. The light fixture center heights shall be level.

3-12. The semi-flush lights shall be mounted on light +bases embedded in a concrete foundation for each barrette.

3-13. The light bases shall be installed to provide the proper height, horizontal aiming, and level for each light.

3-14. The elevated lights shall be mounted on frangible supports and aimed vertically per Table 2.

3-15. The mounting of the elevated lights shall be as follows:

- For heights up to 6 feet, the support shall be mounted on a frangible coupling for each light. The support shall be conduit.
- For light heights between 6 and 40 feet, the lights shall be mounted on low-impact-resistant support towers (See FAA AC 150/5345-45 for additional information about lightweight support structures. See also UFC-3-535-02 for detailed installation drawings.
- If the height of the lights is more than 40 feet, semi-frangible supports should be used. Semi-frangible supports have the top 20 feet low-impact resistant and the bottom section rigid.

3-16. EQUIPMENT. The approach light system centerline lights are both elevated and semi-flush incandescent light fixtures (Table 1). See the approach light system manufacturer's instruction book for detailed photometric information. The semi-flush lights shall be installed on light bases. The frangible-mounted elevated lights use frangible couplings and the proper length of conduit. The low-impact-resistant and semi-frangible supported lights require type FAA-E-2702 fiberglass supports, type FAA-E-2690 1500-watt isolation transformers, type FAA-E-982 lamp holders with failed lamp shorting devices, and quick disconnect cable connectors at the support base for all electrical wiring. FAA Equipment or "E" specifications may be downloaded from: www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/lsg/vgleap/specifications/

3-17. See also FAA AC 150/5345-45 for detailed frangible light support information and UFC 3-535-02, Figure 50, for system installation drawings and dimensions.

4-1. SEQUENCE FLASHING LIGHTS (SFL).

4-2. DESCRIPTION. This lighting system consists of the Sequence Flashing Lights (SFL) and the master control unit. The SFL are high-intensity blue-white xenon strobe flashing lights and are flashed in sequence starting from the outer or approach end of the system.

4-3. The system flashes twice per second with an interval of 1/60 second between adjacent stations and a pause before repeating.

4-4. The standard 3000-foot ALSF 1 uses 21 elevated, unidirectional SFL.

4-5. Each SFL system has a master control unit that provides power for the system, the trigger signals for the flashing sequence, and the monitoring function.

4-6. The purpose of the SFL lights is to provide early identification of the approach lighting system and runway centerline alignment information during final approach.

4-7. LOCATIONS. One SFL unit shall be located at each centerline light barrette from station 10+00 to the outer end of the system (Figure 1). All SFL shall be along the same line on or parallel to the centerline. If necessary, the SFL may be displaced not more than 5 feet in front of the corresponding centerline barrette. The master control unit may be located in the approach lighting vault or other site and shall be not less than 200 feet from the light system centerline and shall not be an obstruction.

4-8. INSTALLATION. The flasher head may be mounted as part of the unit power supply or separated to allow the proper positioning of the light.

4-9. If the centerline lights are mounted on frangible or low-impact-resistant supports, the flasher heads are remotely mounted usually by the same method as are the steady-burning lights.

4-10. The row of flasher heads shall be in a line within or just below the light plane. The preferred height is the same as the centerline lights for the station.

4-11. The row of SFL flasher heads shall be not more than 4 feet below the elevation of the centerline lights.

4-12. The flasher heads shall be aimed with the axes of the beams six degrees above the horizontal for all stations.

4-13. The power supply units are usually mounted at the base of the supports for the flasher head with a cable length of not more than 150 feet.

4-14. EQUIPMENT. The sequence flashing lighting shall consist of the master control unit and 15 to 21 SFL (see Table 1). The SFL shall be the elevated type which permit the flasher heads to be located away from the power supply units. Refer to FAA-E-2628b for detailed photometric requirements about SFL. The FAA equipment specifications may be downloaded at: www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/lsg/vgleap/specifications/

4-15. The frangible-mounted SFL use frangible couplings and a proper length of conduit.

4-16. The low impact resistant and semi-frangible supported SFL shall be mounted on the same supports as the centerline lights.

4-17. The wiring to the lights shall use quick disconnect type cable connectors at the base of the support.

4-18. The SFL system shall provide one of three selectable intensities.

4-19. The master control unit shall provide the power at the selected intensity and the trigger signal for each of the SFL.

4-20. The control of the SFL shall be interlocked with the steady-burning lights so the SFL cannot operate unless the steady-burning lights are operating. Refer to (10-12, APPROACH LIGHTING CONTROLS, this WP).

5-1. 1000-FOOT CROSSBAR.

5-2. DESCRIPTION. The 1000-foot crossbar consists of a bar of elevated, white, steady-burning lights on each side of the centerline light barrette at station 10+00. The purpose of the light crossbar is to indicate to the approaching pilot that the runway threshold is 1000 feet away. It also serves as a visual roll attitude reference to assist in keeping the aircraft level during final approach.

5-3. LOCATION. The 1000-foot crossbar is normally located at station 10+00 (Figure 1). The lights of the crossbar are located in line with the lights of the centerline barrette at this station. The lights, including the centerline lights, form a bar of lights 100 feet long that is symmetrical about the ALSF-1 system.

5-4. INSTALLATION. The 1000-foot crossbar uses elevated lights only, but is also the terminal for the end zone light plane. If the end zone light plane is too low for mounting the elevated lights, the height of the 1000-foot crossbar lights shall be at the minimum height of the fixture above the end zone plane at this station.

5-5. The outer approach lighting plane shall be through the light centers of the 1000-foot crossbar lights. All lights of the 1000-foot crossbar, including the centerline barrette, shall be at the elevation of this line.

5-6. The 1000-foot crossbar shall have 8 lights on each side at 5-foot spacing, starting 15 feet from the approach lighting centerline (Figure 1). The crossbar shall be perpendicular to the centerline.

5-7. The lights shall be mounted on frangible couplings or low-impact-resistant supports. The aiming of the crossbar lights shall be the same as for the centerline barrette lights at this station.

5-8. EQUIPMENT. The 1000-foot crossbar lights are elevated, white, unidirectional light fixtures (Table 1). For photometric requirements, refer to UFC 3-535-01.

6-1. TERMINATING BAR.

6-2. DESCRIPTION. The terminating bar lights indicate the end of the approach light system and begin the transition to the runway light system. The red side-barrette lights are used to show that the area is unsafe for touchdown. This bar also serves as a visual roll attitude reference to assist the pilot in keeping the aircraft level. The centerline barrette is part of the centerline lights, but also forms part of the terminating bar.

6-3. LOCATION. The terminating bar lights are 200 feet into the approach area at station 2+00 (Figure 1). The 5-light barrette across the approach lighting centerline is considered to be part of the ALSF-1 centerline lights. The innermost lights of the 3-light barrettes shall be 15 feet from the centerline of the approach light system.

6-4. INSTALLATION. The 3-light barrettes on each side of the ALSF-1 centerline shall be elevated lights with 5-foot spacings, and the light centers may be at the minimum height above the end zone light plane. The lights of the 3-light barrettes shall have the beams parallel to the runway centerline in azimuth and shall be aimed vertically per Table 2 for this station.

6-5. EQUIPMENT. The lights are red, unidirectional, elevated lights (Table 1). These lights shall use red filters. For photometric requirements refer to (9-1, PHOTOMETRIC REQUIREMENTS, this WP). Frangible couplings are required for these lights.

7-1. PRETHRESHOLD WING BAR LIGHTS.

7-2. DESCRIPTION/LOCATION. The pre-threshold wing bar lights (also called wing bar lights) are located 100 feet into the approach zone (station 1+00) from the runway threshold. The two bars consist of 5-light barrettes with a barrette on each side of the centerline. The inner light of each barrette shall be 75 feet from the centerline.

7-3. INSTALLATION. The pre-threshold wing bar lights shall be in a line perpendicular to the approach light centerline with the lights spaced at 40.5 inch intervals (Figure 1). The elevated lights may be above the light plane to avoid having part of the light below the surface of the blast pad. The height of the lights above the light plane shall not be more than the minimum mounting height of the fixture. These lights shall have the beams parallel to the runway centerline in azimuth and shall be aimed vertically per Table 2.

7-4. EQUIPMENT. The pre-threshold wing bar lights are red, elevated, unidirectional light fixtures (Table 1). For photometric requirements refer to the approach lighting system manufacturer's instruction book. Frangible couplings are required for mounting these lights.

8-1. RUNWAY APPROACH THRESHOLD LIGHTS.

8-2. DESCRIPTION. The approach threshold lights are threshold lights that are powered by the approach lighting circuits.

8-3. The lights are located only at the approach threshold between the lines of runway threshold lights (see UFC 3-535-02, Figure 50).

8-4. The approach lights should be in line with the runway threshold lights (see WP 004 02 or WP 004 03). The lights are unidirectional but may use bidirectional fixtures emitting green light toward the runway approach and red light toward the runway takeoff.

8-5. Both semi-flush and elevated lights are used. The purpose of the approach threshold lights is to augment the runway threshold lights for marking the beginning of the runway.

8-6. The red beams of bidirectional lights serve as runway end lights to mark the rollout end of the runway for landings from the opposite direction or the beginning of the runway for takeoff.

8-7. INSTALLATION. The approach threshold lights shall be installed in line with the runway threshold lights.

8-8. The approach threshold lights shall be equally spaced between the innermost lights of the runway threshold lights except that a gate 35 feet each side of the runway centerline may be without lights to prevent tail-hook bounce.

8-9. The light spacing shall be not more than 10 feet.

8-10. The line of threshold lights shall be at right angles to the runway centerline.

8-11. If threshold lights are installed in the center section gate, unidirectional semi-flush lights shall be used.

8-12. At light positions 36 feet or more from the centerline, the lights may be elevated or semi-flush types. The semi-flush lights shall be mounted on light bases per the manufacturer's instruction book or recommendations.

8-13. The lights shall be level with the axes of the beams parallel in azimuth to the runway centerline.

8-14. The elevated lights shall be mounted on frangible couplings and leveled and may be unidirectional or bidirectional types. If the type of lights used have a toe-in, the toe-in shall be towards the runway centerline with equal angles for both beams.

8-15. The elevated lights may extend above the light plane, but the height shall be not more than the minimum mounting height for the fixtures.

8-16. EQUIPMENT. The approach threshold lights are per Table 1. If used, there shall be 7 or 8 optional semi-flush lights

8-17. If bidirectional lights are used, green filters are required for the runway threshold light beams and red filters for the beams toward takeoff end of the runway.

8-18. Unidirectional lights shall have green filters. Dichroic filters may be used. The lamp type is determined by the manufacturer.

8-19. The number of elevated lights will vary with the width of the runway, but for a 200-foot-wide runway there shall be 4 additional lights.

8-20. The elevated lights may be either unidirectional lights or bidirectional lights.

8-21. Bidirectional elevated lights shall have green and red filters and unidirectional lights shall have green filters.

8-22. Elevated lights shall be mounted on frangible couplings (see FAA AC150/5345-46 for details about frangible mountings).

9-1. PHOTOMETRIC REQUIREMENTS.

9-2. All the approach lights shall be unidirectional lights except the inboard threshold lights may be bidirectional lights (combination threshold and runway end lights. The axes of the beams shall be parallel to the runway centerline in azimuth, except the elevated inboard threshold lights, if bidirectional, may be toed-in towards the runway centerline at not more than 4.5 degrees. For elevation of the beam axis, refer to (2-22, AIMING CRITERIA, this WP). The chromaticity limits of incandescent (filament) based lamps shall be per SAE AS25050 as follows:

- Centerline and 1000-foot crossbar lights – aviation white.
- Terminating side barrettes and pre-threshold wing bars lights – aviation red.
- Threshold lights – aviation green.
- Sequence flashing lights (SFL) – white or bluish-white.
- Lamp intensities shall be per the requirements in UFC 3-535-01.

9-3. Light chromaticity limits for LED based lamps shall be per FAA Engineering Brief 67. To download FAA Engineering Briefs from the FAA website, use the following URL: www.faa.gov/airports/engineering/engineering_briefs/

9-4. INTENSITY OF STEADY-BURNING LIGHTS. The intensity of steady-burning lights shall be variable in five steps of 100, 20, 4, 0.8, and 0.16 percent of rated intensity. The intensity distribution for the lights at rated current shall be per UFC 3-535-01 for the specific light fixture.

9-5. INTENSITY OF SFL.. See UFC 3-535-01 for intensity steps and max./min. intensity levels.

10-1. POWER AND CONTROLS.

10-2. POWER SOURCES. The primary source of power for the ALSF-1 approach light system is usually from commercial electrical power sources (WP 009 00) via appropriate distribution transformers. Because the use of the approach lights is critical for air operations, a secondary or emergency power source, usually an engine-generator set, is provided (WP 009 01). An automatic power transfer that switches to the emergency power source in less than 15 seconds when the primary power source fails, shall be provided.

10-3. SYSTEM POWER. The ALSF-1 incandescent steady-burning lights are powered by three series circuits (Figure 4).

10-4. Each series circuit consists of a constant-current regulator, power cables, and isolation transformers.

10-5. The constant-current regulators (WP 009 02) shall be 30KW or 50KW size with 5-step intensity settings.

10-6. The regulators shall be located in the regulator room of the approach lighting system vault.

10-7. The cables shall be types appropriate for overhead or underground installation.

10-8. Lights shall be equipped with series isolation transformers of the proper type.

10-9. The light circuits may be interleaved to provide lights throughout the system if one circuit should become inoperative.

10-10. Power to the SFL shall be from the primary or emergency source through suitable distribution transformers and the master control unit.

10-11. Multiple type circuits supply the power to each light (WP 009 04).

10-12. APPROACH LIGHTING CONTROLS. The ALSF-1 approach lights shall be remotely controlled from the airfield lighting control panel (WP 009 05) in the air traffic control tower and from the approach lighting system vault. The steady-burning lights are controlled as one unit for operating the lights and for selecting any of five intensity settings. The SFL have a separate control for switching but can be operated only when the steady-burning lights are operating. The three intensity settings shall also be interlocked with the steady-burning light intensity as follows:

- The SFL shall be on high intensity only if the steady-burning lights are on intensity steps 4 or 5.
- The SFL shall be on medium intensity only if steady-burning lights are on intensity step 3.
- The SFL shall be on low intensity only if steady-burning lights are on steps 1 or 2.

10-13. APPROACH LIGHTING VAULT. Each ALSF-1 approach light system should be provided with an approach lighting vault to house the power and control equipment. This vault should have three or more compartments containing the following:

- The lighting control compartment.
- The generator room with the emergency engine-generator set and the automatic power transfer equipment.
- The regulator room with the constant-current regulators, distribution transformers, and major switching components. The size of this room should allow space for additional regulators and equipment.
- The SFL master control unit may be located in the regulator room, or it may be located separately at a more convenient location.

Table 1. Schedule of Lighting Equipment For ALSF-1

	FIXTURE			LAMP	ISOLATION TRANSFORMER	
SYSTEM COMPONENT	**QUANTITY AND MOUNTING**	**TYPE AND SPECIFICATION FAA**	**COLOR**	**RATING AND TYPE**	**RATING**	**FAA TYPE AC 150/5345-47**
CENTERLINE LIGHTS						
Centerline Barrettes 1+00 to 9+00	45 Semiflush	L-850E D38 (1) AC150/5345-46	White	As determined by manufacturer	200W, 20/6.6A or two 150W, 20/6.6A	L-830-7 L-830-11
Centerline Barrettes 10+00 to 30+00	105 Elevated	FAA-E-982	White	300W, 20A Q20A/PAR56	300W, 20/20A	L-830-9
Sequence Flashing Lights (SFL)	21 Elevated	FAA-E-982 type 1, or FAA AC 150/5345-51, type L-849, style E	Bluish-White	As determined by manufacturer	Special power unit and control	
1000-FOOT CROSSBAR						
10+00 Side Bars	16 Elevated	FAA-E-982	White	300W, 20A Q20A/PAR56	300W, 20/20A	L-830-9
TERMINATING BAR LIGHTS						
Side Barrettes 2+00	6 Elevated	FAA-E-982	Red	500W, 20A Q20A/PAR56/1	500W, 20/20A	L-830-13
PRETHRESHOLD WING BAR						
Side Barrettes 1+00	10 Elevated	FAA-E-982	Red	500W, 20A Q20A/PAR56/1	500W, 20/20A	L-830-13

Table 1. Schedule of Lighting Equipment For ALSF-1 (Cont)

SYSTEM COMPONENT	FIXTURE: QUANTITY AND MOUNTING	FIXTURE: TYPE AND SPECIFICATION FAA	FIXTURE: COLOR	LAMP: RATING AND TYPE	ISOLATION TRANSFORMER: RATING	ISOLATION TRANSFORMER: FAA TYPE AC 150/5345-47
APPROACH THRESHOLD LIGHTS						
Center Section Threshold Bar	7 or 8 Semiflush (optional)	L-850D or E [(1)] AC150/5345-46	Grn 180° Red 180°	As determined by manufacturer	One or two 200W, 20/6.6A	L-830-7
Outer Section Threshold Bar	0, 6, 14 [(2)] Elevated	–	Grn 180° Red 180°	500W, 20A Q20A/T20/3	500W, 20/20A	L-830-13
		FAA-E-982	Green	500W, 20A Q20A/PAR56/1	500W, 20/20A	L-830-13

NOTES:

1. Existing installations using MIL-L-26202 lights may continue using these lights for replacement only.
2. Minimum number of elevated lights for runway widths of 150', 200', and 300' respectively, with an equal number of elevated lights on each side.

Table 2. Elevation-Setting Angles For ALSF-1 Elevated Unidirectional Lights

A. Steady-burning type MB-2 and FAA-E-982 lights

	Setting Angle above Horizontal[1] (Degrees)			Setting Angle above Horizontal[1] (Degrees)	
Station	Preferred	Permitted	Station	Preferred	Permitted
30+00	8.0	8.0	14+00	7.0	7.0
29+00	7.9	8.0	13+00	6.9	7.0
28+00	7.9	8.0	12+00	6.9	7.0
27+00	7.8	8.0	11+00	6.8	7.0
26+00	7.7	7.5	10+00	6.7	6.5
25+00	7.7	7.5	9+00	6.7	6.5
24+00	7.6	7.5	8+00	6.6	6.5
23+00	7.6	7.5	7+00	6.5	6.5
22+00	7.5	7.5	6+00	6.5	6.5
21+00	7.4	7.5	5+00	6.4	6.5
20+00	7.4	7.5	4+00	6.3	6.5
19+00	7.3	7.5	3+00	6.3	6.5
18+00	7.2	7.0	2+00	6.2	6.0
17+00	7.2	7.0	1+00	6.2	6.0
16+00	7.1	7.0	0+00	6.1	6.0
15+00	7.0	7.0			

NOTES:

1. For approach slopes other than 3 degrees, the setting angles shall be adjusted for the difference.

B. Elevated SFL are all aimed 6 degrees above horizontal.

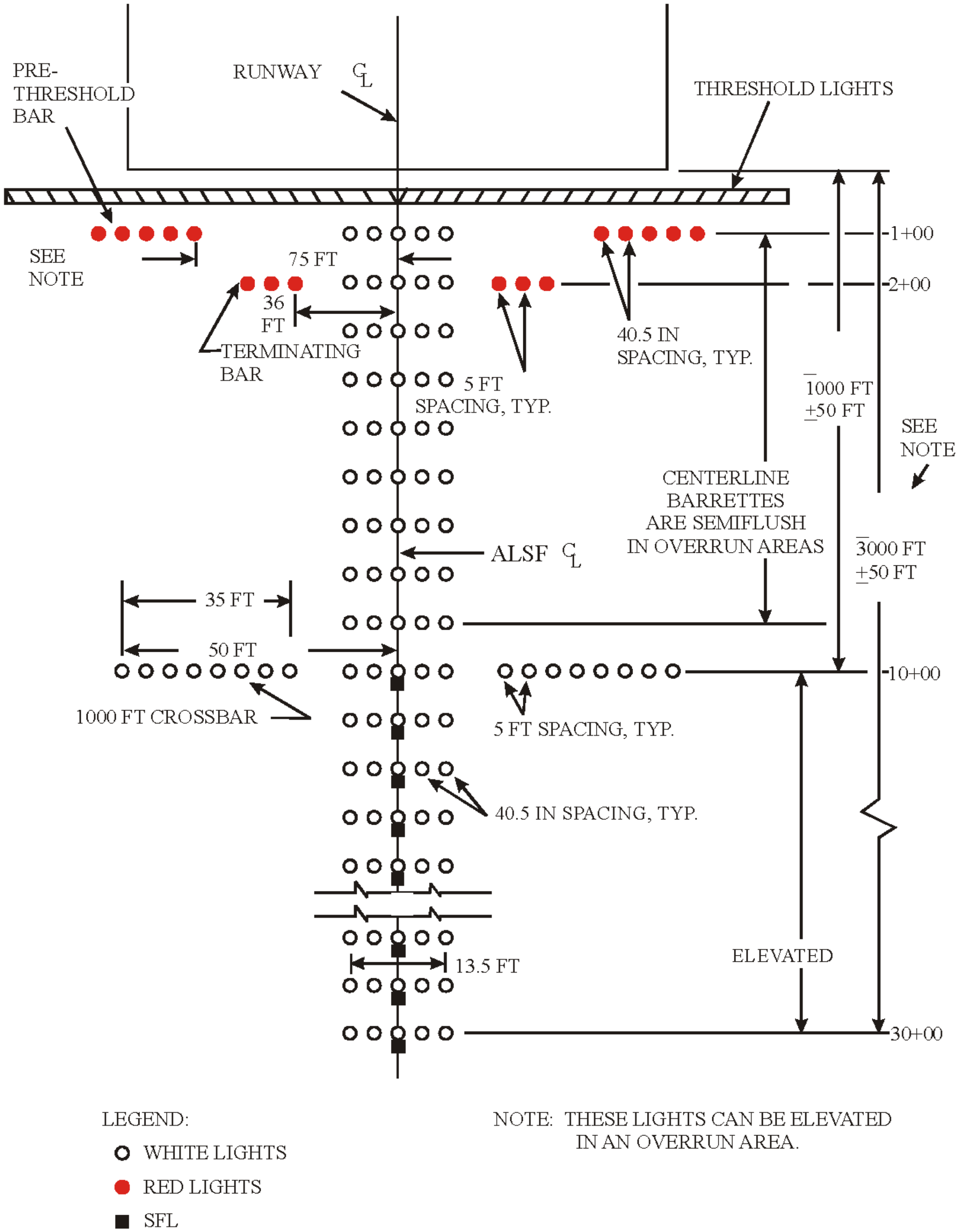
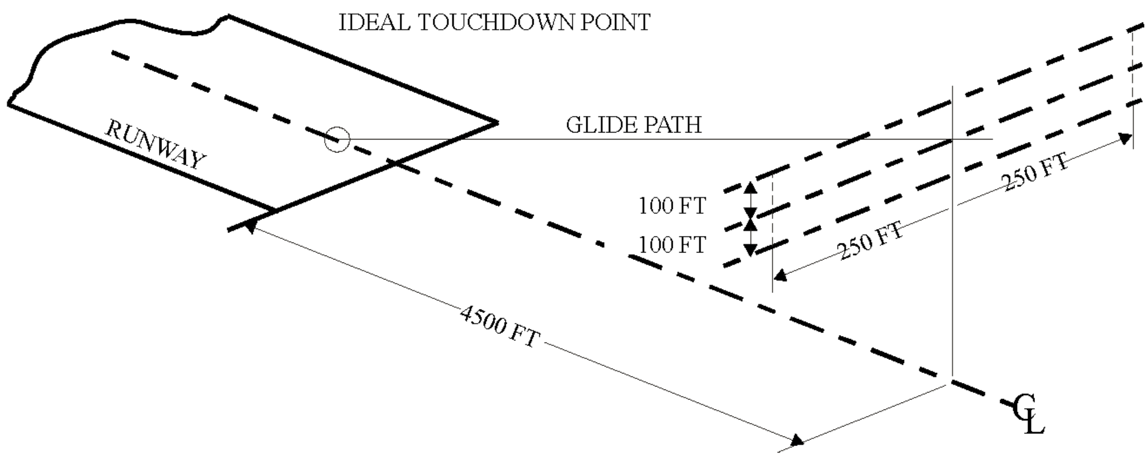
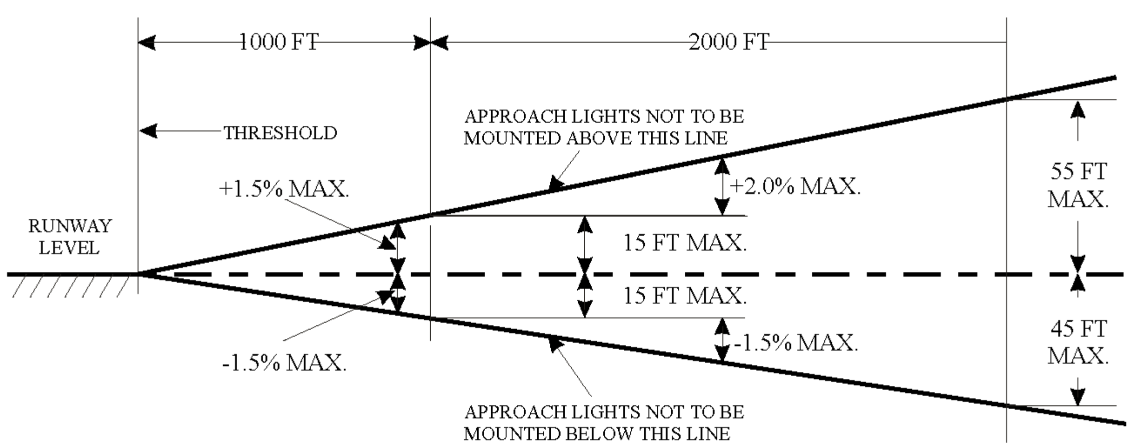


Figure 1. Plan For Approach Light System, Category I - ALSF-1



NOTE: OBSTRUCTIONS SHOULD BE CLEARED SO THAT ALL LIGHTS OF THE APPROACH PATH WILL BE VISIBLE FROM ANY POINT IN A 200 FT X 500 FT RECTANGLE, CENTERED ON THE GLIDE PATH, 4500 FT FROM THE THRESHOLD.

Figure 2. Viewing Window For Approach Lights



NOTE: THE BOUNDARIES OF THE LIGHT PLANES ARE THE RUNWAY THRESHOLD, 200 FT AHEAD OF THE END LIGHT STATION, AND 200 FT EACH SIDE OF CENTERLINE.

Figure 3. Light Plane Limits For Elevations Of Approach Lights

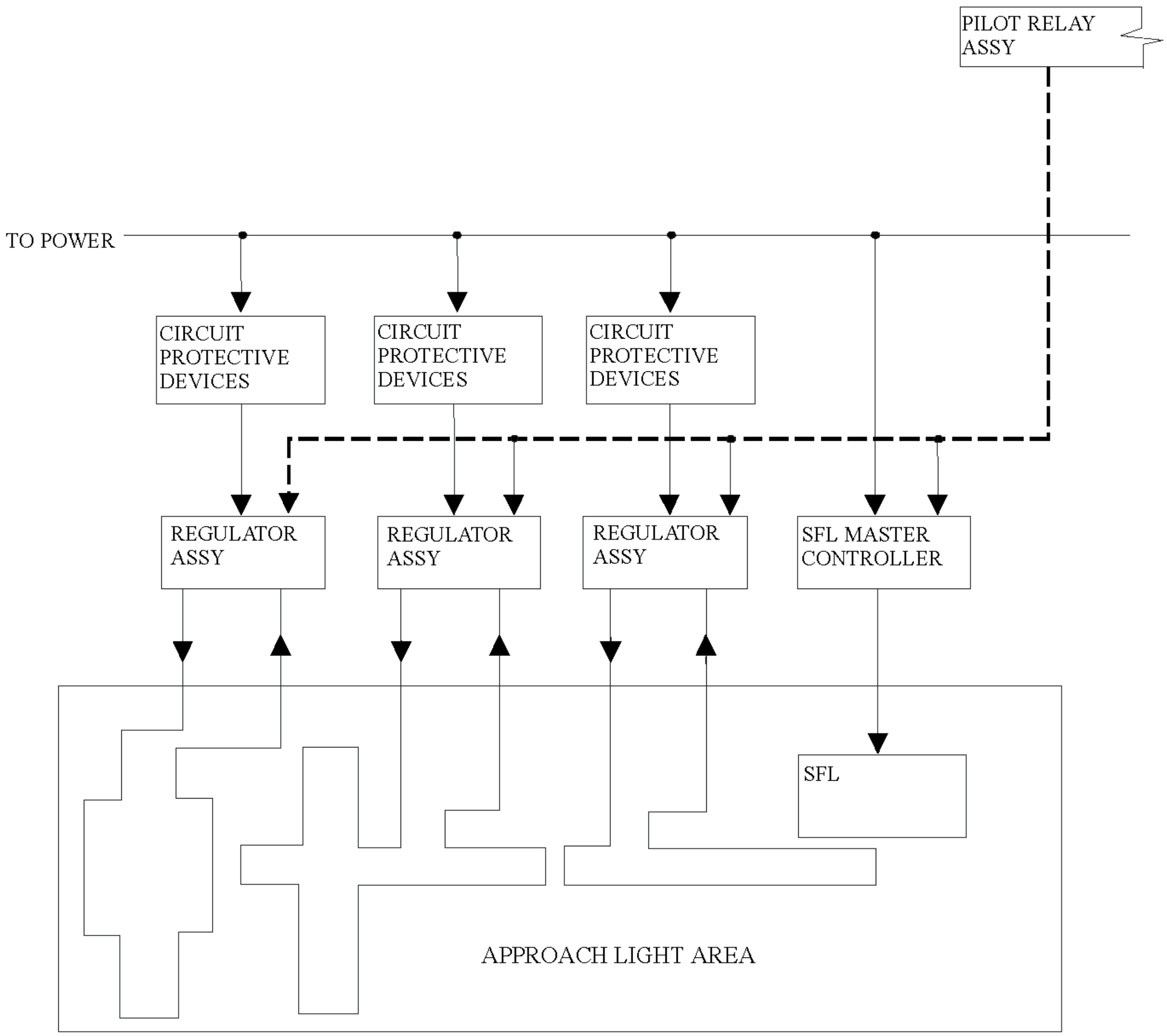


Figure 4. Block Diagram - Approach Light Circuits

ORGANIZATIONAL

APPROACH LIGHTS, CATEGORY II, AND CATEGORY III - ALSF-2

APPROACH VISUAL AIDS

Reference Material

1-1. INTRODUCTION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the Approach Light System with Sequence Flashers (ALSF-2) required for operations in Category II and Category III conditions. The requirements in this WP are to be used for new installations and for upgrading existing installations. Category II and Category III conditions require Instrument Flight Rules (IFR) operations (WP 002 00). The ALSF-2 is similar to the ALSF-1 (WP 003 05) approach light system with additional lights intended to provide visual guidance for precision IFR approaches in very low visibilities. This system provides the visual guidance for alignment of the aircraft with the runway and final corrections before landing at night and during low visibility weather conditions. Approval of plans or requests for deviations shall be processed per WP 002 00.

1-3. JUSTIFICATION REQUIREMENTS. Any runway that is equipped with a precision electronic approach aid such as an Instrument Landing System (ILS), Microwave Landing System (MLS), or Precision Approach Radar (PAR) and intended for operation in RVR conditions below 1600 feet should qualify for an ALSF-2 (WP 003 00). Criteria to be considered for obtaining approval for an ALSF-2 include:

- Mission requirements for operations in Category II or Category III conditions.
- The frequency of occurrence of these low RVR conditions.

1-4. ASSOCIATED FACILITIES. In addition to the ILS, MLS, or precision PAR electronic aids, other airfield facilities required for use with the ALSF-2 for operations in Category II and III should include the following:

- The runway shall be paved and not less than 150 feet wide. The runway length shall not be less than 6000 feet.
- The runway shall be equipped with the following:
  - Precision approach instrument runway markings (WP 004 01),
  - High-intensity runway edge lights (HIRL) (WP 004 05),
  - High-intensity threshold lights (WP 004 02),
  - Runway end lights (WP 004 04),
  - Runway centerline lights (WP 004 06),
  - Touchdown zone lights (TDZL) (WP 004 07).
- The runway approach shall have a paved or stabilized end zone area extending 1000 feet into the approach area and not less than the width of the runway. The first 300 feet of this paved or stabilized area shall have the same slope as the first 1000 feet of the runway. The remainder of the paved or stabilized area may have a slope of not more than ±1.5 percent.
- The runway shall have two or more RVR systems.
- Air traffic control shall be provided during normal operating hours.

1-5. TYPE OF PROJECT. The requirements for the ALSF-2 are for new installations. However, these requirements can apply for projects that replace existing ALSF-2 approach light systems or to upgrade ALSF-1 approach light systems.

2-1. GENERAL INFORMATION.

2-2. For general ALSF-2 installation criteria and a plan view of a typical installation, see FAA JO 6850.2B, dated 8/20/2010. FAA JO 6850.2B may be downloaded free of charge at: www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.information/documentID/321004

2-3. For detailed information about the ALSF-2 equipment shelters, detailed power requirements, electronic equipment, lamps, photometrics, and frangible light supports, see equipment specification FAA-E-2689a. The FAA specification may be downloaded free of charge at: www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/lsg/vgleap/specifications/

2-4. Be certain to read the ALSF-2 equipment manufacturer’s installation instructions for general installation information and for information that may be unique to the manufacturer’s system.

ORGANIZATIONAL

SHORT APPROACH LIGHT SYSTEM (SALS)

APPROACH VISUAL AIDS

Reference Material

1-1. INTRODUCTION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the centerline Short Approach Light System (SALS).

1-3. The SALS may be installed where there is a requirement for a high-intensity visual approach system when it is not practical to install a standard Approach Light System, Category I ALSF-1 (WP 003 05) or Category II ALSF-2 (WP 003 06).

1-4. The SALS provides guidance for operations in Visual Flight Rules (VFR) and some Instrument Flight Rules (IFR) conditions (WP 002 00).

1-5. The SALS does not provide the standard approach visual aids requirements to qualify for Category I operations (WP 003 00). However, approach visibility minimums of 4000 feet Runway Visual Range (RVR) or less with precision electronic approach aids may be permitted.

1-6. Refer to OPNAV Inst. 3722.16.

1-7. The SALS system provides the visual direction and roll guidance for alignment of the aircraft with the runway and final corrections before landing at night and during low visibility weather conditions.

1-8. The length of the SALS system shall be between 2300 feet and 1500 feet measured from the runway threshold.

1-9. Approval of plans or requests for deviations shall be processed as directed in WP 002 00.

1-10. JUSTIFICATION REQUIREMENTS. Any runway that is equipped with a precision electronic approach aid such as a precision Instrument Landing System (ILS), Microwave Landing System (MLS), or Precision Approach Radar (PAR) but where an ALSF-1 is not practical should qualify for a SALS.

1-11. The SALS may be used for approaches without precision electronic aids (WP 003 00) if approved by Naval Air Systems Command. Criteria to be considered for obtaining approval for a SALS include:

- Mission requirements for operations in restricted visibility conditions.
- The frequency of occurrence of IFR conditions.
- Terrain features in the approach areas that do not provide adequate visual guidance or that produce misleading or deceptive cues to the pilots.
- Fixed objects or hazards near the approach path or runway end that could endanger aircraft deviating from the approach course or undershooting the runway.

1-12. ASSOCIATED FACILITIES. In addition to the electronic approach aids, other airfield facilities required for use with the SALS should include the following:

- The runway should be paved and not less than 150 feet wide. The runway length shall not be less than 6000 feet, but shorter runway lengths may be approved for special operating conditions.
- The runway should be equipped with the following:
  - Precision approach instrument runway markings (WP 004 01),
  - High-intensity runway edge lights (HIRL) (WP 004 05),
  - High-intensity threshold lights (WP 004 02),
  - Runway end lights (WP 004 04).
- The approach should have a paved or stabilized end zone area extending 1000 feet into the approach area and not less than the width of the runway. The first 300 feet of this paved or stabilized area should have the same slope as the first 1000 feet of the runway. The remainder of the paved or stabilized area may have a slope of not more than ±1.5 percent.
- The runway may have an RVR system.
- If approved, the runway may be equipped with runway centerline lights (WP 004 06) or displaced threshold lights (WP 004 03).
- Air traffic control should be provided during normal operating hours.

1-13. TYPE OF PROJECT. These requirements for the SALS shall apply for new installations; however, these requirements should apply for projects that replace or upgrade existing SALS approach light systems. Existing equipment that is in excess of these requirements may be removed. As an example, remove the sequence-flashing lights in the end zone area.

2-1. GENERAL INFORMATION.

2-2. SYSTEM DESCRIPTION. The SALS is a system of light bars and barrettes in the approach zone immediately ahead of the runway threshold.

2-3. The length of a SALS is from 1500 to 2300 feet where terrain or other local conditions prevent an ALSF-1 installation.

2-4. A plan view of the SALS is shown in Figure 1 and the schedule of lighting equipment is given Table 1.

2-5. The SALS consists of centerline light barrettes, sequence flashing lights, 1000-foot crossbar, terminating bar, pre-threshold wing bars, and threshold lights.

2-6. A barrette is three or more lights closely spaced in a transverse line so that from a distance they appear as a single short illuminated bar.

2-7. For the SALS, the length of a barrette shall not exceed 15 feet and the center-to-center spacing of the lights shall not exceed 5 feet.

2-8. OBSTRUCTION CLEARANCES. The following restrictions apply:

- No object will be permitted to obstruct the visibility of any approach light from the viewing window.
- Per Figure 2, the viewing window is a rectangular area 100 feet above and below and 250 feet left and right of the ideal glide path at 4500 feet before the runway threshold.
- A light plane or planes (Figure 3), in which the lights of the system are located, are used for determining obstruction clearances of the approach lights.
- The side boundaries of the light plane are 200 feet on each side of the runway centerline extended.
    - The end boundaries are at the runway threshold and at 200 feet before the start of the approach light system.
    - All lines in the plane perpendicular to the centerline are level.
    - The ideal light plane is a single horizontal plane through the runway threshold.
    - If the 1000 feet of runway at the runway threshold end is sloped, the first 300 feet of the paved or stabilized area of the end zone and light plane for this area shall continue with the same slope.
    - The final 700 feet of the paved or stabilized area may have a slope of not more than 1.5 percent up or down.
    - From the 1000-foot crossbar to the beginning of the approach light system, the preferred light plane is horizontal and will include the 1000-foot crossbar lights. If the clearance of obstructions or terrain prohibits using a horizontal light plane, this plane may be sloped.
    - The slope of this plane shall not exceed 2 percent up or 1.5 percent down.
    - The preferred light plane in the area beyond the 1000-foot crossbar is a single plane, but changes in the slope of the plane are permitted.
    - All light planes shall start and end at a light station and shall contain not less than three light stations.
- No objects except elevated lights of the SALS in the end zone should be permitted to extend above the light planes within the boundaries.
    - All railroads are considered as objects which extend 23 feet above the rails
    - Interstate highways are considered as objects 17 feet above the highest point of the road surface.
    - Other highways, public roads, and parking areas are considered as objects which extend 15 feet above the surface.
    - Private or military roads are considered as objects 10 feet or higher except for airport service roads where all vehicular traffic is controlled by air traffic control.
    - When not directly controlled by air traffic control, airport service roads shall have signs that require a full stop and driver determination for the presence of aircraft before proceeding.
    - Parking or stopping between the stop signs.
- Every effort must be made to remove or relocate objects that penetrate the light plane. For objects that cannot be moved, such as an ILS localizer, the height must be kept to a minimum and shall be located as far from the threshold as possible.

- For objects that are not feasible to remove, lower, or relocate and that cannot be cleared by the permitted slopes, a waiver may be granted (WP 002 00) to exceed the slope limits.
- Obstruction lights (WP 003 09) are required on all objects protruding through the light plane with the exception of frangible-mounted elevated lights of the approach light system.

2-9. INSTALLATION REQUIREMENTS. For the details about the design and installation of the SALS, refer to UFC 3-535-02. General requirements for installation are given in this WP under the discussions of each type of light.

2-10. TOLERANCES. The approved tolerances for positioning steady-burning SALS lights are as follows:

- Lateral tolerance of a bar is ±3 inches.
- Distance between individual light centers is ±1 inch.
- Height for light centers up to 6 feet is ±1 inch.
- Height for light centers between 6 and 40 is ±2 inches.
- Height for light centers over 40 feet is ±3 inches.
- Tolerance for vertical aiming of light units is ±1.0 degree.
- Tolerance for horizontal aiming of light unit is ±5 degrees.
- Longitudinal tolerance for the light bar from the designated station is ±10 feet.
- Light bars may be displaced 50 feet longitudinally to avoid omitting a barrette where obstructions cannot be removed or cleared by acceptable clearance planes.
- Where barrettes must be located more than 10 feet from the usual station position, the nearby barrettes may be relocated to provide more uniform spacing between barrettes.

2-11. LIGHT IDENTIFICATION (STATION LOCATION). Positions of the lights may be identified by station or distance. Stations are the longitudinal distances in feet into the approach zone from the runway threshold. The runway threshold is station 0+00. Equipment that is located 745 feet from the runway threshold would be at station 7+45.

2-12. AIMING CRITERIA. The beams of all approach lights shall be aimed into the runway approach path and away from the runway threshold (Figure 1). Some runway threshold lights are bidirectional and will have the red beam (as runway end lights) aimed parallel with the runway.

2-13. All SALS lights, except bidirectional lights with toe-in, shall be aimed in azimuth with the beam axes parallel to the extended runway centerline. Some existing elevated runway threshold and semi-flush threshold lights may have from 3.5 to 4 degrees toe-in toward the runway centerline which shall be allowed.

2-14. The vertical aiming of the SALS elevated, unidirectional, steady-burning lights shall be per Table 2. The aiming angles are based on a glideslope angle of three degrees. If other glideslope angles are used, the vertical aiming shall be adjusted for the difference. The semi-flush lights and the elevated bidirectional threshold lights have fixed elevation angles for the beams. Some existing SFL may also have fixed elevation angles for the beam.

2-15. ACCESS FOR SERVICING. Provisions for servicing the SALS system should be provided by such facilities as access roads, footpaths, and catwalks.

2-16. LIGHTING EQUIPMENT. The lighting equipment for the SALS shall be per Table 1 and Figure 1.

3-1. CENTERLINE LIGHTS.

3-2. DESCRIPTION. The SALS centerline lights are white, incandescent type, steady-burning lights located in barrettes along the extended centerline of the runway. In the runway end zone, semi-flush type lights are used in paved areas. Elevated lights may be used in unpaved areas. In the outer approach area, including lights at station 10+00, elevated type lights are used. All the centerline lights are arranged in 5-light barrettes.

3-3. LOCATIONS. (See Figure 1.) The SALS centerline lights are located at 100-foot intervals from station 1+00 to the outer end of the system.

3-4. Each barrette is perpendicular to the extended runway centerline.

3-5. The middle light of each barrette shall be centered on the extended runway centerline, unless the runway already has or will be equipped with runway centerline lights.

3-6. For runways equipped with centerline lights, the middle light of the barettes will be on an extended line drawn through the center of the runway centerline light fixtures. (WP 004 06). The line may be offset a maximum of 24 inches to either side of the centerline.

3-7. A barrette may be located up to ±10 feet from its base location station in a longitudinal direction to avoid any local installation problems.

3-8. To avoid major obstructions such as roads, buildings, railroads, and large objects that cannot be removed, the barrette may be displaced up to 50 feet from its station. Omit the barrette if larger displacement is necessary.

3-9. If displacement greater than the 10-foot station longitudinal tolerance is necessary, the adjacent barrette ahead of and behind this station may be relocated to obtain more uniform spacing.

3-10. INSTALLATION. The light fixtures within the centerline barrettes shall be uniformly spaced between 40 and 42 inches apart. The light-center heights shall be level.

3-11. Individual semi-flush lights shall be mounted on airport marker light bases embedded in a concrete foundation for each barrette (see FAA AC 150/5345-42 for additional information about light bases).

3-12. The semi-flush light fixture light bases shall be installed to provide the proper height, horizontal aiming, and level for each light.

3-13. Elevated lights shall be mounted on frangible supports and aimed vertically as shown in per Table 2. The mounting of the elevated lights shall be as follows:

- For heights up to 6 feet, the support shall be mounted on a frangible coupling for each light. The support shall be conduit.
- For light heights between 6 and 40 feet, the lights shall be mounted on low-impact-resistant (LIR) supports (see FAA AC 150/5345-45 for more information about LIR supports).
- If the height of the lights is more than 40 feet, semi-frangible supports should be used

NOTE

Semi-frangible supports are defined as: where the bottom 20 feet of the structure is rigid and top 20 feet low-is an LIR support (see FAA AC 150/5345-45 for more information about LIR structures).

3-14. EQUIPMENT. The SALS centerline lights currently use both elevated and semi-flush incandescent light fixtures (Table 1).

3-15. For light photometric requirements, refer to FAA JO 6850.2B (dated 8/20/10), paragraph 204, Lighting Fixtures, a. High Intensity Systems.

NOTE

JO 6850.2B may be downloaded free of charge at: https://www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.information/documentID/321004

FAA specifications may be downloaded free of charge at: www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/lsg/vgleap/specifications/

3-16. The SALS semi-flush lights shall be installed on compatible light bases.

3-17. Frangible mounted elevated lights below 6 feet in height typically use frangible couplings and the proper length of conduit.

3-18. Low-impact-resistant and semi-frangible structure supported lights require supports specified in FAA-E-2702 and FAA AC 150/5345-45, 1500-watt isolation transformers specified in FAA-E-2690, lamp holders specified in FAA-E-982, with failed-lamp shorting devices, and quick-disconnect cable connectors at the support base for all electrical wiring.

4-1. SEQUENCE FLASHING LIGHTS (SFL).

4-2. DESCRIPTION. This lighting system consists of the Sequence Flashing Lights (SFL) and the master control unit. The SFL are high-intensity blue-white xenon strobe flashing lights. The lights are flashed in sequence starting from the outer or approach end of the system. The system flashes twice per second with an interval of 1/60 second between adjacent stations and a pause before repeating. The SALS uses 6 to 14 elevated, unidirectional SFL. Each SFL system has a master control unit that provides power for the system, the trigger signals for the flashing sequence, and the monitoring function. The purpose of these lights is to provide early identification of the approach lighting system and centerline alignment information during final approach.

4-3. LOCATIONS. One SFL unit shall be located at each centerline light barrette from station 10+00 to the outer end of the system (Figure 1). The lights shall not be offset more than 5 feet from the centerline of the runway approach light system. All SFL shall be along the same line on or parallel to the runway centerline. If necessary, the SFL may be displaced not more than 5 feet in front of the corresponding centerline barrette. The master control unit may be located in the approach lighting vault or other suitable building and shall be not less than 200 feet from the light system centerline. Under no circumstances should the master control unit and its housing constitute an obstruction.

4-4. INSTALLATION. The SFL flasher head may be mounted as part of the unit power supply or separately to allow the proper positioning. If the centerline lights are mounted on frangible or LIR supports, the flasher heads are mounted by the same method as the steady-burning lights. The row of flasher heads shall be in a line within or just below the light plane. The preferred height is the same as the centerline lights for the station. The row of SFL flasher heads shall be not more than 4 feet below the elevation of the centerline lights. The flasher heads shall be aimed with the beam axes six degrees above the horizontal for all stations. The power supply units are usually mounted at the base of the supports for the flasher head with the cable length to be not more than 150 feet.

4-5. EQUIPMENT. The SFL shall consist of the master control unit and 6 to 14 SFL (see Table 1).

4-6. The SFL shall be the elevated type which permit the flasher heads to be located away from the power supply units.

4-7. For SFL detailed photometric requirements refer to: FAA-E-2628b. FAA specifications may be downloaded free of charge at: www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/lsg/vgleap/specifications/

4-8. The frangible-mounted SFL use frangible couplings and a proper length of conduit.

4-9. The low-impact-resistant and semifrangible supported SFL shall be mounted on the same supports as the centerline lights. The wiring to these lights shall use quick-disconnect cable connectors at the base of the support.

4-10. The SFL system shall provide one of three selectable intensities. See FAA-E-2628b for additional information about intensities.

4-11. The master control unit shall provide the power at the selected intensity and the trigger signal for each of the SFL.

4-12. The control of the SFL shall be interlocked with the steady-burning lights so the SFL cannot operate unless the steady-burning lights are operating. Refer to (10-11, APPROACH LIGHTING CONTROLS, this WP).

5-1. 1000-FOOT CROSSBAR.

5-2. DESCRIPTION. The 1000-foot crossbar consists of a bar of elevated, white, steady-burning lights on each side of the centerline light barrette at station 10+00. The purpose of this light crossbar is to indicate to the approaching pilot that the runway threshold is 1000 feet away. It also serves as a visual roll attitude reference to assist in keeping the aircraft level during final approach.

5-3. LOCATION. The 1000-foot crossbar is normally located at station 10+00 (see Figure 1). The lights of the crossbar are located in line with the lights of the centerline barrette at this station. The lights, including the centerline lights, form a bar of lights 100 feet long that is symmetrical about the SALS system centerline.

5-4. INSTALLATION. The 1000-foot crossbar uses elevated white lights.

5-5. If the end zone light plane is too low for mounting the elevated lights, the height of the 1000-foot crossbar lights shall be at the minimum height of the fixture above the end zone plane at this station.

5-6. The outer approach lighting plane shall be through the light beam centers of the 1000-foot crossbar lights. All lights of the 1000-foot crossbar, including the centerline barrette, shall be at the elevation of this line.

5-7. The 1000-foot crossbar shall have 8 lights on each side at 5-foot spacing starting 15 feet from the approach lighting centerline (see Figure 1).

5-8. The crossbar shall be perpendicular to the SALS system extended runway centerline.

5-9. The crossbar lights shall be mounted on frangible couplings or low-impact-resistant supports. The aiming of these crossbar lights shall be the same as for the centerline barrette lights at this station.

5-10. EQUIPMENT. The 1000-foot crossbar lights are elevated, white, unidirectional light fixtures (Table 1). For light photometric requirements, refer to FAA-E-2689a.

6-1. TERMINATING BAR.

6-2. DESCRIPTION. The terminating bar lights indicate the end of the approach light system and start the transition to the runway light system. The red side-barrette lights are used to show that the area is unsafe for touchdown. This bar also serves as a visual roll attitude reference to assist the pilot in keeping the aircraft level. The centerline barrette is part of the centerline lights, but also forms part of the terminating bar.

6-3. LOCATION. The terminating bar lights are 200 feet into the approach area at station 2+00 (see Figure 1). The 5-light barrette across the approach lighting centerline is part of the SALS system centerline lights. The innermost lights of the 3-light barrettes shall be 36 feet from the centerline of the approach light system.

6-4. INSTALLATION. The 3-light barrettes on each side of the centerline shall be elevated lights with 5-foot spacings, and the light centers may be at the minimum height above the end zone light plane. The lights of the 3-light barrettes shall have the beams parallel to the runway centerline in azimuth and shall be aimed vertically per Table 2 for this station.

6-5. EQUIPMENT. The lights are red, unidirectional, elevated lights (see Table 1). The lights shall use red filters. For photometric requirements, refer to FAA-E-2689a. Frangible couplings are required for the lights.

7-1. PRETHRESHOLD WING BAR LIGHTS.

7-2. DESCRIPTION/LOCATION. The pre-threshold wing bar lights (also called wing bar lights) are located 100 feet into the approach zone (station 1+00) from the runway threshold. The two bars consist of 5-light barrettes with a barrette on each side of the centerline. The inner light of each barrette shall be 75 feet from the SALS centerline.

7-3. INSTALLATION. The pre-threshold wing bar lights shall be in a line perpendicular to the approach light centerline with the lights spaced at 40.5-inch intervals (see Figure 1). The elevated lights may be above the light plane to avoid having part of the light below the surface of the blast pad. The height of the lights above the light plane shall be not more than the minimum mounting height of the fixture. These lights shall have the beams parallel to the runway centerline in azimuth and shall be aimed vertically per Table 2.

7-4. EQUIPMENT. The pre-threshold wing bar lights are red, elevated, unidirectional light fixtures (Table 1). For photometric requirements refer to FAA-E-2689a. Frangible couplings are required for mounting the lights.

8-1. APPROACH THRESHOLD LIGHTS.

8-2. DESCRIPTION. The approach threshold lights are powered by the approach lighting circuits. These lights are located only at the approach threshold between the lines of runway threshold lights (see Figure 1). The approach lights should be in line with the runway threshold lights (WP 004 02 or WP 004 03). The lights are unidirectional but may use bidirectional fixtures emitting green light toward the approach and red light toward the runway. Both semi-flush and elevated lights are used. The purpose of the approach threshold lights is to augment the runway threshold lights for marking the beginning of the runway. The red beams of bidirectional lights serve as runway end lights to mark the rollout end of the runway for landings from the opposite direction or the beginning of the runway for takeoff.

8-3. INSTALLATION. The approach threshold lights shall be installed in line with the runway threshold lights.

8-4. The approach threshold lights shall be equally spaced between the innermost lights of the runway threshold lights except a gate 35 feet each side of the runway centerline may be without lights.

8-5. The approach threshold light spacing shall be not more than 10 feet.

8-6. The line of threshold lights shall be at right angles to the runway centerline.

8-7. If approach threshold lights are installed in the center section gate, unidirectional semi-flush lights shall be used.

8-8. At light positions 36 feet or more from the centerline, the lights may be elevated or semi-flush types.

8-9. The semi-flush lights shall be mounted on compatible light bases with the top of the base below the runway surface per the manufacturer's installation instructions.

8-10. The approach threshold lights shall be level with the axes of the beams parallel in azimuth to the runway centerline.

8-11. Elevated approach threshold lights shall be mounted on frangible couplings and leveled and may be unidirectional or bidirectional types.

8-12. If the type of lights used feature a toe-in, the toe-in of the lights shall be towards the runway centerline with equal angles for both runway approach and runway end beams.

8-13. Elevated lights may extend above the light plane, but the height shall be not more than the minimum mounting height for the fixtures.

8-14. EQUIPMENT. The approach threshold lights per Table 1. If used, the lights shall be 8 semiflush lights.

8-15. If bidirectional lights are used, green filters are required for the threshold lights and red filters for the runway end lights.

8-16. Unidirectional lights shall have green filters. Dichroic filters may be used.

8-17. The light fixture lamp type is determined by the manufacturer.

8-18. The number of elevated lights will vary with the width of the runway, but for a 200-foot-wide runway there shall be 4 additional lights.

8-19. The elevated lights may be either unidirectional lights or bidirectional lights.

8-20. The bidirectional elevated lights shall have green and red filters and unidirectional lights shall have green filters.

8-21. Elevated lights shall be mounted on frangible couplings.

9-1. PHOTOMETRIC REQUIREMENTS.

9-2. All the approach lights shall be unidirectional lights except the inboard threshold lights may be bidirectional lights as combination threshold and runway end lights. The axes of the beams shall be parallel to the runway centerline in azimuth, except the elevated inboard threshold lights, if bidirectional, may be toed-in towards the runway centerline at not more than 4.5 degrees. For elevation of the beam axis, refer to (2-12, AIMING CRITERIA, this WP). The color of the emitted light shall be per SAE AS25050 (FAA Engineering Brief 67 for LED type lamps) as follows:

- Centerline and 1000-foot crossbar lights - aviation white.
- Terminating side barrettes and pre-threshold wing bars lights - aviation red.
- Threshold lights - aviation green.
- Sequence flashing lights (SFL) - white or bluish-white xenon discharge type lamps which may not meet aviation white requirements.

9-3. SAE documents are not free – there is a charge for download at: www.sae.org/standards/content/as25050/

9-4. FAA Engineering Brief 67 may be downloaded free of charge at: www.faa.gov/airports/engineering/engineering_briefs/

9-5. INTENSITY OF STEADY-BURNING LIGHTS. The intensity of these lights shall be variable in five steps of 100, 20, 4, 0.8, and 0.2 percent of rated intensity for the steady-burning lights. See FAA-E-2689a for lamp min./max. intensities.

9-6. INTENSITY OF SFL. The intensity and flash sequence of SFL shall be per FAA-E-2628b.

9-7. The FAA specification may be downloaded free of charge at: www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/lsg/vgleap/media/FAA-E-2628b.pdf

10-1. POWER AND CONTROLS.

10-2. POWER SOURCES. The primary source of power for the SALS approach light system is usually from commercial electrical power sources via appropriate distribution transformers (WP 009 00). Because the use of the approach lights is critical for air operations, a secondary or emergency power source shall be provided (WP 009 01). The emergency power source is usually an engine/generator set. An automatic system power transfer, which switches to the emergency power source in less than 15 seconds when the primary power source fails, shall be provided.

10-3. SYSTEM POWER. The SALS incandescent steady-burning lights are powered by three constant current series circuits (see Figure 4). Each high series lighting circuit consists of a constant current regulator, power cables, and isolation transformers.

10-4. The constant current regulators (WP 009 02) shall be 30 kilowatts (KW) or 50KW size with 5-step lighting circuit intensity settings.

10-5. The regulators shall be located in the regulator room of the approach lighting system equipment vault.

10-6. All electrical cables shall be types appropriate for overhead and underground installation.

10-7. All ALSF-2 system lights shall be equipped with series isolation transformers of the proper wattage.

10-8. The ALSF-2 light circuits may be interleaved to provide lights throughout the system if one circuit should become inoperative.

10-9. Power to the SFL shall be from the primary or emergency source through suitable distribution transformers and the master control unit.

10-10. Multiple type circuits supply the power to each light (WP 009 04).

10-11. APPROACH LIGHTING CONTROLS. The SALS approach lights shall be remotely controlled from the airfield lighting control panel (WP 009 05) in the air traffic control tower and the approach lighting vault.

10-12. The steady-burning lights are controlled as one unit for operating the lights and for selecting any of five intensity settings. The sequence flashing lights have a separate control for switching but can be operated only when the steady-burning lights are operating.

10-13. The three intensity settings shall also be interlocked with the steady-burning light intensity as follows: The SFL shall be on high intensity only if the steady-burning lights are on intensity steps 4 or 5. The SFL shall be on medium intensity only if the steady-burning lights are on intensity step 3. The SFL shall be on low intensity only if the steady-burning lights are on intensity steps 1 or 2.

10-14. APPROACH LIGHTING VAULT. Each SALS approach light system should be provided with an approach lighting vault to house the power and control equipment. This vault should have three or more compartments containing the following:

- The lighting control compartments.
- The generator room with the emergency engine-generator set and the automatic power transfer equipment.
- The regulator room with the constant-current regulators, distribution transformers, and major switching components. The size of this room should allow space for additional regulators and equipment.
- The SFL master control unit may be located in the regulator room, or it may be located separately at a more convenient location.

Table 1. Schedule Of Lighting Equipment For SALS

SYSTEM COMPONENT	FIXTURE: QUANTITY AND MOUNTING	FIXTURE: TYPE AND SPECIFICATION[1] FAA	FIXTURE: COLOR	LAMP: RATING AND TYPE	ISOLATION TRANSFORMER: RATING	ISOLATION TRANSFORMER: FAA TYPE[1] AC 150/5345-47
CENTERLINE LIGHTS						
Centerline Barrettes 1+00 to 9+00	45 Semiflush	L-850E[2] AC 150/5345-46	White	As determined by manufacturer	200W, 20/6.6A 300W, 20/6.6A	L-830-7 L-830-11
Centerline Barrettes 10+00 - 15+00 or 23+00	30 to 70 Elevated	FAA-E-982	White	300W, 20A Q20A/PAR56	300W, 20/20A	L-830-9
Sequence Flashing Lights (SFL)	6 to 14 Elevated	FAA-E-2628b type 1, or AC 150/5345-51, type L-849, style E	Bluish-White	As determined by manufacturer	Special power unit and control	
1000-FOOT CROSSBAR						
10+00 Side Bars	16 Elevated	FAA-E-982	White	300W, 20A 20A/PAR56	300W, 20/20A	L-830-9
TERMINATING BAR LIGHTS						
Side Barrettes 2+00	6 Elevated	FAA-E-982	Red	500W, 20A Q20A/PAR56/1	500W, 20/20A	L-830-13
PRETHRESHOLD WING BAR						
Side Barrettes 1+00	10 Elevated	FAA-E-982	Red	500W, 20A Q20A/PAR56/1	500W, 20/20A	L-830-13

Table 1. Schedule Of Lighting Equipment For SALS (Cont)

SYSTEM COMPONENT	FIXTURE: QUANTITY AND MOUNTING	FIXTURE: TYPE AND SPECIFICATION[1] FAA	FIXTURE: COLOR	LAMP: RATING AND TYPE	ISOLATION TRANSFORMER: RATING	ISOLATION TRANSFORMER: FAA TYPE[1] AC 150/5345-47
APPROACH THRESHOLD LIGHTS						
Center Section Threshold Bar	7 or 8 Semiflush	L-850D[2] AC 150/5345-46	Grn 180° Red 180°	As determined by manufacturer	One or two 200W, 20/6.6A	L-830-7
Outer Section Threshold Bar	0, 4, 14[3] Elevated	–	Grn 180° Red 180°	500W, 20A Q20A/T20/3	500W, 20/20A	L-830-13
		FAA-E-982	Green	500W, 20A Q20A/PAR56/1	500W, 20/20A	L-830-13

NOTES:

1. Either Military or FAA types may be used, but a single type for each installation is preferred.
2. Existing installations using MIL-L-26202 lights may continue using these lights for replacement only.
3. Minimum number of elevated lights for runway widths of 150', 200', and 300' respectively, with an equal number of elevated lights on each side.

Table 2. Elevation-Setting Angles For SALS Elevated Unidirectional Lights

A. Steady-burning type MB-2 and FAA-E-982 lights

	Setting Angle above Horizontal[1] (Degrees)			Setting Angle above Horizontal[1] (Degrees)	
Station	Preferred	Permitted	Station	Preferred	Permitted
23+00	7.6	7.5	11+00	6.8	7.0
22+00	7.5	7.5	10+00	6.7	6.5
21+00	7.4	7.5	9+00	6.7	6.5
20+00	7.4	7.5	8+00	6.6	6.5
19+00	7.3	7.5	7+00	6.5	6.5
18+00	7.2	7.0	6+00	6.5	6.5
17+00	7.2	7.0	5+00	6.4	6.5
16+00	7.1	7.0	4+00	6.3	6.5
15+00	7.0	7.0	3+00	6.3	6.5
14+00	7.0	7.0	2+00	6.2	6.0
13+00	6.9	7.0	1+00	6.2	6.0
12+00	6.9	7.0	0+00	6.1	6.0

NOTES:

1. For approach slopes other than 3 degrees, the setting angles shall be adjusted for the difference.

B. Elevated SFL are all aimed 6 degrees above horizontal.

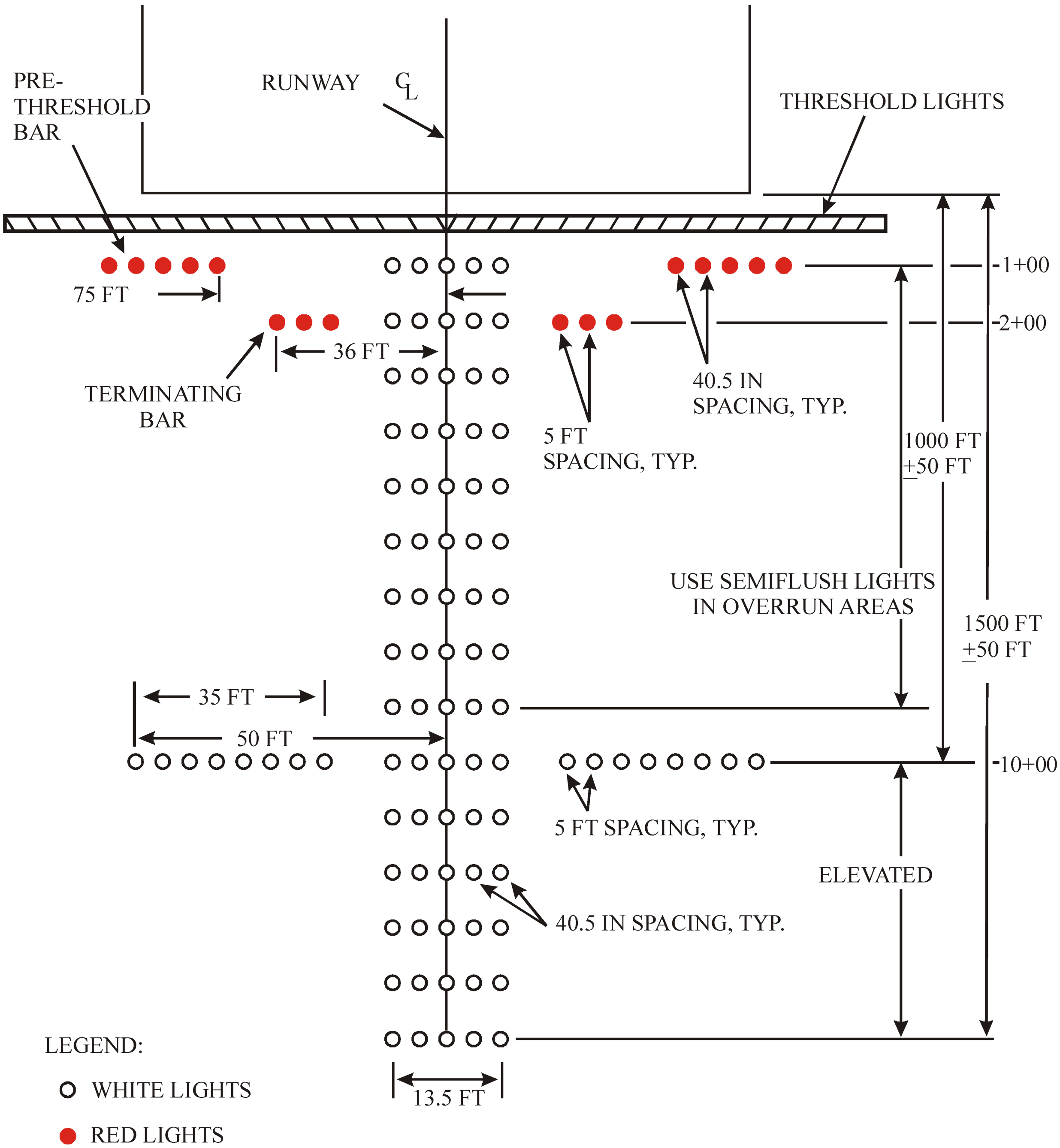
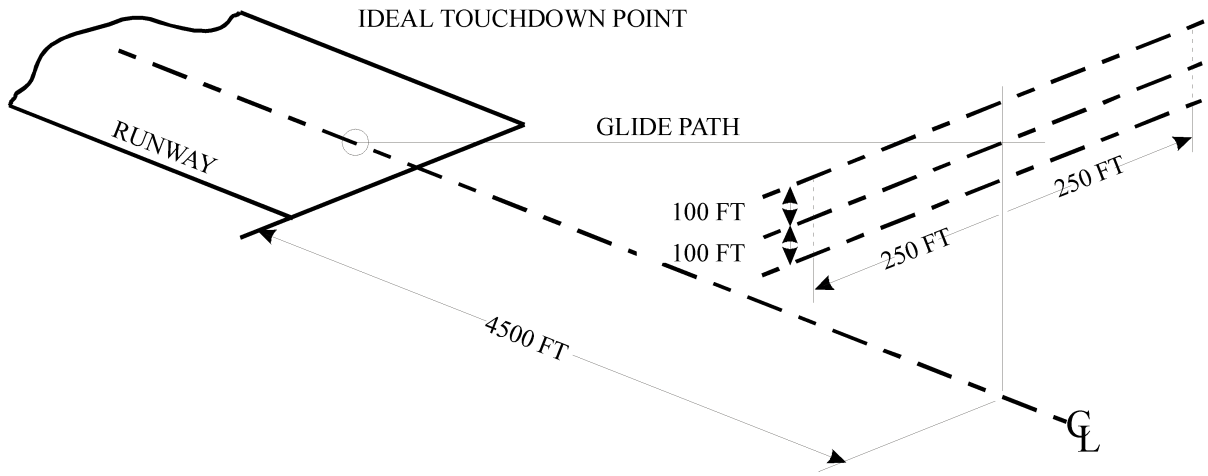
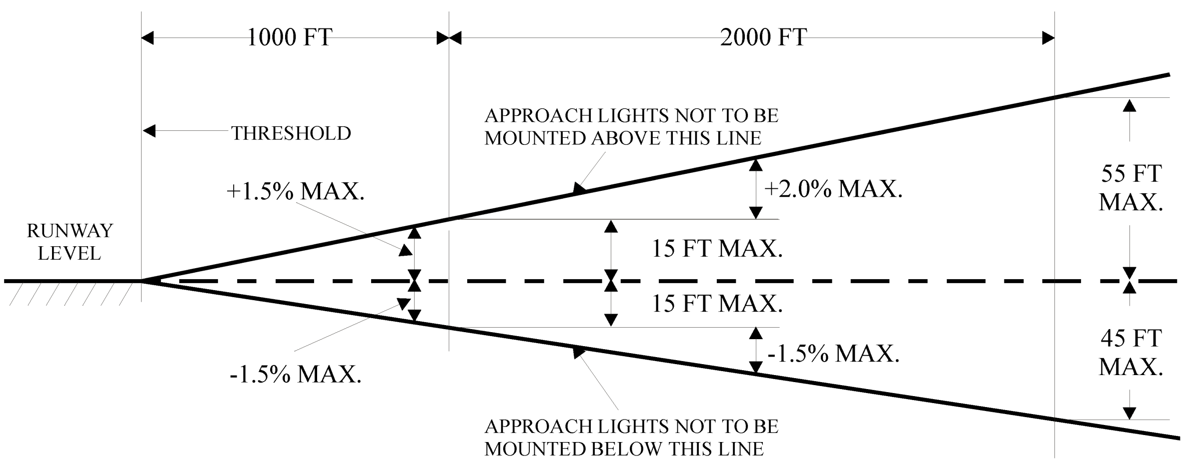


Figure 1. Plan For Approach Light System, SALS



NOTE: OBSTRUCTIONS SHOULD BE CLEARED SO THAT ALL LIGHTS OF THE APPROACH PATH WILL BE VISIBLE FROM ANY POINT IN A 200 FT X 500 FT RECTANGLE, CENTERED ON THE GLIDE PATH, 4500 FT FROM THE THRESHOLD.

Figure 2. Viewing Window For Approach Lights



NOTE: THE BOUNDARIES OF THE LIGHT PLANES ARE THE RUNWAY THRESHOLD, 200 FT AHEAD OF THE END LIGHT STATION, AND 200 FT EACH SIDE OF CENTERLINE.

Figure 3. Light Plane Limits For Elevations of Approach Lights

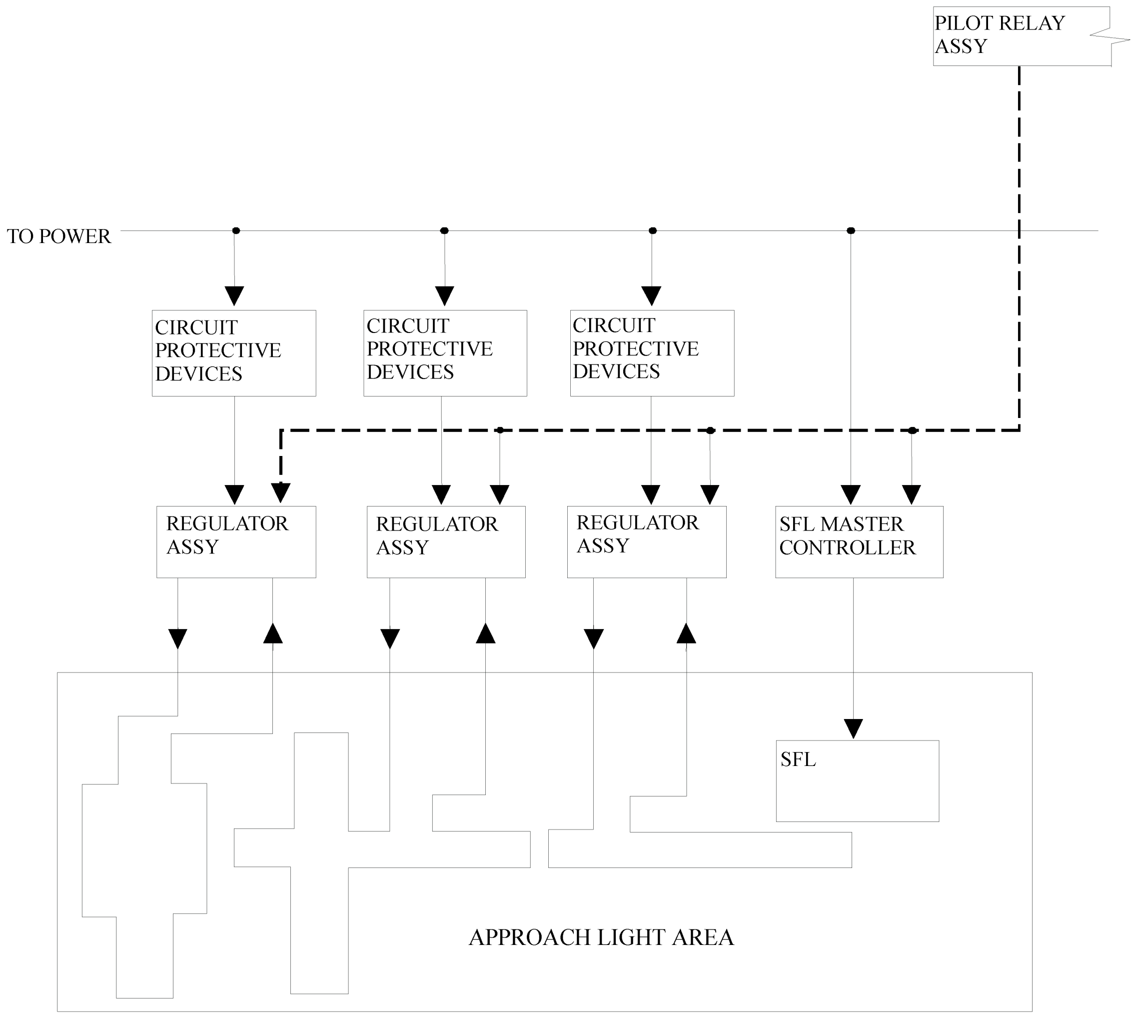


Figure 4. Block Diagram - Approach Light Circuits

ORGANIZATIONAL

OBSTRUCTION MARKINGS

APPROACH VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for obstruction markings. The purpose of obstruction markings is to provide visual identification of objects that are potentially hazardous to safe air navigation and to warn airmen of their presence during daylight hours. These requirements shall be used to mark objects which are new or unmarked where investigation has determined that they are hazards to air operations. Existing obstruction markings may continue in service until repainting is necessary. Deviations from these requirements shall be approved using the procedures of WP 002 00 and also obtaining approval of the proposed obstruction marking changes from Federal Aviation Administration (FAA).

1-3. IDENTIFYING OBSTRUCTIONS. Obstructions are usually objects that extend above the air safety clearance surfaces established for the airfield. For these clearance requirements, refer to UFC 2-000-05N and 14 CFR Part 77. The FAA has primary responsibility for identifying obstructions. An FAA investigation may determine that objects that do not penetrate any safety clearance surface are obstructions. Such objects are usually isolated and have heights more than 200 feet above the terrain. Also, the FAA investigation may find that objects which penetrate the safety clearance surfaces do not require obstruction marking. Any object which has been identified as an obstruction shall be treated as follows:

- Remove the object if practical.
- Reduce the height of the object below the hazard level.
- Mark the object as an obstruction.
- High- or medium-intensity white obstruction lights for daytime. (See WP 003 09.)

1-4. JUSTIFICATION REQUIREMENTS. Obstruction removal or marking may or may not be the responsibility of the Airfield. The owner of the facility or property usually is required to provide and maintain the obstruction markings. The Airfield's responsibility for marking obstructions may include the following:

- All obstructions on the Airfield.
- Navigation installations or facilities that are obstructions and are located off the Airfield property.
- Structures or natural objects that existed before the Airfield was installed or before the change in operational procedures that results in the object being classified as an obstruction.

1-5. RELATED FACILITIES. The only airfield visual aids related to the use of obstruction markings are obstruction lighting (WP 003 09). However, certain lights and facilities for visual aids may be obstructions and require obstruction marking.

1-6. COORDINATION WITH THE FAA. The Federal Aviation Administration (FAA) has responsibility for promoting air safety. For primary guides relevant to obstruction marking and lighting, refer to FAA AC 70/7460-1. All Government agencies and organizations are required to be in compliance with the AC recommendations. Therefore, the latest issue of the Advisory Circular shall be used to determine the minimum requirements in the design and installation of obstruction markings. The determination of which objects are potential obstructions or hazards to air operations should be coordinated with the FAA Regional Office. If the obstruction presents special problems in marking, a further determination may be made with the FAA on whether the marking can be modified or a deviation from the standard is permitted. Modifications or deviations of markings which may be approved are as follows:

- Marking only a portion of the object. An example is only the upper portion of the object above the terrain or surrounding objects requires marking.
- No marking is required. The location with respect to terrain or other objects or the conspicuity of the object makes marking the obstruction unnecessary.
- Modifying the marking pattern. The shape or height of the obstruction may be such that modifying the marking pattern will be more effective and more practical to install.
- Dimensions of patterns.
- Colors.
- Use of high- or medium-intensity white obstruction lights instead of marking.

2-1. DESCRIPTION.

2-2. GENERAL. The details for obstruction markings requirements are given in FAA AC 70/7460-1 and shall be followed. The descriptions given here are only for general information which is not likely to be changed by revisions of the Advisory Circular. The markings for different types of obstructions may vary depending on the nature of the object and its location. The types of markings or markers used for obstructions are as follows:

- Painted markings.
- Markers.
- Vehicle markings.

2-3. PAINTED MARKINGS. Most obstructions are marked by painting the surface. The obstruction marking colors are international orange chip #12197 and insignia white chip #17875 per SAE AMS-STD-595. Other colors sometimes used are yellow, black, red, and aluminum. See FAA AC 7460-1 for detailed information about acceptable paint compositions and gloss. Painted surfaces change color with time, and repainting is necessary whenever the change in color, scaling, or chipping is visually noticeable. Patterns of various types are used for painted surface markings of obstructions. See FAA AC 7460-1 for additional detailed information about color schemes and patterns for marking obstructions.

2-4. The FAA AC may be downloaded free of charge at: https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.current/documentNumber/70_7460-1

2-5. MARKERS. Markers should be used to mark obstructions where it is impractical to mark the obstruction by painting. Markers may also be used in addition to painted markings if the markers may improve the conspicuity of the obstruction. The markers shall be displayed in conspicuous positions on or adjacent to the obstructions to retain the general definition of the obstruction. The markers shall be distinctively shaped to avoid being mistaken for markers for other purposes. The markers should not increase the hazard that they mark. The two types of obstruction markers used are:

- Spherical markers.
- Flag markers.

2-6. See FAA AC 7460-1 for detailed information about marking catenary structure and wire (overhead transmission line wires).

2-7. For flag marker information about size, shape, color patterns, and proper display, see FAA AC 7460-1.

2-8. VEHICLE MARKINGS. Vehicles used in the aircraft operational areas of the airfield shall be painted and marked per FAA AC 150/5210-5.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For details for installing the obstruction markings and markers refer to FAA AC 70/7460-1. Examples of marking layouts are in Appendix A of the AC.

3-3. EQUIPMENT AND MATERIALS. See FAA AC 7460-1 for detailed information about paint standards that include paint types, application, and SAE AMS-STD-595 color numbers.

4-1. POWER AND CONTROLS.

4-2. Obstruction markings do not require electrical power or control.

ORGANIZATIONAL

OBSTRUCTION LIGHTINGS

APPROACH VISUAL AIDS

Reference Material

Introduction	WP 002 00
Approach Visual Aids, Obstruction Markings	WP 003 08
Aeronautical Ground Light and Surface Marking Colors	ICAO, Annex 14, Vol. 1, App. 1
Airport Lighting Equipment Certification Program (lists sources of qualified equipment)	FAA AC 150/5345-53
Colors, Use in Government Procurement	SAE AMS-STD-595
Design and Installation Details for Airport Visual Aids	FAA AC 150/5340-30
Facilities Planning Factors Criteria for Navy and Marine Corps Shore Installations	UFC 2-000-05N
Light, Navigational, Beacon, Beacon Obstacle for Code, Type G-1	MIL-L-6273
Obstruction Marking and Lighting	FAA AC 70/7460-1
Painting, Marking and lighting of Vehicles Used on an Airport	FAA AC 150/5210-5
Safe, Efficient Use, and Preservation of the Navigable Airspace	14 CFR Part 77
Specification for Obstruction Lighting Equipment	FAA AC 150/5345-43
Star-of-Life Ambulance	FED KKK-A-1872

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for obstruction lighting. The purpose of obstruction lighting is to provide visual identification of objects at night, or in some cases daytime, that are hazardous to air navigation. The requirements in this WP shall be used to light obstructions when an investigation has determined that the object is a hazard to air operations or when replacement of existing obstruction lights is required. Existing obstruction lighting may continue to be used if serviceable.

1-3. JUSTIFICATION REQUIREMENTS. Any object that projects above the airspace safety clearance surfaces and has been determined to be an obstruction or a hazard shall be lighted. For determining clearances refer to UFC 2-000-05N and 14 CFR Part 77.

1-4. See 14 CFR Part 77.7, Form and time of notice, for additional detailed information about construction or alterations on Department of Defense airports or locations and the submission of FAA Form 7460-1.

1-5. Hazards are objects which do not project through an airspace safety clearance surface but should be marked as obstructions, especially if the height is more than 200 feet above the surrounding terrain, because they are potential hazards to air operations. The obstructions that are the responsibility of the Navy for lighting include the following:

- All hazardous obstructions on the Air Station.
- Navigation installations or facilities that are obstructions that may be located elsewhere than on the Air Station property.
- Natural objects or structures that existed before the Air Station or before a change in procedures that resulted in the object being classified as an obstruction.

1-6. The approval of deviations from these requirements shall follow the procedures of WP 002 00.

1-7. RELATED FACILITIES. The only airfield visual aids related to the use of obstruction lighting are obstruction markings (WP 003 08). Normally, objects requiring obstruction markings also require obstruction lighting including certain lights and facilities for visual aids.

1-8. COORDINATION WITH THE FAA. The Federal Aviation Administration (FAA) has responsibility for promoting air safety. For primary guides about obstruction lighting refer to FAA AC 70/7460-1. The latest issue of the AC shall be used to determine the minimum requirements for the design and installation of obstruction lighting. The determination of which objects are obstructions or hazards should be coordinated with the FAA Regional Office. If the obstruction presents special problems in lighting, a further determination may be made with the FAA on whether the lighting can be modified or a deviation from the standard is permitted. Approval for these modifications or deviations that may be approved are as follows:

- Lighting only a portion of the object. Example: Only the upper portion of the object above the terrain or surrounding objects requires lighting.
- No lighting required. Example: The location with respect to terrain or other objects or the conspicuity of the obstruction makes lighting the obstruction unnecessary.
- Modifying the lighting configuration. Example: The shape or height of the obstruction may be such that modifying the lighting configuration will be more effective or more practical.
- Using an alternate system. Example: A high intensity flashing white light system may be more effective.
- For obstruction lighting requirements, refer to FAA AC 7460-1. The AC provides detailed information relevant to the determination of structures to be lighted, FAA approvals of structures that will affect navigable airspace, lighting layouts, types of construction lights, and the lighting of catenary structures.
  FAA AC 7460-1 may be downloaded free of charge at: www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.current/documentNumber/70_7460-1
- For obstruction lighting equipment details, refer to FAA AC 150/5345-43.

2-1. VEHICLE OBSTRUCTION LIGHTING.

2-2. Vehicles or mobile equipment operating within the aircraft traffic areas other than aprons are considered obstructions or hazards and shall be lighted. For all vehicle lighting requirements, refer to FAA AC 150/5210-5.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For details about obstruction lighting equipment installation refer to FAA AC 70/7460-1. Typical examples of obstruction lighting are shown in Appendix A of the AC.

4-1. EQUIPMENT.

4-2. FIXTURES. The approved equipment for the obstruction lighting is given in Table 1.

4-3. PHOTOMETRIC CHARACTERISTICS. The light emitted by the obstruction lighting fixtures shall have the following photometric characteristics:

4-4. Colors.

4-5. The colors of obstruction lights shall be as follows:

- Steady-burning red lights and the red flashing beacons shall be red per FAA AC 150/5345-43.
- High-intensity and medium intensity flashing white lights shall be white per FAA AC 150/5345-43.
- Vehicle flashing beacons shall be red, white, or yellow, per FAA AC 150/5210-5, Appendix 2.

4-6. Flash Characteristics.

4-7. The flashing characteristics of obstruction lights shall be as follows:

- Steady-burning red lights shall operate continuously except some installations may flash these lights simultaneously with the red beacons.
- See FAA AC 150/5345-5 for vehicle beacon flash rates.

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for obstruction lights are usually energized from multiple AC circuits. The power source may be from a central location such as the airfield lighting vault or from a locally available source. Lights energized from multiple AC circuits usually operate from 120, 208, 240, or 480 volts. Some lights may be capable of operating at more than one voltage. Emergency power is not essential, but it is desirable if available.

5-3. CONTROLS. The obstruction lights may be controlled manually from the air traffic control tower or automatic local control using photoelectric switches. Manual control in the tower is usually preferred for the red lighting systems. This control is usually only switching the lights on and off but may be used in restricted visibility during daylight hours. For many obstructions it is not practical to provide manual control. The automatic local controls for red lighting systems use photoelectric switches which energize the lights before the north sky illuminance decreases below 35 Footcandles (Fc) and turns off the lights before this illuminance increases above 58 Fc. For obstruction lights using more than one intensity setting, the automatic control switches at the following north sky illuminance levels:

Day to twilight	60 and 30 Fc
Twilight to night	5 to 2 Fc
Night to twilight	2 to 5 Fc
Twilight to day	30 to 60 Fc

5-4. MONITORING. Monitoring of obstruction lights is required and may be accomplished by visual observation once each 24 hours. If visual monitoring is not practical and for some especially hazardous obstructions such as tall towers, remote monitoring is required. The top lights and all beacons and high intensity flashing white lights shall be included in remote monitoring of the system. See FAA AC 150/5345-43 for more information about monitoring equipment. See FAA AC 70/7460-1 for additional information about monitoring requirements for obstruction light systems.

Table 1. Schedule of Equipment For Obstruction Lighting

PURPOSE TYPE OF FIXTURE [1]	LAMP RATING AND TYPE	POWER TRANSFORMER OR COMMENTS RATING
Steady-burning red lights.		
FAA AC 150/5345-43, Type L-810 or L-810(L)	Determined by manufacturer	See manufacturer's installation information.
Flashing red beacon, medium intensity.		
MIL-L-6273 Type G-1	Two 700W 120V 700PS40P	
or FAA AC 150/5345-43, Type L-864, or L-864(L)	Two 700W 120V 700PS40P or determined by manufacturer	Includes flasher unit.
High-intensity, flashing white light.		
FAA AC 150/5345-43, Type L-856, L-857, L-856(L) L-857(L)	Determined by manufacturer.	Controller unit includes flasher and power supply.
Medium-intensity, flashing, white system, dual system, or appurtenance light, omnidirectional.		
FAA AC 150/5345-43, Type L-865, L-865(L), L-866, L-866(L)	Determined by manufacturer.	Controller unit includes flasher and power supply.
Vehicle obstruction beacon, rotating, flashing.	Determined by manufacturer.	
Red and white or red only commercial		
Yellow only, commercial		

NOTES:

1. Number of units varies with type and height of obstruction.

Also see Appendix A of FAA AC 70/7460-1.

LED Light Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of third party certified light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See “Advisory Circulars” at www.faa.gov/airports. Light fixtures with an (L) designation denote that the light fixture uses light emitting diodes (LED).

2. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

ORGANIZATIONAL

PRECISION APPROACH PATH INDICATOR (PAPI) SYSTEM

APPROACH VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the Precision Approach Path Indicator (PAPI) systems. The PAPI system provides the pilot on final approach with the approach slope angle information and assists him in intercepting and maintaining the correct runway approach slope angle. The PAPI system provides this information during the day and night for Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) operations as low as Category I conditions (WP 002 00).

1-3. JUSTIFICATION REQUIREMENTS. A PAPI system shall be installed for an approach to any runway where existing visual cues do not provide adequate approach slope guidance or where a more accurate touchdown position is desired. The PAPI system shall not be activated while Simulated Carrier Deck operations using the OLA systems are operational. Approval for deviations from the PAPI requirements shall follow the procedures in WP 002 00.

1-4. Criteria for Justifying a PAPI System.

1-5. Conditions that may justify the requirement for a PAPI installation are:

- When the runway is used by aircraft where the runway approach angle must be maintained within close limits including speed and rate of descent.
- When the runway is situated in an area where the pilots of some aircraft may have difficulty in judging the proper approach angle for any of the following reasons:
  - The approach is over water or featureless terrain that does not provide adequate visual cues.
  - Lack of sufficient extraneous lights in the approach area at night.
  - Visual information is misleading and there is deceptive terrain or a sloped runway.

- Objects in the runway approach area which may be a serious hazard if an aircraft descends below the normal runway approach path.
- Conditions at the runway ends may present special hazards to aircraft undershooting or over-running the runway.
- Terrain or meteorological conditions that create severe or unusual turbulence along the runway approach path.
- The runway length is short and there is serious danger of overrun if the touchdown is long.

1-6. RELATED FACILITIES. The use of a PAPI system provides approach slope information independent of other visual aids. However, it does not provide longitudinal alignment information. This alignment information is provided by the runway markings (WP 004 01) during the day and by the following runway lights at night:

- Runway edge lights (WP 004 05),
- Runway threshold lights (WP 004 02),
- Runway end lights (WP 004 04), and
- Runway centerline lights (WP 004 06), if available.

2-1. DESCRIPTION.

2-2. The PAPI system consists of four light units arranged in a wing bar near the edges of the runway in the touchdown area. Each light unit consists of two or more lamps and projects a beam of light, fan-shaped in azimuth and split vertically with a white sector above and a red sector below the transition zone. Each light unit is aimed at a slightly different elevation angle to present a different color pattern to a pilot on final approach depending on his position relative to the established approach slope. When the PAPI is observed from the ideal runway approach slope, the two inboard light units are seen as red and the two outboard units as white. If more light units are red, the pilot is too low relative to the ideal runway glideslope, and if more are white, he is too high. The PAPI is operated whenever the runway is active.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. The PAPI light units shall be installed on stable concrete bases and mounted on a frangible coupling. See FAA AC 150/5340-30 for more detailed information concerning PAPI light unit concrete base mounting and other installation related requirements.

3-3. LOCATION AND AIMING. The PAPI system shall be located and aimed per FAA AC 150/5340-30, Chapter 7 and related figures and table.

4-1. EQUIPMENT.

4-2. The PAPI equipment shall be per FAA AC 150/5345-28.

4-3. FIXTURES. Each light unit shall have not less than two lamps. The lamps or sources may be enclosed in a single housing or in separate housings assembled as a unit. The light units shall provide for elevation aiming of the transition plane over a range not less than 2 to 6 degrees above the horizontal. If one lamp fails, the other lamps in the light unit shall continue to operate.

4-4. PHOTOMETRIC CHARACTERISTICS. See FAA AC 150/5345-28 for additional detailed information about PAPI photometric requirements and operation from runway series constant current sources (PAPI Style B) or separate standard utility power sources (PAPI Style A).

5-1. POWER AND CONTROLS.

5-2. POWER. See FAA AC 150/5340-30 for detailed requirements for PAPI power and recommended power sources. See also the PAPI manufacturer's installation instructions. Monitoring of the PAPI is not required except for daily visual checks of operations.

5-3. CONTROLS. The controls for the PAPI shall be by remote control from the Air Traffic Control tower with alternate control from the airfield lighting vault (WP 009 00). Both the power on-off control and the 5-step intensity control shall be at the airfield lighting control panel (WP 009 05). The intensities shall be 100, 20, 4, 0.8 and 0.2 percent of rated intensity corresponding to intensity steps 5, 4, 3, 2, and 1. If it is not practical to provide remote control, the PAPI may be automatically controlled by a photoelectric switch with power from a local source instead of the vault. For automatic control, the PAPI is at 100 percent intensity (step 5) during daytime and at 4 percent intensity (step 3) at night. The PAPI should operate at night only when the runway edge lights are operating. See FAA AC 150/5340-30 for additional PAPI control considerations.

5-4. CERTIFICATION. The PAPI System requires an annual certification procedure be accomplished in accordance with NAEC-91-8082, (Navy Precision Approach Path Indicator Certification Requirements).

ORGANIZATIONAL

OPTICAL LANDING AIDS (OLA)

APPROACH VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for Optical Landing Aids (OLA) for shore-based airfields. The purpose of the OLA is to provide the pilot approaching for a landing with a visual signal to assist in intercepting and maintaining the correct approach glide slope. The OLA is a required visual aid for landings on aircraft carriers, but on shore-based airfields the OLA is primarily an aid for training or practice. The OLA may be used during day or night operations and in all weather conditions.

1-3. JUSTIFICATION REQUIREMENTS. Each runway landing area with a simulated carrier deck lighting installation shall be provided with a site installation and OLA equipment. Most OLA systems are portable and may be moved to different sites as the approach runway is changed. The use of OLA is for runway ends with simulated carrier deck lighting only. The PAPI system WP 003 10 shall not be activated when the OLA systems are in operation on Simulated Carrier Decks.

1-4. RELATED FACILITIES. Each simulated carrier deck lighting installation (WP 006 04) should be provided with an OLA system. The OLA provides approach glide slope information independent of other visual aids; however, it does not provide longitudinal alignment information. The alignment information is obtained from the runway centerline markings (WP 004 01) during the day and runway edge lights (WP 004 05) or runway centerline lights (WP 004 06) at night and during low visibility conditions.

2-1. DESCRIPTION.

2-2. GENERAL. The OLA systems are located near the touchdown point on the runway and consist of the following lighting components:

- Source lights. The source lights are a yellow line of lights or images often referred to as the "meatball." The system presents a red signal when the aircraft is too low. The source lights may be formed by light tables and lens assemblies.
- Datum lights. The datum lights are a horizontal bar of green lights that provides a visual reference for determining the aircraft's position in relation to the ideal approach glide path. The datum lights bar is in two groups of lights with

a group on each side of the source lights. The visual signals presented to a pilot making an approach for landing are the same as his position relative to the glide slope path. If the source light appears to be above the datum lights, he is too high, or if the source light appears to be below the datum lights, he is too low and should adjust his approach path angle to obtain the correct on glide path signal with the source light in line with the datum lights.

- Wave-off lights. The wave-off lights are flashing red lights along each side of the source lights. The wave-off lights are activated only to inform the pilot that he must execute a missed approach procedure.
- Cut lights. The optical landing system has flashing green lights located above the source lights which are activated to instruct the pilot of propeller-driven aircraft to cut engine power.

2-3. The height of the mounting pad shall be at ground level to preclude the creation of an obstruction when the OLA system is relocated from the site. During the calibration process, the optimum height of the OLA system can be achieved by placing blocks under the equipment trailer cart and/or the addition of load leveling jacks to the cart.

2-4. OLA SYSTEMS. The IFLOLS is a fixed signal systems which automatically indicates to the pilot his position in relation to the established glide path. The MOVLAS is a temporary replacement system for which the LSO controls the position of the source (meatball) light.

2-5. Manually Operated Visual Landing Aid System (MOVLAS).

2-6. The MOVLAS is an emergency system to be used when the IFLOLS is inoperable (Figure 1). The MOVLAS source light is operated by the LSO using a special controller. The source lights are 23 lights arranged in two closely spaced vertical rows. The three lowest lights are red and the other 20 are yellow. Three lights at adjacent heights are operated to form the source lights. As the controller handle is moved upward, the source lights are switched on progressively towards the top in clusters of three. This gives an approaching pilot the signal to increase his elevation as directed by the LSO. The LSO therefore guides the pilot by signaling to raise or lower his altitude to achieve the proper glideslope. The MOVLAS is provided with 10 green datum lights, 8 red wave-off lights, and 2 green cut lights.

2-7. Improved Fresnel Lens Optical Landing System (IFLOLS).

2-8. The land-based Improved Fresnel Lens Optical Landing System MK 14 MOD 0 (IFLOLS) is the replacement system for the FLOLS MK 8 MOD 0 and MK 8 MOD 1 land-based systems. The IFLOLS consists of 12 cells which provide greater sensitivity and resolution to the light in the cell seen by the pilot (“meatball”). The position of the “meatball” relative to the datum lights indicates to the pilot where he is relative to proper glideslope. The IFLOLS system also has greater acquisition distance than the FLOLS system. The land-based IFLOLS is also trailer-mounted for easy portability.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. The OLA equipment is portable for transporting from one prepared site to another. For details on installing the site refer to UFC 3-535-02. The instructions on assembling and positioning the equipment are given in the Technical Manual for the particular type and model as referred to in (4-1, EQUIPMENT, this WP). General design and site installations requirements are discussed below.

NOTE

> Any new OLA pads installed at an FCLP shall be made to accommodate an IFLOLS configuration. Pad size 11 feet x 17 feet, distance from runway edge is 15 feet, pad elevation shall be at terrain level. See NAVAIR 51-40ABA-24 for complete details.

3-3. LOCATIONS. The OLA site shall be located on the left hand side of the runway as viewed by the approaching pilots. If the OLA is associated with a simulated carrier deck installation, the face of the lens cells or mirror shall be located 430 feet forward of the ramp athwartship lights. If the OLA is an independent installation for a three degree glideslope, the preferred location of the face of the lens cells or mirror is 750 ±10 feet forward of the runway threshold but may be influenced by the following factors:

- The glide path angle for the primary electronic approach system.
- Special threshold crossing height requirements.
- Special ground point intercept for the runway or instrument approach system.
- Approach zone obstruction clearance requirements.
- Intersecting runways or taxiways.

3-4. The mounting pad shall be located so that the centerline of the lens cells is not less than 115 feet from the runway centerline and not less than 10 feet from the runway edge. To preclude the mounting pad from becoming an airfield obstruction when the OLA is relocated, the height of the pad should be no higher than 2-3 inches above terrain level (almost at ground level). The required height of the OLA (which shall be the same as the FCLP centerline) should then be achieved by the use of concrete blocks on the pad and/or jacking screws attached to the OLA. The mounting pad shall be 11 x 17 feet, level, and have a permanent survey marker for correct location and alignment of the centerline. At 150 feet toward the runway threshold from the position for the face of the cells on a line parallel to the runway centerline, a survey monument for the siting mirror station shall be installed. This monument or pad shall have a permanent survey marker for correct location of this equipment and should be at the same elevation as the mounting pad.

NOTE

Contact NAWCADLKE for data on locating and alignment of the IFLOLS for wide-body aircraft operations.

4-1. EQUIPMENT.

4-2. The OLA equipment is Government Furnished Equipment (GFE) and is obtained from the Naval Depot. It shall be one of the following

- MOVLAS MK 2 MOD 2 (see Figure 1). For a description of this equipment, refer to NAVAIR 51-40ACA-3.
- IFLOLS MK 14 MOD 0 (see Figure 2). For a description of this equipment, refer to NAVAIR 51-40ABA-24.

5-1. PHOTOMETRIC REQUIREMENTS.

5-2. The lamps and light sources are specified for this service and shall be as required. The intensity settings may be several steps or continuously variable. The chromaticity ranges for the lights shall be aviation yellow for source lights, aviation green for datum and cut lights, and aviation red for wave-off lights per SAE AS25050.

6-1. POWER AND CONTROLS.

6-2. POWER. The power for the OLA may be from the airfield lighting vault or from a portable engine-generator set. Emergency power and automatic power transfer should be provided if available (WP 009 01). The power requirements are as follows:

- MOVLAS. 3KVA, 120V single-phase.
- IFLOLS. 4.8 KVA, 120/240V three phase 5-wire. The current rating should be not less than 40 amperes, 60 Hz.

6-3. CONTROLS. Local operating procedures shall prescribe the intensity setting for the various light conditions. The wave-off lights on these systems when FCLPs are conducted shall be operated by the LSO.

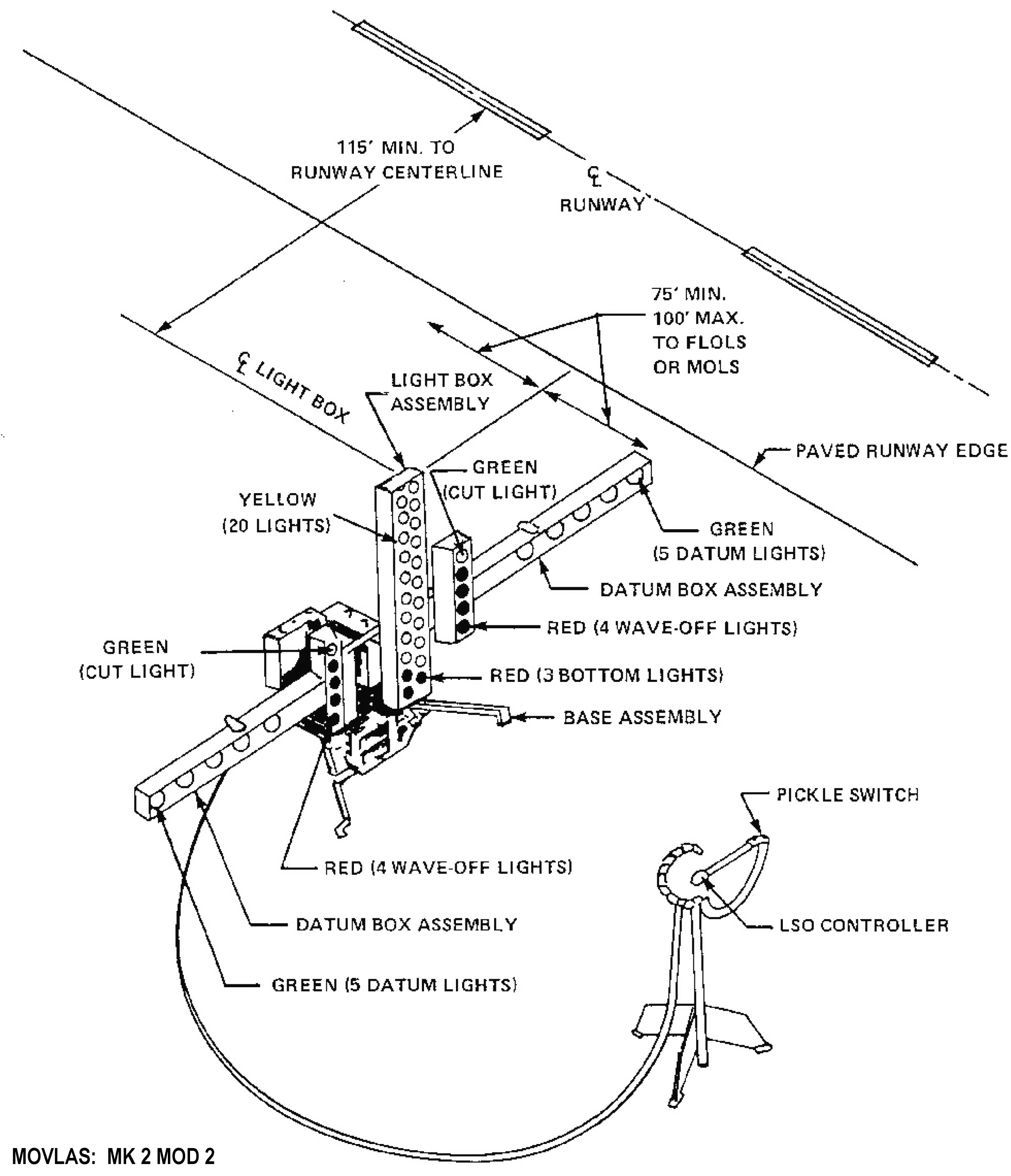


Figure 1. A Typical Manually Operated Visual Landing Aid System (MOVLAS)

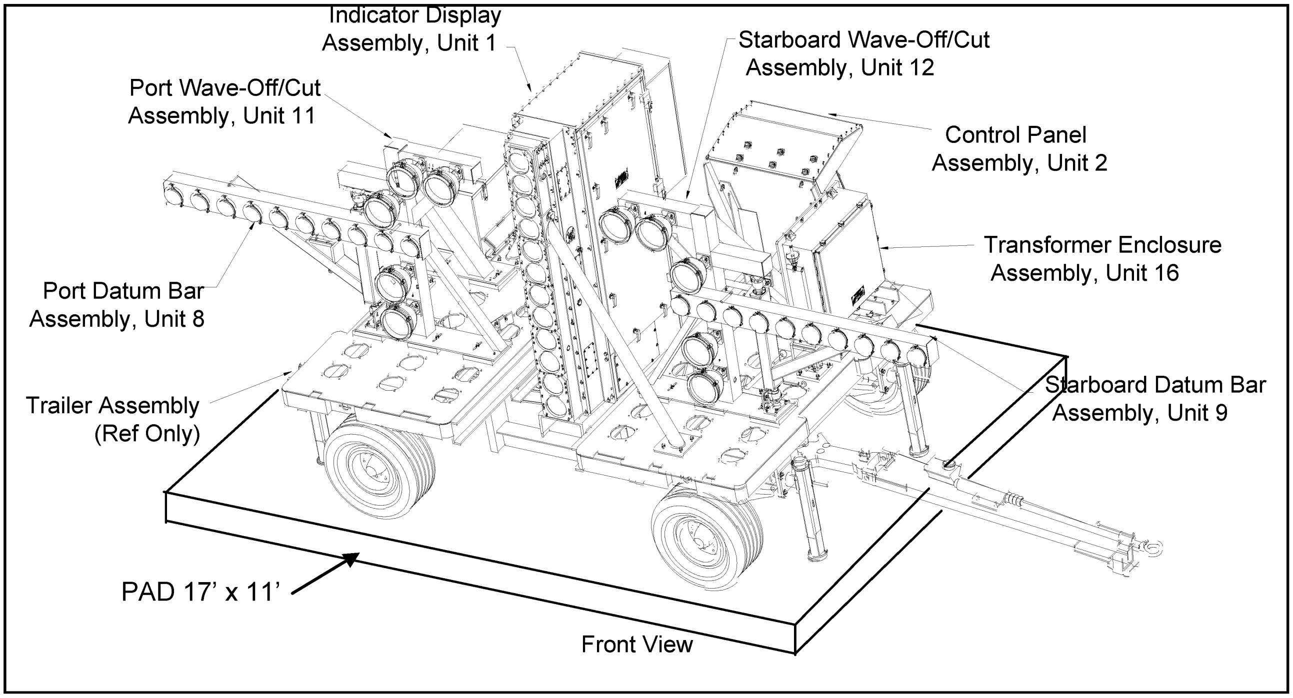


Figure 2. Improved Fresnel Optical Landing System (IFLOLS)

ORGANIZATIONAL

MEDIUM-INTENSITY APPROACH LIGHT SYSTEM WITH RUNWAY ALIGNMENT INDICATOR LIGHTS (MALSR)

APPROACH VISUAL AIDS

Reference Material

1-1. INTRODUCTION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the Medium-intensity Approach Lights Systems (MALSR) with Runway Alignment Indicator Lights (RAIL). The MALSR is intended to be used for precision runway approach instrument operations, CAT I conditions (200 feet DH and 2400 feet RVR). If the runway approach is planned for an eventual upgrade to Category II (ALSF-2) (WP 003 06), or a Short Approach Light System (SALS) (WP 003 07), a MALSR should not be installed because it cannot be converted to one of the high-intensity type systems. The MALSR provides visual approach area identification, centerline alignment, and roll reference for aircraft making runway approaches for landings during day or night operations. Approval of plans or requests for deviations shall use the procedures directed in WP 002 00.

1-3. JUSTIFICATION REQUIREMENTS. Any runway that is equipped with a precision electronic approach aid such as an Instrument Landing System (ILS), Microwave Landing System (MLS), or Precision Approach Radar (PAR) should qualify for a MALSR. The FAA no longer uses ALSF-1 systems and has replaced them with MALSR for energy economy. The exceptions to the preceding requirements are: approaches with an ALSF-2 for Category II conditions (WP 003 06) or if it is not feasible to install an ALSF-2 and consider an ALSF-1. Criteria to be considered for obtaining approval for an ALSF-1 include:

- Mission requirements for operations in Category I conditions.
- The frequency of occurrence of IFR conditions.
- Terrain features in the approach areas that do not provide adequate visual guidance or produce misleading or deceptive cues to the pilots.
- Fixed objects or hazards near the approach path or runway end that could endanger aircraft deviating from the approach or undershooting the runway.

1-4. ASSOCIATED FACILITIES. In addition to the ILS, MLS, or PAR electronic aids, other airfield facilities required for use with the MALSR for operations in Category I conditions should include the following:

- The runway should be paved and not less than 150 feet wide.
- The runway length shall not be less than 6000 feet, but shorter runway lengths may be approved for special operating conditions.
- The runway should be equipped with the following:
  - Precision approach runway markings (WP 004 01),
  - High-intensity runway edge lights (HIRL) (WP 004 05),
  - High-intensity threshold lights (WP 004 02),
  - Runway end lights (WP 004 04).
- The approach should have a paved or stabilized end zone area extending 1000 feet into the approach area and not less than the width of the runway.
  - The first 300 feet of this paved or stabilized area should have the same slope as the first 1000 feet of the runway.
  - The remainder of the paved or stabilized area may have a slope of not more than ±1.5 percent.
- The runway should have an RVR system.
- Air traffic control should be provided during normal operating hours.
- The runway may also be equipped with a PAPI system.

2-1. GENERAL INFORMATION.

2-2. See FAA JO 6850.2B for additional information about MALSR and RAIL. The FAA Joint Order may be downloaded free of charge at: https://www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.information/documentID/321004

2-3. See FAA Specification FAA-E-2980 for detailed information about the MALSR equipment. The FAA specification may be downloaded free of charge at: www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/lsg/vgleap/specifications/

2-4. See also the MALSR manufacturer's installation instructions.

3-1. POWER AND CONTROLS.

3-2. POWER. The electrical power for the MALSR approach lights shall be as follows:

- For the centerline and 1000-foot crossbar steady-burning lights, a special power unit shall furnish power to these lights from a multiple circuit rated at 120 volts or 120/240 volts 3-wire. This power unit shall energize the lights at either of the three intensity settings as selected.
- For the SFL, the power to operate these lights shall be 120 volts multiple circuits furnished by the master control unit (WP 009 04) for the RAIL section of the system. The master control unit controls the flashing sequence of the lights and the intensity setting as selected. These lights have individual power supply units which may be combined with or separated from the flasher head.
- Emergency power is not essential for the MALSR system, but if emergency power is available, it should be used with the automatic emergency power transfer (WP 009 01).
- Always consult the equipment manufacturer's installation handbook for power system requirements and details before the installation of any power system.

3-3. CONTROLS. The MALSR shall be remotely controlled from the airfield lighting control panel (WP 009 05) in the air traffic control tower. A backup or alternate control from the airfield lighting vault is desirable. A separate control shall provide for switching ON and OFF and for selecting the intensity setting of the centerline lights, the 1000-foot bar lights, and the SFL.

3-4. MONITORING. The operation of the MALSR system, including intensity selection, should be visually observed at least once each day. Automatic monitoring is not required, but it may be used if the equipment installed has this capability.

ORGANIZATIONAL

DESCRIPTION

RUNWAY VISUAL AIDS

Reference Material

Introduction	WP 002 00
Approach Visual Aids, Description	WP 003 00
Runway Visual Aids, Runway Markings	WP 004 01
Runway Visual Aids, Runway Threshold Lights	WP 004 02
Runway Visual Aids, Displaced Threshold Lights and Markings	WP 004 03
Runway Visual Aids, Runway End Lights	WP 004 04
Runway Visual Aids, High-Intensity Runway Edge Lights (HIRL)	WP 004 05
Runway Visual Aids, Runway Centerline Lights (RCL)	WP 004 06
Runway Visual Aids, Touchdown Zone Lights (TDZL)	WP 004 07
Runway Visual Aids, Runway Exit Lights	WP 004 08
Runway Visual Aids, Runway Distance Markers (RDM)	WP 004 09
Runway Visual Aids, Arresting Gear Markers and Markings	WP 004 10
Airport Lighting Equipment Certification Program (lists sources of qualified equipment)	FAA AC 150/5345-53
Design Drawings for Visual Aid Navigation Facilities	UFC 3-535-02
Design and Installation Details for Airport Visual Aids	FAA AC 150/5340-30
Standards for Airport Markings	FAA AC 150/5340-1M
Standards for Specifying Construction of Airports	FAA AC 150/5370-10
United States Standard for Terminal Instrument Procedures (TERPS)	OPNAV Inst. 3722.16

1-1. GENERAL INFORMATION.

1-2. PURPOSE. Runway visual aids consist of marking and lighting on or near the runway. The purpose of the visual aids is to provide guidance to pilots for safe takeoffs and landings during any operational condition. The visual aids shall clearly define the runway surface and its limits and provide directional and distance cues for properly orienting and controlling the aircraft. The information must be easily recognized and used in both fair weather and in restricted visibility conditions, day or night, to the minimums authorized for the runway.

1-3. SCOPE. The runway visual aids section of this Technical Manual contains the configuration requirements, applications, basic design and installation criteria, and equipment required for the runways of Navy shore-based airfields. Each runway shall have the visual aids which will satisfy the requirements for the operations authorized for that runway. The requirements contained in the individual Work Package(s) (WP) provide guidance for all personnel servicing existing systems or designing completely new installations. Existing installations of similar visual aids may be used and maintained as installed. Extensions, major modifications, or upgrading of existing installations shall comply with the requirements of the WP for the individual visual aid.

1-4. STANDARDIZATION. The WP for each runway visual aid establishes the requirements to be used for most Navy airfields. By combining the WP for all the runway visual aids required for the mission and special characteristics of the airfield, standardization of runway visual aids for Navy airfields is attained. Standardization of visual aids on a nationwide basis is essential to promote operational safety. When deviation of installations is necessary, these changes shall be authorized in accordance with the approved procedures of WP 002 00.

2-1. FLIGHT RULES.

2-2. GENERAL. The types of runway visual aids required for an airfield depends on the flight operations that will be performed, and the runway approach visual aids (WP 003 00) already installed. Flight operations are separated into Visual Flight Rules (VFR) operations and Instrument Flight Rules (IFR) operations. Major airfields usually have both types of operations. The runway visual aids associated with the different flight rules are indicated in Table 1.

2-3. VISUAL FLIGHT RULES (VFR). Flight operations for which the approach and landing guidance depends mostly on visual contact with the ground may follow VFR. VFR requires good visibility and may apply for day or night flights. Internationally, the conditions for these operations are referred to as Visual Meteorological Conditions (VMC). See WP 002 00 for the criteria. The runway visual aids for these operations are basic for any runway.

2-4. INSTRUMENT FLIGHT RULES (IFR). Flight operations for which at least part of the navigation depends on electronic guidance must use Instrument Flight Rules (IFR). IFR involves low ceilings or poor visibility or both whether day or night. Internationally, the conditions for these operations are referred to as Instrument Meteorological Conditions (IMC). See WP 002 00 for criteria. As the ceiling becomes lower or the visibility more restricted, the pilot must be presented with more precise visual information.

2-5. APPROACH MINIMUMS. To be permitted to make approaches to a runway, the weather conditions must be at, or above specified levels called runway approach minimums. The minimums depend on several factors that include the following:

- Type of aircraft.
- Minimum visibility or Runway Visual Range (RVR).
- Minimum height of ceiling.
- Minimum Descent Altitude (MDA) or Decision Height (DH).
- Type of approach and runway visual aids.
- Type of approach.

2-6. For methods to determine runway approach minimums, refer to OPNAV Inst. 3722.16.

2-7. RUNWAY VISUAL RANGE (RVR). Runway visual range is a system of measuring the visibility along the runway. It is an instrumentally derived value that represents the horizontal distance a pilot will see down the runway from the approach end. It is based on the sighting of either High Intensity Runway edge Lights (HIRL) or the visual contrast of other targets, whichever yields the greater visual range.

2-8. IFR CATEGORIES. To permit flight operations at different approach minimums, IFR operations are divided into categories defined in WP 002 00.

3-1. DESCRIPTION OF RUNWAY VISUAL AIDS.

3-2. The runway visual aids consist of markings and lighting installed on or near the runway. The runway lights include the basic edge lights, low-visibility runway lights, and supplemental runway lights. The basic runway lights function to define the limits of the runway surface are runway edge lights, runway threshold lights, and the runway end lights. The runway lights used in low visibility conditions are the centerline and touchdown zone lights. Supplemental runway lights may be runway exit lights, runway distance markers, and arresting gear markers. The configuration of the markings differs for the class of the runway. The marking and types of light may be different for runways on the same airfield.

4-1. SELECTION OF RUNWAY VISUAL AIDS.

4-2. The types of runway visual aids required depend on the mission and the approach minimums that may be necessary. Table 1 is a guide for determining the visual aids to be provided. The design requirements are found in the WP for each type of approach aid. Installation details are given in FAA AC 150/5340-30 and UFC 3-535-02 for runway lights. FAA AC 150/5340-18 details the installation requirements for airside signs, and FAA AC 150/5340-1M provides detailed requirements for runway markings.

5-1. IMPLEMENTATION.

5-2. The WP and requirements of this section of the Manual are not intended to direct or request implementation but are to establish uniformity when implementation is undertaken.

Table 1. Runway Visual Aids Requirements

VISUAL AIDS SYSTEM	AUTHORIZED OPERATIONS						
		IFR CATEGORY					
	VFR	NON-P-REC	I	II	IIIA	IIIB	IIIC
Runway Marking (WP 004 01)	R	R	R	R	R	R	IN
Runway Threshold Lights (WP 004 02)	R	R	R	R	R	R	IN
Displaced Threshold Lights and Markings (WP 004 03)	RS	RS	RS	RS	RS	RS	IN
Runway End Lights (WP 004 04)	R	R	R	R	R	R	IN
Runway Edge Lights (HIRL) (WP 004 05)	R	R	R	R	R	R	IN
Runway Edge Lights (MIRL) (WP 004 05)	R	R	–	–	–	–	–
Runway Centerline Lights (WP 004 06)	NR	C	C	R	R	R	IN
Touchdown Zone Lights (TDZL) (WP 004 07)	NR	RS	OPT	R	R	R	IN
Runway Exit Lights (WP 004 08)*	RS	RS	RS	RS	RS	RS	IN
Runway Distance Markers (RDM) (WP 004 09)	R	R	R	R	R	IN	IN
Arresting Gear Markers (WP 004 10)	R	R	R	R	R	IN	IN

C - Recommended

R - Required (These visual aids are required for operating in the IFR Category, but other factors may negate approval for installation. See Justification for Installation, WP 002 00.)

RS - Required under special conditions. *An example: Only if high speed exit is installed.

OPT - Option as recommended by air station commander and approved by NAVAIR.

IN - Installation necessary.

NR - Not Required.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).

2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.

3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

ORGANIZATIONAL

RUNWAY MARKINGS

RUNWAY VISUAL AIDS

Reference Material

Materials Required

Nomenclature	Specification/Part Number	HMWS Index Number
Glass Spheres, Type III or Type I, gradation A.	TT-B-1325	–
Paint, Black	TT-P-1952, SAE AMS-STD-595, chip No. 27038	1
Paint, White	TT-P-1952, SAE AMS-STD-595, color chip No. 17875	2
Paint, Yellow	TT-P-1952, SAE AMS-STD-595, chip No. 23538	3

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the Runway Markings for paved runways on shore-based airfields. The markings provide visual cues to pilots for runway identification, longitudinal alignment information, touchdown zone, and runway edges for paved runways. In addition, runway markings assist pilots in operating aircraft during landings, rollouts, and takeoffs. The requirements in this WP are intended to establish runway marking uniformity for ease of recognition and use in the interest of safety and efficient aircraft operations. Runway markings vary with the operational class of the runway. The classes of runways for markings are:

- Basic runways.
- Non-precision instrument runways.
- Precision-approach instrument runways.

1-3. The markings for paved overruns, stabilized runway shoulders, and closed runways are included in this WP. The marking requirements in this WP shall be used for all new or resurfaced runways and at any time the existing markings are to be repainted. Existing runway markings may be used until repainting is needed provided, they meet the minimum requirements for the runway classification.

1-4. JUSTIFICATION REQUIREMENTS. The runway markings are basic visual aids for aircraft landings and takeoffs. All paved runways shall be marked with at least the minimum requirements for the runway.

- Basic runways are intended for Visual Flight Rules (VFR) operations (WP 004 00) only.
- Non-precision instrument runways permit Instrument Flight Rules (IFR) operations (WP 004 00) of non-precision approaches and VFR operations only.
- Precision-approach instrument runways permit IFR operations in Category I or Category II conditions, non-precision IFR, and VFR operations.

1-5. Additional markings of a higher level may be approved for special site or operating conditions (WP 002 00).

1-6. RELATED FACILITIES. Other markings on the runway may include:

- Displaced threshold markings (WP 004 03).
- Arresting gear markings (WP 004 10).
- Simulated carrier deck markings (WP 006 04).
- Taxiway entrance and exit markings (WP 005 01).

2-1. DESCRIPTION.

2-2. GENERAL. The runway markings consist of a system of markings identified by the functions which they serve. These markings are defined in the FAA's Advisory Circular (AC) 150/5340-1. The standard elements of runway markings are as follows:

- Runway designation markings.
- Centerline markings.
- Threshold markings.
- Side stripes markings.
- Touchdown zone markings.
- Fixed distance markings.

2-3. BASIC RUNWAY MARKINGS. (See FAA AC 150/5340-1M, figure A-3, Visual Runway Markings.) The minimum markings for the basic runway class are:

- Runway designation markings.
- Centerline markings.

2-4. Threshold markings should be used if the runway requires better identification or if international commercial aircraft use this class of runway. Side stripes may be added if the runway edges are not easily recognizable. Fixed distance markings shall be added for runways that are 4,000 feet or more in length and used by jet aircraft.

2-5. NON-PRECISION INSTRUMENT RUNWAY MARKINGS. (See FAA AC 150/5340-1M, Figure A-2, Non-Precision Runway.) The minimum markings for the non-precision instrument runways are:

- Runway designation markings.
- Centerline markings.
- Threshold markings.

2-6. Touchdown zone markings may be added for runways 5000 feet or more in length. Side stripes may be added if the runway edges are not easily recognizable. Refer to (2-27, SIDE STRIPES MARKING, this WP). Fixed distance markings shall be added for runways that are 4,000 feet or more in length and used by jet aircraft.

2-7. PRECISION APPROACH INSTRUMENT RUNWAY MARKINGS. (See FAA AC 150/5340-1M, Figure A-1, Precision Runway Markings.) The markings for precision approach instrument runways include all elements for runway markings. Refer to (2-2, GENERAL, this WP).

2-8. SUPPLEMENTAL RUNWAY MARKINGS. Some runways require supplemental markings to provide information on runways with special features associated with the runway. These supplemental markings are:

- Displaced threshold markings (WP 004 03).
- Closed or nonoperational runway markings,
- Arresting gear and barrier markings (WP 004 10).
- Simulated carrier deck markings (WP 006 04).
- Overrun markings.
- Runway shoulder markings.
- Taxiway entrance and exit markings (WP 005 01).

2-9. RUNWAY DESIGNATION MARKINGS. (See FAA AC 150/5340-1M, paragraph 2.3, Runway Landing Designator Marking, and figures A-1, Precision Runway Markings, A-2, Non-Precision Runway, A-3, Visual Runway Markings, and A-6, Runway Designation Numerals and Letters.)

2-10. The runway designation (direction) markings consist of a number indicating the direction of the runway by its magnetic azimuth and, in cases of parallel runways, a letter.

2-11. The runway designation number shall be a whole number from 1 to 36 to the nearest one-tenth of the azimuth (in degrees) of the runway centerline.

2-12. The runway azimuth is measured clockwise from magnetic north as viewed from the approach direction. Examples: if the centerline magnetic azimuth is 183 the number is "18"; for the opposite approach - azimuth 03 - the number is "36". If the centerline magnetic azimuth is 87, the number is "9" and the number for the opposite runway end is "27".

2-13. The numbers on opposite ends of the same runway shall be a difference of 18.

- If the runway is one of two or three parallel runways, a letter is added to the runway designation marking.
- For two parallel runways, the letters are "L" and "R".
- For three parallel runways, the letters are "L", "C", and "R".
- The letters shall be located between the runway threshold or threshold marking and the number as shown in FAA AC 150/5340-1M, figures A-1, Precision Runway Markings, A-2, Non-Precision Runway, and A-3, Visual Runway Markings.

2-14. The color of the designation markings shall be retroreflective white.

2-15. The numbers and letter shall be block type as shown in FAA AC 150/5340-1M, figure A-6, Runway designation numerals and letters.

2-16. RUNWAY CENTERLINE MARKINGS. (See FAA AC 150/5340-1M, paragraph 2.4, Runway Centerline Marking, and figures A-1, A-2, and A-3).

2-17. The runway centerline markings shall be centered upon the physical center of the runway width.

2-18. The runway stripes are 120 feet (36.5 m) in length and the gaps are 80 feet (24.3 m) in length.

2-19. The minimum width of the stripes shall be:

- 36 inches for precision runways.
- 18 inches for non-precision runways.
- 12 inches for visual runways.

2-20. To accommodate varying runway lengths, all adjustments to the uniform pattern of runway centerline stripes and gaps are made near the runway midpoint (defined as the distance between the two thresholds or displaced thresholds). Under such cases, reduce the lengths of both the stripes and gaps starting from midpoint and proceed toward the runway thresholds. Reduced stripes must be at least 80 feet (24 m) in length, and the reduced gaps must be at least 40 feet (12.3 m) in length. The affected stripes and gaps within the section should show a uniform pattern.

2-21. The color of the runway centerline markings shall be retroreflective white.

2-22. THRESHOLD MARKINGS. (See FAA AC 150/5340-1M, paragraph 2.5, Runway threshold marking.)

2-23. The runway threshold markings shall consist of longitudinal stripes on each side, parallel to and symmetrical about the runway centerline.

2-24. See paragraph 2.5 of FAA AC 150/5340-1M for appropriate threshold marking dimension criteria.

2-25. The color of the runway threshold markings shall be retroreflective white.

2-26. If the runway is less than 200 feet wide, the overall width of the threshold markings shall be 20 feet less than the runway width. The width of the stripes and the spaces between stripes shall be reduced proportionally.

2-27. SIDE STRIPES MARKING. (See FAA AC 150/5340-1M, paragraph 2.8, Runway edge marking and figures A-1, A-2, and A-3.)

2-28. The runway side stripe markings shall be continuous lines at each edge of the runway parallel to the runway centerline.

2-29. The outside edge of the side stripe is located at the designated runway width, regardless of whether the area outside of the stripe is stabilized.

2-30. The runway side stripes shall be 3 feet wide.

2-31. For runways 200 feet or less in width, the outer edge of these stripes shall be at the designated edge of the runway.

2-32. For runways more than 200 feet wide, the inner edges of the side stripes shall be 200 feet apart and symmetrical about the runway centerline.

2-33. If the runway has a displaced threshold, the side stripes shall continue through the paved area prior to the displaced threshold section.

2-34. Preferably, the side stripes shall extend to the runway ends but may terminate in line with the beginning of the threshold markings except where the threshold is displaced from the runway end.

2-35. The color of the side stripes shall be retroreflective white.

2-36. TOUCHDOWN ZONE MARKINGS. (See FAA AC 150/5340-1M, paragraph 2.7, Runway Touchdown Zone Marking, figures A-1, A-2, and A-3.)

2-37. The runway touchdown zone (TDZ) markings shall consist of groups of three, two, and one rectangular bars symmetrically arranged in pairs about the runway centerline.

2-38. For runway widths 150 feet or greater, the TDZ bar shall be 6 feet wide and 75 feet long.

2-39. The rectangular bars within a group shall have lateral spacing between the inner sides on the same side of the runway centerline spaced 5 feet apart.

2-40. The second group of bars from the runway threshold shall be fixed distance markings as single bars 30 feet wide and 150 feet in length.

2-41. For runways less than 150 feet wide, the width of bars and spaces shall be reduced proportionally. The inner edges of the bars in a pair shall be 72 feet apart.

2-42. The first pair of bars shall begin 500 feet down the runway from the beginning of the threshold markings (520 feet from the runway end).

2-43. The pairs of bars are at 500-foot intervals as follows:

DISTANCE IN FEET FROM RUNWAY END	NO. OF BARS IN GROUP
520	3 bars
1020	1 fixed distance bar
1520	2 bars
2020	2 bars
2520	1 bar
3020	1 bar

2-44. On shorter runways, the pairs of bars which would extend to within 900 feet of the midpoint of the runway shall be eliminated.

2-45. The color of the runway touchdown zone markings shall be retroreflective white.

2-46. FIXED DISTANCE MARKINGS. The fixed distance markings are part of the runway touchdown zone markings (if touchdown zone markings are used) but may be required for basic runways and non-precision instrument runways if they are more than 4,000 feet in length and used by jet aircraft.

2-47. For precision approach runways, the fixed distance markings are used instead of the second set of three-bar touchdown zone markings.

2-48. The fixed distance markings shall consist of a pair of single, rectangular bars 30 feet wide by 150 feet long located symmetrically about and 36 feet from the runway centerline.

2-49. The beginning of the bars is 1,020 feet from the runway threshold.

2-50. The color of these markings shall be retroreflective aviation white.

2-51. CLOSED OR NONOPERATIONAL RUNWAY MARKINGS. Closed runways shall be marked with yellow Xs at each end of the runway.

2-52. The yellow X shall be placed over each of the runway designation markings.

2-53. If there is ongoing runway construction, the yellow Xs may be placed just off of the runway ends.

2-54. The closed runway markings shall also be placed near the entrances of active intersecting runways and taxiways and may be placed at other locations if considered necessary.

2-55. The yellow X dimensions and appearance shall be per FAA AC 5340-1M, Figure A-27, Closed runway and taxiway markings.

2-56. For temporarily closed runways, the X's may be reduced to 8 feet in width to permit the use of plywood, fabric, or other material which can be painted the appropriate color, fastened in place, and easily removed.

2-57. For permanently closed runways, the runway lights shall be disconnected, runway markings shall be obliterated, and the Xs painted on the surface at intervals not to exceed 1000 feet.

2-58. The color of the closed runway markings shall be non-retroreflective yellow.

2-59. LIGHTED VISUAL AID TO INDICATE TEMPORARY RUNWAY CLOSURE. A lighted visual aid for indicating a temporarily closed runway shall be equipment per the requirements in FAA AC 150/5345-55.

2-60. OVERRUN MARKINGS. The runway overrun area markings are a series of chevrons or partial chevrons to be located on the paved overrun area per FAA AC 150/5340-1M, figure A-9. Markings for blast pads and stopways.

2-61. The apex of the chevrons shall be along the runway centerline with each leg making an angle of 45° to the centerline.

2-62. The markings shall be only in the overrun area beyond the runway threshold or end.

2-63. The apex of the initial full chevron shall be 50 feet from the threshold line.

2-64. The legs of the chevron shall be 3 feet wide and extend out to the edge of the paved area but not more than 100 feet on each side of the centerline.

2-65. The chevrons shall be equally spaced at 100-foot intervals through the paved overrun area.

2-66. The final chevron shall be only one-half the width of the full chevrons.

2-67. The outer half of a chevron for which the apex would be 50 feet down the runway from the threshold shall be terminated at the runway threshold.

2-68. The color of the runway overrun markings shall be non-retroreflective yellow.

2-69. RUNWAY SHOULDER MARKINGS. Paved runway shoulders may be marked to better define the full-strength limits of the runway. The runway shoulder marking location is per the requirements in FAA AC 150/5340-1M, paragraph 2.11, Runway shoulder marking and figure A-12.

2-70. BORDERS FOR MARKINGS. For some runways, the runway markings and surface do not provide sufficient contrast for easy recognition. In such cases, the contrast may be improved by outlining the markings with a non-glossy black border. Runway marking enhancements shall be per FAA AC 150/5340-1M, paragraph 1.4.

2-71. STRIATED MARKINGS. In cold areas, where frost heaves of pavement may be a serious problem, the markings may be modified by using striations within to reduce the effects of uneven solar heat absorption. Striation of markings is accomplished by applying paint in narrow stripes alternating with unpainted narrow spaces. When viewed from a distance, the striated markings will appear as marked areas; however, the contrast of the marked areas may be reduced because of the reduction in the total painted area. Striated markings should be cleaned and repainted more frequently to maintain the contrast level. Striated markings are not recommended for precision approach instrument runways used for Category II and Category III operations. If striated markings are used, the paint shall be applied in uniform stripes 4 to 6 inches wide and separated by uniform spaces not to exceed the width of the stripes. The color of the striated markings shall be that required for the particular marking.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details refer to FAA AC 150/5340-1M.

3-3. PRECEDENCE OF MARKINGS.

NOTE

If a simulated carrier deck is installed on the runway, the carrier deck markings shall have precedence, and runway markings shall not be installed between the edges of the carrier deck. Touchdown zone and fixed distance markings shall be omitted if any part of them are in conflict with the carrier deck installation.

3-4. If two runways intersect, the markings on the runway with the higher precedence continues through the intersection and interrupt the markings of the runway with lower precedence. Runway side stripes of both runways may be continued. If the intersection of runways is near the threshold of the lower precedence runway, the threshold markings, designation markings, and touchdown zone markings may be relocated to avoid the intersection area. For intersections of runways of equal precedence, the runway with the greater amount of traffic will have precedence. The order of runway precedence in descending order is as follows:

- Precision approach instrument runway, Category III.
- Precision approach instrument runway, Category II.
- Precision approach instrument runway, Category I.
- Non-precision instrument runway.
- Basic runway.

3-5. See FAA AC 150/5340-1M, figure A-5, Details of markings for intersecting runways, for additional information.

3-6. MATERIALS. The materials required for runway markings are paint and retroreflective spheres (beads). The materials used should be approved for the purpose and type of pavement. The approved materials and colors are per Table 1.

Table 1. Materials for Runway Markings

COLOR OF MARKING	FEDERAL SPECIFICATION	AUTHORIZED USE
Retroreflective White	FED SPEC TT-P-1952F, paint, white and TT-B-1325 glass spheres, Type III, gradation A. The color shall be SAE AMS-STD-595 color chip No. 17875.	All runway markings except arresting gear, overrun, shoulder, and closed runway markings.
Non-retroreflective Yellow	FED SPEC TT-P-1952F paint, yellow. The color shall be SAE AMS-STD-595, chip No. 23538.	Overrun, shoulders, and closed runway markings.
Non-retroreflective Black	FED SPEC TT-P-1952F, Paint, black. The color shall be SAE AMS-STD-595, chip No. 27038.	Border around white or yellow markings.

3-7. RESTRICTIONS. Regulations of some states, such as California, or other authorities may prohibit or restrict the use of solvent based paints. For white and yellow markings use type FED SPEC TT-P-1952F paint. For the slower drying type FED SPEC TT-P-1952F paint, timing of application of the retroreflective beads (spheres) may be required to assure adherence of the beads without sinking too deeply into the paint. For black surfaces or outlines, semigloss or flat black paint that meets FED SPEC TT-P-1952F may be used with compatible surfaces.

ORGANIZATIONAL

RUNWAY THRESHOLD LIGHTS

RUNWAY VISUAL AIDS

Reference Material

Approach Visual Aids, Approach Lights, Category I - ALSF-1	WP 003 05
Approach Visual Aids, Approach Lights, Category II, and Category III - ALSF-2	WP 003 06
Approach Visual Aids, Short Approach Light System (SALS)	WP 003 07
Runway Visual Aids, Runway Markings	WP 004 01
Runway Visual Aids, Displaced Threshold Lights and Markings	WP 004 03
Runway Visual Aids, Runway End Lights	WP 004 04
Runway Visual Aids, High-Intensity Runway Edge Lights (HIRL)	WP 004 05
Electrical Power and Control for Visual Aids, Auxiliary Power and Power Transfer Equipment	WP 009 01
Airport Lighting Equipment Certification Program (lists sources of qualified equipment)	FAA AC 150/5345-53
Design Drawings for Visual Aid Navigation Facilities	UFC 3-535-02
Design and Installation Details for Airport Visual Aids	FAA AC 150/5340-30
Isolation Transformers for Airport Lighting Systems	FAA AC 150/5345-47
PAR-56 Lampholder	FAA-E-982
Specification for Runway and Taxiway Light Fixtures	FAA AC 150/5345-46

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the Runway Threshold Lights. Threshold lights define the beginning of the runway for approaching aircraft during night operations and during periods of reduced visibility. The threshold light requirements in this WP shall be used for all new runway edge light installations. Existing installations of runway threshold lights that fail to meet the requirements in this WP should be fully evaluated to determine the need for replacement.

1-3. JUSTIFICATION REQUIREMENTS. Threshold lights shall be provided for the approach ends of all runways equipped with runway edge lights. Threshold lights, HIRL edge lights and runway end lights are considered to be a basic runway lighting system.

1-4. RELATED FACILITIES. Related runway visual aids should include the following:

- High-Intensity Runway Edge Lights (HIRL) (WP 004 05) and Runway End Lights (WP 004 04) are integral parts of the basic runway lighting system. A runway end light and threshold light may be combined in a single fixture.
- Runway markings (WP 004 01) are considered to be visual aids for VFR daytime operations and supplement the lighting aids in IFR and nighttime operations.
- The threshold lights for the approach light system ALSF-1 (WP 003 05), ALSF-2 (WP 003 06), and SALS (WP 003 07) are a supplement to the runway threshold lights.
- Displaced runway threshold lights and markings (WP 004 03) are used where the beginning of the landing area is not at the runway end.

2-1. DESCRIPTION.

2-2. See various figures in FAA AC 150/5340-30, Appendix 1, for examples of displaced runway thresholds.

2-3. The runway threshold lights shall be a straight line of lights at each end of the runway. The lines shall be perpendicular to the runway centerline, and the pattern of lights shall be symmetrical about the centerline. Each line of lights shall consist of two groups, one on each side of the runway centerline. These threshold lights are connected into and form an integral part of the runway edge light circuit.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details of the runway threshold lights refer to UFC 3-535-02. General design and installation requirements are in FAA AC 150/5340-30.

3-3. METHODS OF INSTALLATION. Elevated runway threshold lights are installed on FAA Type L-867/L-868 in-pavement light bases.

3-4. All elevated lights shall be mounted on frangible couplings.

3-5. The height of elevated lights shall be not more than 14 inches above the ground surface.

3-6. In areas with frequent accumulations of snow to depths of 12 inches or more, and where the nearest inboard lights are more than 50 feet from the runway centerline, the height of elevated lights may be increased (with prior approval from Naval Air Systems Command) but shall not exceed 24 inches above the surface.

3-7. If semi-flush threshold lights are used, the lights shall be mounted on FAA Type L-868 in-pavement light bases.

4-1. EQUIPMENT.

4-2. FIXTURES. See Table 1.

Table 1. Schedule of Lighting Equipment for Threshold Lights

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
Outboard Wing Bar Lights, Elevated, Unidirectional, 8 per threshold.			
FAA-E-982 Green	500W 20A Q20/PAR56/1	500W 20/20A or 500W 6.6/20A	L-830-13 L-830-12
Inboard Section Lights, Elevated, Bidirectional, 10 per threshold.			
FAA AC 150/5345-46 L-862E, L-862E(L) Red/Green	BY MFR	SIZED TO LAMP	L-830
Semiflush Lights, if used, may be bidirectional or unidirectional.			
FAA AC 150/5345-46 Type L-850D or E, L-850D(L) or L-850E(L) Green/Red or Green	175W or 200W, 6.6A, as determined by mfr. (One or two lamps)	One or two 200W, 20/6.6A or determined by mfr.	L-830-7 or determined by mfr.
LED Lighting Notes:			

Table 1. Schedule of Lighting Equipment for Threshold Lights (Cont)

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).			
2. LEDs are recommended for new installations, or complete replacement; however, do not install them in an existing circuit or system with incandescent fixtures. See FAA AC 150/5340-30 for detailed information about mixing or interspersing LED light fixtures with their incandescent based counterparts.			
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.			

5-1. POWER AND CONTROLS.

5-2. POWER. The runway threshold lights are usually connected to the HIRL series lighting circuit for the runway. The circuit may be either 20 or 6.6 amperes for which suitable isolation transformers are required. The emergency power and automatic transfer requirements (WP 009 01) are the same as for the HIRL. If the HIRL has two or more circuits and the edge lights are interleaved, the threshold lights shall be interleaved. The approach lighting system threshold lights (ALSF-1, SALS, ALSF-2) are on different circuits that are separate from the runway threshold lights.

5-3. CONTROLS. The runway threshold lights are part of the HIRL circuits and do not have separate controls. Both power and intensity control are provided by the HIRL series current regulator controls. Normally, the runway lighting operational control is located in the air traffic control tower. Local runway lighting control for maintenance and emergency operations shall be provided in the airfield lighting vault.

ORGANIZATIONAL

DISPLACED THRESHOLD LIGHTS AND MARKINGS

RUNWAY VISUAL AIDS

Reference Material

Approach Visual Aids, Approach Lights, Category I - ALSF-1	WP 003 05
Approach Visual Aids, Approach Lights, Category II, and Category III - ALSF-2	WP 003 06
Approach Visual Aids, Short Approach Light System (SALS)	WP 003 07
Approach Visual Aids, Medium-Intensity Approach Light System with Runway Alignment Indicator Lights (MALSR)	WP 003 12
Runway Visual Aids, Runway Markings	WP 004 01
Runway Visual Aids, Runway Threshold Lights	WP 004 02
Runway Visual Aids, Runway End Lights	WP 004 04
Runway Visual Aids, High-Intensity Runway Edge Lights (HIRL)	WP 004 05
Runway Visual Aids, Runway Centerline Lights (RCL)	WP 004 06
Runway Visual Aids, Touchdown Zone Lights (TDZL)	WP 004 07
Runway Visual Aids, Runway Distance Markers (RDM)	WP 004 09
Airport Lighting Equipment Certification Program (lists sources of qualified equipment)	FAA AC 150/5345-53
Beads (Glass Spheres); Retro-Reflective	FED TT-B-1325
Colors, Use in Government Procurement	SAE AMS-STD-595
Design Drawings for Visual Aid Navigation Facilities	UFC 3-535-02
Design and Installation Details for Airport Visual Aids	FAA AC 150/5340-30
Isolation Transformers for Airport Lighting Systems	FAA AC 150/5345-47
Standards for Airport Markings	FAA AC 150/5340-1M
Paint, Airfield Marking, Solvent Base	FED-TT-P-85
Paint, Traffic and Airfield Marking, Waterborne	FED SPEC TT-P-1952F
PAR-56 Lampholder	FAA-E-982
Specification for Runway and Taxiway Light Fixtures	FAA AC 150/5345-46
Standards for Specifying Construction of Airports	FAA AC 150/5370-10

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the lights and markings for runways with displaced thresholds. A displaced threshold exists where the threshold for landings is located down the runway from the physical end of the runway. Displaced thresholds may be permanent or temporary. The displaced area between the runway end and the landing threshold may be used for takeoffs or for rollout when landing from the opposite direction. Often the reason for the displaced threshold is to provide additional clearance for obstructions in the runway approach area where it is not practical to remove the obstruction. The purpose of the displaced threshold lights and markings is to clearly define the beginning of the landing area of the runway. The lights and markings are used for runway approaches during daytime, nighttime, and all-weather conditions for which the runway is authorized to operate. Runway and threshold lights and runway markings in the displaced area shall be modified to clearly identify that this area is not to be used for landings, but must provide visual guidance.

1-3. JUSTIFICATION REQUIREMENTS. The justification for installing displaced threshold lights and markings is the official approval of operating procedures requiring the landing threshold to be other than at the physical end of the runway. Temporary displaced thresholds (less than six months) may be permitted for repairs or construction in the approach area. These requirements include guidelines for lights and markings of temporary displaced runway thresholds. For installations where the end of the runway is relocated (and the area involved is not intended for use in takeoff and rollouts), the existing threshold and runway lights and markings shall be removed, and standard threshold lights and markings installed at the new location. If the pavement in the relocated area remains, it shall be marked as an overrun, or in some cases where it is used as a taxiway, the required taxiway lights and markings shall be installed. See FAA AC 150/5340-30 for illustrations of typical runway threshold displacements and associated lighting/marking requirements.

1-4. RELATED FACILITIES. The airfield visual aids that are related to permanently displaced threshold lights and markings include the following:

1-5. High-Intensity Runway Edge Lights (HIRL) (WP 004 05).

1-6. The displaced threshold lights shall be connected to and integrated into the HIRL as part of the circuit for power and control.

1-7. Threshold lights (WP 004 02).

1-8. The threshold lights for this approach shall be modified to runway end lights or removed.

1-9. Runway end lights (WP 004 04).

1-10. New lights or modified threshold end lights with red light emitted for 360° shall be provided at the physical end of the runway.

1-11. Runway markings (WP 004 01).

1-12. The runway markings shall be changed to accommodate the new threshold and runway length. Any existing runway markings shall be removed except for runway edge markings already located in the new displaced threshold area.

1-13. Runway Centerline Lights (RCL) (WP 004 06).

1-14. If the runway displaced threshold is 700 feet or less, the runway approach view of the RCL shall be obscured. For runway thresholds that are displaced more than 700 feet, the RCL in the displaced area shall be configured so that they may be switched “OFF” during landing operations and switched “ON” for takeoff and rollout operations.

1-15. Touchdown Zone Lights (TDZL) (WP 004 07).

1-16. Any existing TDZL in the displaced area shall be disconnected and a new TDZL that reflects the new runway configuration installed.

1-17. Approach Lights – ALSF-1 (WP 003 05), ALSF-2 (WP 003 06), SALS (WP 003 07), or MALSR (WP 003 12).

1-18. The system approach lights shall be relocated to the new displaced threshold position and all lights in the displaced area between the lines of runway edge lights shall be semi-flush lights. The runway approach threshold lights will then be only those lights between the displaced threshold lights that are required for the approach light system.

1-19. Runway Distance Markers (RDM) (WP 004 09).

1-20. Because the RDM is related to the rollout end of the runway, the location of the markers and the displayed numerals are not changed by displacing the runway threshold. However, if the displaced threshold distance is beyond one or more RDM, the approach side of the RDM should be blanked out.

2-1. DESCRIPTION.

2-2. LIGHTS. The displaced runway threshold lights shall be lights at the designed runway threshold. The lights shall be in two groups, one on each side of the runway.

2-3. Permanently Displaced Runway Threshold Lights.

2-4. If the runway threshold is permanently displaced, and the section between the end of the runway and the displaced threshold is used for takeoffs and rollouts, the threshold lights shall be permanently installed.

2-5. The outboard threshold lights shall be not less than 4 elevated lights in each group and runway edge lights shall be elevated.

2-6. Each group of runway end lights that are located at the physical end of the runway shall have not less than 5 red omnidirectional elevated lights.

2-7. For relocated or permanently displaced thresholds (and if the displaced section of the runway is not used for takeoffs or rollouts) any existing threshold lights, runway end lights, runway edge lights, centerline lights, and touchdown zone lights in the displaced area shall be removed.

2-8. Runway threshold and end lights shall be installed in the standard configuration at the displaced threshold.

2-9. The runway edge, centerline, and touchdown zone lights should be converted to the standard configurations starting at the displaced threshold.

2-10. Temporary Displaced Threshold Lights.

2-11. For temporary displaced thresholds (6 months or less,) if the displaced section is used for rollout and takeoff operations, temporary lighting shall be installed.

2-12. The displaced runway threshold lights shall be 4 elevated unidirectional green lights that are located outboard of the runway threshold bar on either side of the physical runway centerline. The innermost runway threshold light shall be a bidirectional light fixture that is in line with the runway edge lights. The bidirectional light fixture shall emit white light toward the takeoff end and green light toward the approach end of the runway. In addition, four semi-flush unidirectional green lights shall be installed inboard from the runway edge on either side of the physical runway center line and in line with the elevated runway threshold lights.

2-13. The runway end lights shall be 5 bidirectional, red/red lights (usually the existing permanent threshold lights) on each side of the permanent runway threshold.

2-14. The existing runway edge lights along the displaced section shall be converted to bidirectional, red/white lights.

2-15. Runway centerline lights in the displaced area shall not emit light in the approach direction. However, if the displaced section is more than 700 feet long, a remote control for the centerline lights shall be installed. The remote control shall allow the runway centerline lights in the displaced area to be turned OFF for approaching aircraft and to be turned ON for takeoffs.

2-16. Touchdown zone lights may be disabled for short temporary displaced sections or discontinue using the touchdown zone light system for temporary displaced sections that are more than 700 feet in length.

2-17. If the temporary displaced section of runway is not used for rollouts and takeoffs (example: during construction) the permanent threshold lights, runway end lights, runway edge lights, centerline lights, and touchdown zone lights in the displaced section shall be disabled.

2-18. Runway end lights shall be provided at the temporary displaced threshold by using bidirectional green/red inboard threshold lights. For short lengths of displaced sections, the lights may be disabled by removing the lamps or disconnecting the secondary connections from the isolation transformers. For longer temporary runway threshold displacements, where more than 25 percent of the lights in the circuit will be disabled, this part of the circuit should be disconnected.

2-19. MARKINGS. The runway markings for the displaced threshold area shall be per FAA AC 150/5340-1M.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details of the displaced threshold lights and markings refer to UFC 3-535-02 for the lights and FAA AC 150/5340-1M for the markings. General runway displaced threshold lighting design and installation requirements are in FAA AC 150/5340-30.

Table 1. Schedule of Lighting Equipment and Materials for Displaced Threshold Lights and Markings

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER RATING	ISOLATION TRANSFORMER FAA TYPE AC 150/5345-47
Outboard Displaced Threshold Lights, Elevated, Unidirectional.			
FAA-E-982 Green	500W 20A Q20/PAR56/1	500W 20/20A or 500W 6.6/20A	L-830-13 L-830-12
Inboard Displaced Threshold Lights, Semiflush, Unidirectional, 8.			
FAA AC 150/5345-46, Type L-850E, L-850E(L) Green	Manufacturer determined	SIZED TO LAMP	SIZED TO LAMP
Runway End Light for Displaced Threshold, Elevated, Bidirectional, 10.			
FAA AC 150/5345-46 L-862E, L-862E(L) Red	Manufacturer determined	SIZED TO LAMP	SIZED TO LAMP
Runway Edge Light for Displaced Threshold, Elevated, Bidirectional, 0 to 2 and Modify Exiting Lights to Show Red/Green.			
FAA AC 150/5345-46 Type L-862, L-862(L) Green/White	200W, 6.6A, as determined by manufacturer.	200W 20/6.6A or 200W 6.6/6.6A	L-830-7 L-830-6
Displaced Threshold Markings.			
Non-retroreflective yellow, Spec, FED SPEC TT-P-85(1) or FED SPEC TT-P-1952F, yellow, color SAE AMS-STD-595, color chip No. 23538.(2)			
Non-retroreflective white, Spec, FED TT-P-85(1)or TT-P-1952, white, color SAE AMS-STD-595, color chip No. 17875.(2)			

NOTES:

1. Some authorities may prohibit or restrict the use of this type of paint.
2. Temporary displaced threshold markings may use tape or temporary paint of the required color.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of “certified” light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See “Advisory Circulars” at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).

Table 1. Schedule of Lighting Equipment and Materials for Displaced Threshold Lights and Markings (Cont)

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures. 3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.			

ORGANIZATIONAL

RUNWAY END LIGHTS

RUNWAY VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for runway end lights. Runway end lights define the longitudinal limits or ends of the runway during night landing and/or reduced visibility rollouts and takeoff operations. The requirements for runway end lights in this WP shall apply for all new installations and should be considered for replacement of existing runway end lights. Existing runway end lights may be used and maintained unless all lights for one end of the runway are to be replaced.

1-3. JUSTIFICATION REQUIREMENTS. Runway end lights shall be provided for any runway that is equipped with runway edge lights. Runway end lights are required for:

- Nighttime operations in Visual Flight Rules (VFR) operations.
- Instrument Flight Rules (IFR) operations (WP 002 00).

1-4. For new installations and for all runways to be used for IFR operations, the runway end lights shall be the high-intensity type.

1-5. RELATED FACILITIES. The runway end lights shall be an integral part of the High-Intensity Runway Edge Lights (HIRL) (WP 004 05) circuit and normally share the bidirectional runway threshold light fixtures (WP 004 02); however, they may also be separate light fixtures. If the runway has a displaced threshold (WP 004 03), the runway end lights will have separate light fixtures located at the runway end and not at the threshold.

2-1. DESCRIPTION.

2-2. The runway end lights shall be located at each end of the runway along a line beyond the edge of the full-strength pavement. The lights shall consist of two groups of lights symmetrically arranged about the runway centerline. Each group of lights shall consist of four elevated lights and be equally spaced beginning in line with the runway edge lights and extending inboard towards the runway centerline. The runway end lights and the threshold lights will usually share the same bidirectional light fixtures. The red beams directed along the runways are the runway end lights, and the green beams directed into the approach zone are the runway threshold lights.

2-3. If there are maintenance issues, or existing installations make it impractical to use elevated fixtures for runway end lights, semi-flush bidirectional lights may be used. If the runway threshold is displaced, runway end lights shall be at the end of the useful runway pavement. The runway end lights at displaced threshold areas shall be two groups of **not less than five** elevated bidirectional red lights. The color of the beams of lights shall be red in both directions.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For details on design and installation of the runway end lights refer to UFC 3-535-02.

3-3. METHODS OF INSTALLATION. The runway end lights are usually elevated light fixtures. They may be combined with the threshold lights into single bidirectional fixtures with the green beams directed towards the approach zone and the red beams along the runway.

3-4. Elevated lights shall be mounted on frangible couplings which may be installed on FAA Type L-867/L-868 light bases or conduit elbows set in concrete foundations.

3-5. The height of elevated lights shall be not more than 14 inches above the ground surface.

3-6. In areas with frequent accumulations of snow to depths of 12 inches or more, and where the nearest inboard lights are more than 50 feet from the runway centerline, the height of elevated lights (with approval by Naval Air Systems Command) may be increased but shall not exceed 24 inches above the surface.

3-7. To raise the height of the lights, consult the manufacturer's installation instruction book.

3-8. The beams of the bidirectional lights are toed-in towards the runway centerline at 3.5 to 4 degrees.

3-9. For some installations, semi-flush light fixtures are used as runway end/threshold lights to reduce the damage to lights from aircraft, arresting gear, or surface vehicles

3-10. Runway end lights shall be connected to the HIRL lighting circuit.

3-11. DIMENSIONS. The runway end lights shall be located in a line perpendicular within ±2 degrees to the extended runway centerline.

3-12. The runway end lights shall be not more than 5 feet beyond the runway end. Individual lights shall have a tolerance of two inches from the centerline of lights.

3-13. The outermost light of each group of runway end lights shall be in line with the runway edge lights.

3-14. The runway end lights shall be equally spaced not more than 10 feet laterally toward the runway centerline.

3-15. The height of elevated runway end lights shall be not more than 14 inches above the runway/ground surface.

3-16. Semi-flush lights shall be installed with the top surface of the flange of the light base level and at the correct depth below the pavement surface.

3-17. All lights shall be level ±1 degree and oriented horizontally ±2 degrees.

3-18. Elevated lights shall have their beams toed-in towards the runway centerline.

3-19. Semi-flush lights shall have the axes of the beams parallel to the runway centerline.

4-1. EQUIPMENT.

4-2. The lighting equipment for the basic runway end lights shall be as given in Table 1 and typical figures are in UFC 3-535-01.

Table 1. Schedule of Lighting Equipment for Runway End Lights

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
For basic runway end lights. 10 elevated lights at each runway end.			
FAA AC 150/5345-46 L-862E, L-862E(L)	BY MFR	SIZE TO LAMP	L-830
Semiflush Lights, optional.			
FAA AC 150/5345-46 Type L-850D, L-850D(L)	BY MFR	SIZE TO LAMP	L-830

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

5-1. PHOTOMETRIC REQUIREMENTS.

5-2. The runway end lights shall be unidirectional lights except they may be bidirectional at the rollout end of a displaced threshold or as combination threshold and end lights.

5-3. The axes of the beams for unidirectional runway end lights shall be directed down the runway parallel to the runway centerline in azimuth.

5-4. Bidirectional runway end lights may have the beams toed-in towards the runway centerline at not more than 4.5 degrees.

5-5. The color of the emitted light shall be aviation red per FAA AC 150/5345-46.

5-6. The intensity of the runway end lights shall be in five steps of 100, 20, 4, 0.8, and 0.2 percent of rated intensity.

5-7. The intensity beam pattern of the runway end lights when operated at their rated current shall be per FAA AC 150/5345-46.

6-1. POWER AND CONTROLS.

6-2. POWER. The runway end lights are a part of the HIRL series lighting circuit. Power shall be provided by one or more series lighting circuits with a constant current regulator for each circuit. If two or more circuits are used and the runway edge lights are interleaved, the end light circuits shall be interleaved to provide a usable system if one circuit fails. The constant-current regulator shall have adequate capacity for the runway end and threshold lights. The runway end lights shall have the same emergency power source and automatic transfer requirements (WP 009 01) as the HIRL or approach lighting system.

6-3. CONTROLS. The runway end lights (a part of the HIRL) will not have separate power and intensity controls. Both remote control (WP 009 00) in the control tower and local control in the lighting vault shall be as for the HIRL.

ORGANIZATIONAL

HIGH-INTENSITY RUNWAY EDGE LIGHTS (HIRL)

RUNWAY VISUAL AIDS

Reference Material

Introduction	WP 002 00
Runway Visual Aids, Runway Markings	WP 004 01
Runway Visual Aids, Runway Threshold Lights	WP 004 02
Runway Visual Aids, Displaced Threshold Lights and Markings	WP 004 03
Runway Visual Aids, Runway End Lights	WP 004 04
Runway Visual Aids, Runway Centerline Lights (RCL)	WP 004 06
Runway Visual Aids, Touchdown Zone Lights (TDZL)	WP 004 07
Airport Lighting Equipment Certification Program (lists sources of qualified equipment)	FAA AC 150/5345-53
Design Drawings for Visual Aid Navigation Facilities	UFC 3-535-02
Design and Installation Details for Airport Visual Aids	FAA AC 150/5340-30
Isolation Transformers for Airport Lighting Systems	FAA AC 150/5345-47
Specification for Runway and Taxiway Light Fixtures	FAA AC 150/5345-46

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the High-Intensity Runway Edge Lights (HIRL). The HIRL define the lateral limits of the usable runway surface for landings and takeoffs during all nighttime operations and in reduced visibility. The HIRL requirements in this WP shall be used for all new runway edge lighting installations and should be considered for replacement or improvements of existing runway edge lighting systems.

1-3. JUSTIFICATION REQUIREMENTS. High intensity runway edge lights are part of a precision instrument runway airfield lighting system. With its associated threshold lighting and runway end lighting, it can function without other lighting support. All runways intended for use at night or during Instrument Flight Rules (IFR) operations (WP 002 00) shall be provided with high intensity runway edge lights. Existing Medium-Intensity Runway Edge Lighting (MIRL) installations may be used for visual runways or non-precision instrument runways. Any variations from these requirements shall be approved in accordance with the procedures of WP 002 00.

1-4. RELATED FACILITIES. In addition to the HIRL, related visual aid facilities should include the following:

- Runway threshold lights (WP 004 02).
- Runway end lights (WP 004 04).
- Runway markings (WP 004 01).

1-5. For some runways, the following visual aids may be installed:

- Displaced threshold lights and marking (WP 004 03).
- Runway centerline lights (RCL) (WP 004 06).
- Touchdown zone lights (TDZL) (WP 004 07).

2-1. DESCRIPTION.

2-2. The HIRL shall consist of two straight lines of lights located along each edge of the runway. The lights shall be equally spaced along the edge of the runway, bidirectional, and the emitted color shall be aviation white. On instrument approach runways, the last 2000 ft of the runway shall have bidirectional aviation yellow/white lights installed with yellow facing the takeoff aircraft. The HIRL shall use elevated lights except semi-flush lights shall be used at intersections with taxiways, other runways, or in the area of the arresting gear tape sweep. For both elevated and semi-flush types of runway edge lights, the axes of the light beams shall be toed-in toward the runway centerline. For runways with displaced thresholds, the HIRL shall be installed at the edges of the displaced area if this area is used for rollouts or takeoffs. For HIRL in the displaced threshold area, the color of the emitted light towards the runway approach zone shall be aviation red per FAA AC 150/5345-46.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details of the HIRL system refer to UFC 3-535-02. General equipment design and installation requirements are per FAA AC 150/5340-30J, Chapter 2, paragraph 2.1 and applicable figures.

Table 1. Schedule Of Lighting Equipment For HIRL

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
Elevated, Runways Light.			
FAA AC 150/5345-46, Type L-862, L-862(L)	150W to 209W 6.6A, as determined by manufacturer (mfr.).	200W 20/6.6A or 200W 6.6/6.6A or determined by mfr.	L-830-7 L-830-6 Determined by mfr.
Semiflush, All runways.			
FAA AC 150/5345-46 Type L-850C, L-850C(L)	See manufacturer.	To suit lamp	To suit lamp

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of “certified” light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See “Advisory Circulars” at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED’s are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot’s ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

ORGANIZATIONAL

RUNWAY CENTERLINE LIGHTS (RCL)

RUNWAY VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the Runway Centerline Lights (RCL). The RCL identifies the center of the runway and provides longitudinal alignment during landings, rollouts and takeoffs at night and under reduced visibility weather conditions. They also indicate by color coding the distance remaining to the end of the runway. The RCL, in combination with the High-Intensity Runway Edge Lights (HIRL), aid in reducing pilot confusion caused by landing into “the black hole” between the runway edge lights during night operations. The requirements in this WP apply for new installations and should be considered for replacement or improvement of existing RCL installations.

1-3. JUSTIFICATION REQUIREMENTS. Runways intended for operations in Category II and Category III meteorological conditions require RCL (see WP 002 00 and WP 003 00). RCL installations may be approved for runways that are planned to be upgraded to Category II runways. Runways that are authorized only for Category I operations may be approved (WP 002 00) for RCL if the minimums are less than 2400 feet Runway Visual Range (RVR) or if the runway width is more than 200 feet. Instrument Flight Rules (IFR) apply for operations in these conditions.

1-4. RELATED FACILITIES. In addition to the RCL, facilities for operations in Category II and Category III conditions shall include the following:

- The runway shall be paved and not less than 150 feet wide and 6000 feet long.
- The runway approach shall be equipped with an ALSF-2 approach light system (WP 003 07) and with one of the following precision electronic approach aids:
  - Precision Approach Radar (PAR),
  - Precision Instrument Landing System (ILS), or
  - Microwave Landing System (MLS).

- The runway shall be equipped with the following:
  - Precision Approach Runway Markings (WP 004 01),
  - Touchdown Zone Lights (TDZL) (WP 004 07),
  - High-Intensity Runway Edge Lights (HIRL) (WP 004 05),
  - High-Intensity threshold lights (WP 004 02), or displaced threshold lights (WP 004 03),
  - Runway end lights (WP 004 04).
- The runway shall have a Runway Visual Range (RVR) system. For Category III operations more than one RVR system will be required.
- Air traffic control during normal operating hours shall be provided.

2-1. DESCRIPTION.

2-2. The RCL shall be configured per FAA AC 150/5340-30J, Section 3.3, and related figures.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details about the runway centerline lights (RCL), refer to UFC 3-535-02. General design and installation requirements are per FAA AC 150/5340-30J, Chapter 3 and related figures.

3-3. TYPES OF INSTALLATION. There are two types of RCL installations as follows:

- For runways that have a large percentage of the landings by aircraft equipped with arresting hooks, the RCL fixtures should be resistant to arresting hook damage. Specialized light fixtures are available with added strength to resist potential damage from aircraft arresting hook strikes. The resistant light fixtures have a lower intensity. The longitudinal spacing for arresting hook resistant lights shall be at 25-foot intervals.
  - Arresting hook resistant RCL are Type L-852N and available from lighting equipment manufacturers.
  - See the manufacturer's catalog information for L-852N available lamp types.
  - L-852N light fixtures use direct mounting or FAA Type L-868 light bases for runway installation.
  - See UFC 3-535-01 for hook resistant light fixture photometric requirements.
- For runways that have a small percentage of the landings by aircraft equipped with arresting hooks, the RCL fixtures should be a high intensity type. The RCL spacings for these type lights shall be 50-foot intervals.

4-1. EQUIPMENT.

4-2. The lighting equipment for the RCL shall be per Table 1.

Table 1. Schedule of Lighting Equipment for RCL

PURPOSE AND TYPE OF FIXTURE[1]	LAMP RATING AND TYPE	ISOLATION TRANSFORMER RATING	ISOLATION TRANSFORMER FAA TYPE AC 150/5345-47
Runway for aircraft with arresting hooks.			
Type L-852N	65W 6.6A, as	(Transformer for each light)	
Navy	determined by	100W 20/6.6A	L-830-5
Direct Mounted	manufacturer.	(Transformer for three lights) [2]	
Method, Type VI		200W 20/6.6A	L-830-7
Base Mounted			
Method, Type VII or VIII			
LED	Determined by mfr.	Determined by mfr.	L-830
Runway for aircraft without arresting hook.			
Base Mounted	200W 6.6A, as	200W 20/6.6A	L-830-7
Method, FAA	determined by	Or	
AC 150/5345-46	manufacturer.	Determined by mfr.	L-830
Type L-850A, L-850A(L)			

NOTES:

1. The number of lights required varies with the length of the runway and purpose of the runway.
2. These lights shall be equipped with a shorting device for inoperative lamps.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

5-1. POWER AND CONTROLS.

5-2. POWER. RCL power shall be provided as follows:

- The power for the RCL shall be provided by one or more 20 ampere or 6.6 ampere series lighting circuits and one or more constant-current regulators.
- If more than one circuit is used, the circuits may be interleaved to provide a usable system if one circuit fails.
- The interleaving shall be arranged to prevent a false indication of runway distance remaining if any single circuit is inoperative.
- The constant-current regulators shall be rated for 6.6 or 20-ampere output and have 5 selectable intensity steps.
- For constant current regulator requirements, refer to WP 009 02.
- The power sources for the RCL shall include an auxiliary or secondary power source with arrangement for automatic transfer of power (WP009 01).
  - The transfer time shall be not more than one second for Category II and Category III operations and not more than 15 seconds if only for Category I operations.
  - The one second transfer time may be provided by operating on power from the auxiliary source during Category II and Category III conditions with transfer to the primary source in one second if the auxiliary source malfunctions.
- The RCL lights shall be provided with shorting devices to short out the lamp if a lamp fails. This shorting device prevents the other two lights from being inoperative when any one lamp fails.

5-3. CONTROL. (See WP 009 00.) The RCL shall be provided with power and intensity control that are separate from the other lighting systems. The lights shall be controlled from the air traffic control tower. Local control for maintenance and emergency operations shall be from the airfield lighting vault. The intensity of the RCL shall be one of five steps as selected at levels of approximately 100, 20, 4, 0.8, and 0.2 percent of the rated intensity.

ORGANIZATIONAL

TOUCHDOWN ZONE LIGHTS (TDZL)

RUNWAY VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for Touchdown Zone Lights (TDZL). The touchdown zone lights provide visual guidance during final approach and landing and define the portion of the runway used for touchdown. Also, they provide visual cues for more accurately centering the aircraft on the runway, adjusting aircraft pitch attitude for landing flare/touchdown, and determining the touchdown position. The requirements in this WP apply for new installations and should be considered for replacement or improvement of existing TDZL installations.

1-3. JUSTIFICATION REQUIREMENTS. Runways intended for operations in Category II and Category III meteorological conditions (see WP 002 00 and WP 003 00) require TDZL. They may be approved for runways that are planned to be upgraded to Category II runways. Runways that are authorized for Category I operations only may be approved (WP 002 00) for TDZL if the minimums are less than 2400 feet Runway Visual Range (RVR) or if the runway width is 250 feet or greater.

1-4. RELATED FACILITIES. In addition to the TDZL, facilities for operations in Category II and Category III conditions shall include the following:

- The runway shall be paved and not less than 150 feet wide and 6000 feet long.
- The runway approach shall be equipped with an ALSF-2 approach light system (WP 003 06) and shall include one of the following precision electronic approach aids:
  - Precision Approach Radar (PAR),
  - Precision Instrument Landing System (ILS), or
  - Microwave Landing System (MLS).
- The runway shall be equipped with the following:
  - Precision Approach Runway Markings (WP 004 01),
  - Runway Centerline Lights (RCL) (WP 004 06),

    - High-Intensity Runway Edge Lights (HIRL) (WP 004 05),
    - High-Intensity threshold lights (WP 004 02), and
    - Runway end lights (WP 004 04).
- The runway shall have a Runway Visual Range (RVR) system. For Category III operations more than one RVR system will be required.
- Air traffic control during normal operating hours shall be provided.

2-1. DESCRIPTION.

2-2. The TDZL shall consist of pairs of light barrettes, with semi-flush white unidirectional light fixtures, located on each side of the runway centerline and be in a line perpendicular to and symmetrical about the centerline of the runway centerline lights (WP 004 06). Each light barrette shall consist of three lights spaced laterally. Pairs of barrettes shall be spaced at 100-foot intervals for 3000 feet along the runway starting from the threshold forming two rows of barrettes. For runways that are less than 6,000 feet long, the rows of TDZL shall extend for one-half the runway length (measured from the runway threshold) with the first barrettes located 100 feet from the threshold.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details for the TDZL, refer to UFC 3-535-02. General design and installation requirements for the TDZL are given in FAA AC 150/5340-30J, Chapter 3 and related figures.

3-3. METHODS OF INSTALLATION.

NOTE

Direct mounted TDZL fixtures are not recommended because they may have a tendency to become FOD if the adhesive fails. The installation of TDZL with an L-868 light base is preferred because of its resistance to repeated aircraft landing gear impacts.

3-4. The preferred method of installing the TDZL is the light base mounted installation (see NOTE). Semi-flush lights are mounted on FAA Type L-868 light bases set in a concrete foundation and connected by conduit to handholes at the edge of the runway. In some existing runways, the TDZL may use the direct-mounted method by installing inset lights in drilled holes and using saw kerfs for the cable runs.

3-5. DIMENSIONS. The first pair of light bars shall be 100 ±25 feet from the runway threshold and the other light bars shall be space at 100 ±2 foot intervals along the runway. The line of lights in the barrettes shall be perpendicular to the runway centerline within two degrees. The inner lights in each pair of barrettes shall be 36 feet ±6 inches from the centerline of the runway centerline lights.

NOTE

The light fixtures within each barrette will be at different elevations as determined by the lateral slope of the runway surface.

3-6. The spacing of TDZL in a barrette shall be on 5 feet ± one inch centers. The L-868 light bases shall be level and the upper flange at the proper depth below the runway surface. The light beam of the TDZL is toed 4 ± 1 degrees toward the runway centerline. This is achieved by either installing light fixtures that have had their optical assembly toed 4 ± 1 degrees, or by angling the light base 4 ± 1degrees and installing the light fixture. The vertical aiming of TDZL is fixed.

4-1. EQUIPMENT.

4-2. The lighting equipment for the TDZL is shown in table 1.

Table 1. Schedule of Lighting Equipment for TDZL

PURPOSE AND TYPE OF FIXTURE[1]	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
Base-Mounted Installation.			
FAA AC 150/5345-46, Type L-850-B, L-850B(L)	200W 6.6A, or determined by manufacturer.	Determined by manufacturer	L-830
Replacement of existing lights only.			
MIL-DTL-26202 Class BB-25	499W 20A, Q20A/PAR56/3	500W 20/20A	L-830-13

NOTES:

1. 180 lights are required for a complete system.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

5-1. PHOTOMETRIC REQUIREMENTS.

5-2. The intensity of the TDZL shall be variable in five steps of 100, 20, 4, 0.8, and 0.2 percent of rated intensity. The photometrics of the TDZL shall be per the requirements in FAA AC 150/5345-46.

ORGANIZATIONAL

RUNWAY EXIT LIGHTS

RUNWAY VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the lights for long-radius, high speed runway exits and for short-radius, low speed exits with visual identification issues. Both taxiway centerline and taxiway edge lights are used to mark the runway exits. The lights provide visual clues to pilots for departing a runway at high speed exits before complete deceleration of the aircraft and at low speed exits with taxiing speeds at night and during daylight under restricted visibility conditions. The requirements apply for new installations and should be considered for replacement or upgrading of existing runway exits. The runway exit lights, with the exception of standard taxiway lights and guidance signs, are the only illuminated items applicable to runway exits.

1-3. JUSTIFICATION REQUIREMENTS. Long-radius runway exit lights should be provided on runways with high-speed exits which may be used before the aircraft decelerates to taxiing speeds. Short-radius exits are intended for departing the runway at taxiing speeds. Deviations from these requirements shall be approved per WP 002 00.

1-4. RELATED FACILITIES. The related visual aids should include the following:

- Taxiway markings (WP 005 01).
- Runway Markings (WP 004 01).
- Runway Edge Lights (WP 004 05).
- Runway Centerline Lights (WP 004 06).
- Taxiway edge lights (WP 005 02).
- Taxiway centerline lights (WP 005 03).
- Taxiway guidance signs (WP 005 04).

2-1. DESCRIPTION.

2-2. GENERAL. Long-radius (high-speed) exits are taxiways that exit from the runway at an angle between 20 and 30 degrees and have long-radius (greater than 1200 feet) curves for the centerline (Figure 1). Usually, aircraft use these exits only for departure from the runway and not as an entrance. The centerline for these taxiways have four segments:

- A segment parallel to the runway centerline not less than 200 feet in length.
- An entrance curve segment.
- A central curve segment.
- A straight segment along the taxiway centerline.

2-3. For Category III operations and for some exits with confusing visual identification issues, regular short-radius runway exits shall be provided with runway exit centerline lights. Short-radius exits have an entrance curve from a line parallel to the runway centerline to the centerline of the taxiway. For all high-speed exits and for regular exits used for Category III operations or with visual guidance problems, the exit path should be provided with centerline lights. Runway exit lights are green semi-flush lights placed along the runway exit taxiway centerline markings. Edge lights and guidance signs are also used to mark runway exits

2-4. CENTERLINE LIGHTS. Long-radius exits are intended for use only as runway exits and the centerline lights should be unidirectional.

2-5. Bidirectional lights may be installed if the exit is also used as an entrance to the runway.

2-6. The runway exit lights shall commence on a line parallel to the runway centerline (before the beginning of the entrance curve) and continue beyond the end of the central curve to a point on the taxiway centerline where an aircraft can be expected to reach normal taxiing speed (Figure 2).

2-7. For short-radius runway exits, (Figure 3), unidirectional centerline lights shall be installed along the curve and bidirectional lights on the taxiway centerline.

2-8. Runway exit centerline lights on the line parallel to the runway centerline shall be offset toward the departure side from the runway centerline or line of runway centerline lights.

2-9. As the line of runway exit centerline lights curves away from the runway centerline, the lights may be located along the exit curve and taxiway centerline or may be offset to the inside of the curve.

2-10. Exit runway centerline lights located within 35 feet of the runway centerline shall be tail hook resistant type fixtures, type L-852N.

2-11. EXIT EDGE LIGHTS. The edge lights for all runway exits shall be standard taxiway edge lights (FAA Type L-852T) except the spacing shall not exceed 50 feet longitudinally. For taxiway edge light requirements, refer to WP 005 02.

2-12. EXIT GUIDANCE SIGNS. The exit guidance signs shall be standard taxiway guidance signs. For taxiway guidance signs requirements, refer to WP 005 04.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details of the runway exit lights, refer to UFC 3-535-02. General design and installation requirements are given below.

3-3. METHODS OF INSTALLATION. The semi-flush centerline exit lights shall be installed on FAA Type L-868 light bases. The elevated runway exit lights may be installed on FAA Type L-867 light bases. Runway exit guidance signs shall be installed on ground level concrete pads. All elevated lights and signs shall be mounted on frangible couplings. Preferably the high voltage series lighting circuit cable to the centerline lights shall be in duct or conduit and not consist of exposed cable in saw kerfs.

3-4. LOCATION. The runway exit centerline lights shall be equally spaced along the exit path.

3-5. The line of lights may be offset from the runway exit path center inside the curve to provide separation from the runway centerline lights or to avoid pavement joints.

3-6. The offset shall be 3 feet from the runway centerline lights and not more than 15 inches from the center of the exit path or the taxiway centerline.

3-7. For long-radius runway exits, the centerline lights shall start not less than 200 feet before the point of tangency of the curve away from the runway centerline and shall continue for not less than 200 feet beyond the point of tangency with the straight segment of the taxiway centerline (Figure 2).

3-8. For short-radius runway exits the centerline lights shall start at the point of tangency of the exit path with the line parallel to the runway centerline and shall not terminate less than 200 feet beyond the point of tangency of the exit path with the taxiway centerline (Figure 3).

3-9. The runway exit edge lights and guidance signs shall be located per the requirements in WP 005 02 and WP 005 04.

3-10. DIMENSIONS AND TOLERANCES. The spacing of the long-radius exit centerline lights shall be not more than 50 feet. The spacing of the short-radius centerline lights shall be not more than 25 feet. The spacings shall have a tolerance of 12 inches to avoid any pavement joints. For the runway exit edge lights, the spacings and tolerances shall be the same as standard taxiway edge lights (WP 005 02) except the spacing shall not be more than 50 feet for 200 feet along the taxiway edge beyond the point of tangency. The aiming tolerance for the runway exit centerline lights shall not exceed 2 degrees.

3-11. AIMING. The unidirectional runway exit centerline lights shall be aimed to direct the beams of light toward the approaching aircraft. The horizontal alignment shall be as follows:

- For long-radius exits, the lights on the segment parallel to the runway centerline shall have the axes of the beams parallel to the runway centerline.
- For long-radius exits, the lights on the entrance curve and central curve segments shall have the lights aligned so that the axes of the beams intersects the line of lights not less than 200 feet or 4 lights ahead of the light.
- For short-radius exits, the lights along the curved segment shall have the lights aligned with the axes of beams tangential to the curve.
- For both types of exits, the lights on the taxiway segment shall have the axes of the beams parallel to the taxiway centerline.
- The edge lights are omnidirectional and do not require horizontal aiming.

4-1. EQUIPMENT.

4-2. The lighting equipment for the runway high-speed exit shall be per Table 1. Runway exit centerline lights within 35 feet of the runway centerline shall be hook-resistant type fixtures (L-852N). Frangible couplings shall be used for mounting elevated edge lights.

Table 1. Schedule of Lighting Equipment for Runway Exits

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
Centerline exit lights.[1]			
Lights within 35’ of runway centerline.			
Type L-852 Navy style VII or VIII, green.[2]	65W 6.6A, as determined by manufacturer.	65W 6.6/6.6A or 200W 6.6/6.6A for three lights.	L-830-3 L-830-6
LED		Determined by mfr.	Determined by mfr.
Lights more than 35’ from runway centerline.			
FAA AC 150/5345-46, Type L-852A, L-852A(L)	45W 6.6A, as determined by manufacturer (mfr.)	30/45W 6.6/6.6A or 200W 6.6/6.6A for four lights.	L-830-1 L-830-6
straight sections.		Determined by mfr.	Determined by mfr.
FAA AC 150/5345-46, Type L-852B, L-852B(L)	45W 6.6A, or determined by mfr.	65W 6.6/6.6A or 200W 6.6/6.6A for three lights.	L-830-3 L-830-6
curved sections.		Determined by mfr.	Determined by mfr.
Runway exit edge lights.[1]			
FAA AC 150/5345-46 Type L-861T, L-861T(L) blue	45W 6.6A, or determined by mfr.	30/45W 6.6/ 6.6A	L-830-1
		Determined by mfr.	Determined by mfr.
Runway exit signs, one.			
FAA AC 150/5345-44 Type L-858Y size 2, style 2	Determined by manufacturer.	Determined by manufacturer.	

NOTES:

1. The number of lights required varies with dimensions of the runway exit and the spacing interval between lights.
2. The lights of this type are bidirectional but the beam in the opposite direction shall be blanked out.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of “certified” light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See “Advisory Circulars” at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).

Table 1. Schedule of Lighting Equipment for Runway Exits (Cont)

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER RATING	ISOLATION TRANSFORMER FAA TYPE AC 150/5345-47
2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.			
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVD.			

5-1. PHOTOMETRIC REQUIREMENTS.

5-2. The centerline runway exit lights shall be unidirectional for: long-radius exits, along the curve of short-radius exits, and bidirectional along the taxiway centerline.

5-3. The light fixtures used are the same for either type of runway exit light except the unidirectional lights shall include an opaque filter for one beam.

5-4. For bidirectional runway exit lights, the axes of the beams shall be 180 degrees apart in azimuth.

5-5. The elevation of the axes of the runway exit light fixture beams shall be between 2 and 4 degrees above horizontal.

5-6. The color of the runway exit lights shall be aviation green per FAA AC 150/5345-46.

5-7. Runway exit edge lights shall be aviation blue per FAA AC 150/5345-46.

5-8. The intensity of the runway exit centerline lights shall be variable in 3 discrete current steps with the lowest step not more than 10 percent of the light fixture rated intensity.

5-9. The minimum intensity at rated current in green of each runway exit light fixture beam shall be not less than 60 candelas for a beam spread of ±10 degrees in azimuth and 0 to 7 degrees in elevation.

5-10. The photometric requirements for the runway exit edge lights and signs shall be as those required in WP 005 02 and WP 005 04.

6-1. POWER AND CONTROLS.

6-2. POWER. The power for the runway high-speed exit lights shall be supplied by one or more series lighting circuits.

6-3. The runway exit centerline and edge lights may be on separate circuits or on the same series lighting circuit.

6-4. It is not recommended to connect runway exit signs to any 3-step series lighting circuit. Runway exit signs should be powered from a dedicated 5.5A constant current regulator if at all possible.

6-5. The source of power for the runway exit lighting circuits shall be from one or more constant-current regulators (WP 009 02) with 6.6A output current and not less than three intensity steps.

6-6. The power for long-radius exit lights shall have the same auxiliary or secondary power and automatic transfer requirements (WP 009 01) as the runway edge lights.

6-7. Power for short-radius runway exit lights shall be the same as the taxiway lights.

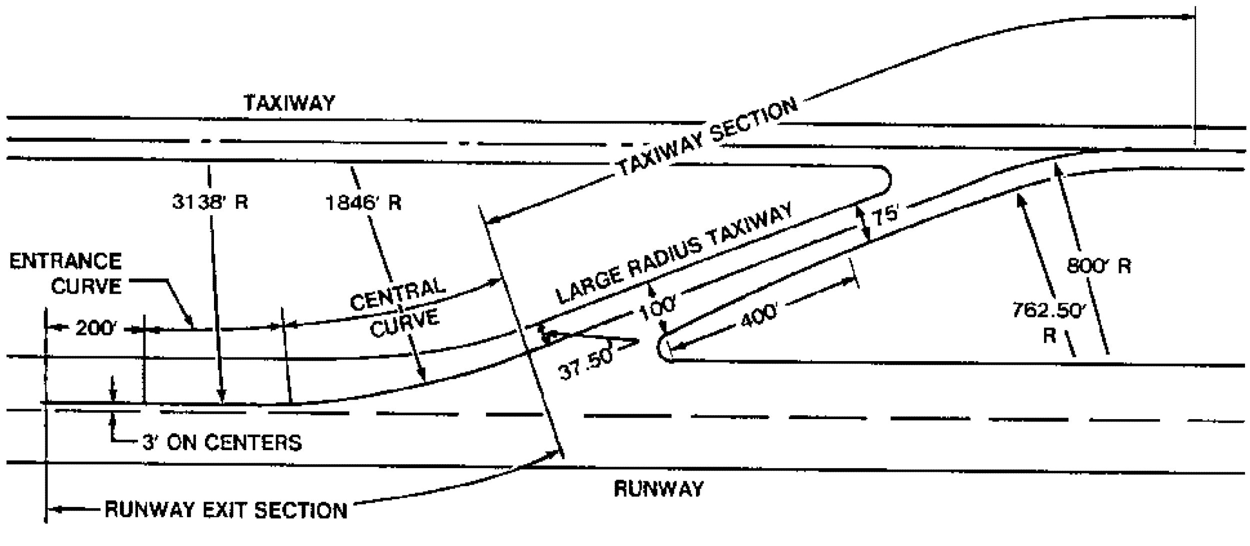
6-8. The power transfer time requirement is usually 15 seconds, except if the runway is authorized for Category II or Category III operations. For CAT II or CAT III ops, the transfer time for long radius exit lights is one second.

6-9. For the runway exit centerline lights an individual isolation transformer for each light is preferred.

6-10. All series lighting cables in the pavement for the runway centerline lights should be within duct or conduit.

6-11. Runway exit edge lights should have isolation transformers for each light.

6-12. CONTROLS. The runway exit lights are controlled from the air traffic control tower lighting panel with secondary control in the airfield lighting vault (WP 009 00). The controls may be part of the taxiway lights control. Not less than three-steps of intensity control should be provided. Although the runway exit centerline and edge lights may be on different lighting circuits, both types of runway exit lights should have the same energizing and intensity setting switches.



<table>
<tr><td rowspan="2">CURVE</td><td colspan="2">20° TURN OFF</td><td colspan="2">30° TURN OFF</td></tr>
<tr><td>RADIUS</td><td>LENGTH</td><td>RADIUS</td><td>LENGTH</td></tr>
<tr><td>ENTRANCE</td><td>3,138’</td><td>283’</td><td>3,138’</td><td>283’</td></tr>
<tr><td>CENTRAL</td><td>1,846’</td><td>478’</td><td>1,846’</td><td>800’</td></tr>
<tr><td>PAVEMENT EDGE</td><td>1,146’</td><td>400’</td><td>1,382’</td><td>723’</td></tr>
</table>

Figure 1. Typical Long-Radius Runway Exit

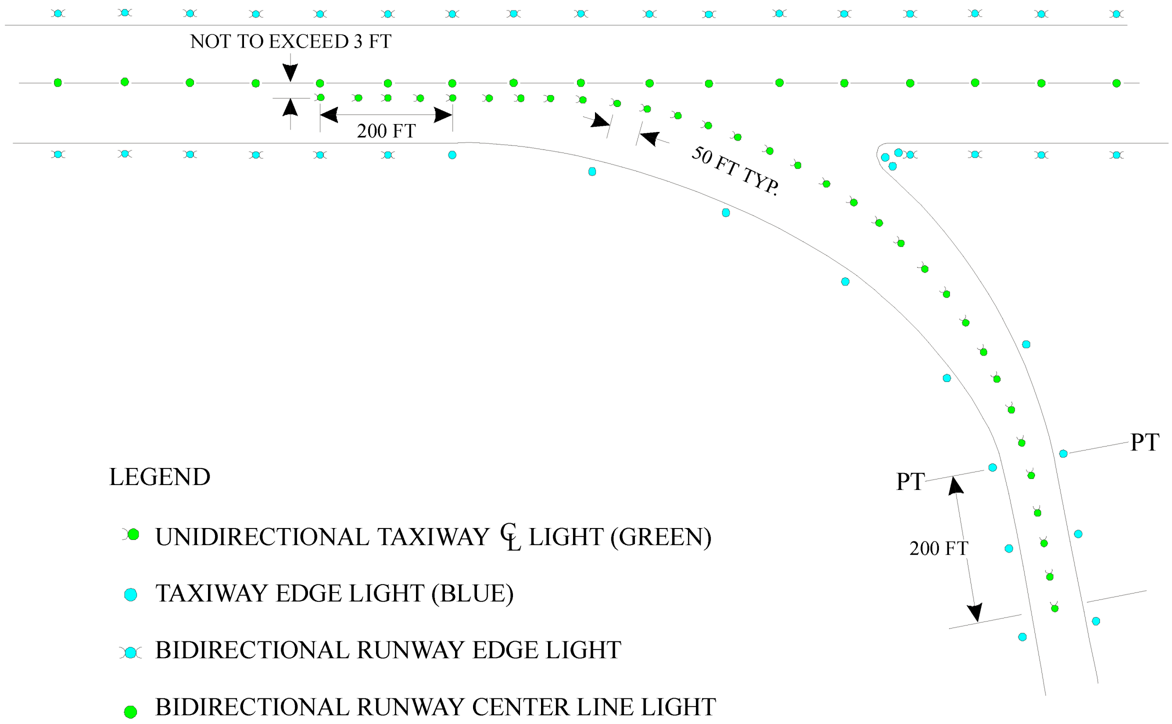


Figure 2. Large-Radius Runway Exit Lighting Configuration

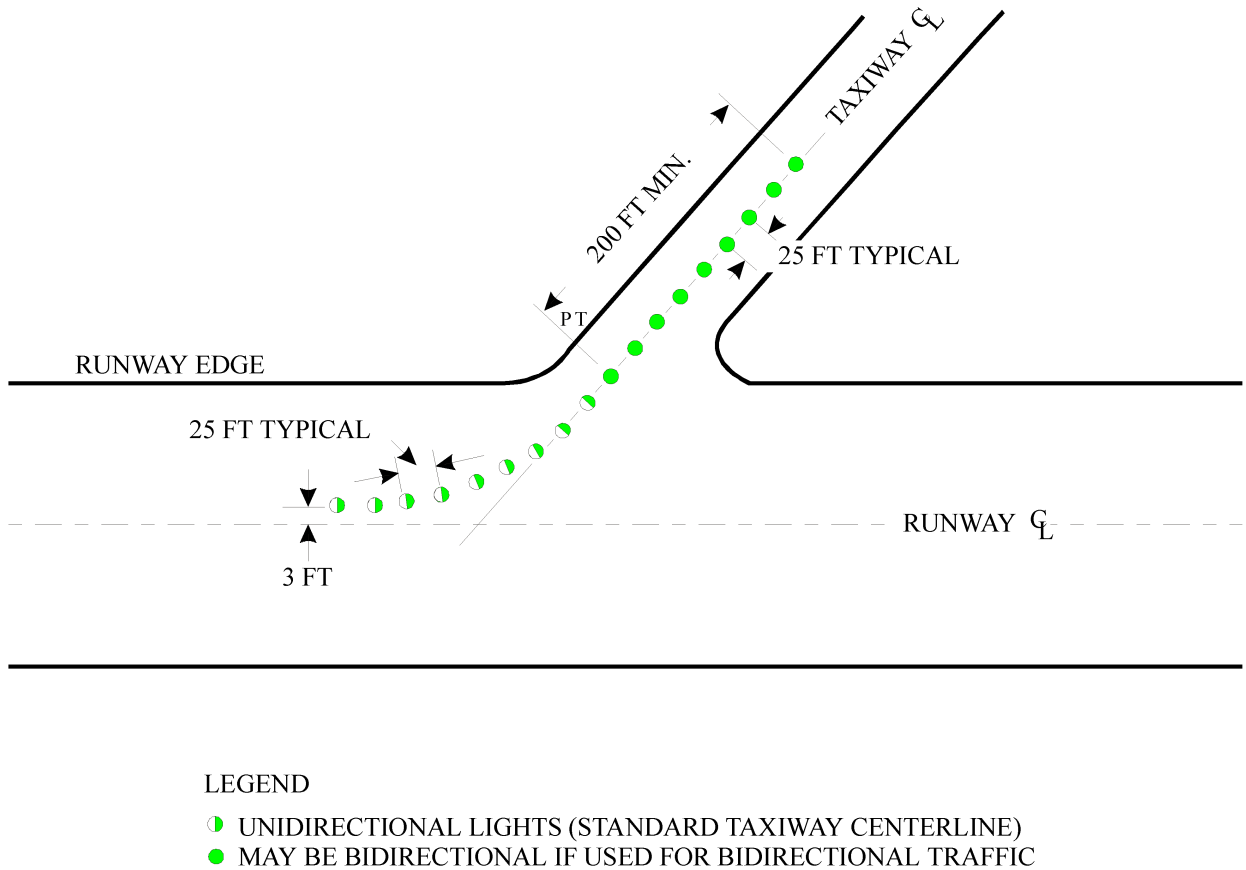


Figure 3. Typical Short-Radius Runway Exit Centerline Lights

ORGANIZATIONAL

RUNWAY DISTANCE MARKERS (RDM)

RUNWAY VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for Runway Distance Marker(s) (RDM). The purpose of the RDM is to indicate the distance remaining to the end of the runway during takeoff or landing to pilots. The RDM provide this information for day or night operations in all weather conditions. The requirements in this WP are a design guide to be used for new installations. Existing installations may continue to be used and maintained, but these requirements shall apply for replacements or major upgrading of the RDM system.

1-3. JUSTIFICATION REQUIREMENTS. The RDM should be provided for all runways where fixed wing jet aircraft operations are conducted and are recommended for runways intended for operations of propeller type aircraft. If the runway is used for nighttime or low visibility Instrument Flight Rules (IFR) operations (WP 002 00), the RDM shall be an internally lighted sign except for some training and auxiliary fields. If the runway is used only for daytime operations, the RDM may be unlighted. For training or auxiliary fields where, nighttime operations are limited to Visual Flight Rules (VFR) conditions and the aircraft are normally equipped with landing lights, the RDM may be unlighted retroreflective type markers. Approval for deviations from these requirements is required (WP 002 00).

1-4. RELATED FACILITIES. The visual aids used in conjunction with the RDM are as follows:

- Runway Markings (WP 004 01),
- High Intensity Runway edge Lights (HIRL) (WP 004 05),
- Threshold lights (WP 004 02),
- Runway End Lights (WP 004 04),
- Arresting gear markers (WP 004 10).

2-1. DESCRIPTION.

2-2. The RDM shall consist of a row of vertical markers (signs) along each side of the runway spaced 1000 feet longitudinally. The faces of the markers shall be vertical. Each face of the markers shall indicate the distance in thousands of feet remaining to the end of the runway. An example of an RDM system installation is shown in Figure 1. The color for the RDM shall be white numerals on a black background. Existing installations of RDM with yellow numerals may continue in service, but only one color should be used for a runway.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details of the runway distance markers, refer to UFC 3-535-02 and FAA AC 150/5340-18. General design and installation requirements are given below.

3-3. METHODS OF INSTALLATION. The RDM shall be mounted on frangible couplings. The electrical cables enter the RDM through conduit in the concrete base and the frangible couplings.

3-4. LOCATION. The rows of RDM are parallel to and equidistant from the runway centerline.

3-5. A pair of RDM on opposite sides of the runway is located at each 1000-foot spacing (Figure 1).

3-6. The lines connecting the pairs of RDM shall be perpendicular to the runway centerline.

3-7. The apex or edges of the RDM nearest the runway in each row shall form a line not less than 50 feet and not more than 75 feet from the full-strength runway edge. The 75-foot distance is preferred.

3-8. The RDM shall be not less than 50 feet from the edge of any intersecting runway or taxiway.

3-9. Where the 1000-foot positions do not provide clearance from an intersecting runway or taxiway, the position of the pair of RDM may be moved a maximum of 100 feet to obtain the required clearance (Figure 2). If this variation in position does not permit the required clearance for both markers, install a single marker if possible.

3-10. For runways with lengths that are not exact multiples of 1000 feet, the extra distance is apportioned at the runway ends by the equation:

$$E = \frac{D - M}{2}$$

Where E = the excess distance in feet to be added to the interval at the runway ends,

D = length of runway in feet,

M = the distance in feet of the maximum number of 1000-foot intervals.

3-11. An example is for a runway 9750 feet in length, the excess distance, E, equals 375 feet. The zero points for measuring the 1000-foot interval are located 375 feet along the runway from each end. RDM are not installed at zero points or runway ends.

3-12. The RDM shall not obstruct or be obstructed by the arresting gear markers. If the normal position for a pair of RDM conflicts with the location of arresting gear markers, the positions of the pair of RDM may be adjusted to provide adequate separation (WP 004 10). The arresting gear markers shall have position precedence over the RDM.

3-13. MOUNTING FOR DEEP SNOW AREAS. In areas with frequent snow accumulations of six inches or more, raising the RDMs may be needed to reduce the buildup of drifting snow against the markers. The bottoms of the markers may need to be raised 12 inches or more above the frangible couplings in some areas. However, because of the increased wind loading with the longer leverage, the RDM should have three or four support legs with at least one leg out of the common alignment. The extension nipples shall fit the frangible couplings and the attachments to the RDM. Check with the sign manufacturers for suitability of their RDM for deep snow installations and any special installation requirements.

3-14. DIMENSIONS AND TOLERANCES. The installation of the RDM shall be as follows:

- The bases of the RDM shall be not less than 6 inches above the ground.
- The top of the RDM shall be not more than 57 ±3 inches above the near runway edge at the position, except for areas with frequent deep snow.
- The longitudinal axis of the RDM shall be at right angles ±2 degrees to the runway centerline and along the lines connecting the pairs of markers.
- The horizontal axis of the pairs of RDM shall be at right angles ±1 degree to the runway centerline.

- Individual RDM may have a tolerance of ±12 inches from the line of RDM.
- The longitudinal location of the pairs of RDM may have a tolerance of ±10 feet to avoid installation problems and ±100 feet to provide clearance from intersecting runways and taxiways.
- The vertical axis of the RDM has tolerance of ±2 degrees.

4-1. EQUIPMENT.

4-2. The basic equipment for the RDM are elevated markers or signs per Table 1. A typical RDM is shown in Figure 3. The faces of the markers shall be 4 feet by 4 feet with a white numeral on a black background per Figure 4. All markers for a runway should have the same size and font numerals. The numeral shall be one or two digits to indicate the distance in thousands of feet to the end of the runway for each direction. Three classes of markers are used for specific purposes as follows:

- Unlighted RDM for daytime operations only are usually constructed locally per Figure 3A and consist of painted numerals and background on a sheet of plywood or metal.
- Unlighted RDM that may be used at night only for VFR operations. This type of RDM is similar to RDM in paragraph “a.” except that the numerals are retroreflective white.
- Internally lighted RDM for general service use are per Figure 3B.

Table 1. Schedule of Lighting Equipment for Runway Exits

PURPOSE AND TYPE OF FIXTURE[1]	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
Day only Unlighted markers, local manufacture	None		
Night, VFR only Retroreflective markers, local manufacture	None		
Standard RDM Internally lighted markers			
FAA AC 150/5345-44 Type L-858B size 4, style 3	As determined by manufacturer.	As determined by manufacturer.	

NOTES:

1. Number of RDM required varies with length of runway.

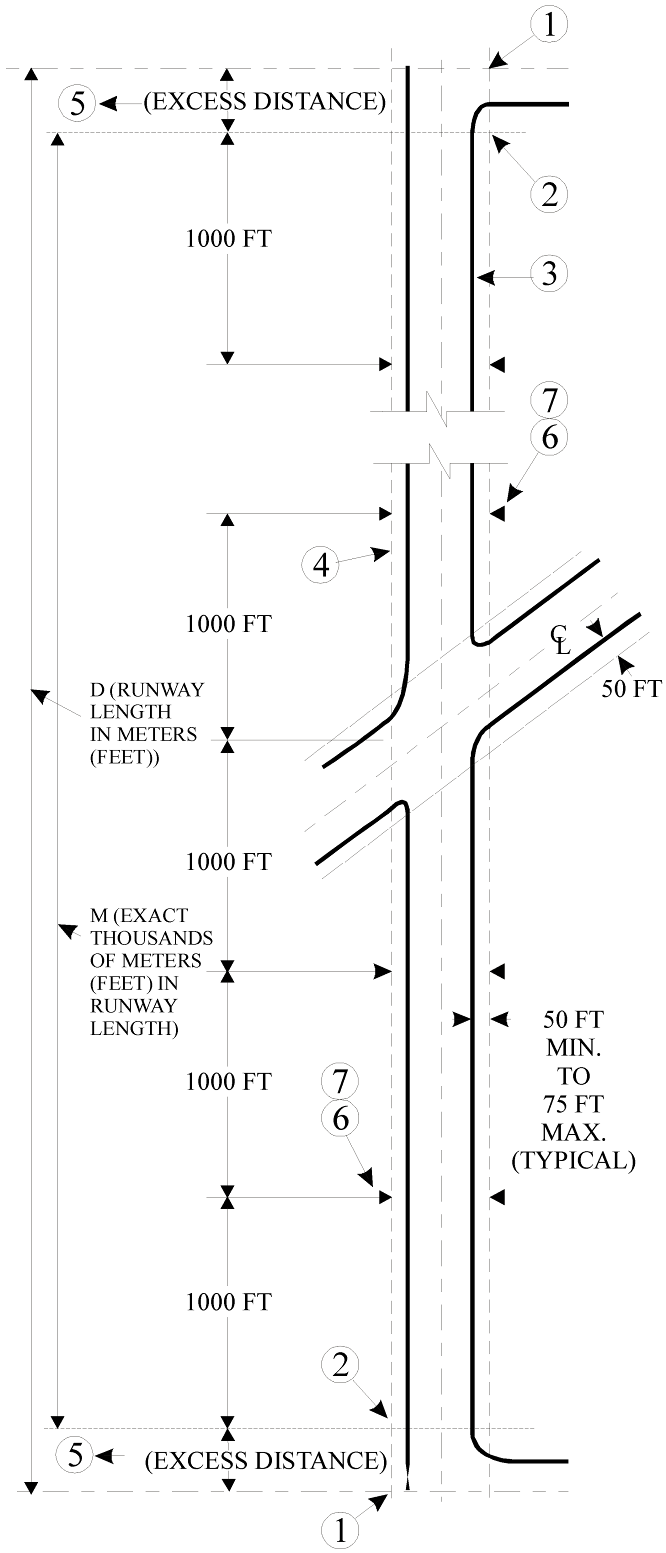
5-1. PHOTOMETRIC REQUIREMENTS.

5-2. The average luminance of the numeral at rated current (6.6 amperes) shall be not less than 5 nor more than 75 footlamberts. The luminous area of the RDM shall be uniformly lighted and legible at not less than 800 feet. The average luminance of the numeral at the lowest brightness setting (2.8 amperes) shall be not less than 50 percent of the average luminance at rated current.

6-1. POWER AND CONTROL.

6-2. POWER. The electrical power required for the internally lighted RDM is usually supplied from the associated HIRL circuit. Each marker is individually powered from the nearest available runway edge light. The circuit may be either 6.6A or 20A for which a suitable isolation transformer is required. The RDM must be provided with power units that maintain the brightness of the markers at not less than 50 percent of full brightness for any intensity setting of the HIRL. Alternatively, a dedicated 3 step constant current regulator set 5.5 amperes may be used to power the RDM. Doing so will prevent any power factor issues that may arise on the HIRL. The RDM emergency power and automatic transfer requirements are directly related to the runway operational category (CAT I, II, or III).

6-3. CONTROL. The RDM do not have brightness control. The RDM ON/OFF control is provided by the system circuit to which the RDM is connected.



NOTES:

1. INDICATES INDEX POINT.
2. INDICATES ZERO POINT. A RUNWAY DISTANCE MARKER SIGN IS NOT INSTALLED AT A ZERO POINT.
3. INDICATES EDGE FULL STRENGTH RUNWAY PAVEMENT.
4. INDICATES LINE OF SIGNS.
5. EXCESS DISTANCE (E) IS EQUAL TO ONE HALF OF THE DISTANCE THAT THE RUNWAY LENGTH EXCEEDS EXACT THOUSANDS OF METERS (FEET). THE EXCESS DISTANCE LOCATES THE ZERO POINT. FORMULA FOR EXCESS DISTANCE:
6. RUNWAY DISTANCE MARKER SIGNS ARE LOCATED LONGITUDINALLY AT 1000 FT INTERVALS ALONG THE LINES OF SIGNS BETWEEN ZERO POINTS.

$$E = \frac{D - M}{2}$$

7. LOCATE SIGN LATERALLY SO APEX OR EDGE OF SIGN NEAREST RUNWAY WILL BE ON THE LINE OF SIGNS.

LEGEND:

▶ INDICATES LOCATION AT WHICH SIGN IS INSTALLED

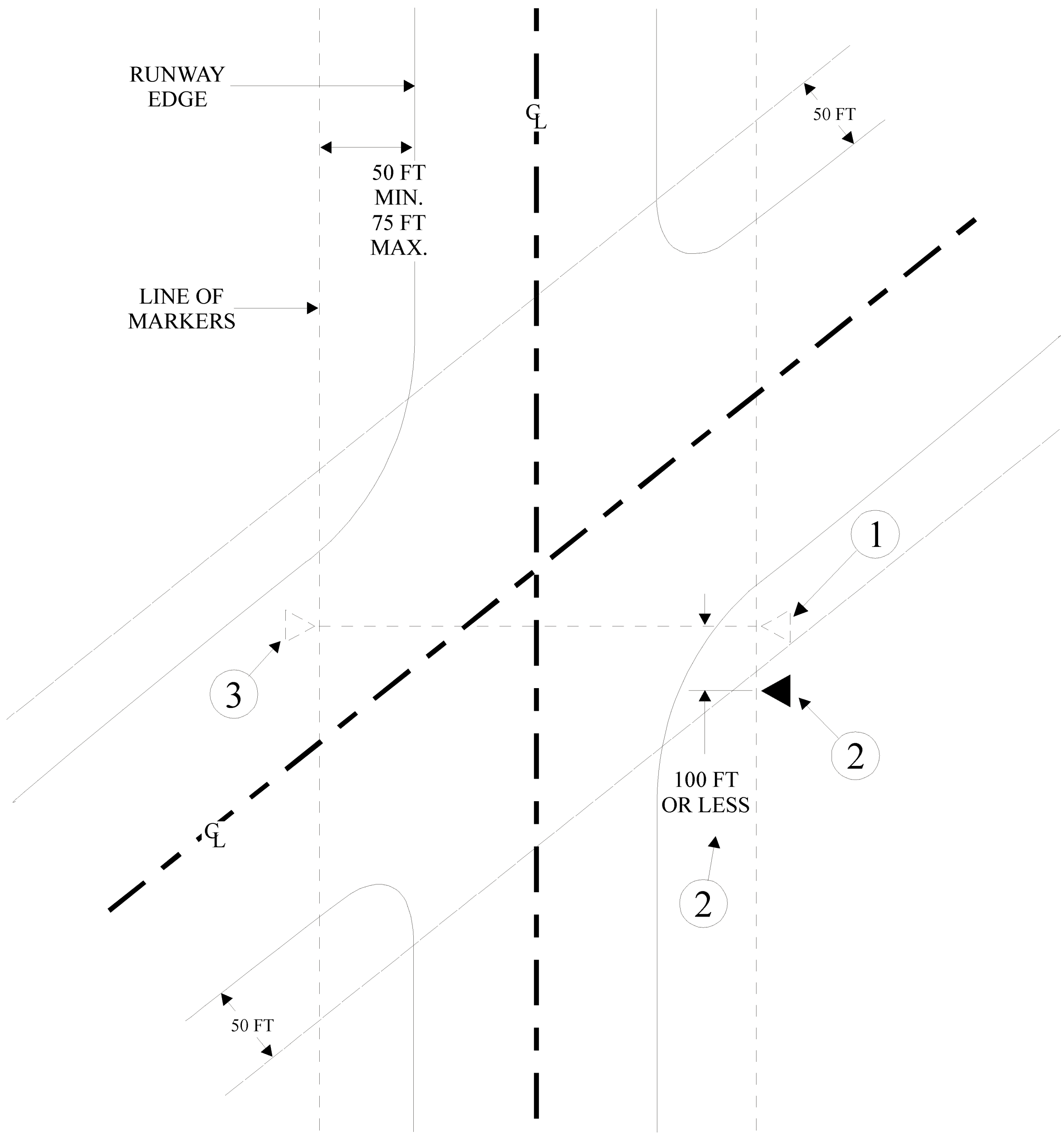
INDICATES LINE OF MARKERS (SIGNS)

INDICATES LINE THROUGH RUNWAY THRESHOLD

INDICATES LINES THROUGH ZERO POINT

INDICATES 50 FT CLEARANCE FROM EDGE OF INTERSECTING PAVEMENT

Figure 1. Runway Distance Marker Installation



NOTES:

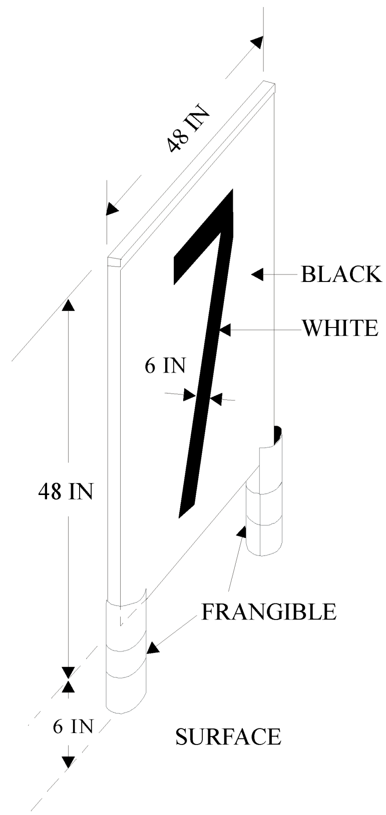
1 INDICATES SIGN LOCATION CLOSER THAN 50 FT TO EDGE OF INTERSECTING PAVEMENT.

2 INDICATES ADJUSTED SIGN LOCATION. THE ADJUSTED LOCATION IS 100 FT OR LESS FROM LOCATION DESIGNATED BY NOTE 1, BUT IS NO MORE THAN 50 FT FROM EDGE OF INTERSECTING PAVEMENT.

3 OMIT THIS MARKER. IT CAN NOT ADEQUATELY CLEAR THE INTERSECTING PAVEMENT.

Figure 2. Typical Distance Marker Installation at Intersection

TYPE: LOCAL MANUFACTURE, WHITE PAINT OR RETROREFLECTIVE TYPE NUMBER ON BLACK BACKGROUND.



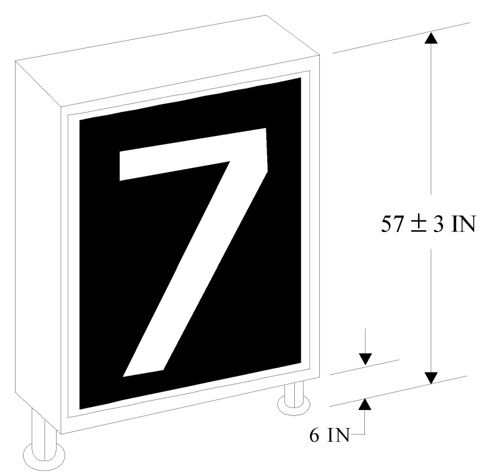
A. UNLIGHTED MARKER

MARKER: FAA AC 150/5345-44, TYPE L-858B, SIZE 4, STYLE 3.

LAMP: TYPE AS DETERMINED BY MANUFACTURER.

ISOLATION TRANSFORMER: RATING AS DETERMINED BY THE MANUFACTURER.

COLOR: WHITE NUMERALS ON A BLACK BACKGROUND OR FOR EXISTING INSTALLATIONS YELLOW NUMERALS ON A BLACK BACKGROUND.



B. INTERNALLY ILLUMINATED MARKER

Figure 3. Typical Runway Distance Markers (RDM)

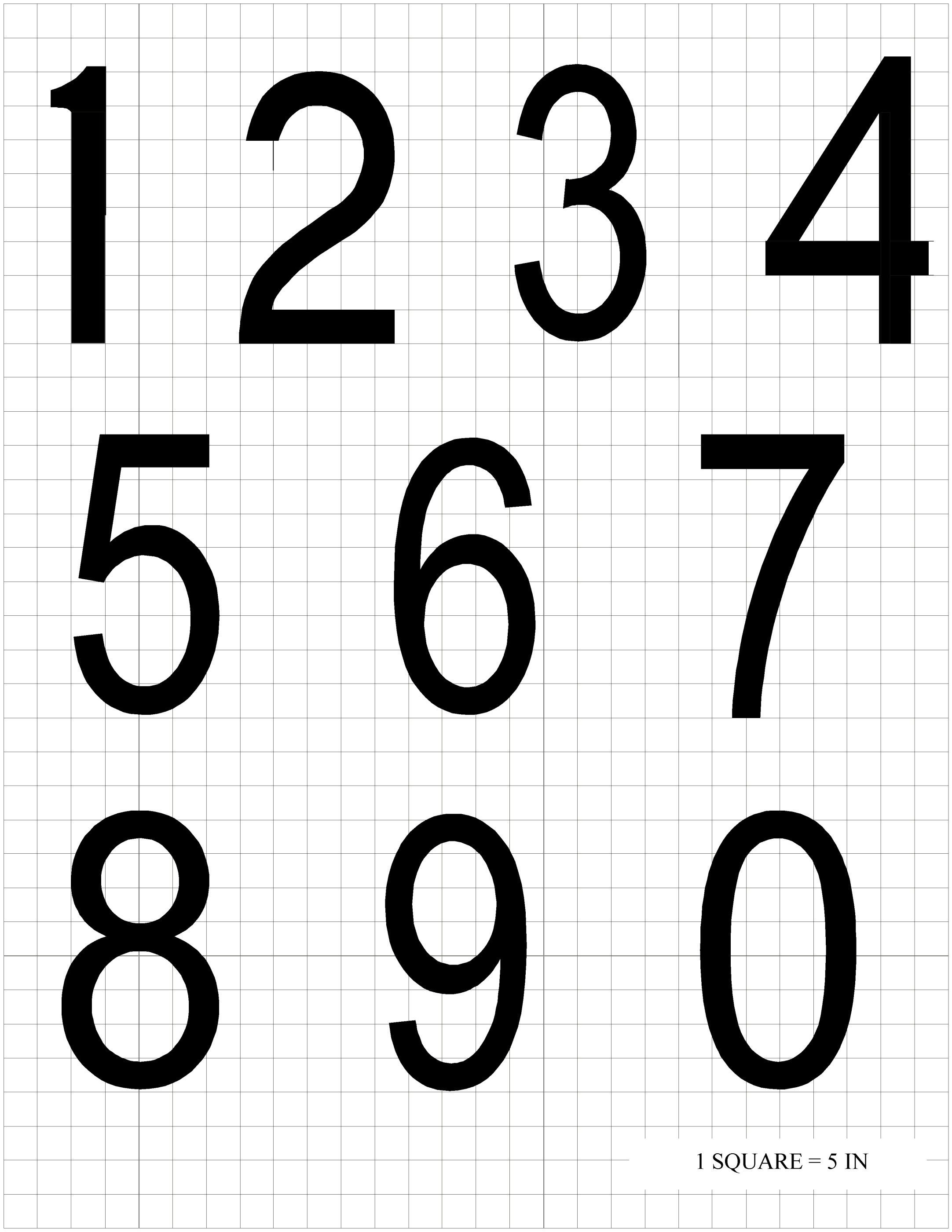


Figure 4. Typical Runway Distance Markers Numerals

ORGANIZATIONAL

ARRESTING GEAR MARKERS AND MARKINGS

RUNWAY VISUAL AIDS

Reference Material

Introduction .... WP 002 00
Runway Visual Aids, Runway Markings .... WP 004 01
Runway Visual Aids, Runway Threshold Lights .... WP 004 02
Runway Visual Aids, Runway End Lights .... WP 004 04
Runway Visual Aids, High-Intensity Runway Edge Lights (HIRL) .... WP 004 05
Runway Visual Aids, Runway Distance Markers (RDM) .... WP 004 09
Electrical Power and Control for Visual Aids, Auxiliary Power and Power Transfer Equipment .... WP 009 01
Aeronautical Ground Light and Surface Marking Colors .... ICAO, Annex 14, Vol. 1, App. 1
Beads (Glass Spheres); Retro-Reflective .... FED TT-B-1325
Colors, Use in Government Procurement .... SAE AMS-STD-595
Design Drawings for Visual Aid Navigation Facilities .... UFC 3-535-02
E-28 Shore-Based Emergency Arresting Gear .... NAVAIR 51-5-31
Isolation Transformers for Airport Lighting Systems .... FAA AC 150/5345-47
Light, Markers, Airport, Semiflush, General Specifications for MIL-L-26202
Paint, Traffic and Airfield Marking, Waterborne .... FED SPEC TT-P-1952F
Specification for Runway and Taxiway Light Fixtures .... FAA AC 150/5345-46
Specification for Taxiway and Runway Signs .... FAA AC 150/5345-44
Standards for Airport Sign Systems .... FAA AC 150/5340-18
Standards for Specifying Construction of Airports .... FAA AC 150/5370-10

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for arresting gear marker (AGM) signs and pendant cable pavement markings used in conjunction with the aircraft arresting gear. The purpose of the AGM signs and pavement markings is to provide the pilot with information relevant to the exact location of the deck pendant. The marker signs and pavement markings are used for day and night operations in all weather conditions. These requirements are to be used for new installations. Existing installations may continue to be used and maintained, but these requirements shall apply for replacements or major upgrading of the arresting gear marker system.

1-3. JUSTIFICATION REQUIREMENTS. All operational arresting gears shall use the associated AGM signs and pavement markings. Approval of requests for deviations from these requirements shall be processed as directed in WP 002 00.

1-4. RELATED FACILITIES. In addition to the arresting gear, other airfield visual aids related to the use of the AGM signs and pavement markings include the following:

- High Intensity Runway edge Lights (HIRL) (WP 004 05),
- Threshold lights (WP 004 02),
- Runway End Lights (WP 004 04),
- Runway Distance Markers (RDM) (WP 004 09),
- Runway Markings (WP 004 01).

2-1. DESCRIPTION.

2-2. Each arresting gear installation shall be provided with a pair of AGM signs. These markers or signs shall be located in line with the deck pendant, one on each side of the runway, and shall be internally lighted for night use. The position of the pendant cable may be marked with a series of yellow disks in a line across the runway.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details about arresting gear marker signs, refer to UFC 3-535-02 and FAA AC 150/5340-18. For installation of runway pavement markings refer to FAA AC 150/5340-1M. General design and installation requirements for AGM signs and runway pavement markings are described below.

3-3. METHODS OF INSTALLATION. The AGM signs shall be mounted on frangible couplings (see FAA AC 150/5345-44 for detailed information about sign sizes and their associated frangible couplings). The electrical cables enter the signs through conduit in the concrete base and the frangible couplings. The pendant cable markings are painted on the surface of the runway.

3-4. LOCATION. The location of the AGM and the pendant cable markings shall be as follows:

3-5. AGM Signs.

3-6. The AGM signs shall be located in line with the deck pendant position and equidistant from the runway centerline for each arresting gear installation. The edge of the sign nearest to the runway shall be not less than 60 feet from the runway edge. If the position of the AGM signs should conflict with or be obscured by the Runway Distance Markers (RDM) the signs shall be relocated. The arresting gear markers shall have precedence for viewing from the runway. Guides for relocating the RDM are as follows:

- If the RDM is the same distance from the runway edge as the AGM sign, but displaced 20 feet or more longitudinally from it, relocating the RDM is not required.
- If the RDM position is less than 20 feet longitudinally along the runway from the AGM sign, the RDM shall be located in line with the deck pendant and 10 feet or more farther from the runway edge than the sign.
- If the RDM position is closer to the runway edge and between 20 and 200 feet longitudinally from the AGM sign, the RDM shall be relocated the same distance from the runway edge as the AGM signs.
- If the RDM position is farther from the runway edge and 200 feet or more longitudinally from the AGM signs, the RDM may be located the same distance from the runway edge as the arresting gear signs if the RDM is obscured.

3-7. Pendant Cable Markings.

3-8. The pendant cable markings (see Figure 1) shall be equally spaced in a line at right angles to the runway centerline with the physical runway centerline between the two center disks.

3-9. The disk markings shall be centered along the cable axis when the cable is rigged for engagement.

3-10. Where the disk markings coincide with the white runway markings (WP 004 01), the runway markings are interrupted at this location for an area not less than one foot from the edge of the disk marking.

3-11. Environmental regulations in some states, such as California, or other authorities may prohibit or restrict the use of solvent base paints.

3-12. For the yellow disk pavement markings, this may require using Federal Specification (Fed. Spec.) TT-P-1952F vice TT-P-85 paint. For the slower drying Fed. Spec. TT-P-1952F paint, timing the application of the retroreflective beads may be required to assure their adherence without sinking too deeply into the paint.

3-13. Optional Markings.

3-14. Arresting Gear Tape Radius. All arresting gear tape radius and tape connector battery markings shall be 6 inches in width and non-retroflective yellow in color.

3-15. The location of the tape connector battery marking should be determined with the arresting gear in the battery position, properly centered across the runway.

3-16. The tape connector battery marking shall have an inner diameter of 2 feet, approximately 18 feet from the center of the runway edge sheaves.

3-17. The arresting gear tape sweep radius should be approximately 18 feet from center of runway edge sheave and follow a 180-degree arc.

3-18. Variations in runway width, and arresting gear set back from runway edge, may cause 18 feet radial dimension to vary.

3-19. Environmental regulations in some states, such as California, or other authorities may prohibit or restrict the use of solvent base paints. For the yellow markings, this may require using type FED SPEC TT-P-1952F vice TT-P-85 paint.

3-20. Donut Wire Support Location. All donut wire support battery location markings shall be 3 inches in width, 12 inches in length and non-retroreflective white in color. Wire support markings shall be located per E28 Technical Manual, NAVAIR 51-5-31. The wire support markings should use a cross deck pendant in battery position with cable meeting proper cable height requirements. The white markings should be FED SPEC TT-P-1952F. paint per with SAE AMS-STD-595, Chip No. 17875.

3-21. DIMENSIONS AND TOLERANCES. The installation of the AGM signs and markings shall be as follows:

- The concrete bases of the arresting gear signs shall be not less than 6 inches above the ground.
- The top edge of the arresting gear marker sign shall be not more than 57 ±3 inches above the level of the near runway edge at the sign position.
- The axis of the runway pavement disk markers shall be at right angles ±2 degrees to the runway centerline and along the line connecting the pairs of markers.
- Individual runway pavement disk markers may have a 1-foot tolerance from the line along the deck pendant.
- The faces of the arresting gear signs shall be vertical ±2 degrees.
- The runway pendant cable markings shall be 10-foot ±2 inches diameter disks with centers spaced at 25 feet ±6 inches across the runway. The nearest edges of the center disks shall be 7.5 feet ±1 inch from the runway centerline on each side.
- A 200-foot wide runway shall have eight disks.

4-1. EQUIPMENT.

4-2. The AGM sign shall be per Table 1 and Figure 2. The signs shall be internally illuminated and the luminance shall be not less than 50 percent of full brightness for any intensity setting.

NOTE

It is not recommended to connect signs to the runway edge lighting circuits. Ideally, signs should use a dedicated constant current regulator set to 5.5 A.

4-3. Each face of the AGM sign shall have a yellow translucent disk not less than 39 inches in diameter centered on a square black opaque background that is 48 inches per side.

4-4. All AGM signs shall be mounted on frangible couplings. If the runway edge lights are an elevated type and may be damaged by the arresting gear during an aircraft arrestment operation, the lights shall be replaced with semi-flush runway edge lights (WP 004 05). Use light fixtures per FAA AC 150/5345-46, Type L-850C. The pendant cable markings shall be retroreflective yellow painted on the runway surface.

Table 1. Schedule of Equipment/Materials for AGM Signs and Runway Pendant Cable Markings

PURPOSE AND TYPE OF FIXTURE[1]	LAMP RATING AND TYPE	ISOLATION TRANSFORMER RATING	ISOLATION TRANSFORMER FAA TYPE AC 150/5345-47
Arresting gear markers. FAA AC 150/5345-44 Type L-858B size 4, style 1 or 3, yellow disk	As determined by manufacturer.	As determined by manufacturer.	
Replacement of elevated runway edge lights. (See WP 004 05)			
Pendant cable markings.			
Paint, retroreflective yellow, FED SPEC TT-P-1952F and glass beads FED SPEC TT-B-1325 Type III gradation A.			

NOTES:

1. Two markers for each arresting gear installed. Number of semiflush lights vary with the installation, usually 4 to 8 per arresting gear.

5-1. PHOTOMETRIC REQUIREMENTS.

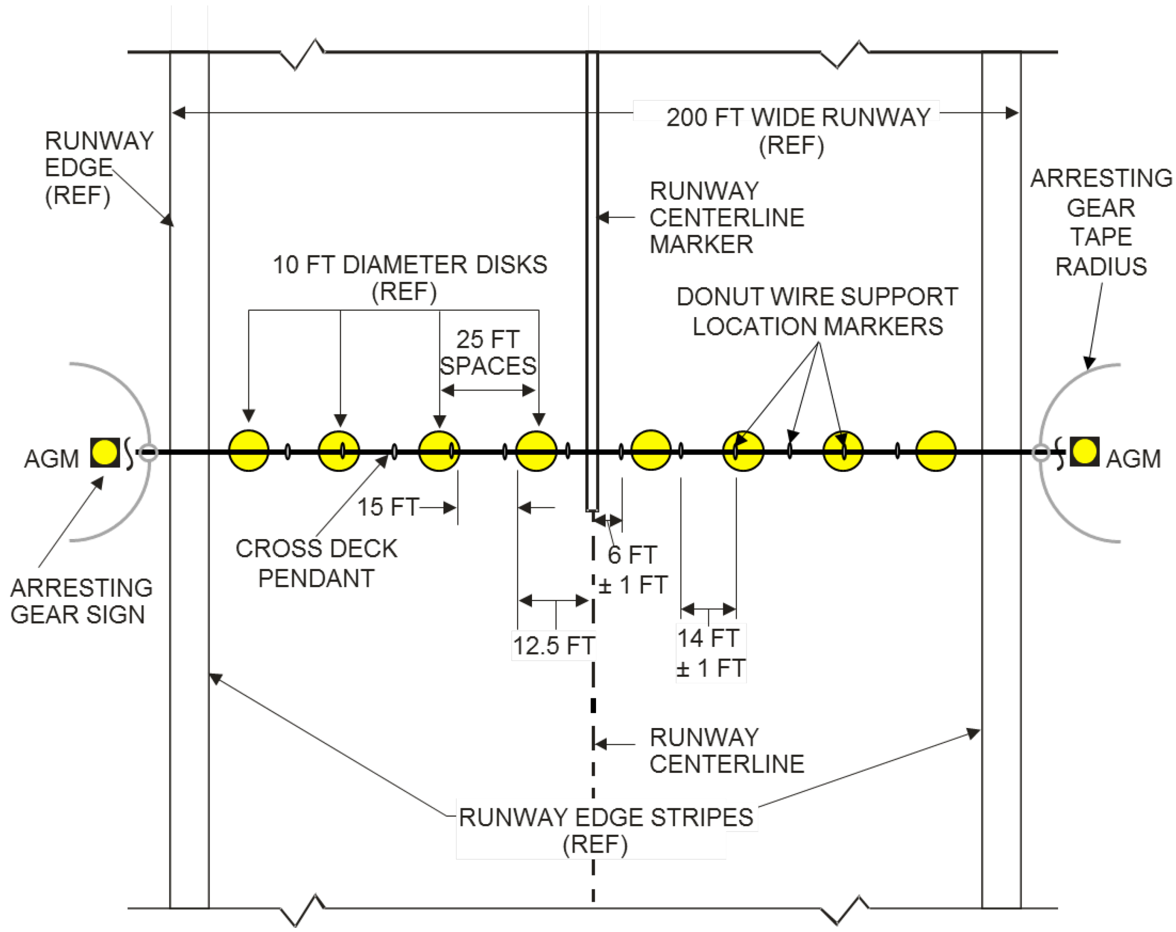
5-2. The average luminance of the AGM sign yellow disk at rated current shall be per the requirements in FAA AC 150/5345-44. The ratio of the brightest area to the darkest areas shall not exceed a ratio of 4:1. The average luminance of the disk at the lowest brightness setting shall be not less than 50 percent of the average luminance at rated current. The color of the emitted light shall be per the requirements in FAA AC 150/5345-44. When the AGM sign is unlighted, the sign colors shall be per SAE AMS-STD-595 chip No. 23538 for yellow and chip No. 27038 for black. The color of the runway pavement pendant cable markings shall be retroreflective aviation surface yellow in accordance with SAE AMS-STD-595, chip No. 23538.

6-1. POWER AND CONTROL.

6-2. POWER. The electrical power required for the arresting gear markers is supplied from one of the following sources:

- A 120 VAC local source, if available. Emergency power should be provided.
- The runway edge light circuit for the runway. Each AGM sign is connected to the circuit at the nearest available runway edge light. The circuit may be either 6.6A or 20A, for which a suitable isolation transformer and sign power adapter is required. Ideally, AGM signs should be powered with a constant current regulator set to 5.5 A that is separate from runway lighting circuits. The AGM signs must be provided with power units that maintain the brightness of the markers at not less than 20 percent of full brightness for any intensity setting. The emergency power and automatic transfer requirements (WP 009 01) are provided by the runway edge light circuits.

6-3. CONTROL. If the AGM signs are powered from the runway edge light circuit, separate switching of the brightness control is not required. A series lighting circuit power adapter may be required. See AC 150/5345-44 for additional information about series lighting circuit power adapters. If the AGM signs are powered from a local 120 VAC source, ON-OFF switching may be provided by photo-electric switches or by a remote manual control. Brightness control is not required.



COLOR OF DISKS IS RETROREFLECTIVE YELLOW

Figure 1. Configuration for Pendant Cable Markings

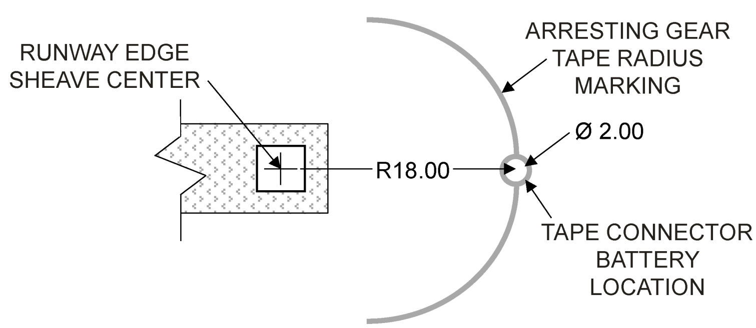
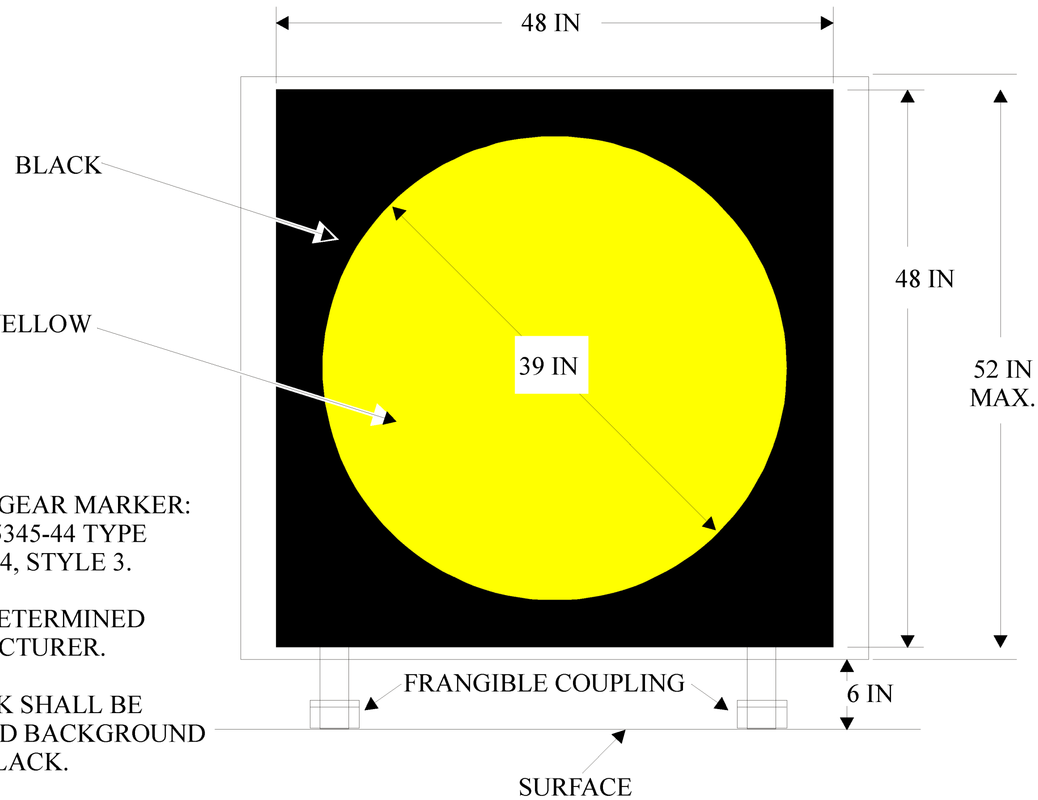


Figure 2. Configuration for Arresting Gear Tape Radius



ARRESTING GEAR MARKER:
FAA AC 150/5345-44 TYPE
L-858B, SIZE 4, STYLE 3.

LAMP: AS DETERMINED
BY MANUFACTURER.

COLOR: DISK SHALL BE
YELLOW AND BACKGROUND
SHALL BE BLACK.

(DIMENSIONS ARE FOR REFERENCE ONLY)

NOTE: BASE MARKER MAY BE TRIANGULAR OR RECTANGLE.

Figure 3. Typical Arresting Gear Marker

ORGANIZATIONAL

DESCRIPTION

TAXIWAY VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. Taxiway visual aids consist of markings, lights, and signs located on or near the taxiways. The purpose of these visual aids is to identify routes and provide guidance to pilots for safe and efficient taxiing to and from runways and service areas during any operational condition. The visual aids shall clearly define the taxiway surface and its limits, provide directional and destination information, and also mark critical areas and areas of special interest. The information must be easily recognized and used in restricted visibility conditions, day or night, to the operating minimums authorized for the airfield.

1-3. SCOPE. The taxiway visual aids Section of this Technical Manual contains the configuration requirements, applications, basic design and installation criteria, and equipment required for installation of taxiways of Navy shore-based airfields. Each taxiway shall have adequate visual aids to satisfy the requirements for aircraft taxiing operations. The requirements in the individual Work Package(s) (WP) provide guidance for personnel servicing existing systems or designing new installations. Existing installations may be used and maintained as installed; however, extensions, major modifications, or upgrading shall comply with the requirements of the WP for these aids.

1-4. STANDARDIZATION. The WP for each visual aid system establishes the requirements to be used for Navy airfields. By combining the WPs for all the taxiway visual aids required for the mission and special characteristics of the airfield, standardization of taxiway visual aids for Navy airfields is attained. When deviations of installations are necessary, they shall be authorized in accordance with the approval procedures of WP 002 00.

1-5. FLIGHT RULES. Flight rules do not apply to taxiing operations, but the taxiway visual aids must perform satisfactorily in all authorized flight conditions. The taxiway visual aids required for Visual Flight Rules (VFR) may not need the number or type of aids necessary for Instrument Flight Rules (IFR). (See WP 002 00 for definitions of flight rules.) The critical areas for clearances from the runway may be greater for Category II and Category III operations than for operations in better visual range conditions. However, the taxiway visual aids required for the lowest authorized flight category will also provide the guidance required for the higher visibility conditions. The design of visual aids for a given taxiway shall be those required for the lowest visibility condition.

2-1. DESCRIPTION OF TAXIWAY VISUAL AIDS.

2-2. The taxiway lights and markings identify the area as a taxiway, define its limits, and provide directional guidance for maneuvering aircraft. The signs provide information about routes to taxi destinations and identify areas along the taxi route. Taxiway markings are painted on the paved surfaces and include centerline, edge, holding position, and checkpoint markings. The taxiway lights include either edge lights, centerline lights, or a combination of both lights, and in some cases holding position lights. Taxiway guidance signs provide information that the pilot must recognize because of potential hazards. In addition, general information is provided that assists the pilot in proceeding along the proper taxi route. Special signs may provide checkpoint information or routing information at complex intersections.

3-1. SELECTION OF TAXIWAY VISUAL AIDS.

3-2. The types of taxiway visual aids required depend on the lowest meteorological conditions authorized for operations and the arrangement of runways and service areas of the airfield. Table 1 is a guide to help determine the required visual aids. The design requirements are found in the WP for each type of taxiway visual aid. When taxiway visual aids are designed, air traffic ground control must be involved with the design process. For taxiway visual aid installation and design details, refer to UFC 3-535-02 and FAA AC 150/5340-30 for taxiway lights. For taxiway sign installation details and design, refer to FAA AC 150/5340-18. For taxiway sign technical details (example: sign types, sign fonts, sign sizes, luminance requirements, and frangible fitting requirements, refer to FAA AC 150/5345-44. Refer to UFC 3-260-04 for taxiway pavement markings.

3-3. The WP and requirements of this WP are not intended to direct or request implementation but are to establish uniformity when implementation is undertaken.

Table 1. Taxiway Visual Aids Requirements

Visual Aids System	Authorized Operations				
		IFR Category			
	VFR	Non-Prec	I	II	III
Taxiway Markings (WP 005 01)	R	R	R	R	R
Taxiway Edge Lights (WP 005 02)	R	R	R	R	C
Taxiway Centerline Lights, Intersections (WP 005 03)	NR	OPT	C	C	R
Taxiway Centerline Lights, Continuous (WP 005 03)	NR	NR	OPT	C	R
Taxiway Guidance Signs (WP 005 04)	RS	C	R	R	R
Special Signs (TACAN) (WP 005 05)	RS	RS	RS	RS	RS
Special Signs (Billboards) (WP 005 05)	RS	RS	RS	RS	RS
Holding Position Signs (WP 005 06)	C	R	R	R	R
Holding Position Lights (WP 005 06)	RS	RS	RS	RS	RS
Taxiway Lights for Runways Used as Taxiways (WP 005 07)	RS	RS	RS	RS	RS

C - Recommended

R - Required

RS - Required under special conditions. * Examples: Established TACAN checkpoint; runway used as taxiway.

OPT - Option as recommended by air station commander and approved by NAVAIR.

NR - Not Required.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3 (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED's are recommended for new installations, or complete replacement; however, do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

ORGANIZATIONAL

TAXIWAY MARKINGS

TAXIWAY VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) identifies the requirements for taxiway markings used for paved taxiways on shore-based airfields. The markings provide visual cues to pilots for taxiway identification, longitudinal alignment information, runway holding position lines, taxiway edge recognition, and runway exits. In addition, taxiway markings assist pilots in taxiing aircraft between the runway and parking or service areas. The requirements in this WP function to establish uniformity of taxiway pavement markings for ease of pilot and ground vehicle recognition in the interest of safety and efficiency. The requirements shall be used for all new or resurfaced taxiways and whenever the existing taxiway pavement markings are to be repainted. Existing taxiway pavement markings may continue to be used until repainting is required.

1-3. JUSTIFICATION REQUIREMENTS. The taxiway pavement markings are the basic visual aids for taxiing guidance during daylight for Visual Flight Rules (VFR) or Instrument Flight Rules (IFR) operations (WP 002 00). Taxiway pavement markings also aid in safe taxiing at night although the taxiway edge lights or centerline lights are the basic visual aid. All paved taxiways shall be provided with taxiway markings. Additional markings or modifications may be approved for special operating conditions (WP 002 00).

1-4. RELATED FACILITIES. This WP includes all the standard taxiway pavement markings. It should be noted that the taxiway pavement markings are related to the runway markings (WP 004 01) used for runway exits and entrances. In addition, the taxiway pavement markings connect with apron and parking area pavement markings (WP 006 01). The taxiway pavement markings are related to the taxiway lights and signs in taxiway visual aids WP 005 00.

2-1. DESCRIPTION.

2-2. GENERAL. The elements of the taxiway pavement markings are as follows:

- Taxiway centerline markings - required.
- Holding position markings (Standard and Category II) - required.
- Runway entrance-exit markings - required.
- TACAN checkpoint markings - required, if established.
- Edge markings - optional.
- Shoulder markings - optional.
- Hazardous area markings - optional.
- Closed taxiway markings - optional.

2-3. The taxiway pavement markings will be painted with the specified color that is applied to the taxiway surface with the exception of temporary hazardous area markings that may use flags or barrier markings. Also, temporary closed taxiway markings may consist of materials such as easily removed tape of the proper color. The taxiway pavement markings identified in section 6 of this WP shall be per FAA AC 150/5340-1M, Appendix A.

NOTE

The VOR pavement marking in FAA AC 150/5340-1M, Appendix A may be used as a TACAN directional marking for aircraft orientation.

2-4. TAXIWAY CENTERLINE MARKINGS. (See FAA AC 150/5340-1M, Appendix A, for examples of taxiway centerline markings.) The centerline markings shall be a continuous retroreflective yellow stripe not less than 6 inches wide located along the physical taxiway centerline. If taxiway centerline lights are installed, the taxiway centerline stripe may be offset not more than 12 inches from the physical taxiway centerline to avoid painting over the lights. These taxiway centerline markings provide longitudinal guidance for steering an aircraft. The centerline markings may continue across intersecting taxiways or merge with the centerline marking of an intersecting taxiway to indicate turns. On taxiway curves or curved sections, the centerline markings shall be smooth curves. The minimum distance from the taxiway edge shall be not less than one-half the taxiway width.

2-5. RUNWAY HOLDING POSITION MARKINGS. (See FAA AC 150/5340-1M, Figures A-13, Holding position marking details, and A-14, Holding position marking details.) The runway holding position markings indicate the minimum safe distance for the taxiing aircraft from the runway when waiting to be cleared for takeoff or to taxi across the runway.

2-6. The holding position markings shall be retroreflective yellow solid and dashed lines that extend across the entire width of the taxiway.

2-7. The holding position markings shall be straight lines perpendicular to the taxiway centerline except at intersections with large areas for aircraft traffic.

2-8. If the runway holding position area extends beyond the holding position and the taxiway edge is not clearly defined, the holding position markings may be parallel to the runway centerline.

2-9. Two types of runway holding position markings are used. In some cases, both types may be installed for a given intersection. The types of holding position markings are:

- Standard holding position markings.
- Category II holding position markings.

2-10. STANDARD HOLDING POSITION MARKINGS. The standard holding position markings are used for all taxiway intersections with runways except for runways authorized for Category II operations. The markings are located **not less than 175 feet (250 feet is preferred) from the runway edge.** The markings consist of four parallel stripes, two continuous and two dashed lines. See FAA AC 150/5340-1M, Figure A-13 (Pattern A), Holding position marking details.

2-11. CATEGORY II HOLDING POSITION MARKINGS. For runways authorized for Category II operations (WP 002 00), the taxiway intersections shall be provided with Category II runway holding position markings.

2-12. The runway holding position markings shall be located **not less than 400 feet** from the runway centerline and outside of the critical area for the runway approach electronic aids.

2-13. The Category II markings consist of two parallel continuous stripes which are 12 inches wide and 24 inches apart and perpendicular to the taxiway together with the double 12-inch-wide connecting lines at 10-foot intervals (FAA AC 150/5340-1M, Figure A-13, (Pattern B) Holding position marking details).

2-14. RUNWAY LEAD-ON/LEAD-OFF MARKINGS. (See FAA AC 150/5340-1M, Figures A-16, Taxiway markings, A-17, Taxiway markings, and A-23, Taxiway shoulder markings.) The markings indicate the paths that are intended for entering or exiting from the runways at intersections with taxiways. The runway lead-on/lead-off markings are extensions of the yellow retroreflective taxiway centerline markings, except where they are interrupted for runway markings.

2-15. Runway lead-on/lead-off markings are yellow curved continuous lines that begin at the Point of Tangency (PT) of the taxiway fillet to a PT 36 inches from the near edge of the runway centerline marking. This curve should have the maximum radius which maintains a separation from the taxiway and runway edges not less than one half the width of the taxiway.

2-16. Beyond the PT near the runway centerline marking, the lead-on/lead-off markings continue parallel to the runway centerline marking for not less than 200 feet from the PT.

2-17. The entrance-exit marking shall be 6 inches wide except for long-radius exits.

2-18. For long-radius (high-speed) exits, the exit stripe shall be not less than 12 inches wide and shall follow the exit curve.

2-19. For taxiway intersections at the ends of the runway, the lead-on/lead-off marking shall terminate in line with the runway edge.

2-20. For other intersections, the lead-off/lead-on line shall be interrupted for the runway side stripes and other runway markings.

2-21. TACAN CHECKPOINT MARKINGS. If a checkpoint is established for checking the operation of the aircraft TACAN navigation equipment before takeoff, the proper aircraft position must be marked so the pilot can properly orient the aircraft.

2-22. The marking position should be on a taxiway centerline near the runway threshold, but far enough away from the runway edge for the TACAN checkpoint sign (WP 005 05) to be outside the immediate runway holding position area.

2-23. The center of the TACAN checkpoint marking shall be not less than 262.5 feet from the runway edge.

2-24. The line-of-sight between the TACAN checkpoint marking and the TACAN facility antenna shall be clear of any obstructions that may adversely affect the quality of the transmitted signal.

2-25. The TACAN checkpoint markings shall be a circle about the checkpoint position. See UFC 3-535-01, Including Change 1, 7 March 2018, Figure 9-7, TACAN Sign Location, for an example of the marking on a taxiway.

- The circle shall be 20 feet in diameter with the marking 12 inches wide.
- The marking shall be non-retroreflective yellow.
- When the aircraft is to be aligned in a specific direction towards the transmitter antenna for the check, an arrow shall be provided across the circle through the center on the desired azimuth and extends outside the circle for another 20 feet.
- The TACAN signal direction arrow marking shall be non-retroreflective yellow with the shaft 12 inches wide and the arrowhead 6 feet long and 3 feet wide.

2-26. TAXIWAY EDGE MARKINGS. (See FAA AC 150/5340-1M, Figure A-15, Taxiway markings, Figure C-3, Continuous Taxiway Edge Marking. Taxiway edge markings are installed only where the visual contrast between the edge of the full-strength taxiway and the adjoining area is such that pilots may tend to run off the taxiway.

2-27. The preferred taxiway edge markings shall consist of a pair of continuous parallel retroreflective yellow lines.

2-28. The taxiway edge marking shall be 6 inches wide and 6 inches apart with the outer edge of the outer marking placed along the edge of the full strength or designated taxiway edge.

2-29. Where used, the edge markings are usually placed along both sides of the taxiway but may be used only in critical areas and do not have to extend for the entire length of the taxiway.

2-30. TAXIWAY SHOULDER MARKINGS. Taxiway shoulder markings are used to mark stabilized shoulder areas that are not full-strength pavement or where aircraft taxiing is undesirable. In some areas such as stabilized islands in apron areas, along some taxiway curves, or former runways which have had part of the width designated as a taxiway, confusion may occur as to which side of the edge marking is the taxiway, and shoulder markings may be needed.

2-31. The taxiway shoulder markings shall be non-retroreflective yellow bars painted on the shoulder surface (see FAA AC 150/5340-1M, A-23, Taxiway shoulder markings).

2-32. The taxiway shoulder bar markings shall be not less than 3 feet wide and are perpendicular to the taxiway edge beginning at the taxiway edge stripes and extending outboard.

2-33. The length of the taxiway shoulder bar markings shall be 25 feet long or to within 5 feet of the outer edge of the shoulder paving whichever is less.

2-34. Along straight sections of taxiway, the shoulder marking bars shall be equally spaced not more than 100 feet apart with a bar at the point of tangency (PT) of a curve or at the end of the taxiway or of the shoulder paving.

2-35. HAZARDOUS AREA MARKINGS. Small hazardous or failed areas on a taxiway shall be marked to assure avoidance by taxiing aircraft.

2-36. The hazardous area on the taxiway shall be outlined with a pair of parallel retroreflective yellow lines (the same as the taxiway edge markings).

2-37. The taxiway damaged area shall also be outlined with yellow or orange rectangular flags not less than 18 inches on each side. The flags shall use stiffeners to keep the flags extended.

2-38. The damaged taxiway area may also use orange or orange and white cones to outline the area.

2-39. If flags and cones are used, they shall be fastened in position to resist movement from prop or jet blast from taxiing aircraft.

2-40. The height of cones and flags shall not exceed 30 inches above the taxiway pavement surface.

2-41. CLOSED TAXIWAY MARKINGS. Taxiways that permanently or temporarily closed shall be marked to visually indicate that the taxiway is closed and not to be used.

2-42. Closed taxiway markings shall be non-retroreflective yellow X-shaped crosses (see FAA AC 150/5340-1M, Figure A-27, Closed runway and taxiway markings).

2-43. The arms of the X-shaped cross shall intersect at right angles and be not less than 5 feet wide.

2-44. The overall length of the closed taxiway marking shall not be less than 30 feet, except temporary markings may be reduced to 4-foot-wide arms to permit use of standard widths of plywood.

2-45. The closed taxiway markings shall be located at each end of the closed taxiway, at any potential entrance from an intersection with an active runway or taxiway, and at intervals not greater than 1000 feet apart along the length of the closed taxiway.

2-46. The distance of a closed taxiway marking cross from the ends of a closed taxiway or from the edges of an intersecting active runway or taxiway shall not exceed 10 feet.

2-47. For permanently closed taxiways, all taxiway markings shall be removed or obliterated and the closed taxiway marking painted on the taxiway surface.

2-48. For temporarily closed taxiways, the closed taxiway marking may be painted on the surface or formed from tape or plywood that is secured in place.

2-49. BORDERS FOR MARKINGS. For some installations, the taxiway markings and the surrounding pavement do not provide sufficient contrast for easy recognition. The contrast between light colored pavements and taxiway markings can be improved by outlining the markings with a nonglossy black border. The borders shall be not less than 6 inches wide.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details and requirements for taxiway markings, refer to FAA AC 150/5340-1M.

3-3. MARKING PRECEDENCE AT INTERSECTIONS. When a taxiway intersects a runway or another taxiway, the taxiway markings shall be interrupted for all runway markings but may intersect the markings on an intersecting taxiway.

3-4. Taxiway markings shall maintain a clearance of 36 inches from the intersecting runway markings by interruption or paralleling.

3-5. At intersections with other taxiways, the intersecting taxiway centerline markings may intersect or curve into directions that taxiing traffic may use.

3-6. For cases where the taxiway edge marking intersects a holding position marking:

- If the holding position marking is outlined in black, the taxiway edge markings should abut the black outlines on both sides of the marking.
- If the holding position is not outlined in black, a 6-inch gap is left between the holding position and taxiway edge marking.
- See FAA AC 150/5340-1M, Figure A13.

3-7. RESTRICTIONS. Environmental regulations in some states or local ordinances may prohibit/restrict the use of solvent base paints.

3-8. See FAA AC 150/5340-1M and UFC 3-260-04 for detailed information about paint types, color specifications, paint application rates and surface preparations.

3-9. Taxiway flags, yellow or orange, with stiffeners, local or commercial sources.

3-10. Taxiway cones, orange or orange-white, local or commercial sources.

3-11. MATERIALS. The materials required for taxiway markings are paint and retroreflective spheres (beads), except for the flags and cones for marking hazardous areas. The approved materials and colors are per UFC 3-260-04.

3-12. PHOTOMETRIC REQUIREMENTS. Taxiway marking color requirements use paint colors specified in UFC 3-260-04.

ORGANIZATIONAL

TAXIWAY EDGE LIGHTS

TAXIWAY VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for taxiway edge lights. The taxiway edge lights outline the routes for taxiing to and from the runways, parking areas, fueling areas, maintenance areas and other locations. The edge lights in conjunction with the taxiway markings and, in some cases taxiway centerline lights, provide the visual cues for movement of aircraft on the ground. Taxiway edge lights are required for operations on airfields at night and during reduced visibility conditions in daytime. Operations in both Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) conditions (WP002 00) shall use taxiway edge lights. These requirements are to be used for designing new lighting installations. Existing taxiway edge lights may be used and maintained until upgrading or replacement is required.

1-3. JUSTIFICATION REQUIREMENTS. All taxiways that are intended for operations at night shall be equipped with edge lights. Any variations from these requirements shall be approved per the procedures in WP 002 00.

1-4. RELATED FACILITIES. The taxiway edge lights are the basic visual aids for use of taxiways at night. Other visual aids related to the taxiway edge lights are:

- Taxiway markings (WP 005 01).
- Taxiway centerline lights (WP 005 03).
- Taxiway guidance signs (WP 005 04).

- Holding Position Signs and Lights for Intersections with Runways (WP 005 06).
- Taxiway Lights for Runways Used as Taxiways (WP 005 07).
- Runway Exit Lights (WP 004 08).
- Runway Edge Lights (WP 004 05).
- Apron and Parking Area Lighting (WP 006 02).
- Fueling Area Lights (WP 006 05).

2-1. DESCRIPTION.

2-2. The taxiway edge lights shall consist of lines of blue lights located along each edge of the taxiway. Elevated light fixtures are normally used, except in areas where they may be a hazard to aircraft. Then semi-flush lights may be used. In addition, elevated lights may be equipped with directional light shields to block out emitted light in directions not necessary to taxiing. Using taxiway edge light shields also can reduce the airfield “sea-of-blue” effect. Taxiway edge light shields are also used in situations where a “tone-down” of light intensity is required for security. Taxiway edge light circuits should be sectionalized to permit selection of routes for taxiing rather than operating the entire taxiway edge light system. Because taxiing routes may have curves, turns, and intersections, the taxiway edge lights may not be equally spaced along the entire route.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details for the taxiway edge lights, refer to UFC 3-535-02. General design and installation requirements are in FAA AC 150/5340-30.

3-3. METHODS OF INSTALLATION. The elevated taxiway edge lights may be mounted on FAA Type L-867 (non-load bearing) light bases or on conduits in concrete foundations.

3-4. All elevated lights shall be mounted on frangible couplings.

3-5. The height of elevated lights shall be not more than 14 inches above the ground level of the taxiway edge.

3-6. There is an exception for areas with frequent accumulations of snow to depths of 12 inches or more where, with approval by Naval Air Systems Command, the maximum height of elevated taxiway edge lights shall not exceed 24 inches. To raise the height of these lights, use longer nipples and, if necessary, longer cables from the connections of the isolation transformers to the lamp. The manufacturer may be able to supply these items.

3-7. Semi-flush taxiway edge lights shall be installed on FAA Type L-867/L-868 light bases and should be used only in areas where aircraft or service vehicles are likely to damage an excessive number of elevated lights or if elevated lights are a hazard to aircraft.

3-8. LOCATIONS AND SPACING. The taxiway edge lights will be spaced per drawings in FAA AC 150/5340-30J, figures 2 through 23.

3-9. TOLERANCES. The preferred location for spacing of the lights is within 6 inches of the equal interval spacing. However, if it is not possible to install lights at the desired location, the lights may be located not more than 5 feet from the equal spacing location. The tolerance from the designated line or smooth curve for locating the lights is ±6 inches.

3-10. AIMING. Taxiway edge lights are usually omnidirectional lights with the elevation angle of the beam fixed by the lens. The only aiming required is leveling of the light when it is installed. However, if hoods are used to shield emitted light, the hoods shall be installed to direct the light along and towards the taxiway. Lights along curves, fillets, and at intersections may require larger distribution angles of light and not permit the use of hoods. If hoods are used, they shall be securely fastened to prevent rotation by jet or prop blast.

4-1. EQUIPMENT.

4-2. FIXTURES. The light fixtures are usually the elevated type, but where needed, semi-flush lights may be used. The fixtures and equipment to be used are listed in Table 1. The use of hoods for shielding is optional.

Table 1. Schedule of Lighting Equipment for Taxiway Edge Lights

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER RATING	ISOLATION TRANSFORMER FAA TYPE AC 150/5345-47
Elevated lights, omnidirectional, blue, type is optional.(1)			
FAA AC 150/5345-46, type L-861T, mode 1, L-861T(L)	45W 6.6A,(2) or type as determined by manufacturer (mfr.).	30/45W 6.6/6.6A	L-830-1
Hoods or shields, types as provided by manufacturer or from commercial sources.			
Semiflush lights, omnidirectional, blue.			
FAA AC 150/5345-46, type L-852TE, mode 1, with blue filter, or L-852E, L-852E(L) mode 1, with yellow filter as required.	66.6A, watts and type as determined by mfr.	45W 6.6/6.6A or determined by mfr.	L-830-4 or determined by mfr.

NOTES:

1. Number of lights required varies with taxiway length and spacing.
2. 45W lamps are used for systems with intensity control. If intensity control is not provided, use 30W lamps.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of “certified” light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See “Advisory Circulars” at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED’s are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot’s ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVD.

4-3. PHOTOMETRIC REQUIREMENTS. The emitted light from the taxiway edge light fixtures shall be omnidirectional in azimuth.

4-4. The emitted light color shall be aviation blue except at termination centerlines, which shall be aviation yellow per the requirements in FAA AC 150/5345-46.

4-5. If required, three steps of intensity shall be provided with the lowest step not more than ten percent of the rated intensity.

4-6. The photometrics for elevated and semi-flush taxiway edge lights shall be per the requirements in FAA AC 150/5345-46.

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for the taxiway edge lights shall be provided by one or more 6.6-ampere series circuits (WP 009 00).

5-3. The constant-current regulators shall have three or five intensity steps (WP 009 02).

5-4. The taxiway edge lights shall be connected to the primary series lighting circuit by individual series-series isolation transformers (WP 009 05).

5-5. The edge lights for taxiways providing access to and from instrument runways shall be provided with emergency power (WP 009 01).

5-6. Emergency power shall be equipped to automatically transfer power in less than 15 seconds after failure of primary power.

5-7. CONTROLS. The taxiway edge lights shall be remotely controlled from the airfield lighting control panel (WP 009 05) in the air traffic control tower with an alternate control station in the lighting control vault. If required, three steps of intensity control shall be provided with the intensity at the lowest setting not more than 10 percent of the intensity at rated current. Most airfields shall have provisions for illuminating selected taxiway routes between the aircraft's position and commonly used destinations. This control is usually provided by circuit selector switches (WP 009 06), and may use a facsimile type control panel for ease in selecting the taxi route. The capability of energizing all taxiway edge lights simultaneously should be provided.

ORGANIZATIONAL

TAXIWAY CENTERLINE LIGHTS

TAXIWAY VISUAL AIDS

Reference Material

Introduction	WP 002 00
Approach Visual Aids, Description	WP 003 00
Runway Visual Aids, Runway Exit Lights	WP 004 08
Taxiway Visual Aids, Taxiway Markings	WP 005 01
Taxiway Visual Aids, Taxiway Edge Lights	WP 005 02
Taxiway Visual Aids, Taxiway Guidance Signs	WP 005 04
Taxiway Visual Aids, Holding Position Signs and Lights for Intersections with Runways	WP 005 06
Special Lights and Markings Visual Aids, Apron and Parking Area Lights	WP 006 02
Electrical Power and Control for Visual Aids, Description	WP 009 00
Electrical Power and Control for Visual Aids, Auxiliary Power and Power Transfer Equipment	WP 009 01
Electrical Power and Control for Visual Aids, Constant-Current Regulators	WP 009 02
Electrical Power and Control for Visual Aids, Isolation and Distribution Transformers	WP 009 03
Electrical Power and Control for Visual Aids, Airfield Lighting Control Panels	WP 009 05
Electrical Power and Control for Visual Aids, Special Remote Control Equipment	WP 009 06
Design Drawings for Visual Aid Navigation Facilities	UFC 3-535-02
Design and Installation Details for Airport Visual Aids	FAA AC 150/5340-30
Isolation Transformers for Airport Lighting Systems	FAA AC 150/5345-47
Light, Markers, Airport, Semiflush, General Specifications for	MIL-L-26202
Specification for Runway and Taxiway Light Fixtures	FAA AC 150/5345-46

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the taxiway centerline lights. Taxiway centerline lights provide accurate alignment and course guidance for taxiing aircraft especially in areas where better full strength pavement definition is required than that provided by the taxiway edge lights. Accurate guidance is required for operations in very low visibility conditions and may be needed to supplement the taxiway edge lights in known problem areas. Possible problem areas are complex intersections, turns, curves, and wide taxiways. Taxiway centerline lights may be required for operations at night and during reduced visibility conditions in daytime. The requirements in this WP are to be used for designing new lighting installations. Existing centerline lights may be used and maintained until upgrading or replacement is required.

1-3. JUSTIFICATION REQUIREMENTS. Taxiway centerline lights shall be installed for the complete taxiway system providing taxiing routes to and from runways when authorized or planned for operations in Category III Instrument Flight Rules (IFR) conditions (WP 002 00). Taxiway centerline lights are also recommended for taxiway systems providing taxiing routes to and from runways authorized for operations in Category II IFR conditions. The centerline lights shall be installed at all complex intersections and other areas where taxiway edge lights do not provide adequate taxiing guidance, especially for taxiways to and from IFR runways. Problem areas are most often identified by operating experience. Any variations from the requirements of this WP shall be approved in accordance with the procedures of WP 002 00.

1-4. RELATED FACILITIES. Other visual aids related to the taxiway centerline lights are as follows:

- Taxiway markings (WP 005 01),
- Taxiway edge lights (WP 005 02),
- Taxiway guidance signs (WP 005 04),
- Holding Position Signs and Lights for Intersections with Runways (WP 005 06),
- Runway Exit Lights (WP 004 08),
- Apron and Parking Area Lighting (WP 006 02).

2-1. DESCRIPTION.

2-2. The taxiway centerline lights shall consist of a line of green bidirectional or unidirectional semi-flush lights located along the centerline of the taxiway. Taxiway edge lights are usually installed along the edges of the taxiways where centerline lights are used; however, centerline lights may be installed in areas where it is not practical to use edge lights. The taxiway centerline lights shall be equally spaced within a straight or curved section, but the maximum spacing varies with the shape and length of the section and the minimum visibility condition authorized for operations on the associated runway. The light at the end of a taxiway section is usually considered as a light in both adjoining sections. Although the taxiway may be divided into additional sections (if needed) for more effective operations, the taxiway shall have not less than the following sections for spacing lights:

- Between Points of Tangency (PT).
- Between PT and holding position or end of taxiway.
- Between holding position and end of taxiway.
- Between PT and 100 feet beyond PT if holding position or runway end is more than 300 feet from PT.
- Between the PT and intersection of centerline or extended centerline at taxiway intersections.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details about taxiway centerline lights refer to UFC 3-535-02. General design and installation requirements are per FAA AC 150/5340-30.

3-3. METHODS OF INSTALLATION. The semi-flush taxiway centerline lights shall be mounted on FAA Type L-868 light bases properly sized to accommodate the light fixture. The preferred method but direct mounting may be used for existing taxiways.

3-4. LOCATIONS. The taxiway centerline lights shall be located in a straight line along the taxiway centerline or on smooth curves between the PT. See FAA AC 150/5340-30J, paragraph 4.3.3, Longitudinal and Lateral Spacing, for detailed information about taxiway centerline light locations.

3-5. On straight sections of taxiway, the preferred location is on the taxiway centerline, but the line may be offset a maximum of 2 feet to avoid joints in the pavement.

3-6. If the taxiway centerline lights are offset, the offset shall be uniform and continuous along the same side of the taxiway to avoid the appearance of "zigzagging."

3-7. On turns and curves in the taxiway, the taxiway centerline lights shall be located on a smooth arc along the taxiway centerline or, if the lights are offset, maintain the offset distance from the centerline.

3-8. At simple taxiway intersections for direct crossing or turning in one direction only, the lights may be located along the extended centerline across or to the intersection with the centerline of the intersecting taxiway.

3-9. At complex intersections, with more than one direction for turns, or for taxiways routed to Category II or III runways, the taxiway centerline lights shall be located along smooth arcs between PT. A maximum radius shall be used that provides a clearance from the inside taxiway edge not less than one-half the width of the narrower taxiway for all turns usually permitted.

3-10. If turns and crossings are permitted, taxiway centerline lights shall be installed along all paths.

3-11. At taxiway intersections with runways, the taxiway centerline lights shall terminate at the runway edge except when long-radius (high-speed) runway exit lights or low-speed exit lights (WP 004 08) are required.

3-12. For taxiing paths that permit taxiing in one direction, but not in the reverse direction, unidirectional lights shall be used.

3-13. For crossing taxiways, the taxiway centerline light at the intersection of taxiway centerlines shall be an omnidirectional type of green light (see Table 2 for light FAA type number).

3-14. SPACING OF LIGHTS. The taxiway centerline lights shall be equally spaced within each section not to exceed the spacing criteria in Table 1.

Table 1. Criteria for Spacing of Taxiway Centerline Lights

TYPE OF SECTION	MAXIMUM SPACING (FEET)	
	CATEGORY II OR III RUNWAYS	ALL OTHER CONDITIONS
Straight sections, 300’ or longer	50	100
Straight sections, less than 300’ or at intersections	50	50
Curves, radius less than 400’	12.5	25
Curves, radius 400’ to 1200’	25	50
Curves, radius more than 1200’	50	100

NOTES:

1. Locate lights at PT, holding position, and taxiway end. Space the other lights equally for each section not to exceed the above criteria.

2. Continue these lights for not less than 100 feet beyond the PT of the centerline lights or of the PT at the taxiway edge, whichever is greater.

3-15. TOLERANCES. The tolerance for longitudinal spacing of the taxiway centerline lights is ±6 inches. However, if it is not possible to install lights at the desired location, due to pavement joints, the lights may be relocated not more than 2 feet from the standard location. The tolerance of a line taxiway centerline lights or within a smooth curve is ±3 inches.

3-16. AIMING. Taxiway centerline lights are usually bidirectional lights with fixed elevation angles of the light beams. When installing the light base or junction box, it shall be level and at the correct distance below the surface of the pavement to prevent excessive light fixture protrusion. In addition, the light base is aligned in azimuth for the axis of the light fixture output beam to be parallel to the taxiway centerline along straight sections and tangential to the arc along curved sections.

4-1. EQUIPMENT.

4-2. FIXTURES. The light fixtures are the semi-flush type. Narrow-beam lights are used along straight sections of taxiways, while wide-beam taxiway centerline lights are used along curves and at a PT. The equipment for taxiway centerline lights shall be per Table 2.

Table 2. Schedule Of Lighting Equipment For Centerline Lights (see FAA AC 150/5340-30)

PURPOSE AND TYPE OF FIXTURE(1) (2)	LAMP RATING AND TYPE	ISOLATION TRANSFORMER RATING	ISOLATION TRANSFORMER FAA TYPE AC 150/5345-47
Semiflush, bidirectional, green lights, for straight sections of regular taxiways.			
FAA AC 150/5345-46, type L-852A, Mode 1, L-852A(L)	45W 6.6A, type determined by mfr. (manufacturer)	30/45W 6.6/6.6A or determined by the mfr.	L-830-1 or determined by the mfr.
Semiflush, bidirectional, green lights, for curved sections of regular taxiways.			
FAA AC 150/5345-46, type L-852B, Mode 1, L-852B(L)	65W 6.6A, type determined by mfr.	65W 6.6/6.6A or determined by the mfr.	L-830-3 or determined by the mfr.
Semiflush, bidirectional, green lights, for straight sections of taxiways for Cat III runways.			
FAA AC 150/5345-46, type L-852C, Mode 1, L-852C(L)	6.6A, 45W, type determined by mfr.	30/45W 6.6/6.6A or determined the mfr.	L-830-1 or determined by the mfr.
Semiflush, bidirectional, green lights, for curved sections of taxiways for Cat III runways.			
FAA AC 150/5345-46, type L-852D, Mode 1, L-852D(L)	6.6A, 65W, type as determined by mfr.	65W 6.6/6.6A or determined by mfr.	L-830-3 or determined by mfr.
Semiflush, omnidirectional, green lights, for centerline intersections.			
FAA AC 150/5345-46, type L-852E or F, Mode 1, 6.6A	6.6A, 115W to 150W, type as determined by manufacturer.	100W 6.6/6.6A or 200W 6.6/6.6A	L-830-4 L-830-6

NOTES:

1. Number of lights required varies with taxiway length and spacing.
2. If needed, unidirectional lights of the same type may be obtained.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).

Table 2. Schedule Of Lighting Equipment For Centerline Lights (see FAA AC 150/5340-30) (Cont)

PURPOSE AND TYPE OF FIXTURE[(1) (2)]	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures. 3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVD.			

4-3. PHOTOMETRIC REQUIREMENTS. The emitted light from the taxiway centerline light fixtures shall be bidirectional in azimuth, except at some intersections where unidirectional lights are required. The color of the emitted light shall be aviation green per FAA AC 150/5345-46. Not less than 5 steps of intensity shall be provided. The intensity and beam pattern shall be per the requirements in FAA AC 150/5345-46.

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for the taxiway centerline lights shall be provided by one or more 6.6-ampere series circuits. The constant-current regulators shall have three or five intensity steps (WP 009 02). The lights shall be connected to the primary series circuit by individual isolation transformers (WP 009 05). The taxiway centerline lights may be on independent circuits or connected in series with the taxiway edge lights. The centerline lights for taxiways providing access to and from instrument runways shall be provided with emergency power (WP 009 03). This emergency power shall be equipped to automatically transfer power in less than 15 seconds after failure of primary power.

5-3. CONTROLS. The taxiway centerline lights shall be remotely controlled from the airfield lighting control panel (WP 009 05) in the air traffic control tower panel with an alternate control station in the lighting control vault. The controls may be separate from or combined with the taxiway edge light controls. Three steps of intensity control shall be provided with the intensity at the lowest setting not more than 10 percent of the intensity at rated current. Normally the airfield shall provide circuits for illuminating selected taxiing routes between the aircraft's position and commonly used destinations. This control is usually provided by circuit selector switches (WP 003 06), and may use a facsimile type control panel for ease in selecting the taxi route. It may be desirable to provide capability for energizing all taxiway centerline and edge lights simultaneously.

ORGANIZATIONAL

TAXIWAY GUIDANCE SIGNS

TAXIWAY VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for taxiway guidance signs. Taxiway guidance signs assist pilots in following a desired route to destinations rapidly and safely with a minimum number of radio contacts to air traffic ground control. The taxiway guidance signs provide information that supplements guidance provided by the taxiway edge lights or centerline lights. This information shall be provided for aircraft operations both day and night in all visibility conditions. The requirements in this WP are to be used for the design of new taxiway guidance sign installations. Existing taxiway guidance sign installations may be used and maintained until upgrading or replacement is required.

1-3. JUSTIFICATION REQUIREMENTS. Taxiway guidance signs shall be installed only when additional guidance to that already provided by the taxiway lights and markings is needed for rapid and safe taxiing. The justification for installing the signs is dependent upon the complexity of the taxiway system and the arrangement of runways, parking, and service areas. The preferred power design scheme for lighted taxiway signs involves the use of dedicated constant current regulators set to 5.5 Amperes. Connection of lighted signs to the taxiway edge lighting circuit is to be avoided because of the possible adverse effect of sign power adapters (see FAA AC 150/5345-44 for more information) on the system power factor. Some airfields without runway or taxiway lights may need to install a limited system of unlighted signs. Any variations from the requirements of this WP shall be approved in accordance with the procedures of WP 002 00.

1-4. RELATED FACILITIES. Taxiway guidance signs are associated with the use of other visual aids as follows:

- Taxiway markings (WP 005 01),
- Taxiway edge lights (WP 005 02),
- Taxiway centerline lights (WP 005 03),
- Holding Position Signs and Lights for Intersections with Runways (WP 005 06),
- Runway Exit Lights (WP 004 08),

- Runways used as taxiways (WP 005 07),
- Apron and Parking Area Lighting (WP 006 02),
- Fueling area lights (WP 006 05).

2-1. DESCRIPTION.

2-2. The taxiway guidance signs shall consist of a system of individual signs along the taxiways, runway exits, and apron areas.

2-3. The signs shall be illuminated if the taxiways are lighted, but the information shall be similarly presented when not lighted for daytime operations.

2-4. Unlighted taxiway guidance signs intended for daytime operations only may be used.

2-5. Taxiway guidance signs may be single faced for observing from one direction or double faced. The information on the opposite faces of the same sign is usually different.

2-6. Three types of taxiway guidance signs are used to provide information to pilots:

- FAA Type L-858Y (Direction, destination and boundary) - black legend on a yellow background.
- FAA Type L-858L (Location signs) - yellow legend on a black background.
- FAA Type L-858R (Mandatory instruction) - white legend on a red background.
    - The mandatory instruction signs involve messages which if not obeyed could cause a hazard to aircraft or violation of security areas. Examples of the messages presented to the pilot are: “NO ENTRY” or “STOP.”
    - Mandatory instruction signs also include runway holding position or clearance signs (WP 005 06).

2-7. Informational signs (black legend on a yellow background) provide instructions that may be needed but often are optional.

- Examples of information signs are: noise abatement procedures, crossing vehicle roadways, or other specialized information.
- The signs need not be lighted, and the size and message of the inscription is at the discretion of the airport operator; however, they should be retro-reflective (if required) and mounted on frangible couplings.

NOTE

See FAA AC 150/5345-44 for more information about sign design, legend characters, and luminance requirements. See FAA AC 150/5340-18 for additional guidance about sign installation details.

2-8. Other symbols or terms that are generally understood and will not be misinterpreted may be used. Some commonly used short words or terms are as follows:

- ACP – Altimeter checkpoint.
- CARGO – Freight or cargo handling areas.
- CIVIL – Civilian areas of joint use airfields.
- FUEL – Refueling area.
- GATE – Position for aircraft to load or unload passengers.
- HGR – Hangar areas.
- (Runway Number) – Holding positions at intersection with runway.
- INST – Clearance holding position for electronic approach aids during Instrument Flight Rules (IFR) conditions.
- INTL – International areas.
- MIL – Military areas of joint use airports.
- OPS – Operations area.
- PARK – Aircraft parking only.
- RAMP – General parking, servicing, and loading areas.
- RUNUP – Run-up areas.

- TACAN – TACAN checkpoint.
- VSTR – Visitors area.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details about taxiway guidance signs, refer to UFC 3-535-02 and FAA AC 150/5340-18.

3-3. METHODS OF INSTALLATION. Taxiway guidance signs are mounted on a concrete slab, concrete pedestals, or angle iron stakes so the top of the sign is level. The concrete edges or stakes may not protrude above grade. Signs are oriented so that the face is perpendicular to the centerline of the taxiway or runway. For special situations where visibility would be improved, single-sided signs may be canted. Power to the signs is provided through breakaway cable connectors installed within the frangible coupling portion of the sign's mounting legs. Auxiliary equipment, such as isolation transformers or series circuit power adapter units, is installed below ground level in an L-867 light base.

3-4. For airfields in areas with frequent occurrences of snow accumulations of more than six inches, it may be desirable to obtain approval by Naval Air Systems Command to raise the height of the guidance signs. The additional height should be kept to the minimum acceptable to reduce aircraft strike hazard and limit the increased wind loading and jet blast forces. As the overall height is increased, the signs must be located farther from the taxiway edges (see 3-5, LOCATIONS, this WP). Raising the signs will require longer nipples and may require longer cables to the terminal strips or connectors of the signs. Before procurement or arranging for installation, check with the manufacturer for adequate strength of the fixtures and any special mounting requirements.

3-5. LOCATIONS. The configuration for locating taxiway guidance signs varies with the arrangement of taxiways, runways, apron, and service areas. To design a taxiway guidance sign system, all potential taxiing routes shall be considered and coordinated with airfield air traffic ground control personnel. The legends for the signs and their location should be determined/evaluated in the design study.

3-6. The taxiway signs shall be located not less than 25 feet from the edge of the full-strength pavement of the taxiway, runway, or apron.

3-7. The height of taxiway signs shall be not more than 24 inches above the edge of the taxiway pavement if located 25 feet from the edge.

3-8. Signs with a height of 30 inches above the taxiway pavement edge shall be not less than 35 feet from the edge of the pavement.

3-9. Taxiway signs are usually located on the radius of the fillet through the point of tangency (PT) at the required distance from the taxiway or runway edge.

3-10. Mandatory taxiway signs shall be located on the left-hand side or on both sides of the taxiway.

3-11. Taxiway destination and runway exit signs indicating turns should be located on the near side of the intersection on the side of the taxiway or runway to which the turn is made.

3-12. Taxiway destination signs with arrows pointing straight ahead may be located on either side of the taxiway, preferably on the approach side to the intersection.

3-13. Taxiway location signs without direction arrows should be located on the left side of the taxiway.

3-14. For additional information about the locations of taxiway signs, see FAA AC 150/5340-18.

3-15. ALIGNMENT. Taxiway guidance signs shall be installed in a vertical position with the sign face or horizontal axis perpendicular to the centerline of the taxiway or runway and aimed toward the direction from which the sign is viewed. Some special signs (WP 005 05) may require a different alignment. If a double-face sign is approached from directions other than directly opposite, the alignment of the faces should provide equal observing angles for each face.

4-1. EQUIPMENT.

4-2. FIXTURES. Taxiway guidance signs shall be lightweight and mounted on frangible couplings to reduce damage to an aircraft if it strikes the sign. The faces of the signs may be vertical or curved. The signs may be in sections with a character on each section or formed as message units. If the taxiway is used for nighttime operations, the signs shall be internally illuminated, but the message shall appear identical similar in shape and color as signs for daytime operations. The sign internal illumination may be furnished by a lamp in each section of the sign or other lighting arrangement that provides clearly lighted characters. The equipment for these signs shall be as listed in Table 1. See FAA AC 150/5345-44 for detailed information about sign construction, lighted and unlighted signs, internal sign illumination, and sign color requirements.

Table 1. Schedule of Lighting Equipment for Taxiway Guidance Signs

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
Mandatory signs, white legends on red background.[1]			
FAA AC 150/5345-44, type L-858R, Size 2, 3, or 5, Style 2 or 3, Class 1 or 2, Legends as specified	Watts, type and number as determined by manufacturer.	6.6/6.6A. Watts and number as determined by manufacturer.	Type as required by the watts.
Informational signs. Direction, destination and boundary. Black legends on yellow background.[1]			
FAA AC 150/5345-44, type L-858Y, Size 2, 3, or 5, Style 2 or 3, Class 1 or 2, Legends as specified	Watts, type and number as determined by manufacturer.	6.6/6.6A. Watts and number as determined by manufacturer.	Type as required by the watts.
Location signs, yellow legends on black background.			
FAA AC 150/5345-44, type L-858L, Size 2, 3, or 5, Style 2 or 3, Class 1 or 2, Legends as specified	Watts, type and number as determined by manufacturer.	6.6/6.6A. Watts and number as determined by manufacturer.	Type as required by the watts.

NOTES:

1. The number of signs varies with the airfield installation.

4-3. PHOTOMETRIC REQUIREMENTS. See FAA AC 150/5345-44 for sign retroreflective sheeting color requirements (lighted and unlighted signs). The retroreflective sheeting requirement in the FAA AC also state the sheeting chromaticity requirements. Taxiway guidance sign luminance requirements shall be per FAA AC 150/5345-44.

4-4. Taxiway signs, day or night in 3000-foot meteorological visibility, shall be discernible (sign color) at distances not less than 800 feet and shall be clearly legible at not less than 500 feet.

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for the taxiway guidance signs shall be provided by the 6.6-ampere series circuits (WP 009 00) for the associated taxiway edge or centerline lights. Check with the sign manufacturer or the sign installation instructions for the proper size of isolation transformer to be used with the sign. If required by the manufacturer, a power adapter shall be provided. Emergency power shall be the same as that required for the associated taxiway edge or centerline lights. The preferred method of sign power is supplied by a dedicated constant current regulator set to 5.5 Amperes.

5-3. CONTROLS. Taxiway signs are controlled via dedicated panels/displays in the air traffic control tower cab. Sign intensity control is not desirable, but if it is provided for the taxiway lights, the luminance of the sign at the lowest intensity setting shall be not less than 50 percent of the luminance at rated current.

ORGANIZATIONAL

SPECIAL TAXIWAY SIGNS (TACAN, BILLBOARD)

TAXIWAY VISUAL AIDS

Reference Material

Introduction	WP 002 00
Taxiway Visual Aids, Taxiway Markings	WP 005 01
Taxiway Visual Aids, Taxiway Edge Lights	WP 005 02
Taxiway Visual Aids, Taxiway Centerline Lights	WP 005 03
Taxiway Visual Aids, Taxiway Guidance Signs	WP 005 04
Taxiway Visual Aids, Holding Position Signs and Lights for Intersections with Runways	WP 005 06
Special Lights and Markings Visual Aids, Apron and Parking Area Lights	WP 006 02
Electrical Power and Control for Visual Aids, Description	WP 009 00
Electrical Power and Control for Visual Aids, Isolation and Distribution Transformers	WP 009 03
Colors, Use in Government Procurement	SAE AMS-STD-595
Isolation Transformers for Airport Lighting Systems	FAA AC 150/5345-47
Specification for Taxiway and Runway Signs	FAA AC 150/5345-44

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for special taxiway signs. Special taxiway signs provide pilots with information for checking operation of the aircraft navigational equipment and for following the desired route for taxiing through complicated areas and intersections rapidly and safely. The special taxiway signs are types of informational taxiway guidance signs installed for a specific purpose and supplement the information and guidance provided by the taxiway edge lights (WP 005 02), centerline lights (WP 005 03), and guidance signs (WP 005 04). Special taxiway sign information shall be provided for flight operations during both day and night in all visibility conditions. The requirements in this WP are to be used for designing new taxiway guidance sign installations. Existing installations may be used and maintained until upgrading or replacement is required.

1-3. JUSTIFICATION REQUIREMENTS. The use of special taxiway signs is not a mandatory requirement, but they should be installed where additional information or guidance is needed. The TACAN/VOR check point signs are installed where the navigational aid checkpoint is located (WP 005 01). The large billboard signs are used only where more information is needed than that already provided by taxiway lights and guidance signs. Special taxiway signs may be powered by a dedicated constant current regulator set to 5.5 Amperes or connected to the taxiway lighting circuits. Any variations from the requirements of this WP shall be approved in accordance with the procedures of WP 002 00.

1-4. RELATED FACILITIES. Special taxiway signs are associated with:

- Taxiway markings (WP 005 01),
- Taxiway edge lights (WP 005 02),
- Taxiway centerline lights (WP 005 03),
- Holding Position Signs and Lights for Intersections with Runways (WP 005 06),
- Apron and Parking Area Lighting (WP 006 02).

2-1. DESCRIPTION.

2-2. TACAN CHECKPOINT SIGNS. The TACAN checkpoint signs shall provide information for the pilot when verifying the operation of the navigational aid in the aircraft before takeoff.

2-3. For location of the TACAN/VOR checkpoint, refer to WP005 01.

2-4. The TACAN/VOR sign shall include the type of navigational aid, identification code, radio channel, magnetic bearing, and the distance in nautical miles to the transmitting antenna from the checkpoint marking (Figure 1).

2-5. The character height shall be not less than 7 inches or more than 8 inches high and the stroke width not less than one inch.

2-6. The sign should have black characters on a yellow background and shall be similar in shape and color when lighted at night and unlighted in daytime.

2-7. The signs may be internally or externally illuminated with uniform brightness. See FAA AC 150/5345-44 for additional information about sign luminance and unlighted sign floodlighting requirements.

2-8. The height of the sign legend panel shall be not more than 30 inches and the length not more than 72 inches see Figure 1).

2-9. The elevation of the sign top edge shall not exceed 40 inches above the taxiway edge ground level.

2-10. If the checkpoint sign is less than 50 feet from the taxiway edge, the sign height should be reduced from 40 inches to provide a clearance of 12 inches for critical aircraft. The clearance is measured from the top edge of the sign.

2-11. BILLBOARD SIGNS. Complex intersections of taxiways with runways, other taxiways, runway thresholds with special warm-up areas, and complex taxiway intersections are the areas that most frequently require billboard signs. In addition, billboard signs may be used when existing taxiway lights and guidance signs are not considered adequate.

2-12. The billboard signs shall show the affected area(s) pictorially.

2-13. The information presented by the signs shall be designed for the individual needs of each site.

2-14. The taxiing routes are usually shown as black on a white background.

2-15. Billboard signs shall be lighted and are usually externally illuminated with appropriate floodlighting.

2-16. The height of billboard signs is between 48 and 54 inches.

2-17. Billboard signs shall withstand winds of 75 miles per hour or greater from any direction.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. Installation details for the TACAN checkpoint signs and special taxiway signs are detailed below.

3-3. METHODS OF INSTALLATION. The special taxiway signs shall be of lightweight construction and shall be mounted on frangible couplings.

3-4. The signs shall be placed on concrete foundations which are not noticeably affected by frost heaves or changes in soil conditions.

3-5. The concrete foundations for signs should be level with grade.

3-6. An FAA Type L-867 light base for containing the sign isolation transformer or power adapter may be installed.

3-7. For airfields in areas with frequent occurrences of snow accumulations of more than six inches, it may be desirable to obtain approval by Naval Air Systems Command to raise the height of the special taxiway signs.

3-8. The additional sign height should be kept to the minimum acceptable to reduce the aircraft strike hazard and limit increased wind loading and jet blast forces.

3-9. When the overall sign height is increased, the signs must be located further from the taxiway edges (see 3-12, LOCATIONS, this WP).

3-10. Raising the signs will require longer mounting nipples and may require longer power cables to the terminal strips or connectors of the signs.

3-11. Before procurement or arranging for installation, check with the manufacturer for adequate strength of the fixtures and any special mounting requirements.

3-12. LOCATIONS. The location and alignment of the TACAN checkpoint sign shall be per Figure 2.

3-13. The TACAN checkpoint sign not closer to the runway edge than the runway holding position marking.

3-14. The TACAN checkpoint sign is usually located on the same side of the taxiway as the turn onto the runway.

3-15. The sign shall be on a line from the center of the checkpoint marking at 45 degrees from the taxiway centerline or 45 degrees to the taxiway edge if the centerline is indefinite or not a straight line.

3-16. The horizontal axis of the TACAN checkpoint sign shall be aligned perpendicular to the line between the checkpoint marking and the sign.

3-17. The elevation of the top edge of the checkpoint sign above the surface of the taxiway edge shall be:

- Not more than 24 inches if less than 35 feet from the taxiway.
- 30 inches if the checkpoint sign less than 50 feet from the taxiway.
- More than 48 inches if 50 feet or more from the taxiway.

3-18. The horizontal axis of the billboard sign shall be aligned for clear viewing by the pilot from the taxiway centerline at the entrance to the area and present a clear correlation of the pictorial routes with current configurations.

4-1. EQUIPMENT.

4-2. FIXTURES. Special taxiway signs shall be mounted on frangible couplings.

4-3. Special taxiway signs shall be illuminated for use at night. The sign legend shall appear similar in shape and color during daytime operations.

4-4. The TACAN checkpoint signs may be either internally or externally illuminated but the billboard signs are usually externally illuminated.

4-5. Special taxiway signs may be fabricated locally or purchased from airport sign manufacturers (example: Lumacurve Signs, AGM Airport Signs, Cooper Industries, ADB Safegate).

4-6. The equipment for these signs shall be as listed in Table 1.

4-7. An example of a TACAN checkpoint sign is shown in Figure 1.

Table 1. Schedule of Lighting Equipment for Taxiway Guidance Signs

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
TACAN checkpoint signs, each individual.			
Modified FAA AC 150/ 5345-44, type L-858Y, Size 3 or 5, Style 2 or 3, black characters on yellow background.	As determined by manufacturer.	6.6/6.6A, watts as determined by manufacturer.	As required.
or			
Local manufacture.	(8) 50W 120V general purpose type.	6.6/6.6A, 200W	L-830-6
Billboard signs, each individual.			
Modified FAA AC 150/ 5345-44, type L-858, Size 4, Style 2 or 3, externally lighted, black on white background.	As determined by manufacturer.	6.6/6.6A, watts as determined by manufacturer.	As required.
or			
Local manufacture.	As required.	6.6/6.6A, watts as required for the lamps.	As required.

4-8. PHOTOMETRIC REQUIREMENTS. Unlighted special taxiway signs shall be yellow characters on a black background for TACAN checkpoint signs and black routes on a white background for billboard signs. These colors shall be per SAE AMS-STD-595 as follows:

- Yellow, color chip No. 23538.
- White, color chip No. 27875.
- Black, color chip No. 27038.

4-9. If unlighted special taxiway signs are fabricated with retroreflective sheeting, the sheeting shall meet the requirements in FAA AC 150/5345-44.

4-10. If the special taxiway signs are unlighted, the sign luminance and chromaticity shall be per the requirements in FAA AC 150/5345-44. Special taxiway signs, during the day or night in 3000-foot meteorological visibility, shall be discernible at distances not less than 800 (sign color) feet and shall be clearly legible at not less than 500 feet.

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for the special taxiway signs shall be provided by the 6.6-ampere series circuits (WP 009 00) for the associated taxiway edge or centerline lights.

NOTE

The preferred method to power signs is with a dedicated properly rated constant current regulator configured for 5.5 Amperes output.

5-3. The signs shall be connected to the primary series circuit by the required number and rating of series-series isolation transformers (WP 009 03). If required by the manufacturer, a power adapter shall be provided. Emergency power shall be the same as that required for the associated taxiway edge or centerline lights.

5-4. CONTROLS. For lighted special taxiway signs, the power shall be controlled from dedicated panels in the air traffic control tower cab or airfield lighting vault. Intensity control is not desirable, but if is provided for the taxiway lights, the luminance of the sign at the lowest intensity setting shall be not less than 50 percent of the luminance at rated current.

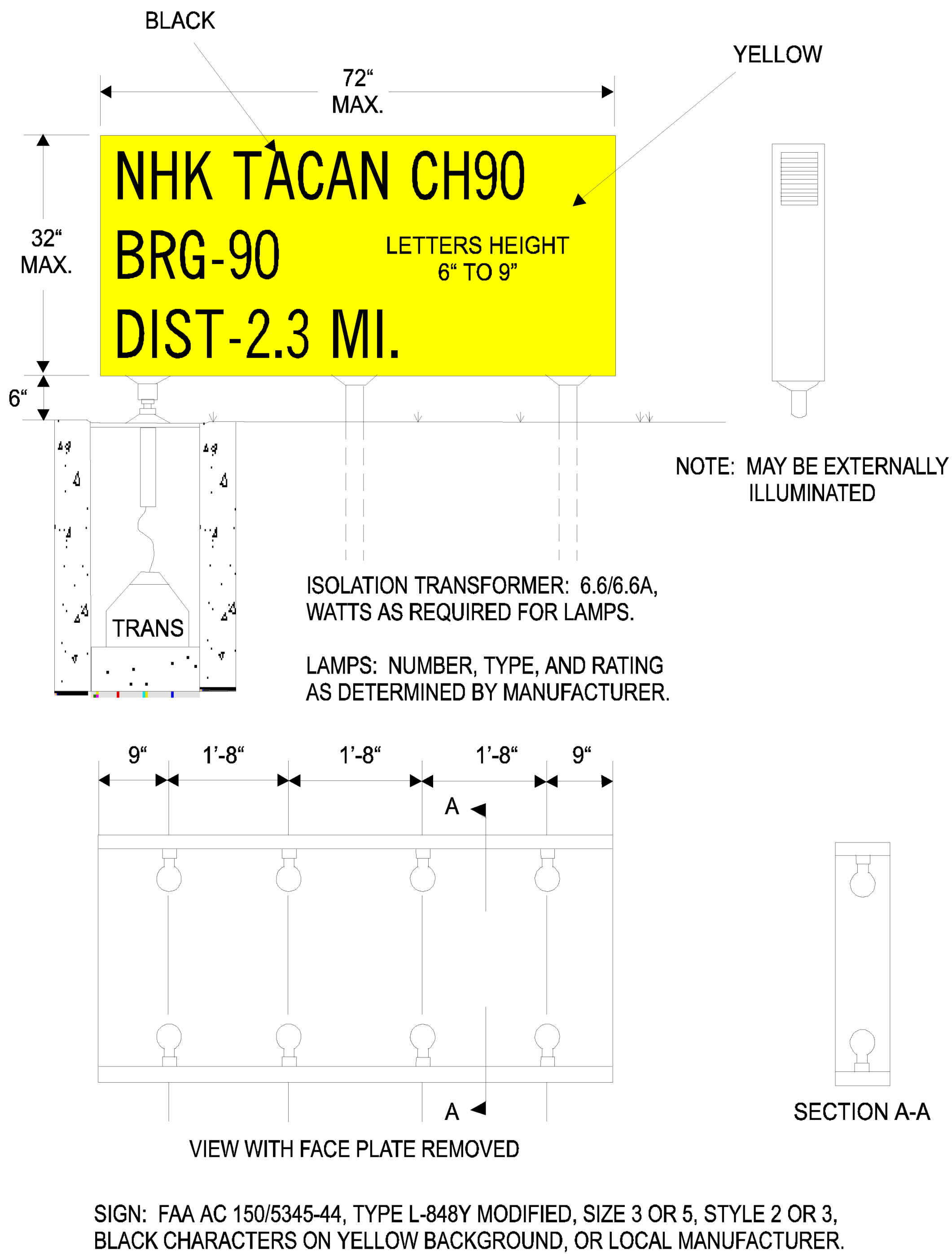


Figure 1. An Example Of A TACAN Checkpoint Sign

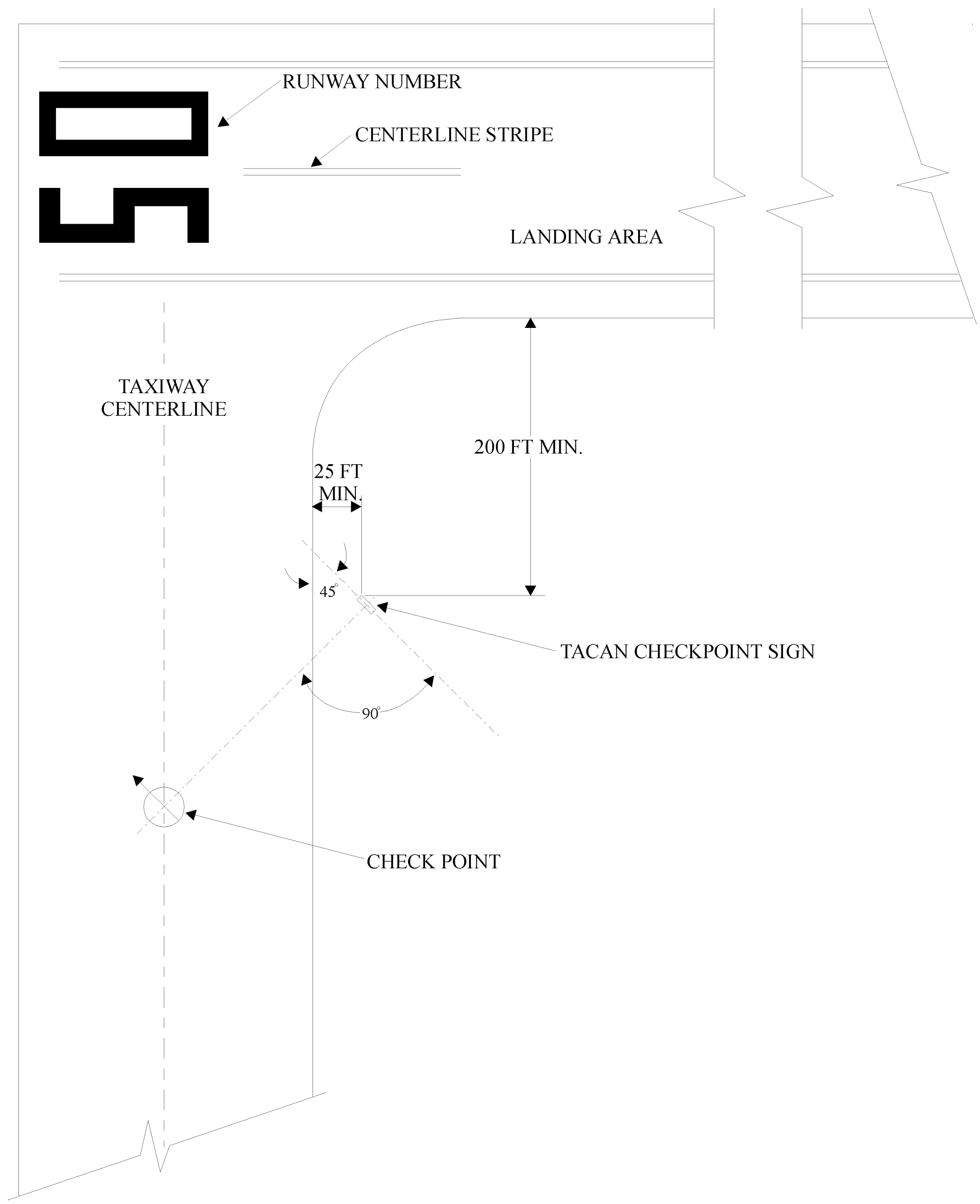


Figure 2. Typical Location Of A TACAN Checkpoint Sign

ORGANIZATIONAL

HOLDING POSITION SIGNS AND LIGHTS FOR INTERSECTIONS WITH RUNWAYS

TAXIWAY VISUAL AIDS

Reference Material

Introduction	WP 002 00
Taxiway Visual Aids, Taxiway Markings	WP 005 01
Taxiway Visual Aids, Taxiway Edge Lights	WP 005 02
Taxiway Visual Aids, Taxiway Centerline Lights	WP 005 03
Taxiway Visual Aids, Taxiway Guidance Signs	WP 005 04
Electrical Power and Control for Visual Aids, Description	WP 009 00
Electrical Power and Control for Visual Aids, Isolation and Distribution Transformers	WP 009 03
Colors, Use in Government Procurement	SAE AMS-STD-595
Design Drawings for Visual Aid Navigation Facilities	UFC 3-535-02
Isolation Transformers for Airport Lighting Systems	FAA AC 150/5345-47
Standards for Airport Markings	FAA AC 150/5340-1M
Specification for Runway and Taxiway Light Fixtures	FAA AC 150/5345-46
Specification for Taxiway and Runway Signs	FAA AC 150/5345-44
Standards for Specifying Construction of Airports	FAA AC 150/5370-10

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the runway holding position signs and lights located at intersections of taxiways with runways. The signs and lights supplement the runway holding position markings on the taxiway to indicate to the pilot the hold short position while awaiting clearance from air traffic control to cross or enter the runway. This information shall be provided for flight operations in all visibility conditions, day or night. These requirements are to be used for designing new holding position signs and light installations. Existing installations of signs and lights may be used and maintained until upgrading or replacement is required.

1-3. JUSTIFICATION REQUIREMENTS. Runway holding position signs shall be installed at all taxiway intersections with runways for airfields with Instrument Flight Rules (IFR) operation (WP 002 00). Airfields authorized for Visual Flight Rules (VFR) operations only may not require these signs; however, if there is a need that justifies installing them, the signs shall be installed at all taxiway intersections with runways. Holding position lights are installed only if taxiway centerline lights are installed at the particular intersection or if experience has shown the need for better identification of the holding position than that provided by the holding position markings and signs. Any variations from the requirements of this WP shall be approved in accordance with the procedures of WP 002 00.

1-4. RELATED FACILITIES. Runway holding position signs and lights are associated with the following:

- Taxiway markings (WP 005 01),
- Taxiway edge lights (WP 005 02),
- Taxiway centerline lights (WP 005 03),
- Taxiway guidance signs (WP 005 04).

2-1. DESCRIPTION.

2-2. RUNWAY HOLDING POSITION SIGNS. The runway holding position signs are mandatory guidance signs.

2-3. The runway holding position signs shall be located at each holding position marking (WP 005 01) and shall have the runway number in white numerals on a red background (Figure 1).

2-4. Holding positions at the standard location and at the instrument clearance positions require markings and may require signs.

2-5. For intersections at the runway threshold, the number for the end of the runway is used.

2-6. For intersections other than at a runway threshold, the sign shall show the runway numbers at both ends such as "33-15." Threshold 33 is on the left and threshold 15 is on the right.

2-7. The letters L, C, and R are included on the runway holding position signs where used in the runway identification.

2-8. Runway holding position sign numerals and letters shall be per Figure 2.

2-9. The height of the letters shall be not less than 15 inches and the height of the sign not less than 24 inches.

2-10. The runway holding position signs shall be internally lighted for night operations. The color and shape of the information shall be similar when observed unlighted during the day.

2-11. The runway holding position signs may be single-faced or double-faced, but only one face is the holding position marker.

2-12. HOLDING POSITION LIGHTS. Runway holding position or clearance lights are a group of three semi-flush lights centered about the taxiway centerline at the holding position marking (see Figure 3). Five lights may be used in very wide taxiway areas.

2-13. If taxiway centerline lights are installed in the area of the holding position, runway holding position lights shall be installed.

2-14. The runway holding position lights (both 3 and 5 light) shall be the same type as the taxiway centerline lights except, they shall use yellow filters per the requirements for an L-852G light fixture in FAA AC 150/5345-46.

2-15. The runway holding position lights shall be unidirectional except the center light may be bidirectional with the green beam towards the runway if this light is part of the centerline lights.

2-16. HOLDING POSITION EDGE LIGHTS. For runway holding positions where holding markings, signs, and clearance lights are not fully effective, holding position edge lights (wig-wag lights) should be installed to emphasize the need for caution and the use of safety procedures.

2-17. Each runway holding position edge light installation shall consist of a fixture on each side of the taxiway at the holding position line.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details about the runway holding position signs and lights, refer to UFC 3-535-02 for the runway holding position marking refer to FAA AC 150/5340-1. General design and installation requirements for the holding position signs and lights are given below.

3-3. METHODS OF INSTALLATION. Runway holding position signs shall be of lightweight construction and shall be mounted on frangible couplings See FAA AC 150/5345-44 for additional details).

3-4. Runway holding position signs shall be placed on a concrete slab or pier which are not noticeably affected by frost heaves or changes in soil conditions.

3-5. Concrete sign foundations shall not protrude above the grade of the local surface.

3-6. An FAA Type L-867 light base for containing the isolation transformer or power adapter may be installed.

3-7. The runway holding position light fixtures shall be installed using FAA Type L-868 light bases (see FAA AC 150/5340-30 for additional information).

3-8. If the runway holding position lights are light base mounted an isolation transformer for each light shall be placed in the base.

3-9. The runway holding position edge (wig-wag) light fixtures shall be installed on light bases using frangible couplings.

3-10. The isolation transformer or power supply unit for the runway holding position wig-wag lights may be located in the same light base or in a separate handhole or light base.

3-11. For airfields in areas with frequent occurrences of snow accumulations of more than six inches, it may be desirable to obtain approval by Naval Air Systems Command to raise the height of the wig-wag lights.

- The additional height should be kept to the minimum acceptable to reduce the hazard of aircraft strikes and limit the increased wind loading and blast forces.
- As the overall height is increased, the signs and wig-wag lights must be located further from the taxiway edge (see 3-12, LOCATIONS, this WP).
- Raising the signs and lights will require longer mounting nipples and may require longer cables to the connectors or terminal strips of the signs and lights.

3-12. LOCATIONS. The location of the runway holding position signs shall be in line with the runway holding position markings (Figure 3).

3-13. A single sign, preferably on the left-hand side of the approach to the intersection, or a sign on each side of the runway holding position if the length of the holding position marking is 150 feet or more, shall be installed.

3-14. The edge of the runway holding position signs shall be not less than 25 feet from the taxiway edge.

3-15. If the elevation of the top of the runway holding position sign is more than 24 inches above the elevation of the edge of the taxiway, the edge of the sign shall be not less than 35 feet from the taxiway edge.

3-16. The runway holding position signs shall be vertical and shall be aligned horizontally with the face of the sign at right angles ±5 degrees to the centerline of the taxiway.

3-17. The runway holding position lights shall be located not more than 3 feet from the edge of the first line of the holding position marking on the approach side to the holding position.

3-18. The runway holding position center light shall be located on or not more than 12 inches from the centerline of the taxiway to avoid painting over the lights when repainting the holding position markings.

3-19. The other two lights (four lights if greater width is needed) shall be on 5 feet ±2 inches on centers from the center light.

3-20. Usually, the line of runway holding position lights is perpendicular to the taxiway centerline, but if the holding position markings are parallel to the runway centerline, the line of lights shall be parallel to the runway centerline. The individual runway holding position lights may not vary more than 2 inches from the line of lights. The axes of the beams for these lights shall be parallel ±2 degrees to the axis of the taxiway.

3-21. The runway holding position edge light fixtures shall be located in line with the holding position and the holding position markers on each side.

3-22. The runway holding position wig-wag light fixture shall be placed as closely as possible to the taxiway edge as permitted by height clearance but not less than 35 feet from the taxiway edge and not less than 3 feet from the outside edge of the holding position markers.

3-23. The height of the fixture shall be not more than 30 inches above the adjacent taxiway edge except for airfields in areas of deep snow accumulations with prior approval by the Naval Air Systems Command for increased light fixture elevation.

3-24. The runway holding position light fixture shall be aimed horizontally with the beam center to intercept the taxiway centerline 100 feet before the holding position. The center of the beams should be aimed at 10 degrees above horizontal.

3-25. The beams for these lights shall be parallel ±2 degrees to the taxiway.

4-1. EQUIPMENT.

4-2. FIXTURES. Both lighted and unlighted runway holding position signs shall be the requirements in FAA AC 150/5345-44.

4-3. Typical examples of the runway holding position signs are in Figure 1.

4-4. The runway holding position lights shall be semi-flush unidirectional yellow lights (L-852G), except the center light shall be a bidirectional yellow/green light if it is part of a taxiway centerline section.

4-5. The runway holding position edge (wig-wag) light fixtures (FAA Type L-804, Runway Guard Light Fixture) shall be per the requirements in FAA AC 150/5345-46.

4-6. PHOTOMETRIC REQUIREMENTS. The photometrics for lighted runway holding position signs shall be per the requirements in FAA AC 150/5345-44.

4-7. The photometrics for the runway holding position lights in Table 1 shall be per the requirements in FAA AC 150/5345-46.

4-8. The photometrics for wig-wag lights shall be per the requirements in FAA AC 150/5345-46.

4-9. The intensity control of the runway holding position lights shall be the same as the taxiway centerline series lighting circuit.

Table 1. Schedule of Equipment for Holding Position Signs and Lights

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER RATING	ISOLATION TRANSFORMER FAA TYPE AC 150/5345-47
Holding position signs, 1 or 2 per holding position.			
Sign: FAA AC 150/5345-44, Type L-858R, Size 2, 3 or 5, Style 2 or 3, Legends as specified.	Watts, type, and number as determined by manufacturer.	6.6/6.6A, watts and number as determined by manufacturer.	Type as required by the watts.
Holding position lights, semiflush, unidirectional, yellow, or bidirectional yellow/green, 3 or 5 per holding position.			
For straight sections of regular taxiways.			
Lights: FAA AC 150/5345-46, Type L-852A, Mode 1, 45W 6.6A L-852A(L)	45W 6.6A, type as determined by manufacturer.	30/45W 6.6/6.6A Determined by the mfr.	L-830-1 Determined by mfr.
For curved sections of regular taxiways.			
Lights: FAA AC 150/5345-46, Type L-852B, Mode 1, 65W 6.6A L-852B(L)	65W 6.6A, type as determined by manufacturer.	100W, 6.6/6.6A	L-830-4 Determined by mfr.
For straight sections of Category III taxiways.			

Table 1. Schedule of Equipment for Holding Position Signs and Lights (Cont)

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
FAA AC 150/5345-46, Type L-852C, Mode 1 L-852C(L)	6.6A, watts and type as determined by manufacturer.	6.6/6.6A, watts as determined by manufacturer.	Determined by mfr.
For curved sections of Category III taxiways.			
FAA AC 150/5345-46, Type L-852D, Mode 1, 6.6A L-852D(L)	6.6A, watts and type as determined by manufacturer.	6.6/6.6A, watts as determined by manufacturer.	Determined by mfr.
Holding position edge lights, elevated, unidirectional, yellow, 2 per holding position.			
FAA AC 150/5345-46, Type L-804, Type L-804(L)	6.6A or 120/240 VAC, as determined by manufacturer.	Determined by manufacturer.	Determined by mfr.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of “certified” light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See “Advisory Circulars” at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED’s are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot’s ability to see LED lamp based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVD.

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for the runway holding position lights shall be provided by the 6.6-ampere series circuits (WP 009 00) for the associated taxiway edge or centerline lights.

5-3. Runway holding position signs shall be powered by a dedicated CCR set to 5.5 amperes.

5-4. The lamps of the runway holding position signs and lights shall be connected to the primary series circuit by the required number and rating of series-series isolation transformers (WP 009 03).

5-5. If required by the manufacturer, a power adapter for the signs and holding position edge lights shall be provided.

5-6. The runway holding position lights may be connected to the associated taxiway light circuit by individual isolation transformers.

5-7. Emergency power shall be the same as that required for the associated taxiway centerline lights.

5-8. CONTROLS. The runway holding position lights shall be controlled by the controls for the associated taxiway edge or centerline lights.

5-9. During daylight in Visual Flight Rules (VFR) conditions, the holding position signs and lights may be unlighted, but for operations in Instrument Flight Rules (IFR) conditions (WP 002 00), the signs and lights shall be lighted.

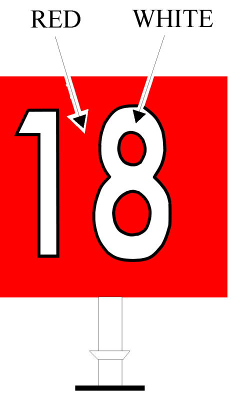
5-10. The runway holding position lights may have the same intensity control as the associated taxiway lights.

5-11. For the holding position edge (wig-wag) lights, power may be from the series lighting circuit (6.6 A – L-804, Mode 1)) or parallel voltage source (120/240 VAC, L-804, Mode 2).

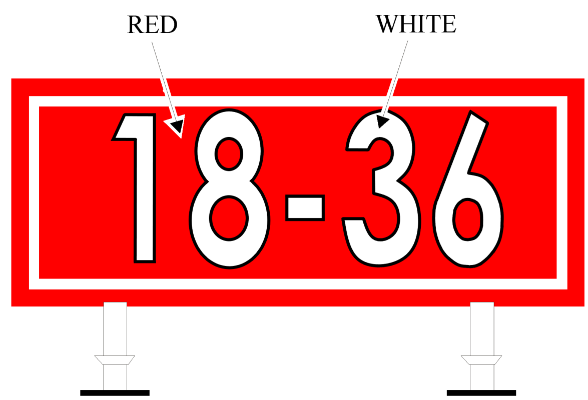
HOLDING POSITIONS SIGNS:
FAA AC 150/5345-44, TYPE
L-858R, SIZE 2, 3, OR 5,
CLASS 1 OR 2,
LEGENDS AS REQUIRED.

LAMPS: RATING AND
TYPE AS DETERMINED
BY MANUFACTURER.

ISOLATION TRANSFORMERS:
6.6/6.6A, WATTS AND
NUMBER AS DETERMINED
BY MANUFACTURER

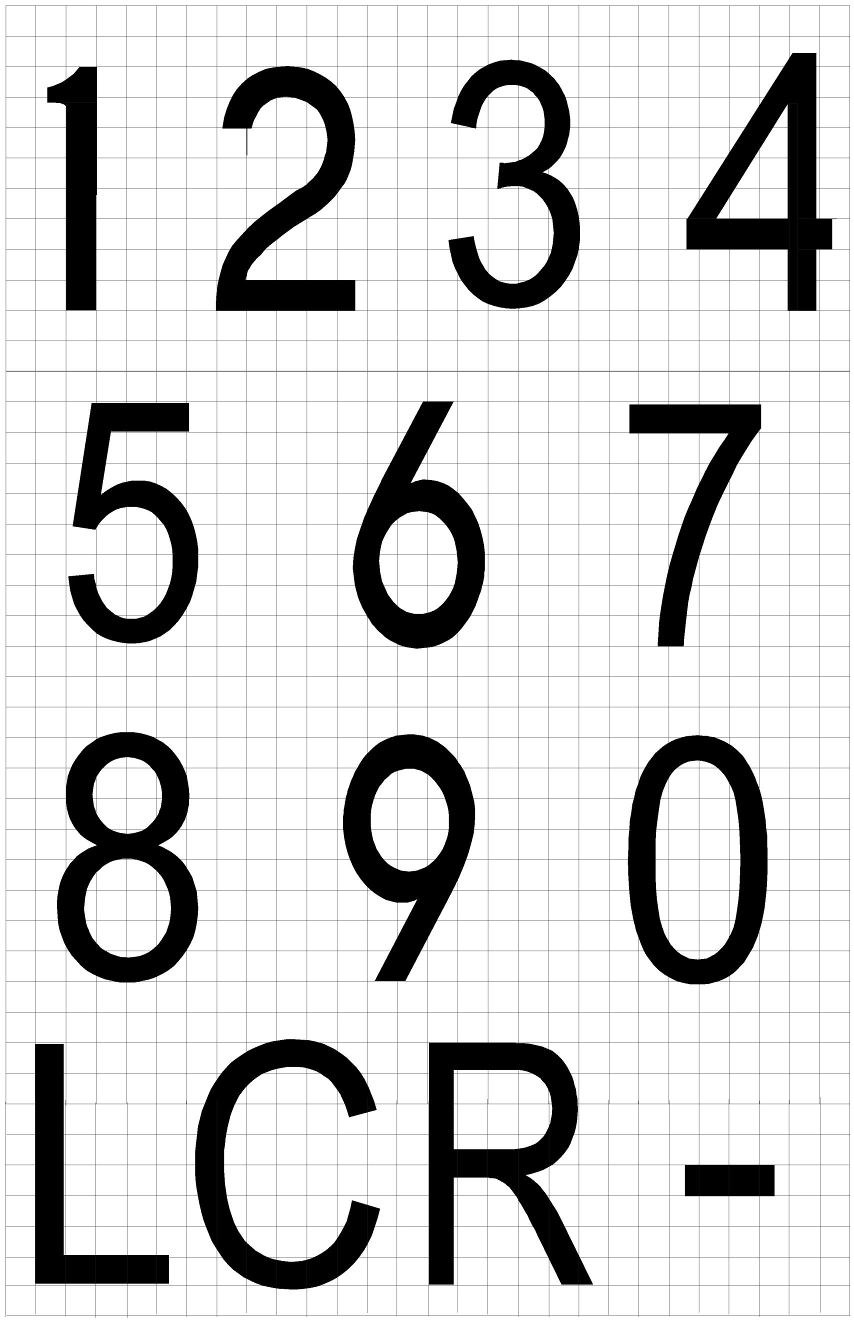


A. HOLDING POSITION SIGN AT RUNWAY THRESHOLD.



B. HOLDING POSITION SIGN AT OTHER THAN RUNWAY THRESHOLD.

Figure 1. Examples of Holding Position Markers (Signs)



COLORS: WHITE NUMERALS AND LETTERS ON A RED BACKGROUND

Figure 2. Typical Numerals and Letters for Holding Position Signs

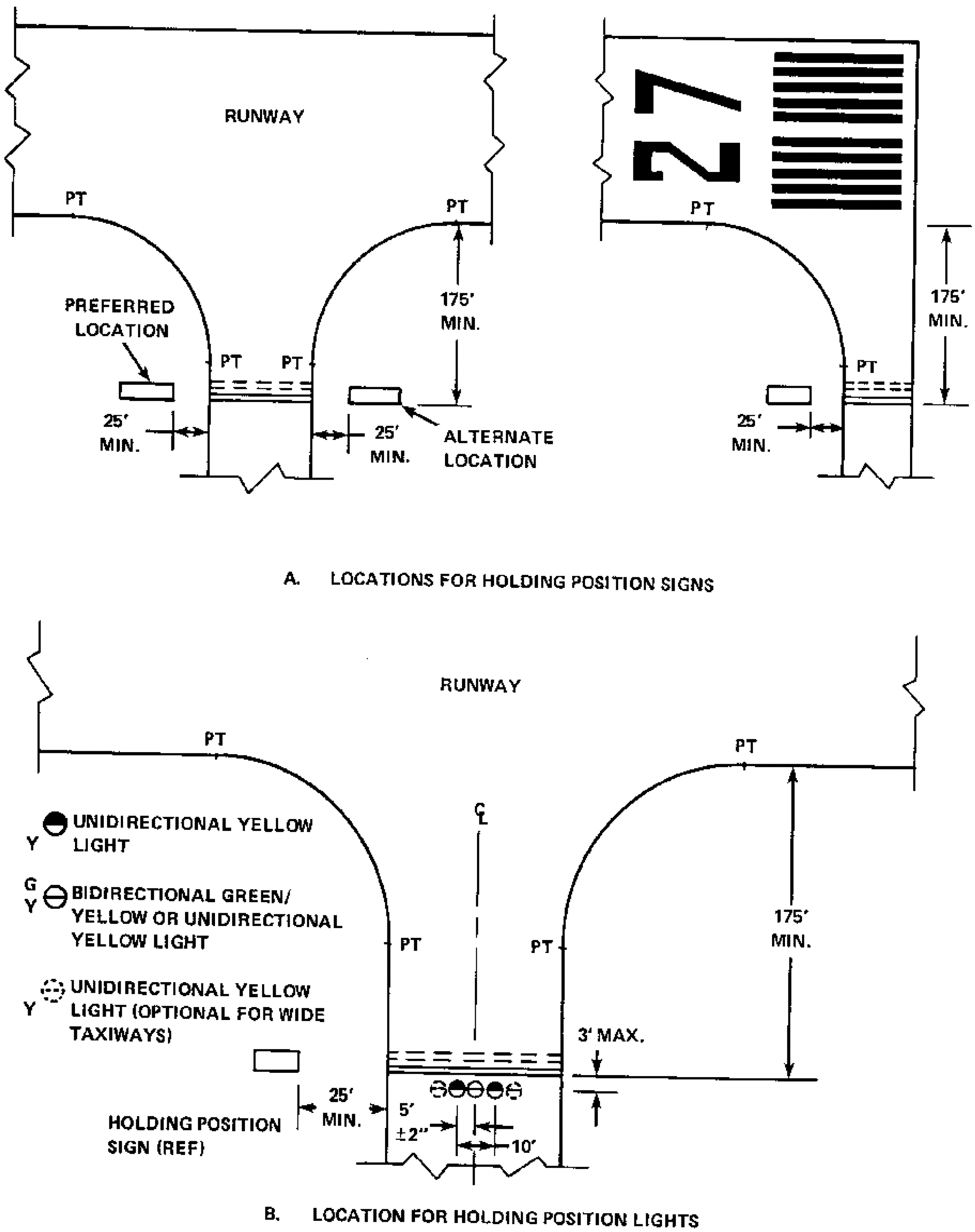


Figure 3. Typical Locations for Holding Position Signs and Lights

ORGANIZATIONAL

TAXIWAY LIGHTS FOR RUNWAYS USED AS TAXIWAYS

TAXIWAY VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the taxiway lights for runways or portions of a runway regularly used as part of a taxiing route at night. The taxiway lights outline the route for taxiing to and from another operational runway or other location. The taxiway lights shall be provided in addition to the runway lights. The requirements in this WP are to be used for designing new taxiway light installations on runways or sections of runways. Existing installations for such runways may be used and maintained until upgrading or replacement is required.

1-3. JUSTIFICATION REQUIREMENTS. The use of runways as taxiways should be avoided. Where it is necessary to use a runway or a section of runway as part of a regular taxi route during nighttime operations, the section of runway shall use taxiway edge lights. Former runways or sections of runways that are no longer used as runways but are used as taxiways should be reduced to standard taxiway width and be provided with standard taxiway lights and markings. Any variations from the requirements in this WP shall be approved in accordance with the procedures of WP 002 00.

1-4. RELATED FACILITIES. The taxiway lights with separate light fixtures and controls shall be in addition to the standard runway lights. The taxiway lights shall be part of the taxiway edge light system. Visual aids related to use of taxiway lights for runways used as taxiways are as follows:

- High-Intensity Runway Edge Lights (HIRL) (WP 004 05),
- Taxiway markings (WP 005 01),
- Taxiway edge lights (WP 005 02),
- Taxiway guidance signs (WP 005 04).

2-1. DESCRIPTION.

2-2. The taxiway lights for runways used as taxiways shall consist of lines of blue lights located along each side of the runway only in the sections used for taxiing. The taxiway lights shall be elevated. An exception to using elevated lights is, in areas where the arresting gear may damage them, semi-flush taxiway lights should be used. The elevated lights shall be standard elevated taxiway lights. The taxiway elevated lights may be equipped with hoods to block out emitted light in directions not necessary to taxiing to reduce the “sea-of-blue” effect or in areas requiring tone down for security. The semi-flush lights shall be omnidirectional blue. The taxiway lights for runways shall be on a circuit which can be deenergized when the runway is not a part of the active taxi route. The taxiway centerline markings should extend onto the runway but shall be interrupted three feet from the runway markings (WP 005 01).

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details for the taxiway lights, refer to UFC 3-535-02 and FAA AC 150/5340-30. General design and installation requirements are given below.

3-3. METHODS OF INSTALLATION. The elevated taxiway lights may be mounted on FAA Type L-867 light bases or on conduits in concrete foundations.

3-4. All elevated lights shall be mounted on frangible couplings per the requirements in FAA AC 150/5345-46.

3-5. The height of elevated lights shall be not more than 14 inches above the runway edge.

3-6. Semi-flush lights shall be installed on light bases (see FAA AC 150/5345-42 for more information about load and non-load bearing (FAA Type L-868 and L-867) light bases).

3-7. Because the taxiway lights are omnidirectional in azimuth, the only beam alignment required is that the lights be properly leveled when installed on the frangible couplings/light bases.

3-8. If hoods are used to shield the emitted light from the taxiway elevated light fixture, the hoods shall be aligned to emit light parallel to and towards the runway.

3-9. For airfields in areas with frequent occurrences of snow accumulations of more than six inches, it may be desirable to obtain approval by Naval Air Systems Command to raise the height of the elevated taxiway edge lights. The additional height should be kept to the minimum acceptable to reduce the aircraft strike hazard.

3-10. See FAA AC 150/5340J, Figure A109, Adjustment of edge light elevation for high snowfall areas, for detailed information about edge light height vs. distance from the runway/taxiway edge.

3-11. Raising the height of the elevated taxiway edge lights will require longer mounting nipples and may require longer cables between the secondary connector of the isolation transformers and the connections to lamps. Before procurement or arranging for installation, check with the light manufacturer for any special mounting requirements.

3-12. LOCATIONS. The taxiway lights for runways used as taxiways shall be located in straight lines along the edges of the runway.

3-13. The taxiway edge lights shall be at a uniform distance, preferably 5 feet, outside the paved or marked edges of the runway but not less than 2 feet outside the line of runway lights (Figure 1).

3-14. The spacing of the taxiway lights shall be similar to that for straight sections of taxiways (WP 005 02) with the spacing sections determined by whether the lights are along both sides of the runway or only one side.

3-15. The length of taxiway edge light sections for spacing are determined by the distance between the Points of Tangency (PT) on the same or opposite side of the runway of intersecting taxiways or other runways.

3-16. For each section along the runway, the taxiway edge lights shall be equally spaced except at the ends of sections where additional lights may be required. The additional lights are used to make a gradual transition to changes in spacing.

3-17. Where the runway edges are parallel, each side of the section shall be the same length.

3-18. All other taxiway sections shall be single edges and there may be more than one section in an area with a single edge.

3-19. When a taxiway terminates at the runway used as a taxiway, a pair of elevated yellow taxiway edge lights shall be installed on the far side of the runway where the extended centerline of the taxiway intersects the line of taxiway lights unless this intersection is beyond the PT of the taxiway.

3-20. The intersection of the taxiway centerline with the line of taxiway lights shall be the boundary for two sections of taxiway edge lights with a single edge, but the yellow lights shall be on each side and not more than 5 feet from the intersection.

3-21. The spacing of taxiway lights for the runways used as taxiways shall be as follows:

3-22. Parallel Edges More than 300 Feet in Length.

3-23. The spacing between lights shall be not more than 200 feet. In each of the end spaces on each side of the runway, an additional light shall be installed 40 feet from the end of the section. The lights on opposite sides of the runway shall be a pair on a line perpendicular to the runway centerline. If it is not practical to install a light at the desired position, the pair of lights may be moved not more than 5 feet along the runway. If displacement for more than 5 feet is necessary, the distance for spacing should be divided into two sections. Examples for spacing of lights in these sections are shown in Figure 1A.

3-24. Single or Parallel Edges 300 Feet or Less in Length.

3-25. The lights in these sections shall be spaced equally at not more than 50 feet. If the section has parallel edges, the lights on opposite sides of the runway shall be in pairs on lines perpendicular to the runway centerline. Examples of spacings for these sections are shown in Figure 1A.

3-26. Single Edges More Than 300 Feet in Length.

3-27. The spacings between lights shall be not more than 100 feet. In each end space an extra light shall be installed 40 feet from the end of the section. Examples of spacings for these sections are shown in Figure 1B.

4-1. EQUIPMENT.

4-2. FIXTURES. The taxiway edge light fixtures are usually the elevated type, but where needed, semi-flush lights may be used. The fixtures and equipment to be used are listed in Table 1. The use of hoods for shielding is optional.

Table 1. Schedule of Lighting Equipment for Taxiway Lights for Runways Used as Taxiways

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER RATING	ISOLATION TRANSFORMER FAA TYPE AC 150/5345-47
Elevated lights, omnidirectional, blue, type is optional.(1)			
FAA AC 150/5345-46, Type L-861T, mode 1	45W 6.6A,(2) type as determined by manufacturer.	30/45W 6.6/6.6A	L-830-1
Hoods or shields, types as provided by manufacturer or from commercial sources.			
Semiflush lights, omnidirectional, blue. (1)			
FAA AC 150/5345-46, Type L-852E, mode 1	6.6A, watts and type as determined by manufacturer.	6.6/6.6A, watts as required for the lamp.	L-830-1

Table 1. Schedule of Lighting Equipment for Taxiway Lights for Runways Used as Taxiways (Cont)

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47

NOTES:

1. Number of lights required varies with taxiway length and spacing.
2. 45W lamps are used for systems with intensity control. If intensity control is not provided, use 30W lamps.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of “certified” light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See “Advisory Circulars” at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED’s are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot’s ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVD.

4-3. PHOTOMETRIC REQUIREMENTS. The emitted light from the taxiway edge light fixtures shall be omnidirectional.

4-4. The color of the emitted light from the taxiway edge lights shall be aviation blue or aviation yellow per the requirements in FAA AC 150/4345-46.

4-5. Not less than three steps of intensity shall be provided with the lowest step not more than ten percent of the rated intensity.

4-6. The intensity for the elevated taxiway edge lights shall be per the requirements in FAA AC 150/5345-46.

4-7. The intensity of the semi-flush taxiway edge lights (FAA Type L-852T) shall be per the requirements in FAA AC 150/5345-46.

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for the taxiway edge lights shall be provided by the 6.6-ampere series circuits (WP 009 00). The constant-current regulators shall have not less than three intensity steps (WP 009 02). The lights shall be connected to the primary series circuit by individual series-series isolation transformers (WP 009 03). The taxiway lights for runways providing access to and from instrument runways shall be provided with secondary or emergency power (WP 009 01). This emergency power shall be equipped to automatically transfer power in less than 15 seconds after failure of primary power.

5-3. CONTROLS. The taxiway edge lights shall be remotely controlled from the airfield control panel (WP 009 05) in the air traffic control tower with an alternate control station in the lighting control vault.

5-4. Three steps of intensity control shall be provided with the intensity at the lowest setting not more than 10 percent of the intensity at rated current.

5-5. The taxiway edge lights for runways used as taxiways shall provide for energizing the lights separately.

5-6. The controls for the runway taxiway edge lights shall be so the taxiway lights cannot be energized when the runway lights are operating.

5-7. The runway taxiway edge light control is usually provided by circuit selector switches (WP 003 06), and may be part of a facsimile type control panel for ease in selecting the taxi route.

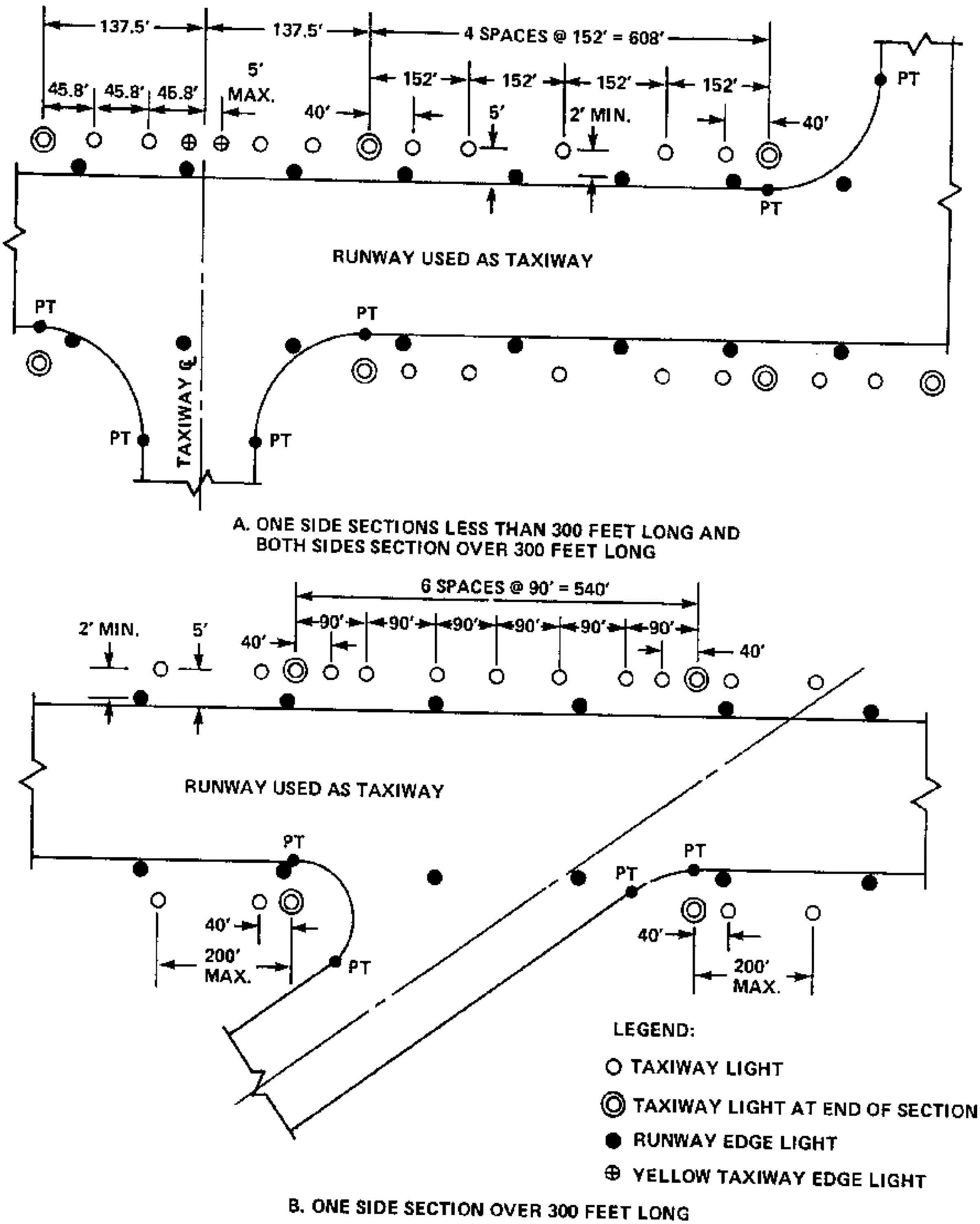


Figure 1. Examples of Locations of Taxiway Lights for Runways Used as Taxiways

ORGANIZATIONAL

DESCRIPTION

SPECIAL LIGHTS AND MARKINGS VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for markings, lights, and signs for aprons and parking areas and for special purposes at other areas of the airfield. The purpose of these visual aids is to provide guidance to pilots for safe and efficient aircraft maneuvering in parking and service areas, illumination for servicing areas, and visual aids for special types of aircraft ground operations. The visual aids are often task oriented, related to safety, servicing, and training, rather than part of the integrated surface movement operations. The information must be easily recognized and used in fair weather and in restricted visibility conditions, day or night, to the operating minimums authorized for the airfield.

1-3. SCOPE. The special lights and markings visual aids section of this Technical Manual contains the configuration requirements, specific applications, basic design and installation criteria, and equipment required for special operations of Navy shore-based airfields. Instead of standardization into an integrated system these aids must be adapted to fit individual installation and operational requirements of the airfield. The requirements contained in the Work Package(s) (WP) for each visual aids system provide guidance for all personnel servicing existing systems or when designing new installations. Existing installations of similar aids may be used and maintained as installed. Extensions, major modifications, or upgrading of existing installations shall comply with the basic requirements of the WP; however, adaptations of the system requirements may be necessary at some airfields.

1-4. STANDARDIZATION. The WP for each visual aid system establishes the requirements to be used for most Navy airfields. By combining the WPs for the special visual aids required for the mission and special characteristics of the airfield, standardization of these visual aids for Navy airfields is attained. When deviations from defined requirements are necessary, these changes shall be authorized per the approval procedures in WP 002 00.

2-1. DESCRIPTION OF SPECIAL VISUAL AIDS.

2-2. The special visual aids consist of markings, lights, and signs installed on or near a particular area. The apron and parking area lights and markings, including fueling area lights, provide the guidance to pilots for safe maneuvering in a congested area. The wheels-up and wave-off lights provide illumination for detecting unsafe conditions for aircraft and present a strong visual signal for a pilot to abort a landing. The simulated carrier deck lights and markings provide the visual aids for training and practicing carrier type approaches and landings. The portable emergency lights provide standby lights for runway and taxiway lights that have failed or are not available.

3-1. SELECTION OF SPECIAL VISUAL AIDS.

3-2. The types of special visual aids required depend on the mission and the arrangement of apron and service areas of the airfield. Table 1 is a guide for determining the aids to be provided. The design requirements are found in the WP for each type of taxiway visual aid. Special visual aids must always be designed with the participation of air traffic control. For installation details about airfield lights, refer to FAA AC 150/5340-30. For additional information about airfield markings and signs refer to FAA ACs 150/5340-1M and FAA AC 150/5340-18. For more information about carrier deck markings, refer to and to UFC 3-535-02 for additional installation information for airfield lights and signs.

4-1. IMPLEMENTATION.

4-2. The WP and requirements of this section of the Technical Manual are not intended to direct or request implementation but are to establish uniformity when implementation is undertaken.

Table 1. Special Lights and Markings Visual Aids Requirements

Special Visual Aids System	Authorized Operations				
		IFR Category			
	VFR	Non-Prec	I	II	III
Apron Markings (WP 006 01)	C	C	C	R	R
Apron Lights (WP 006 02)	R	R	R	R	R
Wheel-up Lights, Intersections (WP 006 03)	OPT	OPT	OPT	NR	NR
Wave-off Lights (WP 006 03)	OPT	OPT	OPT	OPT	OPT
Simulated Aircraft Carrier Deck Lights and Markings (WP 006 04)	RS	RS	RS	X	X
Fueling Area Lights (WP 006 05)	RS	RS	RS	RS	RS
Portable Emergency Lights (WP 006 06)	OPT	OPT	NR	NR	NR

C - Recommended

R - Required

RS - Required under special conditions. * Example: Simulated carrier deck lights and markings.

OPT - Option as recommended by air station commander and approved by NAVAIR.

NR - Not Required.

X - Not recommended.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of “certified” light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3 (Certified Airport Lighting Equipment). See “Advisory Circulars” at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).

Table 1. Special Lights and Markings Visual Aids Requirements (Cont)

2.	LED's are recommended for new installations, or complete replacement; however, do not install them in an existing circuit or system with incandescent fixtures.
3.	Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVD.

ORGANIZATIONAL

APRON AND PARKING AREA MARKINGS

SPECIAL LIGHTS AND MARKINGS VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the markings of aprons and parking areas on shore-based airfields. The markings provide visual cues to pilots for taxiing through a complex or congested area between the end of the taxiway and the final position for aircraft parking. There may be several destinations in this apron/parking area including terminals, hangars, service areas, and taxiways. The apron markings include taxilane centerline and edge markings, shoulder or deceptive area markings for paved areas that are not intended for aircraft traffic, and parking area markings. In addition, apron markings may include special markings to identify destinations or to provide specific information. Taxilanes are specified taxiing areas or taxiways across larger paved areas. The markings in this WP shall be used for all new or resurfaced apron and service areas and at any time the existing markings are to be repainted. Existing markings may continue to be used until the markings are repainted.

1-3. JUSTIFICATION REQUIREMENTS. Apron markings are the primary visual aid for taxiing in the apron area during daylight and to supplement the apron lights during night operations in all meteorological conditions. Often taxilanes are used in the apron/parking areas instead of taxiways. The markings in the apron/parking area should be easily interpreted and standardized where possible. The centerline, edge, and shoulder markings are similar to the taxiway markings, but parking area and identification markings shall be customized for the airfield. All paved taxiways and taxilanes in the apron area shall use centerline markings and if needed, edge and shoulder markings. The use of parking area and spot identification markings are optional for the airfield. Additional markings or modifications may be approved for special operating conditions (WP 002 00).

1-4. RELATED FACILITIES. This WP includes the standard apron markings and recommendations that may be used for parking area and special information markings. These markings are related to other visual aids as follows:

- Taxiway markings (WP 005 01),
- Apron and parking area lights (WP 006 02),
- Taxiway guidance signs (WP 005 04).

2-1. DESCRIPTION.

2-2. GENERAL. The apron and parking area markings consist of a system of markings identified by the functions which they serve. The elements of these taxiway markings are as follows:

- Centerline markings: Required for all taxiways and taxilanes.
- Edge markings: Optional where needed to mark the edge of full-strength pavement or of taxilanes through wider paved areas.
- Shoulder markings: Optional for paved areas which are not intended for aircraft traffic and are not adequately recognized by natural contrast or edge markings.
- Parking area markings: Optional.
- Special identification and information markings: Optional.

2-3. All apron/parking area markings shall be painted in the specified color on the pavement surface. The markings configurations shall be per Figure 1 and 2.

2-4. CENTERLINE MARKINGS. (See Figure 1.) The taxiway/taxilane centerline markings provide identification of a taxiway or taxilane and longitudinal guidance for steering the aircraft.

2-5. Taxiway/taxilane centerline markings shall be a continuous retroreflective yellow stripe not less than 6 inches wide located along the physical centerline of the pavement.

2-6. If centerline lights are installed on the taxilane/taxiway, the centerline stripe may be located not more than 12 inches from the physical centerline to avoid painting over the lights.

2-7. The centerline markings may continue across intersecting taxilanes or merge into the intersecting taxiways and taxilanes to indicate turns that are frequently used.

2-8. On curved sections of the centerline markings, the curves of the markings shall be smooth, and the markings shall be not less than one-half the width of the taxiway/taxilane measured from the edge of the pavement.

2-9. The radius of curves when using taxiway/taxilane centerlines and lead-in and lead-out markings to parking spots shall be 100 feet or more.

2-10. One-way taxiway/taxilanes and lead-in and lead-out lines may be marked with arrows that indicate the direction of travel.

- The arrows shall be chevrons centered on the taxiway/taxilane centerline with the base of the chevron 3 feet wide and the apex of the chevron 5 feet from the base.
- The wings of the chevrons shall be not less than 6 inches wide.
- The apex of the chevron shall be on the axis of the centerline marking, and, if marking the exit from a taxilane, shall be not more than 50 feet from the taxilane centerline (see Figure 2).
- For long taxilanes and lead-in and lead-out lines, additional chevrons may be installed preferably at not greater than 200-foot intervals.

2-11. EDGE MARKINGS. (See Figure 1.) taxiway/taxilane edge markings are installed only where the visual contrast between the edge of the full-strength pavement or designated edge of taxiways/taxilanes and the adjoining area is such that pilots may tend to run off the taxiing area.

2-12. The taxiway/taxilane edge markings shall consist of a pair of continuous parallel retroreflective yellow stripes.

2-13. The stripes shall be 6 inches wide and 6 inches apart with the outer edge of the outer stripe along the edge of the full strength or designated edge of the taxiway or taxilane.

2-14. If necessary, the edge markings may be located not more than 2 feet inside the taxiway edge. Where used, the edge markings may be placed along one or both sides of the taxiing area.

2-15. SHOULDER OR DECEPTIVE AREA MARKINGS. The shoulder or deceptive area markings are used, if needed, to mark stabilized shoulders that are not full-strength pavement or areas where aircraft taxiing is undesirable. Edge markings usually provide adequate indication of the edge of the taxilane; however, in some areas such as stabilized islands in apron areas or along some curves, shoulder markings may be needed.

2-16. Taxiway/taxilane shoulder markings shall be non-retroreflective yellow bars painted on the shoulder surface or deceptive area (see Figure 1).

2-17. The taxiway/taxilane bars shall be not less than 3 feet wide and perpendicular to the taxiing area edge and extending outboard.

- The length of the taxiway/taxilane shoulder marking bars shall be 20 feet or to the outer edge of the shoulder paving whichever is less.
- Along sections of straight edges, the shoulder marking bars shall be equally spaced not more than 100 feet apart with a bar at the PT of a curve or at the end of the edge or shoulder paving.
- On curves, the bars shall be equally spaced along the edge not more than 50 feet apart.

2-18. The shoulder or deceptive area markings are used, if needed, to mark stabilized shoulders which are not full strength pavement or areas where aircraft taxiing is undesirable. Edge markings usually provide adequate indication of the edge of the taxilane; however, in some areas such as stabilized islands in apron areas or along some curves, shoulder markings may be needed. These markings shall be non-retroreflective yellow bars painted on the shoulder surface or deceptive area (see Figure 1). These bars shall be not less than 3 feet wide and perpendicular to the taxiing area edge and extending outboard. The length of the bars shall be 20 feet or to the outer edge of the shoulder paving whichever is less. Along sections of straight edges, the shoulder marking bars shall be equally spaced not more than 100 feet apart with a bar at the PT of a curve or at the end of the edge or shoulder paving. On curves the bars shall be equally spaced along the edge not more than 50 feet apart.

2-19. PARKING AREA MARKINGS. Markings for parking areas, if needed, provide more effective use of the available area. These markings shall consist of one or more elements as follows:

- Nose wheel spots.
- Spot identification markings.
- Lead-in lines.
- Lead-out lines.
- Wing tip trace lines.
- Helicopter spots and identification markings.

2-20. Examples of these parking area markings are shown in Figure 2. The elements used for a particular parking area may vary with the types of aircraft, mixture of aircraft types, operating missions, and access to and from the parking area.

- The color of the markings for nose wheel spots and lines shall be non-retroreflective aviation yellow.
- The nose wheel spots shall be solid yellow squares or rectangles located at the desired position for the nose wheel when parked.
- For nose wheel spots without identification or for single digit identification the squares shall have 36-inch sides.
- For two-digit identification markings, the rectangles shall be 36 inches by 42 inches.
- If the nose wheel spots are identified, the number or letter shall be black paint centered on the spot and not less than 24 inches high.
- The lead-in lines shall be continuous, not less than 6 inches wide, and follow the desired taxi path to the spot.
- Lead-out lines are similar to lead-in lines and are used where a specific path other than the lead-in line is desired for departing from the parking area.
- For large aircraft the use of continuous yellow wing tip trace lines to mark the safe limits for the wing tips during maneuvering in the parking area may be installed.

- The wing tip trace line shall be not less than 6 inches wide and along a smooth curve that provides the minimum safe clearance from other parking areas or obstructions.
- For helicopter parking, yellow circles should be used to mark the parking spot.
- The circle shall be not less than 66 inches outside diameter and the marking shall be not less than 6 inches wide.
- A yellow numeral not less than 36 inches high centered inside the circle shall be used for helicopter spot identification.
- A 6-inch wide yellow line extending out from the spot circle may be used to indicate the alignment of the tail for helicopter parking.

2-21. SPECIAL APRON MARKINGS. To provide identification of areas or specific instructions and information, nonstandard markings may be used in the apron area. These markings shall be non-retroreflective yellow and of the size and location determined as practicable. These markings should not be easily confused with the standard markings. Special apron markings may be coordinated with taxiway guidance signs.

2-22. BORDERS FOR MARKINGS. For some installations, the apron and parking area markings do not provide sufficient contrast with the surrounding pavement for easy recognition. Contrast can be improved by outlining the markings with a non-glossy black border. The borders shall be not less than 6 inches wide.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details and requirements for some apron markings, refer to FAA AC 150/5340-1M. The general requirements are given in (2-1, DESCRIPTION, this WP) through (2-22, BORDERS FOR MARKINGS, this WP).

4-1. MATERIALS.

4-2. The materials required for apron and parking area markings are paint and retroreflective glass spheres (beads). The approved materials and colors are per Table 1. Environmental regulations in some states, such as California, or other area airport authorities may prohibit or restrict the use of solvent based paints. For yellow markings, use FED SPEC TT-P-1952F paint. For the slower drying FED SPEC TT-P-1952F paint, timing of the application of retroreflective beads may be required to assure adherence of the beads without sinking too deeply into the paint.

Table 1. Materials for Apron and Parking Area Markings

COLOR OF MARKING	FEDERAL SPECIFICATION	AUTHORIZED USE
Retroreflective Yellow	FED SPEC TT-P-1952F, paint, SAE AMS-STD-595, chip No. 23538, and TT-B-1325 glass spheres, type III, gradation A.	Taxilane centerline, and taxilane edge markings.
Non-retroreflective Yellow	FED SPEC TT-P-1952F paint, SAE-AMS-STD-595, chip No. 23538.	Shoulder and deceptive areas, parking area, and special apron markings.
Non-retroreflective Black	FED SPEC TT-P-1952F paint, SAE-AMS-STD-595, chip No. 27038.	Nose wheel spot identification and borders around yellow markings.

5-1. PHOTOMETRIC REQUIREMENTS.

5-2. The apron markings shall be airfield marking paints of the aviation surface colors per SAE-AMS-STD-595.

- Yellow, color chip No. 23538,
- Black, color chip No. 27038.

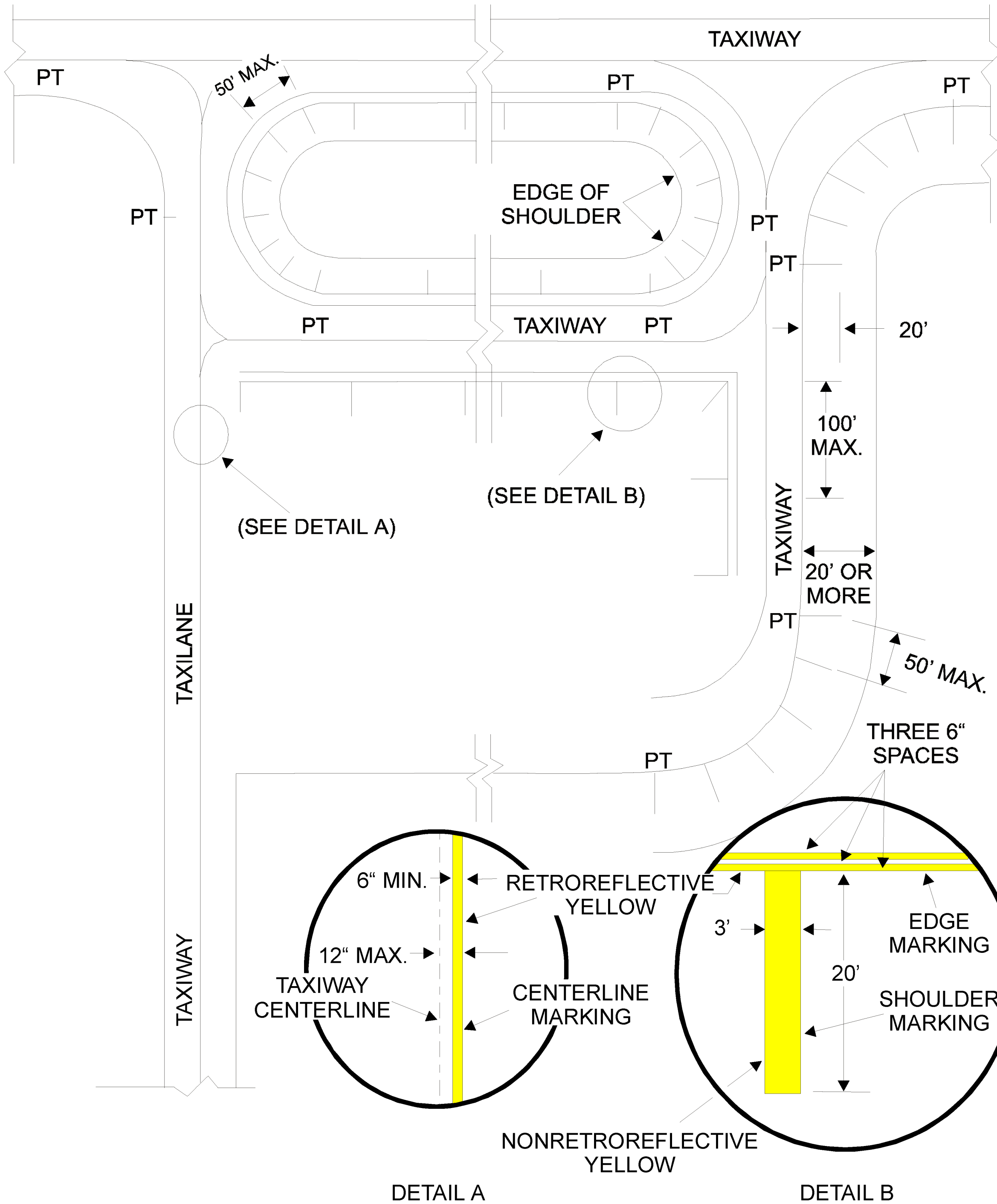


Figure 1. Examples of Apron Centerline, Edge, and Shoulder or Deceptive Area Markings

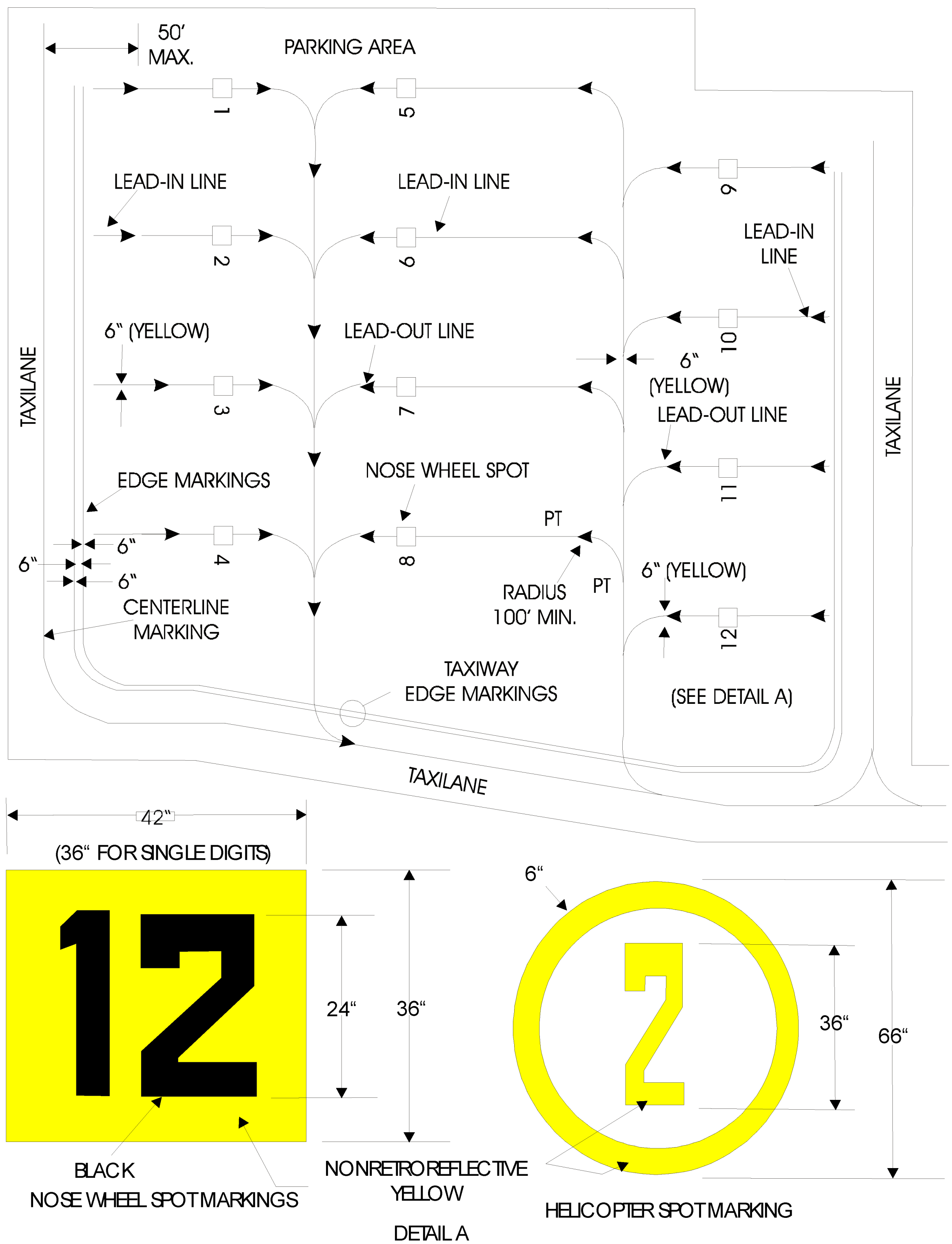


Figure 2. Examples of Parking Area Markings

ORGANIZATIONAL

APRON AND PARKING AREA LIGHTS

SPECIAL LIGHTS AND MARKINGS VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the apron and parking area lights. Apron and parking area lights provide the illumination of the visual aids for the pilot to guide his aircraft into position for loading, servicing, and parking. The apron and parking lights also provide illumination to perform such tasks as aircraft loading, unloading, fueling, and maintenance. The area involved is between the ends of the taxiways and the final parking areas where aircraft are maneuvered or positioned for servicing outside of buildings and hangars. These areas are called aprons and may be defined as areas for ground operations of aircraft not involving landing, taxiing, and taking off. The apron and parking area lights provide three functions:

- Assist in taxiing and maneuvering the aircraft.
- Provide illumination for the servicing tasks.
- Provide illumination for security.

1-3. The lights for these functions include both permanently installed fixtures and portable lights. Portable lights may vary from flashlights to banks of floodlights. This WP contains the requirements for the permanent lighting only. Permanent lights include floodlights, taxilane centerline lights, and peripheral lights. These requirements shall be used for new apron light installations. Existing systems may be used and maintained until upgrading or major replacements are required.

1-4. JUSTIFICATION REQUIREMENTS. The apron areas may vary greatly and the need for a particular type of lighting system varies with the mission, types of aircraft, number of operations at night, and size and arrangement of the aprons. The apron lights shall be tailored for the needs of the airfield. Most airfields with operations at night will require one or more apron light systems. Apron lighting system requirements shall be adapted to provide adequate lighting and visual guidance to ground personnel and pilots. The requirements of this WP are guidelines for lighting installations; however, variations from specific requirements shall be approved with the procedures in WP 002 00.

1-5. RELATED FACILITIES. The apron lights provide illumination and visual guidance for aircraft operations at night in the apron and parking areas. Other visual aids related to the use of apron and parking area lights are as follows:

- Apron and parking area markings (WP 006 01).
- Fueling Area Lights (WP 006 05).

- Taxiway edge lights (WP 005 02).
- Taxiway centerline lights (WP 005 03).

2-1. DESCRIPTION.

2-2. The apron and parking area lighting may consist of floodlights only or a combination of floodlights, taxilane centerline lights, and peripheral lights. The floodlights provide area illumination and the other lights mark designated taxilanes or the edges of the apron.

2-3. FLOODLIGHTS. Floodlights are light fixtures (luminaires) that provide overall apron illumination and may be aimed to light a particular area. Aprons, parking areas, and service areas shall be uniformly illuminated at the required levels. The floodlighting should come from more than one direction to reduce shadows. The distribution of the light from the fixtures shall prevent direct or “spill” light above the horizontal and limit the intensity towards the air traffic control tower and areas for operating aircraft to avoid excessive glare. The location of light fixtures, aiming, shielding, and mounting height may be used to control spill light and glare. The color of the light shall be such that materials, liquids, and markings used in servicing aircraft will be recognizable in the floodlighting. One or more light fixtures may be mounted on a single support. For activities requiring higher levels of illumination, supplemental portable lights shall be used.

2-4. CENTERLINE LIGHTS FOR TAXILANES. Taxilanes are marked routes across large, paved areas intended for taxiing aircraft. In some areas of aprons, the taxilanes may not be sufficiently illuminated by floodlights and taxilane lights are required at night. Centerline lights similar to taxiway centerline lights (WP 005 03) are used for taxilanes. The centerline lights shall be semi-flush, bidirectional, and emit aviation green light.

2-5. PERIPHERAL LIGHTS. Some sections of apron areas may require lights to mark the edge. The peripheral lights shall be blue omnidirectional lights. Elevated lights shall be used, if permitted, but semi-flush lights may be required for some installations. The light fixtures required are the same types as those used for taxiway edge lights (WP 005 02).

2-6. Some sections of the edges of apron areas may require lights to mark the edge. The peripheral lights shall be blue omnidirectional lights. Elevated lights shall be used, if permitted, but semiflush lights may be required for some installations. These lights are the same types as are used for taxiway edge lights (WP 005 02).

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details about apron lights refer to UFC 3-535-02. General design and installation requirements are given below.

3-3. FLOODLIGHTING INSTALLATION. Floodlights provide general illumination of an area.

3-4. The floodlights for apron area illumination shall be mounted not less than 30 feet above the pavement and preferably 50 feet or higher.

3-5. The floodlights may be mounted on buildings, poles, towers, or pylons.

3-6. The floodlight mountings shall be stable so that the floodlight beam axis shifts less than 5 degrees when operating in gale force winds.

3-7. One or more floodlight fixtures may be located on the same support, but lights shall be spaced along the apron and aimed to provide uniform illumination and to reduce shadows from aircraft or equipment.

3-8. The floodlights shall be aimed to provide uniform illumination over the high activity areas of the apron.

3-9. Spill light above the horizontal or any direct light or glare towards the air traffic control tower or runways and taxiways shall be prohibited.

3-10. Louvers, grids, baffles, or higher mounting of the lights may be used to reduce the amount of spill light.

3-11. The installation shall provide a method of access to the floodlights for maintenance.

3-12. TAXILANE LIGHTS INSTALLATION. The installation of taxilane centerline lights is similar to that for taxiway centerline lights (WP 005 03) except the spacing shall be not more than 100 feet.

3-13. The light fixtures shall be semi-flush bidirectional aviation green lights.

3-14. Taxilane centerline lights shall be located along a line or smooth curves on the taxilane axis (Figure 1).

3-15. At taxilane intersections, the line of lights shall extend across the junction with an omnidirectional light located at the intersection of centerlines although the other taxilane may not be lighted.

3-16. If both taxilanes are lighted, lights into the intersecting taxilane may be installed along an arc between the Points of Tangency (PT) that provides a clearance from the taxilane edge not less than one-half the width of the taxilanes

3-17. The centerline lights shall be equally spaced within each section for spacing.

3-18. The line of lights is divided into spacing sections between any two consecutive points as follows:

- End of centerline.
- Point of Tangency (PT).
- Intersections of centerline at taxilane junctions.

3-19. For straight sections, the spacing shall not exceed 50 feet for sections less than 300 feet long and not exceed 100 feet for sections 300 feet or longer.

3-20. For curved sections, the spacing shall not exceed 25 feet if the radius of the curve is less than 400 feet long and shall not exceed 50 feet if the radius is 400 feet or longer.

3-21. Taxilane lights may be base-mounted with individual isolation transformers.

3-22. The taxilane light beam axis shall be aligned in azimuth parallel to the taxilane centerline for straight sections and perpendicular to the radius through this point for curved sections.

3-23. PERIPHERAL LIGHTS INSTALLATION. Peripheral lights are located at the edge of the apron usually off the full-strength pavement.

3-24. The peripheral lights are located in a line not more than two feet from the apron edge.

3-25. The peripheral lights shall be equally spaced at intervals not more than 100 feet for straight sections and per Figure 1 for curved sections.

3-26. The peripheral lights shall be omnidirectional blue lights, usually of the elevated type, but some installations may require semi-flush lights.

3-27. The elevated lights shall be mounted on frangible couplings which may be installed on light bases or on conduit elbows.

3-28. The height of elevated lights shall be not more than 14 inches above the apron surface except in areas with frequent accumulations of snow to depths of 12 inches or more where (with prior approval by Naval Air Systems Command) the maximum height shall not exceed 24 inches.

3-29. Contact the manufacturer of the peripheral lights about any methods used to increase the elevated light height before modifications are attempted.

CURVED SECTIONS (RADIUS IN FEET)	SPACING, MAX. (FEET)
25 or less	17
26 to 50	24

CURVED SECTIONS (RADIUS IN FEET)	SPACING, MAX. (FEET)
51 to 75	30
76 to 100	36
101 to 150	42
150 to 200	49
over 200	50

4-1. EQUIPMENT.

4-2. FIXTURES. There are no specified light fixtures for apron floodlights. Commercial luminaires shall be specified in the design requirements. The taxilane and peripheral lights shall be types similar to taxiway lights. The fixtures and equipment to be used for apron and parking area lights are listed in Table 1.

Table 1. Schedule of Equipment for Apron Lights

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
Floodlights; types, number and rating are as required by the designer.			
Taxilane centerline lights; semiflush, bidirectional, green.			
For straight sections,			
FAA AC 150/5345-46, type L-852A, L-852A(L)	45W 6.6A, type as determined by manufacturer.	As determined by mfr.	As determined by mfr.
For curved sections,			
FAA AC 150/5345-46, type L-852B, L-852B(L)	65W 6.6A, type as determined by manufacturer.	As determined by mfr.	As determined by mfr.
Peripheral lights, omnidirectional, blue.			
Elevated lights.			
FAA AC 150/5345-46, type L-861T, L-861T(L)	45W 6.6A, type as determined by manufacturer.	As determined by mfr.	As determined by mfr.
Semiflush lights.			
FAA AC 150/5345-46, type L-852T, L-852T(L)	6.6A, watts and type as determined by manufacturer.	As determined by mfr.	As determined by mfr.
LED Lighting Notes:			

Table 1. Schedule of Equipment for Apron Lights (Cont)

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVD.

4-3. PHOTOMETRIC REQUIREMENTS. The floodlighting for the apron, parking, and service areas shall provide an average illuminations level on the pavement between 1 and 2 footcandles for an area not less than 200 feet from the building line.

4-4. The illumination shall be uniform with the ratio of the average level to the minimum not more than 6:1.

4-5. Shadows shall be eliminated to the extent that is practicable.

4-6. Areas of the apron more than 200 feet from the buildings and structures may be illuminated at lower levels.

4-7. The emitted light from the taxilane centerline lights shall be aviation green and for the edge and peripheral lights shall be aviation blue per FAA AC 150/5345-46.

4-8. The intensity and beamspread of the beams for the taxiway centerline lights at rated current shall be as required in FAA AC 150/5345-46.

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for the apron lights depends on the light circuits to be installed.

5-3. Floodlights will be energized by multiple circuits and taxilane and peripheral lights shall be energized by one or more 6.6-ampere series circuits (WP 009 00).

5-4. The electrical circuits for the floodlights should be three-phase, usually 277/480-volt multiple circuits.

5-5. The floodlights shall be connected to the circuits to provide uniform lighting levels, balanced loads on the phases, and to reduce stroboscopic effects.

5-6. The power for the taxilane and peripheral lights shall be furnished by one or more constant-current regulators (WP 009 02) with 6.6-ampere output. The lights shall be connected to the primary series circuit by series-series isolation transformers (WP 009 03). Each light may have an individual transformer or three or four lights to a 200-watt transformer. In the latter arrangement, the lights shall be provided with shorting devices to short out the light if the lamp fails.

5-7. CONTROLS. The apron and parking area floodlighting is usually controlled by ground service personnel with ON-OFF switches. Taxilane centerline and peripheral lights shall be controlled in the Air Traffic control tower. For complex apron areas, the taxilane lights may be sectionalized to permit switching for specific taxi routes. Intensity control is not required but may be provided for the taxilane and peripheral lights.

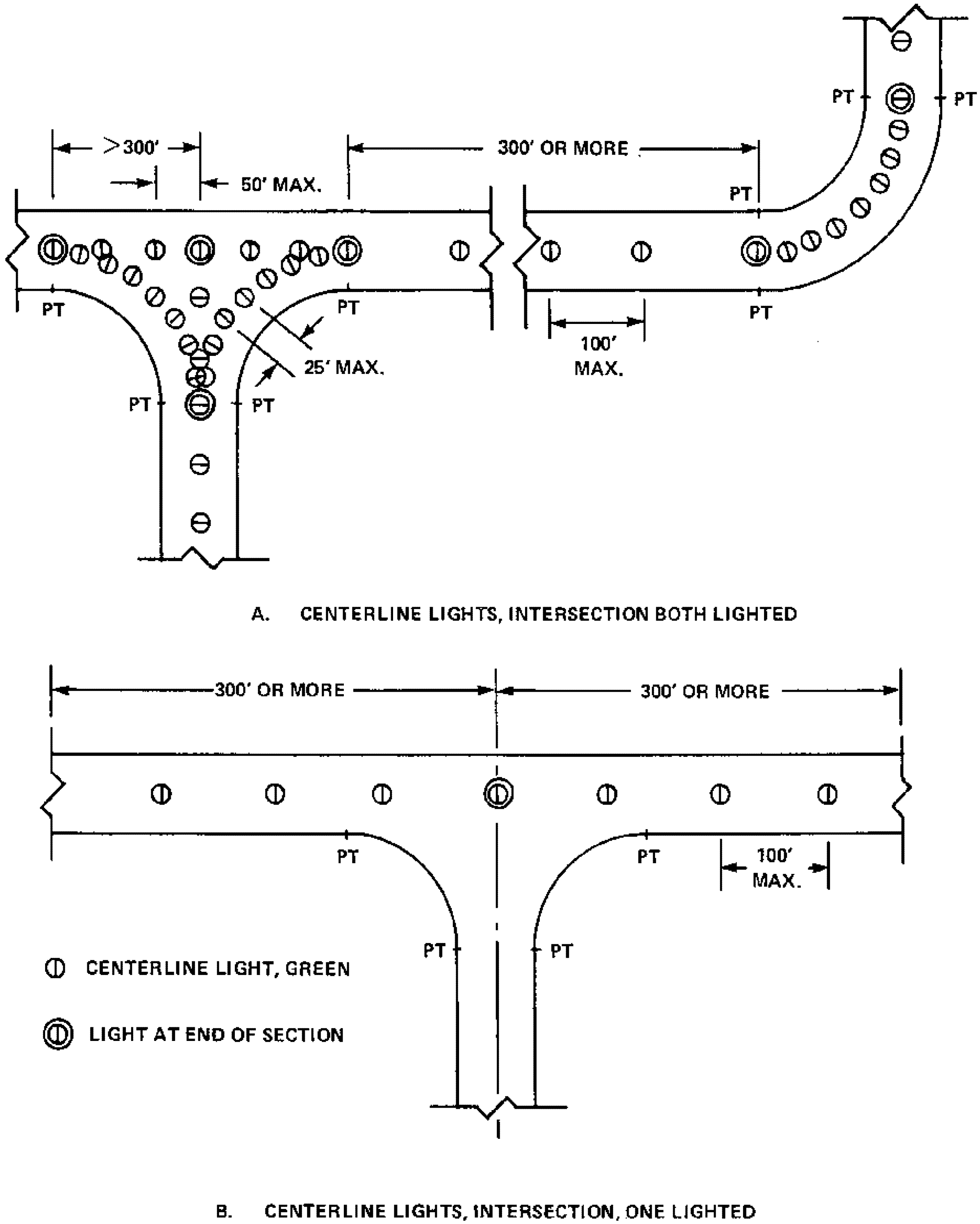


Figure 1. Typical Taxilane Centerline Lights Configuration

ORGANIZATIONAL

WHEELS-UP AND RUNWAY WAVE-OFF LIGHTS

SPECIAL LIGHTS AND MARKINGS VISUAL AIDS

Reference Material

Introduction	WP 002 00
Approach Visual Aids, Obstruction Markings	WP 003 08
Approach Visual Aids, Obstruction Lightings	WP 003 09
Approach Visual Aids, Optical Landing Aids (OLA)	WP 003 11
Special Lights and Markings Visual Aids, Simulated Aircraft Carrier Deck Lights and Markings	WP 006 04
Electrical Power and Control for Visual Aids, Description	WP 009 00
Colors, Aeronautical Lights and Lighting Equipment, General Requirements For	SAE International SAE AS25050
Design Drawings for Visual Aid Navigation Facilities	UFC 3-535-02
Light, Wave-off, Flashing, Capacitance-Discharge	MIL-L-29575
PAR-56 Lampholder	FAA-E-982

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the Wheels-up and Runway Wave-off Lights. These lights consist of two separate light configurations, the wheels-up lights and the runway wave-off lights. The purpose of the wheels-up lights is to illuminate the underside of aircraft on final approach to enable the wheels watch to determine if the aircraft's landing gear is fully lowered. The runway wave-off lights provide a strong visual signal to the pilot by day or night to execute an emergency missed approach. These requirements shall be used for all new wheels-up lights and runway wave-off lights installations.

1-3. JUSTIFICATION REQUIREMENTS. The justification for wheels-up lights and runway wave-off lights depends on the types of air operations. Any runway approach that uses a wheels-watch to support operations should qualify for runway wave-off lights. If a wheels-watch is used during daytime and similar operations occur for the runway at night, the use of wheels-up lights should be justified. Certain types and frequency of air operations may justify the need for one or both systems of lights. Deviations from these requirements will require approval (WP 002 00).

1-4. RELATED FACILITIES. The functions of wheels-up lights and runway wave-off lights are not directly related to other visual aids.

2-1. DESCRIPTION.

2-2. WHEELS-UP LIGHTS. (See Figure 1.) The wheels-up lights are a bar of lights located in the approach area for illuminating the underside of aircraft preparing for landing. The light bar consists of 20 white lights in a line perpendicular to the extended runway centerline. The light beams shall project upward and toward the runway threshold. The light bar shall be on the same side of the extended runway centerline as is the air traffic control tower. A dimmer to control the intensity of the lights shall be provided.

2-3. RUNWAY WAVE-OFF LIGHTS. (See Figure 2.) The runway wave-off lights consist of six lights, three lights along each side of the runway in the touchdown area. The lights present a high-intensity red flashing signal to inform the pilot approaching the runway for a landing to execute an emergency wave-off or missed approach procedure. The lights are in pairs outboard of the runway edges. The runway wave-off lights shall be activated by either the air traffic control tower operators or wheels-up watch. Two types of lights are used. The red capacitance-discharge (strobe) lights are used for new installations and as replacements of existing installations. The three-lamp cluster, flashing, red incandescent lights are obsolete, and replacements, other than for routine maintenance, should use the strobe wave-off lights.

2-4. WHEELS-WATCH SHELTER. The wheels-watch shall be provided with a shelter to protect the observer from inclement weather. The shelter shall have a maximum size of 8 feet square and 8 feet high. The upper portion of the shelter shall be transparent with good viewing quality for observing the aircraft's landing gear position. The wheels-watch shelter shall be located near the wheels-watch handhold approximately 205 feet from the extended runway centerline. The wheels-watch shelter should be portable and may require marking and lighting as an obstruction (WP 003 08 and WP 003 09).

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details for the wheels-up lights and the runway wave-off lights, refer to UFC 3-535-02. General design and installation requirements are as follows:

3-3. METHODS OF INSTALLATION. Elevated, unidirectional lights are used for both the wheels-up lights and the runway wave-off lights. The power to the wheels-up lights is from 120V multiple circuits. Power to the strobe wave-off lights is from 480V multiple circuits to the power converter units which provides the power to the optical assembly units. The power converter units may be separated up to 150 feet from the optical assembly units. The lights for wheels-up lights and wave-off lights are mounted on frangible couplings. The frangible couplings are installed on conduit elbows for wheels-up lights. For the strobe wave-off lights, the power converters are installed on FAA Type L-867/L-868 light bases. The optical assembly units may be installed on FAA Type L-867/868 light bases or conduit elbows. Junction boxes for connections may be used at the optical assembly units. The wheels-watch shelter may be placed on a concrete pad or other suitable foundation/support.

3-4. LOCATION AND DIMENSIONS. Because the sets of wheels-up lights runway wave-off lights have few features in common relevant to locations or dimensions, the requirements for each are discussed separately as follows:

3-5. Wheels-Up Lights.

3-6. (See Figure 1) The wheels-up lights are located in the approach area on a straight line 980 ±5 feet from the runway threshold in Figure 1. The straight line shall be at right angles, ±1 degree, to the extended runway centerline.

3-7. The wheels-up lights shall be spaced at 5-foot intervals with the first light 105 feet from the runway centerline and the twentieth light 200 feet from the centerline.

3-8. The line of wheels-up lights should be on the same side of the runway centerline as the air traffic control tower.

3-9. The wheels-up line of lights shall be horizontal ±2 inches with the height of the light with the shortest support not more than 26 inches above the ground or paved surface.

3-10. The beams of the wheels-up lights shall be directed toward the runway threshold at 30 degrees above horizontal.

3-11. The horizontal aiming of the three lights nearest the extended runway centerline shall be 25 degrees toward the runway centerline referenced from a line drawn through the light parallel to the runway centerline. The remaining lights shall be angled at 30 degrees toward the runway centerline.

3-12. The tolerance for the wheels-up aiming toward the runway centerline shall be ±1 degree.

3-13. The wheels-watch handhole shall be located 5 feet outboard of the last light.

3-14. Runway Wave-Off Lights.

3-15. The runway wave-off lights are located along both edges of the runway in the touchdown area.

3-16. (See Figure 2.) Each pair of runway wave-off lights shall be on a line at right angles (±1 degree) to the runway centerline.

3-17. The three pairs of runway wave-off lights shall be 900, 1700, and 2500 feet from the runway threshold.

3-18. A pair of lights may be moved up to 100 feet to provide clearance for runway and taxiway intersections, facilities such as the arresting gear and OLS, and major construction issues.

3-19. Along each side of the runway the wave-off lights shall be on a straight line parallel to the runway centerline and not less than 10 feet outside the runway edges.

3-20. The beams of the wave-off lights shall be directed toward the runway approach zone.

3-21. The maximum height of the wave-off light optical assembly unit shall be not more than 20 inches above the adjacent runway edge.

3-22. The wave-off light power converter units are usually located 50 to 75 feet from the runway in line with the optical assembly units preferably in a line that is parallel with the runway centerline.

3-23. Each wave-off strobe light shall be aimed vertically 4 degrees above the horizontal and 2 degrees toward the runway.

3-24. An underground wave-off equipment vault shall be provided if an OLS vault is not available.

4-1. EQUIPMENT.

4-2. The lighting equipment for the wheels-up lights and the runway wave-off lights shall be per Table 1. The wheels-up lights require 20 lights of the type in Figure 1B. The runway wave-off lights require 6 lights of the type in Figure 2B arranged in three pairs. The wave-off lights require red filters. All lights shall have frangible couplings.

4-3. The lighting equipment for the wheels-up lights and the runway wave-off lights shall be as shown in Table 1. The wheels-up lights require 20 lights of the type shown in Figure 1B. The runway wave-off lights require 6 lights of the type shown in Figure 2B arranged in three pairs. The wave-off lights require red filters. All lights shall have frangible couplings.

Table 1. Schedule of Lighting Equipment for Wheels-Up and Runway Wave-Off Lights

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
Wheels-up Lights(1)			
FAA-E-982	500W 120V type Q500-PAR56/MFL	2400/120-240V, 15KVA (One for all 20 lights)	Commercial, subway type
Runway Wave-off Lights(1)(2)			
MIL-L-29575	As required by manufacturer.	Power converter unit.	As required by manufacturer.

NOTES:

1. 20 wheels-up lights and 6 runway wave-off lights are required.
2. A signal flasher to flash all the wave-off lights simultaneously at 90 flashes per minute is required.

4-4. PHOTOMETRIC REQUIREMENTS. The color (chromaticity range) of the lights shall be aviation white for the wheels-up lights and aviation red for the wave-off lights per SAE AS25050 and as modified in MIL-L-29575.

4-5. Each of the wheels-up lights shall have a peak intensity at rated voltage of not less than 43,000 candelas and at 21,000 candelas shall have a beamspread of not less than 26 degrees horizontally and 10 degrees vertically.

4-6. The wheels-up lights shall be provided with not less than three steps of intensity control and the intensity at the lowest setting shall be not more than 10 percent of the intensity at the rated operating voltage.

4-7. The xenon strobe wave-off lights shall have a peak effective intensity of not less than 50,000 candelas in red, and at 25,000 candelas effective intensity the beamspread shall be not less than 10 degrees horizontally and 8 degrees vertically.

4-8. The wave-off lights shall be provided with two intensity steps with the lower step at approximately 10 percent of the intensity at rated voltage.

5-1. POWER AND CONTROLS.

5-2. POWER. Power for the wheels-up lights and the runway wave-off lights shall be provided by multiple circuits (WP 009 00).

5-3. A single 15KVA 2400/120-240V, subway (submersible) type distribution transformer may supply the power for the wheels-up lights.

5-4. The power transformer may be located in an underground vault near the lights, or in a suitable housing above ground if it will be more than 200 feet from the extended runway centerline and is not a flight clearance obstruction.

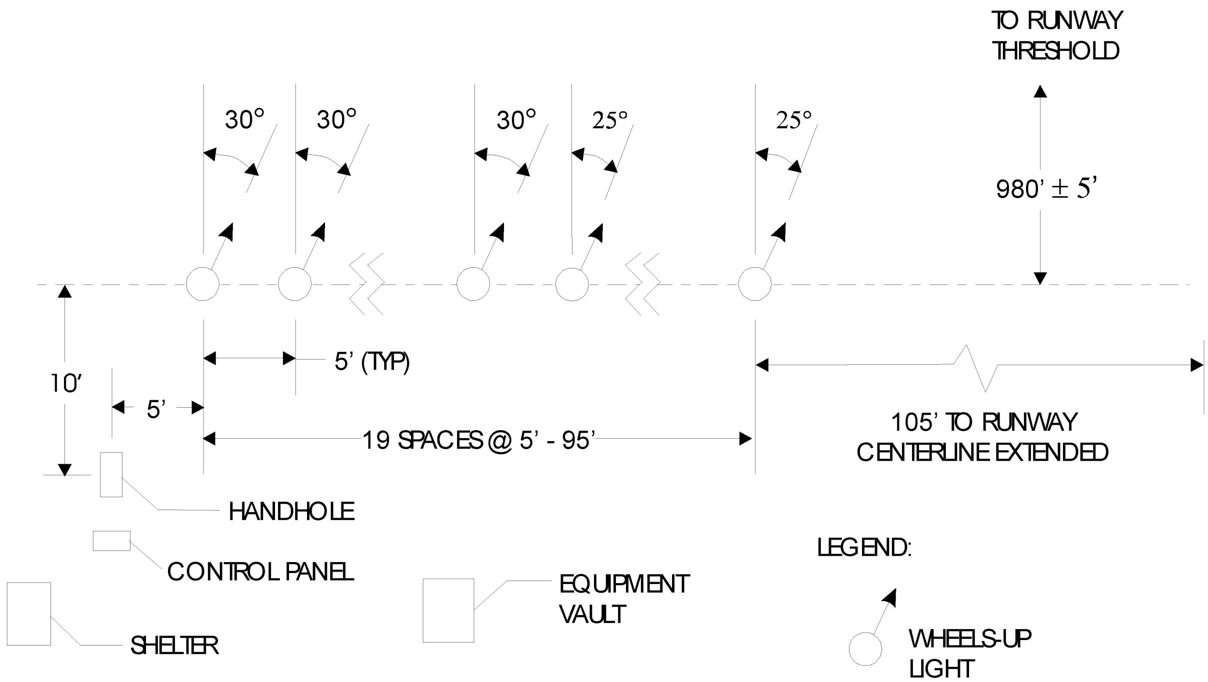
5-5. Power for the strobe wave-off lights may be provided by a single 10KVA 2400/480V, subway (submersible) type transformer, located in a manhole or underground vault.

5-6. The wheels-up and runway wave-off lights do not require emergency power, but if such power is available, it should be considered for use.

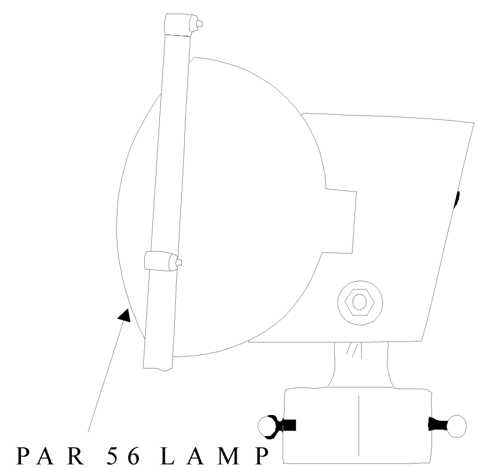
5-7. CONTROLS. The wheels-up lights shall be controlled manually from the wheels-watch control panel only. The control panel shall include a control which can vary the light intensity in not less than three steps with the intensity of the lowest setting not more than 10 percent of rated intensity. The wave-off lights shall be controlled manually using momentary-contact type switches. The switches shall be located only at the following stations:

- Air traffic control tower cab,
- Airfield lighting vault, or
- Wheels-watch stations.

5-8. The wave-off lights shall be automatically flashed between 80 and 100 flashes per minute. The flash duration for the strobe lights should not be longer than 50 milliseconds. See MIL-L-29575 for detailed equipment specifications.



A. PLAN LAYOUT



LIGHT: TYPE FAA-E-982, ELEVATED,
UNIDIRECTIONAL

LAMP: 500W 120V, TYPE Q50PAR56/MFL

B. WHEELS-UP LIGHT

Figure 1. Typical Wheels-Up Lights

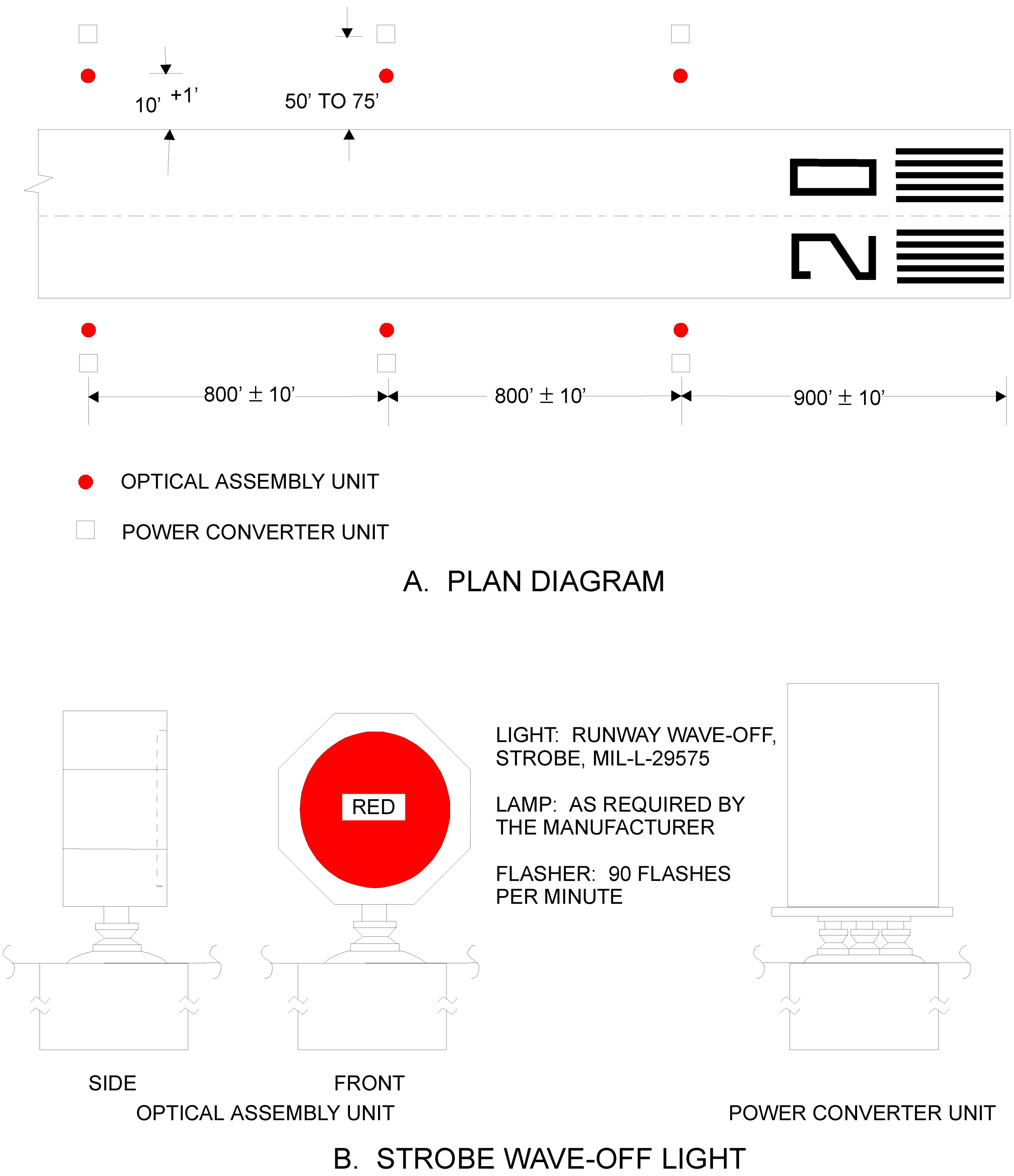


Figure 2. Typical Strobe Runway Wave-Off Lights

ORGANIZATIONAL

SIMULATED AIRCRAFT CARRIER DECK LIGHTS AND MARKINGS

SPECIAL LIGHTS AND MARKINGS VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the lights and markings for simulated aircraft carrier decks. The simulated carrier deck is a standardized, full-scale arrangement of lights and markings of the flight deck of an aircraft carrier and is used to train pilots on shore. The lights are used for training at night and the markings for training during daylight in Visual Flight Rules (VFR) and in some Instrument Flight Rules (IFR) conditions (WP 002 00). However, training operations should not be attempted in Category II and Category III IFR conditions. The requirements in this WP shall be used for all new installations. Existing installations may be used and maintained until upgrading or major replacements are required.

1-3. JUSTIFICATION REQUIREMENTS. If aircraft carrier training is part of the airfield's mission, simulated carrier decks shall be installed. If the training is to be in daylight only VFR conditions, only the simulated carrier deck markings are required. If the training includes night operations or IFR conditions, both lights and markings shall be installed. Variations from these requirements shall be approved per the procedures in WP 002 00.

1-4. RELATED FACILITIES. The use of the simulated aircraft carrier deck lights and markings require the use of optical landing aids, an Improved Fresnel Lens Optical Landing System (IFLOLS), and a Manually Operated Visual Landing Aid System (MOVLAS) (WP 003 11). The installation and operation of the simulated carrier deck will affect the installation or operation of the following runway visual aids:

1-5. Runway markings (WP 004 01).

1-6. The simulated carrier deck markings shall supersede the runway markings and runway markings shall not be installed between the carrier deck edge markings.

1-7. Runway markings for Category I.

1-8. When a simulated carrier deck is installed on a parallel CAT I runway, the runway designation marking dimensions must be shortened per Figure 1 and 2 (reference WP 004 01), and the left side, first set of touchdown markings must be omitted. Also, the left fixed distance marking can overlap the carrier deck.

1-9. Arresting gear.

1-10. If an arresting gear location overlies Field Carrier Landing Practice (FCLP) simulated carrier box landing area, or is within 100’ of either end, the pendant should be removed from the runway during FCLP operations. The pendant removal will avoid an in-flight arrestment and prevent off center landings which could knock A/G motors out of battery. Reinstall the pendant and restore the A/G to battery position at the completion of FCLP operations.

1-11. Runway centerline lights (WP 004 06) and touchdown zone lights (WP 004 07).

1-12. Simulated carrier decks shall not be installed on runways equipped with centerline or touchdown zone lights.

2-1. DESCRIPTION.

2-2. The simulated carrier deck lights and markings are standardized installations representing the visual aids for aircraft carrier landing decks. The markings may be installed without the lights for daytime only operations.

2-3. MARKINGS. The markings shall be painted on the runway surface. If the contrast of the markings against the pavement is poor, the markings may be outlined with a lusterless black border. The markings shall consist of centerline markings, edge markings, and ramp athwartship markings (see Figure 3). There is no athwartship line at the forward end of the deck.

2-4. LIGHTS. The simulated carrier deck light fixtures shall be semi-flush, unidirectional, lights that emit aviation white light.

2-5. The deck lights shall be a tailhook impact resistant type.

2-6. The carrier deck light configuration (see Figure 3) shall consist of a row of centerline lights, a row of edge lights on each side of the deck, a row of ramp athwartship lights across the deck end nearer the runway threshold, and a row of forward athwartship lights across the other end of the deck.

2-7. There shall be 18 centerline lights between the lines of athwartship lights, 17 edge lights in each line, 12 ramp athwartship lights, and 10 forward athwartship lights.

2-8. The forward shape of the deck if formed by omitting two forward athwartship lights and two edge lights on each side.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details for the simulated deck lights refer to UFC 3-535-02. General design and installation requirements are given below. The configurations for markings and lights are shown in Figure 3.

3-3. LOCATION AND DIMENSIONS. The location of the simulated aircraft carrier deck shall be coordinated with the Optical Landing System (OLS) for this runway approach.

3-4. The OLS face of the lenses are located 730 feet from the runway threshold.

3-5. The deck centerline shall be parallel to the runway centerline and 61 feet 9 inches from the left edge of the runway as viewed from the approach.

3-6. The deck lights and markings shall be symmetrical about the deck centerline.

3-7. The line for the ramp athwartship lights shall be 410 feet towards the runway threshold from the point where a line through the face of the OLS perpendicular to the deck centerline intersects this centerline.

3-8. The length of the simulated deck between the line of ramp and forward athwartship lights shall be 765 feet.

3-9. The lines of deck edge lights shall be 35 feet from the deck centerline on each side or 70 feet wide.

3-10. The deck lights are enclosed by a rectangle 70 feet wide by 765 feet long.

3-11. Markings.

3-12. The simulated carrier deck markings shall be painted on the runway pavement surface.

3-13. The markings shall be non-retroreflective white except for the sections of the centerline markings which are non-retroreflective yellow.

3-14. The ramp athwartship marking is a 10-foot-wide white stripe across the ramp end of the deck located on the runway threshold side of the line of ramp athwartship lights. This marking shall be perpendicular to and extend 40 feet each side of the deck centerline.

3-15. The ramp athwartship marking shall be interrupted at the deck centerline by a yellow section of the deck centerline marking.

3-16. The deck centerline markings shall consist of a 3-foot-wide stripe symmetrical about the deck centerline with alternating yellow and white sections.

- The sections shall be 45 feet long beginning with a yellow section starting 13 feet towards the runway threshold from the line of ramp athwartship lights.
- The last section shall be white and 13 feet long ending in line with the line of forward athwartship lights.

3-17. The deck edge markings shall be two white stripes on each side parallel to the deck centerline and extending from the edge of the ramp athwartship marking to the line of the forward athwartship lights.

- The outer edge stripes shall be one-foot wide with the outer edge 40 feet from the deck centerline.
- The inner edge stripes shall be 3 feet wide with the inner edges 28 feet from the deck centerline.
- The two edge stripes shall be connected at 75-foot intervals by 10-foot-wide white bars.

3-18. The edge of the bars nearest the ramp shall be 47.5 feet from the line of ramp athwartship lights and the edge of the last bars shall be 32.5 feet from the line of forward athwartship lights.

3-19. The deck markings will be enclosed by a rectangle 80 feet wide and 775 feet long plus the 3-foot length at the beginning of the centerline marking.

3-20. If borders are used to increase contrast, the borders shall be 6 to 12 inches wide of black lusterless paint outlining the deck markings.

3-21. Regulations in some states, such as California, or other authorities may prohibit or restrict the use of solvent based paints.

3-22. For white and yellow markings, use type FED SPEC TT-P-1952F paint.

3-23. For black outlines, use long-wearing semigloss or flat black paint, such as type FED SPEC TT-P-1952F with black pigment.

3-24. Lights.

3-25. The simulated carrier deck lights usually are direct-mounted in holes drilled in the pavement, and their associated power cables will be placed in saw kerfs cut in the pavement.

3-26. If the carrier deck lights are installed in a new runway, the lights may be FAA Type L-868 light base mounted.

3-27. The beam axis axes of the unidirectional lights shall be aligned parallel to the simulated carrier deck centerline and directed toward the runway threshold.

3-28. Typically, the centerline and edge lights shall be uniformly spaced at 45 feet between the line of ramp and forward athwartship lights.

3-29. The edge lights do not have the two lights in each row at the forward end to simulate the forward end of the flight deck.

- The deck edge lights shall be in two rows 35 feet from and parallel to the carrier deck centerline.
- The deck edge lights shall be located in such a manner that a line perpendicular to the carrier deck centerline and passing through a centerline light shall also pass through the deck edge lights (port and starboard) so that a rectangular, symmetrical pattern results.

3-30. The ramp and forward athwartship lights shall be spaced uniformly on 5-foot centers on each side of the centerline lights.

3-31. There will be 6 lights on each side of the centerline for the ramp athwartship lights and 5 lights on each side for the forward athwartship lights.

3-32. If one light in a set of three (two edge lights and a centerline light) must be relocated longitudinally for any reason, such as a pavement joint, the other two lights shall be relocated accordingly.

3-33. The edge and a centerline lights in groups of three or four are connected to an isolation transformer located at the nearer edge of the runway.

3-34. If the simulated carrier deck lights are base-mounted, individual isolation transformers for each light may be placed in the base.

4-1. EQUIPMENT.

4-2. FIXTURES. The light fixtures for the simulated carrier deck lights shall be unidirectional, semi-flush, white lights which are hook-impact-resistant. The light fixtures are listed in Table 1 and typical fixtures are in Figure 4. The marking materials shall be paint of the types listed in Table 1.

Table 1. Schedule of Equipment and Materials for Simulated Deck Lights and Markings

PURPOSE AND TYPE OF FIXTURE OR MATERIAL	LAMP RATING AND TYPE	ISOLATION TRANSFORMER RATING	ISOLATION TRANSFORMER FAA TYPE AC 150/5345-47
Deck lights, semiflush, unidirectional, white, hook-impact-resistant.(1)			
Direct mounted			
Class L-852N Navy, Type VI (2) LED type light fixtures may be available	a determined by manufacturer.	200W 6.6/6.6A (3 or 4 lights per transformer)	L-830-6
Base mounted			
Class L-852N Navy, Type VII or VIII LED type light fixtures may be available	type as determined by manufacturer.	determined by the mfr.	determined by the mfr.

Marking Materials.

Color of Marking	Federal Specification	Authorized Use
Non-retroreflective White	FED SPEC TT-P-1952F, paint, white	Deck edge, ramp athwartship and part of centerline
Non-retroreflective Yellow	FED SPEC TT-P-1952F paint, yellow	Part of centerline
Lusterless Black	Paint, black	Border around white or yellow markings

NOTES:

1. The light fixtures shall meet the requirements of Navy L-852(N) in the manufacturer's data sheet.
2. The lights shall be equipped with a device for shorting inoperative lamps. Using direct mounted light fixtures for new installations is not recommended.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

4-3. PHOTOMETRIC REQUIREMENTS. The simulated aircraft carrier deck lights all have similar photometric requirements.

4-4. The color of the emitted light shall be aviation white per FAA AC 150/5345-46.

4-5. The colors of the markings shall be per SAE AMS-STD-595:

- White, color chip No. 27875.
- Yellow, color chip No. 23538.
- Black, color chip No. 27038.

4-6. See the manufacturer's data for detailed information relevant to L-852N horizontal and vertical beam widths and intensity distribution.

5-1. POWER AND CONTROLS.

5-2. POWER. The power for the simulated carrier deck lights shall be provided with a 5-intensity step, 6.6A output constant current regulator (WP 009 02).

5-3. The simulated carrier deck light fixtures should be connected to the primary series circuit by individual 6.6/6.6A isolation transformers for light base mounted lights or by three or four fixtures in series to 200W, 6.6/6.6A isolation transformers (WP 009 03) for direct-mounted fixtures.

5-4. Using direct mounted light fixtures is not recommended for new installations. For new installations, FAA Type L-868 light bases shall be used.

5-5. For groups of light fixtures connected to a single isolation transformer, the individual fixtures shall be equipped with shorting devices to short circuit an inoperative lamp.

5-6. Emergency power is not required but should be provided if available.

5-7. CONTROLS. The simulated aircraft carrier deck lights shall be controlled by the Landing Signal Officer (LSO) along with the associated OLS (WP 003 11). The following runway lights are **recommended** to be remote-controlled at the LSO workstation for direct control by the LSO:

- Runway edge lights (WP 004 05),
- Runway threshold lights (WP 004 02),
- Runway end lights (WP 004 04),
- Runway distance markers (WP 004 09),
- Arresting gear markers (WP 004 10),
- Precision Approach Path Indicator (PAPI) (WP 003 10) shall not be active when performing FCLP approaches.

5-8. When operating a simulated carrier deck only those lights shall be active. The LSO will activate the normal runway lights when required.

5-9. For new LSO shack installations , provide location and dimensions to NAWCADLKE Code BL12100 for review. Considerations should be distance from the runway edge, distance from the IFLOLS, height, visibility of the IFLOLS presentation, being below the PAPI OCS, if PAPI is present, etc.

NOTE

Check with the LSO School for possible additional requirements such as radios, etc.

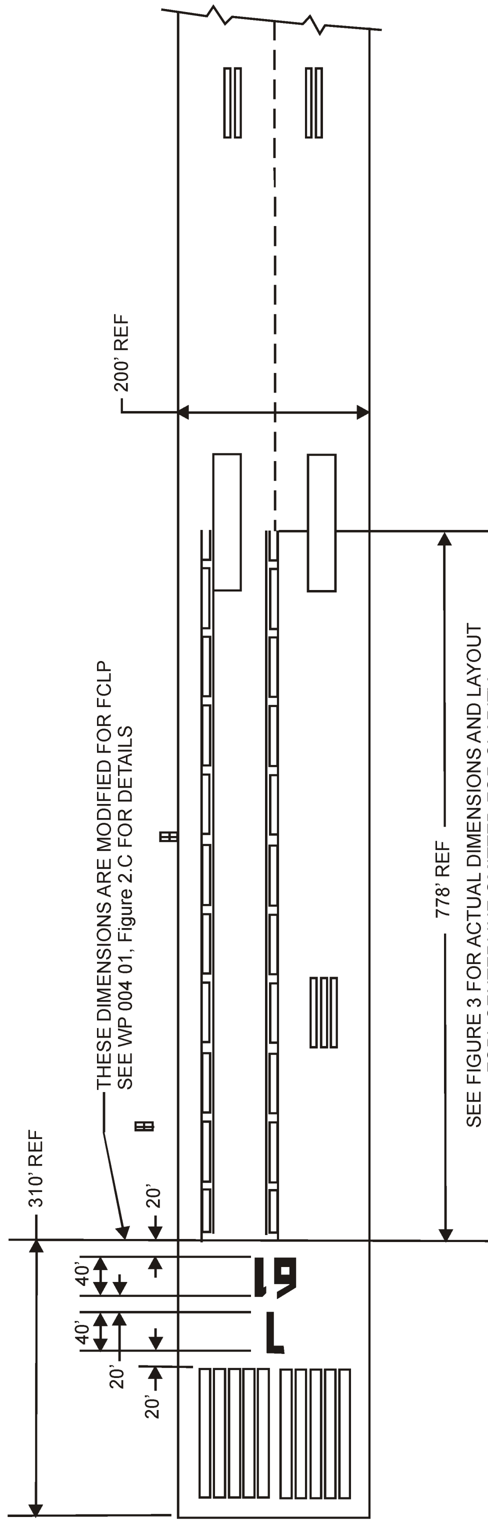


Figure 1. Simulated Carrier Deck Configuration for a 200' Wide Cat I Parallel Runway

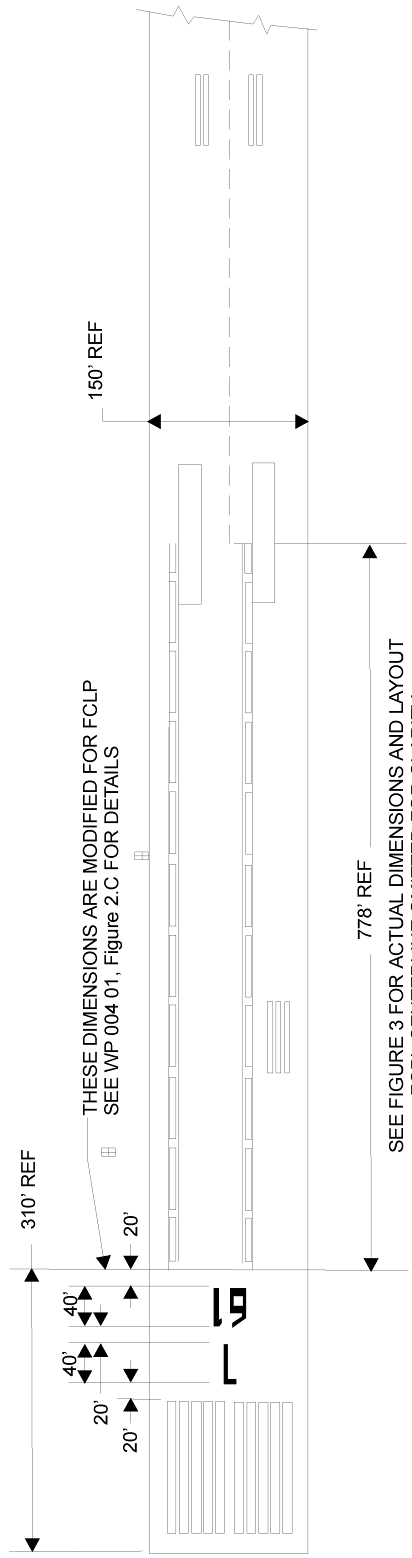


Figure 2. Simulated Carrier Deck Configuration for a 150' Wide Cat I Parallel Runway

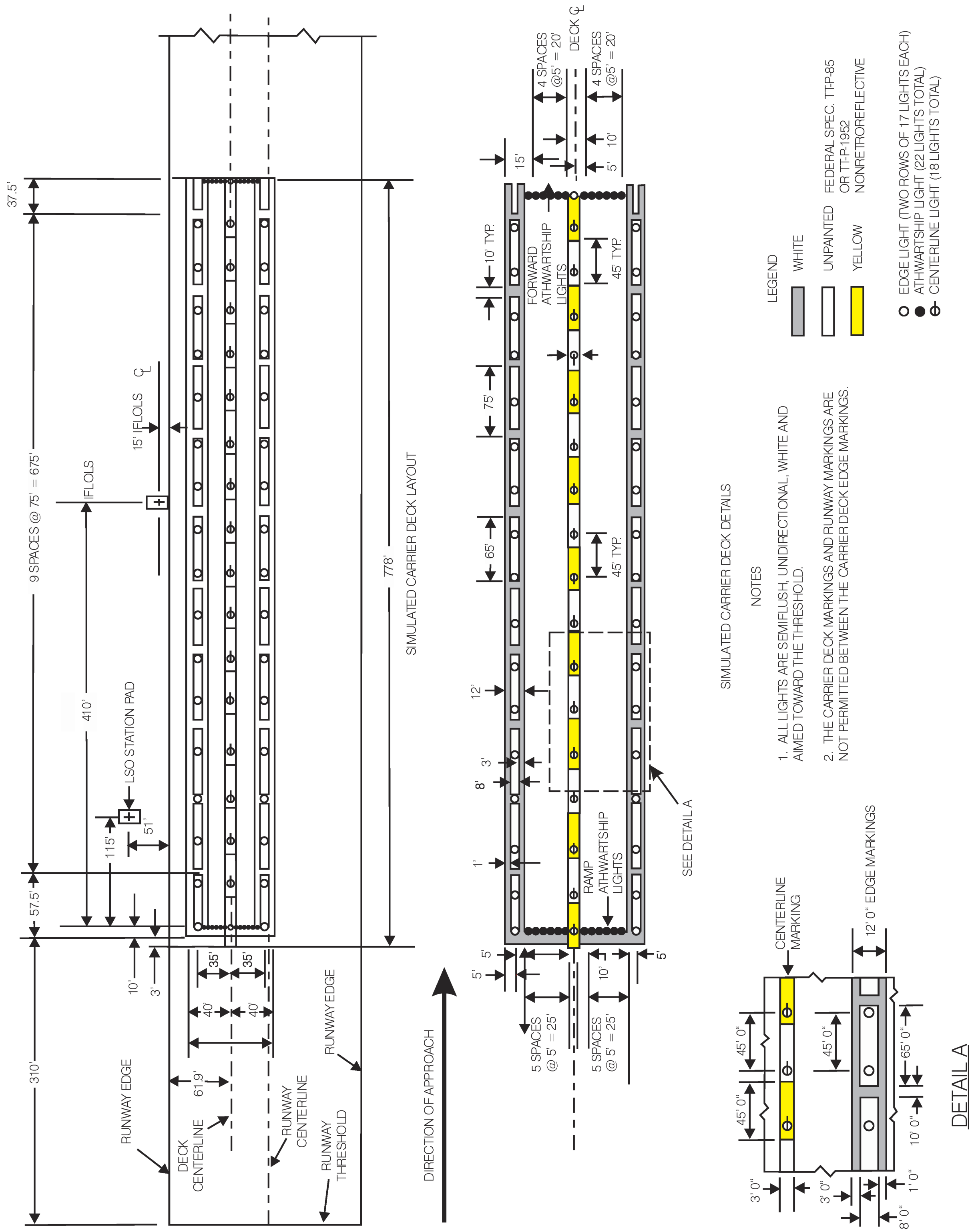
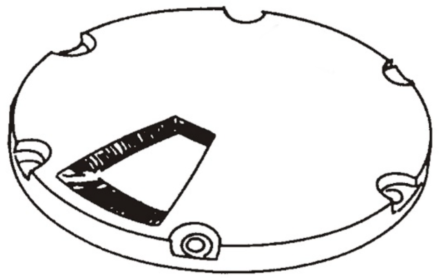


Figure 3. Typical Configuration for Simulated Aircraft Carrier Deck Lights and Markings



LIGHT, DIRECT-MOUNTED: CLASS L-852(N), WITH
SHORTING DEVICEFOR FAILED LAMP

LAMP: TYPE AS DETERMINED
BY MANUFACTURER

ISOLATION TRANSFORMER: FOR THREE OR FOUR LIGHTS
IN THE SECONDARY OF ONE TRANSFORMER. TRANSFORMER
IS 6.6/6.6A 200W FAA AC 150/5345-47 TYPE L-830-6, FOR A
TRANSFORMER FOR EACH LIGHT 6.6/6.6A 30/45W
FAA AC 150/5345-47 TYPE L-830-1.

Figure 4. Typical Arresting-Hook-Resistant Lights For Simulated Carrier Decks, Type FAA L-852 (Navy)

ORGANIZATIONAL

FUELING AREA LIGHTS

SPECIAL LIGHTS AND MARKINGS VISUAL AIDS

Reference Material

Taxiway Visual Aids, Taxiway Markings	WP 005 01
Taxiway Visual Aids, Taxiway Edge Lights	WP 005 02
Taxiway Visual Aids, Taxiway Centerline Lights	WP 005 03
Taxiway Visual Aids, Taxiway Guidance Signs	WP 005 04
Special Lights and Markings Visual Aids, Apron and Parking Area Lights	WP 006 02
Electrical Power and Control for Visual Aids, Description	WP 009 00
Electrical Power and Control for Visual Aids, Isolation and Distribution Transformers	WP 009 03
Colors, Aeronautical Lights and Lighting Equipment, General Requirements For	SAE International SAE AS25050
Design Drawings for Visual Aid Navigation Facilities	UFC 3-535-02
Isolation Transformers for Airport Lighting Systems	FAA AC 150/5345-47
Light, Markers, Airport, Semiflush, General Specifications for	MIL-L-26202
Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures	FAA Engineering Brief 67D
Specification for Runway and Taxiway Light Fixtures	FAA AC 150/5345-46
Specification for Taxiway and Runway Signs	FAA AC 150/5345-44

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the lighting of direct fueling areas at night. The lights outline the fueling lanes, identify and indicate the directions for entering, and also light the area. Lighting for other fueling areas are provided by the apron lighting. The markings are the standard taxiway centerline and edge markings (WP 005 01). The lights provide visual cues to the pilot when entering the fueling lanes, positioning the aircraft for refueling, provide lighting for the fueling operator, and guidance to exit from the fueling lane to a taxiway or apron. These requirements are to be used for designing new lighting installations. Because the shape, size, and location of the fueling areas vary for each airfield, these requirements may be adapted to fit the particular area. Existing fueling area lights may be used and maintained until upgrading or replacement is required.

1-3. JUSTIFICATION REQUIREMENT. All direct fueling areas that are intended for operations at night shall be equipped with fueling area lights.

1-4. RELATED FACILITIES. Other visual aids related to the use of fueling area lights are:

- Taxiway markings (WP 005 01),
- Taxiway edge lights (WP 005 02),
- Taxiway centerline lights (WP 005 03),
- Taxiway guidance signs (WP 005 04),
- Apron and parking area lights (WP 006 02).

2-1. DESCRIPTION.

2-2. The fueling area lights consist of lane edge lights, guidance signs, and floodlights; each performing a different function.

2-3. FUELING LANE EDGE LIGHTS. The fueling lane edge lights shall consist of lines of omnidirectional blue lights located along each edge of the fueling lanes (see Figure 1). Elevated light fixtures are normally used, except when the lights are located in a full-strength paved area where semiflush light fixtures may be used. The light fixtures shall be connected to the taxiway lighting circuit and controlled from the control panel located at each of the fueling stations.

2-4. DIRECTIONAL GUIDANCE SIGNS. Each fueling lane shall be provided with one or more guidance signs that identifies the lane and indicates the direction for entry.

2-5. The signs shall read “FUEL 2→” or similar wording.

2-6. Signs shall be used on each side of the approach to the entrance of the fueling lane if it can be entered from both directions.

2-7. The signs shall be informational type taxiway guidance signs with black legends on a yellow background.

2-8. The face of the sign shall be not less than 24 inches tall with a letter (legend) height not less than 15 inches.

2-9. The signs shall be connected to and controlled by the fueling lane light circuits.

2-10. FLOODLIGHTS. Floodlights shall provide the lighting for refueling operations.

2-11. The floodlights shall be low, post-mounted lights with not less than two on each side of the fueling lane to reduce the effects of shadows.

2-12. The preferred chromaticity range of the floodlight should be within the boundaries of aviation white per SAE AS25050.

2-13. For LED floodlights, the chromaticity boundaries should match the requirements for aviation white in FAA Engineering Brief 67.

2-14. If aviation white floodlights are not available or cost prohibitive, similar chromaticities may be used with local command approval.

2-15. The floodlights should not emit any direct illumination above the horizontal.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details of the fueling area lights, refer to UFC 3-535-02. General design and installation requirements are as follows:

3-3. METHODS OF INSTALLATION. Elevated lights may be mounted on FAA Type L-867 light bases or on conduits in concrete foundations.

3-4. All elevated fueling lane edge lights shall be mounted on frangible couplings.

3-5. The height of elevated fuel lane lights shall be not more than 14 inches above the fueling lane edge.

3-6. An exception to Paragraph 3-5. is with areas that experience frequent snow accumulations to depths of 12 inches or more. Elevated lights may be raised to not more than 24 inches above the fueling lane edge surface with approval by Naval Air Systems Command.

3-7. Semi-flush fuel lane lights shall be installed on FAA Type L-868 light bases.

3-8. The height of guidance signs shall be not more than 24 inches above the edge of the fueling lane if it is located between 25 and 35 feet from the lane.

3-9. The height of the guidance sign shall not be more than 30 inches above the fueling lane edge if it is located 35 or more feet from the fueling lane.

3-10. The height of the floodlights should be kept to a minimum but shall not exceed 54 inches above the edge of the fueling lane.

3-11. LOCATIONS. The fueling lane edge lights shall be located and equally spaced the same as taxiway edge lights (WP 005 02) with the exception that the spacing of lights between the fueling lane entrance and the stopping position for refueling shall not exceed 50 feet.

3-12. The preferred location for the fueling lane edge lights is 2 feet from the lane edge.

3-13. The fueling lane lights shall extend from but not include the point of tangency (PT) of the fillet with the access and departure taxiways.

3-14. The fueling lane guidance signs shall be located on each side of the entrance to the fueling lane at the PT of the fillet with the taxiway.

3-15. The edge of the sign shall be not less than 25 feet from the edge of the taxiway.

3-16. The face of the sign shall be perpendicular to the taxiway centerline.

3-17. Two or more floodlights shall be located on each side of each fueling lane.

- The floodlights lights shall be located not less than 15 feet from fueling lane edge.
- The floodlights shall be spaced on each side of the fueling point approximately 40 to 50 feet apart to provide uniform illumination from all sides and to reduce shadows.

3-18. AIMING. Fueling lane edge lights are omnidirectional with the elevation angle of the beam fixed by the lens. Aiming is accomplished by leveling the light when installing it. Guidance signs are aligned with the face of the signs perpendicular to the taxiway centerline. The floodlights should be aimed vertically for the beam to reach across the fueling lane with no direct light projected above the horizontal. The entire area of the fueling lane involved in the refueling operation should be illuminated uniformly.

4-1. EQUIPMENT.

4-2. FIXTURES. The fueling lane edge light fixtures are usually the elevated type, but some fueling lane lights may be semi-flush lights. The fixtures and equipment to be used for apron and parking lights are listed in Table 1 and typical light fixtures and guidance signs are in Figure 2.

Table 1. Schedule of Equipment for Fueling Area Lights

PURPOSE AND TYPE OF FIXTURE OR MATERIAL	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
Fueling lane edge lights, elevated.(1)			
FAA AC 150/5345-46, type L-861T, Mode 1, L-861T(L)	45W 6.6A, type as determined by manufacturer.	30/45W 6.6/6.6A/ Determined by mfr.	L-830-1/Determined by mfr.
Fueling lane edge lights, semiflush.(1)			
FAA AC 150/5345-46, type L-852T, mode 1, L-852T(L)	6.6A, watts and type as determined by manufacturer.	Determined by mfr.	Determined by mfr.
Guidance signs.(1)			
FAA AC 150/5345-44, type L-858Y, size 2, 3, or 5, legends as specified.	6.6A, watts, type, and number as determined by manufacturer.	6.6/6.6A. Watts and number as determined by manufacturer.	Type as required by the sign wattage

Table 1. Schedule of Equipment for Fueling Area Lights (Cont)

PURPOSE AND TYPE OF FIXTURE OR MATERIAL	LAMP RATING AND TYPE	ISOLATION TRANSFORMER RATING	ISOLATION TRANSFORMER FAA TYPE AC 150/5345-47
Floodlights, low level, post-mounted, 4 each lane.			
To be determined.	As required.	As required.	As required.

NOTES:

1. Number of lights required varies with the fueling lane length and spacing.

4-3. PHOTOMETRIC REQUIREMENTS. The emitted light from the fueling lane edge light fixtures shall be omnidirectional in azimuth.

4-4. The color of the emitted light shall be aviation blue per FAA AC 150/5345-46.

4-5. The intensity and beam pattern of the elevated fueling lane edge light fixtures shall be per L-861T lights in FAA AC 150/5345-46.

4-6. The intensity and beam pattern of the semi-flush lights shall be per FAA AC 150/5345-46.

4-7. The guidance signs shall be per the requirements in FAA AC 150/5345-44 for both lighted and unlighted signs.

4-8. The floodlights shall have no direct light above the horizontal.

- The illumination on the fueling lane surface shall be uniform and should average between 2 and 4 footcandles.
- The preferred floodlight chromaticity is aviation white per SAE AS25050 for incandescent lamps.
- For LED floodlights, the chromaticity requirements are per FAA Engineering Brief 67 for aviation white.
- If aviation white floodlights are not available or cost prohibitive, other suitable lamp chromaticities may be substituted with local command approval.

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for the fueling lane edge lights and guidance signs shall be provided by the 6.6-ampere series taxiway lighting circuits (WP 009 00). The section of the circuit for the fueling lane lights and guidance signs shall be unlighted when the fueling area lights are not energized. The lights shall be connected to the primary series circuit by individual series-series isolation transformers (WP 009 03). The power for the floodlights shall be as required by the type of light fixtures installed.

NOTE

The preferred power source for signs is a dedicated constant current regulator that is set to 5.5 Amperes.

5-3. CONTROLS. The fueling area lights shall be controlled from the fueling area control panels. The intensity for the fueling lane edge lights shall be provided by the taxiway light circuit to which they are connected. The sections of circuits for the fueling lane edge lights and guidance signs shall be unlighted when the fueling area lights are not energized. The control of the floodlights should be independent of the taxiway light circuit.

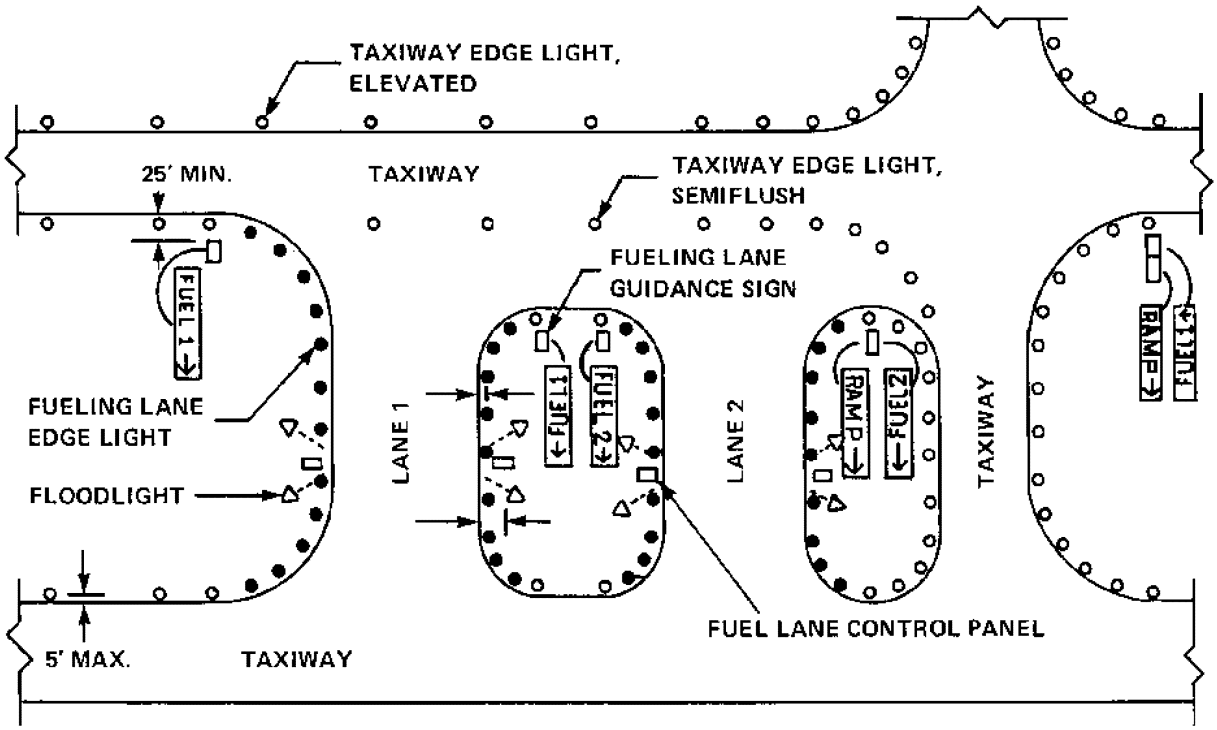


Figure 1. Typical Configuration for Direct Fueling Area Lights

SIGNS: INFORMATIONAL,
FAA AC 150/5345-44,
TYPE L858Y, SIZE 2, 3, OR 5,
STYLE 2 OR 3,
LEGEND AS SPECIFIED

LAMPS: RATING AND TYPE
AS DETERMINED BY
MANUFACTURER.

ISOLATION TRANSFORMERS:
6.6/6.6A, WATTS AND NUMBER
AS DETERMINED BY
MANUFACTURER.

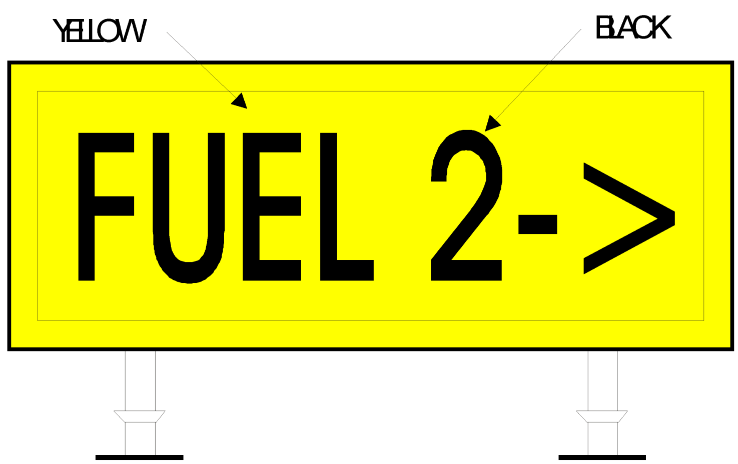


Figure 2. Typical Fueling Lane Guidance Sign, Type L-858y

ORGANIZATIONAL

PORTABLE EMERGENCY AIRFIELD LIGHTS

SPECIAL LIGHTS AND MARKINGS VISUAL AIDS

Reference Material

Runway Visual Aids, Runway Markings .... WP 004 01
Runway Visual Aids, Runway Threshold Lights .... WP 004 02
Runway Visual Aids, Runway End Lights .... WP 004 04
Runway Visual Aids, High-Intensity Runway Edge Lights (HIRL) .... WP 004 05
Taxiway Visual Aids, Taxiway Markings .... WP 005 01
Taxiway Visual Aids, Taxiway Edge Lights .... WP 005 02
Aeronautical Ground Light and Surface Marking Colors .... ICAO, Annex 14, Vol. 1, App. 1
Light, Marker, Portable, Emergency, Airfield, Battery Operated, General Specification for MIL-L-19661
Specification for Portable Runway and Taxiway Lights .... FAA AC 150/5345-50

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for portable emergency airfield lights. Portable emergency airfield lights are temporary replacements for runway and taxiway lights when the permanent light systems have been destroyed or damaged. The portable lights are to be used at night for emergency operations in Visual Flight Rules (VFR) conditions. The portable lights shall provide visual cues to pilots similar to those of runway edge and threshold/end lights and of taxiway edge lights except the intensities are lower and the light longitudinal spacing is greater.

1-3. JUSTIFICATION REQUIREMENTS. Portable emergency lights are required only for those airfields which have a definite commitment to operations at night despite enemy action, natural disasters, or failures of power and lighting equipment. The support for outlying or auxiliary airfields or for civilian areas may be a factor to consider in a justification for procuring and storing portable emergency airfield lights.

1-4. RELATED FACILITIES. Portable emergency airfield lights are a temporary replacement for permanent runway and taxiway light systems. Although the emergency lights are limited in intensity, they provide visual functions similar to the following permanent airfield lights:

- Runway edge lights (WP 004 05),
- Runway threshold lights (WP 004 02),
- Runway end lights (WP 004 04),
- Taxiway edge lights (WP 005 02),

1-5. Providing related visual functions for daytime and to some extent at night are:

- Runway markings (WP 004 01),
- Taxiway markings (WP 005 01).

2-1. DESCRIPTION.

2-2. The portable emergency lights are considered as complete units when equipped with batteries and do not require external wiring or power sources. The portable lights are usually omnidirectional but may be bidirectional or unidirectional. If unidirectional lights are used, the number of lights required may be doubled or the lights shall be realigned if the direction of operations changes. The runway edge lights emit white light, but colored filters may be fitted over the lamps to obtain green for threshold lights, red for runway end lights, green/red for combined threshold/runway end lights, or blue for taxiway edge lights. The lights shall be provided with anchors or attachments to resist jet or propeller blast. The lights shall be capable of routine storage for long periods of time, easily transportable by aircraft or military vehicles and, quickly and easily, both installed and removed. The portable lights should be steady burning for air operations. A complete set of portable emergency lights should include the required number of runway edge and threshold/end lights for the longest runway not to exceed 10,000 feet in length. The set may include emergency lights for the principal taxiways; however, “Follow me” vehicles may be used instead of taxiway lights.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. General design and installation requirements are given below.

3-3. METHODS OF INSTALLATION. Each light shall be placed on a flat level surface, usually on the ground or pavement. The runway threshold and end lights shall be aligned for the green light beams to be directed at the approach and the red beams along the runway parallel to the runway centerline. The lights should be anchored in place to prevent being upset or moved about by jet or propeller blast.

3-4. LOCATION. The portable emergency lights shall be located in rows along the edges of the runways and taxiways and across the ends of the runways per Figure 1 and as follows:

3-5. Runway edge lights.

3-6. The lights shall be located in rows on each side at or near the runway edges. The rows shall be not more than 10 feet from the runway edges. The spacing shall be not more than 300-foot intervals.

3-7. Runway threshold and end lights.

3-8. The lights shall be along a line at each end of the runway and be perpendicular to the runway centerline. The line of lights shall be not more than 5 feet from the runway ends. The lights at each end of the runway shall be in two equal groups one on each side of the runway with not less than four lights in each group. The two outermost runway threshold/end lights shall be in line with the lines of runway edge lights and are spaced at 10-foot intervals toward the runway centerline.

3-9. Taxiway edge lights.

3-10. The taxiway edge lights shall be located in rows along each side of the taxiway not more than 2 feet from the taxiway edges. The lights shall be equally spaced at intervals not to exceed 220 feet, except where the taxiway edges are curved, then the spacing shall not exceed 100 feet. For straight sections of taxiway with parallel edges, the lights shall be located in pairs on a line approximately perpendicular to the taxiway centerline. The spacing at the ends of a section of a taxiway may be less than the spacing interval.

3-11. Alignment.

3-12. Omnidirectional lights do not require horizontal alignment but should be leveled. Bidirectional lights shall be aligned in azimuth with the beams parallel to the centerline of the runway or taxiway. Unidirectional lights shall be aligned in azimuth toward the runway approach direction parallel to the runway centerline or have two lights at each station aligned in opposite directions parallel to the runway centerline.

4-1. EQUIPMENT.

4-2. FIXTURES. These light fixtures are self-contained elevated type with omnidirectional beams except the threshold/runway end lights shall be 180 degrees green and 180 degrees red, or they shall be unidirectional or bidirectional lights with color filters if required. The lights and equipment shall be per Table 1.

Table 1. Schedule of Lighting Equipment for Emergency Lights

PURPOSE AND TYPE OF FIXTURE	LAMP	BATTERY	FILTER
Runway edge, white, 66 or more for 10,000-foot runway.			
MIL-L-19661, type IA	Type PR-12, 2 per light. (1 is a spare.)		None
or			
FAA AC 150/5345-50, type L-863C	Type as determined by manufacturer.	Type as determined by manufacturer.	
Threshold/runway end, green/red, 16 or more per runway.			
MIL-L-19661, type IA	Type PR-12, 2 per light. (1 is a spare.)		Green 180°/red 180° type as determined by manufacturer.
or			
FAA AC 150/5345-50, type L-863 R/G	Type as determined by manufacturer.	Type as determined by manufacturer.	
Taxiway edge, blue, number varies with length and shape of taxiway.			
MIL-L-19661, type IA	Type PR-12, 2 per light. (1 is a spare.)		Blue, type as determined by manufacturer.
or			
FAA AC 150/5345-50, type L-863B R/G	Type as determined by manufacturer.	Type as determined by manufacturer.	

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of “certified” light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See “Advisory Circulars” at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED’s are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot’s ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

4-3. PHOTOMETRIC REQUIREMENTS. The emitted light from the portable emergency lights shall be omnidirectional, bidirectional, or unidirectional in azimuth.

4-4. The color of the emitted light shall be aviation white for the runway edge lights, aviation green/aviation red for threshold/runway end lights, and aviation blue for the taxiway edge lights.

4-5. The portable emergency light photometrics shall be per FAA AC 150/5345-50.

4-6. The portable emergency lights shall be steady burning and the intensity after 12 hours of operation shall be not less than 50 percent of the initial intensity.

5-1. POWER AND CONTROLS.

5-2. The power for these lights shall be provided by the manufacturer's specified batteries. Portable emergency light control is by either manual switches on the individual lights or remote control.

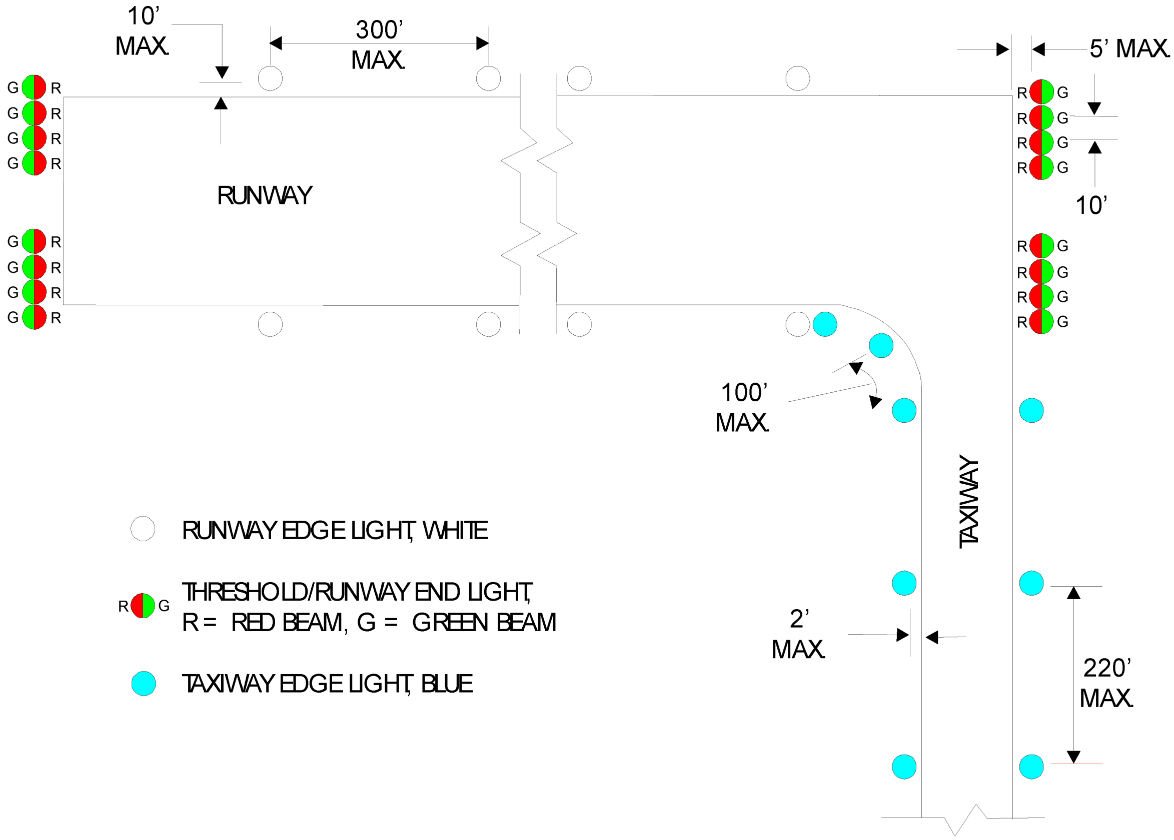


Figure 1. Typical Configuration for Portable Emergency Lights

ORGANIZATIONAL

LHD STOVL FACILITIES MARKING AND LIGHTING

SPECIAL LIGHTS AND MARKINGS VISUAL AIDS

Reference Material

Airfield and Heliport Planning and Design .... UFC 3-260-01

1-1. LHD PAVEMENT MARKING.

1-2. See Department of Defense, UFC 3-260-01, (Airfield and Heliport Planning and Design), paragraph 8-4.7 “LHD Pavement Marking” available on the following web site: https://www.wbdg.org/

2-1. LHD LIGHTING.

2-2. See Department of Defense, UFC 3-260-01, (Airfield and Heliport Planning and Design), paragraph 8-4.8 “LHD Lighting” available on the following web site: https://www.wbdg.org/

NOTE

Other variations exist for lighting and marking VL Pads. For new installations contact NAWCADLKE Code BL12300 for review.

ORGANIZATIONAL

F-35B VERTICAL LANDING (VL) PAD MARKING AND LIGHTING

SPECIAL LIGHTS AND MARKINGS VISUAL AIDS

Reference Material

Airfield and Heliport Planning and Design .... UFC 3-260-01

1-1. VL PAD PAVEMENT MARKING.

1-2. See Department of Defense, UFC 3-260-01, (Airfield and Heliport Planning and Design), paragraph 8-5.7 “VL Pavement Marking” available on the following web site: https://www.wbdg.org/

2-1. VL PAD LIGHTING.

2-2. See Department of Defense, UFC 3-260-01, (Airfield and Heliport Planning and Design), paragraph 8-5.8 “VL Pad Lighting” available on the following web site: https://www.wbdg.org/

ORGANIZATIONAL

DESCRIPTION

HELIPAD VISUAL AIDS

Reference Material

Introduction	WP 002 00
Helipad Visual Aids, Helipad Markings	WP 007 01
Helipad Visual Aids, Helipad Perimeter Lights	WP 007 02
Helipad Visual Aids, Helipad Approach Lights	WP 007 03
Helipad Visual Aids, Heliport Runway Lights and Markings	WP 007 04
Helipad Visual Aids, Heliport Taxiway Lights and Markings	WP 007 05
Helipad Visual Aids, Special Helipad Lights	WP 007 06
Airfield and Heliport Marking	UFC 3-260-04
Airport Lighting Equipment Certification Program (lists sources of qualified equipment)	FAA AC 150/5345-53
Design Drawings for Visual Aid Navigation Facilities	UFC 3-535-02
United States Standard for Terminal Instrument Procedures (TERPS)	OPNAV Inst. 3722.16
Visual Air Navigation Facilities	UFC 3-535-01

1-1. GENERAL INFORMATION.

1-2. PURPOSE. Helipad visual aids consist of marking and lighting on or near the helipad. The purpose of the helipad visual aids is to provide guidance to helicopter pilots for safe takeoffs and landings during Visual Flight Rules (VFR) operations (WP 002 00). The helipad visual aids shall clearly define the helipad surface and its limits and provide directional and distance cues for proper orientation and control of the aircraft. The information must be easily recognized and be useful during the day or night.

1-3. SCOPE. The helipad visual aids section of this Technical Manual contains the configuration requirements, applications, basic design and installation criteria, and equipment required for special operations of Navy shore-based helipads. Each helipad shall have adequate visual aids which will satisfy the requirements for the category of flight operations authorized. The requirements in the Work Package(s) (WP) provide guidance for all personnel servicing existing systems or designing new installations. Existing installations of similar helipad visual aids may be used and maintained as installed. Major modifications or upgrading of existing installations shall comply with the basic requirements of this WP.

1-4. STANDARDIZATION. The WP for each system establishes the requirements to be used for most Navy helipads for the subject visual aid. By combining the WPs for all the helipad visual aids required, standardization of Navy helipads is attained. When deviations of installations are necessary, changes shall be authorized per the approval procedures in WP 002 00.

2-1. FLIGHT RULES.

2-2. GENERAL. The types of helipad visual aids required depends on the flight operations that will be performed. Flight operations are separated into Visual Flight Rules (VFR) operations and Instrument Flight Rules (IFR) operations (WP 002 00). Helipad operations are intended for operations in VFR conditions only, except when the associated airfield provides cues for IFR operations, and the landing may be completed at the helipad. High intensity approach lights and heliport runway and taxiway visual aids WP are reserved until the requirements and potential systems are further evaluated. The visual aids associated with helipad operations are per Table 1.

2-3. The types of helipad visual aids required depend on the kind of flight operations that will be performed. Flight operations are separated into Visual Flight Rules (VFR) operations and Instrument Flight Rules (IFR) operations (WP 002 00). Helipad operations are intended for VFR conditions only, except when the associated airfield provides cues for IFR operations and the landing may be completed at the helipad. High intensity approach lights and heliport runway and taxiway visual aids WP are reserved until the requirements and potential systems have been further evaluated. The visual aids associated with helipad operations are indicated in Table 1.

2-4. VISUAL FLIGHT RULES (VFR). Where the approach and landing guidance depends on visual contact with the ground, helicopter flight operations may follow VFR. VFR may apply for both day or night helicopter flight operations. The VFR for operations at helipads are similar to those for fixed wing aircraft with the exception of some restrictions because of the special maneuvering characteristics of helicopters.

2-5. INSTRUMENT FLIGHT RULES (IFR). Where flight operations depend upon electronic guidance for navigation, IFR must be used. IFR involve low ceilings or poor visibility or both during day or night flight operations. The requirements and procedures for helicopter IFR operations are in OPNAV Inst. 3722.16. IFR operations for helicopters at Navy shore-based airfields are usually limited to fixed-wing aircraft airfields with the landing at a helipad or other designated area.

2-6. IFR CATEGORIES. To permit flight operations at different approach minimums, IFR operations are divided into the following categories:

- Non-precision IFR: Uses non-visual aids, such as Tactical Air Navigation (TACAN), VHF Omnidirectional Range (VOR), VOR/TACAN, etc., providing directional guidance adequate for straight-in approaches.
- Precision Approach IFR, Category I: Uses an Instrument Landing System (ILS) or Precision Approach Radar (PAR) electronic approach aids and visual aids.

3-1. DESCRIPTION OF HELIPAD VISUAL AIDS.

3-2. The helipad perimeter lights and markings are the basic visual aids for helipad operations. The helipad lights and markings identify the helipad area and its boundaries. The landing direction lights and approach direction lights are low-intensity lights for use with helipads where the preferred approach direction is known and approved. The requirements for the visual aids for instrument approaches to helipads are to be provided when available. Special visual aids, such as the heliport beacon, wind direction indicator, helipad floodlights, and descent angle indicator are determined on an individual basis for each helipad.

4-1. SELECTION OF HELIPAD VISUAL AIDS.

4-2. The types of helipad visual aids required depend on the mission and the approach minimums. Table 1 is a guide for determining the aids to be provided. The design requirements are found in the WP for each type of visual aid. For installation details, refer to UFC 3-535-01 and UFC 3-535-02 for helipad lighting. Refer to UFC-3-260-04 for heliport markings.

5-1. IMPLEMENTATION.

5-2. The WP and requirements of this section of the Technical Manual are not intended to direct or request implementation but are to establish uniformity when implementation is undertaken.

Table 1. Helipad Visual Aids Requirements

Helipad Visual Aids System	Authorized Operations		
		IFR Category	
	VFR	Non-Precision	Category I
Helipad Markings (WP 007 01)	R	R	R
Helipad Perimeter Lights (WP 007 02), if used at night	R	R	R
Helipad Landing and Approach Direction Lights (WP 007 03) if approach direction is designated	OPT	NR	NR
High-Intensity Approach Lights (WP 007 03)	NR	OPT	R

Table 1. Helipad Visual Aids Requirements (Cont)

Heliport Runway Lights and Markings (WP 007 04)	R	NR	NR
Heliport Taxiway Lights and Markings (WP 007 05)	R	NR	NR
Special Helipad Lights (WP 007 06)	OPT	OPT	OPT

R - Required

OPT - Option as recommended by air station commander and approved by NAVAIR.

NR - Not Required.

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of “certified” light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3 (Certified Airport Lighting Equipment). See “Advisory Circulars” at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED’s are recommended for new installations, or complete replacement; however, do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot’s ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

ORGANIZATIONAL

HELIPAD MARKINGS

HELIPAD VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for surface markings for shore-based helipads. For this WP, a helipad is defined as a prepared area designated for takeoff and landing of helicopters. The markings provide visual cues to pilots when performing both takeoff and landing operations. Two types of markings are used:

- Identification marking.
- Perimeter or boundary markings.

1-3. The marking requirements in this WP shall be used for all paved helipad installations. Existing markings may be used until repainting is necessary. Deviations from these markings shall be approved by the procedures given in WP 002 00. The requirements for marking closed helipads are included.

1-4. JUSTIFICATION REQUIREMENTS. Any paved surface designated for use for landing and takeoff of helicopters shall be provided with painted identification and perimeter markings. Unpaved helipads shall be provided with some effective type of perimeter marking and, if practical, with an identification marking. The markings may use materials other than paint as markings. Ground limestone, hedges, markers, colored gravel, contrasting vegetation, etc., may be used for marking unpaved surfaces.

1-5. RELATED FACILITIES. Helipad markings are intended to provide the required visual guidance during daytime operations without the use of related facilities. For nighttime operations, perimeter lights (WP 007 02) are required and floodlights (WP 007 06) are optional.

2-1. DESCRIPTION.

2-2. IDENTIFICATION MARKING STANDARD HELIPAD. The identification marking for a paved helipad shall be a capital letter “H” (see Figure 1).

2-3. The “H” marking shall be located in the center of the landing area, and oriented with the preferred approach direction.

2-4. The helipad dimensions shall vary with the size of the landing and takeoff area in Figure 1.

2-5. The color shall be surface aviation white, and if the helipad is intended for use at night, shall be retroreflective white.

2-6. If the paved surface is a light color and improved contrast is needed, the identification marking may be outlined with a lusterless black border. This black border shall not be less than 6 inches wide nor more than 12 inches wide.

NOTE

For areas that have multiple pads, it is recommended that a 3’ (minimum) high number be placed in the upper left corner of each pad. See Figure 1 for an example.

2-7. IDENTIFICATION MARKING HOSPITAL HELIPAD. The identification marking for a hospital or medivac helipad shall consist of a letter “H”, red in color positioned on a white cross made of a series of 4 squares adjacent to each of the sides of a square containing the letter “H” per Figure 2.

2-8. Each of the squares is 10’ on a side, the letter “H” is 10’ high with a stroke width of 18”.

2-9. The width of the letter “H” is 5’ to 6’.

2-10. The hospital helipad marking shall be accented so the cross arm of the letter “H” is at right angles to the preferred helicopter approach direction.

2-11. PERIMETER MARKINGS. See UFC 3-260-04 for additional information about the application of paint and colors of markings.

2-12. The limits of the safe landing area shall be square and marked by broken lines per Figure 1.

2-13. The perimeter markings shall be oriented with the sides of the square parallel to the letter “H”.

2-14. The perimeter markings shall consist of corners and edge bars.

2-15. The corners shall form right angles and the edge bars shall be located midway between the corner markings.

2-16. The outer edges of the markings shall be along the designated limits of the landing and takeoff area.

2-17. The dimensions shall be per Figure 1.

2-18. The paint color of the helipad perimeter markings shall be surface aviation white and, if the helipad is intended for use at night, shall be retroreflective white.

2-19. If needed to improve contrast between the helipad markings and pavement, the helipad perimeter markings may be outlined with black borders between 6 and 12 inches wide.

2-20. CLOSED HELIPAD MARKING. If a helipad is closed either temporarily or permanently, the inoperative condition is indicated by a closed helipad marking.

2-21. The closed marking shall be a non-retroreflective yellow X-shaped cross per Figure 3.

2-22. The cross shall be centered over the helipad identification marking. The dimensions shall be as indicated by the table in Figure 3.

2-23. The color shall be non-retroreflective yellow.

2-24. If the helipad is permanently closed, all helipad markings shall be removed.

3-1. MATERIALS.

3-2. The materials required for the identification and perimeter markings are paint and retroreflective spheres (glass beads).

3-3. The materials used should be approved for the purpose and the type of pavement.

3-4. Paint colors shall per SAE AMS-STD-595:

- Color chip #27875 for white.
- Color chip #23538 for yellow.
- Color chip #27038 for black.

3-5. The approved marking materials are in Table 1.

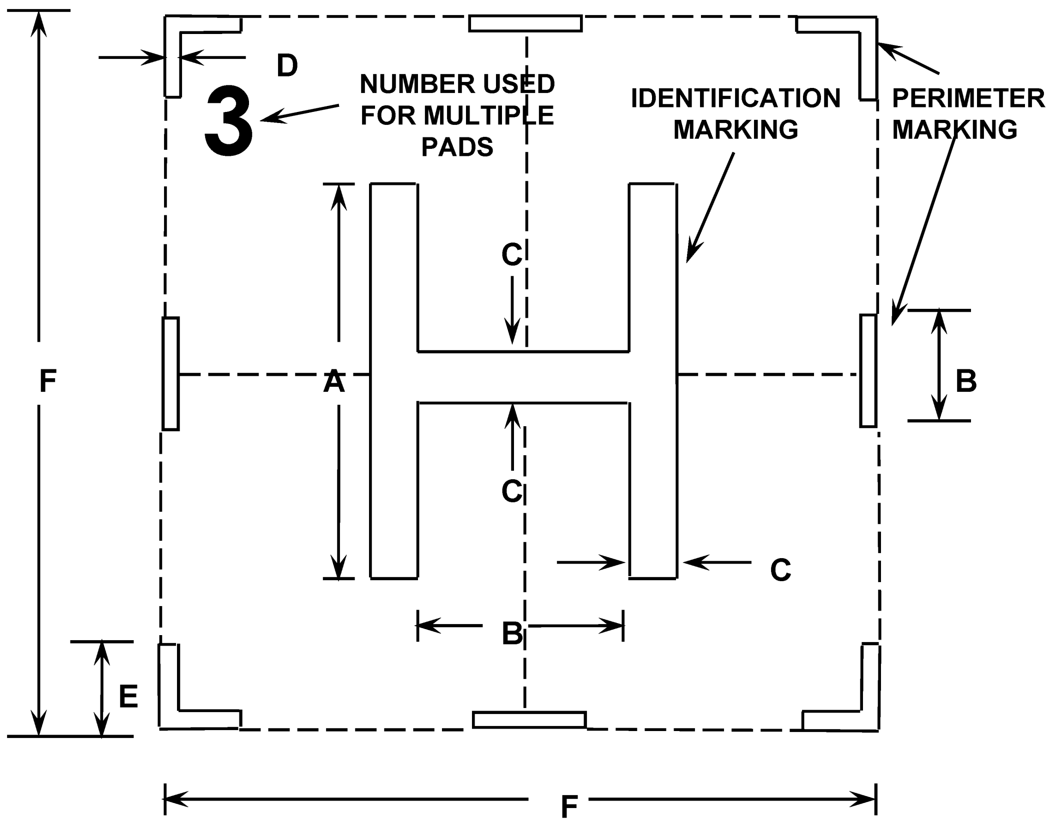
3-6. The closed helipad marking may be yellow paint or, if temporary, of suitable tape or painted panels of an approved color.

Table 1. Materials for Helipad Markings

COLOR OF MARKING	FEDERAL SPECIFICATION	AUTHORIZED USE
Retroreflective White	FED SPEC TT-P-1952F, paint, white and FED SPEC TT-B-1325 glass spheres, type III, gradation A.	Helipad identification and perimeter markings.
Non-retroreflective White	FED SPEC TT-P-1952F paint, white	Helipad markings, daytime only.
Non-retroreflective Yellow	FED SPEC TT-P-1952F paint, yellow	Closed helipad marking.
Non-retroreflective Black	Paint, black	Border around white or yellow markings.

4-1. RESTRICTIONS.

4-2. Regulations of some states such as California, or other authorities may prohibit or restrict the use of solvent based paints. For white and yellow markings, use type FED SPEC TT-P-1952F, Type 1. For slower drying types of FED SPEC TT-P-1952F paint, timing of the application of the retroreflective beads (spheres) may be required to assure adherence of the beads without sinking too deeply into the paint.

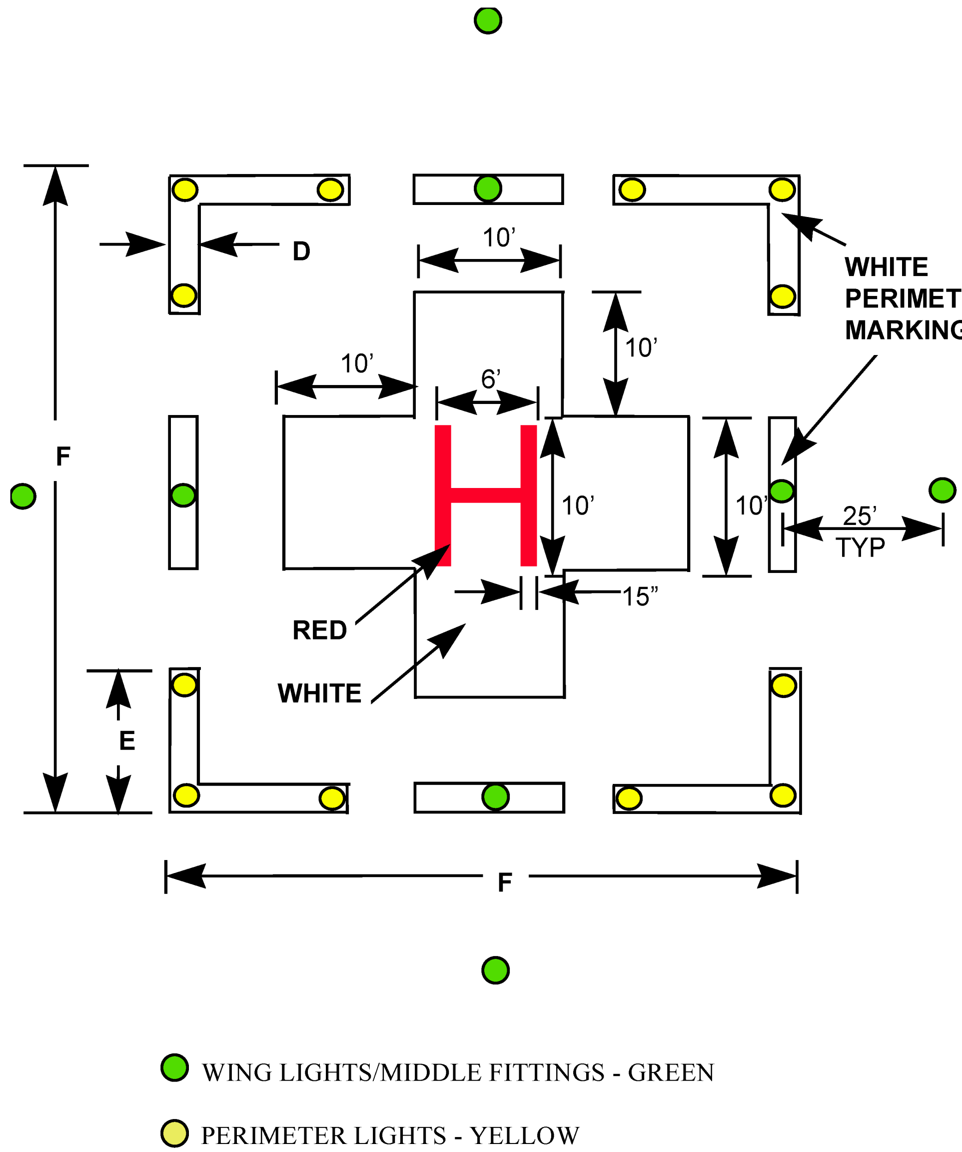


A = 0.6F BUT 60' MAX.
B = 0.5A

HELIPAD SIZE (F)	PATTERN LINE WIDTH (C)	PERIMETER EDGE WIDTH (D)	CORNER EDGE LENGTH (E)
80' - 99'	5'	24"	10' (TYP)
100' - 150'	6'	30"	12' (TYP)

COLOR: RETROREFLECTIVE AVIATION SURFACE WHITE, EXCEPT HELIPADS FOR DAY OPERATIONS ONLY MAY BE NON-RETROREFLECTIVE WHITE

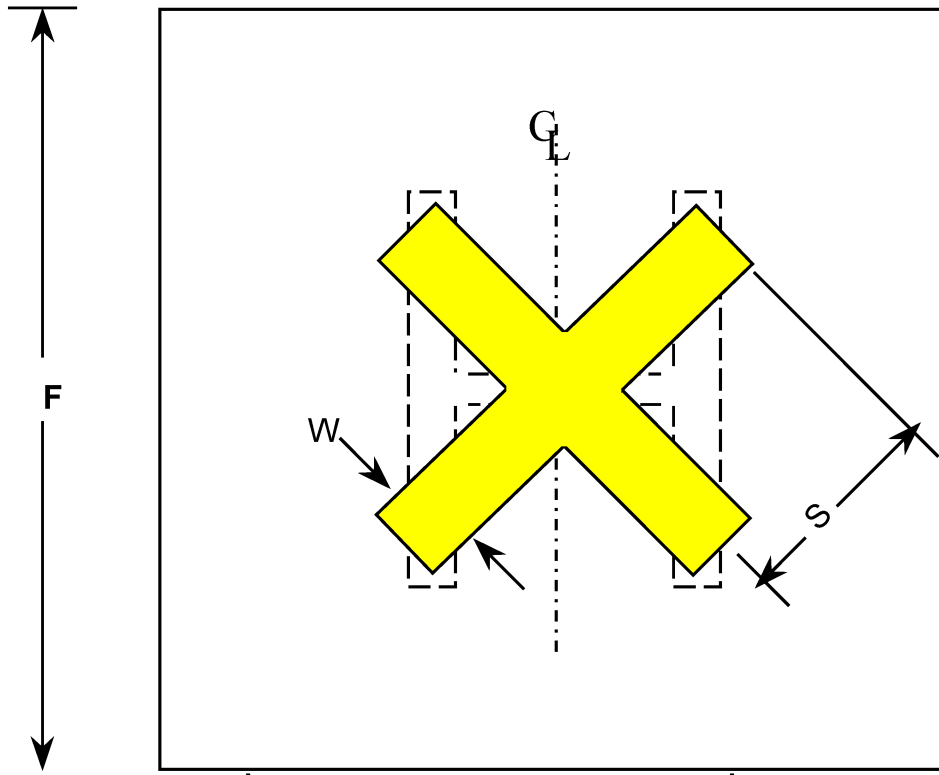
Figure 1. Details of Helipad Identification and Perimeter Markings



NOTE: MARKINGS SHOWN FOR REFERENCE ONLY.

HELIPAD SIZE (F)	PERIMETER EDGE WIDTH (D)	CORNER EDGE LENGTH (E)
80’ - 99’	24”	10’ (TYP)
100’ - 150’	30”	12’ (TYP)

Figure 2. Details for Hospital Helipad Identification



HELIPAD SIZE (F)	ARMS LENGTH (S)	ARM WIDTH (W)
80’ - 99’	38’	15’
100’ - 150’	42’	17’

COLOR: NON-RETROREFLECTIVE AVIATION SURFACE YELLOW

Figure 3. Details of Closed Helipad Markings

ORGANIZATIONAL

HELIPAD PERIMETER LIGHTS

HELIPAD VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for shorebased helipad perimeter lights. The perimeter lights define the boundaries of the helipad for helicopter operations conducted at night. For this WP, a helipad is defined as a prepared area designated for the takeoff and landing of helicopters. The perimeter lights provide a visual cue to the pilot for identifying the helipad area during takeoff or landing operations. The helipad perimeter lights shall be used for all new helipad lighting installations. Existing helipad lighting systems may continue to be used and maintained. Deviations from the lighting requirements for new installations or the replacement of existing systems shall be approved with the procedures in WP 002 00.

1-3. JUSTIFICATION REQUIREMENTS. Any helipad designated for operations at night or in low visibility weather during daytime, except if located on lighted runways or taxiways, shall be provided with perimeter lights. The perimeter lights for paved or unpaved helipads shall be similar except the method of installation may be different.

1-4. RELATED FACILITIES. The helipad perimeter lights provide the required visual guidance at night for Visual Flight Rules (VFR) operations (WP 002 00) without the use of related facilities. The helipad shall be provided with helipad markings (WP 007 01). Related lighting facilities for VFR operations to helipads may include the following:

- Landing direction and approach direction lights (WP 007 03).
- Heliport beacon and helipad floodlighting (WP 007 06).

2-1. DESCRIPTION.

2-2. The helipad perimeter lights shall consist of a row of lights along or near the four sides of a helipad per Figure 1. The perimeter lights are usually the elevated type except semi-flush lights may be used in areas where helicopters with wheels may be taxiing on the surface between the helipad and parking or service areas. Both types of helipad light fixtures shall emit omnidirectional yellow light.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details and requirements for helipad perimeter lights refer to UFC 3-535-02. General design and installation requirements for helipad perimeter lights are given below.

3-3. METHODS OF INSTALLATION. The helipad perimeter lights are usually elevated type fixtures. The elevated lights shall be mounted on frangible couplings. If the helipad is paved, the elevated fixtures shall be mounted on FAA Type L-867 light bases set in concrete or on conduit elbows set in concrete foundations. If the helipad is not paved, the helipad perimeter light fixtures may be installed on mounting stakes. The semi-flush fixtures shall be mounted on FAA Type L-868 light bases encased in concrete foundations. Because the beam of light from the helipad perimeter light fixture is omnidirectional, azimuth aiming is not required. The elevation angle of the perimeter light is fixed, and the aiming is not required. Helipad perimeter lights should be leveled when installed.

3-4. DIMENSIONS. The layout for helipad perimeter light installation in Figure 1.

3-5. The light fixtures shall be located in a straight line ±6 inches along each edge of the helipad, and each line of lights shall be the same distance from the helipad edge.

3-6. The perimeter light fixtures on opposite sides of the helipad shall be opposite each other and equidistant and parallel to the extended centerlines of the helipad.

3-7. Usually, the perimeter light fixtures are adjacent to the helipad edge but may be located not more than 10 feet from the perimeter edge.

3-8. A fixture shall be located at or near each corner of the helipad, and three additional fixtures, equally spaced ±12 inches, are placed between the corner lights along each side.

3-9. The overall height of the light fixture above the ground level shall not exceed 14 inches, except in areas with frequent snow accumulations to depths of 12 inches or more (with approval of Naval Air Systems Command) the maximum height shall not exceed 24 inches.

3-10. If one of more perimeter lights are located in a taxiway or other high traffic areas, the light fixtures in these areas shall be semi-flush lights.

4-1. EQUIPMENT.

4-2. FIXTURES. The lighting equipment required for the perimeter lights is given in Table 1.

Table 1. Schedule of Perimeter Lights Equipment

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
Elevated lights, 16.			
FAA AC 150/5345-46, type L-861, L-861(L) omnidirectional, yellow	6.6A 45W, type as determined by manufacturer.	45W 6.6/6.6A or determined by mfr.	L-830-1 or determined by mfr. for LED
Semiflush lights optional.			
FAA AC 150/ 5345-46, type L-852E, L-852E(L) omnidirectional, yellow	6.6A, watts and type as determined by manufacturer.	6.6/6.6A. watts and type as determined by manufacturer.	

Table 1. Schedule of Perimeter Lights Equipment (Cont)

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER RATING	ISOLATION TRANSFORMER FAA TYPE AC 150/5345-47

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

4-3. PHOTOMETRIC REQUIREMENTS. The light emitted from the helipad perimeter fixtures shall be omnidirectional and the color shall be aviation yellow per SAE AS25050 for incandescent lamps and FAA Engineering Brief 67 for LED lamps. Not less than three steps of intensity shall be provided, and the lowest step shall be less than 10 percent of the rated intensity. The preferred and specified intensity requirements for these lights are in Table 2.

Table 2. The Intensity Requirements for Perimeter Lights

FIXTURE TYPE	SPECIFIED INTENSITIES (CANDELAS) FOR VERTICAL ANGLES		
Preferred	3° to 15° 40 minimum	15° to 25° 15 minimum	45° to 90° 5 minimum
L-861	2° to 10° 37 minimum 67 average	10° to 15° 20 minimum	
L-852E	50 minimum for average		

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for the helipad perimeter lights shall be provided by one or more 6.6-ampere series circuits (WP 009 00). The constant current regulator (CCR) shall have five intensity steps providing current at 6.6, 5.2, 4.1, 3.4, and 2.8 amperes (WP 009 02). The CCR may also furnish the power for the landing direction lights and the approach direction lights. Emergency power is not required but should be used if it is available.

5-3. CONTROLS. The helipad lighting controls shall be separate from other airfield visual aids although the controls should be provided on the remote airfield lighting control panel (WP 009 05) in the air traffic control tower cab and airfield lighting vault.

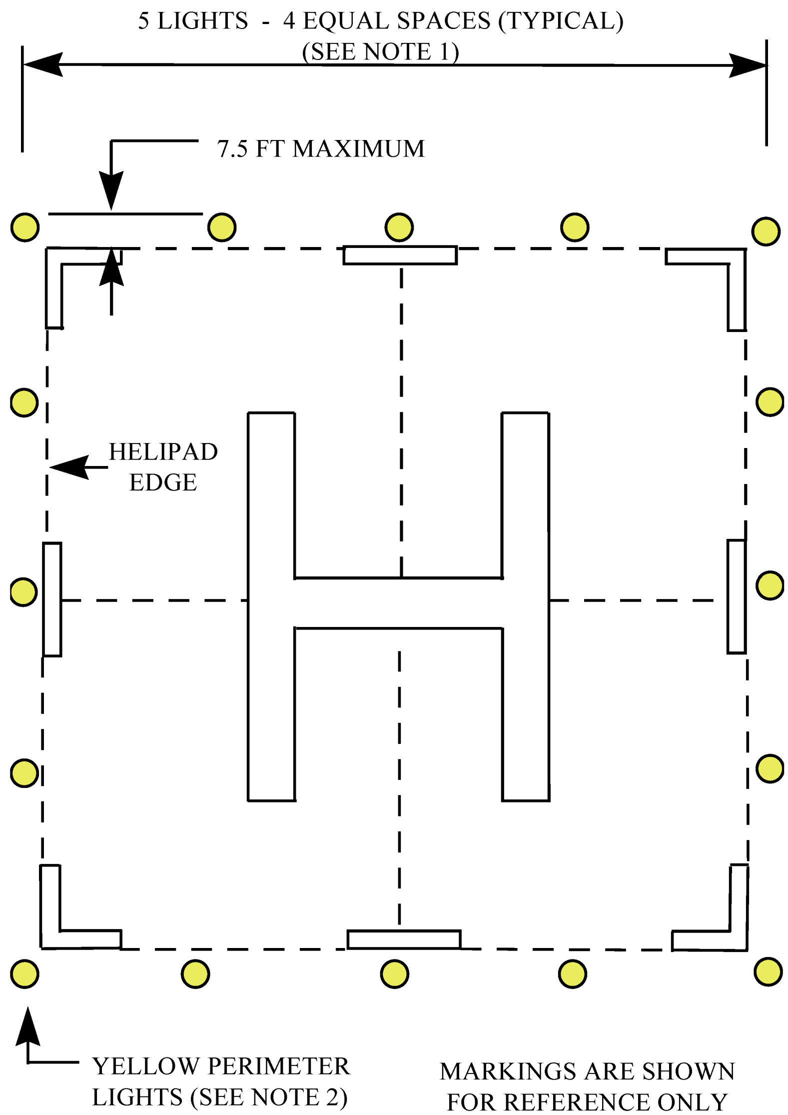
5-4. The helipad perimeter lighting shall be provided with an ON-OFF switch and a brightness switch for three or more intensity settings.

5-5. Other helipad lights, such as landing direction lights and approach direction lights, or other helipads may be controlled by these switches.

5-6. Remote-control circuit-selector switches (WP 009 06) may be used to permit energizing the helipad perimeter lights with or without other helipad lights.

5-7. The lower intensity settings may be selected to provide the preferred intensities for the particular helipad and operating conditions.

5-8. For helipads not equipped with control panels in an air traffic control tower cab, the helipad lighting intensity control may use manual switches or automatic control by photoelectric switches or clock-driven timers.



NOTE 1: ALL FIXTURES SHALL BE THE SAME DISTANCE FROM THE HELIPAD EDGES, A FIXTURE SHALL BE LOCATED AT OR NEAR EACH CORNER. THREE ADDITIONAL FIXTURES SHALL BE EQUALLY SPACED BETWEEN THE CORNER LIGHTS ALONG EACH EDGE.

NOTE 2: THE COLOR EMITTED BY THE PERIMETER LIGHTS SHALL BE AVIATION YELLOW.

Figure 1. Typical Layout of Helipad Perimeter Lights

ORGANIZATIONAL

HELIPAD APPROACH LIGHTS

HELIPAD VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for helipad approach lights that are intended for shore-based helipad operations in Visual Flight Rules (VFR) conditions (WP 002 00). The helipad approach lights indicate the preferred direction to the helipad for helicopter approach and landing operations at night. For this WP, a helipad is defined as a prepared area designated for takeoff and landing of helicopters. The approach lights provide visual cues to helicopter pilots for directional guidance along the designated helipad approach path and landing direction for landings. They are to be installed only when it has been determined that the need to indicate a landing direction and an approach direction is necessary. The lights shall be used for all new helipad approach lighting installations. Existing helipad landing direction lights and approach direction lights may continue to be used and maintained. Deviations from the lighting requirements in this WP for new installations or the replacement of existing systems shall be approved with the procedures in WP 002 00.

1-3. JUSTIFICATION REQUIREMENTS. Any helipad that is designated for helicopter operations at night in VFR conditions, for which a preferred landing direction has been established, shall install landing direction lights. At locations where additional approach guidance is required, approach direction lights shall also be installed. Landing direction lights may be provided without using approach direction lights, but approach direction lights require the installation of landing direction lights.

1-4. RELATED FACILITIES. Related visual aids shall include 1 and 2 and may include 3, 4, and 5:

1. Helipad markings (WP 007 01),
2. Helipad perimeter lights (WP 007 02),
3. Heliport beacon (WP 007 06),
4. Heliport floodlights (WP 007 06),
5. Wind direction indicator (WP 007 06).

2-1. DESCRIPTION.

2-2. The helipad approach light system shall consist of a row of landing direction and approach direction lights installed per Figure 1. The lights are usually the elevated type. Semi-flush lights may be used in areas where helicopters with wheels may be taxiing on the pavement surface. The helipad approach lights shall emit omnidirectional beams.

2-3. LANDING DIRECTION LIGHTS. The landing direction lights shall consist of a single row of six yellow lights outward from the central helipad perimeter light in the established direction for the approach.

2-4. APPROACH DIRECTION LIGHTS. The approach direction lights shall consist of two parallel rows of lights extending outward from the last yellow landing direction light. Each row shall have five pairs of white lights.

2-5. HELIPAD IFR APPROACH LIGHTS CATEGORY I. See Figure 2. These lights are installed whenever it has been determined that additional approach guidance is considered necessary for instrument meteorological conditions, with a decision height of 200 feet and an RVR of 2400 feet.

2-6. Configuration of IFR Approach Lights.

2-7. The approach lighting system will be symmetrical about, and extend for the entire length of, the centerline of the helipad direction lights.

2-8. The IFR approach light system starts at the position of the approach direction lights in Figure 1, at 125 feet from the helipad, and extending out to 1025 feet, per Figure 2.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation details and requirements for helipad approach lights, refer to UFC 3-535-02. General design and installation requirements for helipad approach lights are as follows:

3-3. METHODS OF INSTALLATION. The helipad approach direction lights are usually elevated type fixtures. Elevated fixtures shall be mounted on FAA Type L-867 light bases set in concrete or on conduit elbows set in concrete foundations. For either method of mounting, the light fixtures shall be mounted on frangible couplings. Light fixtures located in paved areas for taxiing wheel-type helicopters or surface traffic shall be semi-flush fixtures mounted on FAA Type L-868 light bases. Because the light fixture beam is omnidirectional, aiming is not required. The light beam elevation angle is determined by the fixture and no adjustment is required. Helipad approach lights should be leveled during installation.

3-4. DIMENSIONS. The layout for installing the helipad approach and landing direction lights is in Figure 1.

3-5. Preferably, the helipad approach direction lights shall be located in a horizontal plane; however, where terrain makes it impractical to stay within the horizontal plane, the elevation of the lights shall be along a continuous slope between +2 and -1 percent.

3-6. The helipad landing direction lights shall be located in a straight line that deviates not more than ±6 inches along the extended centerline of the helipad.

- The first landing direction light shall be 25 ±1 feet from the line of helipad perimeter lights.
- The remaining landing direction lights shall be equally spaced at 15 ±1 feet with the sixth light 100 feet from the line of the helipad centerline.

3-7. The lines of approach direction lights shall be 10 feet apart and symmetrical about the helipad centerline.

3-8. The first pair of approach direction lights shall be 25 ±1 feet from the last landing direction light and the other pairs of lights shall be equally spaced at 50 ±1 feet for a total distance of 325 feet from the line of helipad perimeter lights.

3-9. The height of landing direction and approach direction lights shall be no more than ±2 inches from the established slope.

3-10. In areas with frequent accumulations of snow to depths of 12 inches or more, elevated lights may (with approval of Naval Air Systems Command) be at least 24 inches above ground level.

3-11. The maximum height of semi-flush lights shall not project more than one inch above the level of the paved surface.

4-1. EQUIPMENT.

4-2. FIXTURES. The lighting equipment required for the helipad approach lights is per Table 1.

Table 1. Schedule of Helipad Approach Lights Equipment

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
Elevated landing direction lights, 16.			
FAA AC 150/5345-46, type L-861T, L-861T(L) omnidirectional, yellow	6.6A 45W, or determined by manufacturer.	45W 6.6/6.6A or determined by mfr.	L-830-1 or determined by mfr.
Semiflush landing direction lights, optional.			
FAA AC 150/5345-46, type L-852E, L-852E(L), omnidirectional, yellow	6.6A, watts and type as determined by manufacturer.	6.6/6.6A. watts and type as determined by manufacturer.	
Elevated approach direction lights, 10.			
FAA AC 150/5345-46, type L-861, L-861(L) omnidirectional, white	6.6A 45W, type or determined by mfr.	45W 6.6/6.6A or determined by mfr.	L-830-1 or determined by mfr.
Circuit Selector.			
FAA AC 150/5345-46, type L-847		5000V, 6.6A or 20A. One or more circuits.	

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

4-3. PHOTOMETRIC REQUIREMENTS. The light emitted from the helipad approach lights shall be omnidirectional and the color shall be aviation yellow for landing direction lights and aviation white for approach direction lights per SAE AS 25050 for incandescent lamps and per FAA Engineering Brief (EB) 67 for light emitting diode (LED) lamps. Three or more steps of intensity shall be provided, and the lowest step shall be less than 10 percent of the rated intensity. The preferred and specified intensity requirements for these lights are given in Table 2.

Table 2. The Intensity Requirements for Helipad Approach Lights

FIXTURE TYPE	SPECIFIED INTENSITIES FOR VERTICAL ANGLES CANDELAS (CD)		
	Yellow Landing Direction Lights [1]		
Preferred	3° to 15° 40 cd minimum	15° to 25° 15 cd minimum	45° to 90° 5 cd minimum
L-861	2° to 10° 37 cd minimum 67 cd average	10° to 15° 20 cd minimum	
L-852E[2]	50 cd minimum for average		
	White Landing Direction Lights[3]		
Preferred	3° to 15° 100 cd minimum	15° to 25° 40 cd minimum	45° to 90° 10 cd minimum
L-861	2° to 10° 75 cd minimum 125 cd average	10° to 15° 40 cd minimum	
L-852E[2]	100 cd average		

NOTES:

1. The emitted light shall be omnidirectional in azimuth and aviation yellow in color.
2. For semiflush fixtures, the intensity at not more than six structural ribs may be 25 percent less than the minimum average required.
3. The emitted light shall be omnidirectional in azimuth and aviation white in color.

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for the helipad approach and landing direction lights shall be provided by a 6.6-ampere series circuit (WP 009 00). The constant current regulator (CCR) shall have a minimum of 3 intensity steps providing current at 6.6, 5.5, and 4.8 amperes (WP 009 02). The CCR may also provide power for the helipad perimeter lights. Emergency power is not required but should be used if it is available.

5-3. CONTROLS. The helipad lighting controls shall be separate from other airfield visual aids, although for helipads on airfields, the controls should be provided on the remote airfield lighting control panels (WP 009 05) in the air traffic control tower cab and airfield lighting vault.

5-4. The helipad approach lighting shall be provided with an ON-OFF switch and a brightness switch for three or more CCR intensity settings.

5-5. The controls for the approach lights shall be interconnected to prevent the lights from operating unless the perimeter lights are operating.

5-6. The helipad landing direction lights may be operated without the approach direction lights.

5-7. When the helipad approach direction lights are used, both the helipad perimeter lights, and landing direction lights must be operating.

5-8. Remote-control circuit-selector switches (WP 009 06) may be used to permit energizing the perimeter lights with or without the helipad approach lights.

5-9. The lower CCR intensity settings may be selected to provide the preferred intensities for the particular helipad and operating conditions.

5-10. For helipads not equipped for air traffic control, the CCR intensity control may use manual switches or automatic control by photoelectric switches or clock-driven timers.

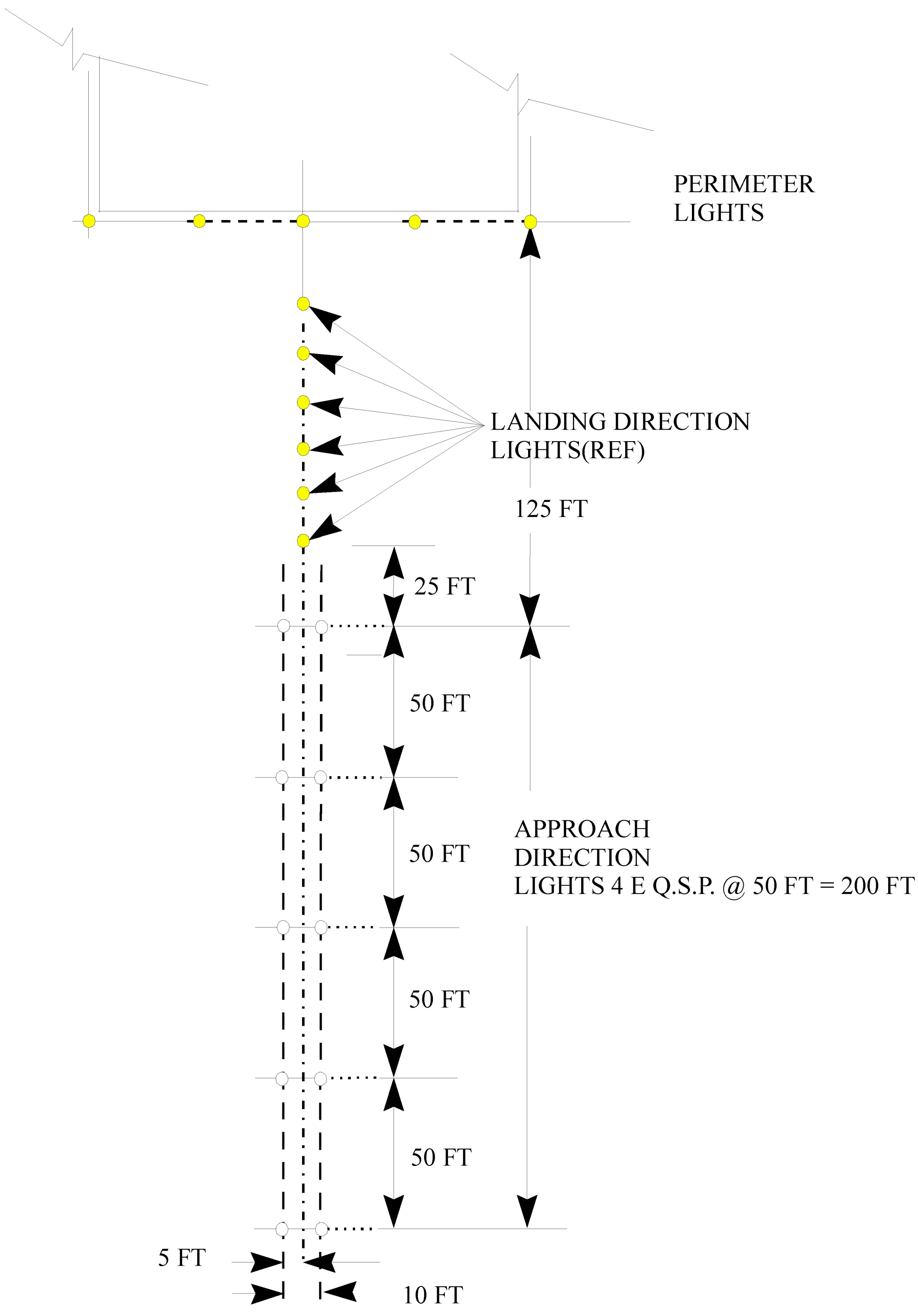
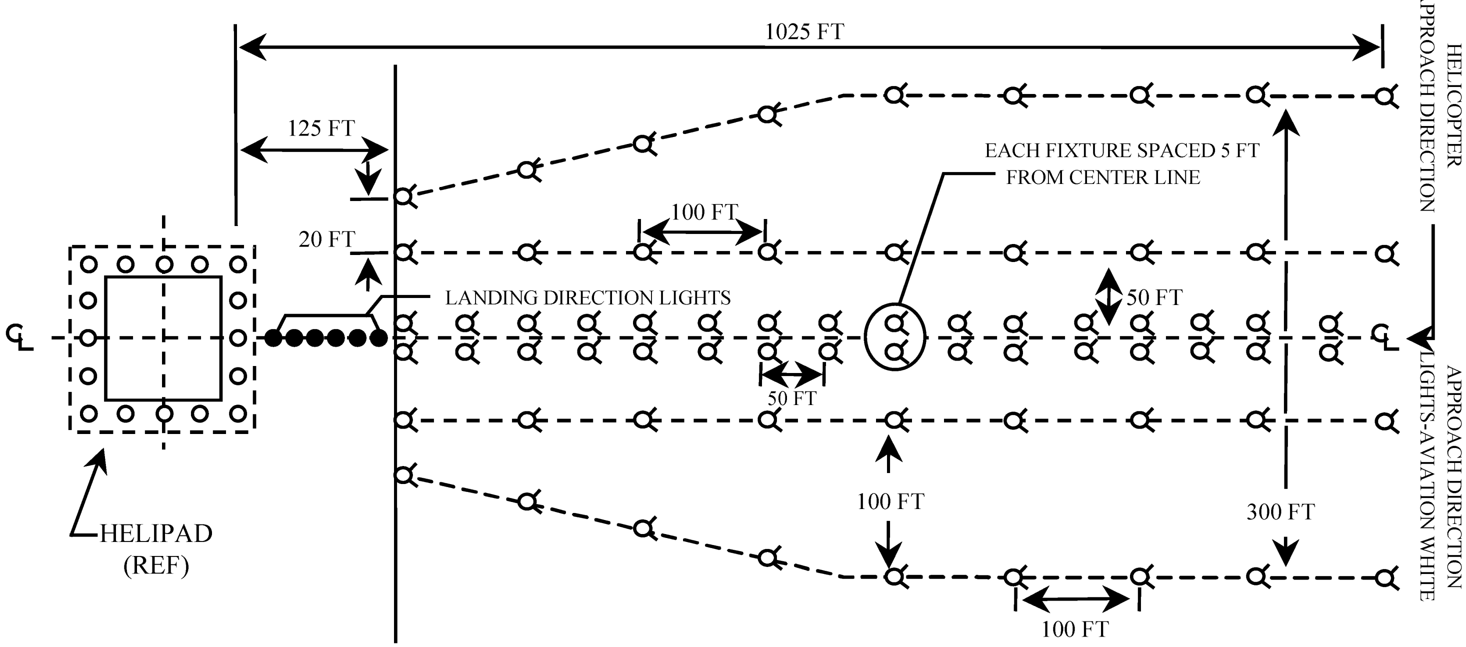


Figure 1. Layout for Helipad Approach Lights



NOTES:

(1) ○ Elevated or semi-flush omni-directional light fixture with luminous features.

(2) ● Normally elevated omni-directional light fixture with luminous features.

(3) Normally elevated uni-directional light fixtures.

(4) Elevated light fittings to be frangible with break-off point at top edge of base mounted plate.

(5) Light fixtures shall be mounted on a horizontal plane and shall not be greater than 18 inches above grade of the helipad. Where deviation of the horizontal plane is necessary, tolerance is to be +2% or -1% in the longitudinal slope. Where a slope is established for the landing direction lights, the same slope shall be continued for the approach direction lights.

(6) Glide slope and setting angles:

glide slope angle	setting angle
3 degrees	6 degrees
8 degrees	11 degrees
9 degrees	15 degrees

(7) If multiple glide slope angles are used, the mean value of 11 degree setting angle shall be used. Three or five progressive stages of brilliance are required for approach direction lights.

Intensities:
A. Horizontal plane 20,000 CDs beam spread ±7.5°.
B. Horizontal plane 5,000 CDs beam spread ±12.5°.

Figure 2. Approach Lights Category I

ORGANIZATIONAL

HELIPORT RUNWAY LIGHTS AND MARKINGS

HELIPAD VISUAL AIDS

Reference Material

Airfield and Heliport Marking .... UFC 3-260-04
Visual Air Navigation Facilities .... UFC 3-535-01

1-1. HELIPORT RUNWAY LIGHTS AND MARKINGS.

1-2. See Department of Defense,UFC 3-535-01, (Visual Air Navigation Facilities), Chapter 8 “Standards for Lighting Heliports”.

1-3. See also UFC 3-260-04, (Airfield and Heliport Marking), Chapter 7 “Marking Pavements for Rotary Wing Operations”, for additional information about heliport runway lights and markings.

1-4. Both publications are available on the following web site:https://www.wbdg.org/

ORGANIZATIONAL

HELIPORT TAXIWAY LIGHTS AND MARKINGS

HELIPAD VISUAL AIDS

1-1. HELIPORT TAXIWAY LIGHTS AND MARKINGS.

RESERVED

ORGANIZATIONAL

SPECIAL HELIPAD LIGHTS

HELIPAD VISUAL AIDS

Reference Material

Introduction	WP 002 00
Approach Visual Aids, Obstruction Lightings	WP 003 09
Helipad Visual Aids, Helipad Markings	WP 007 01
Helipad Visual Aids, Helipad Perimeter Lights	WP 007 02
Helipad Visual Aids, Helipad Approach Lights	WP 007 03
Electrical Power and Control for Visual Aids, Description	WP 009 00
Airport Lighting Equipment Certification Program (lists sources of qualified equipment)	FAA AC 150/5345-53
Design Drawings for Visual Aid Navigation Facilities	UFC 3-535-02
Specification for Airport and Heliport Beacons	FAA AC 150/5345-12
Specifications for Wind Cone Assemblies	FAA AC 150/5345-27

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for special lights and visual aids for helipads. The visual aids include airport beacons, wind direction indicators, floodlights, and descent-angle indicators. The visual aids in this WP are optional aids for helipads with special operations or location requirements. For new installations, the requirements for a specific visual aid shall apply. Existing installations of these visual aids may be used and maintained until replacements are required.

1-3. JUSTIFICATION REQUIREMENTS. Special lights and visual aids are not required for basic helipad installations. Justification is needed for permission to install the particular special visual aid. Approval for installation or for changes in the requirements may be obtained by methods described in WP 002 00.

1-4. RELATED FACILITIES. The visual aids in this WP may not be required for a particular helipad. Related visual aids shall include 1 and 2 and may include 3.

1. Helipad markings (WP 007 01).
2. Helipad perimeter lights (WP 007 02).
3. Landing direction and approach direction lights (WP 007 03).

2-1. DESCRIPTION.

2-2. HELIPORT BEACON. The heliport beacon shall provide identification for a lighted helipad/heliport when it is not closely associated with a lighted airfield. The rotating heliport beacon shall alternately flash the colors of white, green, and yellow. The white flash should be two closely spaced peaks. The flash rate shall be between 10 and 15 flash sequences per minute with the time between adjacent colors one-third of the sequence time.

2-3. WIND DIRECTION INDICATOR. The wind direction indicator indicates the wind direction at the helipad. The wind indicator shall be an 8-foot wind cone. A low-impact-resistant support for the wind cone is preferable. The wind cone shall be lighted for night operations if the helipad is lighted. The wind cones shall be constructed with orange or white fabric to provide good contrast with the background when viewed from the air. See FAA AC 150/5345-12 for detailed information about heliport wind cones.

2-4. HELIPAD FLOODLIGHTS. Helipad floodlights shall be used to illuminate the helipad surface at night. The helipad floodlights provide visual cues to the pilot for determining the height above the helipad surface during the approach touchdown. The floodlights shall provide a uniform illumination of the helipad surface. The floodlights shall not permit any direct light to be visible above the horizontal. The floodlights shall emit a fan-shaped illuminating beam. The floodlight beam shall be adjustable in elevation between 1 degree up and 5 degrees down from horizontal.

2-5. DESCENT ANGLE INDICATOR. Reserved.

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. For installation requirements and details for helipad floodlights, refer to UFC 3-535-02. General design and installation requirements for the special visual aids are as follows:

3-3. BEACON INSTALLATION. A helipad beacon shall not be installed within one mile of an existing airfield beacon or usable runway.

3-4. The helipad beacon shall be located not more than 1500 feet from the helipad or one of several helipads.

3-5. The helipad beacon should be visible from any direction.

3-6. The helipad beacon should be not less than 50 feet above the ground level and above the surface of the helipads.

3-7. If an air traffic control tower is present, the heliport beacon shall be not less than 15 feet above the level of the control tower cab floor.

3-8. An existing water tower, building, or dedicated tower may be used to support the heliport beacon.

3-9. The heliport beacon main light beam shall be aimed not less than 5 degrees above the horizontal with any spillover light below the horizontal not more than 1000 candelas.

3-10. Light shields may be used to reduce heliport beacon spillover light below the horizontal.

3-11. WIND INDICATOR INSTALLATION. The wind cone shall be located near the helipad or helipads in a location where the winds are representative of those occurring at the helipad.

3-12. If feasible, the wind cone shall be not less than 150 feet or more than 500 feet from the helipad edge or the helipad approach direction centerline.

3-13. The height of the wind indicator shall not exceed 10 feet.

3-14. The support for the wind cone shall be mounted on a concrete foundation and be a low-impact-resistant type or have a frangible section.

3-15. The wind cone shall be illuminated if helipad perimeter lights are provided.

3-16. FLOODLIGHTS INSTALLATION. The location of the helipad floodlights shall be per Figure 1.

3-17. The floodlights shall be located not less than 50 feet from the edges on opposite sides of the helipad parallel to and symmetrical about the centerline of the designated helipad approach or the approach most frequently used for night landings.

3-18. The number of floodlights and the spacing between them may vary with the size of the helipad. Example: for a square helipad with 100-foot sides, four floodlights along each side spaced 25 feet apart is typical.

3-19. The height of the floodlights shall be not more than 48 inches above the helipad surface.

3-20. The floodlights shall be installed on a stable concrete foundation and mounted on frangible couplings.

3-21. The floodlights shall be adjusted in azimuth and elevation to obtain uniform illumination of the helipad surface without having any direct light visible above the horizontal.

3-22. DESCENT-ANGLE INDICATOR INSTALLATION. (Reserved).

4-1. EQUIPMENT.

4-2. FIXTURES. The equipment for the special helipad lights shall be as given in Table 1.

Table 1. Schedule of Special Helipad Lights Equipment

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER RATING AND TYPE
Helipad beacon.		
FAA AC 150/5345-12, type L-801H class 2 Modified.	Determined by manufacturer.	Voltage, commercial, output voltage and rating as determined by manufacturer.
Wind direction indicator.		
FAA AC 150/5345-27, type L-806, style I or II, size 1.	120V, number, watts and type as determined by manufacturer.	120 volt output commercial, wattage as determined by manufacturer.
Helipad floodlights.		
(Reserved)		
Descent angle indicator lights.		
(Reserved)		

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

4-3. PHOTOMETRIC REQUIREMENTS. The photometric requirements for the special helipad lights shall be as follows:

4-4. Heliport Beacon.

4-5. The helipad beacon photometric requirement shall be per FAA AC 150/5345-12, FAA Type L-801H, Class 2.

4-6. Wind Direction Indicators.

4-7. The illumination of externally and internally illuminated wind cones shall be per the requirements in FAA AC 150/5345-27. If the height of the unit exceeds the heliport obstruction clearance planes, a double red obstruction light (WP 003 09) shall be installed.

4-8. Helipad Floodlights.

4-9. The floodlights shall provide vertical illumination on the helipad surface that averages not less than two footcandles with the ratio of the average value to the darkest area not greater than 4:1. An average illumination of five footcandles is preferred. The obstruction lights on each floodlight fixture, if used, shall be per the requirements in FAA AC 150/5345-43 for FAA Type L-810 or L-810(L) lights.

4-10. Descent-Angle Indicator.

4-11. (Reserved).

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for the special helipad lights may be from 120-volt multiple circuits or a combination of 120-volt multiple circuits and 6.6-ampere series circuits (WP 009 00). The required voltage or current at the light fixture shall be as required by the manufacturer. The power for the heliport beacon and the wind direction indicator shall be per the equipment manufacturer's installation manual. Emergency power is not required for special helipad lights but should be used if it is available.

5-3. CONTROLS. Controls for the heliport beacon, the wind direction indicator, and the helipad floodlights are ON-OFF switches only. These controls may be manual or automatic from photoelectric or time switches. The floodlights should have controls independent of other lights except the obstruction lights shall be lighted when the helipad perimeter lights, or other obstruction lights are lighted. Except for the descent-angle indicator, intensity control is not required.

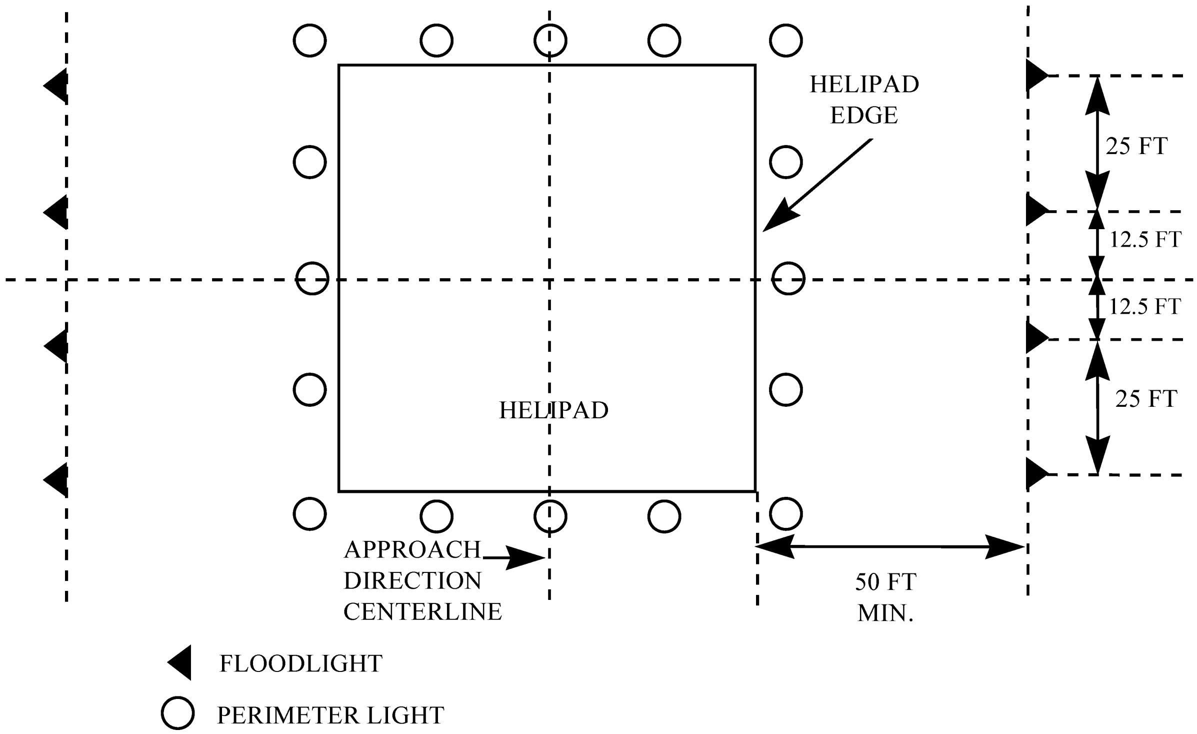


Figure 1. Typical Layout of Helipad Floodlights

ORGANIZATIONAL

DESCRIPTION

AUXILIARY LANDING FIELD LIGHTING AND MARKING

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) contains the requirements for the visual aids for auxiliary landing fields. These airfields are normally used for pilot training and operate under Visual Flight Rules (VFR) or possibly non-precision Instrument Flight Rules (IFR) (WP 002 00). The lower performance visual aids should provide the pilot with the visual guidance required. Airfields with existing lighting and marking aids may continue to use and maintain them, but the requirements in this WP shall be used for new installations or for upgrading of existing installations.

1-3. JUSTIFICATION REQUIREMENTS. Any Navy auxiliary landing field with one or more paved runways qualifies for the visual aids listed in Table 1 for the operations authorized. If additional or higher performance visual aids are required for an airfield, the installation shall be per the requirements in the WP for the particular visual aid. This WP does not authorize installation of visual aids, but if approved, these requirements apply. When deviations from requirements in this WP are necessary, the changes shall be authorized per the approval procedures of WP 002 00.

1-4. RELATED FACILITIES. The visual aids for auxiliary landing fields listed in Table 1 are related to the standard visual aids. The WPs for the standard aids provide additional information that may be helpful in the design and installation of visual aids for the smaller airfields. The related facilities are as follows:

- Runway markings (WP 004 01),
- Taxiway and holding position markings (WP 005 01),
- Wind indicators (WP 003 03),
- Airport beacons (WP 003 02),
- Runway edge lights (WP 004 05),
- Runway threshold/end lights (WP 004 02/WP 004 04),
- Taxiway edge lights (WP 005 02),
- Taxiway signs and holding position markers (WP 005 04/WP 005 06).

1-5. Other visual aids which may be required for auxiliary landing fields and those that shall be in accordance with the standard requirements are:

- Obstruction markings (WP 003 09),
- Obstruction lighting (WP 003 10),
- Optical landing aids (WP 003 11),
- Runway distance markers (WP 004 09),
- Arresting gear markers and markings (WP 004 10),
- Apron and parking area markings (WP 006 01),
- Apron and parking area lights (WP 006 02),
- Wheels-up and wave-off lights (WP 006 03),
- Simulated aircraft carrier deck lights and markings (WP 006 04).

Table 1. Auxiliary Landing Fields Visual Aids Requirements

Type of Visual Aid		Type of Operations Authorized			
		D-V	D-I	N-V	N-I
1.	Runway markings, basic	R	R	R	R
2.	Runway markings, non-precision instrument	OPT	R	OPT	R
3.	Taxiway markings	R	R	R	R
4.	Holding position markings	R	R	R	R
5.	Wind indicator, unlighted	R	R	NR	NR
6.	Wind indicator, lighted	NR	NR	R	R
7.	Rotating beacon	NR	OPT	R	R
8.	Runway edge lights	NR	OPT	R	R
9.	Threshold/runway end lights	NR	OPT	R	R
10.	Taxiway edge lights	NR	NR	R	R
11.	Taxiway signs	OPT	OPT	OPT	OPT

D-V = Daytime VFR
D-I = Daytime IFR
N-V = Nighttime VFR
N-I = Nighttime IFR

R = Required
NR = Not Required
OPT = Optional

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3 (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED's are recommended for new installations, or complete replacement; however, do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

2-1. DESCRIPTION OF THE VISUAL AIDS.

2-2. The special visual aids for auxiliary landing fields should only include the visual aids required for the mission and authorized operations. The special visual aids applicable to smaller airfields are described as follows:

2-3. BASIC OR NON-PRECISION INSTRUMENT RUNWAY MARKINGS. The runway markings consist of surface paint in the specified configuration on the runway pavement.

2-4. The paint shall be an airfield marking type in aviation white.

2-5. If the runway is for daytime operations only, the markings may be non-retroreflective, but if nighttime operations are involved, the markings should be retroreflective.

2-6. For auxiliary airfields the runway markings shall be the basic runway or the non-precision instrument runway markings (see Figure 1).

2-7. The basic runway markings consist of the runway centerline marking and the runway designation marking numerals.

2-8. The non-precision instrument runway markings consist of the runway centerline marking, runway designation marking, and runway threshold markings.

2-9. The details for the runway marking configurations are in WP 004 01 and as follows:

2-10. TAXIWAY MARKINGS. The taxiway markings shall consist of aviation yellow paint.

2-11. The taxiway markings may be non-retroreflective for airfields with daytime operations only but should be retroreflective for airfields with nighttime operation.

2-12. The taxiway markings shall consist of the centerline marking and the runway holding position markings (see Figure 1).

2-13. The runway holding position markings shall consist of two solid lines and two dashed lines across the taxiway.

2-14. The configuration and details for taxiway markings are in WP 005 01 and as follows:

2-15. ROTATING BEACONS. The airport rotating beacon shall be installed only at airfields equipped for nighttime operations and shall be a medium intensity rotating beacon.

2-16. The emitted light shall appear as alternating flashes of white and green light.

2-17. The white light beam should be an optically split-beam or a double beam utilizing two lamps with the axes of the light beams not more than 15 degrees apart.

2-18. The beacon installation shall be similar to that of the airfield rotating beacon in WP 003 02 except for the type of beacon used.

2-19. WIND INDICATORS. Each airfield shall be provided with one or more wind indicators.

2-20. For auxiliary landing fields the wind indicator shall be an 8-foot wind cone.

2-21. The wind cone fabric shall be orange or white in color to provide a good contrast with the background when observed from an altitude of 1000 feet.

2-22. The wind indicator shall be lighted for nighttime operations.

2-23. For runways more than 6000 feet in length, two wind indicators may be installed. The wind indicator installation shall be similar to that of a centrally located wind cone of WP 003 03, except 8-foot wind cones are used.

2-24. RUNWAY EDGE LIGHTS. Each runway used for nighttime operations shall be provided with runway edge lights.

2-25. The runway edge lights for auxiliary landing fields shall be a row of white lights along each edge of the runway.

2-26. The lights shall be elevated high-intensity bidirectional lights.

2-27. The configuration for the runway lights shall be per Figure 2.

2-28. The runway edge light installation shall be similar to the runway edge lights in WP 004 05 except those lights located in paved areas may be omitted.

2-29. THRESHOLD/RUNWAY END LIGHTS. Each runway used for nighttime operations shall be provided with a line of not less than eight threshold/runway end lights along each end of the runway.

2-30. The runway threshold lights shall be high-intensity elevated lights emitting green beams and red beams in opposite directions.

2-31. The green beams directed towards the runway approach area are the threshold lights and the red beams directed along the runway are the runway end lights.

2-32. The configuration for these lights shall be per Figure 2.

2-33. The runway threshold light installation shall be similar to the threshold lights in WP 004 02, and the runway end lights in WP 004 04, except for the number of lights used.

2-34. TAXIWAY EDGE LIGHTS. Taxiways used for nighttime operations shall be provided with taxiway edge lights.

2-35. The taxiway lights shall be elevated, omnidirectional, blue lights located along each edge of the taxiway per Figure 2.

2-36. The taxiway lights and configuration shall be similar to the taxiway edge lights of WP 005 02 except the spacing of lights may be greater.

2-37. TAXIWAY SIGNS. Most auxiliary landing fields do not require taxiway signs; however, some airfields may require signs for improved taxiing guidance. Two types of taxiway signs, mandatory and informational, may be used. The mandatory signs have white legends on red backgrounds, for example, to mark holding positions. If any holding position uses mandatory signs, all holding positions should be provided with these signs. The information signs have black legends on yellow backgrounds and may be used for directions and identification of locations that need improved guidance. The taxiway signs and installations are similar to the taxiway guidance signs (WP 005 04) and holding position markers (WP 005 06).

3-1. INSTALLATIONS.

3-2. INSTALLATION REQUIREMENTS. The installation requirements for auxiliary airfield lights and markings varies with the type of visual aids to be installed.

3-3. For installation details about auxiliary landing field visual aids, refer to UFC 3-535-02.

3-4. For more details on airfield markings, refer to WP 004 01, WP 005 01, WP 006 01, and WP 007 01 and FAA AC 150/5340-1.

3-5. For runway lights, refer to WP 004 02, WP 004 04, and WP 004 05.

3-6. For taxiway lights and signs, refer to WP 005 02, WP 005 04, and WP 005 06.

3-7. For information about airfield beacons and wind indicators, refer to WP 003 02 and WP 003 03.

3-8. General design and installations details for visual aids for auxiliary landing fields are as follows:

3-9. METHODS OF INSTALLATION. The method of installation varies with the type of visual aid; however, more economical methods may be used with an auxiliary airfield than for standard airfield installations. The methods used for the various visual aids and differences in methods from the standard installations are as follows:

3-10. Runway and taxiway markings.

3-11. The markings shall be applied to the pavement by an approved method that is suitable for the type of paint used. If the runways and taxiways are used at night, the retroreflective beads (spheres) should be installed with the paint. Regulations of some states, such as California, or other authorities may prohibit or restrict the use of solvent-based paints. For white and yellow markings, use paint per Federal Specification (FED SPEC) TT-P-1952F. Slower drying type FED SPEC TT-P-1952F paint, timing of application of the retroreflective beads (spheres) may be required to assure adherence of the beads without sinking too deeply into the paint.

3-12. Runway and taxiway lights.

3-13. The lights may be stake-mounted or mounted on FAA Type L-868 light bases or conduit set in concrete and the series lighting circuit high voltage cable may be installed by direct burial. Elevated lights shall be mounted on frangible couplings.

3-14. Taxiway signs.

3-15. Taxiway signs, if used, shall be installed with the requirements in WP 005 04.

3-16. Rotating beacon.

3-17. The airfield rotating beacon shall be located and installed as in WP 003 02.

3-18. Wind indicator.

3-19. The wind indicators should be centrally located on the airfield and shall be located and installed per WP 003 03.

3-20. LOCATIONS AND DIMENSIONS. The location and dimensions for auxiliary airfield visual aids vary and shall follow the requirements of the associated standard WP, with the exception of special requirements or variations cited in this WP. The location and dimension variations are as follows:

3-21. Runway Markings.

3-22. The width of the runway centerline marking shall be 12 inches for a basic runway and 18 inches for a non-precision instrument runway.

3-23. Taxiway Markings.

3-24. The taxiway markings shall be standard centerline and holding position markings (WP 005 01). The holding position marking may be not less than 100 feet from the runway edge.

3-25. Runway Edge Lights.

3-26. The locations of runway edge lights shall be as in WP 004 05 except the spacing between lights may be 200 ±2 feet. The lines of edge lights shall be not more than 5 feet from the runway edges with a tolerance for individual lights of ±6 inches about the line. If a light position is within a paved area, the light may be omitted. A light on one side of the runway is permitted at intersections with other runways or taxiways. The runway edge lights shall be aligned in azimuth with the axes of the beams equally toed-in toward the runway centerline.

3-27. Threshold/Runway End Lights.

3-28. The locations of the threshold/runway end lights shall be in a line at each end of the runway that is perpendicular to the runway centerline. At each end of the runway, the lights shall be in two groups with the outermost light of each group in line with the runway edge lights. Each group shall have not less than four lights spaced at intervals of 10 ±1 feet. The lines of lights shall be not more than 5 feet from the runway end, and individual lights shall not vary more than 6 inches from the light fixture centerline. The axis of each beam shall be approximately parallel to the runway centerline with the green towards the approach area and red towards the runway.

3-29. Taxiway Edge Lights.

3-30. The location of the taxiway edge lights shall meet the requirements in WP 005 02 except that the spacing intervals for straight sections shall not exceed 200 feet. Taxiway edge light spacing on curves shall not exceed 100 feet with not less than three lights on any arc greater than 15 degrees. The additional transition lights in each spacing section may be omitted. The tolerance for light spacing is ±2 feet.

3-31. Taxiway Signs.

3-32. The signs and holding position markers shall be located as required in WP 005 04 and WP 005 06, except the holding position markers may be not less than 100 feet from the runway edge.

3-33. Rotating Beacon.

3-34. The rotating beacon shall be located as required in WP 003 02.

3-35. Wind Indicator.

3-36. The wind indicator shall be located as required in WP 003 03 for 8-foot wind cones, except a single wind cone should be near the center of the airfield.

3-37. Height.

3-38. For all elevated runway and taxiway lights, the maximum height of the lights shall be not more than 14 inches above the surface of the edge of the pavement. In areas with frequent accumulations of snow up to 12 inches or more (with prior approval by Naval Air Systems Command) the elevated runway and taxiway edge lights may be not more than 24 inches above the edge of the pavement.

4-1. EQUIPMENT.

4-2. FIXTURES AND MATERIALS. The paint for marking the runways and taxiways shall be per Federal Specification (FED SPEC) TT-P-1952F, see (3-10, RUNWAY AND TAXIWAY MARKINGS, this WP) for restrictions. The colors of the runway and taxiway markings shall be per SAE AMS-STD-595. If retroreflective markings are required, the glass spheres shall be per Federal Specification TT-B-1325, type III, gradation A. The lighting fixtures are elevated lights. These lights and equipment are listed in Table 2.

Table 2. Schedule of Visual Aids Equipment for Auxiliary Landing Fields

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
Runway edge lights, white, elevated, bidirectional, base or stake mounted.			
FAA AC 150/5345- 46, type L-862, L-862(L) mode 1	120W 6.6A, type as determined by manufacturer.	200W 6.6/6.6A or determined by mfr.	L-830-6 or determined by mfr.
Threshold/runway end, light, green/red, elevated, bidirectional, base or stake mounted.			
FAA AC 150/5345- 46, type L-862E, L-862E(L)	120W 6.6A, type as determined by manufacturer.	200W 6.6/6.6A or determined by mfr.	L-830-6 or determined by mfr.
Taxiway edge light, blue elevated, omnidirectional, stake mounted.			
FAA AC 150/5345- 46, type L-861T, L-861T(L) mode 1	45W 6.6A, type as determined by manufacturer.	30/45W, 6.6/6.6A or determined by mfr.	L-830-1 or determined by mfr.
Taxiway signs, informational, black legend on yellow background.			

Table 2. Schedule of Visual Aids Equipment for Auxiliary Landing Fields (Cont)

PURPOSE AND TYPE OF FIXTURE	LAMP RATING AND TYPE	ISOLATION TRANSFORMER	
		RATING	FAA TYPE AC 150/5345-47
FAA AC 150/5345-44, type L-858Y, size 2, style 3	As determined by manufacturer.	As determined by manufacturer.	
Taxiways signs, mandatory, for holding positions, white legend with black outline on red background.			
FAA AC 150/5345-44, type L-858R size 2, style 3	As determined by manufacturer.	As determined by manufacturer.	
Rotating beacon, split white/green.			
FAA AC 150/5345-12, type L-801A (modified)	Type and rating determined by manufacturer.	Not required.	
Wind indicator, wind cone (sock).			
FAA AC 150/5345-27, type L-806, size 3, style I or II.	As determined by manufacturer.	Not required.	

LED Lighting Notes:

1. This manual specifies numerous light fixtures and systems used. A complete listing of "certified" light fixtures and manufacturers can be found in FAA AC 150/5345-53, Appendix 3, (Certified Airport Lighting Equipment). See "Advisory Circulars" at www.faa.gov/airports. Each fixture number will have an (L) designation denoting (LED).
2. LED's are recommended for new installations, or complete replacement; however do not install them in an existing circuit or system with incandescent fixtures.
3. Any light fixture that uses an LED based lighting source may not be compatible with Enhanced Flight Vision Systems (EFVS) that use long wave IR (thermal energy wavelength emissions) for imaging. Furthermore, due to the cockpit lighting filters typically in use with aircraft-based image intensifier (NVD) systems, some red and green LED based light fixtures may not be visible while the NVD system is in use. The preceding may adversely affect the pilot's ability to see LED lamp-based obstruction lighting and various runway/taxiway lights. Use caution when selecting or using any EFVS or NVD system for use in an aircraft. The light fixtures listed in FAA AC 150/5345-53 are currently not tested (certified) for use with EFVS or NVG.

4-3. PHOTOMETRIC REQUIREMENTS. The color of the light emitted. From runway and taxiway edge lights shall be per FAA AC 150/5345-46. The photometric requirements of each type of visual aid shall be as follows:

4-4. Runway and Taxiway Markings.

4-5. The markings shall be uniformly painted. The aviation white runway markings shall match color chip No. 27875 in SAE AMS-STD-595, and the aviation yellow taxiway markings shall match color chip No. 23538 of SAE AMS-STD-595. The markings should be retroreflective if used for operations at night.

4-6. Runway Edge Lights.

4-7. The photometrics shall be per FAA AC 150/5345-46.

4-8. Taxiway Edge Lights.

4-9. The photometrics shall be per FAA AC 150/5345-46.

4-10. Runway Threshold/End Lights.

4-11. The photometrics shall be per FAA AC 150/5345-46.

4-12. Taxiway Signs.

4-13. All taxiway signs and runway holding position signs photometric requirements shall be per FAA AC 150/5345-44.

4-14. Rotating Beacons.

4-15. The emitted light from the rotating airfield beacon shall be per FAA AC 150-5345-12.

4-16. Wind Indicator.

4-17. The color and lighting of the windsocks shall be per the requirements in FAA AC 150/5345-27.

5-1. POWER AND CONTROLS.

5-2. POWER. The electrical power for the visual aids for outlying and utility airfields shall be provided by one or more 6.6-ampere series circuits (WP 009 00) for the runway and taxiway lights and by airfield designer selected AC circuits for rotating beacons and wind direction indicators.

5-3. The runway edge lights, and threshold/runway end lights shall be on one lighting circuit, and the taxiway edge lights and signs on another circuit.

5-4. Airfield signs may be powered from a dedicated constant current regulator set to 5.5 amperes.

5-5. The series circuits shall be energized by one or more constant-current regulators with a rated output current of 6.6-amperes and not less than three intensity settings (WP 009 02).

5-6. The lowest intensity setting shall produce an intensity not more than 10 percent of intensity at rated current.

5-7. The lights shall be connected to the primary series circuit by individual 6.6/6.6-ampere isolation transformers (WP 009 03).

5-8. The AC power source for wind cones and airport beacon shall be selected by the airfield designer.

5-9. Emergency power for the visual aids is not required but should be used if available.

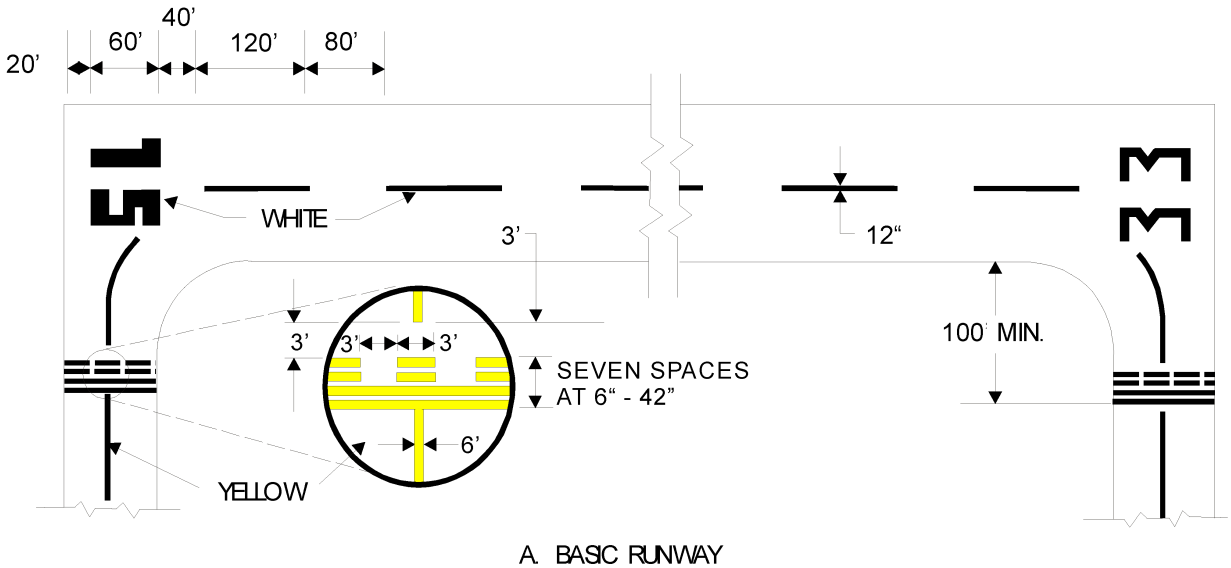
5-10. CONTROLS. Remote control of the auxiliary visual aids via the air traffic control tower cab remote panel or other central location that is manned when the airfield is in operation is preferable. However, control from other locations such as the lighting vault is acceptable. The control panel should be a simple type of FAA AC 150/5345-3, type L-821 (WP 009 05).

5-11. The control panel should provide for runway selection if more than one runway is lighted and switching ON-OFF of runway lights, taxiway lights, rotating beacon, wind indicator, obstruction lights, and other visual aids.

5-12. A minimum of 3 intensity steps intensity control for the runway taxiway lights should be provided.

5-13. If the runway/taxiway lights are LED types, a 5-step constant current regulator should be used.

5-14. If power for the rotating beacon and wind indicators is not furnished by circuits from the lighting vault, automatic photoelectric controls may be used.



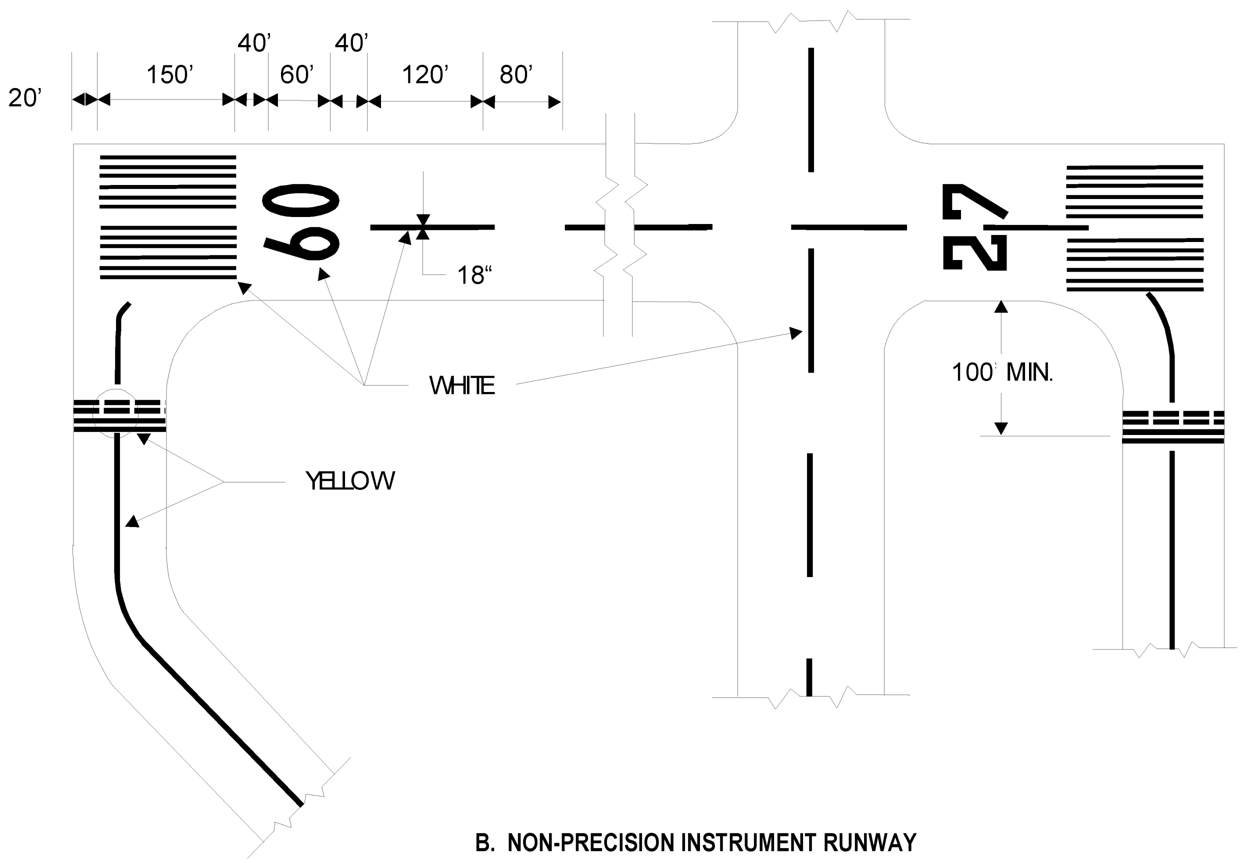


Figure 1. Typical Configurations for Runway and Taxiway Markings for Auxiliary Landing Fields

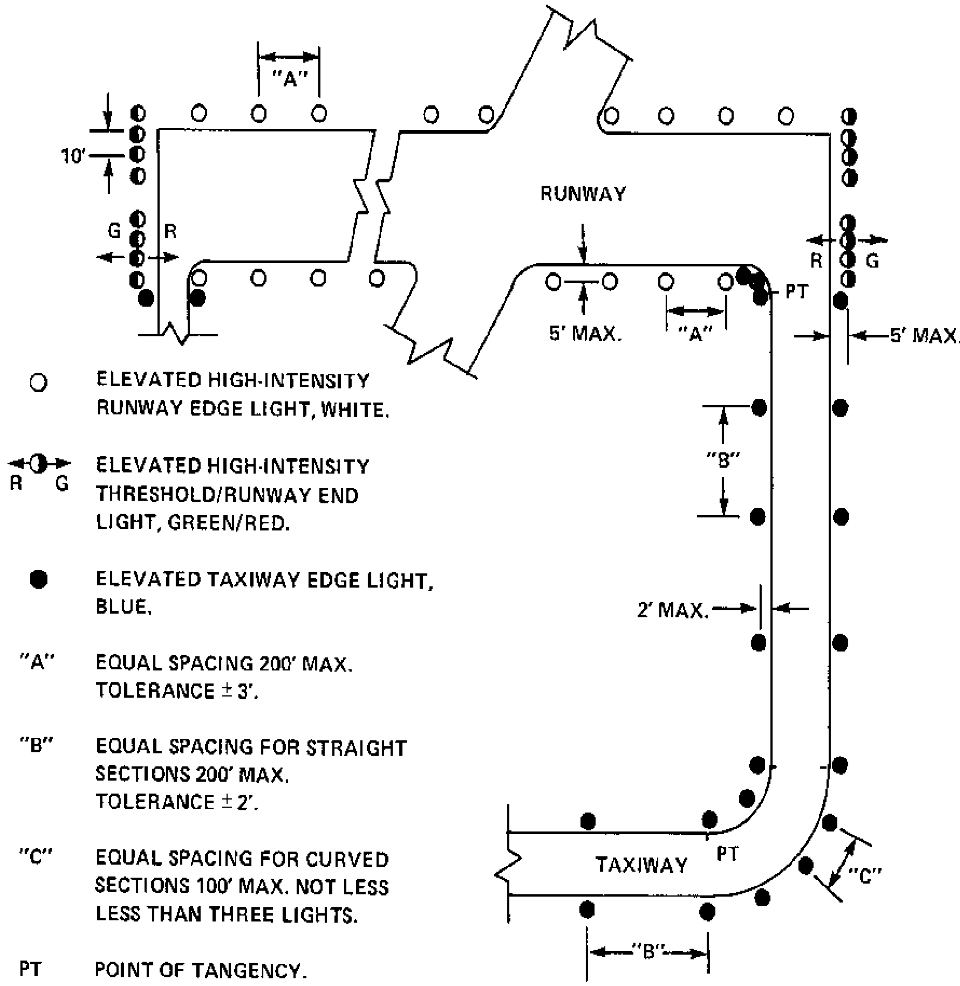


Figure 2. Typical Configuration for Runway and Taxiway Lights for Auxiliary Landing Fields

ORGANIZATIONAL

DESCRIPTION

ELECTRICAL POWER AND CONTROL FOR VISUAL AIDS

Reference Material

1-1. GENERAL INFORMATION.

1-2. PURPOSE. Most airfield visual aids, except for markings, are supplied with electrical power and provided with operating and intensity controls. This Work Package (WP) discusses the general design requirements for providing power and operating control for the visual aids. For details of the design and installation of the visual aids refer to UFC 3-535-02.

1-3. SCOPE. The information provided by this WP is concerned with the special requirements for designing the power and control circuits and is intended only as a guide. The visual aids operate in an environment requiring high reliability and accurate performance. The lights and equipment must be a minimum hazard to operating aircraft. The power and control equipment have been specially developed to provide the performance and reliability required, but proper design and installation practices must be followed to obtain the full capability of each visual aid.

1-4. SELECTION OF POWER AND CONTROL EQUIPMENT. In designing the installation of airfield visual aids, the equipment usually is expected to operate for 20 years or longer in a hostile environment. The power and control equipment must reliably interface the power correctly between the voltage, current, and frequency required by the visual aids. The equipment should be selected to allow for some expansion in the load.

1-5. ASSOCIATED COMPONENTS. Major items of power and control equipment are discussed in separate WPs. This additional information should be helpful in making the selection of equipment. The WPs are as follows:

- Auxiliary Power and Power Transfer Equipment (WP 009 01),
- Constant-Current Regulators (WP 009 02),
- Isolation and Distribution Transformers (WP 009 03),
- Special Power Supplies (WP 009 04),
- Airfield Lighting Control Panels (WP 009 05),
- Special Remote Control Equipment (WP 009 06).

2-1. DESCRIPTION.

2-2. POWER CIRCUITS. The visual aid may be a single light such as a beacon, many runway lights, or a combination of aids such as taxiway lights and signs. The cables for these circuits are installed underground except at the connections to the lights. Power for most of these aids is provided by series circuits, but multiple circuits are used for some aids. A block diagram of the power circuits for the visual aids is shown in Figure 1.

2-3. Series Circuits.

2-4. A series circuit consists of a single-conductor cable from a constant current regulator to each light in succession and returning to the regulator. The same current flows through each light, and all lights in the circuit are at the same selected intensity. The power for the series circuits is controlled by constant current regulators. The rated current from the regulators and the primary circuit current is either 6.6 or 20 amperes. Most regulators can also operate at reduced currents to lower the intensity of the lights. The lights in a series lighting system are connected to the circuit via isolation transformers.

2-5. Multiple Circuits.

2-6. Some airfield visual aids are supplied power by multiple circuits where the lights are connected between two conductors from an AC voltage source. Because of voltage drop in the conductors, each light farther from the voltage source will have a slightly lower current and a lower intensity. For some visual aids involving only a few lights, multiple parallel AC circuits may be acceptable and more practical. Some applications are the beacon, wind indicator lights, obstruction lights, sequence flashing lights, floodlights, optical landing systems, and medium-intensity approach lights. The circuit usually is energized at 120- or 240-volts AC. Other circuit voltages may be used and adjusted to the rated voltage of the lights by distribution transformers. Intensity control may be provided.

2-7. POWER SOURCES. The primary source of power for airfield visual aids is usually commercial power although some airfields may have their own primary generating plants. For Navy airfields, this primary power is usually distributed at 2400/4160 volts, three phase, 60 hertz, but other voltages may be available. Distribution voltages may be adjusted with step-down or step-up distribution transformers to that required by the regulators or other equipment. For Navy installations the distribution voltage into the lighting vault is usually 2400/4160 volts or 2400 volts single phase; however, it may be desirable to reduce this voltage to 120/240 volts because 240-volt-input regulators may be more economical. Most airfields require one or more auxiliary or standby power sources for the visual aids in the event of primary power source failure.

2-8. The auxiliary power source is usually an engine generator set located at the lighting vault. The kilowatt capacity of the engine generator should be sufficient to power all of the critical visual aids. A new engine generator should have sufficient capacity for at least a 20 percent expansion of the airfield load. For the engine generator set or standby power source, a power transfer switching arrangement is also required. Most airfields require that a power transfer be completed automatically in 15 seconds or less. For Category II or III airfields, the transfer of power shall be completed in one second. For engine-generator auxiliary power sources, this transfer time is usually accomplished by using the auxiliary power as the operating source during the period of Category II or lower visibility conditions and transferring to the primary source in the event of auxiliary power failure.

2-9. For additional detailed information about airfield emergency standby power systems, see FAA AC 150/5340-30.

2-10. CONTROL CIRCUITS. The operation of most airfield visual aids are remotely controlled from the air traffic control tower. This requires control circuits between the air traffic control tower and lighting vault or power equipment stations (see Figure 1). Most airfields have a second remote control point that is usually in the lighting vault.

2-11. The constant-current regulators and other power equipment have manual controls at the individual units that are used for maintenance. Except for the wave-off lights, only one remote control point shall be able to operate the visual aids. A control transfer switch and transfer relay panels, usually located in the lighting vault, are required. Airfield lighting system control is normally at the air traffic control tower cab but may be at the lighting vault during maintenance or emergency operations.

2-12. See FAA AC 150/5340-30J, Chapter 13.2.6, Control Systems, for detailed information about airfield lighting control systems. Information about computerized lighting control systems is included.

2-13. Some visual aids may be located where it is not practical to install control cables. One option is to use ground-to-ground radio control from a transmitter at the air traffic control tower to a receiver at the power source for the visual aid. The requirements for the radio control systems are included in FAA AC 150/5345-49, L-854, type II, but there are currently no approved sources. See FAA JO 6850.2B, Appendix B, Remote Radio Control for Visual Guidance Lighting Systems, for detailed information about ground-to-ground radio frequency control systems. Some radio manufacturers may have acceptable equipment on a commercial procurement. For some visual aids, local automatic controls such as photoelectric controls and time switches, may be practical.

NOTE

FAA JO 6850.2B may be downloaded free of charge at: www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.information/documentID/321004

2-14. CABLES. A major item for both power and control circuits is the cables. Most of the cables for visual aids are installed underground and must be suitable for direct burial. Only a few types of cables are considered suitable for the hostile environment of airfield visual aids installations. See FAA AC 150/5345-7 for more information about direct burial and control cables.

2-15. Whenever possible, either factory or field attached connectors per FAA AC 150/5345-26, Specification L-823 should be used. Wrapped splices shall be avoided. The approved types of cable for the frequently used circuits are as follows:

2-16. Series circuits.

2-17. For primary series lighting circuits, the cable shall be per FAA AC 150/5345-7, Specification L-824 type B or C. Secondary cables shall be two-conductor 600-volt, No. 12 AWG, stranded, FAA L-824, preferably type C. The connectors shall be FAA type L-823. Cable to be installed in saw kerfs in pavement may be single-conductor, 600-volt No. 10 AWG or larger, stranded, type THWN.

2-18. Multiple circuits.

2-19. The preferred cable for multiple circuits shall be single- or two-conductor, 600-volt, No. 12 AWG or larger, FAA L-824 type A, B, or C. FAA L-823 connectors should be used.

2-20. Control circuits.

2-21. The cables for the control circuits between tower and vault should be multi-conductor, 600-volt, No. 12 AWG, with insulation suitable for wet locations. Several of these cables may be required. Two-conductor cable of similar type may be used for single function control circuits. Splices and connectors shall be avoided. The 48 VDC controls may use larger numbers of multiconductor, stranded No. 19 AWG conductors with 300-volt polyvinyl insulation.

2-22. Counterpoise.

2-23. The wire for the counterpoise shall be a single, bare, copper, No. 4 AWG, stranded conductor. The connections for counterpoise cables shall be exothermic welds or brazed.

3-1. INSTALLATIONS.

3-2. CABLES. All primary series lighting circuit cables shall be installed underground.

3-3. The preferred installation of lighting and control cables is within ducts or conduit. For some auxiliary fields, temporary installation, and for short runs of less important visual aids, direct burial of cable may be used. Under paved areas the ducts shall be encased in concrete or be of rigid steel conduit.

3-4. The depth of the cable or ducts shall be not less than 18 inches, but 24 inches is preferred.

3-5. Suitable cables for runway centerline lights, touchdown zone lights, and taxiway centerline lights in existing pavements may be installed in saw kerfs.

3-6. Wrapped cable splices are not permitted.

3-7. FAA type L-823 (per FAA AC 150/5345-26) connectors shall be used for connections to isolation transformers.

3-8. Connections to isolation transformers and fixtures shall be in handholes or light bases.

3-9. Control cables should be installed in duct or rigid steel conduit.

3-10. All cables shall be identified with a permanent tag. Cable tags shall be visible in manhole and handholes.

3-11. GROUNDING. Grounding is primarily for safety in case of cable faults.

3-12. Each light fixture and metal case or frame of equipment shall be grounded.

3-13. The grounding may be provided by ground rods or connections to a grounding cable.

3-14. The equipment grounds should not be connected to the counterpoise to avoid equipment damage from lightning strikes.

3-15. Refer to FAA AC 150/5340-30J, paragraph 12.5 for additional information about the counterpoise and lightning protection.

NOTE

The FAA has different wire gauge requirements for the counterpoise – see the following:

3-16. COUNTERPOISES. Counterpoises are installed to protect the airfield lighting circuits and equipment from lightning damage.

3-17. A counterpoise should be considered as a separate grounding system and should not be connected to equipment grounds because this may channel the lightning into the circuit.

3-18. A counterpoise shall be installed for new installations at Naval Air Stations or equivalent airfields and may be installed at auxiliary fields in areas with frequent thunderstorms.

3-19. The counterpoise shall be bare, stranded, copper wire size No. 4 AWG.

3-20. This counterpoise wire shall be installed not less than 4 inches and preferably 6 inches above the circuit which it protects.

3-21. Except under paved areas the counterpoise should be direct burial and preferably not in direct contact with the duct bank.

3-22. Not less than 6 inches clearance should be provided between the counterpoise and metal parts of the fixtures and equipment grounds.

3-23. The counterpoise shall be continuous along the circuit it protects.

3-24. The counterpoise shall be connected to driven ground rods at the lighting vault, where the feeders connect to the lighting circuit, and at intervals not more than 2000 feet apart along the circuit.

3-25. The ground rod resistance shall be less than 25 ohms.

3-26. The ground rods shall be not less than 3 feet and preferably 10 from any equipment grounds.

3-27. Counterpoises for other circuits shall be connected together where this is practical.

3-28. The connections of the counterpoise to ground rods shall be exothermic welds or brazed.

3-29. LIGHTNING ARRESTORS. Lightning arrestors shall be installed on the power leads into the lighting vault and on the input and output terminals of constant-current regulators and other major power distribution equipment. The arrestors protect the equipment if lightning strikes the circuits. Lightning arrestors may be installed at other locations such as manholes or at the ends of feeder circuits.

3-30. VAULTS. The airfield lighting vault is the main vault, but one or more auxiliary vaults may be required for approach lighting systems. The vaults are located above grade at locations most suitable for power distribution. Other power and control locations may be in manholes or handholes for the optical landing system and the wheels watch or on concrete pads which may be fenced for security. Lighting vaults usually consist of three or four rooms as follows:

- Regulator room: Where the regulator, transformers, and most control equipment are located.
- Engine-generator room: Where the engine-generator set and automatic power transfer equipment is located. The batteries for starting the engine-generator are also located in the room. Some airfields may house the batteries in a separate compartment within the engine generator room.
- Entrance and control room: Where the lighting control panel, transfer relay panels, and pilot relay cabinets are located. High-voltage equipment should be prohibited from this room.
- Some vaults may have a room for supplies, spare parts, and special maintenance equipment.

3-31. A new vault should be designed to permit adding one or two more constant current regulators and other accessory equipment or a larger engine-generator set.

3-32. For an example of an airfield lighting vault, refer to UFC 3-535-02.

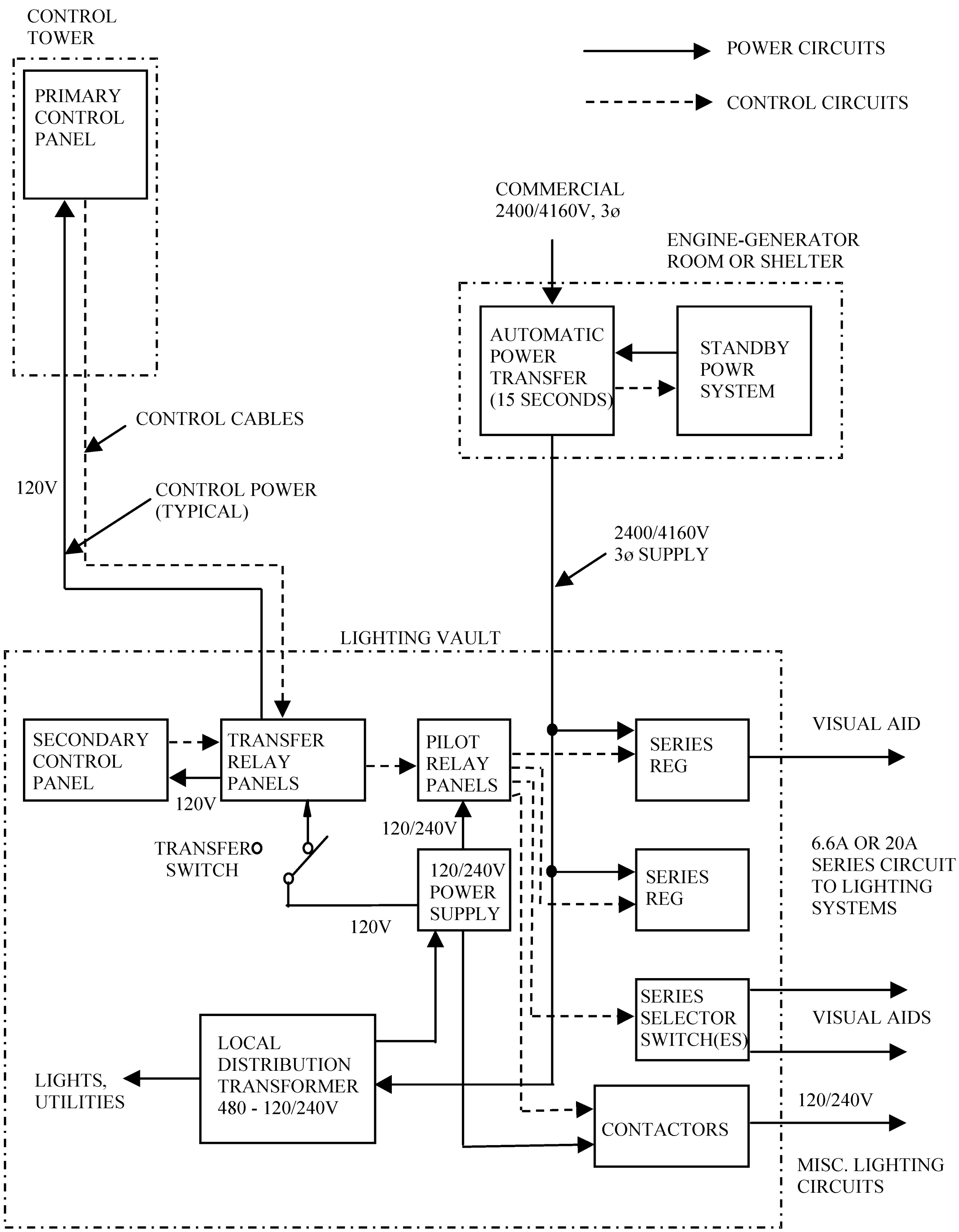


Figure 1. Typical Power and Control Systems Block Diagram

ORGANIZATIONAL

AUXILIARY POWER AND POWER TRANSFER EQUIPMENT

ELECTRICAL POWER AND CONTROL FOR VISUAL AIDS

Reference Material

Electrical Power and Control for Visual Aids, Description .... WP 009 00
Electrical Power and Control for Visual Aids, Constant-Current Regulators .... WP 009 02
Electrical Power and Control for Visual Aids, Airfield Lighting Control Panels .... WP 009 05
Design Drawings for Visual Aid Navigation Facilities .... UFC 3-535-02
Engine Generator Sets (EGS) Diesel and Propane Fueled – 10 KW To 1500 KW FAA-E-2204

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) provides the requirements for auxiliary power sources and power transfer equipment for shore-based Navy airfield lighting. The mission for most airfields requires the airfield lighting to be available at all times; therefore, in case of failure of the primary power source, auxiliary power is required. The equipment that provides auxiliary power is discussed in the WP.

1-3. RELATED EQUIPMENT. The auxiliary power must be provided to the lighting equipment at the same voltage and frequency as the primary power source. Related power equipment for the airfield lighting are constant-current regulators (WP 009 02). For certain conditions, the auxiliary power source should be controlled remotely from the air traffic control tower cab and provide an indication that the auxiliary power source is operating. Auxiliary power controls and indicator lights are located on the lighting control panel (WP 009 05). The lighting circuits and controls are discussed in WP 009 00.

2-1. DESCRIPTION.

2-2. SOURCES OF AUXILIARY POWER. Local engine generator sets are the most frequent source of auxiliary power, but other sources may be used. The operations at some airfields may be such that auxiliary power for the lighting is not necessary. Most airfields will require auxiliary power as a backup power source. Some airfields may have a second prime source available which is independent of the primary source such that a single fault would not result in a power failure from both sources. An alternate prime power source may be both the simplest and most practical method of providing auxiliary power.

2-3. ENGINE-GENERATOR SET. An engine generator set often provides the auxiliary power locally when the primary source fails or if selected for specific conditions or maintenance. The engine drives the generator at a synchronous speed for the electrical frequency and is designed for a specified voltage, single or three phase output, and a rated kilowatt power output. The generator requires output connections and switch gear for connecting the electrical power to the circuits in the vault. The kilowatt rating of the generator should be adequate for the load which it is intended to supply plus an additional 20 percent capacity for expansions. The engine-generator set shall be able to start and assume the load within the required transfer time which is normally 15 seconds.

2-4. AUTOMATIC POWER TRANSFER EQUIPMENT. When the primary power fails, the lighting vault load must be transferred to the auxiliary power source within a certain time. The transfer equipment must detect the power loss, start the generator-set, and transfer the load within this time. Most airfield lighting should transfer in less than 15 seconds. For operations in Category II conditions, the transfer of power must be within one second. To provide the one second transfer time for Category II conditions, the engine-generator set is started and used to deliver power to the lights as visibility decreases to Category II conditions and continues to furnish the power until well after the weather has improved above the Category II conditions. If the engine-generator should fail, the transfer to primary power can be made within one second. The power transfer equipment shall also provide for remote control of the auxiliary power system and energize the indicator lights at the remote lighting control panel.

2-5. BATTERIES. The auxiliary power source shall be provided with a bank of batteries for starting the engine-generator set when primary power fails. These batteries shall be maintained at full charge by a battery charger. The power for the battery charger is from the airfield lighting power. These batteries must be able to start the engine within the minimum amount of time.

2-6. CONTROLS. The power transfer equipment shall automatically start the auxiliary power source and transfer the load when the primary power malfunctions. Also, remote control for starting the auxiliary power source and switching the load shall be provided at the lighting control panel in the air traffic control tower cab. The remote control is used to put the lighting load on the auxiliary power when Category II conditions occur or as a back-up control if the automatic power transfer should fail. There shall be provisions for starting the auxiliary power source locally for maintenance without transferring the load from the primary source or for transferring the load if desired. The lighting control panel in the control air traffic control tower cab shall be provided with an indicator light that is energized when the auxiliary source is operating.

3-1. INSTALLATIONS OF ENGINE-GENERATOR.

3-2. The engine-generator set and power transfer equipment shall be installed in the engine-generator room of the lighting vault (see Figure 1) or in a nearby shelter.

3-3. The engine generator set shall be bolted to a concrete mounting pad.

3-4. The cooling air for the radiator should be obtained from outside the engine generator room.

3-5. The engine generator exhaust shall be discharged outside the engine generator room.

3-6. The main fuel tank for the engine generator shall be installed outside the building.

3-7. A day tank for fuel may be installed inside the engine generator room but shall prevent the emission of fuel vapors.

3-8. The automatic power transfer equipment may be within a cubicle or switch-gear that is mounted on a wall or the floor.

3-9. The primary input power and engine generator output shall be connected to the power transfer equipment.

3-10. The batteries and battery charger should be in the same room as the engine-generator set.

3-11. A distribution transformer for lights and local power are usually installed where convenient.

3-12. For installation details refer to UFC 3-535-02.

4-1. EQUIPMENT.

4-2. The engine-generator set and the power transfer equipment shall be per Table 1. The engine-generator shall start and accept not less than 75 percent of rated load within 12 seconds. The equipment shall be from manufacturers of FAA-qualified products.

Table 1. Schedule of Standby Power and Power Transfer Equipment

PURPOSE AND TYPE OF EQUIPMENT	RATING		
	SIZE	FREQUENCY	VOLTAGE AND PHASES
Standby engine-generator, diesel fuel, fixed installation style, fast start.			
Specification FAA-E- 2204, type I, with automatic power transfer.	5-300 KW	60 Hertz	As specified.
Commercial, optional for 2400/4160V power	As specified.	As specified.	As specified.
Power transfer equipment, automatic in 15 seconds.			
Commercial	As specified.	As specified.	As specified.
Other accessories.			
Fuel tanks, engine lubricating oil heaters, cooling system, exhaust system, batteries, battery charger, and other accessories as specified.			

4-3. SELECTION OF EQUIPMENT. The kilowatt rating for the engine generator should be for the total rated power of all the regulators and distribution transformers connected or planned to be supplied from the lighting vault plus an additional 20 percent of capacity for future expansion. The generator output voltage, phases, and wiring shall match the primary power input to the lighting vault, these values may also include step-up distribution transformer(s). The automatic power transfer equipment shall be rated for the number of wires, current, voltage, and minimum transfer time required and shall be capable of sensing the failure of any phase or the total power from either the primary power or of the auxiliary power. The type and size of the battery bank will depend on the size of the engine and the most severe starting temperatures.

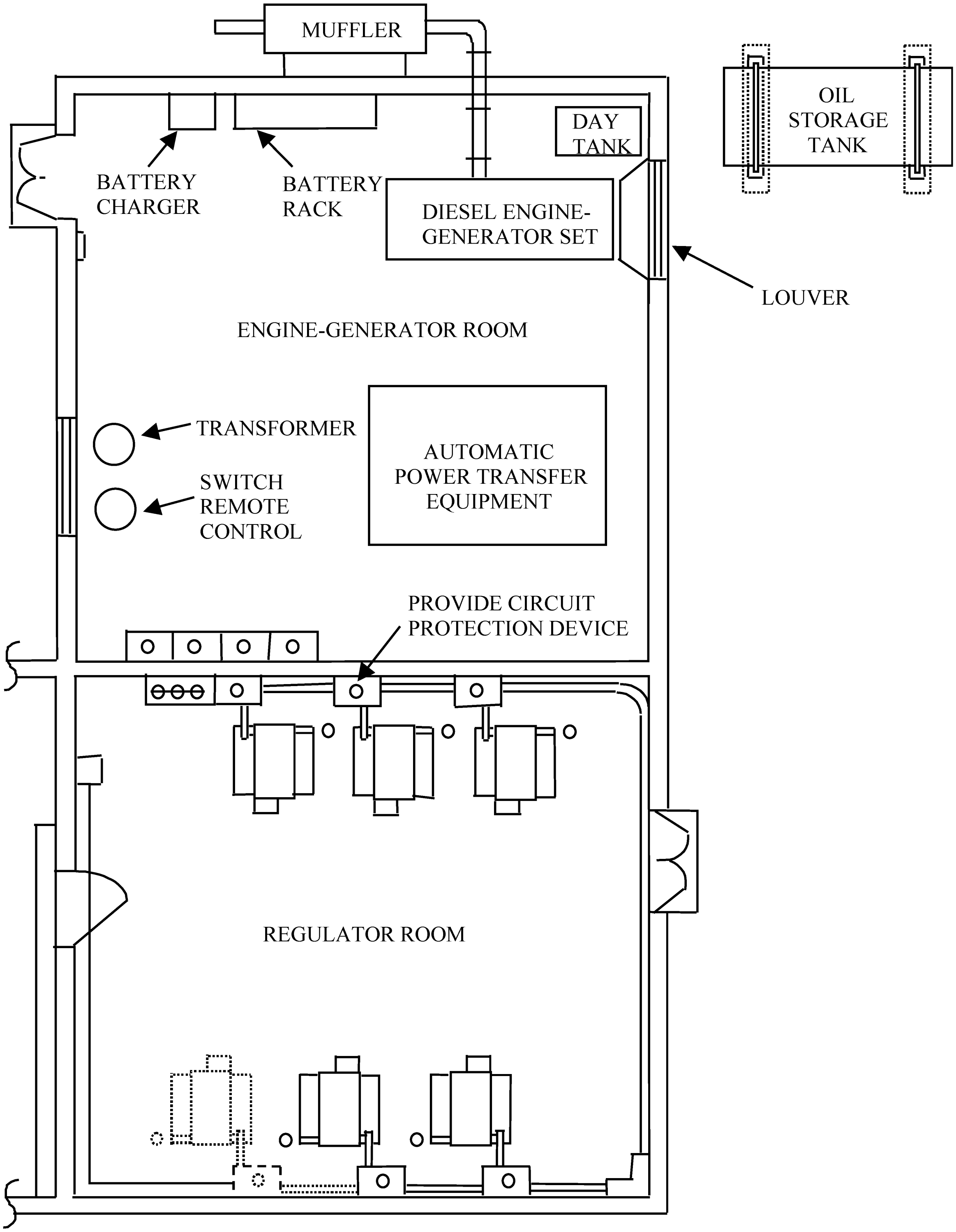


Figure 1. Typical Installation Plan for Standby Engine-Generator and Automatic Transfer Equipment

ORGANIZATIONAL

CONSTANT-CURRENT REGULATORS

ELECTRICAL POWER AND CONTROL FOR VISUAL AIDS

Reference Material

Electrical Power and Control for Visual Aids, Description .... WP 009 00
Electrical Power and Control for Visual Aids, Auxiliary Power and Power Transfer Equipment .... WP 009 01
Electrical Power and Control for Visual Aids, Isolation and Distribution Transformers .... WP 009 03
Electrical Power and Control for Visual Aids, Special Power Supplies .... WP 009 04
Electrical Power and Control for Visual Aids, Airfield Lighting Control Panels .... WP 009 05
Design Drawings for Visual Aid Navigation Facilities .... UFC 3-535-02
Specification for Constant Current Regulators and Regulator Monitors .... FAA AC 150/5345-10

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) provides the requirements for constant-current regulators (CCRs) used to supply the current to the series airfield lighting circuits. The features and requirements of the CCRs are discussed in this WP.

1-3. RELATED EQUIPMENT. The use of series circuits to provide electrical power to airfield lighting systems is discussed in WP 009 00. The sources of primary and auxiliary power for the lighting vaults that provides the input power and voltage to the constant-current regulators are discussed in WP 009 01. The output current from the CCRs is the input current to the isolation transformers that connect the airfield lighting fixtures to the primary series circuit (WP 009 03). Some special power supplies (WP 009 04) may obtain input power from the series lighting circuit and the regulator to provide a specific voltage or current to some visual aids. Remote control of the CCRs is provided by the airfield lighting control panels (WP 009 05) located in the air traffic control tower cab or the lighting vault.

2-1. DESCRIPTION.

2-2. CHARACTERISTICS. CCRs provide a constant output current for any load between no load and their rated load for a fixed input voltage. All CCRs shall be per the requirements in FAA AC 150/5345-10 (current version), Specification for Constant Current Regulators and Regulator Monitors. See FAA AC 150/5345-53 (current version), Airport Lighting Equipment Certification Program, for a list certified manufacturer of CCR equipment.

3-1. INSTALLATIONS.

3-2. The constant current regulators shall be installed in the regulator room of the lighting vault for the airfield lighting system (see Figure 1). Space around the CCR regulator shall be provided for both operation and maintenance. All CCR controls and meters shall be readily accessible. The case or frame of the CCR shall be grounded to the vault grounding system. The CCR lightning arrestors shall be connected to the lighting vault ground system. Both CCR input and output terminals shall be protected to prevent accidental physical contact.

3-3. The constant-current regulators shall be installed in the regulator room of the lighting vault for the lighting system (see Figure 1). Space around the regulator shall be provided for operating and performing maintenance on the regulator and for air circulation. All controls and meters shall be readily accessible. The case or frame of the unit shall be grounded to the vault grounding system, and the lightning arrestors properly connected to this ground. The input and output terminals shall be protected to prevent accidental physical contact.

WARNING:

The input and output terminals of CCRs are at high voltage potential. Physical contact with the terminals will result in serious injury or death.

3-4. For installation details about CCRs refer to UFC 3-535-02.

4-1. EQUIPMENT.

4-2. The constant-current regulators shall be per the requirements in FAA AC 150/5345-10, FAA type L-828, class 1 or 2, style 1 or 2 (without monitoring), or FAA type L-829, class 1 or 2, style 1 or 2 (with monitoring).

4-3. The CCR size (kilowatt rating) shall be not less than the total load connected plus 20 percent.

4-4. The CCR class (output current) shall be as required for the lamps in the lighting system or for the primary winding of the isolation transformers.

4-5. Style 2 (5-step) regulators provide greater flexibility and should be used in most installations (see FAA AC 150/5340-30 for additional information about 5-step CCRs and LED airfield lights.

4-6. To provide monitoring for existing CCRs and airfield lighting circuits, add FAA type L-827 monitors.

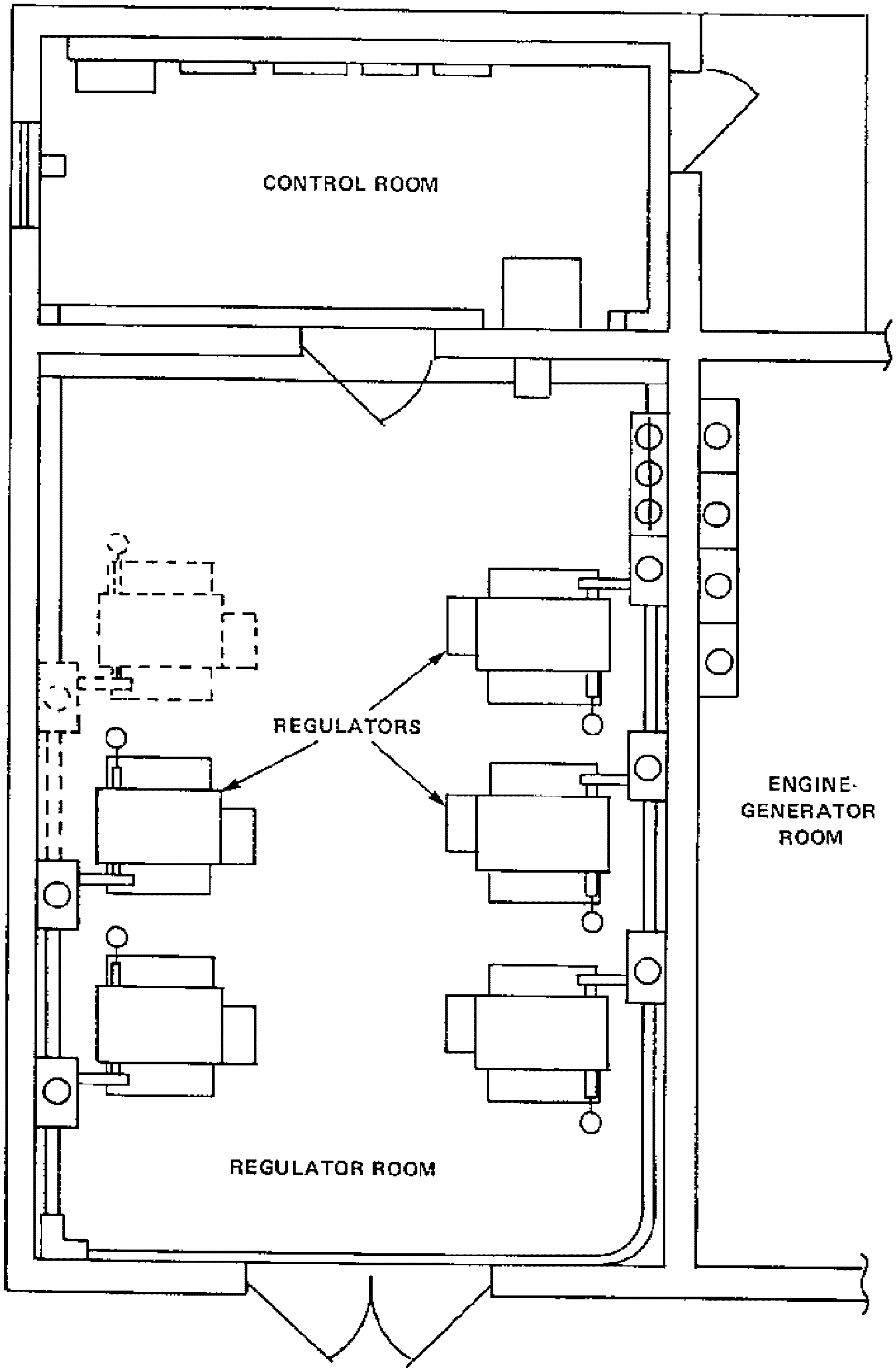


Figure 1. Typical Arrangement of Regulators in Vault

ORGANIZATIONAL

ISOLATION AND DISTRIBUTION TRANSFORMERS

ELECTRICAL POWER AND CONTROL FOR VISUAL AIDS

Reference Material

Electrical Power and Control for Visual Aids, Description .... WP 009 00
Electrical Power and Control for Visual Aids, Constant-Current Regulators .... WP 009 02
FAA Specification for L-823 Plug and Receptacle, Cable Connectors .... FAA AC 150/5345-26
Isolation Transformers for Airport Lighting Systems .... FAA AC 150/5345-47
Isolation Transformer (1500 Watt) for High-Intensity Approach Light Systems FAA-E-2690
Transformer, Power, Distribution .... FED W-T-631

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) provides the requirements for series circuit isolation transformers and for voltage distribution transformers used for airfield visual aids. The isolation transformers transfer the power from the series primary circuit to the individual lighting fixtures. The distribution transformers connect voltage type fixtures to a multiple (voltage) distribution circuit. The features and requirements of these transformers are discussed in this WP.

1-3. RELATED EQUIPMENT. The use of series and multiple circuits to provide electrical power to the airfield lighting systems is discussed in WP 009 00. The power for a series circuit is provided by a constant-current regulator (WP 009 02). The power for a multiple circuit is from the voltage between two conductors from a voltage distribution system which usually involves a distribution transformer having a suitable ratio of voltage. Many types of lights and fixtures may be connected to the secondary (output) of transformers of either type.

2-1. DESCRIPTION.

2-2. SERIES ISOLATION TRANSFORMERS. Isolation transformers for series/series circuits have their output current at a fixed ratio to the input current. For airfield lighting systems, the transformers are encased in a waterproof material suitable for direct burial. The output circuit (secondary) is electrically isolated from the input circuit (primary). The values of rated series current for airfield lights are 6.6 or 20 amperes, which may be used for primary and secondary circuits. The ratios of secondary to primary current may be 6.6/6.6, 20/20, 20/6.6, and 6.6/20 amperes. The wattages of isolation transformers are restricted to 30/45, 65, 100, 200, 300, 500, and 1500 watts. Not all sizes are available in all current ratios. The isolation transformers are designed for either 60 or 50 hertz power circuits, most Navy airfields use 60 hertz. The primary leads have two single conductors with a molded plug on one lead and a molded receptacle on the other.

2-3. The primary leads shall be not less than 500- volt insulation. The secondary lead is a 2-conductor cable with a molded receptacle and shall be not less than 600-volt insulation. The isolation transformers, plugs and receptacles shall conform to the specifications in FAA AC 150/5345-26.

2-4. VOLTAGE DISTRIBUTION TRANSFORMERS. The distribution transformers for voltage type lights have a fixed ratio of secondary (output) voltage to the input voltage. Often the input voltage is at a higher level to reduce line drop or use smaller size conductors and stepped-down to lamp voltage at the particular fixture. The distribution transformer may be located in the lighting vault or other convenient source of power. Most distribution transformers are not intended for burying underground or for submersion in water.

2-5. SERIES/MULTIPLE TRANSFORMERS. Some fixtures or equipment require a fixed input voltage, but the convenient power source is a series circuit. Taxiway guidance signs, obstruction lights, or a lighted wind cone at the end of a runway are examples of these fixtures. This power may be provided by a series to multiple transformer or power converter (see FAA AC 150/5345-44 for more information about series lighting circuit power converters). Power converters are available from airfield sign manufacturers.

3-1. INSTALLATIONS.

3-2. The series isolation transformers may be buried underground at the light fixture, but the preferred installation is in a light base or handhole at the fixture. Often the fixture may be mounted on the same base. Installation in light bases provides easy access to the transformer for both maintenance and replacement. The connections to the primary circuit and to leads to the lamp are via FAA L-823 connectors. Multiple distribution transformers are often installed in the lighting vault or other source of power where convenient.

4-1. EQUIPMENT.

4-2. The series isolation transformers shall be per the specifications in FAA AC 150/5345-47, FAA type L-830. If the power is at 50 hertz, use FAA type L-831 transformers. Select the specific type of transformers required for the wattage, input current, and output current. The options are as follows:

- Wattage: 30/45, 65, 100, 200, 300, and 500 watts.
- Input current: 6.6 and 20 amperes.
- Output current: 6.6 and 20 amperes.

4-3. For centerline approach lights mounted on low-impact resistant supports, a 1500-watt transformer for five lights is required. The approach lighting system transformers shall be per Specification FAA-E-2690.

ORGANIZATIONAL

SPECIAL POWER SUPPLIES

ELECTRICAL POWER AND CONTROL FOR VISUAL AIDS

Reference Material

Approach Visual Aids, Runway End Identification Lights (REIL) .... WP 003 04
Approach Visual Aids, Approach Lights, Category I - ALSF-1 .... WP 003 05
Approach Visual Aids, Approach Lights, Category II, and Category III - ALSF-2 .... WP 003 06
Approach Visual Aids, Short Approach Light System (SALS) .... WP 003 07
Approach Visual Aids, Optical Landing Aids (OLA) .... WP 003 11
Approach Visual Aids, Medium-Intensity Approach Light System with Runway Alignment Indicator Lights (MALSR) .... WP 003 12
Runway Visual Aids, Runway Distance Markers (RDM) .... WP 004 09
Runway Visual Aids, Arresting Gear Markers and Markings .... WP 004 10
Taxiway Visual Aids, Taxiway Guidance Signs .... WP 005 04
Taxiway Visual Aids, Special Taxiway Signs (TACAN, Billboard) .... WP 005 05
Special Lights and Markings Visual Aids, Apron and Parking Area Lights .... WP 006 02
Special Lights and Markings Visual Aids, Wheels-Up and Runway Wave-Off Lights .... WP 006 03
Special Lights and Markings Visual Aids, Fueling Area Lights .... WP 006 05
Helipad Visual Aids, Special Helipad Lights .... WP 007 06
Design Drawings for Visual Aid Navigation Facilities .... UFC 3-535-02
General Requirements for Lighting System, Airport Approach, Condenser Discharge Sequence Flashing MIL-L-26311
Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) FAA-E-2980
Sequenced Flashing Lighting System, Elevated and Semi-Flush with Dimming and Monitoring FAA-E-2628b
Specification for Discharge-Type Flashing Light Equipment .... FAA AC 150/5345-51
Specification for Taxiway and Runway Signs .... FAA AC 150/5345-44

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) discusses special power supplies used for airfield lighting. Special power supplies do not include series/series isolation transformers or voltage distribution transformers. Some of the power supplies have important functions in addition to providing power, but others are only variations of standard series isolation transformers or voltage transformers. The lighting system design specifications state the type of power supply to be used, or that a special unit is required to provide power from a convenient electrical source. To assist in explaining the applications, the features and requirements of special power supplies are discussed in this WP and in the WP for the specific visual aid.

1-3. RELATED EQUIPMENT. Since these power supplies are part of a lighted visual aid system, these units are related to the light fixtures and controls of the system. The following lighting systems may include the use of special power supplies:

- Sequence Flashing Lights (SFL) for high-intensity approach lights (WP 003 06, WP 003 07, and WP 003 08),
- Runway End Identification Lights (REIL) (WP 003 05),
- Medium-intensity Approach Lights System with RAIL (MALSR) (WP 003 12),
- Optical Landing Systems (OLS) (WP 003 11),
- Guidance signs (WP 004 09, WP 004 10, WP 005 04, WP 005 05),
- Wave-off lights (WP 006 03),

- Wheels-watch lights (WP 006 03),
- Floodlights power (WP 006 02, WP 006 05, WP 007 06).

2-1. DESCRIPTION.

2-2. SEQUENCE FLASHING LIGHT (SFL) POWER SUPPLY. The power to the SFL for the high-intensity approach light systems is furnished by a master control unit. This unit provides the following functions for the SFL:

- Supplies 240-volt, 60 hertz, conditioned power to each SFL unit for up to 21 lights.
- Transmits triggering signal for each SFL fixture in time synchronization. With SFL spaced at 100-foot intervals the trigger signal to adjacent lights shall be at one cycle intervals of the 60 hertz power. The flash cycle is repeated twice per second.
- If used, monitoring of each SFL indicates that the required number of lights are flashing.
- Provides three steps of intensity control of the SFL as selected at the lighting control panel.

2-3. The master control unit shall be provided with 120/240-volts, 60 hertz, 3 wire, input power.

NOTE

Some earlier units used 240/480-volt input.

2-4. The control unit shall include an elapsed time meter for recording time operating at 100 percent intensity and local and remote controls. Each SFL fixtures shall have a unit power supply to provide the power and trigger signal to each light. The master control unit and the light power units are special equipment that are part of the SFL system. Refer to FAA-E-2628 or to MIL-L-26311 for additional information.

2-5. RUNWAY END IDENTIFICATION LIGHTS (REIL). The power supply unit for the REIL shall be capable of operating either the REIL or the MALSR SFL or both. This unit provides the following functions for the REIL:

- Supplies 240-volt, 60 hertz, conditioned power to each of the two SFL of the REIL.
- Transmits triggering signal for each of the two flashing lights. Both lights shall flash simultaneously at a steady rate between 60 and 120 times per minute.
- Provides steps of intensity control (high, medium, low).

2-6. The power supply unit shall be per FAA AC 150/5345-51, type L-849, style E. The power supply unit shall be suitable for outdoor installation and the input voltage shall be 120/240-volts, 60 hertz. Some installations may require a special REIL power supply that has an adapter for the input power from the series circuit for the runway edge lights. Each flashing light should have a unit power supply, or one unit may serve both lights because they flash simultaneously.

2-7. MEDIUM-INTENSITY APPROACH LIGHTS WITH RAIL (MALSR). The power supply unit for the MALSR supplies power for both the steady-burning lights and the SFL. The input power is 120/240-volts, 60 hertz. The unit supplies 120/240-volts with three steps of intensity control to the steady-burning lights. A control unit, which may be part of the power supply unit, shall be used for the SFL of the system. This control unit provides the following functions for the SFL and MALSR:

- Supplies 240-volt, 60 hertz conditioned power for up to five SFL of the MALSR and the two REIL.
- Transmits triggered signal for each of the SFL in time synchronization. With the SFL spaced at 200-foot intervals the trigger signal to adjacent lights shall be at two cycles timing of the 60 hertz line. The flash cycle is repeated twice per second.
- Provides three steps of intensity control of the SFL selected at the lighting control panel.
- The control unit shall provide local or remote control and should include an elapsed time meter to record the hours of operation at full intensity.
- Each SFL fixture shall have a unit power supply.
- The MALSR power supply unit is a 15 KVA commercial distribution transformer unit with 120/240-volt output and intensity settings.
- The SFL control unit and the light power units shall be per FAA-E-2980.

2-8. GUIDANCE SIGNS POWER UNITS. Most taxiway and other guidance signs operate from series circuits by isolation transformers. The incandescent lamps may be series type lamps or in some cases voltage type lamps in a series-parallel arrangement. Some signs may use light emitting diodes (LEDs) with special power supplies to drive the LEDs. The signs which may use these types of power supplies include taxiway guidance signs, runway distance markers, arresting gear markers, and TACAN and billboard signs. The power supply is considered part of the sign and is not procured as a special item and does not require special connections to the circuit. Signs with the special power supplies shall be in accordance with FAA AC 150/5345-44.

2-9. WAVE-OFF LIGHTS POWER CONVERTER. The strobe wave-off lights require a voltage source of power and a flasher for each six-light system. The input voltage to the power converter units shall be 480-volts. Both the power converter units and the optical assembly units are above ground and may be separated a maximum of 150 feet. The power converter units condition the power and the trigger signal for the optical assembly flash units.

2-10. WHEELS-UP LIGHTS POWER SUPPLY. The wheels-up lights require a voltage source of 120-volts. A single 2400-to-120/240-volt 15 kilovolt-amperes distribution transformer and a stepped or continuously variable autotransformer to control the intensity of the 20 lamps provides the required power. These are standard commercial items of equipment.

2-11. FLOODLIGHT POWER. Several types of floodlights are used, and these often require special power supplies. Except for floodlights using incandescent lamps, special power supply units are usually required. In most cases, the power unit is included as an integral part of each light fixture. The type of input power required is specified for the light and the lights require several minutes before re-starting after the light is turned off. LED types of floodlights use their own special power supplies. Floodlights are used for apron and parking areas, fueling area, and some helipad lights. Most floodlights are commercial items and include the special ballast or power supply. Floodlights used for fueling lanes or helipad may use a series circuit for input power. The power supply is usually included with the light.

2-12. SERIES/MULTIPLE TRANSFORMERS. Some airfield lights require a voltage input that is connected to a series circuit. These lights may require special power adapters or use a commercial series/multiple transformer. If a special adapter is required, the type will be specified. For other lights a series/multiple transformer with the correct input current, output voltage, and load rating can be used.

2-13. WIND DIRECTION INDICATORS. Power adapters or boosters may be used to provide adequate voltage to the lighting circuit of wind direction indicators where the voltage drop in long lines is excessive.

3-1. INSTALLATIONS.

3-2. The installations of the special power supplies varies with the lighting system and the type of power supply. For details about installing some of the special power supplies, refer to UFC 3-535-02. General guidelines for installing the power supply units are as follows:

- The master control units for the SFL of high intensity approach lights are installed on a concrete pad in the approach zone near the SFL or in the approach lighting vault. A two-conductor cable for the 240-volt power and a single conductor cable for the triggering signal is installed between the master control unit and each SFL power unit. The individual power units are mounted at the base of the support for the light.
- The power supply unit for REIL shall be in an enclosure suited for outdoors installation and mounted on a concrete pad at the master REIL light. If a power adapter for a series circuit is used, it will usually be located at the same place on the pad or in a handhole or light base. The light power units shall be at the site for each light on a concrete base. Usually, the light is mounted on the power unit.
- The MALSR power supply is in an enclosure suitable for outdoors installation mounted on a concrete pad in the approach area. The SFL control unit may be in the same enclosure or as a separate unit more convenient to the SFL. The light power units are located on the ground at the base of the SFL supports. All units are usually elevated installations on concrete pad or bases.
- The power and control boxes for the OLS are mounted on the trailer of the OLS unit.

- The special power units for guidance signs are usually in the housing of the sign. The isolation transformers may be in light bases or buried near one of the supports for the signs. The cables to the sign are installed in one of the supports.
- The power converter unit for each strobe wave-off light is above ground on a light base 30 to 100 feet from the optical assembly unit. Both units are mounted on frangible couplings.
- The distribution transformer and switching equipment for the wheels-up lights are in an underground manhole. The dimmer control and connection plugs are in an elevated control panel near the wheels watch handhole.
- The special power supply units for floodlights are usually in the light housing. The light installation includes the power supply.
- The series isolation transformers are manufactured with molded connectors on the leads and are often installed in light bases or handholes.

ORGANIZATIONAL

AIRFIELD LIGHTING CONTROL PANELS

ELECTRICAL POWER AND CONTROL FOR VISUAL AIDS

Reference Material

Electrical Power and Control for Visual Aids, Description .... WP 009 00
Electrical Power and Control for Visual Aids, Auxiliary Power and Power Transfer Equipment .... WP 009 01
Electrical Power and Control for Visual Aids, Constant-Current Regulators .... WP 009 02
Electrical Power and Control for Visual Aids, Special Remote Control Equipment .... WP 009 06
Specification for L-821 Panels for the Control of Airport Lighting .... FAA AC 150/5345-3

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) discusses the requirements and major features of the airfield lighting control panels. The control panels provide the switches for remotely controlling airfield lighting systems. Most airfields have two or more panels. Different lighting systems may be selected, turned ON and OFF, and intensity controlled. This WP provides guide information for planning for lighting controls.

1-3. RELATED EQUIPMENT. Remote control of airfield lights involves energizing the constant current regulators (CCR) (WP 009 02) for the lights to be operated or to directly energize other types of equipment, and to select one or more lighting circuits (WP 009 00) by obtaining power from a CCR. A circuit selector switch (WP 009 06) is operated from the control panel to connect the CCR to the proper circuit. Most airfields have an alternate control panel in the lighting vault, and to prevent conflicting operations, control transfer panels allow only one remote lighting panel to be active (WP 009 06). To prevent voltage line, drop from affecting remote control if the control circuits cables are long, pilot relay panels (WP 009 06) are used. The control panel should have a switch to start the auxiliary power source and an indicator light to show that this power source is supplying the load (WP 009 01). Programmable Logic Control (PLC) or computers with a touch screen display may also be used in place of FAA Type L-821 panels with new installations – see FAA AC 150/5345-3 for additional information.

2-1. DESCRIPTION.

2-2. CHARACTERISTICS. A lighting control panel has several switches for energizing lighting circuits and individual visual aids. The switches may be toggle, push-pull, push-button, or similar types adequate for the purpose. To prevent simultaneously energizing lights on intersecting runways or opposite approaches, a single rotary runway selector switch is used. To provide intensity settings for the various lighting systems, one or more rotary brightness setting switches with three or five positions are used. Some switches are automatically lighted to correspond with the lighting circuits that are energized to more accurately determine the status of the airfield lights. A facsimile plan of the airfield is often installed on the control panel to aid in selecting the lights and reviewing the status of operating systems. In some cases, the energizing switches are located on or near the section of the facsimile corresponding to the lighting circuits. Lighting control panels for large airfields may also have digital read-out or displays showing the status of the airfield visual aids and related information. The control panels should provide indicator lights showing that the auxiliary power source is supplying power and also may show the monitored status of the sequence flashing lights, steady-burning lights, or monitored status of CCRs. The control panel may also include a timer and buzzer to alert the traffic controller that certain lights have been operating at 100 percent intensity for 15 minutes or longer.

2-3. TYPES OF CONTROL PANELS. The type of panel required usually depends on the size and complexity of the airfield and the lighting systems installed. For some airfields the traffic patterns of aircraft may require more intricate control panels. Small airfields may require only basic control panels with:

- Beacon.
- Obstruction lights.
- Wind direction indicator.
- Runway edge lights.
- One approach light system.
- Taxiway lights.

2-4. Panels may have additional controls for runway centerline and touchdown zone lights, taxiway centerline lights, and an associated intensity control. Additional controls for optical landing systems, monitoring indication of outages of sequence flashing lights and additional approach light systems may also be required. The FAA control panels may have features which would be desirable for some airfields, especially for controlling the auxiliary power source.

3-1. INSTALLATIONS.

3-2. The primary lighting control panel is located in the air traffic control tower cab. The alternate control panel is usually located in the main airfield lighting vault control room. The alternate control panel for the approach lights should be in the approach lighting vault. The control panel may be surface-mounted or flush-mounted in the console. The alternate control panel is usually mounted on a rack. Exterior terminal boxes may be used for control cable terminals and shall be marked for easy identification. All connections should be identified and marked at all terminal boards. Spare wires and terminals should be provided for expansion of the system.

4-1. EQUIPMENT.

4-2. Control panels per FAA AC 150/5345-3, type L-821 should be used.

ORGANIZATIONAL

SPECIAL REMOTE CONTROL EQUIPMENT

ELECTRICAL POWER AND CONTROL FOR VISUAL AIDS

Reference Material

Electrical Power and Control for Visual Aids, Description .... WP 009 00
Electrical Power and Control for Visual Aids, Constant-Current Regulators .... WP 009 02
Electrical Power and Control for Visual Aids, Airfield Lighting Control Panels .... WP 009 05
Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of
Airport Lighting Circuits .... FAA AC 150/5345-13

1-1. GENERAL INFORMATION.

1-2. PURPOSE. This Work Package (WP) discusses the requirements and features of special control equipment required for airfield lighting systems. This equipment provides for control transfer, selection of circuits to be energized by a given constant current regulator (CCR), and low-current pilot relay panels to provide long distance control circuits. The special requirements and features of the equipment in this WP are provided as guide information for designing the airfield lighting control system.

1-3. RELATED EQUIPMENT. The general requirements for the control circuits for airfield lighting systems are discussed in WP 009 00. The requirements for remote control panels are discussed in WP 009 05. One constant current regulator (WP 009 02) may be used to supply power to more than one lighting circuit alternately or simultaneously, and associated equipment to provide the proper circuit selection is necessary.

2-1. DESCRIPTION.

2-2. CHARACTERISTICS. The special remote-control equipment is used for specific control functions where each item of equipment relates to the airfield lighting control panels operation.

2-3. The number of special control items required for a given airfield varies with the size and complexity of the airfield.

2-4. CONTROL TRANSFER PANELS. Most airfields have the primary remote-control panel in the traffic control tower cab and an alternate remote-control panel in the lighting vault. Simultaneous control from both panels shall be prevented by using control transfer panels. Control transfer panels usually contain an 8-pole double-throw relay in an enclosure. Several of these panels may be needed to accommodate all the control circuits. The relay connects either control panel to the control circuit loads. Normally the control panel in the control tower is connected to the load circuits, but by actuating a transfer switch, the relays transfer the load to the alternate control panel.

2-5. CIRCUIT SELECTORS. When a given CCR is used to energize more than one circuit, one or more circuit selectors or circuit selector switches are required to transfer the circuits to the secondary (output) of the regulator. The circuit selectors shall be capable of transferring load circuits for regulators of 5000 volts or less for either 6.6-ampere or 20-ampere outputs or both. Circuit selector switches can be obtained to handle up to four circuits (FAA Type L-847-4). Any one or all the circuits may be energized from one CCR.

2-6. The transfer of the circuits shall be accomplished in one second or less.

2-7. The output circuit of the CCR shall be shorted before opening or closing the load contacts of the circuit selector. The leads to the load circuit being switched are shorted before the circuit is connected or disconnected for circuit selector switches, but connections to other load circuits are not affected.

2-8. When a load circuit is not connected for operation, it shall be isolated from the CCR output.

2-9. If none of the load circuits are selected, the output of the CCR shall be shorted.

2-10. Circuit selector switches may be used for connecting taxiway lighting circuits where one or more circuits may be operated simultaneously from a single CCR.

2-11. Circuit selector switches may also be used for transferring the load between intersecting runways when both runways are not to be lighted at the same time.

2-12. PILOT RELAY REMOTE CONTROL PANELS. The relay coils for operating the constant-current regulators often require one ampere of current. This current requirement limits the length of control circuits for direct operation to only a few thousand feet. Often the cable length between the control tower and lighting vault may be several thousand feet. To permit longer control cable distances, pilot relay panels are used. The pilot relay panels consist of 20 or more relays, terminal boards, and wiring in an enclosure. The relays have low-current type coils and double pole contacts. Most relays are single-throw type but some may be double-throw.

2-13. 120-Volt Alternating Current (VAC) Controls.

2-14. Most Navy airfields use 120 VAC control circuits and pilot relay panels. Two types of pilot relay panels with 24 relays are permitted. The maximum length of control circuits between the lighting control panel in the tower and the pilot relay panel is considered to be 7350 feet and is adequate for most airfields.

2-15. 48-Volt Direct Current (VDC) Controls.

2-16. The length of control circuits between the control tower and some lighting vaults, especially approach lighting vaults, may be longer than the use of 120 VAC circuits permit. For these circuits, 48 VDC control circuits may be used. The FAA type L-841 pilot relay assemblies are this type of system. These assemblies provide a 48 VDC power supply by using a full wave rectifier and feature 20 plug-in relays. With 48 VDC circuits the length of control circuits may be three miles or more when using 19 AWG telephone control cables.

2-17. AUTOMATIC CONTROLS. Some airfield visual aids, which are operated on a routine schedule, may be located nearer to local sources of electrical power than the lighting vault. In instances of long distances for control cables, it may be more practical to use automatic controls such as photoelectric switches or time clock controllers. Timer switches can turn circuits ON and OFF on a fixed schedule that can be adjusted as required. Photoelectric switches can turn circuits ON or OFF and can automatically select the desired intensity for visual aids that are intermittently operated by remote control. Automatic controls are more often used for isolated visual aids or at airfield without 24-hour air traffic control. Some of these visual aids include beacons, lighted wind indicators, obstruction lights, wave-off lights, REILS, RAILS, helipad lights, etc. Automatic controls can be used for runway and taxiway lights during periods when remote controls are not manned.

3-1. INSTALLATIONS.

3-2. The control transfer relays, and transfer switches are installed in the control room of the lighting vault. The electrical power is 120 VAC for the vault accessories. The control transfer panels are wired for the remote-control panel in the control tower and connected to the control load when the relays are not energized, and the transfer switch is in the remote position. The circuit selector switches are located in the regulator room of the lighting vault near the regulator. The circuit selector switches are connected to the regulator output, the load circuits, and the controls circuits as required. The pilot relay panels are located in the control room of the lighting vault. The input power to these panels is 120 VAC which may be rectified for the 48 VDC control panels.

3-3. The controls for the relays are connected to the load side of the control transfer panels. The output side form the relay contacts are connected to the operating controls of the lighting equipment. The input side to the relay contacts are usually connected to 120 VAC. Photoelectric switches are usually located on or near the visual aid with the photocell aimed at the north sky.

4-1. EQUIPMENT.

4-2. The special remote-control equipment is listed in Table 1. The choice of type of circuit selector switches usually depends on the number of circuits to which the CCR is to supply power. The choice of pilot relay panels usually will be determined by the length of the control circuits. Some installations may prefer the 48 VDC assemblies to permit using smaller wire sizes for the control cables.

Table 1. Schedule of Special Remote Control Equipment

PURPOSE AND TYPE OF EQUIPMENT	RATING
Control transfer panels.	
Commercial	By manufacturer.
Circuit selector switch.	
FAA AC 150/5345-5, type L-847-1, -2, -3, -4	6.6A or 20A, 5000V; one or more of 1, 2, 3, or 4 circuits.
Pilot relay panels.	
FAA AC 150/5345-13, type L-841	48 VDC, 20 relays.
Photoelectric switches and timers	
Commercial or lighting equipment manufacturers.	As required.