SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

SAE ARP693 REV. C

Issued 1961-06
Revised 1998-05
Reaffirmed 2006-06

Superseding ARP693B

Landing and Taxiing Lights - Design Criteria for Installation

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

FOREWORD

The recommendations set forth herein are the results of the combined efforts of engineers associated with the manufacture of lamps, equipment, and airframes, as well as engineers from the air transportation field and interested government agencies.

This SAE Aerospace Recommended Practice (ARP) does not include recommendations for the use of any specific equipment.

1. SCOPE:

This document includes requirements of installations of adequate landing and taxiing lighting systems in aircraft of the following categories:

a. Single engine personal and/or liaison type
b. Light twin engine
c. Large multiengine propeller
d. Large multiengine turbojet
e. Military high performance fighter and attack
f. Helicopter

1.1 Purpose:

The purpose of this document is to provide certain basic considerations and design criteria for installation of landing and taxiing light systems for night operation.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2. REFERENCES:

2.1 Federal Aviation Regulations, Part 23, Airworthiness Standards: Normal, Utility, and Acrobatic Category Airplanes.

2.2 Federal Aviation Regulations, Part 25, Airworthiness Standards: Transport Category Airplanes.

2.3 Federal Aviation Regulations: Part 27, Normal Category Rotorcraft.

2.4 Federal Aviation Regulations: Part 29, Transport Category Rotorcraft.

2.5 Federal Aviation Regulations, Part 121, Certification and Operations: "Domestic, Flag and Supplemental Air Carriers and Commercial Operators of Large Aircraft."

2.6 Federal Aviation Administration Order 8000.31, "Operation Lights On," dated August 29, 1973.

2.7 Aerospace Standard 580, "Pilot Visibility From the Flight Deck Design Objectives for Commercial Transport Aircraft."

2.8 MIL-L-6503, "Military Specification, Lighting Equipment, Aircraft, General Requirements For."

3. DETAILED RECOMMENDATIONS:

3.1 Landing Lights (See Table 1):

3.1.1 General Provisions:

3.1.1.1 Landing lights are used primarily to provide ground reference information during final approach, touchdown, ground roll, and takeoff, and to illuminate any major obstructions in the airplane approach glide path or on runway at night.

3.1.1.2 It may also be used for signaling purposes in flight. The landing lights may be turned "on" when:

a. Operating within 10 miles of any airport, day or night
b. Operating in conditions of reduced visibility, i.e., haze, dust, etc.
c. Operating under special visual flight rules (VFR) conditions
d. Operating where flocks of birds may be expected (coastal area, swamp lands, migratory areas, etc.)

This requires that all or some landing lights are functional when gear and slats/flaps are retracted.

TABLE 1 - Lamps for Landing Service

NOTE: The lamps listed below represent current industry standards for this type of installation. However, other lamps with similar characteristics (electrical, environmental, dynamic and luminous intensity) may be used with comparable results.

Lamp No.	Watts	Volts	Bulb	Rated Ave. Lab. Life (hours)	Initial Beam CP on Centerline	Nominal Beam Spread to 10% of Center Beam CP (deg)	Nominal Beam Spread to 10% of Center Beam CP (deg)	Category See Section 1
4509	100	13	PAR-36	25	110,000	12	6	a
Q4509	100	13	PAR-36	100	140,000	3	3	a
4591	100	28	PAR-36	25	90,000	12	6	a
4537	100	13	PAR-46	25	200,000	11	6	a
4313	250	13	PAR-36	25	140,000	16	7	a,b
4522	250	13	PAR-46	25	290,000	12	10	a,b
4553	250	28	PAR-46	25	300,000	11	12	a
4552	250	28	PAR-46	25	500,000	7	8	b
4581	450	28	PAR-46	10	400,000	13	14	b,e,f,
4559	600	28	PAR-64	25	600,000	11	12	c,d,f
Q4559	600	28	PAR-64	100	600,000	12	8	c,d,f
Q4559X	600	28	PAR-64	100	765,000	11	7-1/2	c,d,f,
4556	1000	28	PAR-64	25	700,000	12	13	c,d
Q4681	450	28	PAR-46	50	310,000	15	9	c,d
4557 Land.	1000	28	PAR-64	25	540,000	11	15	c,d
Taxi.	400	28	PAR-64	100	100,000	25	11	c,d

3.1.1.3 Each landing light should be designed and be installed such that:

a. No objectionable glare is visible to the pilot.
b. The pilot is not adversely affected by halation.

3.1.1.4 Each landing light should provide sufficient illumination on the runway for night landing. As a design objective, 2 ft-c minimum at 400 ft in front of the pilot at touchdown attitude and 0.5 ft-c minimum at 300 ft in front of the pilot during ground roll should be provided.

It should be noted that normal approach attitude varies between particular airplanes, depending upon speed, flap conditions, etc. In most cases, the landing attitude and taxiing attitude of the airplane are not the same; however, the landing lights should accommodate adequate light coverage for final approach, touchdown, and ground roll illumination. So, for some airplanes, it may be necessary to re-aim the landing lights, once the aircraft is on the ground.

3.1.1.5 Minimum recommended number of landing lights required for night flying are listed in Table 2.

TABLE 2 - Recommended Number of Landing Lights for Different Category Airplanes

Airplane Categories	Minimum Number of Landing Lights
Single engine personal and/or liaison type	2
Light twin engine	2
Large multiengine propeller	3
Large multiengine turbojet	4
Military high performance fighter and attack	2
Helicopter:	
Retractable landing light	1
Searchlight (may be used as landing light)	1

NOTE: The recommended quantities listed in Table 2 refers to equipment installation only and should not be misinterpreted as quantities required for aircraft dispatch.

3.1.1.6 Possible locations of lights are recommended as follows:

a. Location of Landing Lights:

1. Nose landing gear strut
2. Each side of fuselage (ahead of wing)
3. Wing/body strake (wing root)
4. Flap track fairing
5. Lower wing surface or wing leading edge

b. Location of Runway Turnoff/Taxi Lights:

1. Nosewheel gear (steerable)
2. Nose landing gear strut
3. Wing/body strake (wing root)
4. Each side of fuselage (ahead of wing)

3.1.2 Aiming: It is recommended that adequate landing light aiming be provided to cover the following airplane attitudes:

a. Prior to touchdown, the pilot will start using the lights as he initiates the flare. The landing light shall be aimed somewhat ahead of the pilot vision limit, and along the glide slope (see Figure 1).

b. Before the point of touchdown is reached, the airplane is positioned in a nose up attitude and the centerline of the beam moves further down the runway relative to the pilot's field of vision. At touchdown, it is desirable to provide illumination of the runway centerline and possible obstructions as far as 400 ft away from the pilot (see Figure 2).

c. After touchdown, the nosewheel gradually drops to the ground and the airplane assumes a ground roll attitude. At this point, it is desirable to provide illumination of the runway centerline at least 300 ft away from the pilot (see Figure 3).

3.1.3 Relamping: It is recommended that the landing light fixture contain provisions to orient the lamp to assure the correct horizontal and vertical beam pattern (see Table 1).

3.1.4 Controls:

3.1.4.1 It is recommended that each landing light be controlled by a separate switch.

3.1.4.2 One switch may be used for the lights of a multiple light installation at one location.

3.1.4.3 For retractable landing lights, it should be possible to turn the light on or off without altering the position of the light fixture by providing a separate switch controlling the motor drive circuit. This switch may allow aiming control at any position between fully extended and fully retracted position.

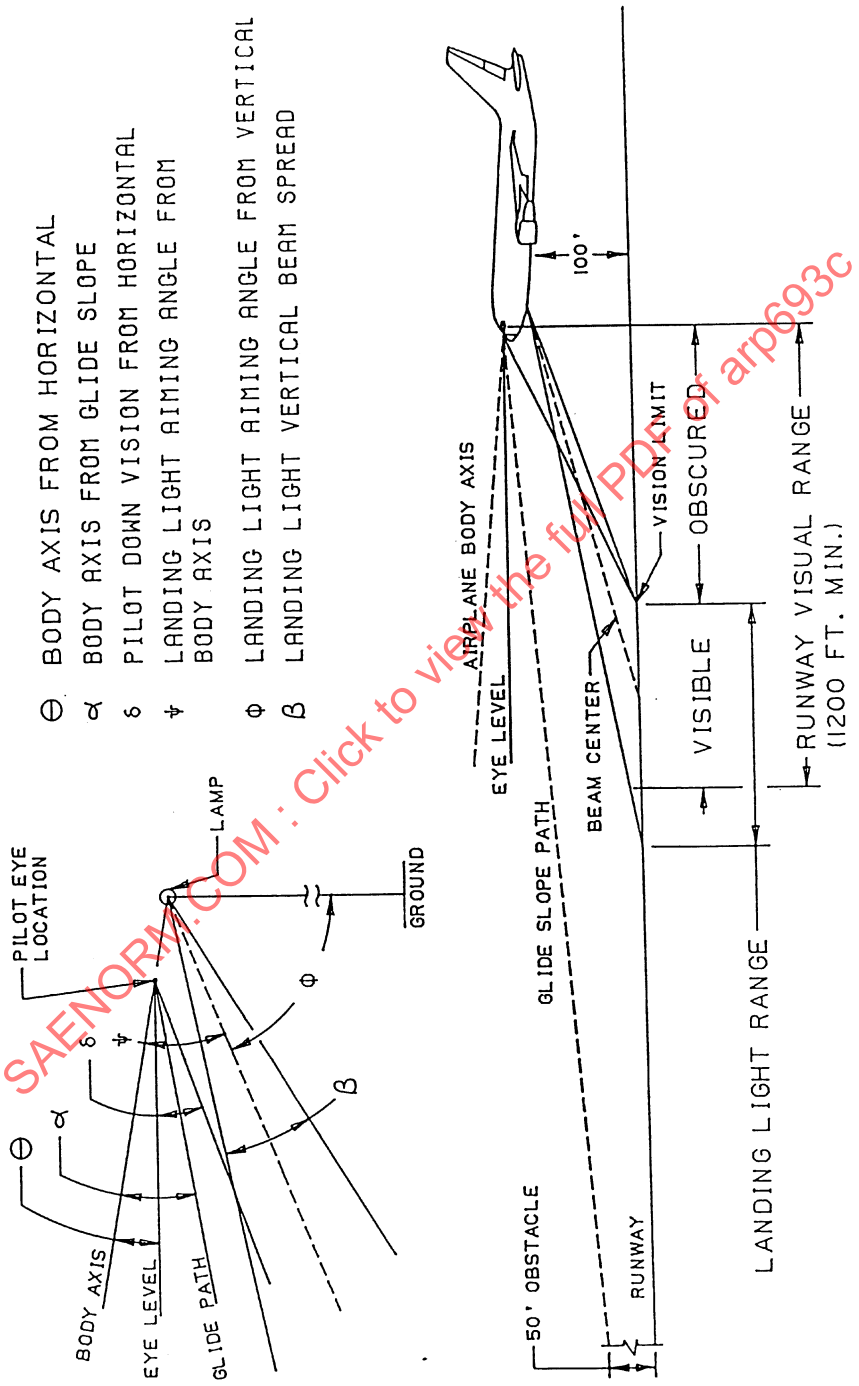

FIGURE 1 - Landing Light at Approach Attitude

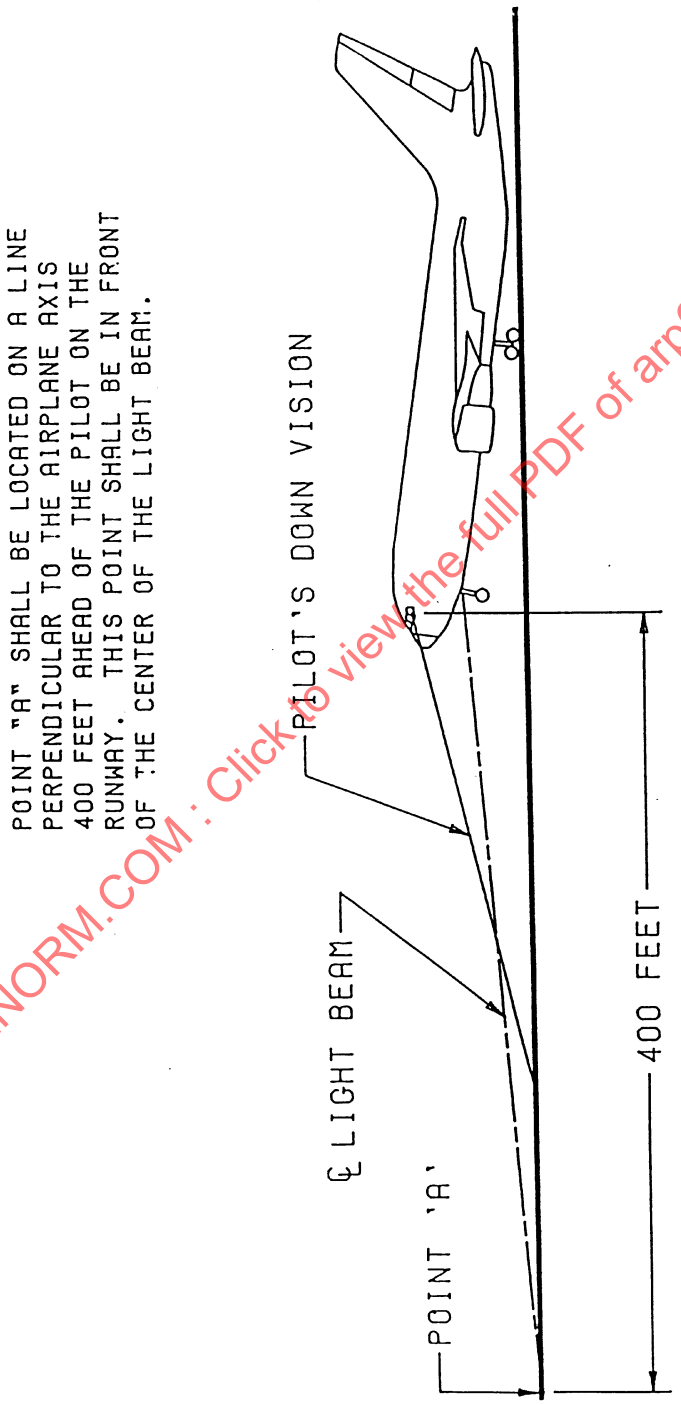

FIGURE 2 - Landing Light at Touch Down Attitude

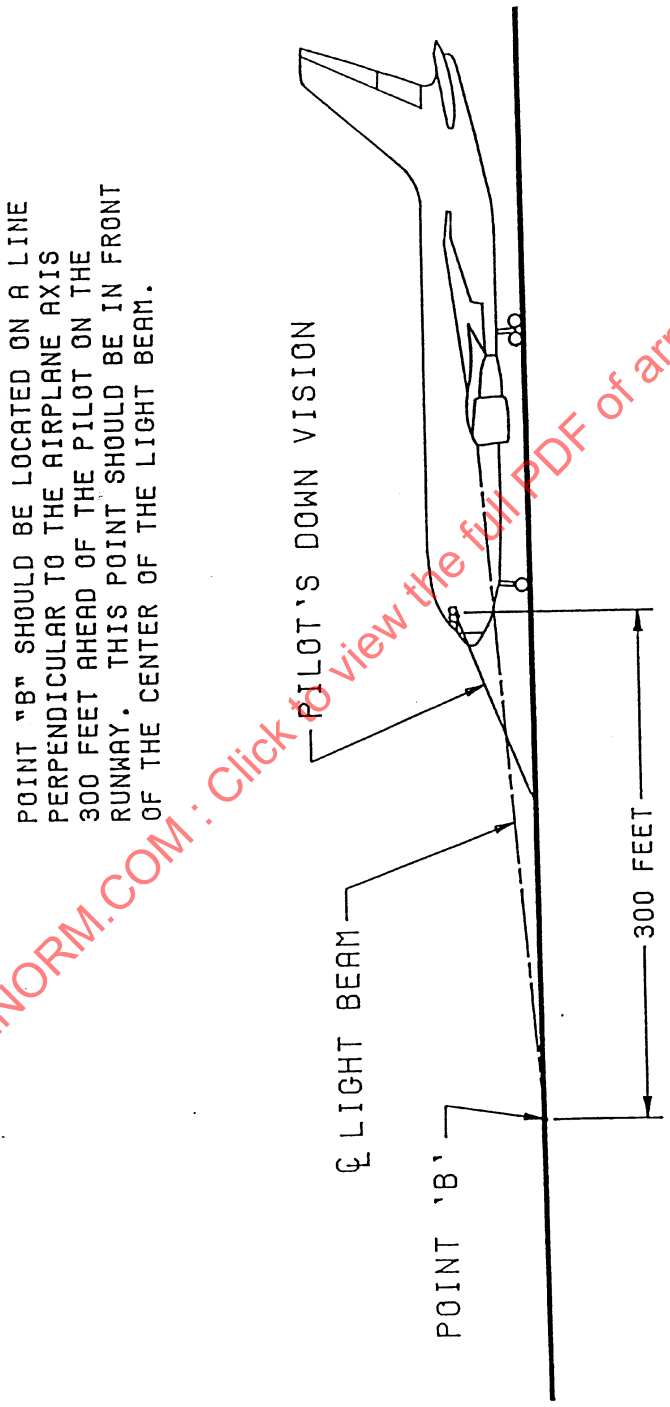

FIGURE 3 - Landing Light at Ground Roll Attitude

3.1.4.4 There should be a means to indicate to the pilots when the landing lights are extended.

3.1.4.5 An automatic control switch should be provided to turn off the landing lights, which are installed in the wheel well when the gears are retracted.

3.1.4.6 An automatic control switch may be provided to operate the externally mounted landing lights at dim mode when the landing gears are retracted.

3.1.4.7 Consideration should be given to redundancy of lighting circuit and lamps to minimize the consequences of failures and improve dispatch reliability.

3.1.4.8 For rotary-wing aircraft the controllable searchlight should be so installed that when the light is fully stowed, the plane of the lamp mounting ring will be horizontal when the aircraft is in normal, level flight. The searchlight should be of a type that can be extended not less than 120° from its fully stowed position.

3.2 Runway Turnoff/Taxi Lights (See Table 3):

3.2.1 General Provisions:

3.2.1.1 Taxi lights are used to maneuver the aircraft on the ground at night. Runway turnoff lights are used to augment the taxi light on large multiengine jet aircraft. The landing lights are normally switched off to conserve the lamps and to avoid blinding oncoming traffic.

3.2.1.2 Sufficient intensity and beam spread should be provided to aid the pilot in locating the following:

a. Taxiways (or painted centerline)
b. Runway turnoff locations
c. Obstructions which might contact any parts of the aircraft

The taxiing and runway turnoff lights should provide a minimum illumination on each side of the centerline of the aircraft to 10 ft outboard from each wingtip.

As a design objective, 2 ft-c minimum at 50 ft in front and 80 ft outboard of the pilot should be provided for the runway turnoff light, and 5 ft-c minimum at 100 ft in front of the pilot should be provided for the taxiing light respectively (see Figure 4).

3.2.1.3 On small airplanes taxi lights may not be installed. If installed, a single lamp in the nose or on the nosewheel strut is usually sufficient.

3.2.1.4 On large airplanes at least two runway turnoff lights should be required. The combination of both runway turnoff lights and taxiing lights would provide most desirable coverage, even in low visibility conditions.

TABLE 3 - Lamps for Taxiing Service

NOTE: The lamps listed below represent current industry standards for this type of installation. However, other lamps with similar characteristics (electrical, environmental, dynamic and luminous intensity) may be used with comparable results.

Lamp No.	Watts	Volts	Bulb	Rated Ave. Lab. Life (hours)	Initial Beam CP on Centerline	Nominal Beam Spread to 10% of Center Beam CP (deg)	Nominal Beam Spread to 10% of Center Beam CP (deg)	Category See Section 1
4503	40	14	PAR-36	400	11,000	--	--	a
4502	50	28	PAR-36	400	10,000	40	7	a
4570	150	28	PAR-46	300	32,000	50	9	b,c
4551	250	28	PAR-46	25	75,000	50	10	c,d,e,
Q4631	250	13	PAR-36	500	80,000	13	12	c,d
4554	450	28	PAR-46	25	90,000	50	16	c,e
Q4554	450	28	PAR-46	100	65,000	50	11	c,d
4557 Land.	1000	28	PAR-64	25	540,000	11	15	c,d
Taxi.	400	28	PAR-64	100	100,000	25	11	c,d

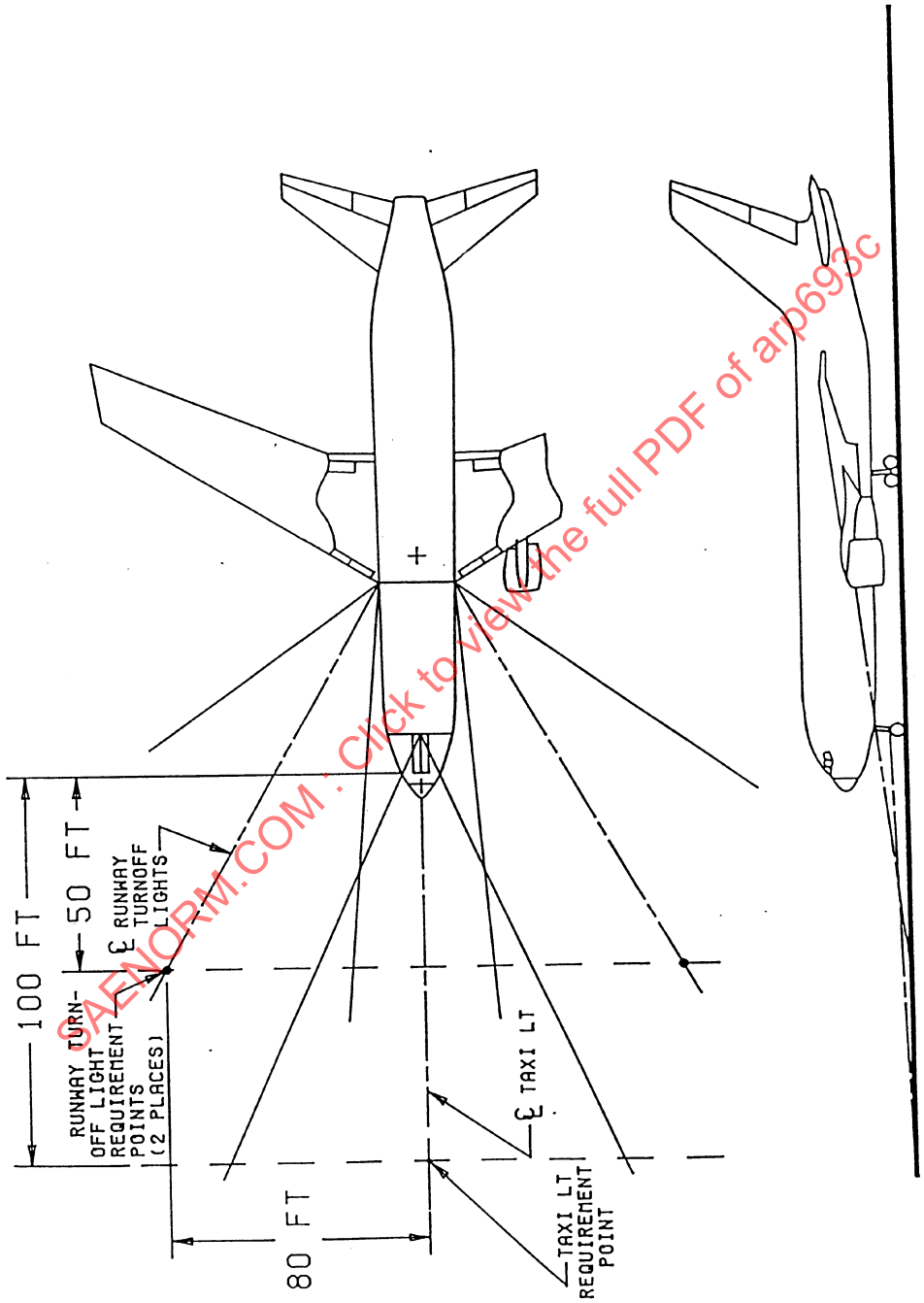

FIGURE 4 - Steerable Taxi and Runway Turnoff Light

3.2.2 Aiming: It is recommended that runway turnoff lights be aimed so that the center of the beam of each light strikes the ground in normal taxiing attitude at 50 ft minimum and 80 ft outboard in front of the pilot as shown in Figure 4.

It is recommended that the taxiing light on the nosewheel be aimed in the direction of travel with the center of the beam horizontal. It is desirable to install the light on the nosewheel movable strut so that the light will turn laterally with the nosewheel strut.

3.2.3 Relamping: It is recommended that the runway turnoff/taxiing light fixture design contain provisions to orient the lamp to assure the correct horizontal and vertical beam pattern is achieved (see Table 3).

3.2.4 Control: The runway turnoff/taxiing light system should be operated independently from the landing light system by a separate switch.

Each runway turnoff/taxiing light should be controlled by a separate switch.

3.3 Installation Design:

3.3.1 Environmental Conditions:

3.3.1.1 Each light fixture, and its associated wiring and equipment (such as transformer or motor), mounted in or attached to the fixture, should be capable of withstanding all environmental conditions anticipated in ground and flight operation. The requirement of RTCA Document DO-160 may be used except where anticipated conditions are more severe.

3.3.1.2 Each light fixture and its attachment provisions should provide solid mounting to avoid amplification of vibration between aircraft structure and lighting fixture.

3.3.1.3 When light fixtures are installed in an area which can possibly contain explosive vapors, special design conditions shall be given to assure safe operation and explosion-proofing. FAA Advisory Circular 25.981-1A provides guidelines for components in close proximity to fuel tanks or tank surfaces.

3.3.1.4 All exposed terminals should be coated or guarded to eliminate the possibility of striking an arc.

3.3.2 Maintainability: Special consideration should be given to the installation of the lights so that the lamps can be changed with a minimum amount of time. It should be replaced by using conventional tools without readjustment or re-aiming the light. For retractable landing lights, relamping should be accomplished in either the retracted position or extended position.