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AEROSPACE RECOMMENDED PRACTICE

ARP 991A

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POSITION AND ANTI-COLLISION LIGHTS - TRANSPORT CATEGORY AIRPLANES

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1. INTRODUCTION

This Aerospace Recommended Practice (ARP) provides recommendations for a standard of airplane navigation position* and anti-collision lights which have intensities, redundancy, and are of a configuration commensurate with the vital role these lights play in collision avoidance during night-time or darkened sky conditions.

The combination of these two lighting systems permits pilots to detect and to assess the potential of a collision between airplanes in common airspace. The anti-collision lighting system permits early initial visual detection of aircraft. The navigation position lights allow an assessment of direction of flight, and visual tracking as well as orientation or position of an airplane relative to the observer.

While the purpose of these two lighting systems differs, there is a definite relationship between the intensities of each. Airport traffic density continues to increase in the United States. Large metropolitan areas suffer increased degradation of visibility due to manmade atmospheric smoke and haze. There is need to increase the recommended light intensity levels and to give consideration for redundancy of lights. Further, large city areas are brightly illuminated at night and this serves to reduce overall aircraft conspicuity when viewed against the city background.

During initial design development of the Super Sonic Transport (SST), it appeared necessary to create special requirements for the exterior lighting for these airplanes. Ecological considerations have resulted in SST speed control coincident with other jet transports while operating in the areas and at altitudes of greatest collision threat. The recommendations of this ARP, therefore, apply to both types of airplanes.

The recommendations, although desirable for increased visual detection, may be beyond practical limitations for small business jet airplanes.

2. PURPOSE

This ARP recommends navigation position and anti-collision lighting systems commensurate with the acknowledged needs for visual detection and collision avoidance between airplanes inflight and on the ground. Customers for new airplanes, or lighting components, and designers or manufacturers may take advantage of this ARP in specifying a standard of lighting which exceeds the applicable Federal Aviation Regulations.

3. SCOPE

This ARP covers the recommended lighting performance and design criteria for:

(a) Left Forward Navigation Position Lights (Red)
(b) Right Forward Navigation Position Lights (Green)
(c) Rear Navigation Position (White)
(d) Anti-Collision Lights (Red and/or White Flashing)

*In consideration of International Civil Aviation Organization (ICAO) nomenclature, "NAVIGATION LIGHTS", this ARP utilizes "NAVIGATION POSITION LIGHTS" to describe the equivalent devices.

4. DESIGN REQUIREMENTS

4.1 Navigation Position Lights: It is recommended that the following minimum light intensities from navigation position lights be provided:

TABLE I

MINIMUM INTENSITIES IN THE HORIZONTAL PLANE
FOR NAVIGATION POSITION LIGHTS

Navigation Position Light Type	Angle from Right or Left of Longitudinal Axis Measured from Dead Ahead (Deg.)	Minimum Intensity (Candelas)
Fwd. - Red and/or Green	0 - 20	100
	20 - 50	60
	50 - 110	30
Rear - White	110 - 180	100

TABLE II

MINIMUM INTENSITIES ABOVE AND BELOW THE HORIZONTAL PLANE
FOR NAVIGATION POSITION LIGHTS

Angles Above and Below the Horizontal Plane (Deg.)	Minimum Intensity (I)
0 - 5	1.00 I.
5 - 10	.90
10 - 20	.80
20 - 30	.60
30 - 50	.40
50 - 75	.20
75 - 90	.10

4.1.1 The values of Intensity (I) in Table II refer to intensity values of Table I for the corresponding angles in the horizontal plane. When lights are provided with significantly higher intensity than the minimum in Table I, the values of intensity in Table II should be applied to the actual value of intensity rather than the minimums in Table I.

Intensities in overlaps between adjacent signals shall satisfy the requirements in FAR 25.1389.

4.1.2 The location of the forward navigation position lights should be as near the wing tips as practicable.

Where availability of space and/or frontal area projection does not permit single fixtures of sufficient size and viewing angles to provide required candlepower distribution, consideration may be given to multiple fixtures. These fixtures may be installed in other wind locations and in the fuselage. In this case, each light individually should meet the distribution and intensity requirements through portions of the required sector angles, so that all lighting fixtures, including aerodynamic fairings, when taken together fully comply with required candlepower distribution about the airplane.

4.1.3 Where lights are installed on components of the airplane which vary geometrically in orientation to the major axes of the airplane during different phases of ground or flight operations, the recommendations of 4.1 must be satisfied under each condition.

4.1.4 The location of the rear navigation position lights should be as near the extreme aft portion of the aircraft as practicable with location on the trailing edge of the wing tips or horizontal stabilizer as an alternative.

When availability of space and/or aft area projection does not permit single fixtures of sufficient size and viewing angles to provide required candlepower distribution, consideration may be given to multiple fixtures. In this case, each light individually should meet the distribution and intensity requirements through portions of the required sector angles, so that all lighting fixtures when taken together fully comply with required candlepower distribution about the airplane.

4.2 Anti-Collision Lights: It is recommended that the following minimum light intensities from the anti-collision lights be provided:

4.2.1 The term "effective intensity" means the intensity of a steady burning light which will have the same visual range as the flashing light. This term is defined the SAE AS 8017 and in Illuminating Engineering (See Bibliography, ref. 3). The location of the anti-collision may be in the fuselage, wings, or other portions of the airplane, depending on which location or combination of locations is most practicable for the geometry of the airplane. High intensity white lights should be located as far outboard from the pilots as practical to minimize backscatter. Consideration should be given to other unfavorable effects on the crew's vision or on personnel outside the aircraft. For this reason, consideration should be given to providing dual operating modes or redundant lights to give the crew capability of controlling the light output by operation of the white light(s) or the red light(s) to obtain the values specified in Table III.

TABLE III

MINIMUM EFFECTIVE INTENSITIES FOR ANTI-COLLISION LIGHTS

Angle Above or Below the Horizontal Plane (Deg.)	Minimum Effective Intensity (Candelas)	
	Aviation Red	Unfiltered White
0 - 5	400	2000
5 - 10	320	1200
10 - 20	160	600
20 - 30	80	300
30 - 75	20	75

4.2.1.1 When lights are installed which have significantly higher intensity than Table III, vertical distribution intensities shall be increased proportionately.

4.2.2 It has become common practice for flight crews to alert ground crews when engine starting is about to commence by turning on the red anti-collision lights. For this reason and the fact that international standards have not yet recognized white anti-collision lights, it is most practical to recommend redundant lights. Since F.A.R.'s require only a single anti-collision lighting system, redundant red and white lighting systems provide for dispatch of flights with all or portions of either inoperative so long as the minimum requirements are satisfied.

4.2.3 Flash rate from the combination of all anti-collision lights, not including supplemental lights, when viewed from any sector shall be not less than 40 and not more than 100 flashes per minute (FPM). Simultaneous flashing of lights may be used to limit the apparent flash rate when viewed from a distance.

Consideration may be given to providing different flash rates in various sectors around the horizontal plane. In such cases the higher flash rate shall be displayed forward of the aircraft, but should not exceed 180 FPM, including areas of overlap.

4.2.4 Obstruction of Light: The regulations do not permit obstruction of anti-collision lights except in the aft sector. Frequently, light is obstructed by portions of the airframe, antennas, fluid drain masts, etc. It is most probable that such obstructions can be overcome with light fixtures installed on the wing tips and empennage or by the use of redundant fixtures.

4.3 Color Requirements: Colors in the navigation position and anti-collision lights, including the effects of lens and aerodynamic covers shall comply with the appropriate requirements of FAR 25.1397 as revised by Amendment 25-27. In areas where the red and white lights overlap, a mixture of the colors is permitted.

4.4 Aerodynamic Drag: The aerodynamic countour of high speed airplanes is such that lighting equipment, designed to meet certain of these lighting requirements, must protrude from the contour of the airplane. Since these protrusions offer considerable drag during supersonic operation, the use of retractable fixtures or fairings is anticipated to permit improved aerodynamic efficiency when the lights are not actually required, such as daylight hours, in clouds, or when electronic collision avoidance equipment becomes operational.

Articulated fixtures have undesirable side effects including increased initial cost, increased maintenance and overhaul costs, and lower MTBF.

4.5 Environmental Conditions:

4.5.1 All lighting fixtures and associated equipment mounted in or attached to the fixture should be capable of withstanding all environmental conditions anticipated including rainfall, temperatures, altitude and vibration associated with ground and flight operation. Alternately, the appropriate requirements of RTCA Document DO-160 may be used except where anticipated conditions are more severe.

4.5.2 Lighting fixtures and their attachment provisions should provide solid mounting to avoid amplification of vibration between aircraft structure and lighting fixtures.

4.5.3 Electric wires used for circuit connections within or external to the light fixtures should be appropriately rated for all environmental conditions expected to be encountered in the particular installations. Consideration should be given to the total temperature rise including, but not limited to, aerodynamic heating, lamp heating and wire self-heating.

4.5.4 When light fixtures are installed in areas which can possibly contain explosive vapors, special considerations shall be given to assure safe operation and explosion-proofing, including likely failure conditions.

4.5.5 Aircraft exterior lights normally are subjected to exterior environment of the aircraft and should be tested for waterproofness and compatibility with cleaning fluids, deicing fluids, and other fluids normally used in aircraft servicing.

4.5.6 Service experience has shown that special attention is necessary during initial design phases to the severe electromagnetic interference effects from high intensity capacitor-discharge lights. RTCA Document DO-160, Sections 19, 20 and 21, provide acceptable requirements.