



AEROSPACE RECOMMENDED PRACTICE

ARP6336™

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Lighting Applications for Unmanned Aircraft Systems (UAS)

RATIONALE

This document provides recommendations for external lighting on Unmanned Aircraft.

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) provides technical recommendations for the lighting applications for Unmanned Aircraft Systems (UAS). The technical content of this ARP discusses the unique trade-offs that are necessary to maintain commonality to the U.S. Federal Aviation Regulations (FARs)¹ for aerospace lighting. The recommendations set forth in this document are to aid in the design of Unmanned Aircraft (UA) lighting for the size of aircraft and operation for which the aircraft is intended. In addition, certain concepts of operation for which UASs are suited will require unique lighting solutions.

1.1 Purpose

An unmanned aircraft is a device that is used for flight with no onboard pilot. These devices may be as simple as a Radio Controlled (RC) model aircraft or as complex as a DoD surveillance aircraft flying over hostile areas in warfare. All are controlled by a data link to connect the pilot to the aircraft via a Ground Control Station (GCS). Unmanned aircraft range in size from wingspans of 6 inches to a several hundred feet and weigh from 4 ounces to over 25000 pounds. The collective components for operating these devices are called an Unmanned Aircraft System (UAS). The three things all UASs have in common are:

- The Unmanned Aircraft System (UAS), often referred to as Unmanned Air Vehicle (UAS)
- The Ground Control Station (GCS) and Pilot
- The data link software for the Command and Control (C3) between the GCS and aircraft

This Aerospace Recommended Practice (ARP) describes the functions and characteristics of lighting design for the Unmanned Aircraft operating as a system with the GCS. The C3 interface for controlling the UA lighting will be briefly mentioned and some areas of covert lighting are discussed along with lighting for ground operations.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the contractual purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.2 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR1106	Some Factors Affecting Visibility of Aircraft Navigation and Anticollision Lights
ARP991	Position and Anticollision Lights – Fixed-Wing Aircraft
ARP5825	Design Requirements and Test Procedures for Dual Mode Exterior Lights
ARP6253	LEDs and Aircraft Applications
AS8017	Minimum Performance Standard for Anticollision Light Systems
AS8037	Minimum Performance Standard for Aircraft Position Lights

¹ Lighting designs that deviate from the FARs could bear the burden of justifying equivalent safety to the FAA

2.3 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

2.3.1 Code of Federal Regulations (CFR)

Available from the United States Government Printing Office, 732 North Capitol Street, NW, Washington, D.C. 20401, Tel: 202-512-1800, www.gpo.gov.

Code of Federal Regulations Title 14 Part 23, 25, 27, 29

§ 23.2530 External and cockpit lighting Taxi and Landing Lights

§ 91.209 Aircraft Lights

2.3.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

FAA Advisory Circular 91-57

FAA Advisory Circular 107-2

2.3.3 FAR Publications

Available from Federal Aviation Regulations, <https://faa.gov>.

Part 23 Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes

Part 25 Airworthiness Standards: Transport Category Airplanes

Part 27 Airworthiness Standards: Normal Category Rotorcraft

Part 29 Airworthiness Standards: Transport Category Rotorcraft

Part 107 Small Unmanned Aircraft Systems

2.3.4 Military Publications

MIL-L-006730

MIL-STD-TBD

2.4 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA DO-178 Software Considerations in Airborne Systems and Equipment Certification

2.5 Definitions and Acronyms

See Appendix A.

3. KEY CONSIDERATIONS

3.1 UAS Size and Weight Groups

Categorization of UASs will improve industry communication, facilitate knowledge sharing and result in a common reference when discussing performance of the UAS and an appropriate lighting design. There are five groups of UAS based on the commonly accepted attributes of size, weight, altitude, and speed as can be seen in Table 1.

Table 1 - Unmanned aircraft system groups

General Description	U.S. DoD Group	Weight (Pounds)	Size (Feet)	Normal Operating Altitude (Feet)	Airspeed (Knots)	Mission Radius (Miles)	Mission Duration (Hours)
HALE	Group 5	>1320	>60	>18000 MSL	ANY	>100	>15
Large	Group 4	>1320	<60	<18000 MSL	>250	>100	>15
Medium ⁽¹⁾	Group 3	<1320	<45	<18000 MSL	<250 <120 ⁽¹⁾	25 to 100	>15
Small	Group 2	21 to 55	<10	<3500 AGL	<250	3 to 25	2 to 15
Micro/Mini	Group 1	<20 ⁽²⁾	<3	<1200 AGL	<100	1 to 3	1 to 2
Nano		<1 to 4.5 ⁽²⁾	<1	<400 AGL	Slow	<1	<1

⁽¹⁾ Denotes commonly accepted attributes with existing FAA category of Light-Sport manned aircraft except as noted for airspeed.

⁽²⁾ Small hand launched vehicle.

3.1.1 UAS Operations

In the United States, the focus of this ARP, there are three types of unmanned aircraft system operations: civil, public, and model aircraft. Other countries such as the United Kingdom (UK) have only two system operations designations: military and civil.

- Civil UAS Operations (Non-Government)

Obtaining a Special Airworthiness Certificate in the experimental category for a particular UAS is currently the only way civil operators of unmanned aircraft are accessing the U.S. National Airspace System Space (NAS). Experimental certificate regulations preclude carrying people or property for compensation or hire, but do allow operations for research and development, flight and sales demonstrations and crew training.

Part 107 for Class 1-3 UASs.

- Public UAS Operations (Governmental)

Certificates of Waiver or Authorization (COAs) are available to public entities that want to fly a UAS in civil airspace. Common uses today include law enforcement, firefighting, border patrol, disaster relief, search and rescue, military training, and other government operational missions. Applicants make their request through an online process and the FAA evaluates the proposed operation to determine if it can be conducted safely.

- Model Aircraft Operations

Recreational use of airspace by model aircraft is covered by FAA Advisory Circular 91-57, which generally limits operations for hobby and recreation to below 400 feet, away from airports and air traffic, and within sight of the operator. In June 2014, the FAA published a [Federal Register notice](#) on its interpretation of the statutory special rules for model aircraft in the FAA Modernization and Reform Act of 2012. The law is clear that the FAA may take enforcement action against model aircraft operators who operate their aircraft in a manner that endangers the safety of the National Airspace System. In the notice, the FAA explains that this enforcement authority is designed to protect users of the airspace as well as people and property on the ground.

Policy Statement

The current FAA policy for UAS operations is that no person may operate a UAS in the National Airspace System without specific authority. For UAS operating as public aircraft, the authority is the COA; for UAS operating as civil aircraft the authority is special airworthiness certificates; and for model aircraft, the authority is AC 91-57.

3.1.2 UAS User Classifications

In addition to classifying the UA system above, there are four user classifications:

1. **Military Users:** This user class includes the Army, Navy, Air Force, Marines, Reserve and National Guard units, and the Coast Guard.
2. **Public Users:** This user class includes governments and government agencies at federal, state, and local levels. For example, it includes the Departments of Homeland Security, Justice, Interior, Transportation, FAA, FBI, and others at the federal level. State police and militias are in this class, as are local law enforcement agencies. Environmental, public health, and other government services at all levels are in the class of public users.
3. **Commercial Users:** This user class includes all companies or business partnerships operating UAS or causing them to be operated in the course of their business. Non-profit corporations are also included in this class.
4. **Private and Recreational Users:** This class of users includes all individuals or groups of citizens operating UAS for recreation, competition, or any other private endeavor.

3.1.2.1 Nano, Micro/Mini UAS

The nano, micro/mini, and some small unmanned aircraft (Groups 1 and 2) will become more prominent in civil operations by commercial users because of the vehicle's versatility and relatively low initial cost and operating expenses. The FAA is developing a proposed rule governing the use of a wide range of small civil unmanned aircraft systems.

Due to the size of these UASs, they represent a safety concern to manned aircraft, and the effects of some daylight conditions can make them difficult to control and maintain line of sight. Lighting on the Group 1, and smaller Group 2, vehicles should be achieved to the extent practicable for meeting overall safety and performance. At a minimum, a white anti-collision light located in the upper hemisphere for the unlikely occurrence of adjacent manned vehicles to observe is the best place to start. Additional illumination on the bottom as surface area and SWAP trade-offs allow. This will aid in pilot and ground spotter tracking of the vehicle or recovery if the vehicle is downed.

3.2 UAS Air Vehicle Characteristics

The design and development of a UAS with an appropriate exterior lighting system, is based on the category or Group of vehicles being developed (see Table 1) and the operations shown in 3.1.1 herein and the user classification shown in 3.1.2 herein. Given this information, along with a concept of operation – how the air vehicle will be utilized – the design process can begin.