The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE STANDARD

SAE AS5134

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Aviation Distress Signal

1. SCOPE:

This SAE Aerospace Standard (AS) provides minimum performance and design standards to be applied to an Aviation Distress Signal, a handheld, high-intensity, stroboscopic light source designed to facilitate location and rescue of aviation accident/ditching survivors by ground, sea or airborne search and rescue resources.

1.1 Purpose:

The purpose of this document is to define a device that can be used in lieu of pyrotechnic devices in aviation survival kits - while meeting two primary objectives: (1) provide an equivalent level of safety to pyrotechnics with respect to utility as an aid to search and rescue, and (2) eliminate significant potential equipment and personnel hazards posed by the use of pyrotechnics by untrained personnel in inflatable life rafts.

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 theh issue in effect on the date of the 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.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

ARP577	Emergency Placarding - Internal and External
ARP1282	Survival Kit, Life Rafts and Slide/Rafts

2.1.2 FAA Publications: Available from Federal Aviatioin Administration, 800 Independence Avenue, SW, Washington, DC 20591.

FAA Technical Standard Orders TSO-C69, TSO-C70

2.1.3 RTCA Publications: Available from RTCA Inc., 1140 Connecticut Avenue, NW, Suite 1020, Washington, DC 20036.

RTCA/DO-160	Environmental Conditions & Test Procedures for Airborne Equipment
RTCA/DO-227	Minimum Operational Performance Standards for Lithium Batteries

2.1.4 IESNA Publications: Available from IESNA, 120 Wall Street, Floor 17, New York, NY 10005.

Illumination Engineering Society of North America (IESNA) Lighting Handbook

2.2 Definitions:

2.2.1 LUMINOUS INTENSITY: In the case of stroboscopic lights, a light measurement in units of effective candela, as defined by the Blondel-Rey formula, given as:

$$I_c = \frac{\int_{t_1}^{t_2} I(t)dt}{0.2 + (t_2 - t_1)} \qquad \text{(Eq. 1)}$$

where:

I_c = effective luminous intensity (cd)
$I(t)$ = instantaneous intensity at time t
t_1, t_2 = flash time interval

2.2.2 OPERATING LIFE: The total elapsed time that the device will function at or above its minimum performance requirements. In the case of the power source, operating life is further limited by rated service life.

2.2.3 EXTENDED OPERATING LIFE: A calculated extension of operating life used in testing new, non-preconditioned power sources for showing compliance with power source operating life requirements; this is fully defined in 5.1.2.2.

2.2.4 SERVICE LIFE: The total calendar time from date of manufacture that a device can be expected to yield its full operating life before maintenance, service, or replacement is required. In the case of the power source, rated service life is further defined to be the maximum calendar time since manufacture during which the power source can yield the voltage and current necessary for the device to meet the minimum performance standards of this document with performance degradation due to extended storage taken into account.

2.2.5 UNTRAINED PERSONNEL: Individuals who are unfamiliar with and have no prior experience with civil or military survival equipment of the type carried on life rafts and specifically have no knowledge or experience with handheld strobe lights.

3. MINIMUM PERFORMANCE STANDARDS:

3.1 General:

The device shall be designed and configured in such a way as to (1) optimize ease and simplicity of use by survivors of aircraft accidents, (2) optimize effectiveness as a means to identify survivor location to air, sea and ground borne search and rescue forces, (3) optimize durability and reliability in the range of anticipated usage environments, and (4) minimize collateral harm or damage to personnel and equipment during use and storage.

3.2 Light Characteristics:

3.2.1 General: The device shall provide a flashing stroboscopic-type light with a flash rate in the range of 50 flashes per minute ± 10 flashes per minute over the rated service life of the power source, including end-of-life conditions at critical operating temperature extremes. The selection of flash duration (pulse width) and peak luminous intensity should be optimized for visual acquisition at greater distances from the source. Emitted light shall be full spectrum, unfiltered.

3.2.2 Intensity and Distribution: The light output of the device shall have four major components as described below and in Figure 1. These represent minimum performance requirements for each of the three sequenced flashes within each cycle at the end of rated service life for the power source, at the end of the minimum 200 h of operating life of the device, and at the extreme operating temperatures, as specified in this document.

3.2.2.1 Hemispherical Component: The device shall provide a mean luminous intensity of 2.0 effective candela over the hemisphere centered on and defined by the primary (vertical) axis of the device and the horizontal plane perpendicular to it; the tolerance on the center of this beam shall be ±5°. This requirement is intended to assure an omnidirectional signal most effective at relatively short acquisition distances.

3.2.2.2 Horizontal Component: The device shall provide a mean luminous intensity of 4.0 effective candela over a minimum 10° beam centered on the plane perpendicular to the primary (vertical) axis of the device; the tolerance on the center of this beam shall be ±10°. This requirement applies to a full 360° of horizontal arc, though gaps of lower intensity totaling no more than 30° of arc are allowed. This requirement is intended to assure an effective signal for SAR resources conducting a scanning search over the horizon.

3.2.2.3 Vertical Component: The device shall provide a mean luminous intensity of 4.0 effective candela over a minimum 5° beam centered on the primary (vertical) axis of the device; the tolerance on the center of this beam shall be ±10°. This requirement is intended to assure an effective signal when directed (pointed) by the user toward a SAR resource at a specific location as determined by sight or sound.

3.2.2.4 Oblique Component: The device shall provide a mean luminous intensity of 4.0 effective candela over a minimum 5° beam centered 45° down from the primary (vertical) axis of the device; the tolerance on the center of this beam shall be ±10°. This requirement applies to a full 360° of horizontal arc, though gaps of lower intensity totaling no more than 30° of arc are allowed. This requirement is intended to assure an effective signal during rough sea conditions for SAR resources conducting a scanning search over the horizon.

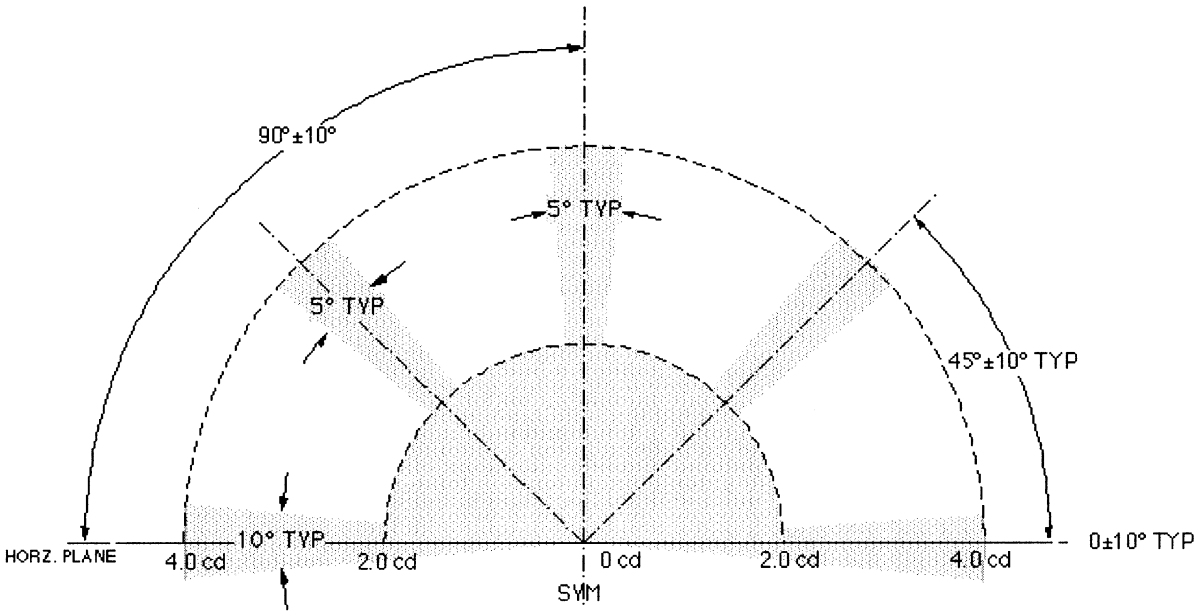

FIGURE 1

3.3 Operating and Service Life:

3.3.1 Operating Life: The device, including the lamp but excluding the power source, should be designed for a minimum operating life of 200 h without component failure or necessity for maintenance or repair. The power source shall be capable of meeting minimum performance requirements during 16 h of constant operation at the end of the power unit's rated service life at ambient air temperatures between 30.2 °F (-1 °C) and 120 °F (+48 °C). This requirement may be met by a single power source, or two separate, replaceable power sources designed for use one at a time.

3.3.2 Service Life: The device and its approved power source(s) shall have a minimum service life of four years before maintenance, inspection, and/or power source replacement is required. A non-disposable device should be designed to allow replacements of the power source to provide an extended service life through multiple power source replacement and survival kit stowage cycles.

3.4 Environmental Performance Standards:

3.4.1 Extreme Temperature Exposure/Storage and Temperature Variation: The device shall be capable of being stored for extended periods at static and fluctuating temperatures in the range of -65 to +160 °F (-54 to 71 °C) without damage or degradation.

3.4.2 Mechanical Shock and Vibration: The device shall be capable of withstanding mechanical shock and vibration regimes that can be expected in normal aircraft operation as well as crash/ditching situations.

3.4.3 Waterproofness/Humidity/Salt Spray: The device shall be waterproof, and resistant to the effects of humidity and salt spray.

3.4.4 Altitude and Decompression: The device shall be capable of withstanding the altitude and decompression environments applicable to the equipment location/installation.

3.4.5 RF Susceptibility: The use of the device shall not interfere with the operation of emergency radio equipment, such as emergency locator transmitters, nor shall the performance of the device be compromised by the operation of such equipment.

4. DESIGN STANDARDS:

4.1 General:

4.1.1 Materials: Materials used in the construction of the device shall not corrode, degrade, or prove harmful to personnel or equipment during extended use in a marine environment.

4.1.2 Protection: The device shall be designed, constructed, and shown to be resistant to the compressive forces generated within life raft and slide/raft packs during packing and stowage. Special care shall be given to the design and/or protection of appurtenances (e.g., external switching means, lenses) which would be susceptible to damage in these conditions. An acceptable means of meeting this requirement is to provide a suitable protective package with the device. If this approach is used, retrieval of the device from the protective package must be simple, self-evident, and capable of execution by an untrained user.

4.1.3 Utility: The device shall be as compact and lightweight as possible. It shall be capable of being held securely in one hand, with the lens completely free and unobstructed.

4.1.4 Personnel/Equipment Interface: The device shall have no sharp points or edges that could harm or damage personnel or equipment.

4.1.5 On/Off Switching: On/off switching provisions shall be obvious, and consistent with good ergonomic practice. The switch shall be easily operated by an untrained individual in daylight or darkness while the device is being held by a single hand. Switch design and its manner of operation shall preclude inadvertent activation from mishandling or mechanical shock.

4.1.6 Security Means: The device shall include a closed loop lanyard of a non-rotting material with a minimum opened diameter of 20 in. The lanyard material shall be of a type, texture, and size to minimize the effects of abrasion or laceration of bare skin when worn around the neck or wrist, and when a steady force of 25 lb (11.4 kg) is applied to the device. The lanyard shall have an effective cross-sectional area of no less than 0.30 in^2 (1.93 cm^2) or a diameter of no less than 0.120 in (0.30 cm). The lanyard and its security point(s) shall have a minimum breaking strength of 50 lb (22.75 kg).

4.1.7 Mounting Provisions: The security lanyard and its attachment provisions shall anticipate and facilitate the attachment or mounting of the device to other structures, including the canopy and/or available raft structures, so that the device may operate with minimum obstruction in a hands-free mode.

4.2 Power Source:

4.2.1 General: The device shall have a self-contained power source capable of meeting the applicable requirements of this specification. If the power source contains lithium metal, it shall be tested and certified in accordance with RTCA DO-227 or the applicable FAA Technical Standard Order.

4.2.2 Electrical Connections: Electrical connections between the power source and the device, and between individual battery cells (in the case of multiple cell power sources), shall be of a type and design that provides a mechanically secure, low impedance connection that shall not be adversely affected by moisture or corrosion effects, or the environmental conditions specified in 4.3. The use of aviation-standard, locking connectors and resistance-welded or soldered inter-cell connections is generally recommended, though any electrical connection means which can be shown to provide an equivalent level of reliability and performance may be considered. Dissimilar metals should be avoided in mating electrical contacts unless suitable corrosion-inhibiting provisions are made.

4.2.3 Circuit Protection: In the case of series/parallel power source configurations, appropriate circuit protection for each parallel subsystem shall be provided.

4.2.4 Power Unit Replacement: If operating life requirements are met with two separate power sources, replacement of the power source must be shown to be easily accomplished by an untrained user without tools. Replacement of the power source must not, in and of itself, compromise the integrity, functionality, security, or waterproofness provisions of the device.

4.3 Markings:

4.3.1 Data Plate: The device shall be indelibly marked, as a minimum, with the following information in English: (a) device nomenclature, part number and model number (as applicable), (b) name and location of manufacturer, (c) date of manufacture and/or serial number, (d) operating voltage (as applicable), and (e) recommended replace by date (battery pack only).

4.3.2 Operating Instructions: Any operating instructions or markings needed in support of 4.1.5 shall be permanently imprinted or embossed on the device; operating means (e.g., ON/OFF switches) and their mode of operation shall be clearly marked or identified using, at a minimum, high contrast markings and/or legends.

4.3.3 Ancillary Instructions: Separate instructions, if not included in a general survival manual installed in the survival kit, shall be provided to optimize the effective use of the device in survival and rescue scenarios and shall provide cautionary information regarding possible negative physiological effects of the operation of high-intensity stroboscopic light sources in close proximity, including disorientation, eyesight impairment, and nausea/motion sickness. These instructions, where required, shall be indelibly imprinted on waterproof materials and should rely extensively on graphics. These instructions shall be attached to the device in such a manner as to ensure their availability to operators when the unit is initially unpacked from the survival kit, but so as to allow for removal during actual use of the device. As an alternative, these instructions may be permanently affixed to the device by waterproof markings or label.

4.3.4 Color: The body of the device shall be of high contrast international yellow or orange color as usually is identified with survival or safety equipment. Markings shall be of a high contrast color relative to the background color of the device.

4.3.5 Power Source Marking: The date of manufacture and “replace by” date of any replaceable power source shall be conspicuously marked on the exterior of the device and shall likewise be marked on or be visible through any protective packaging to facilitate easy readability if the device is stowed in clear survival kit packaging. In addition, any replaceable power source shall bear all of the markings of 4.3.1 through 4.3.2.

4.3.6 Hazard Markings: Explosion/fire, and toxic or corrosive effluent warnings shall be conspicuously marked on any replaceable power source, or on the exterior of the device in the case that internal power sources are not replaceable.

5. QUALIFICATION TESTING:

5.1 Environmental Performance:

5.1.1 General: As a minimum, the device shall be tested to show compliance with the following Sections, using the applicable procedures of RTCA DO-160. Tests shall be conducted by a qualified facility, using test equipment maintained in current, traceable calibration. In addition to the pass/fail criteria imposed by RTCA DO-160, the device shall be shown to meet the minimum performance standards of Section 3 after completion of all tests and show no evidence of deterioration in function, materials, sealing provisions, or other characteristics which could affect the performance or long term storage of the device.

5.1.2 Pretest Conditioning:

5.1.2.1 To show compliance to the operating and service life requirements of 3.3, any stored energy or battery power source(s) shall be preconditioned, prior to testing, to simulate end of service life status (e.g., loss of ampere-hour capacity due to self-discharge and cell degradation) expected by the battery cell manufacturer over the rated service life. This preconditioning should be done in a manner and to an extent prescribed or endorsed by the cell manufacturer. Pretest conditioning must be accomplished before any other qualification testing is accomplished.

5.1.2.2 As an alternative to pre-test conditioning for operating and service life testing requirements, the device may be tested with a fresh power source, but the minimum performance standards must be shown to have been met at an “extended” operating life defined as follows: the “extended” operating life is the required operating life as defined by 3.3.1 (e.g., 16 h for a single power source), extended by the cumulative percentage of the power source (e.g., cell) manufacturer’s established and documented annual degradation estimate for the particular power source (cell).

5.1.2.2 (Continued):

Sample Calculation: The “extended” operating life for a power source with a 5 year service life rating using a primary alkaline cell for which the cell manufacturer estimates a 3% annual degradation due to self-discharge would be calculated as:

$$\begin{aligned} \text{Extended Operating Life} &= [100\% + (5 \text{ years} \times 3\% \text{ per year})] \times 16 \text{ h} \\ &= 115\% \times 16 \text{ h} \\ &= 18.4 \text{ h} \end{aligned} \qquad \text{(Eq. 2)}$$

5.1.3 Ground Survival Low Temperature and Low Temperature Operating Test: Testing per RTCA DO-160 (latest revision), Category A3, Table 4.1, shall apply, with the following exceptions: (a) after the ground survival temperature test, the test chamber shall be adjusted so that the device and its power source shall be stabilized at -1 °C (30.2 °F) for at least 3 h prior to initiation of the operating low temperature test, (b) the operating low temperature test shall be conducted at 30.2 °F (-1 °C) and data recorded for no less than 20 h.

5.1.3.1 Low Temperature Operating Test (Determination of Initial and Critical End-of-Life Voltage and Current): After stabilization at 30.2 °F (-1 °C), and immediately upon initiation of the low temperature operating test, the initial power source voltage and current shall be recorded. For power source preconditioned per 5.1.2.2, record the power source voltage and current after 16 h of operation at 30.2 °F (-1 °C) (8 h for a dual power source system); for a power source tested under the “extended” operating life option of 5.1.2.2, record the power source voltage after the calculated “extended” hours of operation at 30.2 °F (-1 °C) (half that for a dual power source system).

5.1.4 Ground Survival High Temperature/Short Time Operating High Temperature Test: Category A3, per RTCA DO-160.

5.1.5 Altitude Test: Category A3, per RTCA DO-160.

5.1.6 Decompression Test: Category A3, per RTCA DO-160.

5.1.7 Temperature Variation Test: Category C, per RTCA DO-160.

5.1.8 Humidity Test: Category C, per RTCA DO-160.

5.1.9 Operational Shocks Test: Per RTCA DO-160.

5.1.10 Vibration (Standard) Test: Per RTCA DO-160.

5.1.11 Waterproofness Test: Category R, per RTCA DO-160. In addition to the requirements of RTCA DO-160 (latest revision), verify that imprinted markings, dyes used in the lanyard material, and any other physical elements of the device are not degraded by exposure to this test. If a separate instruction sheet is to be provided with this device per 4.3.3, this sheet should be subjected to this test as well, verifying that it withstands the test in a usable, readable condition.

5.1.12 Salt Spray Test: Category S, per RTCA DO-160.

5.1.13 RF Susceptibility Test: Category “W”, per RTCA DO-160.

5.2 Luminous Intensity and Flash Rate/Cycle Testing:

5.2.1 Flash Rate Testing:

5.2.1.1 After determining power source output voltage and current at both the initial and the critical, end-of-life point, as specified in 5.1.3.1 above, flash rate shall be tested to show compliance with 3.2. For this testing, the standard power source shall be removed and the device shall be connected to a regulated DC power supply. Ensure that the DC power supply is capable of providing the current levels determined in 5.3.1.1, and that the unit is set up to provide the level of current required.

a. Set the DC power supply to the initial power source voltage recorded in 5.1.3.1 and record flash rate. Flash rate and cycle shall be demonstrated to be within the limits established in 3.2.1.

b. Set the DC power supply to the critical, end-point voltage recorded in 5.1.3.1 above and record flash rate. Flash rate and cycle shall be demonstrated to be within the limits established in 3.2.1.

5.2.2 Luminous Intensity Testing:

5.2.2.1 After determining power source output voltage and current at initial and the critical, end-of-life point, as specified in 5.1.3.1 above, luminous intensity shall be tested to show compliance with 3.2.

5.2.2.2 Testing, including test facilities and methodologies, shall be in accordance with generally accepted lighting industry testing practices and standards to show full compliance with minimum performance requirements specified herein. Production-equivalent luminaires must be tested to demonstrate compliance; compliance cannot be shown by theoretical derivation, calculation, extrapolation of small data sets, or use of data other than those generated in these tests.

5.2.2.3 Photometric equipment used shall be of a type specifically designed for testing of rapid stroboscopic light sources, shall be within current calibration, set to manufacturer recommended settings for the testing to be conducted, and shall be accurate within 3%. Measurements shall be in effective candela with appropriate adjustments for the human response to flashing light sources per Blondel-Rey and measurement distance effects. If the photometer is not capable of recovering in sufficient time to effectively measure single flash performance without integrating the effects of multiple, rapid flashes, the test set-up and/or equipment shall be modified to make effective and true measurements of single flash performance.

5.2.2.4 For this testing, the standard power source shall be removed and the power source contacts of the device shall be connected directly to a regulated DC power supply.

5.2.2.5 Luminous intensity measurements in effective candela shall be recorded at polar coordinates over 360° of arc at increments of no more than 20° of arc at the following angles (±5°) from the horizontal plane of the device: 0° (horizontal), 15°, 30°, 45°, 60°, 75°, and 90° (vertical). This requires no fewer than 18 readings at each of the six angles below vertical, and a least one reading at vertical (a minimum of 109 readings).

5.2.2.6 With the device fixed in the test fixture or set-up, set the DC power supply to the critical, end-of-life power source voltage and current recorded in 5.1.3.1. Record luminous intensity on polar coordinates as specified in 5.2.2.5. Luminous intensity shall be demonstrated to be at or above the minimum requirements of 3.2.2 at all points specified in 5.2.2.5.

5.3 Other Qualification Testing:

5.3.1 Lanyard Strength Test: With the lanyard properly attached to the device, loop the loose end of the lanyard around a 2 to 3 in (5 to 7.6 cm) diameter horizontal structural member, and apply a 50 lb static load to the device in such a manner as to verify that the minimum breaking strength of the lanyard and its attachment to the device is met or exceeded.

5.3.2 Device Operation and Personal Safety Test: Seat an untrained subject, as defined in 2.3.5, in a darkened room measuring no more than 0.003 fc of ambient light. Instruct the subject only that he/she will be asked to activate a handheld strobe light, and that they will be timed. Place the device, with its lanyard in its normally stowed configuration, into the hands of the subject and commence timing. Stop and record the test time immediately after the subject activates the device. Turn on the lights and ask the subject if any discomfort or personal injury resulted from activating the device. A successful activation/operation design is demonstrated when 80% of at least five untrained subjects can activate the device within 60 s, and none of the subjects report or demonstrate any personal injury.

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