F-01-13

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AEROSPACE STANDARD

AS 8034

Issued 12-30-82
Revised

MINIMUM PERFORMANCE STANDARD FOR AIRBORNE MULTIPURPOSE ELECTRONIC DISPLAYS

1. PURPOSE: This Aerospace Standard (AS) specifies minimum performance standards for airborne, electronic displays except for single purpose/single function (i.e., weather radar, fuel quantity, radar altitude, digital clock, etc.) which are primarily intended for use by the pilot or other flight personnel under standard and other environmental conditions.

2. SCOPE: This AS covers all types of electronic display systems, as qualified in "Purpose", both panel mounted (head down) and electro-optical (head up), monochromatic and color which are used in the cockpit by flight personnel.

Three basic types of displays are covered as follows:

Type I Primary Flight and Navigation Displays
which include vertical and horizontal situation displays.

Type II Systems & Warning Displays
which include engine instrument, aircraft systems performance, warning, and documentation displays.

Type III Control Displays
which include communication, navigation and system control displays.

Airborne Multipurpose Electronic Displays can include one or more of the following interconnected components. An example is shown in Figure 1. Other configurations are possible.

Symbol Generator/Processor Unit (SG)
containing display processing and symbol generation capability, power supplies, interface logic/buffer circuits and Display Unit interface capability. The SG receives data from external sources, produces symbols as electronic signals, and transmits the symbols to the Display Unit(s).

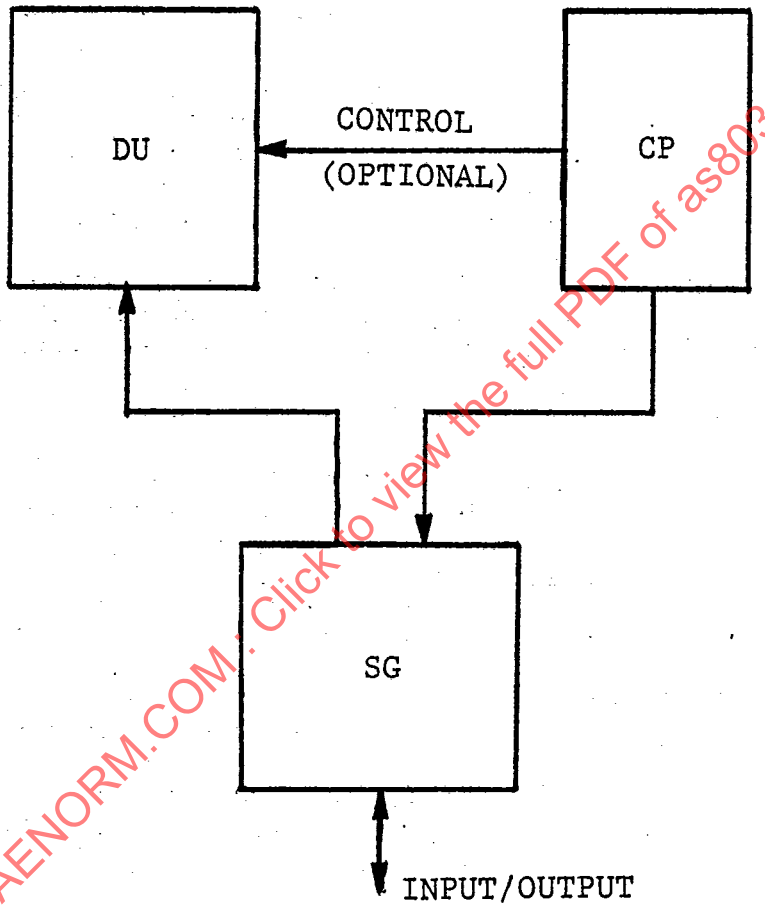

Figure 1. Block Diagram Typical Electronic Display System

2. Continued:

Control Panel (CP)
is an optional component providing the means for manually selecting display symbology options/modes, selections, settings and brightness controls, etc.

Display Unit (DU)
providing the visual display of SG symbology. In the case of Head up Displays, this information is combined with a view of the real world.

Electronic display systems covered by this AS are multifunction and/or multipurpose displays, whose failure can lead to loss of critical displayed information. System design or installation must recognize this characteristic and include appropriate redundancy criteria where applicable.

2.1 Applicable Documents: The following documents shall form a part of this AS to the extent specified herein. In event of conflict between these documents and this standard, the contents of this standard shall govern.

2.1.1 Federal Air Regulations: The applicable portions of the following document should be adhered to:

FAR 25 - "Airworthiness Standards: Transport Category Airplanes", including Appendix F Effective change September 9, 1980

2.1.2 SAE Documents:

*ARP 1782 - Color and Light Intensity Measurements for Direct View CRT

2.1.3 Other:

Radio Technical Committee for Aeronautics:

RTCA DO-160A - Environmental Conditions and Test Procedures for Airborne Equipment, dated: January 25, 1980

Electronic Industries Association:

TEPAC PUB. NO. 64D - Recommended Practice for Measurement of X-Radiation from Direct View Television Picture Tubes

2.2 Related Documents: The following document provides information related to the equipment of this AS:

ARP 1068 - Flight Deck Instrumentation and Display Design Objectives for Transport Aircraft

*Currently in preparation

3. GENERAL STANDARDS:

3.1 Material: Material shall be of a quality which experience and/or tests have demonstrated to be suitable and dependable for use in aircraft instruments.

3.2 Workmanship: Workmanship shall be consistent with high quality aircraft electromechanical and electronic instrument manufacturing practices.

3.3 Compatability of Components: If a display system component is individually acceptable but requires calibration adjustments or matching to other components in the aircraft for proper operation, it shall be identified in a manner that will insure performance to the requirements of this AS.

3.4 Interchangeability: Display system components which are identified with the same manufactured part or model number shall be completely interchangeable.

3.5 Accessibility of Controls: Controls which are not normally adjustable in flight shall not be readily accessible to flight personnel when the instrument is installed in accordance with the instrument manufacturer's instructions.

3.6 Self-Test Capability: If the equipment contains integral arrangements to permit pre-flight and/or in-flight self-test checks on the operation of the equipment in combination with other aircraft sub-systems, such tests shall not adversely affect any associated subsystem.

In-flight, self-test activation features must include a means to warn the pilot or appropriate flight crew member of this mode of operation.

3.7 Effect of Tests: Unless otherwise stated, the application of all prescribed in service testing shall not produce a subsequent condition which would be detrimental to the continued performance of the instrument.

3.8 Malfunction Indication: Means must be provided to indicate malfunctions or failures to the appropriate crew member.

3.8.1 Power Failure Indication: Means shall be incorporated in the instrument to indicate when adequate electrical power (voltage and/or current of all required phases), is not being made available for proper operation of the instruments.

3.8.2 Fail Safe Provision: No single failure or malfunction of the instrument system shall introduce unsafe transients to associated interconnected instruments.

3.9 Multiple Mode Indications: When an instrument has more than one mode, each mode of operation shall be identified by the instrument system.

3.10 Identification: The following information shall be legible and permanently marked on the instrument or nameplate attached thereto.

a) Name of instrument
b) Manufacturer's part number
c) Manufacturer's serial number or date of manufacture
d) SAE AS 8034 or equivalent approval identification
e) Manufacturer's name or trademark
f) Weight to the nearest 0.05 kilogram (tenth of a pound)
g) Environmental Categories

3.11 Display: The information being displayed should functionally conform to the applicable Aerospace Recommended Practice.

3.11.1 Discernibility: Appropriate means shall be incorporated to prevent obscuration or confusion of critical information.

3.11.2 Critical Information: Means shall be provided to prevent the removal of information deemed critical to safe aircraft operation.

3.11.3 Information Limit Indication: A means shall be provided to identify when critical displayed information exceeds display format functional limits.

3.11.4 Scale Readability: The display scaling, graduations, and numeration shall be appropriate for the level of reading accuracy and dynamic range required.

3.11.5 Ambiguity: Appropriate means shall be provided to prevent ambiguous indications within the operating range of the instrument.

3.11.6 Integral Lighting: When integral lighting is provided, it must, under normal cockpit lighting conditions, make all indices within the required viewing envelope easily readable.

3.12 Hermetic Sealing: When hermetically sealed, the case shall be filled with an inert gas, free of dust particles, and sufficiently dry so that fogging of the indicator glass does not occur during the low temperature and fogging tests of this AS.

3.13 Mechanical Hazard System Protection: The display should be so designed that no hazard will result from implosion, or other mechanical failures.

3.14 Fire Resistance: Except for small parts, (e.g. fasteners, grommets, knobs, seals, small electrical parts), that would not contribute significantly to the propagation of a fire, all materials used must be self-extinguishing when tested in accordance with the requirements of Federal Aviation Regulation 25.853 and 25.1359 (d) and Appendix F thereto, with the exception that materials tested may be configured in accordance with paragraph (b) of Appendix F or may be configured as used.

3.15 Supplemental Heating/Cooling: Where supplemental heating or cooling is required by the equipment to ensure conformance with this standard, it shall be the responsibility of the manufacturer to specify such requirements.

4. MINIMUM PERFORMANCE STANDARDS UNDER STANDARD CONDITIONS:

The manufacturer shall conduct sufficient tests to prove compliance with this AS.

4.1 Equipment Functions and Mechanical Operation: Equipment shall display information in modes with contents as specified by the appropriate standard documents for that display. All mechanical devices shall operate satisfactorily.

4.2 Viewing Characteristics: The following requirements apply to the instrument in its installed position and as viewed under all cockpit light conditions from the manufacturer's design eye viewing envelope.

The instrument manufacturer shall specify the instrument's design eye viewing envelope. This limitation shall contain, as a minimum, the total viewing angles in both the horizontal and vertical planes measured normal to the plane of the display surface, and the minimum and maximum distances from the center of display surface for which the instrument complies with this minimum standard.

4.2.1 Viewing Angle: The display system shall have sufficient viewing angle to provide complete visibility of the displayed information from any viewing position within the specified design eye viewing envelope.

4.2.2 Symbol Alignment: Symbols which are interpreted relative to each other, including mechanically produced symbols that are interpreted relative to electronically produced symbols, shall be aligned, including parallax effects throughout the design eye viewing envelope, to preclude misinterpretation of information.

4.2.3 Positional Accuracy: The display absolute positional accuracy shall be better than 5% of the maximum diagonal dimension of the display. In no case shall the absolute positional error cause erroneous data to be presented.

4.2.4 Drift: Dimensional and positional stability of display system presentations shall be sufficient to ensure the requirements of paragraphs 4.2.1, 4.2.2, and 4.2.3 are met. Drifts shall in no case cause an erroneous interpretation of the information presented.

4.2.5 Line Width: Line widths shall be of sufficient size and sharpness to display the intended information with no distracting visual effects or ambiguities.

4.2.6 Jitter: Display jitter shall be no greater than 0.6 milliradians when viewed within the design eye viewing envelope as specified by the instrument manufacturer.

4.2.7 Flicker: The display shall not exhibit an unacceptable level of flicker under the full range of ambient environment up to the maximum ambient illumination level specified by paragraph 4.3.1 when viewed from any viewing angle defined in paragraphs 4.2 and 4.2.1, with both foveal and full peripheral vision.

4.2.8 Symbol Quality: Lines, symbols, and characters shall have no tails, squiggles, skews, or gaps discernible from the design eye viewing envelope which cause erroneous interpretation.

4.3 Photocolorimetric Characteristics:

4.3.1 Discrimination: Displayed information shall have sufficient luminance contrast and/or color difference to discriminate between the following as applicable:

a) Between symbols, characters and/or lines and overlayed background (ambient or generated).

b) Between individual symbols, characters and lines when they overlay ambient or generated backgrounds.

c) Between generated backgrounds and ambient backgrounds.

d) Between generated backgrounds of various specified colors.

In all cases the luminance contrast and/or color differences between all symbols, characters, lines, or all backgrounds shall be sufficient to preclude confusion or ambiguity as to information content of any displayed information. When operationally required, the absolute color of the information shall be identifiable. The manufacturers shall specify the maximum ambient illumination level and illuminate characteristic for which this requirement is met.

4.3.2 Luminance Characteristics:

4.3.2.1 Luminance: The display luminance shall be sufficient to provide a usable display under the maximum ambient illumination level appropriate to the display type (as defined in paragraph 2 of this AS) and application.

4.3.2.2 Luminance Uniformity: The luminance of a given symbol, line, character, or generated background shall not vary more than:

1) ±30% when located within the useful display area, or

2) ±20% when located within the central 80% of the useful display area.

These requirements apply for any luminance control setting.

4.3.2.3 Manual Luminance Control: The display system shall have capability for manual luminance control.

4.3.2.4 Automatic Luminance Control: If the display system has automatic luminance compensation, the operation of this compensation shall function so that the system meets the requirements of paragraph 4.3.1 under changing cockpit ambient light levels. Manual luminance control shall not be adversely affected by failure of the automatic luminance control.

4.3.2.5 Luminance Tracking: When the luminance of the display is varied from maximum to minimum, the relative luminance of all displayed symbols, characters, lines, and generated backgrounds shall visually remain constant. In no case shall any symbols or characters become invisible at the minimum luminance setting while other characters or symbols are visible.

4.3.3 Color: Where multiple colors are used to enhance discrimination, the use of color shall not result in the erroneous or ambiguous interpretation of the displayed information. In no case should colors be selected which conflict with the requirements of paragraph 4.3.1.

In general, color should not be used as the only coding dimension for critical information.

4.3.4 Color Uniformity: The color difference between any symbols of the same color located at any position within the useful display area shall not be sufficient to cause an ambiguity or an incorrect identification of an assigned color over the entire range of luminance control.

4.3.5 Convergence: When a display element is a composite of multiple traces (such as multiple guns of a shadow mask CRT, or alternate fields of a beam penetration CRT), the beam centers shall be converged. This convergence value at any point shall be within the average of the line widths of the respective traces at that point. This requirement applies over the useful display area for all symbol intensity settings.

4.3.5 Continued:

When a display element is comprised of two or more closely spaced traces (such as raster generated symbology) the primary gun beam centers shall be converged. This convergence value shall be within one display line width or 0.7 milliradians, whichever is greater, when viewed from the manufacturer's specified design eye position.

In no case shall misconvergence cause a line, symbol, or character color or form to be ambiguous.

4.4 Head Up Display (HUD) Supplemental Requirements: The following additional requirements shall apply to Head Up Displays.

4.4.1 Line Width: The HUD symbol line width shall be no greater than two milliradians when measured at the 50% intensity points with symbol luminance set at maximum.

4.4.2 Display Visibility: The HUD symbology shall be clearly visible against a white light ambient background of 34,000 candelas/m^2 (10,000 foot-lamberts). The HUD contrast shall be not less than 1.1. Contrast is defined as follows:

$$C = \frac{D + B}{B}$$

where C = Contrast
D = Display luminance reflected off combiner
B = Background luminance through the combiner.

4.4.3 Transmissivity: The light transmissivity of the HUD combiner over the field of view of the HUD shall be a minimum of 65% at an angle of incidence determined by the horizontal reference line intersection with the combining glass surface.

4.4.4 Collimation: Displayed HUD symbols shall be collimated to appear to be focused at not less than 15 meters (50 feet) in front of design eye viewing envelope for all head positions within the allowable head motion envelope and over the total field of view of the HUD.

4.4.5 Parallax: For a single display element viewed with two eyes laterally displaced 6.4 centimeters (2.5 inches) from each other and centered within the design eye viewing envelope, the HUD parallax shall not exceed:

a) 1.0 milliradian - vertically
b) 1.0 milliradian azimuth - eyes diverging
c) 4.2 milliradians azimuth - eyes converging

4.4.6 Combining Glass Assembly: The combining glass assembly shall be designed so that the pilot(s) will not be injured by contact with the combiner.

4.4.6.1 Real World Distortion: The HUD combining glass assembly shall not cause the angular location of real world objects, as they appear through the combining glass assembly, to deviate by more than 0.5 milliradian. This deviation requirement shall apply for all head positions within the allowable HUD head motion envelope and over the total field of view of the HUD. The 0.5 milliradian maximum allowable radial error shall be computed as the root sum square of the azimuth and elevation component errors.

4.4.7 Mechanical Boresight Accuracy: The maximum allowable misalignment of the HUD boresight in relationship to the mounting points of the HUD, shall be no greater than 2 milliradians in elevation and 4 milliradians in azimuth.

4.4.8 Symbol Positioning Accuracy: The maximum allowable symbol position error relative to the HUD boresight shall be 8 milliradians when measured from the design eye position. This allowable error shall apply over the field of view visible from the design eye position. An additional 2 milliradians of error shall be allowed for the remaining HUD field achieved by head movement. Symbol position error shall be defined as the root sum square of the azimuth and elevation displacements from specified position. This paragraph supersedes the requirements contained in paragraph 4.2.3.

4.4.8.1 "Real World" Symbol Position Errors: Symbol position error allowances of paragraph 4.4.8 shall apply to all symbols that are required to overlay a defined "real world" point in space, relative to the HUD mounting points and shall include all sources of error in the display system.

5. MINIMUM PERFORMANCE STANDARDS UNDER ENVIRONMENTAL CONDITIONS:

To demonstrate compliance with this document the following tests shall be conducted in accordance with the applicable paragraphs herein:

		Paragraph
a)	Temperature and Altitude Tests	5.2
b)	Temperature Variation Test	5.3
c)	Humidity Test	5.4
d)	Shock Tests	5.5
e)	Vibration Tests	5.6
f)	Explosion Tests (When Required)	5.7
g)	Waterproofness Test (When Required)	5.8
h)	Fluids Susceptibility Test (When Required)	5.9
i)	Sand and Dust Test (When Required)	5.10
j)	Fungus Resistance Test (When Required)	5.11
k)	Salt Spray Test (When Required)	5.12
l)	Magnetic Effect Test	5.13
m)	Power Input Test	5.14
n)	Voltage Spike Conducted Test	5.15

5. Continued:

o)	Audio Frequency Conducted Suspectibility Test	5.16
p)	Induced Signal Susceptibility Test	5.17
q)	Radio Frequency Susceptibility Test	5.18
r)	Emission of Radio Frequency Energy Test	5.19
s)	X-Ray Radiation	5.20
t)	U.V. Radiation	5.21
u)	Fogging	5.22
v)	Thermal Shock	5.23
w)	Dielectric Test	5.24

Unless otherwise specified, the environmental measurement procedures applicable to a determination of performance under environmental conditions are set forth in Radio Technical Commission for Aeronautics, RTCA document number DO-160A dated January 25, 1980. Performance tests which must be made after subjection to test environments may be conducted after exposure to several environmental conditions. The order of tests must be in accordance with paragraph 3.2, page 5 of DO-160A.

5.1 Requirements: The following requirements shall be met for the environmental conditions as required in the applicable paragraph.

5.1.1 Viewing Characteristics: The display system shall meet the viewing characteristics of the following paragraphs:

a)	4.2.2	Symbol Alignment
b)	4.2.4	Drift
c)	4.2.5	Line Width
d)	4.2.7	Flicker
e)	4.2.8	Symbol Quality

5.1.2 Luminance: The display luminance shall be sufficient for the display to perform its intended function.

5.1.3 Color: Where multiple colors are used, any change in color shall not cause ambiguous or erroneous information to be presented.

5.1.4 Color Registration: For multicolor displays, color misregistration shall not cause symbol color to be ambiguous or erroneous information to be presented.

5.1.5 Mechanical Operation: All mechanical devices shall operate satisfactorily.

5.2 Temperature and Altitude Tests: (Paragraph 4.0, DO-160A)

5.2.1 Low-Temperature Test: When the display system is subjected to this test, the requirements of paragraph 5.1 of this AS shall be met.

5.2.2 High Temperature Test:

a) When subjected to the High Short-Time Operating Temperature, the equipment shall function both electrically and mechanically.

b) When the equipment is operated at the High Operating Temperature:

1. The requirements of paragraph 5.1 of this AS shall be met.

2. Systems which require cooling air shall meet paragraph 5.1 of this AS when subjected to the High Operating Temperature for a period of 30 minutes with no cooling air.

5.2.3 Altitude Test: When subject to this test, the requirements of paragraph 5.1 of this AS shall be met.

5.2.4 Decompression Test (When Required): When subjected to this test, the requirements of paragraph 5.1 of this AS shall be met.

5.2.4.1 Decompression: When installed in accordance with the instrument manufacturer's instructions, the instrument shall function and not be adversely affected following exposure to the decompression test conditions of DO-160A, paragraph 4.6.2.

5.2.4.2 Outgassing: The instrument shall be so designed as to safeguard against hazards to the aircraft and crew, and/or malfunction of the instrument due to outgassing of organic or inorganic compounds when subjected to the altitude conditions of DO-160A, paragraph 4.6.

5.2.5 Overpressure Test (When Required): When the equipment is subjected to this test, the requirements of paragraph 5.1 of this AS shall be met.

5.3 Temperature Variation Test (Paragraph 5.0, DO-160A): When the equipment is subjected to this test, the requirements of paragraph 5.1 of this AS shall be met.

5.4 Humidity Test (Paragraph 6.0, DO-160A): After being subjected to this test, the following shall apply:

5.4.1 Within 15 minutes after primary power is applied, the equipment shall operate at a level of performance which indicates that no significant failures of components or circuitry have occurred.

5.4.2 Within four hours after primary power is applied, the requirements of Section 4 of this AS shall be met.

5.5 Shock Tests (Paragraph 7.0, DO-160A):

a) After being subjected to the Operational Shock Test, the requirements of Section 4 of this AS shall be met.

5.5 Continued:

b) After being subjected to the Crash Safety Shocks, the equipment shall remain in its mounting and no parts of the equipment or its mounting shall have become detached.

5.6 Vibration Tests (Paragraph 8.0, DO-160A):

a) When subjected to this test, the display shall not distort either dimensionally or in visual characteristics to the extent that it presents ambiguous or erroneous information.

b) At the conclusion of vibration testing, the requirements of Section 4 of this AS shall be met.

5.7 Explosion Test (When Required) (Paragraph 9.0, DO-160A): During this test, the equipment shall not cause detonation of the explosive mixture within the test chamber.

5.8 Waterproofness Test (When Required) (Paragraph 10.0, DO-160A): After being subjected to this test, the requirements of Section 4 of this AS shall be met.

5.9 Fluids Susceptibility Test (When Required) (Paragraph 11.0, DO-160A: After being subjected to this test, the requirements of Section 4 of this AS shall be met.

5.10 Sand and Dust Test (When Required) (Paragraph 12.0, DO-160A): After being subjected to this test, the requirements of Section 4 of this AS shall be met.

5.11 Fungus Resistance Tests (When Required) (Paragraph 13.0, DO-160A): After being subjected to this test, the requirements of Section 4 of this AS shall be met.

5.12 Salt Spray Test (When Required) (Paragraph 14.0, DO-160A): After being subjected to this test, the requirements of Section 4 of this AS shall be met.

5.13 Magnetic Effect Test (Paragraph 15.0, DO-160A): When the equipment is subjected to this test, it shall meet the requirements of DO-160A for the category of installations for which it is intended.

5.14 Power Input Test (Paragarph 16.0, DO-160A):

5.14.1 Normal Operating Conditions: When the equipment is subjected to this test, the requirements of Section 4 of this AS shall be met.