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COLLISION AVOIDANCE SYSTEM

RATIONALE

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

1. SCOPE:

This document presents criteria for flight deck controls and displays for Airborne Collision Avoidance Systems providing vertical-only guidance, and provides design guidance for operational, functional, and installation characteristics and requirements for airborne collision avoidance systems in existing and future aircraft.

2. REFERENCES:

2.1 Applicable Documents:

This annex should be used in conjunction with ARP4102 core document. The following documents may also be applicable:

SAE ARP4101 Flight Deck Layout and Facilities
SAE ARP4102/4 Flight Deck Alerting System
SAE ARP4102/7 Electronic Displays
SAE ARP4105A Abbreviations and Acronyms for Use on Flight Deck
SAE ARP4153 Human Interface Criteria for Collision Avoidance Systems
SAE AS8034 Airborne Multi-Purpose Electronic Displays

2.1.1 Guidance may also be received from the following documents:

ATA Standard for T-CAS II Displays, Symbology and Controls Revision A, dated September 1, 1989

Advisory Circular 20-131A, Airworthiness Approval of Traffic Alert and Collision Avoidance Systems (T-CAS II) and Mode S Transponders, dated April 27, 1990

ICAO Guidelines on Airborne Collision Avoidance Systems - AN 7/11, 12-90/76, dated September 14, 1990

Advisory Circular 120-55, Air Carrier Operational Approval and the Use of T-CAS II, dated October 23, 1991

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2.2 Definitions:

- 2.2.1 RESOLUTION ADVISORY (RA): Aural and visual information given to pilots to avoid a potential collision (Emergency Condition, Level 3 ARP4102/4).
- 2.2.2 TRAFFIC ADVISORY (TA): Aural and visual information given to pilots pertaining to the position of other aircraft in the immediate vicinity (Abnormal Condition, Level 2 ARP4102/4).
- 2.2.3 THREAT: Traffic that has satisfied the threat detection logic and requires a Resolution Advisory. This traffic may be beyond the altitude or range constraints of proximate or other traffic.
- 2.2.4 PROXIMATE TRAFFIC: Any traffic not generating a Resolution Advisory or Traffic Advisory but is within 6 nautical miles horizontally and within ± 1200 ft vertically.
- 2.2.5 OTHER TRAFFIC: Any other traffic within the range and selected altitude band of the display.
- 2.2.6 NO BEARING TRAFFIC: A Resolution Advisory or Traffic Advisory generated by traffic from which no directional information can be derived.
- 2.2.7 FALSE ADVISORY: A Resolution Advisory or Traffic Advisory given when the design criteria for issuing such an advisory do not actually exist.
- 2.2.8 MISSED ADVISORY: A Resolution Advisory or Traffic Advisory not given when the threat of a potential collision does exist.
- 2.2.9 NUISANCE ADVISORY: A Resolution Advisory or Traffic Advisory given in accordance with the design criteria, but when the threat of a potential collision does not exist.

3. OPERATIONAL REQUIREMENTS:

3.1 General Requirements:

- 3.1.1 The system shall be usable during all flight conditions, including instrument meteorological conditions (IMC).
- 3.1.2 The system shall be a time critical alerting system and capable of providing a clear and unambiguous Resolution Advisory.
- 3.1.3 False and Missed Advisory rates shall be low enough to inspire crew confidence in the system. A maximum rate of one in 1000 events is required.
- 3.1.4 The system shall modify a Resolution Advisory after it has been issued if the projected separation is less than the predetermined safe separation.
- 3.1.5 Nuisance Advisory rates shall be sufficiently low as to inspire crew confidence in the system.

3.2 Functional Requirements:

- 3.2.1 Required sensitivity or inhibiting adjustments shall be automatic. This does not prohibit the use of additional manual mode inhibit functions.
- 3.2.2 The system shall annunciate a failure of the Resolution Advisory capability by displaying an alert (ARP4102/4, Level 1). This system failure annunciation shall be displayed so as to be clearly visible to each pilot.
- 3.2.3 Any failure annunciation shall be distinguishable from a mode annunciation.
- 3.2.4 The system shall be designed to permit the pilot to select Traffic Advisory mode only which inhibits the Resolution Advisory mode.
- 3.2.5 When a Resolution Advisory or a Traffic Advisory condition exists, at least all Resolution Advisories and Traffic Advisories within the selected range of the display shall be displayed.
- 3.2.6 Aural and Visual presentation of a Resolution Advisory shall be coordinated.
- 3.2.7 Each voice message shall be distinctive and unique to the required maneuvers and shall not contain similar phraseology which may be misinterpreted if one or more words are not heard (e.g., the words "climb" and "do not climb" shall not be used in the same system).
- 3.2.8 The system shall not interfere with the autoflight system.
- 3.2.9 The system should interface with the Flight Director system in order to provide pitch guidance.

3.3 Aural Alerts:

3.3.1 General:

- 3.3.1.1 Aural alerts shall be presented by a high fidelity distinguishable voice announcement only.
- 3.3.1.2 Aural alerts shall be inhibited below an altitude determined by the system logic or by a higher priority alert.
- 3.3.1.3 Aural alerts shall be discernible at all ambient noise levels in normal operations with the pilots either wearing a headset or not, but not so loud as to be disruptive to crew communications. The volume should be automatically adjusted to ambient noise level.

3.3.2 Traffic Advisories:

- 3.3.2.1 The Traffic Advisory aural alert shall be the message "TRAFFIC - TRAFFIC" for one cycle only.

3.3.3 Resolution Advisories:

- 3.3.3.1 Resolution Advisory messages consisting of a single word shall be spoken only two times. Longer messages shall be spoken only once.

3.3.3.2 The Resolution Advisory message shall be:

- a. "Climb - Climb." This advisory is used when it is necessary to climb to avoid the threat aircraft.
- b. "Climb Crossing Climb." This advisory is used to indicate when own flight path will cross through that of the threat aircraft.
- c. "Descend - Descend." This advisory is used when it is necessary to descend to avoid the threat aircraft.
- d. "Descend Crossing Descend." This advisory is used when own flight path will cross through that of the threat aircraft.
- e. "Adjust Vertical Speed." This advisory is used when it is necessary to reduce the existing climb or descent rate to avoid the threat aircraft.

3.3.3.3 Increased Strength, Resolution Advisory messages:

- a. "Increase Climb." This advisory is used when it is necessary to increase the climb rate after a "Climb" message has been issued.
- b. "Increase Descent." This advisory is used when it is necessary to increase the descent rate after a "Descent" message has been issued.
- c. "Climb, Climb Now." Follows a "Descend" advisory. This advisory is used when it is necessary to reverse the current vertical speed to avoid the threat aircraft.
- d. "Descend, Descend Now." Follows a "Climb" advisory. This advisory is used when it is necessary to reverse the current vertical speed to avoid the threat aircraft.

3.3.3.4 "Clear of Conflict". Shall indicate that the encounter has ended.

3.4 Visual Alerts:

3.4.1 Color shall be used to discriminate targets by threat levels. In addition, shape may be also used. For advanced displays, other symbologies may be more appropriate.

3.4.2 The discrete visual alert associated with a Traffic Advisory or Resolution Advisory shall be clearly visible to both pilots.

4. PANELS:

Not applicable.

5. CONTROLS:

5.1 General:

5.1.1 The controls used to select the operational modes of the system shall be located on one panel that is accessible to both pilots.

5.1.2 As a minimum, the system should have the following selectable modes:

- a. Transponder mode only
- b. Transponder and collision avoidance
- c. Transponder and Traffic Advisories only (Resolution Advisories shall be inhibited in this mode)

5.2 System Mode Annunciation:

5.2.1 The system shall be designed to permit both pilots to visually identify the mode selected either through switch position and/or mode annunciation.

5.3 Traffic Display Controls:

- 5.3.1 The controls used to select traffic display modes should permit the selection of additional displays and be collocated with the display control panel. The following modes are desirable:
- a. The display of all traffic within the range of the display and within ± 2700 ft of own aircraft altitude
 - b. The display of all traffic from 2700 ft below own aircraft to the upper limit of surveillance or the display of traffic from 2700 ft above own aircraft to the lower limit of surveillance
 - c. Multiple ranges
 - d. The ability to view weather radar with or without traffic on shared displays
 - e. The ability to display traffic full time, automatically, or pilot selectable
 - f. The ability to inhibit a traffic display on a time shared display if no longer required for situational awareness

6. TRAFFIC DISPLAYS:

6.1 General Requirements:

6.1.1 A display of traffic shall be clearly visible to both pilots.

6.1.2 The display of traffic shall include the following:

- a. Characters used for traffic display shall be sized for optimal readability without obscuring or detracting from other information being displayed
- b. The position of own aircraft in a traffic display should be centered in the lower third of the display