ETSO-C119c
Date: 08.12.2009

European Aviation Safety Agency

European Technical Standard Order

Subject: TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS) AIRBORNE EQUIPMENT, TCAS II

1 - Applicability

This ETSO gives the requirements that new models of traffic alert and collision avoidance system airborne equipment must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - General

3.1.1 - Minimum Performance Standard

Standards set forth in EUROCAE Document ED-143 Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System II (TCAS II) dated September 2008, as modified by **Appendix 1** of this ETSO.

The optional functionality set forth in RTCA, Inc. Document DO-300, Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance, dated December 13, 2006, Sections 2 and 3, as modified by RTCA, Inc. Document DO-300 change 1 dated 1 July 2009 may be included.

3.1.2 - Environmental Standard

See CS-ETSO Subpart A paragraph 2.1.

3.1.3 - Computer Software

See CS-ETSO Subpart A paragraph 2.2.

3.1.4 - Electronic Hardware Qualification

If the article includes a complex custom micro-coded component, the component must be developed according to EUROCAE ED-80 Design Assurance Guidance for Airborne Electronic Hardware, dated April 2000. Those articles containing hardware upgraded from an original product developed before EUROCAE ED-80 (RTCA DO-254) was published (April 2000), need only apply the requirements in EUROCAE ED-80(RTCA/DO-254) to the changed hardware and all hardware affected by the change.

3.2 - Specific

3.2.1 Failure Condition Classification

Failure of the function defined in paragraph 3.1.1 of this ETSO has been determined to be a hazardous/severe-major failure condition. The applicant must develop the system to at least the design assurance level commensurate with this failure condition classification.

4 - Marking

4.1 - General

Marking is detailed in CS-ETSO Subpart A paragraph 1.2.

4.2 - Specific

None.

5 - Availability of Referenced Document

See CS-ETSO Subpart A paragraph 3.

APPENDIX 1

HIGH-LEVEL PSEUDOCODE

Replace ED-143 Volume II Attachment A page 8-P16 with the following:

```
PROCESS Set_up_display_outputs;

<Determine advisory annunciation precedence>
IF (an RA is to be displayed this cycle)
    THEN  IF (increase rate RA issued)
              THEN  CLEAR reversal, maintain rate, and altitude crossing flags;
                    IF (increase rate RA was not present last cycle)
                        THEN indicate that RA changed to increase rate this cycle;
              ELSE  CLEAR indication that increase rate RA was present last cycle;
                    IF (RA requires maintenance of rate)
                        THEN  SET maintain rate indication;
                              CLEAR sense reversal indication, if any; <announce maintain>
                        ELSE  IF (previous cycle's RA was dual negative AND current RA is
                                  either single negative or positive)
                                  THEN CLEAR maintain rate indication;
                    IF (sense of previously displayed RA has been reversed)
                        THEN  CLEAR altitude crossing flag; <Reversal needs to be
                                  announced even if the reversed RA is altitude crossing>
                              CLEAR maintain rate indication; <If reversing maintain RA>
                    IF (RA is preventive) <Initial preventive neg. or VSL RA or weakening>
                                          <Note: All positive RAs are now corrective>
                        THEN  IF (RA is dual negative) <Don't Climb/Don't Descend>
                                  THEN  SET maintain rate indication; <announce maintain>
                                  ELSE  CLEAR maintain rate indication;
                                        IF ((positive Climb is weakening to negative Don't
                                            Descend OR (positive Descend is weakening to
                                            negative Don't Climb AND not weakening due
                                            to extreme low altitude condition)) AND not
                                            weakening due to multiaircraft "sandwich"
                                            encounter with both up-sense and down-sense
                                            VSLs)
                                            THEN  indicate that weakened RA is corrective;
                                                  <Results in green "fly-to" arc plus
                                                  corrective aural annunciation for initial
                                                  weakening>
                              Set displayed-model-goal rate to 0 fpm;  <RA display device
                                  will use prescribed vertical rates for neg. & VSL RAs>
                        ELSE  IF (RA is corrective negative or VSL)
                                  THEN  CLEAR maintain rate indication;
                                        Set displayed-model-goal rate to 0 fpm;
          CLEAR clear of conflict flag;
    ELSE  CLEAR maintain rate indication; <no RA is to be displayed this cycle>
          Set displayed-model-goal rate to 0 fpm;
          IF (an altitude-reporting threat became non-altitude-reporting during preceding RA)
              THEN  CLEAR track drop and clear of conflict flags;
              ELSE  IF (a threat's track was dropped during preceding RA)
                        THEN  CLEAR clear of conflict flag;
PERFORM Load_display_and_aural_info; <Load display information to be sent to the RA display,
                                      TA display and aural annunciation subsystem.>

    END Set_up_display_outputs;
```

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Appendix 1

LOW-LEVEL PSEUDOCODE

Replace ED-143 Volume II Attachment A page 8-P17 with the following:

```
PROCESS Set_up_display_outputs;

    IF (any bit in G.RA(1–10)EQ $TRUE)
        THEN  IF (G.ANYINCREASE EQ $TRUE)
                  THEN  CLEAR G.ANYREVERSE, G.MAINTAIN, G.ANYCROSS;
                        IF (G.PREVINCREASE EQ $FALSE)
                            THEN  SET G.ANYCORCHANG, G.PREVINCREASE;
                  ELSE  CLEAR G.PREVINCREASE;
                        IF ((G.RA(1) EQ $TRUE AND G.ZDMODEL GT P.CLMRT AND
                              G.ZDOWN GT P.CLMRT) OR (G.RA(6) EQ $TRUE AND
                              G.ZDMODEL LT P.DESRT AND G.ZDOWN LT P.DESRT))
                            THEN  SET G.MAINTAIN;
                                  CLEAR G.ANYREVERSE;
                            ELSE  IF ((G.CLSTROLD EQ 4 AND G.DESTROLD EQ 4) AND
                                        (G.CLSTRONG EQ 0 OR G.DESTRONG EQ 0))
                                      THEN  CLEAR G.MAINTAIN;
                        IF (G.ANYREVERSE EQ $TRUE)
                            THEN  CLEAR G.ANYCROSS;
                                  CLEAR G.MAINTAIN;
                        IF (G.CORRECTIVE_CLM EQ $FALSE AND
                              G.CORRECTIVE_DES EQ $FALSE)
                            THEN  IF (G.RA(2) EQ $TRUE AND G.RA(7) EQ $TRUE)
                                      THEN  SET G.MAINTAIN;
                                      ELSE  CLEAR G.MAINTAIN;
                                            IF (G.CLSTRONG EQ 4 AND
                                                G.CLSTROLD EQ 8 AND
                                                G.DESTRONG EQ 0)
                                                THEN  SET G.CORRECTIVE_CLM,
                                                            G.ANYPRECOR;
                                                ELSE  IF (G.DESTRONG EQ 4 AND
                                                          G.DESTROLD EQ 8 AND
                                                          G.CLSTRONG EQ 0 AND
                                                          G.EXTALT EQ $FALSE)
                                                          THEN  SET G.CORRECTIVE_DES,
                                                                      G.ANYPRECOR;
                                  G.ZDMODEL = 0;
                            ELSE  IF (G.RA(1 and 6) EQ $FALSE)
                                      THEN  CLEAR G.MAINTAIN;
                                            G.ZDMODEL = 0;
              CLEAR G.ALLCLEAR;
        ELSE  CLEAR G.MAINTAIN, G.ANYINCREASE;
              G.ZDMODEL = 0;
              IF (ANYALTLOST EQ $TRUE)
                  THEN  CLEAR ANYTRACKDROP, G.ALLCLEAR;
                  ELSE  IF (ANYTRACKDROP EQ $TRUE)
                            THEN  CLEAR G.ALLCLEAR;
    PERFORM Load_display_and_aural_info;

END Set_up_display_outputs;
```

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Appendix 1

STATECHARTS

Replace ED-143, Volume II, page 125, Section 2.1.11.2, State Corrective_Climb with the following:

Transition(s): Yes → No

Location: Advisory_Status$_{s-261}$ ▷ Corrective_Climb$_{s-123}$

Trigger Event: Composite_RA_Evaluated_Event$_{e-C2}$

Condition:

				OR		
	Climb_RA_Weakened$_{m-374}$	T	T	.	T	
	Climb_Goal$_{f-467}$ = 0 ft/min	F	T	.	T	
	Own_Tracked_Alt_Rate$_{f-564}$ > Climb_Goal$_{f-467}$	T	.	.	.	
AND	Own_Tracked_Alt_Rate$_{f-564}$ > −300 ft/min$_{(HYSTERCOR)}$	.	T	.	T	
	Own_Tracked_Alt_Rate$_{f-564}$ ≤ 300 ft/min$_{(HYSTERCOR)}$	.	T	.	.	
	Descend_Goal$_{f-473}$ = 0 ft/min	.	T	.	.	
	Not_Meeting_Descend_Goal$_{m-411}$	.	.	T	.	
	Descend_Goal $_{f-473}$ < 100,000 ft/min$_{(HUGE)}$	.	.	.	T	

Output Action: Corrective_Climb_Evaluated_Event$_{e-C2}$

Notes: **1.** ***Description:*** *Transition out of corrective climb occurs for a weakened climb RA condition when either the own aircraft altitude rate exceeds a non-zero climb goal or the aircraft is considered level (i.e., within hysteresis) for a zero climb and descend goal. This transition also occurs whenever the aircraft is not meeting the current descend goal or there is a simultaneous opposite-sense VSL due to a multi aircraft encounter.*

2. ***Pseudocode Reference:*** *Corrective_preventive_test, Set_up_display_outputs.*

Replace ED-143 Volume II, page 127, Section 2.1.11.3, State Corrective_Descend with the following:

Transition(s): Yes → No

Location: Advisory_Status$_{s\text{-}261}$ ▷ Corrective_Descend$_{s\text{-}229}$

Trigger Event: Corrective_Climb_Evaluated_Event$_{e\text{-}C2}$

Condition:

				OR		
	Descend_RA_Weakened$_{m\text{-}378}$	T	T	.	T	T
	Descend_Goal$_{f\text{-}473}$ = 0 ft/min	F	T	.	T	T
	Own_Tracked_Alt_Rate$_{f\text{-}564}$ < Descend_Goal$_{f\text{-}473}$	T	.	.	.	.
	Own_Tracked_Alt_Rate$_{f\text{-}564}$ < 300 ft/min$_{(HYSTERCOR)}$	.	T	.	T	T
AND	Own_Tracked_Alt_Rate$_{f\text{-}564}$ ≥ –300 ft/min$_{(HYSTERCOR)}$	.	T	.	.	.
	Climb_Goal$_{f\text{-}467}$ = 0 ft/min	.	T	.	.	.
	Not_Meeting_Climb_Goal$_{m\text{-}410}$	.	.	T	.	.
	Extreme_Alt_Check$_{m\text{-}378}$	.	.	.	T	.
	Multiple_Threats$_{m\text{-}403}$	.	.	.	F	.
	Climb_Goal$_{f\text{-}467}$ > –100,000 ft/min$_{(HUGE)}$	.	.	.	.	T

Output Action: Corrective_Descend_Evaluated_Event$_{e\text{-}C2}$

Notes: *1.* ***Description:*** *Transition out of corrective descend occurs for a weakened descend RA condition when (1) the own aircraft altitude rate is less than a non-zero descend goal, or (2) the aircraft is considered level (i.e., within hysteresis) for a zero climb and descend goal, or (3) the aircraft is not meeting the current climb goal, or (4) a descend RA is weakened to a zero climb rate goal under extreme low altitude against a single threat aircraft, or (5) there is a simultaneous opposite-sense VSL due to a multi aircraft encounter.*

2. ***Pseudocode Reference:*** *Corrective_preventive_test, Set_up_display_outputs, Extreme_altitude_check.*