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Aircraft in Distress Indication
(Update)

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Summary
ICAO and Europe have released requirements for Autonomous Distress Tracking (ADT). This paper proposes modifying DO-260B to change coding within the Emergency/Priority Status subfield in the Aircraft Status message (Register 61_{16}) to identify "Aircraft in Distress – Automatic Activation" and "Aircraft in Distress – Manual Activation" events. This Working Paper is an update to WP09-45_A which proposed populating Register 61_{16} with a coding of "6" to identify an "Aircraft in Distress" event. Based on feedback at the CSC #9 meeting, and additional requirements from the AEEC Global Aircraft Tracking System (GATS) Working Group, the proposal has been updated (see updates in the Discussion/Proposal section).

Background

ICAO has released requirements that would require aircraft delivered after January 1, 2021 to automatically transmit aircraft position at least once per minute when the aircraft is in distress. ICAO Annex 6 – Operation of Aircraft, Part I — International Commercial Air Transport — Aeroplanes, was revised in July 2016 (10th Edition) to add a new requirement (Section 6.18) as follows:

6.18 LOCATION OF AN AEROPLANE IN DISTRESS

6.18.1 All aeroplanes of a maximum certificated take-off mass of over 27 000 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2021, shall autonomously transmit information from which a position can be determined by the operator at least once every minute, when in distress, in accordance with Appendix 9.

6.18.2 **Recommendation.**— *All aeroplanes of a maximum certificated take-off mass of over 5 700 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2021, should autonomously transmit information from which a position can be determined at least once every minute, when in distress, in accordance with Appendix 9.*

6.18.3 The operator shall make position information of a flight in distress available to the appropriate organizations, as established by the State of the Operator.

In addition, Europe has released requirements that would require aircraft delivered after January 1, 2021 to automatically transmit aircraft position during a distress condition. The European Commission released Commission Regulation EU 2015/2338 which added a new requirement CAT.GEN.MPA.210 for Commercial Air Transport (CAT) aircraft:

Annex IV (Part-CAT):
Annex IV to Regulation (EU) No 965/2012 is amended as follows:
(c) The following point CAT.GEN.MPA.210 is inserted:

'CAT.GEN.MPA.210 Location of an aircraft in distress— Aeroplanes

The following aeroplanes shall be equipped with robust and automatic means to accurately determine, following an accident where the aeroplane is severely damaged, the location of the point of end of flight:

    (1) all aeroplanes with an MCTOM of more than 27 000 kg, with an MOPSC of more than 19 and first issued with an individual CofA on or after 1 January 2021; and

    (2) all aeroplanes with an MCTOM of more than 45 500 kg and first issued with an individual CofA on or after 1 January 2021.'.

The minimum criteria for setting a "distress event" is established in EUROCAE ED-237, "MINIMUM AVIATION SYSTEM PERFORMANCE SPECIFICATION FOR CRITERIA TO DETECT IN-FLIGHT AIRCRAFT DISTRESS EVENTS TO TRIGGER TRANSMISSION OF FLIGHT INFORMATION". Aircraft distress events can include, but are not limited to, unusual attitudes, unusual speed conditions, collision with terrain, and the total loss of thrust/propulsion on all engines. Figure 1 is a functional block diagram from ED-237 showing that the distress event detection logic outputs a distress event to Transmission Systems,

Figure 1 IN-FLIGHT AIRCRAFT DISTRESS EVENT DETECTION AND TRIGGERING CRITERIA SYSTEM MODEL
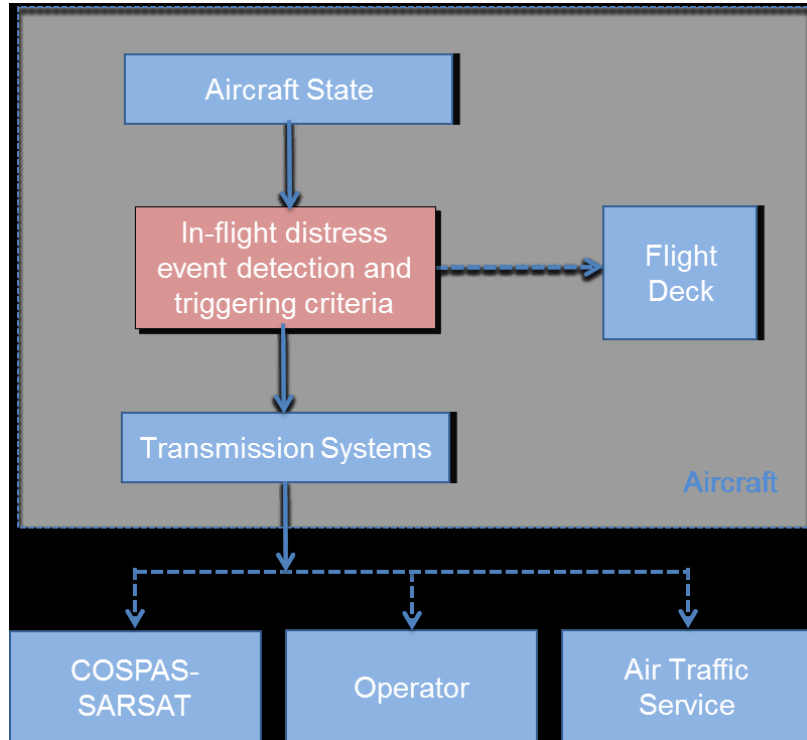
Possible "Transmission Systems" that have been identified to transmit the distress event, the aircraft's identification, and the aircraft's position information are the aircraft's ADS-B OUT system, Emergency Locator Transmitter-Distress Tracker (ELT-DT), and SATCOM (Iridium or Inmarsat).

Also, note that the Airline Electrical Engineering Committee (AEEC) has established a Global Aircraft Tracking System (GATS) working group to address interface standards for Autonomous Distress Tracking (ADT). This group has developed a proposed ARINC 429 Label 202 (see Figures 2 through 4) that provides a Distress Trigger command, as well as a Distress Trigger Cancel command, which would be sent from the "In-Flight Distress Event Detection and Triggering Criteria" function to the "Transmission Systems" (reference Figure 1). Label 202 also indicates whether the distress was automatically generated by the distress trigger logic or manually generated (via a flight deck switch). The new Label 202 is planned to be formally adopted at the AEEC Mid-Term Session October 18 – 19, 2018.

Figure 2 – Label 202 Trigger in Flight

Bit	Definition	Content
1	First Label 2	1
2		0
3	Second Label 0	0
4		0
5		0
6	Third Label 2	0
7		1
8		0
9	SDI	0
10		0
11		Trigger/Cancel/Default Matrix (See Figure 3)
12		
13		
14		
15		Transmitter Enable/Disable Command
16		FDT Enable/Disable Command
17		Distress Trigger Origin Matrix (See Figure 4)
18		
19		
20		
21		Pre-Distress Trigger Origin
22		
23		
24		
25		ADT System Functional Status
26		ADT System Functional Status
27		ADT System Fail Status
28		Reserved for Implementer Systems Status use
29		Reserved for Implementer Systems Status use
30	SSM	
31		
32	Parity bit	

Figure 3 – Trigger/Cancel/Default Matrix

Position	14	13	12	11	trigger/cancel/default
1	0	0	0	0	Default
2	0	0	0	1	not used
3	0	0	1	0	not used
4	0	0	1	1	not used
5	0	1	0	0	not used
6	0	1	0	1	not used
7	0	1	1	0	not used
8	0	1	1	1	Distress Trigger Signal
9	1	0	0	0	not used
10	1	0	0	1	not used
11	1	0	1	0	not used
12	1	0	1	1	Distress Trigger Cancel Signal
13	1	1	0	0	Initiate Self Test
14	1	1	0	1	Pre-Distress Trigger Signal
15	1	1	1	0	Pre-Distress Trigger Cancel Signal
16	1	1	1	1	not used

Figure 4 – Distress Trigger Origin Matrix

Distress Trigger Origin Matrix				
ADT Label 202 or 201 bits				
20 ▾	19 ▾	18 ▾	17 ▾	Distress Trigger Origin ▾
0	0	0	0	No Distress Trigger
0	0	0	1	Manual Trigger
0	0	1	0	Spare
0	0	1	1	Spare
0	1	0	0	G-switch/deformation activation
0	1	0	1	Spare
0	1	1	0	Spare
0	1	1	1	Spare, or, for 201 Label, if this output is not implemented, then this is the "field not implemented" or "data not available" status
1	0	0	0	Automatic Distress Trigger (Other, or non-specific, multiple or currently undefined)
1	0	0	1	ED-237 Scenario 1: Unusual Attitude[1]
1	0	1	0	ED-237 Scenario 2: Unusual Speed[1]
1	0	1	1	ED-237 Scenario 3: Collision with Terrain[1]
1	1	0	0	ED-237 Scenario 4: Total Loss of thrust/propulsion[1]
1	1	0	1	Reserved for OEM Use[1]
1	1	1	0	Reserved for OEM Use[1]
1	1	1	1	Remote Ground Activation[1]
				Notes:
				Reserved: Bits are being held for future use and are not available for general implementation use
				Spare: Bits are not being held for future use and could potentially be used for specific implementation purposes, the bits could be used in a future version of the label definition. Note that spares will not necessarily map to COSPAS-SARSAT supported activation or rolling field values.
				[1] These bit patterns (or words) are currently listed as SPARE in the COSPAS-SARSAT specification. This use for ELTs would need to be coordinated with COSPAS SARSAT. Prior to such coordination, it is expected that these origin words would all be reported with an Automatic Distress Trigger code by an ELT.

Discussion / Proposal

Based on feedback at the CSC #9 meeting, the following changes were proposed:

- Update section 2.2.3.2.3.2 "Surveillance Status" Subfield in the ADS-B Airborne Position Messages to add Aircraft in Distress logic. This section currently points to DO-181 and states that the "Surveillance Status" subfield is populated based strictly on the aircraft's Mode A transponder code.

- In sub-section 2.2.3.2.7.8.1.1, Table 2-78: "Emergency/Priority Status" Subfield Encoding, change the meaning of code '0' from "No Emergency" to "No **Reported** Emergency".

- In sub-section 2.2.3.2.7.8.1.1, Table 2-78, change codes '2' (Lifeguard/Medical Emergency) and '3' (Minimum Fuel) to "**Reserved**", since these are not actually being used by anyone.

- In sub-section 2.2.3.2.7.8.1.1 "Emergency/Priority Status" Subfield in Aircraft Status Messages, specify that "Aircraft in Distress" has priority over all other codes.

- Add a sub-section to section 2.2.5 ADS-B Transmission Device Message Processor Characteristics that identifies the input data source for the Aircraft in Distress input.

  __Note:__ Sub-sections 2.2.5.1.4 Surveillance Status Data and 2.2.5.1.46 Emergency/Priority Status Data already cover the inputs (in a general manner). Notes were added to provide additional information on the data sources.

Based on requirements updates from the AEEC GATS WG (to address draft EASA CS ACNS.E.LAD requirements), the following additional changes are proposed:

- In sub-section 2.2.3.2.7.8.1.1, Table 2-78: "Emergency/Priority Status" Subfield Encoding, change the meaning of codes '6' and '7' to support reporting of two Aircraft in Distress states, respectively:
  - 6 = Aircraft in Distress - Automatic Activation
  - 7 = Aircraft in Distress - Manual Activation

Propose to update the following sections of DO-260B:

2.2.3.2.3.2 **"Surveillance Status" Subfield in ADS-B Airborne Position Messages**

The "Surveillance Status" subfield is a 2-bit ("ME" bits 6 and 7, Message bits 38 and 39) field that **shall** be ~~used to~~ encoded based on information from the aircraft's Mode-A transponder code and the Aircraft in Distress input as provided in Table 2-15.

Table 2-15: "Surveillance Status" Subfield Code Definitions

Coding		Meaning
(Binary)	(Decimal)	
00	0	No Condition Information
01	1	Permanent Alert Condition (Emergency)
10	2	Temporary Alert Condition (change in Mode A Identity Code other than emergency condition)
11	3	Special Position Identification (SPI) Condition

> *Note:* *Codes 1 and 2 take precedence over code 3.*

For a Mode-S Transponder-Based system, the "Surveillance Status" coding value shall be set to "1" based on either:

a) the transponder function Mode A code is set to 7500, 7600, or 7700 as appropriately specified in RTCA DO-181E, §2.2.18.2.7 & §2.2.23.1.8 (EUROCAE ED-73E, §3.23.1.6 & §3.28.8), or

b) a valid "Aircraft in Distress – Automatic Activation" or "Aircraft in Distress – Manual Activation" input is received.

For a Mode-S Transponder-Based system, ~~T~~the setting of the "Surveillance Status" coding values of "2" and "3" are based strictly on the ~~is a~~ transponder function and ~~is~~ are appropriately specified in RTCA DO-181E, §2.2.18.2.7 & §2.2.23.1.8 (EUROCAE ED-73E, §3.23.1.6 & §3.28.8).

When not implemented in a Mode-S Transponder-Based system, the ADS-B function **shall** set the "Surveillance Status" subfield to ~~ZERO~~ "1" if a valid "Aircraft in Distress – Automatic Activation" or "Aircraft in Distress – Manual Activation input is received.

2.2.3.2.7.8.1.1 **"Emergency/Priority Status" Subfield in Aircraft Status Messages**

The "Emergency/Priority Status" subfield in the Extended Squitter Aircraft Status Message **shall** be encoded in accordance with Table 2-78.

Table 2-78: "Emergency/Priority Status" Subfield Encoding

Coding		Meaning
(Binary)	(Decimal)	
000	0	No Reported Emergency
001	1	General Emergency
010	2	~~Lifeguard/medical Emergency~~ Reserved
011	3	~~Minimum Fuel~~ Reserved
100	4	No Communications
101	5	Unlawful Interference
110	6	~~Downed Aircraft~~ Aircraft in Distress - Automatic Activation
111	7	~~Reserved~~ Aircraft in Distress - Manual Activation

a. If the pilot enters a Mode A Code of 7500, the "Emergency/Priority Status" subfield **shall** be encoded with a value of decimal 5 indicating "Unlawful Interference."

b. If the pilot enters a Mode A Code of 7600, the "Emergency/Priority Status" subfield **shall** be encoded with a value of decimal 4 indicating "No Communications."

c. If the pilot enters a Mode A Code of 7700, the "Emergency/Priority Status" subfield **shall** be encoded with a value of decimal 1 indicating "General Emergency."

d. The emergency condition initiated by the pilot entry of Mode A Code 7500, 7600 or 7700 **shall** be terminated when the pilot changes to any other Mode A Code.

Note: *The "Surveillance Status" subfield value of ONE corresponds to the emergency condition activated by Mode A Code 7500, 7600 or 7700 and the change from the value of ONE signals the termination of the emergency condition (see §2.2.3.2.3.2).*

e. If a valid "Aircraft in Distress – Automatic Activation" input is received, the "Emergency/Priority Status" subfield **shall** be encoded with a value of decimal 6 indicating that the aircraft is in distress (as determined by the aircraft's onboard distress detection logic) and that it was automatically activated by the onboard distress detection logic.

f. If a valid "Aircraft in Distress –Manual Activation" input is received, the "Emergency/Priority Status" subfield **shall** be encoded with a value of decimal 7 indicating that the aircraft is in distress (as determined by the pilot) and that it was manually activated by the pilot.

g. If a valid "Distress Trigger Cancel" input is received, the "Emergency/Priority Status" subfield **shall** be encoded with a value of decimal ZERO (000) indicating that the aircraft is no longer in distress.

h. If multiple valid inputs are received simultaneously such that multiple encoding values are possible, priority **shall** be given as follows:

Priority	Encoding Value
1	7
2	6
3	1, 4, or 5

ie. If an update has not been received from an on-board Mode A data source for the "Emergency/Priority Status" within the past 2 seconds, then the "Emergency/Priority Status" subfield in the Aircraft Status Message **shall** be encoded with a value of ZERO (binary 000) indicating "No Reported Emergency."

Note: *The encoding of the "Emergency/Priority Status" subfield values 2, 3 and 6 do not have a corresponding Mode A Code value that denotes the emergency condition. The establishment of these emergency conditions by providing a pilot interface to activate them is optional in this version of these MOPS.*

j. If an update has not been received from an on-board Aircraft in Distress data source for the "Emergency/Priority Status" within the past 1.8 seconds, then the "Emergency/Priority Status" subfield in the Aircraft Status Message **shall** be encoded with a value of decimal 6 indicating that the aircraft is in distress (due to no input from the onboard Aircraft in Distress detection system).

2.2.5   **ADS-B Transmission Device Message Processor Characteristics**

The primary functions of the ADS-B Transmission Device Message Processor are described in the following subparagraphs.

2.2.5.1   **ADS-B Transmission Device Data Processing and Message Formatting**

• • •

2.2.5.1.4   **Surveillance Status Data**

The ADS-B Transmitting Subsystem **shall** accept Surveillance status information via an appropriate data input interfaces and use such data to establish the "Surveillance Status" subfield in the ADS-B Airborne Position Message (see §2.2.3.2.3) as specified in §2.2.3.2.3.2.

Notes:

1. *The Surveillance Status information consists of Mode A code and SPI information, as well as Aircraft in Distress information.*

2. *The Mode A Code and SPI information interface is an internal interface in transponder implementations.*

• • •

2.2.5.1.46   **Emergency/Priority Status Data**

The ADS-B Transmitting Subsystem **shall** accept own vehicle Emergency/Priority Status information via an appropriate variable data input interfaces and use such data to establish the "Emergency/Priority Status" subfield transmitted in the "Emergency/Priority Status" subfield transmitted in the ADS-B Extended Squitter Aircraft Status Message as specified in §2.2.3.2.7.8.1.

Notes:

1. *The Emergency/Priority Status information consists of Mode A emergency code (7500, 7600, and 7700) information, as well as Aircraft in Distress information.*

2. *The Mode A Code interface is an internal interface in transponder implementations.*

2.4.3.2.7.8.1.1 Verification of "Emergency/Priority Status" Subfield in Aircraft Status Messages (§2.2.3.2.7.8.1.1)

Purpose/Introduction:

The Extended Squitter Aircraft Status Message (TYPE=28) is used to provide additional information regarding aircraft status. Subtype=1 is used specifically to provide the Emergency / Priority status, the broadcast of the Mode A Code, Airspeed and Airspeed Type.

Specific formatting of the TYPE=28, Subtype=1 Message is provided in Figure 2-14 and Appendix A, Figure A-8.

1) Measurement Procedure (Mode A code "Emergency/Priority Status" Subfield Encodings 1, 4, and 5):

Configure the ADS-B Transmitting Subsystem to transmit Airborne Position Messages. Set the ADS-B Transmitting Subsystem to Airborne status. Produce valid Airborne Position Messages at the nominal rate with valid position and altitude data with the Surveillance Status Subfield set to ONE (binary 01) to signify an Mode A code emergency condition.

Verify that the ADS-B Transmitting Subsystem begins to transmit Extended Squitter Aircraft Status Messages at the nominal rate with the TYPE Subfield set to 28 (binary 1 1100) and the Subtype Subfield set to ONE (binary 001).

Verify that for each Mode A code Emergency/Priority Status input value (7500, 7600, 7700) in Table 2-78 the system generates Extended Squitter Aircraft Status Messages with the TYPE subfield set to 28, the Subtype subfield set to ONE, and the Emergency/Priority Status subfield in each such message set equal to the corresponding binary coding in Table 2-78.

2) Measurement Procedure (Aircraft in Distress "Emergency/Priority Status" Subfield Encodings 6 and 7)

Configure the ADS-B Transmitting Subsystem to transmit Airborne Position Messages. Set the ADS-B Transmitting Subsystem to Airborne status. Produce valid Airborne Position Messages at the nominal rate with valid position and altitude data.

Verify that the ADS-B Transmitting Subsystem begins to transmit Extended Squitter Aircraft Status Messages at the nominal rate with the TYPE Subfield set to 28 (binary 1 1100) and the Subtype Subfield set to ONE (binary 001).

Verify that for each "Aircraft in Distress" Emergency/Priority Status input value in Table 2-78 the system generates Extended Squitter Aircraft Status Messages with the TYPE subfield set to 28, the Subtype subfield set to ONE, and the Emergency/Priority Status subfield in each such message set equal to the corresponding binary coding in Table 2-78.

For each Aircraft in Distress encoded value in Table 2-78 (values 6 and 7), verify that a subsequent "Distress Trigger Cancel" input changes the "Emergency/Priority Status" subfield value to decimal ZERO (000) indicating that the aircraft is no longer in distress.

Upon removal of the Aircraft in Distress input for >1800msec, verify that the system generates Extended Squitter Aircraft Status Messages with the TYPE subfield set to 28,

the Subtype subfield set to ONE, and the Emergency/Priority Status subfield is set to a decimal value of 6 (110) indicating Aircraft in Distress – Automatic Activation.

Appendix A

Figure A-8a: Extended Squitter Aircraft Status
(Subtype 1: Emergency/Priority Status and Mode A Code)

Register 61₁₆

Bits	Field	
1	MSB	
2		
3	FORMAT TYPE CODE = 28	
4	(§A.1.4.1)	
5	LSB	
6	MSB	
7	SUBTYPE CODE = 1	
8	LSB	
9	MSB	
10	EMERGENCY STATE	
11	LSB	
12	MSB	
13		
14		
15		
16		
17	MODE A (4096) CODE	
18	(§A.1.4.12)	
19		
20		
21		
22		
23		
24	LSB	
25	AIRSPEED TYPE	
26	(0 = CAS, 1 = TAS, 2 = Reserved, 3 = Reserved)	
27	AIRSPEED (10 bits)	
28	CAS, TAS: LSB = 1 knot	
29	All zeros = no velocity info	
30	Value	Velocity
31	1	0 kts
32	2	1 kt
33	3	2 kts
34	---	---
35	1022	1021 kts
36	1023	> 1021 kts
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47	RESERVED	
48		
49		
50		
51		
52		
53		
54		
55		
56	RESERVED for ADS-R	

PURPOSE: To provide additional information on aircraft status.

Subtype shall be coded as follows:

0 = No information
1 = Emergency/Priority Status and Mode A Code
2 = TCAS RA Broadcast
3 to 7 = Reserved

Emergency state shall be coded as follows:

Value	Meaning
0	No reported emergency
1	General emergency
2	~~Lifeguard/Medical~~ Reserved
3	~~Minimum fuel~~ Reserved
4	No communications
5	Unlawful interference
6	~~Downed aircraft~~ Aircraft in Distress – Automatic Activation
7	~~Reserved~~ Aircraft in Distress – Manual Activation

Notes:
1) *Message delivery is accomplished as specified in §2.2.3.3.1.4.3.1.*

2) *Termination of emergency state is detected by coding in the surveillance status field of the Airborne Position Message.*

3) *Emergency State value 1 is set when Mode A code 7700 is provided to the transponder.*

4) *Emergency State value 4 is set when Mode A code 7600 is provided to the transponder.*

5) *Emergency State value 5 is set when Mode A code 7500 is provided to the transponder.*

6) *Emergency State value 6 is set when a valid "Automatic Distress Trigger" input is received OR if the Aircraft in Distress data input is missing.*

7) *Emergency State value 7 is set when a valid "Manual Distress Trigger" input is received.*

8~~6~~) *The Mode A Code shall be coded as defined in ICAO Annex 10, Volume IV, §3.1.2.6.7.1.*

Conclusion

Incorporation of the proposed updates will support the implementation of Autonomous Distress Tracking whereby distress event indication, aircraft identification, and position information are transmitted via the 1090MHz ADS-B Out link.