International Civil Aviation Organization

THE THIRD MEETING OF MODE S DOWNLINKED AIRCRAFT PARAMETERS WORKING GROUP (MODE S DAPs WG/3)

Web-conference, 12 – 15 May 2020

Agenda Item 4: Mode S monitoring and analysis

1090 MHZ SPECTRUM AND 24-BIT AIRCRAFT ADDRESS ISSUES WITH UAS

(Presented by the Secretariat)

SUMMARY

This paper presents a brief summary on regional activities on 1090 MHz spectrum and 24-bit aircraft address issues associated with unmanned aircraft and the latest updates contained in ICAO State Letter SP 44/2 – 19/77 issued on 8 November 2019. It was reproduced from IP/05 of SEA/BOB ADS-B WG/15.

1. INTRODUCTION

1.1 Proper and efficient utilization of available bandwidth and capacity at 1090 MHz is a key element to ensure the safe operation of aeronautical surveillance systems. The related issues have been addressed from time to time in APAC region at various meetings. On 8 November 2019, ICAO issued a State Letter with **Subject:** *1090 MHz spectrum issues and proper management of 24-bit aircraft addresses associated with unmanned aircraft operating exclusively at very low level*, Ref.: SP 44/2 - 19/77. This State Letter is provided as **Appendix A** to this information paper.

2. DISCUSSION

2.1 APAC Aeronautical Surveillance Workshop was held from 5 to 6 November 2018, at ICAO APAC Regional Office, Bangkok, Thailand. Under its Session 8, **SP801 Spectrum Considerations** was presented by Mr. Doug Arbuckle, the Chairperson of the ICAO Surveillance Panel and Rapporteur of the ICAO Surveillance Panel Aeronautical Surveillance Working Group. The presentation described major points for ANSPs and State regulators to consider, including: ADS-B and TCAS/ACAS utilization of 1090 MHz are related to the number of equipped aircraft in an airspace volume; ATCRBS SSR operation is less spectrum efficient than Mode S SSR; Mode S Downlink of Aircraft Parameters (DAPs) should be used with caution; and an ongoing 1090 MHz RF monitoring effort may be warranted. The briefing also presented a summary of two U.S. studies of the potential 1090 MHz impact if large numbers of small UAS operating at low altitudes equipped with ADS-B. These studies concluded that even at RF transmit power levels which are equivalent to cell phones (1W), small UAS equipped with ADS-B Out operating in an 800 nm^2 urban area at airspace densities of one vehicle per 2 km^2 would be expected to cripple any ICAO

standard surveillance system. Therefore, widespread ADS-B Out equipage by small UAS does not appear to be feasible.

2.2 The Fourteenth Meeting of the South-East Asia/Bay of Bengal Sub-Regional ADS-B Implementation Working Group (SEA/BOB ADS-B WG/14) was held in November 2018 in Bangkok, Thailand. Working Paper 07 *Address and Spectrum Issues for Small UAS* was presented by the United States. The meeting discussed outcomes of these studies on "small UAS" by USA and endorsed the following draft conclusion:

<table>
<tr><td colspan="3">Draft Conclusion 14/02 – Small UAS Cooperative Surveillance Equipage</td></tr>
<tr><td colspan="2">What: That, States are invited to be aware that widespread 1090ES-capable Mode S transponder equipage by small UAS may not be feasible in some States due to limited 24-bit aircraft address allocation and congested spectrum concerns.

Note: "small UAS" mentioned in this Conclusion refers to those weighing less than 55 pounds (25 kg). Reference is made to U.S. 14 Code of Federal Regulations, Part 107.</td><td>Expected impact:
☐ Political / Global
☐ Inter-regional
☐ Economic
☐ Environmental
☒ Ops/Technical</td></tr>
<tr><td>Why: To assist States considering appropriate management and procedural limitations for sUAS operations in their airspace that are not receiving air traffic service as defined in ICAO Doc 4444 (PANS-ATM).</td><td colspan="2">Follow-up: ☒Required from States</td></tr>
<tr><td>When: 12-Jul-19</td><td colspan="2">Status: Draft to be adopted by Subgroup</td></tr>
<tr><td colspan="3">Who: ☒Sub groups ☒APAC States ☐ICAO APAC RO ☐ICAO HQ ☐Other:</td></tr>
</table>

2.3 The Surveillance Seminar and Fourth Meeting of the Surveillance Implementation Coordination Group (SURICG/4) were held at Nanjing, China from 9 to 12 April 2019. As requested by the SURICG Co-chair, the ICAO SP chair presented Working Paper 12 *Potential Issues Associated with RPAS Operating Exclusively at Low Altitudes (Less Than 500 Feet above Ground Level)*. The paper informed the meeting that draft guidance material had been proposed by the ICAO Surveillance Panel for further action by the ICAO Air Navigation Bureau, including coordination with other ICAO panels as well as regional officers. The paper also described some potential issues associated with large numbers of Remotely Piloted Aircraft System (RPAS) at low altitudes attempting to make use of current Mode S surveillance avionics. Particular focus has been placed on the topics of 24-bit aircraft address availability for RPAS and potential 1090 MHz congestion from RPAS. The draft guidance on these topics had been proposed by the ICAO Surveillance Panel to be distributed to States. The meeting further discussed a draft Conclusion to invite State/Administrations to carefully monitor potential congestion on 1090 MHz and 24-bit aircraft address limitation due to operation of RPAS or other emerging aircraft types. As result of discussion, the proposed draft conclusion was integrated into the following draft Conclusion endorsed by the meeting under the discussion on the outcome of SEA/BOB WG/14 meeting.

Draft Conclusion SURICG/4/2 (SEA/BOB WG 14/2) – UAS Cooperative Surveillance Equipage	
What: That, States are invited to be aware that widespread 1090ES-capable Mode S transponder equipage by large population of UAS may not be feasible in some States due to limited 24-bit aircraft address allocation and congested spectrum concerns. States should monitor potential congestion on 1090 MHz and availability of 24-bit aircraft address due to operation of UAS, or other emerging aircraft types.	Expected impact: ☐ Political / Global ☐ Inter-regional ☐ Economic ☐ Environmental ☒ Ops/Technical
Why: To assist States considering appropriate management and procedural limitations for UAS operations in their airspace that are not receiving air traffic service as defined in ICAO Doc 4444 (PANS-ATM).	Follow-up: ☒Required from States
When: 6-Sep-19	Status: Draft to be adopted by CNS Subgroup
Who: ☒Sub groups ☒APAC States ☐ICAO APAC RO ☐ICAO HQ ☐Other:	

2.4 The Twenty Third Meeting of the Communications, Navigation and Surveillance Sub-group (CNS SG/23) of Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG), was held at the ICAO Regional Office, Bangkok, Thailand, from 2 to 6 September 2019. The meeting noted the outcome of discussions on these issues at SURICG/4 meeting and adopted the following Conclusion:

Conclusion CNS SG/23/11 (SURICG/4/2) – UAS Cooperative Surveillance Equipage	
What: That, States are invited to be aware that widespread 1090ES-capable Mode S transponder equipage by large population of UAS may not be feasible in some States due to limited 24-bit aircraft address allocation and congested spectrum concerns. States should monitor potential congestion on 1090 MHz and availability of 24-bit aircraft address due to operation of UAS, or other emerging aircraft types.	Expected impact: ☐ Political / Global ☐ Inter-regional ☐ Economic ☐ Environmental ☒ Ops/Technical
Why: To assist States considering appropriate management and procedural limitations for UAS operations in their airspace that are not receiving air traffic service as defined in ICAO Doc 4444 (PANS-ATM).	Follow-up: ☒Required from States
When: 6-Sep-19	Status: Adopted by Subgroup

Who: ☒Sub groups ☒APAC States ☐ICAO APAC RO ☐ICAO HQ ☐Other:

2.5 On 8 November 2019, ICAO issued a State Letter with Subject: *1090 MHz spectrum issues and proper management of 24-bit aircraft addresses associated with unmanned aircraft operating exclusively at very low level*, Ref.: SP 44/2 - 19/77. The letter provided as **Appendix A** to this information paper is expected to draw the attention to ongoing ICAO initiatives to ensure the continued safe and reliable operation of aeronautical surveillance systems, and encourage State to make use of the guidance material enclosed in the letter.

3. ACTION BY THE MEETING

3.1 The Meeting is invited to:

a) note the information contained in this paper; and

b) make use of the **guidance material** provided with the State Letter attached.

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Ref.: SP 44/2 - 19/77

8 November 2019

Subject: 1 090 MHz spectrum issues and proper management of 24-bit aircraft addresses associated with unmanned aircraft operating exclusively at very low level

Action required: As in paragraph 3

Sir/Madam,

1. I have the honour to draw your attention to ongoing ICAO initiatives to ensure the continued safe and reliable operation of aeronautical surveillance systems, including secondary surveillance radar (SSR), automatic dependent surveillance broadcast (ADS-B) and airborne collision avoidance systems (ACAS).

2. Proper and efficient utilization of available bandwidth and capacity at 1 090 MHz is a key element to ensure the safe operation of the aforementioned surveillance systems. Studies conducted by ICAO expert groups have identified certain issues and potential technical concerns to the operation of these surveillance systems in the presence of large numbers of unmanned aircraft (UA), if those UA are equipped with an ADS-B OUT transmitter on 1 090 MHz and operating at very low levels. Recognizing issues associated with those UA which may adversely affect safety for all aircraft in the area, ICAO has developed the attached guidance material to assist States in validating the utilization of 1 090 MHz and for withholding 24-bit aircraft addresses to UA unless certain criteria have been met.

3. In order to ensure that the surveillance capabilities being provided by the aforementioned systems are adequate to support the required air traffic services, I would like to encourage your State to make use of the guidance material in the attachment hereto, as well as any other related provisions. ICAO stands ready to provide assistance in facilitating the implementation of the procedures, guidance and the sharing of best practices.

Accept, Sir/Madam, the assurances of my highest consideration.

Fang Liu
Secretary General

Enclosure:
Unedited version of the guidance on 1 090 MHz spectrum issues and proper management of 24-bit aircraft addresses associated with unmanned aircraft (UA) (English only)

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ATTACHMENT to State letter SP 44/2-19/77

GUIDANCE ON 1 090 MHZ SPECTRUM ISSUES AND PROPER MANAGEMENT OF 24-BIT AIRCRAFT ADDRESSES ASSOCIATED WITH UNMANNED AIRCRAFT (UA)

Note. — This document is an unedited advance version of an ICAO publication as approved in principle, by the Secretary General, which is made available for convenience. The final edited version will be included in the next amendment to the Aeronautical Surveillance Manual (Doc 9924), which will be published in due course.

1. Background

1.1 The frequencies 1 030 and 1 090 MHz, acting as a frequency pair, support several aeronautical surveillance systems including secondary surveillance radar (SSR), multilateration (MLAT), airborne collision avoidance systems (ACAS) and automatic dependent surveillance-broadcast (ADS-B). Aircraft are interrogated by ground SSR/MLAT (or other aircraft, in the case of ACAS) on 1 030 MHz and reply (or broadcast) on 1 090 MHz with information such as their position, altitude and velocity vector.

1.2 The increasing density of ground-based and on-board surveillance systems using the 1 030/1 090 MHz frequencies is currently raising concerns, especially in dense airspaces. Ultimately it may result in a reduction to the overall performance of ACAS as well as the SSR/MLAT and ADS-B systems. In addition, the increased usage of ADS-B OUT applications for safety of life services and potential future evolution of those applications, such as space-based ADS-B, have raised serious concerns of potential congestion at 1 090 MHz. To ensure continued safe operation for all aircraft, proper and efficient utilization of available bandwidth at 1 090 MHz is required. This may include, when necessary, limiting access to 1 090 MHz by certain users.

1.3 Furthermore, it is important to note that those aeronautical surveillance systems rely on a limited capacity 24-bit aircraft address scheme. The allocation of a 24-bit aircraft address and its correct configuration in aircraft is a key element for safe operation of aircraft and associated protocols used to support communication and surveillance systems.

1.4 As defined in Annex 10 — *Aeronautical Telecommunications*, Volume III — *Communication Systems*, aircraft addresses are allocated in blocks by ICAO to the State of Registry or to the common mark registering authority. Using its allocated block of addresses, the State of Registry or the common mark registering authority assigns an individual aircraft address to each suitably equipped aircraft entered on a national or international register.

1.5 It is essential for States to recognize that their allocated block of 24-bit aircraft addresses is a finite and valuable asset. There are only 16 777 214 aircraft addresses in total and many of those have already been allocated to States of Registry or common mark registering authorities. Aircraft traffic growth has been forecast to double in the next 15 years and to manage these addresses in a sustainable manner, States need to validate whether new aircraft address allocation requests by aircraft operators fit the conditions defined in Annex 10, Volume III.

2. Issues identified in relation to operation of unmanned aircraft

2.1 As described above, concerns are being raised about congestion of the 1 090 MHz frequency and shortage of 24-bit aircraft addresses. The rapid growth in the number of UA is making those concerns more severe.

2.2 *Exponential increase of the safety risk due to 1 090 MHz congestion*

2.2.1 A recent study indicates that large numbers of UA (one UA per 2 square kilometres) operating at low level (less than 500 feet above ground level) in a typical high-density terminal airspace (760 ADS B-equipped aircraft operating within a 200 NM radius and from ground level to FL180) can

interfere with ADS-B ground station reception of ADS-B reports when the transmit power of each UA is 1 watt or higher.

Note. — Some other studies indicate that even a low power (0.1W) transmission from large numbers of UA can reduce the coverage range of ADS-B.

2.2.2 All studies reviewed conclude that the operation of ADS-B OUT by a large number of UA raises a serious concern for the safety of other aircraft in the same airspace.

2.3 *Future depletion of 24-bit aircraft addresses*

2.3.1 The 24-bit aircraft address scheme was not designed for a very large number of aircraft. Some studies predict that based on the present growth of UA, there will be over a million such vehicles by 2025. Based on these current projections, it will be impossible to accommodate all UA in the current scheme.

2.3.2 In some situations UA may require a 24-bit aircraft address, for instance if the UA fly in controlled airspace or in proximity to traditional manned aircraft. States will need to evaluate such situations on a case-by-case basis when receiving a new aircraft address application from the UA community.

Note. — As described in the Manual on Remotely Piloted Aircraft Systems (RPAS) (Doc 10019), an aircraft which is intended to be operated with no pilot on board is classified as unmanned and an unmanned aircraft which is piloted from a remote pilot station is a remotely piloted aircraft (RPA) (refer to the following figure).

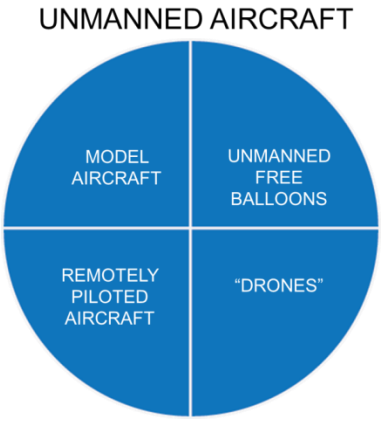

Figure 1-1 Unmanned aircraft

3. **Procedure to ensure proper utilization of 1 090 MHz and for non-allocation of (24-bit) aircraft address for UA**

3.1 There is increasing pressure to use 1 090 MHz Mode S or ADS-B OUT applications by UA. Given the large forecasted increase of UA and the fact that transmissions from their transponders or ADS-B OUT devices will impact the already congested use of 1 090 MHz by existing aeronautical surveillance and collision avoidance systems, States are urged to:

1) perform radio frequency spectrum analysis to analyse the degree of congestion of 1 090 MHz and, based on the outcome of this analysis, consider how 1 090 MHz ADS-B UA operations might impact the performance of the air navigation service provider (ANSP)-operated surveillance

systems in airspace of interest as well as the automatic collision avoidance systems on board aircraft operating in that airspace;

2) formulate the circumstances and define procedures to determine the potential requirement for 1 090 MHz ADS-B OUT equipage on UA in order to allow or prohibit such equipage as appropriate. During this process, States should consider:

   - the degree to which individual UA may or may not require air traffic services. For example, a UA operating in uncontrolled airspace may not be required to use ICAO-compliant aeronautical surveillance systems; and

   - the degree to which the operation of individual UA may or may not interoperate in the airspace with traditional manned aircraft. For example, if UA are not operating in proximity to traditional manned aircraft, then the use of ICAO-compliant aeronautical surveillance equipment by UA may not be justified.

3) in cases where UA are not required to equip with ICAO-compliant aeronautical surveillance equipment**,** States should not allocate 24-bit aircraft addresses.

Note. — 24-bit aircraft address allocation should be a part of the UA registration or operator approval process. For guidance material on reliable usage of 24-bit aircraft addresses, refer to Annex 10, Volume III and Doc 9924.

— END —