**FREQUENCY SPECTRUM MANAGEMENT PANEL (FSMP)**

NINTH MEETING OF THE WORKING GROUP

Montreal, Canada, 22-30 August, 2019

Agenda Item 3: Radio Altimeter and Wireless Avionics Intra-Communications (WAIC) issues

Update on Draft SARPs for Wireless Avionics Intra-Communications (WAIC)

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| **SUMMARY** |
| This Working Paper contains an update of the draft Standards and Recommended Practices (SARPs) for Wireless Avionics Intra-Communication (WAIC) systems currently under preparation by the FSMP WG. The draft SARPs text contained in the Annex to this document is based on the previous draft as included in the Working Paper 5 presented at the eighth meeting of FSMP WG. That meeting approved the SARPs draft in its proposed form, except for the unwanted emissions mask. The SARPs Correspondence Group was tasked to establish consensus on the unwanted emission mask and to finalize the WAIC SARPs text. The new SARPs draft text that is included herein represents the output of the Correspondence Group and is presented to FSMP for approval. Additional Annexes include the proposed text for implementation, impact and validation statements to be used when submitting these SARPs to ANC. |

1. INTRODUCTION

Pursuant to Job Card FSMP.007.01, the Frequency Spectrum Frequency Management Panel (FSMP) has been developing Standards and Recommended Practices (SARPs) for Wireless Avionics Intra-Communication (WAIC). The availability of SARPs is a necessary pre-requisite for the development and deployment of WAIC systems, according to Resolution 424 of World Radiocommunication Conference 2015. That resolution created a new aeronautical mobile (route) service allocation for WAIC in the radio frequency band 4 200 – 4 400 MHz and required that WAIC must not cause harmful interference to radio altimeters that are operated worldwide under the aeronautical radionavigation service allocation in that same frequency band. The Job Card requested FSMP to develop SARPs that will provide technical conditions for safe coexistence of WAIC systems on one aircraft with radio altimeters and WAIC systems on other aircraft. Further, the Job Card requested FSMP to rely whenever possible on detailed technical specifications to be developed by EUROCAE and RTCA.

This working paper includes an updated draft of SARPs, resulting from the work of the SARPs Correspondence Group that was originally created at the seventh meeting of FSMP WG, held in September 2018. At the eighth meeting of FSMP WG, held in January 2019, the Correspondence Group presented a draft SARPs text as included in Working Paper 05 of that meeting. The meeting approved that draft SARPs text, except for the unwanted emissions mask requirement. The Correspondence Group was requested to reexamine the unwanted emissions mask and to finalize the SARPs draft accordingly. In the course of Group’s work, several proposals were made to expand the scope and modify WAIC SARPs beyond the unwanted emissions mask issue. This Working Paper discusses those proposals and their proposed resolution for FSMP to consider.

The updated draft SARPs text is consistent with and refers to the new Minimum Aviation System Performance Specification (MASPS) for WAIC that was concurrently published by EUROCAE and RTCA on 1 July 2019 as ED-260 and as DO-378. This satisfies the Job Card mandate to make the full use of technical work by EUROCAE and RTCA. Accordingly, the Correspondence Group presents these SARPs for approval by FSMP. Drafts of Impact Assessment and Validation Statement are also included as additional Annexes, in preparation for the submission to the Air Navigation Commission.

1. DISCUSSION

**Unwanted Emissions Mask**

The newly proposed unwanted emissions mask for WAIC fully addresses the concerns of the two national delegations that voiced their concern at the eighth meeting of FSMP–WG. Considerable effort was made to assure that the mask is compliant with Radio Regulations and applicable ITU-R Recommendations. The Correspondence Group is in full agreement that the mask provides sufficient protection for any services in the adjacent bands that may be allocated in the future. Accordingly, the only technical item that was requested by the eighth meeting of FSMP-WG is now fully satisfied.

**Protecting Radio Altimeters**

One proposal for expanding the scope of SARPs was to include an additional separate requirement section explicitly referencing radio altimeter protection criteria from Recommendation ITU-R M.2059. This proposal was not agreed on by the majority of the Correspondence Group, and accordingly it is not included in the draft SARPs presented herein.

The argument in favor of the new additional requirement was to assure consistency between: (a) how ICAO requires non-aeronautical services to protect aeronautical services; and (b) how ICAO analyzes and assures coexistence between aeronautical services. It was argued that the general protection criteria from Recommendation ITU-R M.2059 need to be equally applied to WAIC in SARPs. Specifically, a requirement was proposed to limit the aggregate power spectral density received from WAIC by radio altimeters on other aircraft.

The opposing view of the majority of the Correspondence Group was that referencing Recommendation ITU-R M.2059 was not needed and would be inappropriate in view of how the WAIC allocation was established. Instead, Recommendation ITU-R M.2085 provides specific conditions to protect altimeters from WAIC interference, and should be used in these SARPs.

It should be noted that Recommendation ITU-R M.2059 was developed specifically as part of the preparatory work to establish the new WAIC allocation. It provides technical characteristics and protection criteria that should be used when conducting ITU-R compatibility studies to assure protection of radio altimeters. Report ITU-R M.2319 provides details of just such compatibility study between WAIC and altimeters using the characteristics and criteria from Recommendation ITU-R M.2059. Then, Recommendation ITU-R M.2085 combines findings of both Recommendation ITU-R M.2059 and Report ITU-R M.2319 and specifies a method to assure protection of altimeters via a limit on EIRP power density emitted by WAIC on one aircraft. That limit on emitted power is given as 6dBm/MHz or equivalently 4mW/MHz.

Further, Resolution 424 (WRC-15) invites ICAO to take into account Recommendation ITU-R M.2085 when developing SARPs. Consequently, ICAO is specifically requested to use Recommendation ITU-R M.2085 to establish requirements for WAIC. This implies that limiting the EIRP spectral power density emitted by a WAIC-equipped aircraft is identified as the desirable and sufficient method to protect altimeters. It should be noted that the RTCA Special Committee 236 (SC-236) and EUROCAE Working Group 96 (WG-96) have analyzed the sufficiency of the 4mW/MHz limit in view of the same AVSI engineering analysis that is being presented to FSMP-WG in a separate Information Paper. This emitted power limit is now included in ED-260 and DO-378. It was also previously approved by the eighth meeting of FSMP-WG to be used by WAIC SARPs.

Because of the above, the majority of the Correspondence Group is of the view that the requirement xx.4.2, as currently proposed, provides sufficient protection to radio altimeters, and there is no need to specify any additional criteria.

The main concern voiced against this approach is the apparent disparity of treatment between how WAIC and non-ICAO systems must protect radio altimeters. To address this concern, the Group notes that WAIC is an ICAO system fully under aviation control and subject to strict aviation certification processes, as are radio altimeters. As such, operational scenarios of both WAIC and altimeters are fully understood and may be analyzed jointly. Potential susceptibility of altimeters with respect to WAIC was found to be most severe in the Worst Case Landing Scenario (WCLS). The maximum allowable level of WAIC emissions was established taking into account how altimeters actually operate under that specific scenario.

The WCLS susceptibility study was not a general ITU-R compatibility study. Instead, it was an ICAO engineering study to analyze coexistence of two ICAO systems. This kind of analysis was possible only because both systems are under tight control of aircraft integrators and their interactions may be modeled to a very high degree of accuracy. On the other hand, operation of non-ICAO systems cannot be modeled with any appropriate accuracy, and for compatibility studies it must be considered as random. This necessitates using the most conservative criteria to protect radio altimeters from non-ICAO systems. It should be recognized that ICAO engineering studies are not expected to follow guidelines for ITU-R compatibility or sharing studies.

The aforementioned apparent disparity in treatment stems from the fact that non-ICAO systems are not subject to aviation airworthiness certification and their operation is highly uncertain. If a non-ICAO system vendor put itself under certification and operational control of aviation authorities, then its compatibility with ICAO systems could be analyzed using the same ICAO approach. Otherwise such non-ICAO systems must adhere to general, hence very conservative, protection criteria, which in this case would be Recommendation ITU-R M.2059. In conclusion, there is no disparity in treatment at all.

The above argument, while shared by the majority of the Correspondence Group, is not fully agreed on. A separate Working Paper FSMP-WG09-WP01 contributed by the French delegation is asking FSMP to consider this issue in general, not only for protection of altimeters, and to provide guidance that will influence acceptance of the current draft of SARPs. The current SARPs scope has not been expanded by the above proposal. The Correspondence Group requests the FSMP to consider this issue.

**Aviation Safety Margin**

The second proposal to modify the text of SARPs was to amend the power level in requirement xx.4.2 below its current value of 4mW/MHz. The motivation for this proposal was to allow for an additional safety margin to protect altimeters. This proposal was not agreed on by the majority of the Correspondence Group, and accordingly it is not included in the draft SARPs presented herein.

The argument in favor of the amendment was based on the altimeter susceptibility testing results as reported in the Information Paper 04 that was presented at the eight meeting of FSMP WG. Those results showed that when WAIC operates at 4mW/MHz there is at least 3dB of margin before the onset of possible harmful interference to altimeters in the WCLS scenario. To protect altimeters, it was suggested to lower the WAIC power limit to assure at least 6dB of safety margin.

The argument against this modification is twofold. Firstly, the notion of an aviation safety margin is defined for compatibility analysis between ICAO and non-ICAO systems, to account for uncertainties in the latter. Further, the Handbook of Radio Frequency Spectrum Requirements for Civil Aviation requires a safety margin of at least 6 dB “*until established on the basis of further study on a case-by-case basis.*” The AVSI susceptibility study represents such a further study performed for a very carefully defined worst case scenario. In an aeronautical safety analysis of this kind, if all known sources of uncertainty are accounted for, any positive margin of safety is sufficient. Therefore the at least 3dB of margin, as reported at the eighth meeting, assures safe operation of altimeters.

The second argument against this modification is the conservatism of the AVSI susceptibility study. Several worst case assumptions were made, which amounted in practice to a significant intrinsic safety margin. Those conservative assumptions are described in detail in a separate Information Paper FSMP-WG09-IP02 submitted to this meeting. Among those sources of conservatism, the overly conservative measurement altitude was corrected at the request of Thales, and all WCLS testing was repeated. Details of how and why the testing was modified are included in the accompanying Information Paper. With those modifications, a part of the previous intrinsic safety margin can now be explicitly observed. The updated test results show at least 6dB of margin between the onset of harmful interference and the interference power that may actually be received by altimeters when WAIC emits at 4mW/MHz. This means that even if WAIC were subject to the aviation safety margin requirement, which they should not be by virtue of being an ICAO system, the 4mW/MHz limit will still satisfy this requirement.

Based on the above, The Correspondence Group did not alter the requirement xx.4.2. The Correspondence Group requests the FSMP to consider this issue.

**WAIC Modulation Type**

The third proposal for expanding the scope of SARPs for WAIC was to include an additional separate requirement on the modulation type for WAIC. This proposal was not agreed on by the majority of the Correspondence Group, and accordingly it is not included in the draft SARPs presented herein.

The argument in favor of the amendment was based on the particular reading of the altimeter susceptibility testing report included in the Information Paper 04 presented at the eighth meeting of FSMP WG. The AVSI testing campaign used OFDM waveforms to represent aggregate WAIC interference received by a single altimeter originating from multiple WAIC transmitters on multiple neighboring aircraft. Because of the use of the OFDM waveform as a test interference signal, it was proposed to require that WAIC may only use OFDM as its modulation scheme.

The argument against the proposed amendment was based on the fact that a wide-band OFDM interference signal was only used as a convenient method to simulate the total aggregate WAIC interference signal with an approximately uniform power spectrum density spread across the entire 200 MHz band. The AVSI analysis indicates that the susceptibility testing results hold regardless of the actual modulation type that may be employed by individual transceivers, so specifying a modulation type requirement is not necessary.

Additionally, the proponents of WAIC strongly desire to retain a high degree of design flexibility when designing and deploying initial WAIC systems. Because of the conditions of the WAIC allocation, as specified in Resolution 424 (WRC-15), existence of and compliance with SARPs is a necessary condition for the first use of the allocation. Only after SARPs are finalized will the industry be able to fully evaluate the relative merits of various potential modulation schemes for WAIC. Limiting modulation to just one type so early in the process will dramatically restrict design options and will prevent the industry from developing an efficient technology option. For this reason it is highly desirable not to specify any modulation type at this time.

Immediately prior to the submission of this Working Paper, the modulation type issue had not yet been settled. However, on-going discussions indicate that there is a good possibility to find a consensus solution to preclude some specific forms of modulation that may cause specific concerns. The Correspondence Group expects to achieve consensus before or during the meeting itself. The SARPs draft presented herein does not include a modulation type requirement.

**Discussion Summary**

An amended draft SARPs text is contained in the Annex to this Working Paper in form of proposed amendments to Annex 10 to the Convention on International Civil Aviation. The meeting is requested to consider the two newly emerged issues of the applicability of Recommendation ITU-R M.2059 and of the aviation safety factor. Additionally, a method to resolve the modulation type issue will be discussed during the meeting. After those considerations at the meeting, members of the Correspondence Group are of the view that this text is in condition for approval by FSMP.

1. ACTION BY THE MEETING

The meeting is invited to note and review the contents in the Annex of this Working Paper. .

The meeting is requested to approve these SARPs.

— END —

ANNEX 1

Proposed Modifications to Annex 10 to the Convention on International Civil Aviation

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| Insert new text as follows |

CHAPTER xx. WIRELESS AVIONICS INTRA-COMMUNICATIONS (WAIC)

**xx.1 DEFINITIONS**

***Wireless Avionics Intra-Communications (WAIC) –*** WAIC is defined as radiocommunication between two or more aircraft stations located on board a single aircraft; supporting the safe operation of the aircraft.

***WAIC System*** – A WAIC System provides wireless communications between points on board a single aircraft for aircraft applications related to the safety and regularity of flight using the aeronautical mobile (route) service (AM(R)S) allocation in the frequency band 4 200 – 4 400 MHz. A WAIC System may be comprised of one or more WAIC Networks necessary for establishing, maintaining and securing wireless communications. A WAIC System is understood as the entirety of all WAIC components on board the same aircraft, so that a single aircraft contains only a single WAIC System.

***WAIC Network*** – A WAIC Network comprises interrelated WAIC Components, e.g. components used for wireless communications, security or network management.

***WAIC Component*** – Any tangible entity of a WAIC Network on board an aircraft.

***WAIC Node*** – A WAIC Node is a specific category of a WAIC Component establishing wireless communications between aircraft applications or parts thereof.

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| **Origin:**  FSMP | **Rationale:**  The above definitions are specific to WAIC and are provided in addition to the general definitions given in Chapter 1, Part 1 of Annex 10 Volume III. |

**xx.2 INTRODUCTION**

xx.2.1 WAIC Systems provide wireless communications between points on board a single aircraft for aircraft applications related to the safety and regularity of flight using the aeronautical mobile (route) service (AM(R)S) allocation in the frequency band 4 200 – 4 400 MHz. WAIC Systems are not allowed to communicate off board a given aircraft. This frequency band is shared with existing radio altimeters, which must be protected from WAIC emissions.

xx.2.2 These Standard and Recommended Practices (SARPs) define the requirements that ensure that WAIC Systems and radio altimeters can provide their intended functions while multiple aircraft are in mutual radio range. Coexistence requirements between WAIC Systems and radio altimeters installed on board the same aircraft are covered by established airworthiness certification processes and are outside the scope of these SARPs.

**xx.3 GENERAL**

xx.3.1 WAIC Systems shall comply with the applicable provisions of the ITU Radio Regulations.

xx.3.2 WAIC shall only be used for communications between two or more points on a single aircraft.

xx.3.3 WAIC Systems shall not cause harmful interference to radio altimeter systems on other aircraft while in operation in the frequency band 4 200 – 4 400 MHz.

*Note: Compliance with xx.3.3 is achieved by limiting the power of WAIC emissions below the level at which altimeter performance may be affected. The RTCA document DO-378 and the EUROCAE document ED-260 specify the power spectral density limit for a WAIC system that is consistent with xx.4.2 below, and provide one acceptable method of demonstrating compliance with that power spectral density limit.*

xx.3.4 WAIC systems shall tolerate interference from radio altimeters and WAIC systems on other aircraft in the frequency band 4 200 – 4 400 MHz.

*Note: The RTCA document DO-378 and the EUROCAE document ED-260 provide one acceptable method of demonstrating compliance with xx.3.4 via test. Alternatively, the critical coexistence scenario described in DO-378 and ED-260 may also be used to develop appropriate analyses to demonstrate compliance with xx.3.4.*

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| **Origin:**  FSMP | **Rationale:**  The sections above describe the basic function and purpose of WAIC. |

**xx.4 RADIO FREQUENCY (RF) CHARACTERISTICS**

xx.4.1 **Frequency Band:** WAIC systems shall operate in the frequency band 4 200 – 4 400 MHz.

xx.4.2 **WAIC System’s Total Radiated Power:**

The power spectral density of the total emissions of all WAIC transmitters on board an aircraft shall not exceed an equivalent isotropic radiated power spectral density of 4mW/MHz assuming a point source located at the geometrical center of the aircraft.

*Note: The RTCA document DO-378 and the EUROCAE document ED-260 provide one acceptable method of demonstrating compliance with xx.4.2.*

xx.4.3 **Unwanted Emissions Limits for a WAIC System:**

The unwanted emissions of a WAIC system shall not exceed the mask as defined in Table 1 and illustrated in Figure 1 below, referenced to the power spectral density limit in Requirement xx.4.2. The spectrum mask shall be respected under all operational conditions (i.e.: temperature, vibration, pressurization, frequency stability).

*Note: It is important to take into account the occupied bandwidth defined by the RR 1.153. For a WAIC emission, this occupied bandwidth is defined as its 23 dB attenuation.*



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| Frequency F (MHz) | Emissions mask (dB) |
| F ≤ 4197.4 | -43 |
| 4197.4 < F ≤ 4200.0 | -25 |
| 4200.0 < F ≤ 4201.3 | -3 |
| 4201.3 < F < 4398.7 | 0 |
| 4398.7 ≤ F ≤ 4400.0 | -3 |
| 4400.0 ≤ F < 4402.6 | -25 |
| F ≥ 4402.6 | -43 |

Table 1 WAIC emissions mask

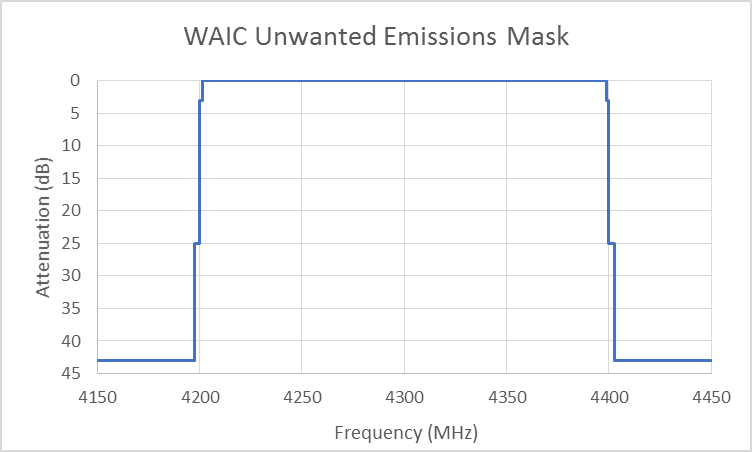


Figure 1 WAIC emissions mask

xx.4.4 **Out-of-Band Interference Tolerance:**

* WAIC receivers shall implement a front end filter, which in combination with the antenna provides at least 40 dB/decade rejection roll‐off from the band edges.
* WAIC receivers shall tolerate interference from sources operating outside of the frequency band 4 200 – 4 400 MHz whose total combined power as measured at the WAIC receiver (following the front end filter) does not exceed ‐30 dBm.
* WAIC receivers shall tolerate interference from sources operating outside of the frequency band 4 200 ‐ 4 400 MHz whose total combined emitted power falling within the frequency band 4 200 ‐ 4 400 MHz as measured at the WAIC receiver (following the front end filter) does not exceed a power spectral density of ‐101 dBm / MHz.

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| **Origin:**  FSMP | **Rationale:**  The sections above describe the minimum RF characteristics of WAIC transmitter and receiver. |

**xx.5 PERFORMANCE REQUIREMENTS**

xx.5.1 A WAIC system located on board one aircraft shall maintain its intended function while subject to emissions from WAIC and radio altimeter systems located on board other aircraft.

*Note: The RTCA document DO-378 and the EUROCAE document ED-260 provide one acceptable method of demonstrating compliance with xx.5.1 via test. Alternatively, the critical coexistence scenario described in DO-xxx and ED-260 may also be used to develop appropriate analyses to demonstrate compliance with xx.5.1.*

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ANNEX 2

Impact and Implementation Assessment

Proposed Text to be Submitted to ANC

**PART 1: IMPACT ASSESSMENT**

1.1 What is the problem/opportunity that this proposal is designed to address?

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| *Please include reference to Jobcard / ASBU / work programme item, as applicable* |
| (Reference: Job Card FSMP 07.01 – Develop and maintain SARPs and guidance to prevent WAIC / Radio Altimeter interference)  Resolution 424 of the World Radiocommunication Conference 2015 established a new aeronautical mobile route service allocation in the frequency band 4200 – 4400 MHz, reserved exclusively for Wireless Avionics Intra Communications (WAIC), and invited ICAO to develop SARPs for WAIC taking into account Recommendation ITU-R M.2085. As specified in Resolution 424, WAIC cannot cause harmful interference to, nor claim protection from radio altimeters operating in the same band as part of the pre-existing frequency allocation to the aeronautical radionavigation service. These proposed SARPs specify conditions that will assure such safe coexistence between future WAIC installations and radio altimeters.  WAIC is a new type of wireless on-board communication serving aircraft functions related to safety and regularity of flight. To-date, wireless data links have been feasible only for non-critical and non-essential aircraft functions. Availability of a new route allocation for WAIC will allow the use of wireless links for a wide range of aircraft systems. Possible applications of WAIC, as discussed in detail in Report ITU-R M.2283, include a variety of sensing, monitoring and control functions. The ability to deploy new sensors without additional wiring will allow introduction of new sensing and monitoring capabilities, leading to increased safety and efficiency of flight. Dissimilar redundant wireless links will make it easier to design safety critical systems by reducing common failure modes in data links. Aircraft reconfiguration and retrofit will be made more efficient when fewer wired data links have to be physically rerouted. Reduction of wire weight will also be consistent with ICAO environmental contributions to Sustainable Development Goals. Other, not yet fully understood benefits of WAIC will likely become apparent once the technology becomes commercially available.  In order to realize the many potential benefits of WAIC, ICAO needs to develop and approve SARPs. Per Resolution 424 (WRC-15) WAIC can operate only in compliance with ICAO SARPs. In order to fully invest in technical development of WAIC, the industry must have a high level of certainty about technical requirements that WAIC equipment and networks must satisfy. Therefore, the approval of these SARPs will be a crucial and necessary step towards practical deployment of WAIC systems. |

1.2 What is the overall impact of this proposal on the strategic objectives of ICAO, namely:

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|  | Positive / Negative / Negligible/None | Rationale:  *Please provide an explanation for your choice and highlight any caveats or limitations in the selection* |
| Safety | Positive | WAIC is an enabling technology introducing a new communications medium between aircraft functions. WAIC will enable expanded intra-system communications and the introduction of new sensors/actuators. WAIC-related safety impacts can only be assessed in association with future intended functions. The current level of safety will be at least maintained. Depending on the actual function WAIC is used for, safety may be improved for particular circumstances, e.g. by allowing dissimilar redundancy or adding new safety functionalities. |
| Security | Negligible/None | WAIC Systems do not provide communication between two aircraft. Specific equipment security capabilities and system implementations are defined in the WAIC MOPS to protect systems against specific threats. |
| Environment | Positive | Enhanced sensing, without additional weight penalty of new wiring, will enable more energy-efficient operation of aircraft systems, thus reducing the overall fuel consumption and carbon emissions. |
| Efficiency | Positive | Reduction of wiring, with associated harnesses and connectors, will simplify the design effort needed to add and route new wiring, and will reduce assembly and installation labour. New sensing and monitoring functions made possible by WAIC will facilitate predictive and condition-based maintenance, reducing gate delays and improving air transport efficiency. |

*Note: In the following questions ‘States’ applies to the adoption and oversight of new SARPs. ‘Industry’ applies to the service provision and use, whether State owned or not (e.g. ANSPs, airlines aerodromes, meteorology, general aviation, etc). With respect to financial costs for States, it refers to the cost to develop, implement, maintain, and consider oversight issues associated with the proposed change. For Industry, it refers to the cost of implementing the change, where compliance is required by the State, which may translate in costs for equipage, human resources, training, documentation, aircraft modifications or upgrades, operations and airworthiness for example.*

1.3 What is the overall impact on resources (financial, personnel, etc) of this proposal for:

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|  | Increase/decrease/negligible/unknown | Rationale:  *Please provide an explanation for your choice and highlight any caveats or limitations in the selection* |
| States | Negligible/No impact | No changes to existing systems or infrastructure will be needed when WAIC Systems are introduced. WAIC involves communication only between points on a single aircraft, and does not require any new infrastructure. |
| Industry | Negligible/No impact | The proposed WAIC Systems will be implemented on new aircraft being delivered from the aircraft manufacturers and also potentially on retrofit aircraft, with no impact on other aircraft that does not use WAIC. |

1.4 In your opinion, do the benefits of this proposal justify the cost of implementing the proposal from the perspective of:

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|  | *Answer* | Rationale:  *Please provide an explanation for your choice and highlight any caveats or limitations in the selection* |
| States | Yes | WAIC will allow design of more efficient and intelligent aircraft systems with enhanced sensing and monitoring functionalities, facilitating technical progress in aviation and improving efficiency of air travel. |
| Industry | Yes | The new AM(R)S allocation for WAIC was established due to industry request. The availability of SARPs for WAIC will allow taking advantage of the many potential benefits of WAIC. |

**PART 2: IMPLEMENTATION PLAN**

To assist ICAO and States ensure this proposal will be effectively implemented please answer the following questions.

*Note: The ANC recognizes that panel experts may feel limited in their ability to answer some or all of these questions, however, encourages the panels to provide their views. If still unsure, it is acceptable to leave one or more blank. The answers presented to the ICAO Council with the proposed amendment will be further developed by ICAO.*

2.1 What supporting documentation is required for this proposed amendment?

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| *Please include reference to any documents that require initial release/amendment e.g. ICAO Document or Circular name and number, industry specification, etc* |
| * Add a new chapter to Annex 10 Aeronautical Telecommunications, Volume ? on the Wireless Avionics Intra-Communications (WAIC) |

2.2 What other guidance, training and support activities do you recommend ICAO undertake to ensure the effective implementation of this proposed amendment?

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| *Please include reference to any existing support/promotional programmes and whether it is required globally or regionally e.g. regional seminars, ikits, etc* |
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2.3 What are the essential steps to be followed by a State in order to implement this proposed amendment?

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| *Please include the major steps e.g. amendment of national legislation, change of oversight procedures, training of oversight personnel, required competencies, etc.* |
| * National radio frequency spectrum regulations need to be adapted to reflect the changes in the Radio Regulations for WAIC agreed by WRC-15 for WAIC. |

2.4 What is the timeframe needed to implement this proposal by:

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|  | Answer | Rationale:  *For the State, the timeframe is the length of time needed to implement in the national regulatory framework*  *For industry, the timeframe is the length of time needed for industry to start implementing in their operations* |
| States | 1 - 2 Years | National radio frequency spectrum regulations need to be adapted to reflect the changes in the Radio Regulations for WAIC agreed by WRC-15 for WAIC. |
| Industry | 1 - 2 Years | The lack of SARPs is the main factor preventing the industry from developing and deploying WAIC solutions. Once these SARPs are approved, the expectation within the industry is to have first WAIC solutions available within 2 years. |

**PART 3: AUDIT PLAN**

*Note: This section will be completed by ICAO prior to the presentation of any proposed changes to SARPs or PANS. The Panel Secretary will coordinate with the relevant experts in ICAO.*

3.1 Does this proposal require an amendment of the USOAP CMA protocol questions to assess effective implementation by States?

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| *Please include reference to existing PQs that may need amendment or description of any new PQs that may be required. State ‘Not applicable’ if no impact* |
| * Not applicable |

ANNEX 3

Validation Statement

Proposed Text to be Submitted to ANC

**WAIC SARPS VALIDATION REPORT**

1. **INTRODUCTION**
   1. Wireless Avionics Intra-Communications (WAIC) is a new class of wireless data links intended for communication between various functions on-board a single aircraft. A new aeronautical mobile route service allocation for WAIC within the radio frequency band of 4 200 – 4 400 MHz was established by the 2015 World Radiocommunication Conference (WRC-15).
   2. The same radio frequency band includes an aeronautical radionavigation service allocation reserved for radio altimeters. The new allocation for WAIC requires that WAIC cannot cause harmful interference to nor claim protection from radio altimeters. Therefore, in development of SARPs for WAIC the main technical task was to establish and validate conditions under which WAIC shall not harmfully interfere with altimeters.
   3. This report summarizes studies that were undertaken to characterize susceptibility of radio altimeters with respect to interference from WAIC and to validate technical requirements to be included in WAIC SARPs. The particular technical parameter under consideration was the total radiated power emitted from a WAIC system on board a single aircraft. A series of experimental studies investigated the highest power that may be emitted from a WAIC-equipped aircraft that allows normal operation of altimeters on other aircraft. Results of those studies were presented to and analyzed by FSMP.
   4. Prior to finalization of these SARPs, the EUROCAE Working Group 96 and RTCA Special Committee 236 jointly developed a Minimum Aviation System Performance Standard (MASPS) for WAIC, which is now published as ED-260 and DO-378. That joint committee reviewed the same experimental study and confirmed its validity. The technical specifications in WAIC SARPs are consistent with conditions specified within this WAIC MASPS.
2. **WAIC POWER LIMIT**
   1. Resolution 424 (WRC-15) invited ICAO to take into account Recommendation ITU-R M.2085 when developing WAIC SARPs. That Recommendation specifies that the maximum equivalent isotropically radiated power (EIRP) spectral density generated by a WAIC system installed on board a single aircraft must not exceed 6 dBm/MHz, or equivalently 4mW/MHz.
   2. ED-260 and DO-378 adopt the 6dBm/MHz EIRP spectral density limit for WAIC and provide a practical verification procedure how to ascertain whether the limit is satisfied.
   3. The validation study summarized herein took as the basis the power limit from ITU-R M.2085, later adopted by ED-260 and DO-378. The goal was to confirm experimentally whether that limit assures safe operation of actual radio altimeter implementations aboard other aircraft under worst case operational scenarios.
3. **INTERFERENCE SUSCEPTIBILITY STUDY**
   1. The experimental study was performed by the Aerospace Vehicle Systems Institute (AVSI). The project team included three leading altimeter manufacturers (Honeywell, Rockwell Collins, Thales), two airframers (Airbus, Embraer), as well as equipment manufacturers (Lufthansa Technik, UTC, Zodiac) and NASA specialists.
   2. The study was performed at Texas A&M University to enable objective and repeatable testing in an independent academic setting.
   3. A collection of commercial altimeters was placed within a calibrated test bench. Controlled interference signals were injected into altimeter receivers’ additive to their return signals.
   4. Through analysis and experimental iteration, the project team established the worst-case operational scenario under which multiple WAIC-equipped aircraft generate most severe interference received by altimeters on a victim aircraft. That worst-case scenario involves landing when the multiple WAIC-aircraft aircraft parked or taxiing at the airport, consistent with ICAO regulations for aerodromes, generate the most severe composite interference environment.
   5. The study crucially considered interference from multiple altimeters installed on multiple aircraft at the airport, as well as from multiple redundant altimeters aboard the landing (victim) aircraft. That was a primary concern for FSMP, as other altimeters represent the most severe interference source for a victim altimeter, often exceeding the effects of potential interference from WAIC.
   6. The study used a set of very conservative assumptions and was thoroughly reviewed by the altimeter experts on the AVSI team. It was also reviewed and accepted by a wider team on the joint WG-96 and SC-236 committee, including experts from EASA and FAA.
   7. Details of the study were reviewed by FSMP in form of a series of Information Papers submitted by AVSI.
4. **VALIDATION OF REMAINING SARPS REQUIREMENTS**
   1. Additional parameters specified by this SARPs were experimentally found to have no effect on the interference sensitivity of radio altimeters. However to properly implement WAIC systems, these additional parameters are required to meet international radio frequency spectrum regulation and have been verified by FSMP members as sufficient to satisfy these regulations.
   2. Specifically, the unwanted emissions limits were thoroughly discussed to assure compliance with applicable ITU-R recommendations and national regulations. The final version of the emissions mask satisfies all the requirements introduced by FSMP members representing different national regulatory bodies.
   3. Out-of-band interference tolerance was similarly thoroughly examined discussed to assure compliance with applicable ITU-R regulations. The final version of the requirement addresses all concerns voiced by FSMP members.
   4. The FSMP reviewed and validated these SARPs for regulatory compliance.
5. **CONCLUSIONS**
   1. The AVSI study verified that if EIRP spectral density generated by WAIC aboard a single aircraft does not exceed 6dBm/MHz, then performance of altimeters aboard other aircraft will not be negatively affected.
   2. The conclusion holds in most unfavorable worst case operational scenarios, under a set of conservative worst case assumptions.
   3. FSMP concludes that the EIRP spectral density limit of 6dBm/MHz is an appropriate requirement for WAIC and satisfies the condition of protecting radio altimeters.
   4. All requirements in WAIC SARPs were validated by FSMP for regulatory compliance.