**FREQUENCY SPECTRUM MANAGEMENT PANEL (FSMP)**

Eleventh Working Group meeting

**Virtual Meeting, 1 – 12 March 2021**

Agenda Item 3: Radio Altimeter SARPS

Working Paper to Encourage ICAO and Panel Member Participation in Country Regulatory Activities that Could Cause Interference to Radio Altimeters

(Presented by ICCAIA)

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| **SUMMARY** |
| This paper reports on activities undertaken by industry to address the deployment of new cellular terrestrial systems supporting “5G” applications in in the C band, to bring to the attention of the FSMP the potential for harmful interference to radio altimeters, and to request information regarding potential 5G deployment in their countries in the C Bandfrom FSMP participants  |

INTRODUCTION

* 1. Many countries have already deployed, are starting to deploy or are considering to deploy 5G terrestrial systems in C band. The aviation industry has studied potential impacts to radio altimeters as a result of such deployments. The studies raise concerns with 5G deployments in this frequency range; and the overall results are provided in this document.
	2. In April, 2020 the aviation industry created an RTCA 5G Task Force to study the performance of currently fielded radio altimeters, which operate in the frequency band 4200-4400 MHz, with respect to 5G transmissions. This study was only focused on regulatory activity in the United States and is limited to 5G transmissions in the frequency range 3700 – 3980 MHz. The final report was published on October 7th, 2020 and concluded that 5G systems will interfere with some radio altimeters under certain operating circumstances. The full report can be found on the RTCA website.[[1]](#footnote-1)
	3. The results presented in the report reveal a risk that 5G telecommunication systems operating in the frequency range 3700–3980 MHz will cause harmful interference to certain radio altimeters operating in certain conditions, including commercial aircraft, general aviation, and helicopters.
	4. The results of the performed studies indicate that this risk is widespread and has the potential for broad impacts to aviation operations. Serious safety implications must be carefully assessed specifically during Cat III landing for Air transport aircraft, particularly during critical phases between 200 and 100 feet above the touchdown point.

DISCUSSION

* 1. Radio altimeters (also known as radar altimeters, low range radar/radio altimeters, or by the abbreviations RA, LRRA, RALT, or RADALT) operate under the Aeronautical Radionavigation Service (ARNS) in the radio frequency band 4200-4400 MHz. The radio altimeter is a critical sensor used to determine an aircraft’s height above the terrain immediately below the aircraft. The information derived from the radio altimeter enables and enhances several different safety and navigation functions throughout all phases of flight on all commercial aircraft and a wide range of other aircraft. Such functions include, but are not limited to, Terrain Awareness Warning Systems (TAWS), Traffic Alert and Collision Avoidance Systems (TCAS) and Airborne Collision Avoidance Systems (ACAS), Predictive Wind Shear detection systems, flight control systems, and autoland systems (including autothrottle and automated landing flare and rollout).
	2. The radio altimeter is the only sensor onboard the aircraft capable of providing a direct measurement of the clearance height above the terrain and any obstacles which may protrude above the terrain. Its measurements play a crucial role in providing situational awareness to the flight crew. No other sensor or system is used to provide height above terrain information, particularly with the same level of integrity, availability, and continuity provided by the radar altimeter.

2.3 The RTCA report divided radio altimeter models into three usage categories: Usage Category 1 covering commercial air transport aircraft; Usage Category 2 covering all other fixed-wing aircraft not included in Usage Category 1, including general aviation aircraft; and sage Category 3, covering both transport and general aviation helicopters.

* 1. The RTCA report provides detailed analysis of the problem within the United States. These details are not provided in this document. However, in short, all usage categories are not impacted in the same manner and even in a single category, impacts are different. Some altimeter models are more impacted than others, and there are variations within models due to manufacturing differences over time.
	2. According to one OEM manufacturer, approximately 11,000 Category 1 altimeters on its own commercial platforms are potentially impacted. This does not include non-civilian aircraft based on commercial models or aircraft on all the other manufacturers. It is anticipated that this represents just under half of all Category 1 altimeters.

2.5 The aviation industry understands that future equipment will need to consider the new radio frequency environment. This effort has already started with the on-going development of a new Radio-Altimeter MOPS by RTCA and EUROCAE, expected by the end of 2022, against which new equipment will need to be certified. However, in the meantime, it will take time to properly:

* Determine the impact to the many types of radio altimeters in use by aircraft and helicopters
* Assess operational impacts at the aircraft level
* Determine the impact to different types of operating environments – where does the problem occur?
* Determine technical solutions that will resolve the interference issue.
* Implement retrofits if necessary , which could be different for each type of aircraft/helicopter.
* Issue new aviation and communications regulations based on the new industry standards which are critical to allow fixes to occur.
* While doing all of this, find ways to pay for very costly aircraft/helicopter modifications during a time when the aerospace industry is facing unprecedented financial crisis.

For these reasons, temporary mitigation measures are needed to provide the aviation industry time to obtain data on 5G regulatory implementations and technical information in order to complete these assessments

**Need for Additional Information**

2.6 Because the scope of determining the problem is significant, there is a need to obtain an understanding of the regulations being formulated in each country with respect to 5G deployment. The introduction of 5G networks in frequencies near that used by radio altimeters causes the aircraft industry to address multiple and varying interference scenarios across the world.

2.7 Attachment A provides a convenient chart of useful regulatory and technical information administrations and aviation stakeholders can fill out and provide to ICAO.

**Conclusion**

2.8 ICCAIA strongly recommends administrations implement all practicable measures to ensure aviation safety and to provide sufficient time for the aviation industry to develop standards and implement mitigations that will permit 5G signals to be fully deployed in frequency ranges near that used by radio altimeters.

ACTION BY THE MEETING

3.0 The meeting is invited to:

1. note and review the contents of this working paper;
2. provide to the FSMP information regarding current and upcoming potential regulatory activities to deploy 5G cellular systems in Member’s countries or regions

— — — — — — — —**ATTACHMENT A**

**Regulatory and Technical Information Being Considered by Countries Regarding Current and Potential 5G Deployments in Frequency Ranges Near the Radio Frequency Band 4200 – 4400 MHz**

The following table (Table 1) provides details on a representative 5G Base Station (BS) rollout in the US (across 3.7 – 3.98 GHz). This was used to help analyse the impacts of 5G systems on radar altimeters. Updated tables similar to the one below will be helpful to assay the overall interference environment (in other frequency bands around the radar altimeter band) and related impacts to radar altimeter based operations across the world.

Table 1: Representative US 5G base station characteristics (3.7 -3.98 GHz)

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Sectoral Antenna** | **8x8 AAS Array** | **16x16 AAS Array** |
| **Environment** | Urban | Suburban | Rural | Urban | Suburban | Rural | Urban | Suburban | Rural |
| **Antenna Pattern** | ITU-R F.1336-5 | ITU-R F.1336-5 | ITU-R F.1336-5 | ITU-R M.2101-0 | ITU-R M.2101-0 | ITU-R M.2101-0 | ITU-R M.2101-0 | ITU-R M.2101-0 | ITU-R M.2101-0 |
| *ka* = 0.7 | *ka* = 0.7 | *ka* = 0.7 |
| *kp* = 0.7 | *kp* = 0.7 | *kp* = 0.7 |
| *kh* = 0.7 | *kh* = 0.7 | *kh* = 0.7 |
| *kv* = 0.3 | *kv* = 0.3 | *kv* = 0.3 |
| **Peak Antenna Gain** | 18 dBi | 18 dBi | 18 dBi |   |   |   |   |   |   |
| **Horizontal 3 dB Beamwidth (Sector)** | 65 degrees | 65 degrees | 65 degrees |   |   |   |   |   |   |
| **Vertical** **3 dB Beamwidth** | 7.56 degrees | 7.56 degrees | 7.56 degrees |   |   |   |   |   |   |
| **Array Size** |   |   |   | 8 x 8 | 8 x 8 | 8 x 8 | 16 x 16 | 16 x 16 | 16 x 16 |
| **Element Gain** |   |   |   | 6.4 dBi | 7.1 dBi | 7.1 dBi | 6.4 dBi | 7.1 dBi | 7.1 dBi |
| **Element Horizontal 3 dB Beamwidth** |   |   |   | 90 degrees | 90 degrees | 90 degrees | 90 degrees | 90 degrees | 90 degrees |
| **Element Vertical 3 dB Beamwidth**  |   |   |   | 65 degrees | 54 degrees | 54 degrees | 65 degrees | 54 degrees | 54 degrees |
|
| **Front-to-Back Ratio** |   |   |   | 30 dB | 30 dB | 30 dB | 30 dB | 30 dB | 30 dB |
| **Horizontal Array Spacing Coefficient** |   |   |   | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| **Vertical Array Spacing Coefficient** |   |   |   | 0.7 | 0.9 | 0.9 | 0.7 | 0.9 | 0.9 |
| **Vertical Scan Range** |   |   |   | -30 to 0 degrees | -10 to 0 degrees | -10 to 0 degrees | -30 to 0 degrees | -10 to 0 degrees | -10 to 0 degrees |
| **Peak Array Gain** |   |   |   | 24.5 dBi | 25.2 dBi | 25.2 dBi | 30.5 dBi | 31.2 dBi | 31.2 dBi |
| **Mechanical Downtilt** | 10 degrees | 6 degrees | 3 degrees | 10 degrees | 6 degrees | 3 degrees | 10 degrees | 6 degrees | 3 degrees |
| **Mast Height** | 20 meters | 25 meters | 35 meters | 20 meters | 25 meters | 35 meters | 20 meters | 25 meters | 35 meters |
| **Downlink Bandwidth** | 100 MHz | 100 MHz | 100 MHz | 100 MHz | 100 MHz | 100 MHz | 100 MHz | 100 MHz | 100 MHz |
| **Activity Factor** | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% |
| **Conducted Power per Element** |   |   |   | 25 dBm | 25 dBm | 25 dBm | 25 dBm | 25 dBm | 25 dBm |
| **Antenna FDR in 4.2–4.4 GHz Band** | 3 dB | 3 dB | 3 dB |   |   |   |   |   |   |
| **Peak Output EIRP Per Sector** | 61 dBm | 61 dBm | 61 dBm |   |   |   |   |   |   |
| **Peak Output EIRP** |   |   |   | 67.5 dBm | 68.2 dBm | 68.2 dBm | 79.6 dBm | 80.3 dBm | 80.3 dBm |
| **Peak Output PSD (EIRP)** | 41 dBm/MHz | 41 dBm/MHz | 41 dBm/MHz | 47.5 dBm/MHz | 48.2 dBm/MHz | 48.2 dBm/MHz | 59.6 dBm/MHz | 60.3 dBm/MHz | 60.3 dBm/MHz |
| **Conducted PSD, Spurious** | -20 dBm/MHz | -20 dBm/MHz | -20 dBm/MHz | -20 dBm/MHz | -20 dBm/MHz | -20 dBm/MHz | -20 dBm/MHz | -20 dBm/MHz | -20 dBm/MHz |
| **Peak Output PSD, Spurious (EIRP)** | -5 dBm/MHz | -5 dBm/MHz | -5 dBm/MHz | -13.6 dBm/MHz | -12.9 dBm/MHz | -12.9 dBm/MHz | -13.6 dBm/MHz | -12.9 dBm/MHz | -12.9 dBm/MHz |

Table 2 seen below shows the regulatory limits set for the 3.7 – 3.98 GHz band per the FCC Report and Order (R&O), GN Docket No. 18-122

Table 2: FCC regulatory limits (3.7 – 3.98 GHz band)

|  |  |  |  |
| --- | --- | --- | --- |
| **Non-Rural Base station power level** | 1640 | W/MHz | EIRP |
| **Rural base station power level** | 3280 | W/MHz | EIRP |
| **User equipment Power levels** | 30 | dBm | EIRP |
|  |   |   |   |
| **Base Station - Out-Of-Band Emissions** | -13 | dBm/MHz | (at band edge) |
| **Mobile Devices - Out-Of-Band Emissions** | -13 | dBm/MHz | (at band edge) |

It is to be noted that the information provided in table 2 is necessary but not adequate for the purposes of detailed technical analysis, testing and/or standardization efforts to help address radar altimeter compatibility with 5G systems in the near/adjancent band. Additional information (as detailed in Table 1) is necessary for such efforts. However, if only the information (power levels, out-of-band emission limits and spectrum usage, etc.) is available, such information would still be helpful.

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1. [file:///C:/Users/vk394c/Documents/Issues/Radar%20Altimeter/SC-239%205G%20Interference%20Assessment%20Report\_274-20%20PMC-2073%20Submitted.pdf](file:///C%3A/Users/vk394c/Documents/Issues/Radar%20Altimeter/SC-239%205G%20Interference%20Assessment%20Report_274-20%20PMC-2073%20Submitted.pdf) [↑](#footnote-ref-1)