October 27, 2020

VIA ELECTRONIC FILING

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
45 L Street, NE
Washington, DC 20554

Re: Ex Parte Presentation, *Expanding Flexible Use of the 3.7-4.2 GHz Band*, GN Docket No. 18-122

Dear Ms. Dortch:

CTIA[1] submits this response to a recent filing by RTCA, "Assessment of C-Band Mobile Telecommunications Interference on Low Range Radar Altimeter Operations" ("Report").[2] As described below, the Report is severely lacking in several respects: the underlying test data driving the conclusions has not been made available for review, the analysis is suspect, and its findings are unsupported. The Commission should dismiss the Report.

I. Introduction.

As an initial matter, the Commission concluded in the C-Band Order that the 3.7 GHz Service technical rules and the spectral separation of at least 220 megahertz from radio

[1] CTIA – The Wireless Association® ("CTIA") (www.ctia.org) represents the U.S. wireless communications industry and the companies throughout the mobile ecosystem that enable Americans to lead a 21st century connected life. The association's members include wireless carriers, device manufacturers, suppliers as well as apps and content companies. CTIA vigorously advocates at all levels of government for policies that foster continued wireless innovation and investment. The association also coordinates the industry's voluntary best practices, hosts educational events that promote the wireless industry and co-produces the industry's leading wireless tradeshow. CTIA was founded in 1984 and is based in Washington, D.C.

[2] RTCA, *Assessment of C-Band Mobile Telecommunications Interference on Low Range Radar Altimeter Operations*, RTCA Paper No. 258-20/SC239-006 (rel. Sept. 18, 2020) ("RTCA Report"), *attached to* Letter from Terry McVenes, RTCA, Inc., to Marlene Dortch, FCC, GN Docket No. 18-122 (filed Oct. 20, 2020).

altimeter operations "are sufficient to protect aeronautical services in the 4.2-4.4 GHz band."[3] The Commission "nonetheless agree[d] with [aviation interests] that further analysis is warranted on why there may even be a potential for some interference given that well-designed equipment should not ordinarily receive any significant interference (let alone harmful interference) given these circumstances."[4] Ultimately, the Commission directed the aviation community to resolve any issues as necessary: "[w]e expect the aviation industry to take account of the RF environment that is evolving below the 3980 MHz band edge and take appropriate action, if necessary, to ensure protection of such devices."[5] As discussed below, the Report fails to provide any reasonable basis for revisiting the Commission's conclusions.

Consistent with other aviation submissions, the Report examines altimeter models grouped into three usage categories of aviation: Usage Category 1—commercial air transport (passenger and cargo); Usage Category 2—all other fixed wing aircraft, including regional, business aviation, and general aviation; and Usage Category 3—helicopters.[6] The Report relies on the testing efforts of Texas A&M University's Aerospace Vehicle Systems Institute ("AVSI") and follows earlier AVSI reports submitted into the record measuring an "interference tolerance threshold" for several models of radar altimeters.[7] Here, AVSI collected test data for nine altimeters at three altitudes and under various conditions. The test data, however, have not been made publicly available and the Report is lacking in several ways:

- The Report relies on input data assembled by extracting the worst-performing data points from multiple altimeters into a single performance envelope for each Usage Category.

[3] *Expanding Flexible Use in the 3.7-4.2 GHz Band*, Report and Order and Order Proposing Modification, 35 FCC Rcd 2343 ¶ 395 (2020) ("C-Band Order").

[4] *Id*.

[5] *Id*.

[6] RTCA Report at 49.

[7] *See* Letter from David Redman, AVSI, to Marlene Dortch, Secretary, FCC, GN Docket No. 18-122 at 10 (filed Jul. 2, 2020) ("AVSI Jul. 2 Ex Parte"); Letter David Redman, AVSI, to Marlene Dortch, Secretary, FCC, GN Docket No. 18-122 at 6 (filed Feb. 4, 2020) ("AVSI Feb. 4 Ex Parte"); Letter from David Redman, AVSI, to Marlene Dortch, Secretary, FCC, GN Docket No. 18-122 at 10 (filed Oct. 22, 2019).

- The end result is a performance envelope for each Usage Category that is unlikely to match the performance characteristics of any individual altimeter.
- AVSI's approach permits a few altimeter models of unknown age, design, condition, and penetration to drive the RTCA conclusions. For example, AVSI included a pulsed altimeter model (Type 8 altimeter) in the testing, and the Commission has not certified a pulsed altimeter in more than 40 years. This altimeter very likely could be driving results in Usage Categories 2 and 3.

- The Report does not identify the altimeter models tested nor does it provide any individualized (even anonymized) data of altimeter model performance results.
  - AVSI refuses to make available individualized altimeter data in the C-band 5G/aeronautical coexistence context, but has done so in other studies.
- AVSI applied pass/fail criteria, which are stricter than RTCA's recommended minimum performance standard for low-range radar altimeters, DO-155. Under AVSI's flawed approach, several altimeter models could fail the criteria under a baseline assessment *with no C-Band 5G operations present*, as these models were designed to satisfy performance criteria less stringent than AVSI's pass/fail criteria.
- AVSI included several unwarranted margins in the reported interference tolerance thresholds, which RTCA subsequently used in its interference calculations.
- The Report improperly applies a worst-case landing scenario with settings and assumptions that do not match real-world situations.
- The Report improperly accounts for 5G operations, despite the wireless industry's explanations of 5G operations.
- And notably, applying the Report's approach to existing radio operations in the vicinity of the 4.2-4.4 GHz band, several existing systems and services would exceed AVSI's interference tolerance threshold. These include the Navy AN/SPN-43 radar operating at very high radiated power levels below 3.65 GHz, Citizens Broadband Radio Service ("CBRS") operations below 3.7 GHz, and Federal systems in the adjacent band, 4.4-4.94 GHz band, including ground-to-air communications that would require a ground antenna to focus energy upward toward aircraft. Notably, none of these existing services have been shown to contribute harmful interference to aviation altimeters.

These flawed inputs and analytical missteps lead to the Report's unsound conclusions regarding the impact of C-Band 5G operations on altimeters in the 4.2-4.4 GHz band.

Finally, CTIA is compelled to dispute RTCA's claim that it qualifies as a multi-stakeholder group responsible for assessing 5G/aeronautical co-existence in response to the C-Band Order's directive.[8] RTCA is an aviation organization, it has no representation from the wireless industry, and it is not a cross-industry multi-stakeholder group. In contrast, the C-Band Multi-Stakeholder Group is comprised of representatives from approximately 60 different companies and associations across a dozen different industry sectors, and Technical Working Group 3, which is the forum for discussion of 5G and aeronautical coexistence, is comprised of 28 different companies and associations across the aviation industry, wireless service providers and manufacturers, cable providers, Wireless Internet Service Providers, and others. TWG-3 is co-chaired by aviation and wireless industry association representatives, and membership is evenly split between aviation and 5G stakeholders.

In TWG-3, the RTCA Report is not a consensus document. CTIA, working with wireless industry representatives including service providers, equipment manufacturers, and device makers, submitted extensive feedback to a draft version of this Report that RTCA had put out for public comment.[9] CTIA identified significant shortcomings in the draft, including many of the points raised below, "reject[ed] its findings" contained within the Report, and concluded that "the Draft Report cannot be characterized as consensus-based."[10] Except for minor considerations, RTCA rejected CTIA's concerns. This final Report too is not a consensus document.

II. Aviation Stakeholders Continue to Rely on Aggregated Performance Envelopes and Fail to Disclose Important Information Necessary to Accurately Assess Interference.

Throughout the TWG-3 process and in the comment process on the draft RTCA report, the wireless industry repeatedly requested access to the list of tested altimeters and the underlying AVSI test data used to compile the aggregated altimeter performance results. Accurate conclusions of altimeter performance can only be reached through a careful review of the test conditions, procedures, quantities, and results, with an understanding of the models

[8] RTCA Report at 4.

[9] *See* Letter from Kara Graves, CTIA, to Rebecca Morrison, RTCA (Sept. 28, 2020).

[10] *Id*. at 1.

under test. The identity of the altimeter models, for example, is essential to understanding model specifications and capabilities, verifying that the manufacturers warrant their altimeter's performance under the tested conditions, and confirming that no known problems exist with the altimeter models under test.[11]

Aviation stakeholders, however, declined to provide altimeter information, stating: "RTCA SC-239 received summary data from AVSI and is not able to provide individual altimeter performance data."[12] In TWG-3 discussions, CTIA was told that AVSI's confidentiality agreements with altimeter manufacturers did not permit them to disclose the identity of altimeters and the underlying test data, even in an anonymized fashion.

Making matters worse, the Report aggregates the worst test points across all altimeter models under each Usage Category:

> Within each usage category, an overall Interference Tolerance Mask (ITM) is determined by combining the measured interference tolerance thresholds among all altimeter models included in that usage category. This is done by taking the worst-case interference tolerance threshold across all altimeter models applicable to a given usage category for each interference test case.[13]

This approach provides no transparency into individual altimeter performance. It obscures the actual performance of the altimeters under test. It creates an unrealistic mask made up of the worst elements among all altimeters in a Usage Category. And it does not permit any reviewer to evaluate the purported findings or to fully understand the coexistence

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[11] The Thales ERT-530 altimeter has a history of in-flight issues. *See, e.g.*, ICAO Uniting Aviation, *Airbus Erroneous Radio Altitudes*, https://www.icao.int/safety/acp/ACPWGF/ACP-WG-F-25/ACP-WGF25-IP07_Appendix2_FMG15%20PPT02%20Airbus%20Erroneous%20Radio%20Altitudes.pdf. *See also* Marc Baillion and Lorraine de Baudus, *Radio Altimeter Erroneous Values*, SAFETYFIRST, at 4 (Jan. 2011), https://safetyfirst.airbus.com/app/themes/mh_newsdesk/documents/archives/radio-altimeter-erroneous-values.pdf (describing Airbus certification of a new digital altimeter as a remediation step for erroneous values).

[12] RTCA Report at 152.

[13] *Id*. at 35.

environment: aggregated altimeter performance data based only on the envelope of the worst performing altimeter characteristics within the various Usage Categories shrouds the performance of specific radar altimeters in specific scenarios, thwarts the ability to confirm that manufacturers warrant their devices' operations under the tested conditions, and prevents experts from making informed assessments about the extent of any impact and whether mitigation measures might be beneficial. The Report's approach impedes the ability of stakeholders—including the Commission—to use the Report to independently assess 5G/altimeter coexistence.

A. Refusal to Disclose Individual Altimeter Results is Inconsistent with Past Aviation Practices.

Contrary to its statements and approach here, AVSI has, in other contexts, publicly disclosed the identity of altimeters under test and allowed the publication of test parameters and anonymized test results. This is the case with respect to prior AVSI work on Wireless Avionics Intra-communication ("WAIC").[14] WAIC is an AVSI-led project to replace cabling on new aircraft with wireless transceivers operating in the 4.2-4.4 GHz band.[15] For the WAIC project, AVSI performed laboratory testing of five altimeters and publicly disclosed the identity of the altimeters under test. Further information on the AVSI test bed setup, evaluation criteria, and anonymized test results for each altimeter was made publicly available through a master's thesis on the WAIC testing.[16]

In the context of C-Band 5G/aeronautical coexistence, however, the aviation industry refuses to identify altimeter models tested or to disclose individualized (even anonymized) altimeter performance data, despite allowing such information in the WAIC context.

[14] "Update on AVSI WAIC-Radio Altimeter Coexistence Testing," Fourth Working Group Meeting of the Frequency Spectrum Management Panel (FSMP – WG/4), ICAO APAC, Bangkok, Thailand, 29 March – 7 April 2017.

[15] *See generally* Wireless Avionics Intra-Communications, https://waic.avsi.aero/.

[16] Joshua Ruff, *Radio Altimeter Tolerance of Wireless Avionics Intra-Communications Systems*, submitted to the Office of Graduate and Professional Studies of Texas A&M University, at 58 (May 2019) ("Thesis") ("Five different altimeters were tested: the Rockwell Collins LRA2100, The Rockwell Collins LRA900, the Thales ERT530, the Thales ERT550, and the Honeywell ALA52B").

B. *CTIA Nonetheless Can Make Some Assessment of Tested Models, and RTCA's Undisclosed Altimeters Appear to Include One Model Certified More than 40 Years Ago.*

RTCA relied on AVSI's interference tolerance thresholds developed from nine altimeter models, including seven from previous testing and two that AVSI added specifically for the RTCA study.[17] Although the Report did not identify any individual altimeter model information, it did reveal that one of those additional altimeters (Type 8) is a pulsed altimeter.[18] CTIA and its members compiled information on all aviation altimeters that the Commission has certified since 1980 (FCC certification records are not available prior to 1980), and CTIA has found no record of any certification of pulsed altimeters *in the last 40 years,* as shown in the table below.

Aviation Altimeters Certified by the FCC Since 1980				
Unit #	**Manufacturer**	**Model Number**	**Year**	**Type**
1	Honeywell	SARA 9.1	2019	FMCW
2	Garmin	GRA 5500	2013	FMCW
3	Honeywell	ALA-52B	2011	FMCW
4	Rockwell Collins	LRA-2100	2010	FMCW
5	Thales	AHV1600	2009	FMCW
6	FreeFlight Systems	RA-4000	2009	FMCW
7	Honeywell	ALA-52B	2008	FMCW
8	FreeFlight Systems	RA-4000e	2007	FMCW
9	Thales	ERT 550	1997	FMCW
10	Honeywell	ALA-52B	1996	FMCW
11	Honeywell	KRA 405B	1996	FMCW
12	Rockwell Collins	ALT-4000	1995	FMCW
13	Rockwell Collins	ALT-1000	1994	FMCW
14	Thales	ERT 540	1993	FMCW
15	Trimble	TRA-3500	1985	FMCW
16	Trimble	TRA-3000	1985	FMCW
17	Trimble	Unavailable	1982	Unavailable
18	Trimble	Unavailable	1982	Unavailable

Table 1: Altimeter Type 8, Incorporated into Usage Categories 2 and 3, was not certified in the last 40 years.

[17] RCTA Report at 40.

[18] *Id*. at 38.

With an FCC certification dating back at least 40 years, there are substantial questions of obsolescence and potential malfunctions for the Type 8 altimeter. With no transparency, however, CTIA is unable to gain any insight into the Type 8 altimeter's history, condition, or manufacturer's specifications. But one thing is clear: AVSI's decision to add the Type 8 altimeter into two of the Report's three Usage Categories directly contradicts the C-Band Order's focus on "well-designed equipment," which "should not ordinarily receive any significant interference (let alone harmful interference)" given the adopted technical rules and 220 megahertz of separation.[19]

Further, there is evidence that no pulsed altimeters are in commercial use today. According to an Aerospace Fellow from Honeywell International, "[a]ll commercial radar altimeters in use today make use of a radar modulation method known as Linear Frequency Modulation – Continuous Wave or LFM-CW or FM-CW"[20]—meaning no pulsed altimeters.

AVSI incorporated the pulsed altimeter Type 8 into its analysis of two of the three Usage Categories of civil aviation: Usage Category 2 (regional, business aviation, and general aviation) and Usage Category 3 (helicopters).[21] Because RTCA relies on a worst case envelope mask for each Usage Category, and because AVSI incorporated data from the pulsed altimeter, this outdated (and quite possibly, out-of-service) altimeter may be driving the whole analysis for both Usage Categories 2 and 3.

Additionally, although the Report does not identify the altimeters that AVSI tested, CTIA believes it is reasonable to presume that AVSI tested the same altimeter models here that it identified as part of a separate coexistence review with WAIC operations. The AVSI WAIC test bed identified the following specific altimeter models used in the testing effort:

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[19] C-Band Order, 35 FCC Rcd 2343 ¶ 395.

[20] *See* Comments of David Vacanti, Aerospace Fellow, Honeywell International, ET Docket No. 10-123, at 2 (filed Apr. 25, 2011).

[21] AVSI, AFE 76s2 Report: Effect of Out-of-Band Interference Signals on Radio Altimeters (Apr. 17, 2020), https://www.rtca.org/wp-content/uploads/2020/08/SC-239-TOR-Approved-04-17-2020.pdf.

Manufacturer	Model Number	Type	Usage Category
Honeywell	ALA-52B	FMCW	1
Rockwell Collins	LRA-900	FMCW	1
Rockwell Collins	LRA-2100	FMCW	1
Thales	ERT 530	FMCW	1
Thales	ERT 550	FMCW	1

Table 2: WAIC-Tested Altimeters and Likely Used in Early C Band Testing

AVSI launched the WAIC test bed in 2017 and testing occurred into 2019, at which time early coexistence testing on neighboring bands beyond 4.2-4.4 GHz began to take place.[22] The test setup used for WAIC is very similar to that used in AVSI testing exploring C-band 5G/aeronautical coexistence.[23] And this time period coincides with the Commission's consideration of commercial mobile services in the C-band.

Contrary to RTCA's position, examination of individual altimeter models is important in order to understand each altimeter model's specifications and how they would be expected to perform under AVSI's test pass/fail criteria. In the section below, we apply the design specifications for these altimeter models to the AVSI pass/fail criteria, which shows those levels are overly conservative and faulty.

III. AVSI's Overly Conservative Pass/Fail Criteria Are So Flawed that Altimeters Could Fail Under Conditions with No C-Band 5G Operations Present.

AVSI developed pass/fail criteria to assess the impact of 5G operations on altimeters, but the values it applied are fundamentally flawed. And as shown below, altimeters complying with RTCA's own altimeter performance standard could exceed the pass/fail criteria even when there are no C-Band 5G operations present.

[22] Thesis, Section 2.6.4, "Out of Band Testing."

[23] Compare Thesis, Figure 2.18, p. 49, with AVSI October 2019 Interim Study, Figure 3, p. 8.

As an initial matter, AVSI defined three pass/fail criteria and asserts that exceedance of any of the three would result in a claim that interference exists:

1. A mean height error greater than 0.5%.
2. Fewer than 98% of the data points fall within ± 2% of the average height with interference off.
3. Any height reading labeled NCD (no computed data).[24]

Notably, however, the pass/fail criteria applied by AVSI and used in the Report are significantly more stringent than that of DO-155—RTCA's minimum performance standard for low-range radar altimeters that is in force today. The pass/fail criteria are also more stringent than EUROCAE ED-30, the European civil aviation specification for the minimum performance of altimeters, referenced in AVSI's earlier reports.[25]

As discussed below, DO-155 states that altimeter accuracy shall be ± 3% from 100 to 500 feet[26]; permits further tolerance of ± 5% from 100 to 500 feet for the pilot's display[27]; and only

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[24] RTCA Report at 115. CTIA's analysis here focuses on the first two criteria, as the NCD criteria appears to be part of each manufacturer's proprietary implementation and may not be standard across all altimeters.

[25] EUROCAE ED-30, Minimum Performance Specification for Airborne Low Range Radio (Radar) Altimeter Equipment, March 1980, section 3. EUROCAE ED-30 defines four classes of altimeter:

> 1) Category A1: for the needs of automated landing. Accuracy is +/- 3% from 100 to 500 ft, and +/- 5% above 500 ft. The pilot's display permits a 2% higher tolerance.
>
> 2) Category A2: identical to A1 except that the accuracy is not in accordance with A1, but shall be declared by the manufacturer.
>
> 3) Category B: expected to meet the needs of ground proximity warning systems. Accuracy is +/- 5% for 100 ft and above.
>
> 4) Category C: altimeter should meet +/- 2% but over smooth terrain. Cat. C is also expected to be certified under A1, A2 or B.

[26] Minimum Performance Standards Airborne Low-Range Radar Altimeters, RTCA DO-155, at 3 (Nov. 1, 1974), Table 1.

[27] DO-155, at 3, Table 1. The pilot's display tolerance is the overall system altitude tolerance, consisting of the altimeter tolerance and the display tolerance.

requires 95% of the measured points to fall within that tolerance.[28] RTCA does not explain why its own altimeter performance standard in use today differs so markedly from the pass/fail criteria AVSI devised and RTCA relied on for this Report. Moreover, DO-155 only "recommends" compliance with the performance standard; no information has been provided in the Report to indicate that all altimeters tested by AVSI comply with DO-155.[29]

AVSI's first criterion, mean height error greater than 0.5%, may not be achievable in an altimeter's baseline test—meaning that an altimeter could exceed the pass/fail criteria and thus register "interference" even when there is no C-Band 5G operation present. Many altimeters state a manufacturing accuracy of ± 2% for altitudes less than 500 feet.[30] Variations in altimeter performance between different tests could well exceed an average variation of 0.5% *when no external RF operations are present*, thus raising the likelihood of false indications of harmful interference. CTIA notes further that this criterion does not appear in ARINC's altimeter characteristics document, ARINC 707-7, or in D0-155.

AVSI's second criterion, ± 2% of the average height, is problematic for multiple reasons. First, AVSI's default test setup only simulates flying over rough terrain, which is more challenging for proper radar altimeter operation, not flying over smooth terrain (like a runway). AVSI applies the 0.01 worst-case terrain reflection coefficient,[31] simulating flying over rough terrain where little energy is reflected off of the surface below.[32] But industry guidance suggests that stringent accuracy requirements like ± 2% of the average height (or for that matter, 0.5%

[28] DO-155, at 4, section 2.2: "[the precision equipment output] shall not exhibit errors in excess of those set forth in Column 2 of Table 1 for 95% of all observations conducted under any combination of the measurement conditions listed within Table 1 and paragraph 2.1(b)."

[29] DO-155, at vii: "Compliance with these standards is recommended as a means of assuring that the equipment will satisfactorily perform its intended functions over all conditions normally encountered in routine aeronautical operations."

[30] Manufacturer information for the Honeywell ALA-52B states an accuracy of ± 2% below 500 ft. Information for other altimeters, including the Garmin GRA-5500 and the Rockwell Collins ALT-1000 and ALT-4000, reflect the same.

[31] RTCA Study at 37.

[32] A reflection coefficient of 0.01 means 20 dB less altimeter signal level is received compared with a smooth, perfectly reflecting surface and a reflection coefficient of 1.0. The use of the coefficient of 0.01 over a smooth runway artificially increases the altimeter's susceptibility to out-of-band signals.

mean height error) can only be met when the aircraft is over the smooth surface of a runway with very high signal-to-noise ratios.[33] And manufacturer specifications show that some altimeter models listed in Table 2 were not designed stringently enough to satisfy AVSI's pass/fail criteria. The specifications for the Thales ERT-530 states that the altimeter accuracy is ± 2% "when over flying smooth terrain" but degrades to ± 5% "when over flying rough terrain."[34] Thus, the Thales ERT-530 would not be expected to meet the test criterion of ± 2% based on AVSI's test setup with a 0.01 reflection coefficient, even when no C-Band 5G operations are present. These invalid results are baked into the interference tolerance masks that the RTCA Report's conclusions rely upon.

And the second criterion's requirement that 98% of data must fall within ± 2% of the mean average height is inconsistent with altimeter manufacturers' specifications. The Honeywell ALA-52B altimeter's specification sheet, for example, states an accuracy of ± 2% is required but does not include a confidence interval.[35] As such, there is no evidence that the manufacturer would have warranted the altimeter model for 98% or more of the values within the listed tolerance—once again pointing to flawed criteria. And, notably, DO-155 only requires that 95% of data must fall within the defined criteria.

To summarize, several altimeters, some of them highly likely to have been used in the AVSI testing, are not warranted by their manufacturers to meet the accuracy criteria AVSI used in forming its pass/fail determinations for RTCA.[36] DO-155, RTCA's own standard for minimum performance for altimeters, set altimeter accuracy at ± 3% from 100 to 500 feet (and permits a

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[33] Recommendation ITU-R M.2059 at 10 (referring to the ARINC 707 measurement accuracy indicating that "[s]uch accuracy requirements within the bandwidth available are achieved utilizing data processing techniques of the signal. However, such techniques are only possible with exceptionally high signal-to-noise ratios and over the flat surface of the runway at low altitudes.").

[34] ICAO Uniting Aviation, *Airbus Erroneous Radio Altitudes*, at 7, https://www.icao.int/safety/acp/ACPWGF/ACP-WG-F-25/ACP-WGF25-IP07_Appendix2_FMG15%20PPT02%20Airbus%20Erroneous%20Radio%20Altitudes.pdf.

[35] Honeywell Component Maintenance Manual Part Number 066-50007, ALA-52B Radio Altimeter, Sep 01/04, page 4 notes the tolerance as ± 2% but does not state a confidence level.

[36] As noted above, the Thales ERT-530 only meets ± 5%. *See also* Honeywell, KRA-405B Radio Altimeter, https://aerospace.honeywell.com/en/learn/products/navigation-and-radios/kra-405b-radar-altimeter.

pilot's display accuracy of ± 5%), and requires that only 95% of data points must fall within that tolerance. The AVSI criteria are flawed, which makes the interference tolerance thresholds unsound, and together they render all conclusions drawn from the AVSI data invalid.

IV. The Report Adds Unwarranted Margins to Make Its Case.

In the Report, the aviation stakeholders take other steps to fabricate an interference problem. In pursuit of such contrived showings, the Report adds up to 12 dB of margins into the interference levels it claims to show.

Specifically, RTCA includes a 6 dB aeronautical safety margin, but there is no technical justification for applying this margin here.[37] The Commission does not apply an aeronautical safety margin outside of aeronautical spectrum, and especially 220-500 megahertz outside of aeronautical spectrum as is the case for C-band 5G operations. Incorporating the use of such a margin at frequencies so far removed from an aeronautical band would set a potentially devastating precedent: allowing such an aeronautical safety margin to be applied to non-aeronautical spectrum separated by 500 megahertz would allow such a margin to be applied to all spectrum below 2 GHz, and to 68 percent of all spectrum below 10 GHz.[38]

Further, AVSI included an additional 6 dB of margin in the interference tolerance thresholds reported to RTCA,[39] but it did not include these margins in its earlier studies submitted into the docket and did not explain why the added margin is only included here. Therefore, each altimeter model that AVSI measured and incorporated into its February 2020 test report is now identified as 6 dB more susceptible to interference in the RTCA Report.[40]

V. The Report Improperly Applies a Worst Case Landing Scenario.

AVSI uses a Worst Case Landing Scenario ("WCLS") that simulates an aircraft on its landing approach at a very low altitude with 16 airplanes parked near the target runway, all

[37] RTCA Report at 58, 19.

[38] Between 2 GHz and 10 GHz, there are aeronautical allocations in the bands at 2.7-2.9 GHz, 4.2-4.4 GHz, 5.0-5.25 GHz, 5.35-5.46 GHz, and 9.0-9.2 GHz.

[39] RTCA Report at 40.

[40] AVSI Feb. 4 Ex Parte at 2.

simultaneously producing interference via their radar altimeters.[41] AVSI makes two critical errors with regard to WCLS, and RTCA incorporates this unsound analysis into the Report.

First, AVSI applied a reflection coefficient of 0.01 meant for rough terrain,[42] but this contradicts actual aircraft landing circumstances. The measurement point for landing scenarios is over the runway, which is smooth terrain. The WCLS analysis' use of the value of 0.01 for the reflection coefficient is incorrect, given the landing scenario involves runway landings. If the correct (smooth terrain) reflection coefficient were applied, the altimeter would be much more resistant to external interference due to the stronger desired signal.

Second, AVSI applied the WCLS test setup to locations and altitudes where it does not belong. WCLS is defined for a specific, limited configuration where the incoming aircraft is over the runway at altitude of 200 feet or less and within roughly 450 feet of aircraft on the taxiway.[43] This very small geographic area is shown in Figure 1 and indicated by a red circle on the layout of Washington Reagan National Airport. When the subject aircraft is in this WCLS zone at 200 feet altitude or less, the interference from the parked aircraft altimeters could be present.

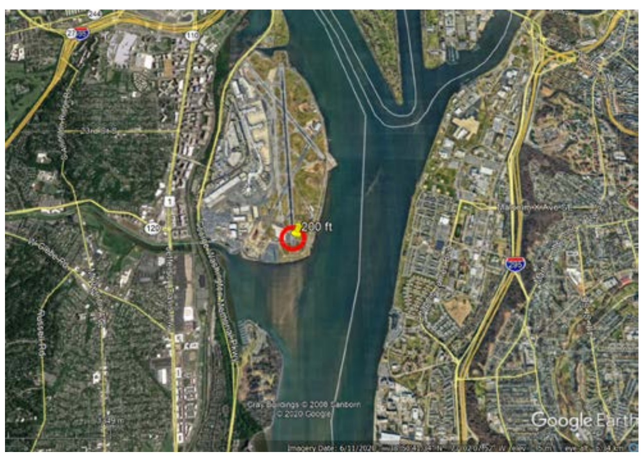

Figure 1: WCLS Area at Washington National Airport

[41] RTCA Report at 38.

[42] *Id*. at 37.

[43] This geographic area is based on an assessment of the aircraft altitude and path loss to the parked aircraft on the taxiway. *Id*. at 106-109.

The WCLS interference from other aircraft altimeters quickly dissipates when the aircraft under consideration is farther from the taxiway or at higher altitudes. But RTCA improperly applies the WCLS interference to aircraft simulations at locations farther away from the airport. AVSI measured altimeter performance at 200 feet and 1,000 feet, and included the WCLS interference from parked aircraft in the 200 foot measurements. AVSI then uses a linear extrapolation from 200 feet to 1,000 feet in altitude, incorrectly incorporating the WCLS interference environment to higher altitude operations. The WCLS interference should not be included at higher altitudes further removed from the aircraft parked at the airport.

VI. Other Aspects of the Report Improperly Account for C-Band 5G Operations.

The Report disregards input regarding 5G operations that the wireless industry provided as part of the dialogue within TWG-3 and in response to a draft of the Report that RTCA circulated for public comment. The Report, for example, applies an improper 5G base station beam steering angle. RTCA modeled a 5G advanced antenna system ("AAS") base station steering the main beam far enough below horizon to create a grating lobe toward an aircraft. In CTIA's response to the Draft Report, it advised that this scenario is highly unlikely in a wireless deployment, and would inflate the perceived exceedance by 14 dB in some cases, but RTCA continued to include it.

Additionally, RTCA based part of its Report on the impact to altimeter operations when multiple handsets would be operated onboard the aircraft.[44] There is no aeronautical mobile allocation in the 3.7-4.0 GHz band and the use of radio devices is not permitted on-board aircraft during take-off or landing, yet RTCA insisted that this scenario must be part of its analysis.[45] The FCC has never considered unlawful on-board use of radio devices in establishing technical limits for radiocommunication services.

[44] *Id*. at 15.

[45] The FCC Table of Frequency Allocations identifies the spectrum within 3.7-4.0 GHz as "MOBILE except aeronautical mobile."

VII. Under RTCA's Analysis, Radio Operations Today in Bands in the Vicinity of 4.2-4.4 GHz Would be Producing Harmful Interference into Altimeters.

Finally, if radar altimeters are as susceptible to adjacent band signals as RTCA claims, then they should already be suffering crippling harmful interference on a routine basis based on other radio systems in operation today. The lack of reports of widespread altimeter interference today is further evidence that the Report's conclusions are critically flawed.

As but one example, we examine the operations of the U.S. Navy's AN/SPN-43 radar.[46] The AN/SPN-43 operates near the coastline and in key U.S. port cities in the frequency bands below 3.65 GHz.[47] The AN/SPN-43 radar is an air traffic control ("ATC") radar system that is used on aircraft carriers and large amphibious assault ships (CV and LH class ships) to provide simultaneous control and identification of aircraft. As such, the high power SPN-43 antenna points above horizon, with maximum gain toward commercial and general aviation aircraft.

The AN/SPN-43 radar routinely operates in areas where all types of non-military aircraft fly. This includes in and around ports and in close proximity to U.S. and possession coastlines to support all aspects of Naval aviation. In addition, three systems are operated on land to support testing and training operations; 1) In Service Engineering Agent, Naval Air Warfare Center Aircraft Division St. Inigoes, Maryland; 2) In Service Engineering Agent Pascagoula, Mississippi; and 3) Naval Air Technical Training Command in Pensacola, Florida.[48]

If the Report were correct, the AN/SPN-43 radar's high power level would pose a significant interference risk to radar altimeters. The EIRP of the AN/SPN-43 is 122.7 dBm, which is several orders of magnitude higher than the limits the Commission adopted for C-Band

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[46] *See* NTIA 3500-3650 MHz Report, at 3 (Dec. 15, 2015), https://www.ntia.doc.gov/files/ntia/publications/compendium/3500.00-3650.00_01DEC15.pdf.

[47] The AN/SPN-43 also operates in the 3650-3700 MHz band at St. Inigoes, MD, Pascagoula, MS, and Pensacola, FL as well as at offshore locations. See US Table of Frequency Allocations, footnote US109.

[48] U.S. Department of Commerce, *An Assessment of the Near-Term Viability Accommodating Wireless Broadband Systems in the 1675-171- MHz, 1755-1780 MHz, 3500-3650 MHz, and 4200-4220 MHz, 4380-4400 MHz Bands*, at 3-31 (Oct. 2010), https://www.ntia.doc.gov/files/ntia/publications/fasttrackevaluation_11152010.pdf ("NTIA Fast Track Report").

mobile operations. The bandwidth of the transmitted signal is approximately 1 megahertz. Using the RTCA methods, the "worst" altimeter in Usage Category 1, with the threshold of -33 dBm, would experience interference when within *400 km* of the AN/SPN-43 radar.[49] The fact that considerable aviation traffic traverses regions in close proximity to U.S. and possession coastlines where the AN/SPN-43 operates, without interference incidents, indicates that the Report is unreasonably conservative in its approach to determining whether harmful interference will occur.

Another example is CBRS, which operates immediately below the 3.7 GHz band. The Report states that interference from C-Band commercial mobile operations will cause Usage Category 2 cases to exceed thresholds by 47 dB and Usage Category 3 use cases by 45 dB.[50] While CBRS operates at power levels 25.1 dB lower than the limits adopted for the C-Band,[51] current CBRS operations would still exceed Usage Categories 2 and 3 interference tolerance thresholds by 20 dB. Thus, if RTCA's claimed altimeter performance is to be believed, then CBRS is already causing harmful interference to radar altimeters by a significant margin.

In addition to the threat posed by high-power radar operations and CBRS operations below 3700 MHz, the radar altimeters also operate immediately adjacent to spectrum allocated to fixed and mobile services used by Federal agencies in the 4.4-4.94 GHz band. Use of this band includes air-to-ground-to-air operations, ship-to-shore-to-ship operations, and other mobile operations. Such mobile uses are likely to pose a much greater threat of interference to radar altimeters due to the immediate adjacency of the frequency bands, without 220 megahertz of guard band to protect the radar altimeters. This potential for interference would be especially significant with the operation of ground-to-air communications, which require that antennas be oriented to transmit upward toward aircraft, or in other words, with potential for mainbeam-

[49] The RTCA Report claimed relatively little fluctuation of the interference threshold as a function of frequency separation, noting approximately 4 dB difference between the 3930 MHz channel and the 3750 MHz channel. This flat frequency response would not provide significant additional protection from the Navy radar—in other words, the altimeter would be equally susceptible to the Navy Radar emissions, as it would be to 5G C-Band operations.

[50] *Id*. at 87.

[51] *See* RTCA Report at 34 (describing Usage Category 1 as "covering commercial air transport airplanes, both single-aisle and wide-body").

to-mainbeam coupling between the ground transmitter and the downward-looking radar altimeter.

If the exceedances and interference claimed by RTCA were accurate, then significant interference to altimeters would have been experienced on a daily basis across the United States. And the lack of reports of widespread altimeter interference today demonstrates the critical flaws in the Report's conclusions.

VIII. Conclusion.

The RTCA Report's conclusions are unfounded. RTCA relied on AVSI's aggregated test data, which was plugged into improperly selected pass/fail criteria. Further, no individual altimeter-specific performance information was shared, and the identities of the altimeters under test were not disclosed. Based on this incomplete data and misguided criteria, RTCA draws incorrect conclusions regarding interference from C-Band 5G system operations. Moreover, the obfuscated nature of the aggregated data impedes the ability of stakeholders—including the Commission—to fully understand RTCA's claims or use the Report to assess 5G/altimeter coexistence. The Commission should reject the Report's showing.

Pursuant to Section 1.1206(b) of the Commission's rules, a copy of this letter is being electronically submitted into the record of this proceeding. Please do not hesitate to contact the undersigned with any questions.

Sincerely,

/s/ Kara Graves
Kara Graves
Assistant Vice President, Regulatory Affairs

Doug Hyslop
Vice President, Technology and Spectrum Planning