Joint Aviation Community Response to Federal Aviation Administration Notice of Proposed Rulemaking on Requirements for Interference-Tolerant Radio Altimeter Systems in Docket No. FAA-2025-5666

EXECUTIVE SUMMARY

The Joint Aviation Community supports the goals of the Federal Aviation Administration's (FAA's) Notice of Proposed Rulemaking on Requirements for Interference-Tolerant Radio Altimeter Systems (FAA NPRM). Maintaining the full functionality of radio altimeter (RA) systems in the presence of next-generation wireless services in the Upper C-band (3.98-4.2 GHz) is essential to aviation safety, and the proposed rule establishes a sound technical and regulatory framework for achieving that outcome. These comments are organized to directly address the specific questions posed by the FAA in the FAA NPRM.

The following issues require particular attention and are addressed in detail below:

Technical Harmonization Across Agencies. Technical details regarding the Interference Tolerance Mask (ITM), emitter height limits, and safety margin for signal power should be consistent across agency directives and rules. In addition, the safety analysis underlying the proposed ITM depends on the Federal Communications Commission (FCC) adopting harmonized out-of-band emissions limits for wireless base stations expressed as effective isotropic radiated power (EIRP) values that are applicable to licensees in both Lower and Upper C-bands. Conducted power limits alone are insufficient, as they do not account for base station antenna gain. Consistent EIRP-based limits across both frequency bands are essential to maintaining the long-term integrity of spectrum compatibility between radio altimeters and C-band wireless operations.

Compliance Timeline. Based on analysis across the aviation stakeholder community, retrofit and replacement of radio altimeters in the Part 121 and Part 129 fleets can be completed by mid-2032, with Part 91 and Part 135 fleets completed by 2034. This schedule reflects a four-

phase process—equipment design and authorization, aircraft certification, manufacturing ramp-up, and fleet installation—and represents an unprecedented acceleration driven by the congressional mandate. The aviation community recognizes the importance of accelerating the retrofit/replacement process and is working to develop a more aggressive timeline assuming financial incentives are available.

Extension of Lower C-Band Voluntary Commitments. The voluntary commitments of twenty-one Lower C-band wireless licensees expire in January 2028, well before most aircraft can achieve compliance with the proposed interference tolerance requirements. Extension of these commitments through the initial RA performance deadline is not procedural — it is a safety prerequisite. Without extension, existing radio altimeters and the safety systems dependent upon them will be left unprotected during the transition, and the FAA would be forced to reimpose the most restrictive operational limitations on a significant portion of the commercial fleet.

Cost. The FAA's estimate of $4.49 billion in undiscounted retrofit costs is likely underestimated. Based on consultation with operators and aircraft and radio altimeter manufacturers, equipment and labor costs may reach $120,000 per RA unit—compared to the $80,000 figure used in the NPRM—resulting in total costs estimated between $4.49 billion and slightly over $7 billion. These figures are being refined and represent externalities imposed on the aviation industry by the spectrum reallocation.

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I. INTRODUCTION

The undersigned organizations (collectively, the "Joint Aviation Community") submit these comments in response to the Federal Aviation Administration (FAA) Notice of Proposed Rulemaking on Requirements for Interference-Tolerant Radio Altimeter Systems (FAA NPRM).[1] The signatories to this document are referred to as the Joint Aviation Community throughout this document.

The Joint Aviation Community is fully committed to preserving the highest levels of aviation safety while also advancing the broader goals of the Federal Communications Commission (FCC) for greater spectrum efficiency across multiple frequency ranges and systems. The Joint Aviation Community supports the open and transparent regulatory processes to date and advocates that they continue. As part of these efforts, there has been extensive focus on radio altimeter (RA)[2] systems and the use of next-generation designs and solutions to support improved compatibility with potential domestic and international spectrum changes outside the 4.2-4.4 GHz band.

We commend the FAA and FCC for conducting extensive interagency coordination prior to releasing their companion notices of proposed rulemaking.[3] The Joint Aviation Community notes that the FCC and FAA comment periods overlapped substantially, constraining the aviation industry's ability to develop fully integrated technical analyses across both proceedings simultaneously. Despite this, the Joint Aviation Community has worked diligently to provide

[1] FAA, Department of Transportation (DOT), Requirements for Interference-Tolerant Radio Altimeter Systems, 91 Fed. Reg. 459 (Jan. 7, 2026) ("FAA NPRM").

[2] The radio altimeter is often known as the radar altimeter given it detects the ground directly beneath the aircraft either with frequency modulated continuous-wave or pulsed radar emissions.

[3] The companion to the FAA NPRM is FCC, *Upper C-band (3.98 to 4.2 GHz)*, Notice of Proposed Rulemaking, GN Docket No. 25-59, FCC 25-78 (rel. Nov 21, 2025) (FCC Upper C-band NPRM).

substantive responses to the FAA's specific questions. Where our comments address technical parameters principally within FCC's jurisdiction, such as out-of-band emissions (OOBE) effective isotropic radiated power (EIRP) limits and emitter siting rules, we refer the FAA to our comments on the companion FCC Upper C-band (3.98-4.2 GHz) proceeding for the full technical record.[4]

II. BACKGROUND

A. The Aviation and Aerospace Industry

The aviation industry is a crucial enabler to the United States (U.S.) economy, supported by aircraft and avionics manufacturers and by aircraft operators. The aerospace manufacturing sector is a cornerstone of American industrial leadership, encompassing the design, production, and maintenance of aircraft, engines, and related systems. In 2023, the most recent year for which data has been released, U.S. aerospace manufacturers directly employed over 545,000 workers, with average earnings nearly twice the national average, while supporting a total of 1.6 million jobs across the broader economy through supply chain and consumer spending effects.[5] The manufacturing activity produced $306.9 billion in aerospace products and contributed $545.2 billion in economic output.[6] The sector is also a powerful engine for U.S. trade: aerospace

[4] *See generally* Comments of Aerospace Industries Association, et. al. on the FCC Upper C-band NPRM, GN Docket No. 25-59 (filed Jan. 20, 2026) (Joint Aviation Community Comments), available at https://www.fcc.gov/ecfs/document/101202993626987/1, and Reply Comments of Aerospace Industries Association (AIA), et. al. on the FCC Upper C-band NPRM, GN Docket No. 25-59 (filed Feb. 18, 2026) (Joint Aviation Community Reply Comments), available at https://www.fcc.gov/ecfs/document/1021912752933/1.

[5] *See* AIA, Contribution of the Aerospace Industry to the U.S. Economy in 2023 (Report by PwC US Tax LLP) (Jun. 2, 2025) (AIA Report) at 3, available at https://www.aia-aerospace.org/wp-content/uploads/FINAL-Aerospace-Industrys-Contribution-to-the-US-Economy_FinalShared-060225.pdf (last visited Mar. 2, 2026). *See also* Airlines for America (A4A), "Jobs Impact of Commercial Aviation" website: https://www.airlines.org/jobs/ (last visited Mar. 2, 2026).

[6] *See* AIA Report at 3.

products generated an $82.8 billion trade surplus in 2024, making it one of only three manufacturing categories to achieve a positive trade balance and by far the largest surplus of any manufacturing sector.[7]

The U.S. economy runs on the safe and efficient movement of people and goods both domestically and worldwide. The U.S. passenger and cargo airlines are an essential element, collectively transporting approximately 2.7 million passengers and 61,000 tons of cargo on about 27,000 flights daily, while employing over 1 million people.[8] Additionally, foreign carriers annually fly 48% of the 312 million available seats into and out of the United States.[9] Overall, commercial aviation drives 5% of U.S. Gross Domestic Product—the equivalent of $1.45 trillion in 2024.[10]

In addition to the airline community, the general and business aviation segments of the industry are equally critical to the U.S. transportation system. In 2024, there were over 200,000 general aviation aircraft in the U.S. flying over 28 million flight hours annually.[11] This industry segment is also responsible for over $339 billion in total economic output, as well as 1.3 million American jobs.[12]

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[7] *See* AIA Report at 11-15.

[8] *See* A4A, "Economic Impact of Commercial Aviation" website: https://www.airlines.org/impact/ (last visited Mar. 2, 2026). *See also* A4A, "Jobs Impact of Commercial Aviation" website: https://www.airlines.org/jobs/ (last visited Mar. 2, 2026).

[9] As calculated for the purpose of these comments by the International Air Transport Association (IATA) for January - November 2025, based on the IATA Direct Data Solutions global database that captures airline sales, market and itinerary data by aggregating data contributed by carriers, IATA's Billing and Settlement transactions and Airlines Reporting Corporation's Area Settlement Plan.

[10] *See* A4A, "Economic Impact of Commercial Aviation" website: https://www.airlines.org/impact/ (last visited Mar. 2, 2026).

[11] *See* FAA, DOT, Air Traffic by the Numbers (Jun. 2025) at 2, available at https://www.faa.gov/air_traffic/by_the_numbers/air-traffic-by-the-numbers-FY2024.pdf (last visited Mar. 2, 2026).

[12] *See* National Business Aviation Association, et al., "CLIMBING. FAST. Business Aviation is an Essential Industry" website: https://climbingfast.com/ (last visited Mar. 2, 2026).

Complementing these segments, the helicopter industry constitutes a distinct and economically significant pillar of the U.S. aviation ecosystem. Helicopter operations support mission-critical sectors including emergency medical services, law enforcement, firefighting, offshore energy, utilities, construction, tours, and disaster response, which are all activities that contribute greatly to the annual economic output attributable to the aviation industry. The U.S. helicopter fleet conducts millions of flight hours each year,[13] enabling time-sensitive services that directly protect life, property, and infrastructure, while providing indispensable access to rural, offshore, and congested urban environments. These operations deliver considerable economic and public value returns relative to fleet size, reinforcing the helicopter sector's essential role in national productivity, resilience, and public safety.

B. Importance of Radio Altimeters to Modern Aviation Safety

Radio altimeters play an essential role in ensuring the safety, reliability, and operational performance of both civil and defense aircraft.[14] These avionics are downward-facing radars that provide precise, real-time height above terrain altitude data that supports critical flight crew decisions, flight operations and feeds numerous safety-essential aircraft systems. Any degradation or failure of these altimeters can disrupt numerous automated functions, delay terrain avoidance alerts, and lead to potentially dangerous misinformed flight crew decisions which reduces safety and can significantly increase operational risks, especially when operating aircraft close to terrain. Since aircraft and pilots rely on accurate altimeter data in a dynamic

[13] *See* FAA, DOT, *General Aviation and Part 135 Activity Survey* Table 1.3 for rotorcraft total flight hours from 2012 to 2023, available at https://www.faa.gov/sites/faa.gov/files/2023GASurveyCh1_508Compliant_04DEC2024V1_0.xlsx (last visited Mar. 2, 2026).

[14] Civil aircraft include those used for commercial air transport as well as business and general aviation purposes.

meteorological environment, uncertainty in altimeter performance can force operators to delay, divert, or cancel flights to maintain safety.

All large commercial aircraft are fitted with at least two radio altimeters, while many general aviation aircraft, including helicopters and light twin-engine piston airplanes, are equipped with at least one radio altimeter. In the business aviation community, larger and more advanced turbojet and turboprop aircraft are generally equipped with at least one radio altimeter. As currently estimated by the FAA, this totals nearly 40,900 aircraft that operate in the U.S. airspace with nearly 58,600 separate radio altimeter units across nearly 14,000 owners and operators.[15] The FAA NPRM affects all of these units and their operators, with potentially more to be discovered in private ownership.

III. DISCUSSION ON FAA'S PROPOSED INTERFERENCE TOLERANCE MASK

The Joint Aviation Community has carefully reviewed the FAA's proposed Interference Tolerance Mask (ITM) and the associated safety analysis set forth in the FAA NPRM. The sections below present the Joint Aviation Community's position on the ITM requirements, the technical feasibility of achieving those requirements, and the underlying safety analysis. Specifically, the Joint Aviation Community concurs with the minimum 6 dB safety margin, as discussed in Section III.B of this document.

The Joint Aviation Community proposes to define external radio frequency interference (RFI) for purposes of the ITM as: any signal originating from systems operating outside the

[15] *See* FAA NPRM at 478.

Aeronautical Radionavigation Service allocation in the 4.2-4.4 GHz frequency band that may adversely affect radio altimeter performance.

A. Endorsement of the Proposed ITM Requirements

Agreement That the Proposed ITM Reflects Best Achievable Interference Rejection. The Joint Aviation Community supports FAA's characterization of the proposed ITM as reflecting "the best achievable interference rejection using current technology without compromising radio altimeter system performance."[16] The proposed ITM was developed with input from all five existing radio altimeter manufacturers and reflects the collective performance capabilities of next-generation designs currently under development. The Joint Aviation Community notes that work is still ongoing to validate the proposed ITM and to ensure it will be feasible for modified and future RA designs to meet their performance requirements while subjected to these levels of interference. While changes to the proposed ITM are not expected to be required as a result of validation efforts, any proposed changes will be shared with the FAA.

Specifying the ITM Power Flux-Density (PFD) Levels to Define the External RFI Environment and Align with Future Long-Term Standards. While the Joint Aviation Community agrees that the ITM levels in Table 3 of the FAA NPRM accurately reflect the current understanding of the best achievable performance for next-generation radio altimeter systems, the way these values are presented in the NPRM does not correctly define the maximum safely tolerable interference environment.[17] The language of the proposed § 91.220(b) rule states that the ITM is meant to define the interference environment.[18] Further, the FAA NPRM states in

[16] FAA NPRM at 459.
[17] *See* FAA NPRM at 468.
[18] *See* FAA NPRM at 469.

the context of the adjacent band compatibility analyses that "[a]s long as the calculated PFD at a given frequency is less than or equal to the ITM, the RA system will perform safely."[19] These statements are only true if the ITM in the § 91.220(b) rule defines the *maximum safely tolerable interference environment*, and not the best achievable next-generation radio altimeter system interference tolerance levels directly. That is, the ITM in the § 91.220(b) rule should provide levels that are 6 dB below those presented in the FAA NPRM to account for the necessary aviation safety margin. Then, the compliance criteria for next-generation radio altimeter systems should require interference tolerance demonstrations to a level 6 dB higher than the § 91.220(b) rule. The latter PFD levels which include the safety margin should be defined only in compliance guidance materials, such as FAA Advisory Circular (AC) 20-199,[20] rather than in the § 91.220(b) rule itself. The requirement that the 6 dB safety margin be included in the compliance demonstrations for radio altimeter systems could also be included in the § 91.220 rules, for example as a separate requirement under a new paragraph § 91.220(c).

This approach will also ensure consistency with the long-term future performance standards under development within RTCA Special Committee 239 (SC-239) and EUROCAE Working Group 119 (WG-119).[21] As noted in the FAA NPRM, the FAA plans to issue new Technical Standard Orders (TSOs) for radio altimeter systems in the future which are based upon the standards developed by SC-239/WG-119.[22] Therefore, ensuring alignment and consistency between the final § 91.220(b) rule (and associated compliance guidance) and the new performance standards will facilitate seamless integration with future TSO rulemaking.

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[19] FAA NPRM at 473.

[20] FAA, DOT, Draft Advisory Circular 20-199, Installation of an Airborne Low-Range Radio Altimeter System, which closed for public comment on Feb. 25, 2026.

[21] *See* RTCA's SC-239, Low Range Radar Altimeter at https://www.rtca.org/sc-239/ and EUROCAE's WG-119, Radar Altimeters at https://www.eurocae.net/working-group/wg-119/ (last visited Mar. 2, 2026).

[22] *See* FAA NPRM at 471.

ITM Coverage Across the Full Operational Envelope of all Aircraft. The Joint Aviation Community emphasizes that the ITM must be defined in this rule throughout the entire operational volume of all affected aircraft for the reasons detailed below, so as to sufficiently establish the basis for spectrum compatibility with next-generation radio altimeter systems in all scenarios, and not solely for the specific case of adjacent-band terrestrial wireless base stations. Radio altimeters are relied upon across a broad range of altitudes during critical flight phases, and the interference environment experienced by the radio altimeter system may vary with altitude. There may also be safety impacts to the aircraft if the radio altimeter interference tolerance level is exceeded even at altitudes above the maximum measurement range of the radio altimeter system (for example, erroneous ground proximity warnings). Further, the best achievable interference tolerance performance for next-generation radio altimeter systems will necessarily decrease above a certain altitude limit due to the required sensitivity characteristics of radio altimeter designs to support their intended function. Failure to define the ITM across the full aircraft operational envelope could leave the radio altimeter, and the safety systems dependent upon it, unprotected during portions of flight where interference to the radio altimeter system could have a safety impact.

Defining the ITM at all altitudes is also critical to maintain alignment with the long-term performance standards under development by SC-239/WG-119, and to ensure that the minimum required interference tolerance and spectrum compatibility characteristics of all next-generation radio altimeter systems are the same—whether those radio altimeter systems were developed to meet the full extent of the future performance standards, or if they have demonstrated compliance with the § 91.220(b) rule through other accepted means.

While the ITM that is defined in the final § 91.220(b) rule must adequately specify the RFI operating environment for all aircraft throughout their entire operational envelope, the means by which the compliance with this operating environment is demonstrated may vary depending on the characteristics of particular radio altimeter designs, system integrations on the aircraft, and aircraft types. For example, although the ITM should be defined up to an indefinite maximum altitude, the compliance demonstration for a given aircraft type would not need to consider the RFI environment above that aircraft's service ceiling. Further, for most radio altimeter designs the entire aircraft operational envelope above the maximum measurement altitude is effectively the same (i.e., there is no observable terrain return signal present, and so the radio altimeter should not report any valid altitude measurements), and therefore this can be represented with only a single test condition when demonstrating compliance of the radio altimeter transceiver in this range. The full extent of such compliance details is beyond the scope of these comments, and does not directly affect the proposed rules in the FAA NPRM, but rather the FAA's compliance guidance in AC 20-199. The Joint Aviation Community will continue to work with the FAA to define the suitable compliance details, including through additional *ex parte* submissions as needed.

Proposed ITMs for § 91.220(b) Rule and Compliance in AC 20-199. As noted in the preceding sections, the Joint Aviation Community proposes some changes to the ITM to be included in the § 91.220(b) rule. As described in the following sections, these changes do not reflect any reductions in "the best achievable interference rejection using current technology without compromising radio altimeter system performance" as described in the FAA NPRM, and the conclusions of the FAA's adjacent-band compatibility analyses presented in the FAA NPRM are unaffected. The proposed ITM for the § 91.220(b) rule is provided in **Table 1** (presented

below), along with the altitude dependence profiles in **Table 2**. The proposed ITM required for radio altimeter system compliance demonstrations to the § 91.220(b) rule, which would be included in AC 20-199, is shown in **Table 3**, along with the altitude dependence profiles in **Table 4**. Note that the altitude profiles referenced in **Table 4** are the same as those shown in **Table 2**, but they are repeated in **Table 4** with cross-references to **Table 3** instead of **Table 1**.

Table 1: Proposed ITM for § 91.220(b) Rule, Defining Safely Tolerable Interference Environment for All Aircraft

Frequency Range (MHz)	Power Flux-Density, Single Polarization, RMS ($dBW/m^2/MHz$)	Altitude Profile
$3000 \leq f < 4000$	3.5	#1
$4000 \leq f < 4100$	3.5	#2
$4100 \leq f < 4150$	3.5	#2
$4150 \leq f < 4160$	0.5	#2
$4160 \leq f < 4180$	-7	#2
$4180 \leq f < 4190$	-23	#2
$4190 \leq f < 4200$	-40	#2
$4200 \leq f \leq 4400$	-88	#2
$4400 < f \leq 4410$	-39	#2
$4410 < f \leq 4430$	-27	#2
$4430 < f \leq 4440$	-14	#2
$4440 < f \leq 4450$	-7	#2
$4450 < f \leq 4460$	0.5	#2
$4460 < f \leq 4500$	3.5	#2
$4500 < f \leq 4600$	3.5	#2
$4600 < f \leq 5600$	3.5	#1

Table 2: Proposed ITM Altitude Dependence Profiles for § 91.220(b) Rule

Above Ground Level (AGL) Altitude Range (ft)	**Altitude Profile #1**	**Altitude Profile #2**
$0 < h \leq 500$	PFD(h) = PFD level in **Table 1**	PFD(h) = PFD level in **Table 1**
$500 < h \leq 1000$	PFD(h) = PFD level in **Table 1**	PFD(h) = PFD level in **Table 1** $- 13\times\log_{10}(h/500\text{ ft})$
$1000 < h \leq 5000$	PFD(h) = PFD level in **Table 1**	PFD(h) = PFD(1000 ft) $- 20\times\log_{10}(h/1000\text{ ft})$
$h > 5000$	PFD(h) = PFD level in **Table 1** $- 16\times\log_{10}(h/5000\text{ ft})$	PFD(h) = PFD(5000 ft)

Table 3: Proposed ITM for Compliance Demonstrations to § 91.220(b) Rule to be Included in AC 20-199, Defining Radio Altimeter System Interference Tolerance

Frequency Range (MHz)	Power Flux-Density, Single Polarization, RMS (dBW/m^2/MHz)	Altitude Profile
$3000 \leq f < 4000$	9.5	#1
$4000 \leq f < 4100$	9.5	#2
$4100 \leq f < 4150$	9.5	#2
$4150 \leq f < 4160$	6.5	#2
$4160 \leq f < 4180$	-1	#2
$4180 \leq f < 4190$	-17	#2
$4190 \leq f < 4200$	-34	#2
$4200 \leq f \leq 4400$	-82	#2
$4400 < f \leq 4410$	-33	#2
$4410 < f \leq 4430$	-21	#2
$4430 < f \leq 4440$	-8	#2
$4440 < f \leq 4450$	-1	#2
$4450 < f \leq 4460$	6.5	#2
$4460 < f \leq 4500$	9.5	#2
$4500 < f \leq 4600$	9.5	#2
$4600 < f \leq 5600$	9.5	#1

Table 4: Proposed ITM Altitude Dependence Profiles for Compliance Demonstrations to § 91.220(b) Rule to be Included in AC 20-199

AGL Altitude Range (ft)	Altitude Profile #1	Altitude Profile #2
$0 < h \leq 500$	PFD(h) = PFD level in **Table 3**	PFD(h) = PFD level in **Table 3**
$500 < h \leq 1000$	PFD(h) = PFD level in **Table 3**	PFD(h) = PFD level in **Table 3** $- 13\times\log_{10}(h/500\text{ ft})$
$1000 < h \leq 5000$	PFD(h) = PFD level in **Table 3**	PFD(h) = PFD(1000 ft) $- 20\times\log_{10}(h/1000\text{ ft})$
$h > 5000$	PFD(h) = PFD level in **Table 3** $- 16\times\log_{10}(h/5000\text{ ft})$	PFD(h) = PFD(5000 ft)

ITM Levels Above 500 Feet Above Ground Level (AGL) and Implications for Spectrum Compatibility. The FAA NPRM does not propose specific ITM requirements for operations above 500 feet AGL, noting that at higher altitudes interference is less likely and the consequence is reduced due to the presumed ability to recover the aircraft following an interference event and stricter obstacle clearance rules.[23] Unfortunately, due to the integrated nature of the radio altimeter to safety systems on the airplane, safety incidents resulting from erroneous radio altimeter data have occurred above 500 feet AGL.[24] Therefore, while this altitude cutoff point may seem pragmatic for the specific case of compatibility with adjacent-band terrestrial wireless base stations (particularly if the maximum height of such base stations is bounded and known), limiting the ITM to the 0-500 feet AGL altitude range alone does not enable it to be a sufficient long-term standard of spectrum compatibility for radio altimeter systems. Further, as noted in the preceding sections, this approach diverges from what is expected to be defined in the new performance standard under development by SC-239/WG-119. The ITM levels proposed by the Joint Aviation Community above address this issue; however, the necessary ITM levels begin to decrease above 500 feet AGL. As a result, the FAA's example adjacent-band compatibility analyses indicate the safely tolerable EIRP levels are only applicable for terrestrial emitters up to a certain height less than 500 feet AGL. As such, the Joint Aviation Community previously identified a maximum emitter height limit of 450 feet AGL as being necessary to ensure compatibility with next-generation radio altimeter systems.[25] With the

[23] *See* FAA NPRM at 474.

[24] In the crash of Turkish Airlines 1951, the flight crew encountered an erroneous output of the radio altimeter at 2000 feet AGL (albeit not due to interference), and the insidious nature of the aircraft response led to a catastrophic outcome. *See* The Dutch Safety Board, "Crashed During Approach, Boeing 737-800, Near Amsterdam Schiphol Airport, 25 February 2009" (May 2010), available at https://catsr.vse.gmu.edu/SYST460/TA1951_AccidentReport.pdf (last visited Mar. 2, 2026).

[25] *See* Joint Aviation Community Reply Comments at 12. Note that the 450 ft emitter height limit is derived considering a reduction in the ITM levels when the aircraft is above 500 ft AGL while also accounting for differing terrain elevation beneath the emitter and the aircraft.

altitude dependence profiles in the ITM proposed by the Joint Aviation Community, applying this same adjacent-band analysis for emitters taller than 450 feet AGL would indicate that compatibility with radio altimeter systems in this case would require a reduced maximum EIRP for emitters taller than 450 feet AGL, given that the 35 feet Minimum Separation Distance (MSD) would still apply to encompass all current aircraft operations.

Helipads on Tall Buildings. As a notable example of an operational scenario in which an aircraft may encounter taller emitters while the radio altimeter system is in an environment greater than 500 ft AGL, the Joint Aviation Community draws particular attention to the presence of helipads on many tall buildings. Helicopter operations to and from rooftop helipads necessarily place rotorcraft in close proximity to wireless base stations that may be collocated on or near the same structures. The MSD analysis and ITM performance requirements must adequately account for these scenarios to ensure that radio altimeters and dependent safety systems, including those Helicopter Terrain Awareness and Warning Systems that utilize RA data, function reliably during approach, hover, and departure phases at such facilities.

B. Safety Analysis Concurrence

Support for 35-Foot MSD. The Joint Aviation Community notes that the FAA, as the expert aviation safety regulator, recommends a 35-foot MSD between adjacent band 5G transmitters and radio altimeters with the view of maintaining continued operational safety.[26] The proposed MSD is appropriate because it preserves the operational integrity of the radio altimeter and its associated integrated safety systems across all nominal, off-nominal, and emergency flight phases, with the exception of scenarios where proximity of an aircraft to a wireless base

[26] *See* FAA NPRM at 473-474.

station or its supporting structure results in a collision hazard that poses a greater risk than interference. The Joint Aviation Community endorses the 35-foot MSD for outdoor terrestrial base station emitters as defined in the FAA NPRM regardless of emitter height.

Agreement with a Minimum 6 dB Safety Margin. The Joint Aviation Community concurs with the FAA's application of a minimum 6 dB safety margin above the expected interference environment as the standard for demonstrating compliance of radio altimeter systems with this environment. As the FAA NPRM notes, this margin accounts for uncertainties in the design and implementation of adjacent-band wireless base stations, which are not required to meet aviation safety and design/development assurance standards, and addresses the risk from unforeseen factors.[27] This approach is consistent with International Civil Aviation Organization (ICAO) recommendations in ICAO Doc 9718, the Handbook on Radio Frequency Spectrum Requirements for Civil Aviation, which indicates that a safety margin of 6 to 10 dB is to be applied for aeronautical safety systems.[28]

However, as noted above, the safety margin should be defined as a required aspect of the compliance demonstration with the interference operating environment defined by the rule. This would ensure that all subsequent compatibility analyses utilizing the proposed § 91.220(b) rule are adequately considering the safety margin. If the FAA were to use the Joint Aviation Community's proposed changes to how the ITM levels are presented in the § 91.220(b) rule and associated AC 20-199 compliance criteria, then there is no need to further account for the safety margin in the compatibility analyses with adjacent-band emitters. For example, in the case of the Adjacent Band Compatibility Analysis in Table 6 of the FAA NPRM,[29] the ITM level (from the

[27] *See* FAA NPRM at 473-475.
[28] *See* FAA NPRM at 474.
[29] *See* FAA NPRM at 473.

§ 91.220(b) rule) would change from +6.5 dBW/m^2/MHz to +0.5 dBW/m^2/MHz, but the 6 dB safety margin row would be eliminated, resulting in the same results for the maximum tolerable EIRP levels (i.e., up to 62 dBm/MHz per polarization for emissions in the 4150–4160 MHz frequency range in the given example).

Endorsement of Safety Analysis Approach. The aviation industry has consistently applied a responsible worst-case approach given the mandate to ensure continued operational safety under all conditions. The general public and the FAA expect no less, and the Joint Aviation Community supports the FAA's adoption of this same methodology in its safety analysis.[30] Assessing compatibility between advanced 5G systems and the complex operational and regulatory requirements of aircraft necessitates the inclusion and resolution of multiple variables, and a worst-case framework is the appropriate means of ensuring that safety is maintained across the full range of operational scenarios.

Comments on Specific Safety Scenarios. The FAA NPRM identifies a broad range of safety-critical systems and operations that depend on accurate radio altimeter data, including Terrain Awareness and Warning Systems (TAWS), Traffic Collision Avoidance Systems (TCAS), autoland operations, windshear alerting, Night Vision Goggle operations, helicopter automation modes, and emergency flight phases.[31] The Joint Aviation Community concurs with the FAA's identification of these scenarios and supports the FAA's conclusion that the ITM is sufficient (provided that the ITM is defined for all altitudes, as proposed by the Joint Aviation Community), and the proposed MSD is necessary, to preserve the function of these systems under the proposed interference environment.

[30] *See* FAA NPRM at 473-475.
[31] *See* FAA NPRM at 465-466.

TAWS: TAWS must be able to function everywhere, as there is no way to predict where a Controlled Flight Into Terrain (CFIT) accident could occur. For clarity, the FAA NPRM does not distinguish between TAWS Class A, which requires RA input, and TAWS Class B, which does not require RA input. Helicopter Terrain Awareness and Warning Systems (HTAWS) also do not require RA input; however, the FAA NPRM acknowledges "some HTAWS do utilize RA data similar to TAWS [Class A] in airplanes."[32] Similarly, TAWS Class B equipment installed to comply with 14 Code of Federal Regulations (CFR) § 91.223 and § 135.154 also may utilize RA data. The 35-foot MSD provides assurance that TAWS will operate in all but the most severe terrain scenarios. The Joint Aviation Community supports the FAA's requirement that the RA system function reliably at the proposed MSD to preserve this critical safety function.[33]

TCAS: TCAS depends on data provided by a properly functioning radio altimeter when below 2,350 feet AGL. If the aircraft's RA is not functioning normally, the TCAS system may fail to issue a collision warning to the pilot and fail to prevent a mid-air collision. The proposed ITM and MSD must ensure that the RA continues to provide accurate data to TCAS throughout the altitude range in which TCAS relies on RA inputs, further reinforcing the need to define the ITM across the full operational altitude range of a radio altimeter as previously proposed.

Autoland and Low-Visibility Operations: Automatic flight control systems rely on radio altimeter data to facilitate autoland and operations in low-visibility conditions, including the determination of flare timing, power reduction, and other critical control inputs. Erroneous or missing RA data during these phases could result in hazardous aircraft maneuvers that may not be correctable by the flight crew in time.

[32] FAA NPRM at 465.
[33] *See* FAA NPRM at 474.

Emergency Operations: The proposed MSD and ITM must remain effective during emergency flight phases during which aircraft may be at lower altitudes or in closer proximity to terrain and structures than during normal operations. The FAA NPRM's consideration of these scenarios in setting the MSD at 35 feet, sufficient to protect one-engine-inoperative vertical obstacle clearance requirements, is appropriate.[34]

IV. RECOMMENDATIONS ON PROPOSED COMPLIANCE TIMELINES

The FAA NPRM proposes an anticipated initial deadline for Part 121 and Part 129 aircraft radio altimeters to meet new performance requirements between 2029 and 2032, with a proposed deadline for radio altimeters in all other (Part 91 and Part 135) aircraft set for two years later.[35] The FAA acknowledges, however, that it "does not have sufficient data to determine a specific date at this time" for the transition deadline.[36] As such, the Joint Aviation Community, which represents multiple stakeholders for each of the activities necessary to implement the retrofit/replacement of radio altimeters as defined within the FAA NPRM and expected applicable portions of the companion draft Advisory Circular 20-199, has developed a schedule that is expected to be achievable by all aviation industry stakeholders, considering the scope, complexities associated with out-of-production (but still in service) aircraft and radio altimeter models, and resource constraints, while balancing the urgency of enabling new commercial wireless spectrum. Based on current analysis by aviation stakeholders, the retrofit and replacement of radio altimeters in the Part 121 and Part 129 fleets would be completed by mid-

[34] *See* FAA NPRM at 474.
[35] *See* FAA NPRM at 472.
[36] FAA NPRM at 470.

2032, with retrofits and replacements in the Part 91 and Part 135 fleets completed by 2034, which is graphically depicted in Annex A and described below. While this timeline is being presented to be responsive to the comment deadline for the FAA NPRM, it is important to note the Joint Aviation Community is continuing to further refine data, to include aircraft fleet percentages associated with each workstream depicted, and further quantify risks and assumptions to refine the timeline and provide FAA the data necessary to support development of a final rule and associated compliance deadlines. In addition to the discussion below, individual aviation stakeholders will also address the more nuanced questions posed within the FAA NPRM regarding the timeline to complete retrofit and replacement of radio altimeters.

Developing a new equipment standard, followed by new equipment design, development, and authorization, certification of that equipment on aircraft, and manufacturing the new equipment is a multi-phase process that aligns with typical aviation practices, as described in more detail below. Once certified, the process of retrofitting the fleet and aircraft production line with the new equipment would require additional time for implementation. Even with published equipment standards, equipment already authorized and being manufactured, and an accompanying mandate for equipment installation, this end-to-end process more typically would extend to at least 2035. The proposed timeline therefore represents an unprecedented acceleration driven by the congressional mandate of the One Big Beautiful Bill Act.[37]

The FAA NPRM presents several examples of other equipage timelines, including for the Automatic Dependent Surveillance Broadcast ("ADS-B") Out equipment mandate, which the aviation industry considers as the most relevant to the scope of the proposed interference-tolerant

[37] Public Law 119–21, § 40002(b)(2) (Jul. 4, 2025). As enacted, the law does not specify a "short title" but was commonly known as the One Big Beautiful Bill Act while being debated.

radio altimeter mandate.[38] The ADS-B Out implementation timeline was established through collaboration between FAA and the aviation industry under the Air Traffic Management Advisory Committee with an agreed upon minimum of *ten years* from issuance of the final rule to mandate completion of rule compliant equipage installation. The ADS-B Out implementation was focused on a fleet-wide equipment mandate for aircraft operating in the U.S. to meet FAA program objectives. By contrast, the interference-tolerant radio altimeter rulemaking has the aviation industry starting at a deficit in multiple facets including no published performance standard to allow equipment design and development to begin before publication of the final rule and a substantially shorter timeline to complete equipment installation. The mid-2032 date for Part 121 and Part 129 fleets therefore represents a compressed timeline relative to historical norms.

This currently proposed timeline reflects aggregated data from aviation stakeholders integral to each activity phase, across all radio altimeter manufacturers and a significant population of aircraft manufacturers and operators. As estimated by the FAA, the scope of the retrofit and replacement under the proposed rule includes nearly 58,600 individual radio altimeter units across nearly 40,900 aircraft operating in the contiguous United States.[39] This broad scope encompasses a significant number of aircraft-radio altimeter combinations with associated design, development, testing, and certification activities, which must be performed concurrently across multiple stakeholders including the FAA and foreign aviation regulators.[40]

[38] *See* FAA NPRM Table 5 at 471-472.

[39] *See* FAA NPRM at 478.

[40] Many aircraft that operate within the contiguous United States are designed and certified by foreign aviation regulators such as the European Union Aviation Safety Agency, Brazil's Agência Nacional de Aviação Civil, or Transport Canada Civil Aviation with validation of those designs by the FAA.

Similarly, supply chain, manufacturing, and installation activities will be completed concurrently by multiple domestic and international stakeholders across the entire affected fleet.

This proposed timeline contains several assumptions. First, this proposed timeline assumes that the radio altimeter retrofits and replacements will not be required to comply with the entirety of the draft AC 20-199 to show compliance with the FAA final rule interference tolerance requirements, as described within the Joint Aviation Community comments on the draft AC which are included as Annex B for reference. The timeline also assumes there are no competing equipage requirements resulting from other aviation regulations that would require retrofit/replacement of radio altimeter systems for aircraft operated exclusively outside the contiguous U.S. (as discussed further in Section VI) or exclusively in the airspace of other sovereign states.[41] This timeline further assumes that radio altimeter retrofits/replacements for continued military aircraft operations within the contiguous U.S. do not cause manufacturing and personnel resource conflicts that adversely impact radio altimeter retrofits/replacements within the commercial and general aviation fleets.

A description of each of the four phases of the radio altimeter retrofit/replacement timeline as depicted in Annex A (Equipment Design, Development and Authorization, Aircraft Certification, Equipment Manufacturing, and Aircraft Fleet Retrofit and Production Line Fit), including their respective activities, considerations, and underlying assumptions, follows.

[41] The term "contiguous United States" or "contiguous U.S." as used in this document includes the 48 contiguous United States and the District of Columbia as used in the FAA NPRM. *See* FAA NPRM at 470. The term "outside the contiguous United States" is intended to include operations exclusively in the airspace over the State of Alaska, the State of Hawaii, Puerto Rico, and other U.S. territories and possessions, including territorial waters.

A. The Four Phases of the Retrofit/Replacement Process

Phase 1 – Equipment Design, Development, and Authorization. This phase reflects the activities of a radio altimeter manufacturer to design, develop, and test an interference-tolerant radio altimeter based on the requirements proposed within the FAA NPRM and to obtain design and production approval under a TSO Authorization (TSOA). In addition to FAA requirements under the TSO, radio altimeter manufacturers must address compatibility requirements specified by each aircraft manufacturer for integration with aircraft systems, which often vary across manufacturers and aircraft models. This phase also includes a range of formal verification and validation testing and production of documentation demonstrating compliance to the FAA.[42]

The timelines for each fleet segment are divided into two workstreams: (1) an in-service upgrade solution (e.g., hardware and/or software modifications) to an existing radio altimeter model under a change to a current TSOA, and (2) development of a new full replacement radio altimeter design where an in-service upgrade solution to achieve interference tolerance requirements is not feasible and thus requires approval under a new TSOA. Both workstreams will be required to address the needed retrofit of the diverse aviation fleet with interference-tolerant radio altimeters. The timelines for an existing radio altimeter in-service upgrade solution under a change to a current TSOA assume only an interference tolerance compliance showing would be required for installation in an aircraft, as opposed to the complete means of compliance prescribed in FAA's draft AC 20-199, therefore expediting approvals where practicable (see

[42] *See* RTCA, Inc., RR-002, Report on Aeronautical Radio Frequency Systems, their Regulatory Framework, and Operational Considerations (Mar. 13, 2025) (RTCA RR-002) at Section 5 for a more comprehensive description of the activities for the design, certification, and installation of aviation electronic systems and equipment on aircraft. Available for purchase at https://store.accuristech.com/publishers/rtca (last visited Mar. 2, 2026).

concerns identified in Annex B). The timelines for a new full replacement radio altimeter development under a new TSOA will inevitably require additional time to complete the necessary design, development, testing, and the documentation required to demonstrate compliance. As noted in the FAA NPRM, "the typical product development schedule for flight-critical avionics is two to four years."[43] The multi-year timelines depicted in Annex A reflect the multiple radio altimeter models that must be upgraded or newly designed concurrently. Critically, there is currently no radio altimeter system that can claim it will meet the interference tolerance requirements of the FAA final rule, as the FAA NPRM serves as the starting point for regulatory technical requirements.

Phase 2 – Aircraft Certification. This phase reflects the activities of an aircraft manufacturer or other applicant to demonstrate that modifications to an aircraft meet FAA airworthiness regulations, via an amended type certificate (ATC) or supplemental type certificate (STC). Depending on the scope and scale of the avionics integration, this process generally takes between one and three years.[44] Certification of an in-service upgraded radio altimeter on a newer aircraft will be less complex, whereas certification of a full replacement radio altimeter on an older out-of-production aircraft will require a more extensive compliance demonstration (see Section VIII for additional considerations associated with older aircraft and RA models). The multi-year timelines depicted in Annex A reflect the significant number of aircraft-radio altimeter combinations and associated certification activities that will occur concurrently as testable retrofit/replacement radio altimeters become available and resources allow.

[43] FAA NPRM at 471.

[44] *See* RTCA RR-002 at Section 5 for a more comprehensive description of the activities for the design, certification, and installation of aviation electronic systems and equipment on aircraft.

Phase 3 – Equipment Manufacturing. This phase reflects the activities of radio altimeter manufacturers to adjust or increase production capabilities to the extent practicable to meet demand for retrofit/replacement radio altimeter systems. Radio altimeter equipment must be manufactured under an FAA-approved quality control system to ensure every article conforms with the approved design.[45] The timelines for this phase reflect an overall increase in production to the extent practicable considering factors such as manufacturing test equipment lead times and other supply chain constraints. Manufacturing facilities will require a significant production ramp-up to meet the anticipated demand for the FAA NPRM mandate. The multi-year timelines depicted in Annex A also reflect the multiple radio altimeter models that must be manufactured concurrently.

Phase 4 – Aircraft Fleet Retrofit and Production Line Fit. This phase reflects the installation of interference-tolerant radio altimeters into the existing aircraft fleet and the introduction of interference-tolerant radio altimeters into aircraft manufacturer production lines. The implementation presents considerable operational and administrative challenges for aircraft operators. This process necessitates the expedited coordination of several interdependent tasks—including engineering releases, supply chain activities, contract approvals, and maintenance planning—that typically span extended timeframes. These tasks must be condensed into shorter timelines while aircraft operators continue their routine operations, thereby imposing significant constraints, especially during peak demand periods and times of limited additional maintenance capacity.

For many Part 121 and Part 129 aircraft, a radio altimeter transceiver replacement can often be completed during an overnight maintenance visit, followed by the required operational

[45] *See, e.g.*, 14 CFR § 21.607 and 14 CFR § 21.608.

testing. More complex installations, however, may require multi-day visits to maintenance facilities to accommodate antenna or cabling replacement, system integration and operational checks, and the resolution of installation issues.

For Part 91 and Part 135 aircraft, installation timelines may vary more widely depending on aircraft configuration, avionics architecture, and the need for engineering approvals or STC data. These aircraft are frequently scheduled through specialized avionics maintenance facilities with limited capacity, and installation must be coordinated with operator scheduling and aircraft availability.

Accordingly, the rate at which next-generation radio altimeter systems can be installed will vary across the fleet based on aircraft type, installation complexity, certification requirements, and maintenance scheduling considerations. Additional factors—including limited hangar and workforce availability,[46] elevated overtime requirements, mixed-configuration fleet management, supply chain constraints, and the distributed nature of the Part 91 and Part 135 fleets—highlight the multidimensional operational demands on operators during this phase.

The multi-year timelines depicted in Annex A reflect these considerations as aircraft operators across the Part 121, Part 129, Part 135, and Part 91 communities concurrently retrofit or replace radio altimeter systems to meet the proposed interference-tolerant performance requirements.

[46] For example, the Aviation Technician Education Council and Oliver Wyman, 2025 Pipeline Report (2025) at 3 states, "Expanding demand and worker retirements are expected to drive a 10% shortage in certificated mechanics to meet commercial aviation needs [in 2025]. This shortfall is project to soften to 6% by the end of the decade but not surpass demand, representing a gap of 4,200 certificated mechanics in 2035. This analysis does not account for business and general aviation or for emerging markets, which will place additional pressure on the technical workforce." Available at https://assets.noviams.com/novi-file-uploads/atec/Pipeline_Report_2025_web_optimized.pdf (last visited Mar. 2, 2026).

B. Alignment with FCC Auction Timeline

The FAA NPRM contains the following question(s):

> *"We also seek comment on how the timing of the aviation industry's future implementation efforts should be aligned with FCC's statutory responsibility to complete an auction by July, 2027."*[47]

The Joint Aviation Community strongly supports the FAA's proposed linkage of the initial RA performance deadline to the date the FCC authorizes wireless services to commence in the Upper C-band, not to the auction completion date. As the National Telecommunications and Information Administration (NTIA) stated in the FCC's Upper C-band proceeding, "[t]he timelines for the [next-generation radio altimeter] retrofit and [the FCC] Report and Order activation of new [commercial wireless] services should align."[48] While spectrum must be auctioned by the FCC by the statutory deadline, the actual licensee service authorization timeline must be tied to radio altimeter retrofit/replacement timelines. To ensure continued aviation safety and operational integrity, under no circumstance should wireless licensees be permitted to utilize Upper C-band spectrum until the initial radio altimeter performance compliance deadline.

C. Financial Incentives and Schedule Impact

The FAA NPRM contains the following question(s):

> *"FAA is seeking comments on the schedule impacts to the proposed RA system performance requirements resulting from such incentives."*[49]

The Joint Aviation Community supports the FCC's exploration of financial incentive mechanisms for RA retrofits, as addressed in the FCC Upper C-band Notice of Proposed

[47] FAA NPRM at 470.

[48] Comments of NTIA on the FCC Upper C-band NPRM, GN Docket No. 25-59, (filed Jan. 20, 2026) (NTIA Comments) at 6, available at https://www.fcc.gov/ecfs/document/10121029347178/1.

[49] FAA NPRM at 471.

Rulemaking (FCC Upper C-band NPRM).[50] Financial incentives could meaningfully accelerate the retrofit schedule, including for Part 91 and Part 135 operators whose smaller fleets face disproportionate per-aircraft costs and in many cases, the inability to absorb or recover those costs. Operators can bring forward installation schedules and potentially enable earlier fleet-wide compliance with incentives to reduce out-of-pocket equipment costs.

Any incentive or compensation mechanism should adequately reflect the full costs borne by the aviation sector, which the Joint Aviation Community currently estimates between $4.49 billion and slightly over $7 billion in total undiscounted costs. This cost represents an externality imposed on the aviation industry by the spectrum reallocation, as recognized in the FAA NPRM's own regulatory analysis under Office of Management and Budget (OMB) Circular A-4.[51]

D. Impact of Early International Adoption

The FAA NPRM contains the following question(s):

> *"FAA specifically requests comments about the potential impact on schedule and cost due to early adoption by operators who do not regularly fly to the U.S."*[52]

Early adoption via rulemaking by foreign aviation regulators of the future RTCA/EUROCAE Minimum Operational Performance Standards, as intended by the standards process, or the performance requirements of the FAA § 91.220 final rule, will increase worldwide demand for next-generation RA systems and could strain manufacturing capacity, extending the

[50] *See* FCC Upper C-band NPRM ¶ 120.

[51] FAA NPRM at 477 stating "The upcoming [FCC] auction would create an externality, defined as a market failure in OMB Circular A–4 occurring when one party's actions impose uncompensated benefits or costs on another party. The proposed utilization of Upper C-band spectrum directly imposes uncompensated safety costs (increased risk of accidents) and fiscal costs (replacing RA systems to redress safety costs) to aircraft operators and the flying public." (footnote omitted)

[52] FAA NPRM at 471.

time available for U.S.-focused production. The Joint Aviation Community reiterates that its timeline assumes no competing equipage requirements for aircraft operated exclusively outside the contiguous U.S. and no manufacturing and personnel resource conflicts from military aircraft radio altimeter retrofits. These assumptions should be revisited in the final rule, and the FAA should maintain flexibility to adjust the final RA performance deadline if global demand materially affects the supply available for U.S. operations.

V. COORDINATION BETWEEN FAA AND FCC RULEMAKING PROCESSES

A. Recommendations for Interagency Coordination

The Upper C-band reallocation implicates overlapping jurisdictions of the FAA and the FCC, and successful implementation requires close, sustained coordination between the two agencies. The Joint Aviation Community commends the FAA and FCC for the interagency coordination conducted prior to the release of their companion notices of proposed rulemaking and urges that this coordination continue through the final rulemaking process. The need for continued coordination and collaboration between FAA and FCC was also a consistent theme within comments filed on the FCC Upper C-band NPRM docket.[53]

Recommendations for Coordinated Final Rules. The Joint Aviation Community strongly recommends that the FAA and FCC coordinate the timing and substance of their respective final rules to ensure consistency and to avoid regulatory gaps or conflicts. The FAA NPRM proposes that the initial RA performance deadline coincide with the date the FCC

[53] *See* Joint Aviation Community Reply Comments at 2-4, including notes 7 and 9.

authorizes wireless services in the Upper C-band.[54] This linkage is critical—if the FCC were to authorize wireless operations to commence before the aviation industry has had reasonable time to complete the applicable retrofit process, aviation safety and operations would be compromised.

Additionally, the Joint Aviation Community emphasizes the importance of ensuring that the FCC's final rules codify, rather than merely reference, all technical parameters and control measures necessary to maintain aviation safety, particularly those that fall outside the FAA's direct regulatory authority. As the FAA will regulate the minimum performance requirements for radio altimeters and specify the aircraft operations in which they must perform their critical functions, the FCC must adequately regulate the characteristics and operations of Upper C-band, and Lower C-band, emitters so as to be compatible with radio altimeters subject to those requirements. As cautioned by NTIA in the FCC's Upper C-band proceeding, "if the FAA final rule and FCC Report and Order are not aligned … aviation and wireless stakeholders could face significant challenges."[55] Additionally, reliance on voluntary commitments, as was necessary in the Lower C-band, is not a sustainable long-term solution.

B. Harmonization of Technical Requirements

Successful coexistence between next-generation wireless services and radio altimeters depends on a coherent, unified technical framework governing both the Lower C-band (3.7–3.98 GHz) and the Upper C-band (3.98–4.2 GHz). The Joint Aviation Community urges the FAA to ensure that the technical parameters and safety assumptions underlying the proposed rule are

[54] *See* FAA NPRM at 467.
[55] NTIA Comments at 10.

fully harmonized with the rules that the FCC will adopt for both bands, and that the FAA communicate this harmonization requirement clearly to the FCC in the companion proceeding.

Importance of Consistent OOBE EIRP Limits Across Lower and Upper C-Band. The radio altimeter band (4.2–4.4 GHz) receives OOBE from wireless base stations. A radio altimeter system cannot distinguish between the source of in-band interference; it must withstand the aggregate interference environment from all emitters. Accordingly, OOBE EIRP limits applicable to Lower C-band licensees and Upper C-band licensees must be consistent and harmonized to ensure that the ITM proposed in this rulemaking, and the safety analysis underlying it, remain valid across the entire operational spectrum environment.

An OOBE limit applied only to the Upper C-band while the Lower C-band is governed by a different, potentially less restrictive standard would create a regulatory inconsistency that the ITM-based safety framework cannot accommodate. As such, the Joint Aviation Community recommends that any final OOBE EIRP limit value adopted for the Upper C-band also be applied to the existing Lower C-band licensee rules. The current Lower C-band OOBE limit in the 4.2–4.4 GHz band is set at a voluntary -48 dBm/MHz conducted;[56] accordingly, no Lower C-band base station equipment modifications would be required to meet a harmonized limit at or below that level. Lower OOBE limits are not only feasible but have already been acknowledged and advocated for by 5G equipment manufacturers in their own comments on the Lower C-band proceeding.[57]

[56] Letter of from Henry G. Hultquist, Vice President-Federal Regulatory, AT&T Services, Inc., et al. to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122 (filed Mar. 31, 2023) ("5G Voluntary Commitments") Appendix at 3, agreeing to limit OOBE as follows: "From outdoor operations, maximum -48 dBm/MHz conducted spurious emissions", available at https://www.fcc.gov/ecfs/document/1033142661477/1.

[57] *See* Joint Aviation Community Comments at 15, note 47. *See also* Joint Aviation Community Reply Comments at 15, note 61.

The Joint Aviation Community also notes that the FCC's 2020 C-band Report and Order preserved the FCC's discretion to "apply section 27.53(i), which states that the FCC may, in its discretion, require greater attenuation than specified in the rules if an emission outside of the authorized bandwidth causes harmful interference."[58] This existing authority provides a clear basis for the FCC to establish harmonized OOBE EIRP limits without requiring new regulatory action.

Need for EIRP-Based Limits vs. Conducted Power Limits. The Joint Aviation Community strongly recommends that any OOBE limits established for the Upper and Lower C-bands be expressed as EIRP rather than conducted power limits in the 4.2–4.4 GHz band. The FAA NPRM itself uses EIRP in its OOBE calculations, given the unknown 5G antenna performance characteristics outside any potential 5G allocation.[59] The FAA should communicate to the FCC that EIRP-based limits are essential to maintain the integrity of the safety analysis underpinning the proposed ITM.

Wireless active antenna system (AAS) emissions and directivity performance outside the commercial wireless licensed band (and inside the 4.2-4.4 GHz band) remain unvalidated at this time. A conducted power limit, standing alone, thus does not account for base station antenna gain, which is a critical factor in determining the actual interference power received by a radio altimeter. An EIRP limit directly addresses this deficiency by capturing the total radiated power at the point of emission, inclusive of antenna gain, regardless of the specific antenna technology or configuration employed by the licensee.

[58] *Expanding Flexible Use of the 3.7-4.2 GHz Band*, FCC GN Docket No. 18-122, Report and Order and Order of Proposed Modification, 35 FCC Rcd 2343 (2020) ¶ 350.

[59] *See* FAA NPRM at 474.

An EIRP-based limit provides several additional advantages that serve the interests of both aviation safety and wireless industry flexibility. First, it eliminates the need to document, standardize, and validate the out-of-band antenna performance characteristics of every 5G AAS configuration across all equipment providers within the compressed timeline dictated by the statutory mandate.[60] Second, it preserves network design freedom for wireless operators by permitting them to take credit for system-level performance and to make trades within their own systems using a single output value. Third, it provides the needed assurance to adjacent-band incumbents, particularly aviation safety systems, without requiring those incumbents to predict or assume performance for systems they do not own or control. Last, the FCC has already implemented an EIRP limit for the Citizens Broadband Radio Service (CBRS) band, which placed significant limits on its OOBE to protect the Lower C-band commercial wireless operators by specifying a -40 dBm/MHz conducted limit for CBRS systems, including many CBRS systems which are based on 3GPP technology.[61] Consequently, there is a clear precedent established by the FCC itself for this approach.

Coordination on Minimum Separation Distance Requirements. The FAA NPRM proposes a 35-foot MSD between wireless base stations and radio altimeters, defined as a sphere with a 35-foot radius originating at the wireless base station antenna phase center, for aircraft at 500 feet AGL and below.[62] The Joint Aviation Community supports this MSD and urges the FAA to ensure that the FCC's rules for Upper C-band wireless operations are fully consistent with this requirement.

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[60] *See* Comments of Aviation Spectrum Resources, Inc. on the FCC Upper C-band NPRM, GN Docket No. 25-59 (filed Jan. 20, 2026) at 6-7 for additional details on the AAS parameters affecting antenna gain, available at https://www.fcc.gov/ecfs/document/1012105237839/1.

[61] 47 CFR § 96.41(e)(2) stating "the conducted power of any emissions below 3530 MHz or above 3720 MHz shall not exceed -40 dBm/MHz."

[62] *See* FAA NPRM at 473-474.

The 35-foot MSD is grounded in the physical characteristics of aircraft equipped with radio altimeters. The smallest transport category airplanes certificated under Part 25 have half wingspans greater than 35 feet, and most helicopters required to be equipped with a radio altimeter have an overall rotor radius of 35 feet or more. The MSD is further supported by the one-engine-inoperative obstacle clearance requirements in 14 CFR §§ 121.189, 135.379, and 135.398, each of which require 35 feet of vertical clearance, and by FAA heliport design criteria, which define obstacle-free areas based on the largest helicopter supported.[63]

The Joint Aviation Community also notes that the MSD analysis must account for base station antenna (emitter) height. If wireless base stations are permitted to transmit without a height limit, then the requested EIRP limit will be incompatible with the altitude dependent ITM. Consistent with this principle, aviation and commercial wireless stakeholders have submitted consensus parameters to the FCC that include an emitter height limit of 450 feet AGL for wireless service operations in the Upper C-band,[64] reinforcing the physical assumptions underlying the 35-foot MSD. The Joint Aviation Community has recommended that the FCC adopt this consensus 450-foot AGL emitter height limit.[65]

Alignment of Safety Analysis Assumptions. The safety analysis presented in the FAA NPRM establishes the analytical framework, including the MSD, the 6 dB safety margin, the in-band aggregation factor, and the PFD formula within which the ITM was derived.[66] The

[63] *See* FAA, DOT, AC 150/5390-2D, Heliport Design (Jan. 5, 2023), available at https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_150_5390_2D_Heliports.pdf (last visited Mar. 2, 2026).

[64] *See* Letter of Dorothy B. Reimold, Vice President, Civil Aviation, AIA, Sharon Pinkerton, Senior Vice President, Legislative and Regulatory Policy, Airlines for America, and Umair Javed, Senior Vice President & General Counsel, CTIA—The Wireless Association to Marlene H. Dortch, Secretary, FCC, GN Docket 25-59 (filed Oct. 2, 2025), attached presentation, "Consensus Parameters: 3980-4160 MHz" slide, available at https://www.fcc.gov/ecfs/document/10022930930436/1.

[65] *See* Joint Aviation Community Reply Comments at 12.

[66] *See* FAA NPRM at 473-474.

assumptions underlying this analysis must be consistently applied and mutually recognized by both the FAA and the FCC when finalizing their respective rules. Any divergence in assumptions between the two agencies could render the ITM inadequate to protect radio altimeters in the actual deployed interference environment.

In-Band Aggregation (6 dB): The FAA NPRM assumes an upper limit of three collocated base stations at the MSD, with an effective aggregation factor of 6 dB above a single base station.[67] The FCC rules governing collocation and co-site operations must be consistent with this assumption to preserve the validity of the in-band interference analysis.

Dual-Polarization EIRP: Based on the aviation industry review of the FAA NPRM, if the FCC were to repurpose only 160 MHz (3.98-4.14 GHz) then it is expected that no polarization constraint would be required for fundamental emissions. However, if the FCC chooses to repurpose the maximum considered 180 MHz (3.98-4.16 GHz) then a polarization constraint will be required for fundamental emissions on the last 20 MHz block (4.14-4.16 GHz).

C. Need for Extension of Voluntary Commitments

The twenty-one wireless service licensees in the Lower C-band have filed voluntary commitments with the FCC to coordinate power levels and limit emissions into the radio altimeter band, with those commitments set to sunset on January 1, 2028, unless extended or reduced by mutual agreement.[68] The Joint Aviation Community aligns with the FAA's position to seek an extension of the current voluntary commitments until the initial RA performance deadline.[69]

[67] *See* FAA NPRM at 474.
[68] *See* 5G Voluntary Commitments, Appendix at 1-3.
[69] *See* FAA NPRM at 475.

This extension is not merely procedural; it is a prerequisite to safe aviation operations during the transition to next-generation radio altimeter systems. As the FAA NPRM explains, existing radio altimeter systems, including those modified in 2022–2024 to be tolerant to Lower C-band wireless signals, are not compatible with wireless services above 3.98 GHz.[70] The wireless voluntary commitments currently underpin the safe operation of these systems, and their expiration without an adequate replacement framework would create an unsafe condition.

Rationale for Extension. The Joint Aviation Community identifies four interconnected reasons why extension of the voluntary commitments is essential to the successful implementation of the proposed rule.

Bridge to New Altimeter Deployment. The voluntary commitments expire in January 2028, which is well before the retrofit/replacement of radio altimeters in the Part 121 and Part 129 aircraft fleets can be achieved. During the intervening period until the initial RA performance deadline, the voluntary commitments are the only mechanism currently in place to bound the Lower C-band interference environment experienced by radio altimeters. Allowing the voluntary commitments to expire in 2028 without extension would leave existing radio altimeters and the safety systems that depend upon them unprotected.

Maintain Current Operational Capability. The voluntary commitments, combined with the FAA's Airworthiness Directives (ADs) issued in 2023, have enabled airlines and other operators to continue flying with Lower C-band tolerant radio altimeters while preserving access to low-visibility operations at 188 designated C-band Mitigation Airports. Without extension, the FAA would be compelled to supersede the current ADs to reimpose the most restrictive operational limitations, including prohibitions on CAT II/III operations and certain aircraft-

[70] *See* FAA NPRM at 461.

specific groundings.[71] The FAA estimates that such limitations would disrupt an average of 135,600 takeoffs and landings per year.[72] The extension of the voluntary commitments avoids this outcome and preserves the current fleet operational capabilities while the next-generation retrofit proceeds.

Avoid Dual Retrofit Burden. The FAA NPRM explicitly considered and rejected a two-phase implementation approach in which operators would first be required to install interim retrofit solutions, followed later by next-generation radio altimeters that meet the proposed ITM.[73] The FAA concluded that any early wireless access requiring an interim retrofit would impose significant additional cost on the aviation industry, increase manufacturing demand that would extend the timeline for all operators to equip with compliant systems, and divert the resources and personnel of aviation manufacturers who are working toward the development and certification of next-generation altimeters.[74] The extension of the voluntary commitments is the necessary counterpart to this decision as it eliminates the pressure to deploy interim solutions and preserves the path to a single retrofit cycle.

Ensure a "One-and-Done" Approach. The Joint Aviation Community has consistently emphasized the importance of aligning timelines for radio altimeter equipment redesign and retrofit/replacement with a "one-and-done" approach, ensuring that radio altimeter equipment and affected aircraft undergo a single, coordinated change process.[75] Extension of the voluntary commitments through the initial RA performance deadline is essential to this objective. A premature lapse in the voluntary commitments would force operators into reactive, piecemeal

[71] *See* FAA NPRM at 477.
[72] *See* FAA NPRM at 477.
[73] *See* FAA NPRM at 476.
[74] *See* FAA NPRM at 476.
[75] *See* Joint Aviation Community Reply Comments at i and 27-28.

modifications, precisely the outcome that the proposed rule is designed to avoid. The "one-and-done" approach also minimizes costs, reduces supply chain disruption, and preserves manufacturing capacity for the next-generation equipment that will provide long-term compatibility with both the Lower and Upper C-band wireless environments.

Further, the Joint Aviation Community supports the FAA's rejection of a two-phase implementation approach in which operators would be required to install interim solutions before the full next-generation retrofit. As the NTIA stated in the FCC's Upper C-band proceeding, "the current generation of RA is not sufficiently resilient to high-power transmissions in the proposed [Upper C-]band or the emissions into the RA band, even those RAs that have been recently retrofitted."[76]

The FAA NPRM and aviation industry comments noted that nearly half of currently installed Lower C-band tolerant radio altimeters are incompatible with high-power terrestrial wireless services in just the 3.98–4.0 GHz band.[77] Deploying high-power services beyond 4.0 GHz will only increase the number of incompatible units. A phased approach would impose a significant additional cost on the aviation industry, increase demand on manufacturers in a way that would extend the overall timeline, and divert resources from the development and certification of next-generation altimeters. The "one-and-done" approach supported by both the FAA NPRM and the Joint Aviation Community is the correct path.

[76] NTIA Comments at 6-7.

[77] *See* FAA NPRM at 466. *See also* Joint Aviation Community Comments at 7 and Joint Aviation Community Reply Comments at 28.

D. Relationship to Existing ADs

A number of ADs currently address the unsafe conditions posed by interference from Lower C-band wireless services. These ADs remain in effect and will continue to govern operations until aircraft comply with the final rule ITM requirements. The Joint Aviation Community supports the FAA NPRM's proposed framework for managing the relationship between the final rule and the existing AD structure and offers the following comments on its implementation.

Support for FAA's Plan to Recognize Compliance with § 91.220(b) as an Alternative Method of Compliance. The Joint Aviation Community strongly supports the FAA's plan to recognize an aircraft's compliance with proposed § 91.220(b) as an Alternative Method of Compliance (AMOC) with all existing C-band-related ADs and any superseding ADs that may be issued during the transition period.[78] This AMOC pathway is essential to enabling an efficient, orderly fleet transition. Once an aircraft is equipped with a radio altimeter system that meets the final ITM requirements, the aircraft should be permitted to operate without the operational limitations imposed by the current ADs without the need for individual, aircraft-by-aircraft coordination with the FAA. The FAA has also indicated that it plans to authorize foreign operators to operate without additional limitations in the U.S. if the aircraft complies with the final ITM requirements,[79] which the Joint Aviation Community likewise supports as necessary to avoid disparate treatment of Part 129 carriers.

[78] *See* FAA NPRM at 475.
[79] *See* FAA NPRM at 475.

Timeline for Superseding or Withdrawing Existing ADs. The Joint Aviation Community supports the FAA's proposed approach to the existing AD structure during and after the transition. Specifically:

Prior to the Initial RA Performance Deadline: Existing ADs addressing Lower C-band interference must remain in full effect. The FAA has assessed the risk for Part 121 and Part 129 aircraft operating under the conditions of the FAA's Policy Statement PS-AIR-600-39-01 and has determined that those conditions will provide an acceptable risk mitigation through a hypothetical initial performance deadline as late as 2032, provided the voluntary commitments are extended to that date.[80] The Joint Aviation Community supports this assessment and the continued reliance on the existing AD and policy framework during this bridge period.

At the Initial RA Performance Deadline: The FAA proposes to supersede the current ADs to impose operating limitations on radio altimeters that do not meet the final ITM requirements, specifically addressing operators who upgraded to Lower C-band tolerant equipment but have not yet upgraded to an ITM-compliant system.[81] The FAA's Policy Statement PS-AIR-600-39-01 and the Flight Standards policy memo addressing CAT II/III C-band assessments would be withdrawn at this time, as the next-generation RA systems will render those interim measures unnecessary.[82] The Joint Aviation Community supports this approach as providing a clear, predictable transition framework.

After the Final RA Performance Deadline: Once the full fleet has transitioned to ITM-compliant radio altimeters, the FAA may elect to remove the C-band-related ADs entirely, as they will be made obsolete by the requirements of § 91.220.[83] The Joint Aviation Community

[80] *See* FAA NPRM at 475.
[81] *See* FAA NPRM at 476.
[82] *See* FAA NPRM at 476.
[83] *See* FAA NPRM at 476.

supports the removal of these ADs at that time and recommends that the FAA communicate a clear schedule for this action to provide regulatory certainty to operators.

Transition Planning for Aircraft with Lower C-band Tolerant (Group 4) Altimeters. The Joint Aviation Community draws the FAA's attention to the transition challenges specific to aircraft currently equipped with Lower C-band tolerant (also known as Group 4) radio altimeters. These are the altimeters that were modified or replaced in 2022–2024 in response to the original Lower C-band ADs, and they represent most of the commercial fleet currently operating in compliance with AD 2023-10-02 and related directives. The Joint Aviation Community notes the following transition considerations for this population:

Single Retrofit Expectation. Under the proposed rule, every aircraft operating with a radio altimeter within the contiguous U.S. will need to be modified to meet the new FAA performance requirements, have the radio altimeter system removed altogether, or be retired from operations in the contiguous United States.[84] For aircraft already carrying Group 4 altimeters, this represents a second modification to the same system within a relatively short period. The Joint Aviation Community emphasizes that the "one-and-done" principle must guide transition planning: operators who have already invested in Group 4 retrofits should not be placed at a schedule or cost disadvantage relative to operators who deferred modification, and the FAA's compliance timeline should account for the fact that Group 4 equipment will need to be retrofitted/replaced, not merely re-qualified.

Interim Operational Posture. Between now and the initial RA performance deadline, Group 4 altimeters must continue to operate under the existing AD framework and the extended voluntary commitments. Operators of Group 4 equipped aircraft expect no interim action, nor

[84] *See* FAA NPRM at 472.

should interim action be required. The Joint Aviation Community supports the FAA's assessment that the existing conditions of FAA's Policy Statement PS-AIR-600-39-01, combined with the extended voluntary commitments, provide acceptable risk mitigation through the initial performance deadline.[85]

Older Aircraft Considerations. The FAA NPRM recognizes that it may be more costly and complex to upgrade radio altimeters in older aircraft models due to reduced manufacturer support for out-of-production units and potential compatibility issues with older integrated systems.[86] The Joint Aviation Community requests that the FAA give particular attention to this population in setting the compliance timeline, and that the two-year extension provided for Part 91 and Part 135 aircraft be evaluated in light of the specific challenges faced by operators of older aircraft that may have limited retrofit options available, as explored in Section VIII.

VI. SCOPE AND APPLICABILITY

A. Contiguous United States

The FAA NPRM contains the following question(s):

> *"FAA specifically requests comments on the suitability of applying the proposed rule only in the airspace of the 48 contiguous United States and the District of Columbia."*[87]

The Joint Aviation Community supports limiting the proposed performance requirements to the airspace of the contiguous U.S. The FAA proposed not to apply the radio altimeter performance requirements to operations in the airspace over Alaska, Hawaii, Puerto Rico, and

[85] *See* FAA NPRM at 475.
[86] *See* FAA NPRM at 479.
[87] FAA NPRM at 470.

other U.S. territories and possessions specifically because the FCC's Upper C-band NPRM is proposing to preserve the status quo regarding its current licenses outside of the contiguous United States.[88] This alignment between the FAA and FCC geographic scopes is appropriate and should be maintained in both final rules. As noted in Joint Aviation Community comments to the FCC Upper C-band NPRM, the unique composition of aircraft fleets and operating environment outside the contiguous U.S. would further complicate the overall altimeter retrofit/replacement effort and proposed implementation timelines.[89]

B. Offshore Waters

The FAA NPRM contains the following question(s):

> *"FAA seeks comments about the need to require specific RA performance, as proposed, in additional offshore waters."*[90]

The Joint Aviation Community supports the FAA's proposed approach of not extending the performance requirements to the 3–12 nautical mile offshore zone.[91] Aircraft departing from or arriving at U.S. airports in the contiguous 48 states are already covered by the proposed rule during those operations.

C. Alaska Intrastate Operations

The FAA NPRM contains the following question(s):

> *"FAA specifically requests comments on the suitability of applying the proposed rule differently for intrastate operations in Alaska."*[92]

[88] *See* FAA NPRM at 470.
[89] *See* Joint Aviation Community Reply Comments at 28-30.
[90] FAA NPRM at 470.
[91] *See* FAA NPRM at 470.
[92] FAA NPRM at 486.

The Joint Aviation Community supports exempting aircraft conducting exclusively intrastate operations in Alaska from the proposed performance requirements, consistent with Section 1205 of the FAA Reauthorization Act of 1996. Alaska depends uniquely on aviation for essential services, and the FCC has proposed the Upper C-band reallocation will not affect spectrum outside the contiguous United States.[93] Aircraft based in Alaska that also operate regularly to the contiguous U.S. should remain subject to the rule.

VII. ICAO ANNEX 10

The FAA NPRM contains the following question(s):

> *"FAA seeks comment on the proposed compliance deadline for part 129 operators, in light of these potential updates to Annex 10."*[94]
>
> *"Considering these SARPs have yet to be finalized, FAA seeks comment on the interoperability of the proposed RA requirements across international airspace and the feasibility of making such updates within the proposed compliance timeline."*[95]

The Joint Aviation Community supports the proposed initial RA performance deadline for Part 129 operators with 30 or more passenger seats or a payload capacity of more than 7,500 pounds.[96] These operators serve the U.S. market regularly and are exposed to the same interference environment as Part 121 operators.

With respect to ICAO Annex 10 Volume V updates, the Joint Aviation Community recommends that the FAA engage actively with ICAO to ensure that any new Standards and Recommended Practices (SARPs) align with the final rule ITM. The Joint Aviation Community notes that compliance demonstrated in the U.S. should be recognized internationally by other

[93] *See* FCC Upper C-band NPRM ¶ 25.
[94] FAA NPRM at 472.
[95] FAA NPRM at 486.
[96] *See* FAA NPRM at 462.

foreign aviation regulators to avoid duplicative or conflicting certification requirements for not only Part 129 foreign operators, but all foreign operators.

VIII. OLDER AIRCRAFT AND LEGACY RA MODELS

The FAA NPRM contains the following question(s):

> *"FAA specifically requests comments about implementation challenges for older RAs and older aircraft and the associated costs of retrofit or aircraft retirement for older aircraft."*[97]

The Joint Aviation Community acknowledges that certain older aircraft models present disproportionately complex retrofit challenges. Reduced manufacturer support for out-of-production RA units, compatibility issues with older integrated avionics architectures, and the need for extensive compliance demonstrations on legacy type designs all increase the cost and timeline for these aircraft.

For older aircraft and legacy avionics architectures, the retrofit process will frequently require engineering development, installation design, and system integration work performed by certificated repair stations and avionics engineering organizations. In many cases, these entities serve as the primary technical resource for developing STCs, installation data packages, and system compatibility solutions for aircraft that are no longer supported by the original manufacturer.

These engineering and certification activities can represent a significant portion of the overall retrofit timeline, particularly for legacy aircraft platforms where integration solutions must be developed on an aircraft-by-aircraft or fleet-by-fleet basis. The Joint Aviation Community therefore encourages the FAA to maintain regulatory flexibility for all stakeholders

[97] FAA NPRM at 472.

to efficiently develop approved retrofit solutions for legacy aircraft while maintaining the required level of safety assurance.

As previously noted, the certification of a new full replacement radio altimeter on an older out-of-production aircraft will require a more extensive demonstration of compliance of the integrated systems than for a newer aircraft. Operators of older aircraft subject to the initial RA performance deadline face a binary choice: invest in a retrofit of increased complexity and cost or retire the aircraft from contiguous U.S. operations. The Joint Aviation Community requests that the FAA's final rule timeline account for this decision process. Retirement decisions will need to be made well in advance of the compliance date to avoid stranded investment; the final rule should provide sufficient notice.

The same retrofit challenges described above apply to older aircraft in the Part 91 and Part 135 fleet, compounded by a highly decentralized operator base. The Joint Aviation Community's timeline analysis projects completion of this segment by 2034, which accounts for the absence of centralized coordination mechanisms for general aviation and the unique market factors for owner-operated aircraft.

IX. ANALYSIS OF REGULATORY IMPACT ON COST

The FAA NPRM contains the following question(s):

> *"FAA requests comments, with supporting documentation, on the expected RA unit price difference, estimated future annual production of units, and any other cost assumptions or estimates presented in this analysis."*[98]

> *"FAA requests comment on the expected schedule of replacement or retrofit of RA units to Upper C-band tolerant systems to develop discounted cost estimates."*[99]

[98] FAA NPRM at 479.
[99] FAA NPRM at 479.

"FAA requests comment on the expected Upper C-band tolerant RA adoption curve for this group of aircraft to develop a discounted cost total."[100]

The FAA's estimate of $4.49 billion in undiscounted retrofit costs is likely an underestimate of actual costs. The FAA used its 2023 estimate of $80,000 per radio altimeter unit for Part 121 aircraft, acknowledging that this figure may not reflect the cost of the new and more complex units required by the forthcoming rules.[101]

Based on initial consultation with aircraft operators and radio altimeter manufacturers about expected equipment and labor costs, the Joint Aviation Community estimates cost of up to $120,000 per new interference-tolerant radio altimeter transceiver inclusive of installation cost. Total costs may be higher for legacy radio altimeter and aircraft installation configurations. With nearly 58,600 radio altimeter units currently installed that will require retrofit or replacement, total equipment and labor costs alone could exceed $7 billion. At this time, the Joint Aviation Community currently estimates the total costs will be somewhere between the FAA NPRM figure of $4.49 billion and slightly more than $7 billion. It is important to note the Joint Aviation Community is continuing to further refine cost estimates based on aircraft fleet data and the radio altimeter solution required for each fleet segment.

In addition to the equipment costs associated with next-generation radio altimeter systems, the Joint Aviation Community notes that a substantial portion of the total economic impact will arise from installation labor, aircraft downtime, engineering development, and certification activities associated with integrating these systems into the existing fleet. These activities are performed by aircraft operators, avionics and aircraft manufacturers, and FAA-

[100] FAA NPRM at 479.
[101] *See* FAA NPRM at 479.

certificated repair stations, and the costs can vary significantly depending on aircraft configuration, system architecture, and installation complexity.

For certain aircraft types, particularly older or out-of-production models, installation may require additional wiring changes, antenna replacements, system integration testing, and certification documentation. These factors contribute to the uncertainty in the total retrofit cost estimate and reinforce the need for flexibility in both compliance timelines and implementation planning.

Refined cost estimate data will be provided to both the FAA and FCC as it is available to support decision making.

X. CONCLUSION

The Joint Aviation Community supports the FAA's proposed rule and urges the agency to finalize it in a manner that preserves the "one-and-done" retrofit approach, anchors compliance deadlines in data-driven stakeholder analysis, and ensures full harmonization with the FCC's companion rulemaking. The compliance timelines of mid-2032 for Part 121/129 operators and by 2034 for Part 91/135 operators are achievable but represent the ceiling of what is feasible given the scale, complexity, and resource demands of the retrofit process. Aviation continues to develop additional fidelity on these timelines and will refine the anticipated dates as data is available.

The FAA's safety analysis is sound and must be strictly adhered to in the FAA's and FCC's final rules. Extension of the Lower C-band voluntary commitments through the initial RA performance deadline is essential to bridge safe operations during the transition period. Absent

that extension and harmonized OOBE EIRP limits, the regulatory framework will be incomplete and the safety assumptions underlying it will not hold in the deployed interference environment.

The Joint Aviation Community remains committed to full collaboration with the FAA and FCC as this rulemaking proceeds and stands ready to provide additional technical and operational data as needed to support a safe and efficient transition.

Respectfully Submitted,

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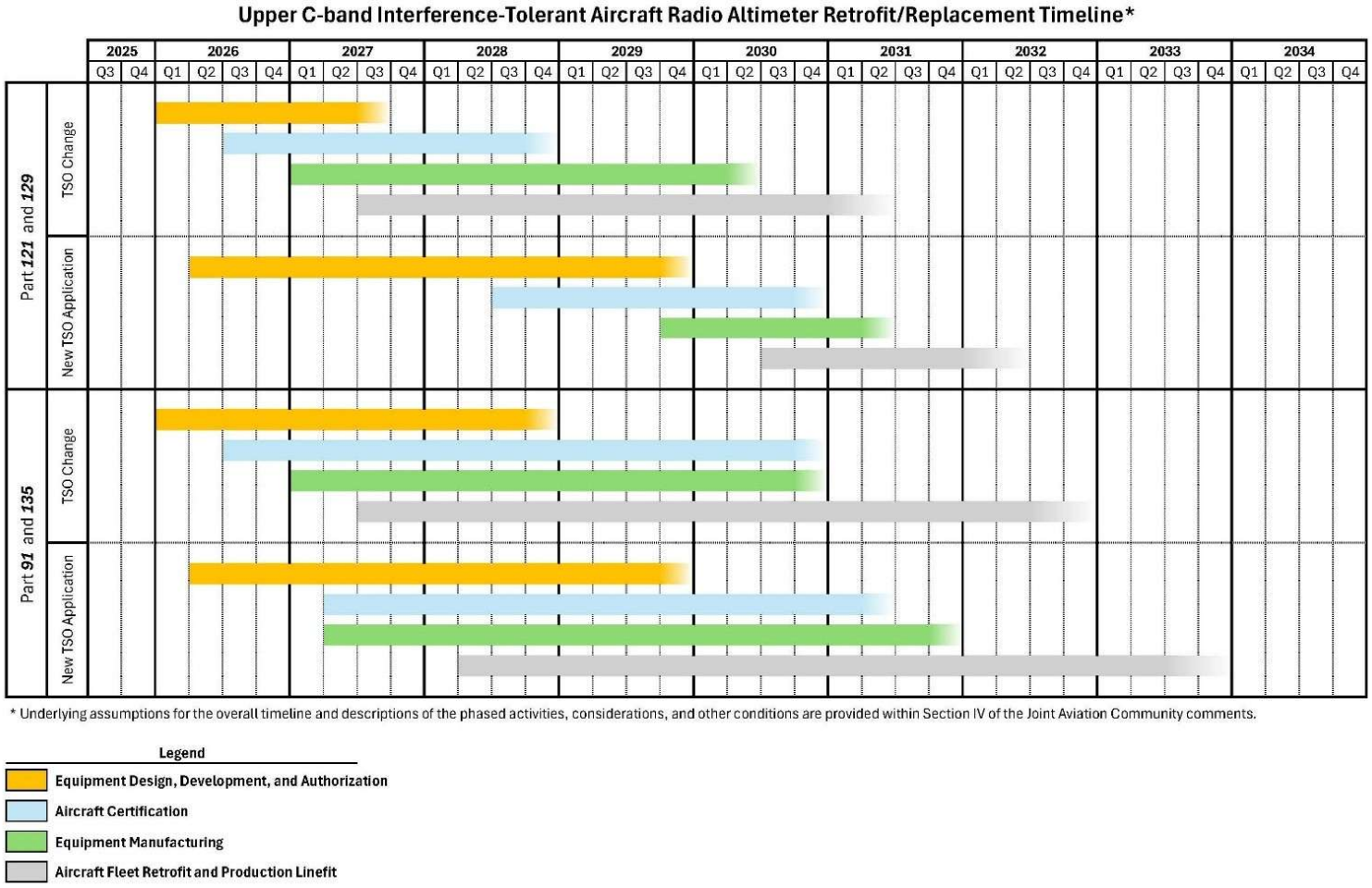
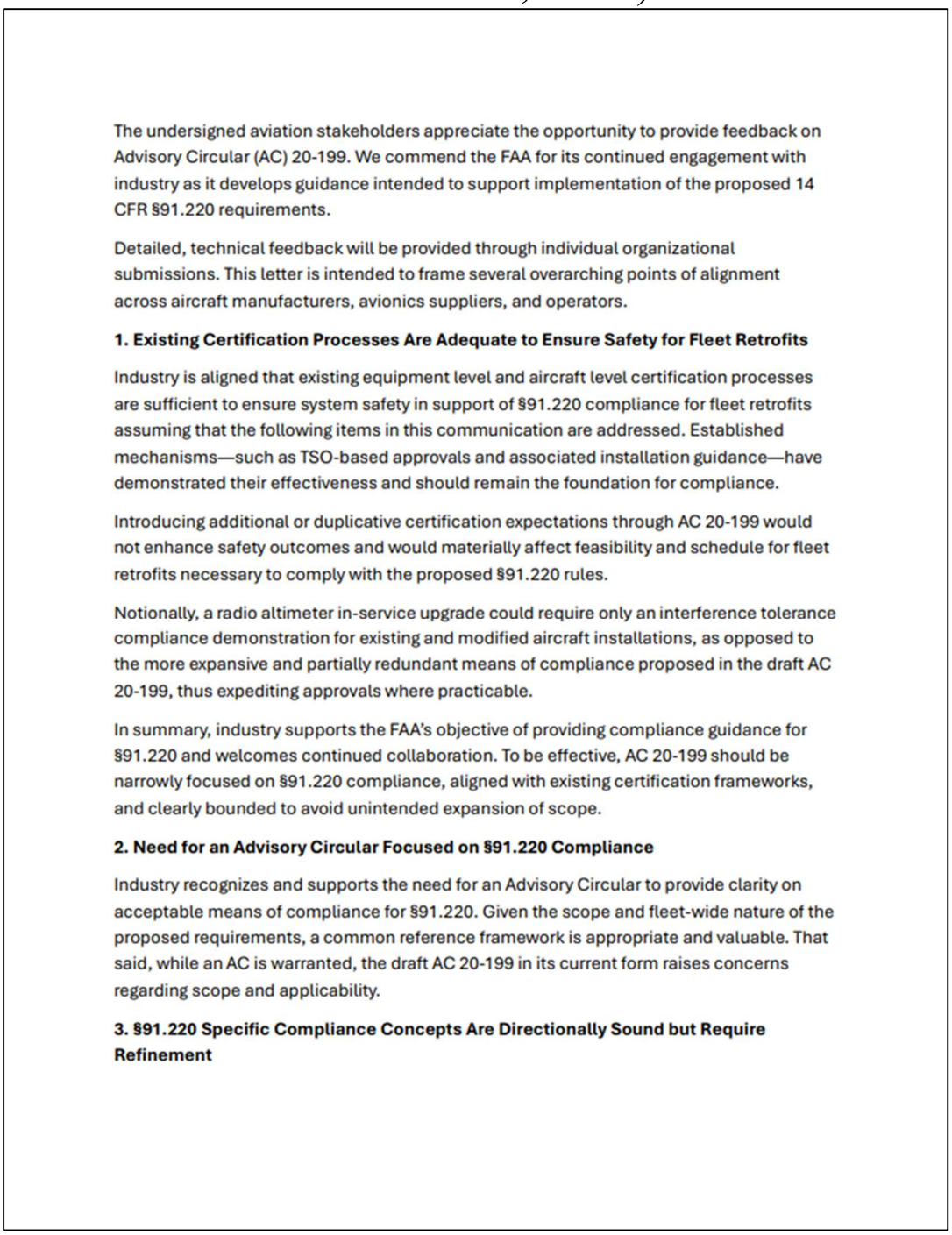
ANNEX A: UPPER C-BAND INTERFERENCE-TOLERANT AIRCRAFT RADIO ALTIMETER RETROFIT/REPLACEMENT TIMELINE



ANNEX B: JOINT AVIATION COMMENTS ON THE FAA ADVISORY CIRCULAR 20-199 (SUBMITTED FEBRUARY 27, 2026)



The undersigned aviation stakeholders appreciate the opportunity to provide feedback on Advisory Circular (AC) 20-199. We commend the FAA for its continued engagement with industry as it develops guidance intended to support implementation of the proposed 14 CFR §91.220 requirements.

Detailed, technical feedback will be provided through individual organizational submissions. This letter is intended to frame several overarching points of alignment across aircraft manufacturers, avionics suppliers, and operators.

1. Existing Certification Processes Are Adequate to Ensure Safety for Fleet Retrofits

Industry is aligned that existing equipment level and aircraft level certification processes are sufficient to ensure system safety in support of §91.220 compliance for fleet retrofits assuming that the following items in this communication are addressed. Established mechanisms—such as TSO-based approvals and associated installation guidance—have demonstrated their effectiveness and should remain the foundation for compliance.

Introducing additional or duplicative certification expectations through AC 20-199 would not enhance safety outcomes and would materially affect feasibility and schedule for fleet retrofits necessary to comply with the proposed §91.220 rules.

Notionally, a radio altimeter in-service upgrade could require only an interference tolerance compliance demonstration for existing and modified aircraft installations, as opposed to the more expansive and partially redundant means of compliance proposed in the draft AC 20-199, thus expediting approvals where practicable.

In summary, industry supports the FAA's objective of providing compliance guidance for §91.220 and welcomes continued collaboration. To be effective, AC 20-199 should be narrowly focused on §91.220 compliance, aligned with existing certification frameworks, and clearly bounded to avoid unintended expansion of scope.

2. Need for an Advisory Circular Focused on §91.220 Compliance

Industry recognizes and supports the need for an Advisory Circular to provide clarity on acceptable means of compliance for §91.220. Given the scope and fleet-wide nature of the proposed requirements, a common reference framework is appropriate and valuable. That said, while an AC is warranted, the draft AC 20-199 in its current form raises concerns regarding scope and applicability.

3. §91.220 Specific Compliance Concepts Are Directionally Sound but Require Refinement

Figure 1 - Page 1 of Aviation Response to FAA Advisory Circular 20-199

The portions of the draft AC 20-199 that explicitly address §91.220 compliance demonstrations are viewed as directionally sound at a conceptual level. These sections appropriately recognize interference-related installation considerations relevant to the rule.

However, additional refinement and clarification are needed to ensure consistency with existing certification practices and to remove ambiguity in interpretation. Industry believes these refinements are best addressed through individual organizational comments, which provide the necessary technical specificity.

4. Significant Concerns with Content Beyond §91.220 Compliance

Industry has significant concerns with any AC content that extends beyond what is necessary to demonstrate §91.220 compliance. As drafted, portions of AC 20-199 could be interpreted as introducing new or expanded expectations related to aircraft-level certification, system performance demonstrations, or testing activities unrelated to interference mitigation.

Beyond what is necessary to demonstrate §91.220 compliance, existing FAA guidance for change impact analyses is sufficient to allow design approval holders to identify and complete necessary certification activities. Additional and duplicative material in the AC-20-199 draft risks introducing substantial complexity, certification uncertainty, and execution risk, particularly for retrofit programs. These impacts would jeopardize achievable implementation timelines without a commensurate safety benefit. Clear scoping of the AC to address §91.220 specific compliance is therefore essential.

We appreciate the FAA's consideration of these framing comments and look forward to continued engagement as the AC is refined.

Respectfully submitted,

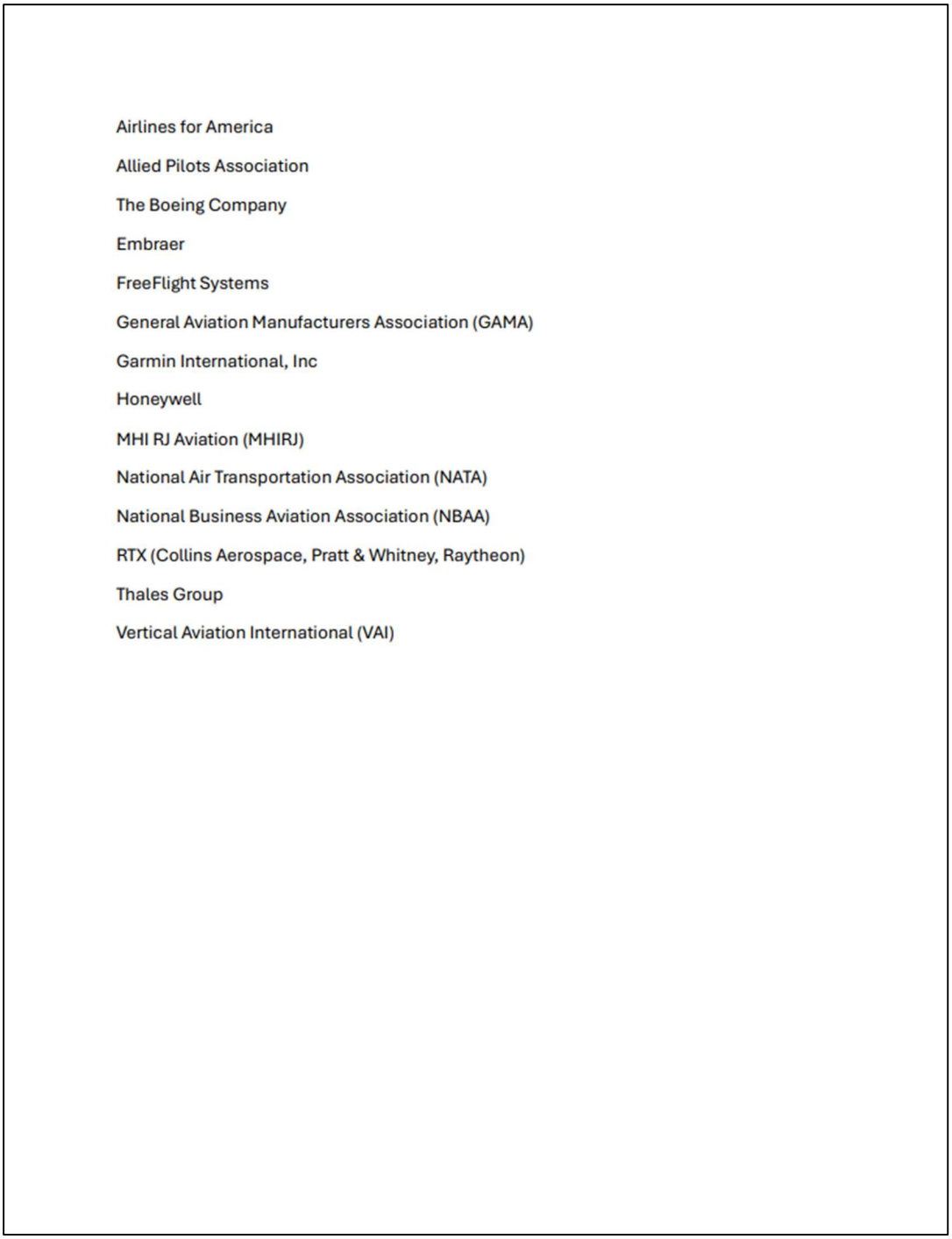
Signatories:

Aerospace Industries Association (AIA)

Airbus Helicopters

Aircraft Electronics Association (AEA)

Figure 2 - Page 2 of Aviation Response to FAA Advisory Circular 20-199



Airlines for America

Allied Pilots Association

The Boeing Company

Embraer

FreeFlight Systems

General Aviation Manufacturers Association (GAMA)

Garmin International, Inc

Honeywell

MHI RJ Aviation (MHIRJ)

National Air Transportation Association (NATA)

National Business Aviation Association (NBAA)

RTX (Collins Aerospace, Pratt & Whitney, Raytheon)

Thales Group

Vertical Aviation International (VAI)

Figure 3 - Page 3 of Aviation Response to FAA Advisory Circular 20-199

EXHIBIT 1

DESCRIPTIONS OF THE JOINT AVIATION COMMUNITY COMMENTATORS

Aerospace Industries Association ("AIA") represents hundreds of aerospace and defense companies, from America's leading manufacturers and developers of commercial aircraft, engines, avionics, and air traffic control systems to family-owned businesses across the supply chain.

Air Line Pilots Association, International ("ALPA") represents and advocates for more than 80,000 pilots at 42 U.S. and Canadian airlines, making it the world's largest airline pilot union. ALPA provides three critical services to its members: airline safety, security, and pilot assistance; representation; and advocacy.

Airbus is a global pioneer in the aerospace industry, operating in commercial aircraft, helicopters, defence and space sectors. The Company is a leader in designing, manufacturing and delivering aerospace products, services and solutions to customers on a worldwide scale.

Aircraft Electronics Association ("AEA") represents over 1,300 member companies in more than 40 countries specializing in the manufacturing, maintenance, repair and installation of aircraft electronics systems in general aviation aircraft.

The Aircraft Owners and Pilots Association ("AOPA") is a not-for-profit individual membership organization of General Aviation Pilots and Aircraft Owners. AOPA's mission is to effectively serve the interests of its members and establish, maintain and articulate positions of leadership to promote the economy, safety, utility, and popularity of flight in General Aviation aircraft. Representing two-thirds of all pilots in the United States, AOPA is the largest civil aviation organization in the world.

Airlines for America ("A4A") is the trade association for the leading U.S. airlines, both passenger and cargo carriers, prioritizing safety and security during this time of record passenger volumes and increased reliance on air cargo shipments. Every day, U.S. airlines operate 27,000 flights carrying 2.7 million travelers and 61,000 tons of cargo while supporting 10 million U.S. jobs and 5 percent of GDP.

Headquartered in Fort Worth, Texas, near Dallas/Fort Worth International Airport, the Allied Pilots Association ("APA") serves as the certified collective bargaining agent for the 16,000 professional pilots who fly for American Airlines. Founded in 1963, APA is the largest independent pilots' union in the world. APA provides a broad range of representation services for its members and devotes a significant portion of its members' dues to advancing the cause of aviation safety.

Aviation Spectrum Resources, Inc (“ASRI”) is the communications company of the U.S. air transport industry and is owned by many of the major U.S. airlines and other airspace users. ASRI draws upon expertise and opinions from across the U.S. aviation sector to act in the interests of safe and efficient operation of commercial aviation radio communications systems in the radio frequency spectrum.

The Boeing Company is a leading global aerospace company and top U.S. exporter, Boeing develops, manufactures and services commercial airplanes, defense products and space systems for customers in more than 150 countries. With corporate offices near Washington, D.C., Boeing employs more than 170,000 people across the United States and in more than 65 countries.

The Cargo Airline Association (“CAA”) represents the major U.S. all-cargo and express airlines to promote the safety, security, and economic growth of the air cargo market. Our carriers collectively operate in over 220 countries and territories, employing over 500,000 people and accounting for 35% of global trade value, using aircraft of various types and sizes depending on the route, airport, and cargo being transported.

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FreeFlight Systems is a leader in NEXGEN aviation systems that designs and manufactures high-performance avionics with a deep-rooted history specifically in Radar Altimeter technology that enhances flight safety. Our solutions deliver substantial safety and unmatched reliability, which are critical for modern flight operations. Founded in 2001 and based in Texas, we pioneered the first certified aviation WAAS/GPS receiver and the first UAT Link 2 compliant ADS-B transmitter system. Today, FreeFlight Systems is a global aerospace leader, specializing in state-of-the-art radio altimeters, surveillance applications and navigation retrofit and line-fit solutions, along with other NextGen aerospace avionics.

Garmin International, Inc., together with its worldwide affiliates, is a leading, worldwide manufacturer of radio altimeters and other products that are enabled by radio altimeters for the aviation industry. These products serve their customers and support aviation operations in general aviation, business aviation, and other aviation sectors throughout the world.

The General Aviation Manufacturers Association (“GAMA”) represents over 150 of the world's leading manufacturers of business and general aviation airplanes, rotorcraft, engines, avionics, components and companies in the emerging sector of innovative/advanced air mobility. GAMA's members also operate repair stations, fixed based operations, pilot and maintenance training facilities and manage fleets of aircraft.

The Gulfstream Aerospace Corporation is an original equipment designer and manufacturer of transport category business aircraft.

The International Air Transport Association ("IATA") is the trade association of the world's airlines, representing some 360 airlines, more than 100 of which serve the U.S. market. IATA works with its U.S. and foreign airline members to promote safe, reliable, and secure air travel.

Lockheed Martin Corporation is a manufacturer and integrator of military, civil, and commercial fixed-wing aircraft and rotorcraft for both domestic and foreign operators.

The National Air Transportation Association ("NATA") represents nearly 3,700 aviation business locations across a broad cross-section of the aviation industry, including on-demand air charter carriers and fractional ownership companies, maintenance providers, fixed-base operators, flight training providers, general aviation airports, and other key industry stakeholders. For more information, please visit NATA's website at https://nata.aero/.

The National Business Aviation Association ("NBAA") is the leading organization representing companies that rely on general aviation aircraft to help make their businesses more efficient, productive, and successful. The association represents more than 11,000 member companies and professionals operating in the National Airspace System.

Regional Airline Association ("RAA") provides a unified voice of advocacy for North American regional airlines aimed at promoting a safe, reliable, and strong regional airline industry. Regional airlines are critically important to our country's economic health and provide the lone source of scheduled passenger air service for about two-thirds of the country's airports. Regional airlines carried more than 121 million passengers last year, providing most of the connections to our nation's non-hub and small-hub airports. RAA members use specialized, small equipment to serve communities that have too few passengers to support air service with larger aircraft, but where air service is critical to economic vitality and quality of life.

RTX is the world's largest aerospace and defense company. With more than 185,000 global employees, we push the limits of technology and science to redefine how we connect and protect our world. Through industry-leading businesses – Collins Aerospace, Pratt & Whitney and Raytheon – we are advancing aviation, engineering integrated defense systems for operational success, and developing next-generation technology solutions and manufacturing to help global customers address their most critical challenges. The company, with 2024 sales of more than $80 billion, is headquartered in Arlington, Virginia.

Thales Group is a global technology leader with more than 83,000 employees on five continents. In the markets of Defence, aerospace and space, cyber and digital, Thales provides solutions, services and products to help its customers – companies, organizations and governments – to carry out their critical missions. Thales multiple avionics solutions include Radio Altimeters for aviation.

Vertical Aviation International ("VAI") is the trade association for the civil vertical aviation industry, representing more than 1,000 aviation businesses and 15,000 aviation professionals in 75 nations. VAI is dedicated to fueling the growth of the vertical aviation industry through connection, education, advocacy, and safety so that communities around the world are strengthened by the power of vertical flight.