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**DEPARTMENT OF TRANSPORTATION**

**Federal Aviation Administration**

**14 CFR Part 39**

**[Docket No. FAA-2022-1647; Project Identifier AD-2022-01379-T; Amendment 39-22438; AD 2023-10-02]**

**RIN 2120-AA64**

**Airworthiness Directives; Transport and Commuter Category Airplanes**

**AGENCY:**

Federal Aviation Administration (FAA), DOT.

**ACTION:**

Final rule.

**SUMMARY:**

The FAA is superseding Airworthiness Directive (AD) 2021-23-12, which applied to all transport and commuter category airplanes equipped with a radio (also known as radar) altimeter. AD 2021-23-12 required revising the limitations section of the existing airplane/aircraft flight manual (AFM) to incorporate limitations prohibiting certain operations requiring radio altimeter data when in the presence of 5G C-Band interference as identified by Notices to Air Missions (NOTAMs). Since the FAA issued AD 2021-23-12, the FAA determined that additional limitations are needed due to the continued deployment of new 5G C-Band stations whose signals are expected to cover most of the contiguous United States at transmission frequencies between 3.7-3.98 GHz. For certain airplanes, this AD requires revising the limitations section of the existing AFM to incorporate limitations prohibiting certain operations requiring radio altimeter data, due to the presence of 5G C-Band interference. This AD also requires modifying certain airplanes to allow safe operations in the U.S. 5G C-Band radio frequency environment. The FAA is issuing this AD to address the unsafe condition on these products.

**DATES:**

This AD is effective May 26, 2023.

**ADDRESSES:**

*AD Docket:* You may examine the AD docket at [regulations.gov](https://www.regulations.gov) under Docket No. FAA-2022-1647; or in person at Docket Operations between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays. The AD docket contains this final rule, any comments received, and other information. The address for Docket Operations is U.S. Department of Transportation, Docket Operations, M-30, West Building Ground Floor, Room W12-140, 1200 New Jersey Avenue SE, Washington, DC 20590.

**FOR FURTHER INFORMATION CONTACT:**

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**SUPPLEMENTARY INFORMATION:**

**Background**

The FAA issued a notice of proposed rulemaking (NPRM) to amend [14 CFR part 39](#) to supersede AD 2021-23-12, Amendment 39-21810 ([86 FR 69984](#), December 9, 2021) (AD 2021-23-12). AD 2021-23-12 applied to all transport and commuter category airplanes equipped with a radio (also known as radar) altimeter. The NPRM published in the **Federal Register** on January 11, 2023 ([88 FR 1520](#)). The NPRM was prompted by the determination that radio altimeters cannot be relied upon to perform their intended function if they experience 5G C-Band interference.

In the NPRM, the FAA proposed to maintain the requirements of AD 2021-23-12, except for the limitations pertaining to Required Navigation Performance with Authorization Required (RNP AR) instrument approach procedures (IAPs), by requiring revising the existing AFM to incorporate limitations prohibiting certain operations in the presence of 5G C-Band wireless broadband interference as identified by NOTAM. Alternatively, the FAA proposed to allow operators to retain the AFM revision required by paragraph (g) of AD 2021-23-12. The FAA also proposed, on or before June 30, 2023, to require revising the existing AFM to incorporate limitations prohibiting these same operations at all airports for non-radio altimeter tolerant airplanes. For radio altimeter tolerant airplanes, the prohibited operations would be allowed at 5G C-Band mitigated airports (5G CMAs) as identified in an FAA Domestic Notice.

Lastly, the FAA proposed, on or before February 1, 2024, to require that airplanes operating under [14 CFR part 121](#) be modified from a non-radio altimeter tolerant airplane to a radio altimeter tolerant airplane. The FAA proposed this AD because radio altimeter anomalies that are undetected by the automation or pilot, particularly close to the ground (e.g., landing flare), could lead to loss of continued safe flight and landing. Additionally, radio altimeter anomalies could lead to increased flightcrew workload and flightcrew desensitization to warnings.

**Discussion of Final Airworthiness Directive**

**Comments**

The FAA provided the public with an opportunity to comment on the proposed AD and received 82 submissions to Docket No. FAA-2022-1647. The FAA received comments from individual commenters as well as from organizations. The majority of the comments were from organizations such as the International Air Transport Association (IATA), Airlines for America (A4A), the Cargo Airline Association, the Aerospace Industries Association (AIA), the Air Line Pilots Association, International (ALPA), the Allied Pilots Association, the Regional Airline Association (RAA), CTIA-The Wireless Association (CTIA), and the American Association of Airport Executives (AAAE); manufacturers such as Airbus DS (Airbus Defence and Space), Airbus SAS (Airbus), The Boeing Company (Boeing), MHI RJ Aviation ULC (MHI RJ), Gulfstream Aerospace Corporation (Gulfstream), Bombardier Inc. (Bombardier), Textron Aviation (Textron), and Thales; and operators such as Atlas Air, Inc. (Atlas), Frontier Airlines (Frontier), Southwest Airlines, and Virgin Atlantic Airways.

The following summarizes the comments received on the NPRM, and provides the FAA's responses.

## **A. Support for the NPRM**

CTIA supported the NPRM without change.

## **B. Alternative Methods of Compliance (AMOCs)**

### **1. Request for Continued NOTAMs and AMOCs**

*Comment summary:* Some commenters asked if the FAA will continue approving AMOCs for radio altimeter tolerant airplanes at non-5G CMAs consistent with the process used for AD 2021-23-12. Airbus Defence and Space asked whether the FAA will still allow AMOCs between July 1, 2023, and January 31, 2024. One commenter asked whether the FAA will take into account the availability of a certified solution before ceasing to process new AMOCs and, if not, when will FAA stop processing AMOCs for non-radio altimeter tolerant airplanes. Other commenters requested that the FAA continue to use NOTAMs and AMOCs until relevant airplanes are retrofitted. Airbus asked when the FAA will stop issuing NOTAMs for identification of the 5G environment.

*FAA response:* Since the publication of the NPRM, the FAA has conducted further analysis of possible 5G C-Band interference to radio altimeter tolerant airplanes at non-5G CMAs and has determined that the risks associated with category (CAT) I autoland, CAT I head-up display (HUD) to touchdown, and enhanced flight vision system (EFVS) to touchdown operations, are mitigated to an acceptable level. The FAA found a lower-than-expected likelihood of interference because of current tower locations, a high percentage of flat terrain around airports, and the expectation that future tower locations will impose no additional interference than current towers do. Risks associated with CAT II/III, SA CAT I, and SA CAT II have been mitigated at non-5G CMAs because all current CAT II/III and SA CAT I/II operations are only at 5G CMAs.<sup>[1]</sup> Therefore, the FAA has determined that radio altimeter tolerant airplanes may conduct these operations at all airports in the contiguous U.S. without limitation.<sup>[2]</sup> As a result, there is no need to use a domestic notice to identify specific airports where radio altimeter tolerant airplanes can perform these procedures. The FAA has removed the references to 5G CMAs and Domestic Notices from the regulatory requirements of this final rule.

NOTAMs identifying the 5G environment are no longer practical because the environment is expected to cover most of the contiguous U.S. In addition, limitations required by this AD apply to non-radio altimeter tolerant airplanes at all airports in the contiguous U.S. For those airplanes, the FAA has determined that the AMOC process used for AD 2021-23-12, which included generating monthly cleared runway lists based on base station data for non-5G CMAs, will be untenable beyond June 30, 2023, due to complexities associated with the continued operational expansion of 5G C-Band emissions.

### **2. Request for Alternative Mitigation**

*Comment summary:* Thales requested that the proposed AD be revised to allow for other mitigations at the airplane level, based on airplane-level architecture, including alerts and crew procedures related to radio altimeter NCD (no computed data) or failure. Thales stated that radio altimeter compliance with the tolerances specified in paragraphs (g)(2)(i) and (ii) of the proposed AD is not the only way to prevent the unsafe condition. Additionally, Airbus Defence and Space stated that it expected stronger operations limitations for non-radio altimeter tolerant airplanes, rather than full prohibition of the operations.

*FAA response:* Although the FAA acknowledges that there may be other ways to prevent the unsafe condition, the alternatives proposed by the commenters must be evaluated on a case-by-case basis to determine an acceptable level of safety. Because including such language to address all airplane type designs would not be feasible in this AD, anyone may propose alternative actions to address the unsafe condition under the AMOC procedures referenced in paragraph (k) of this AD.

### **3. Request To Clarify Credit for Prior AMOCs**

*Comment summary:* Bombardier stated that the existing AMOC methodology remains valid, and therefore radio altimeter/airplane configurations that receive approved AMOCs for 5G CMAs in June 2023 would meet the definition of radio altimeter tolerant airplanes. Bombardier requested that the FAA clarify whether an FAA-approved AMOC for AD 2021-23-12 is a "method approved by the FAA" for demonstrating that an airplane is a radio altimeter tolerant airplane for purposes of the AFM limitations that would otherwise be required by paragraph (i) of the proposed AD.

*FAA response:* In the NPRM, the FAA proposed that AMOCs approved for AD 2021-23-12 would only be approved for the AFM revision in paragraph (h) of the proposed AD. The FAA approved AMOCs for AD 2021-23-12 before the radio altimeter tolerant PSD (power spectral density) curve proposed in the NPRM was defined. Although the FAA expects that the airplanes with AMOCs approved for AD 2021-23-12 will be able to meet the definition of "radio altimeter tolerant airplane," operators will need to provide the FAA with data showing explicitly that the airplane meets the tolerances in paragraph (g)(2) before the FAA will approve the method they propose to use.

## **C. AFM Limitations**

### **1. Request To Change AFM Limitations**

*Comment summary:* Frontier requested that the AD include language allowing operators to omit any portion of the radio altimeter flight restrictions that is not applicable to the operator, such as HUD and EFVS. Frontier stated that this would eliminate confusion when the specified equipment is not installed in the airplane or the operator is not authorized to utilize the equipment.

*FAA response:* The FAA disagrees, as operators may change or add equipment and approvals at a future time. If an airplane is not equipped or approved for an approach, then the operational restrictions would still broadly apply, but would have no impact to the operator.

### **2. AFM Limitations Inappropriate for General Operational Restrictions**

*Comment summary:* MHI RJ and Air Wisconsin Airlines stated that the AFM limitations section was not the appropriate area to document operational restrictions not related to a specific airplane. An individual commenter suggested that the proposed AFM revision does not follow "FAA AFM criteria." Gulfstream stated that the proposed requirement to revise the AFM with limitations places an unnecessary burden on original equipment manufacturers (OEMs). Gulfstream requested that instead the FAA require that operators obtain Letters of Authorization or operations specifications.

*FAA response:* The FAA disagrees. [14.CFR.91.9](#) prohibits any person from operating a civil aircraft without complying with the operating limitations specified in the AFM. The FAA routinely issues ADs to mandate changes to the limitations section of an FAA-approved AFM for airplanes in service.

### **3. Requests for Different Method of Incorporating AFM Limitations**

*Comment summary:* Bombardier and Gulfstream requested the FAA allow other options for incorporating the proposed limitations into the AFM, due to the complexity of updating entire catalogs of flight manual documentation and authoring, approving, and publishing customized limitations based on the unique configuration and characteristics of each airplane model. Specifically, Bombardier requested that the AD include language to automatically delegate approval of AFM changes to civil aviation authorities; automatically recognize AFM changes that have been approved by Transport Canada Civil Aviation Authority for Bombardier airplane models; and state that airplanes with specific AFM revisions meet the intent of the proposed AD. Lastly, Bombardier requested that the proposed AD allow compliance by either incorporating or referencing an electronic or paper copy of the AD, since Bombardier plans on making an electronic copy of the FAA AD available through the Bombardier flight deck application's supplemental documents function.

*FAA response:* The FAA acknowledges that each owner/operator may have a different method for incorporating revisions into the AFM for its airplanes. This is why the FAA did not propose a specific method of complying with this requirement. As long as the language added to the limitations section of the AFM is identical to the language specified in the applicable figure, owners/operators may make the revision electronically, with pen-and-ink changes, by inserting a copy of the AD, by inserting a copy of the applicable figure, by adopting the OEM's AFM revision, or by any other method. To provide clarification, the FAA has changed paragraphs (h), (i)(1), and (j) (1) of this AD to require including "the information" specified in the figure instead of "the limitations" specified in the figure. With regard to Bombardier's request that the proposed AD be revised to state that Bombardier airplanes meet the intent of paragraph (h) of this AD if they have incorporated certain AFM revisions, the FAA disagrees. Although the requested changes to the proposed AD may minimize some requests for AMOC approvals, including language specific to all possible current and future state-of-design 5G C-Band-related ADs, is out of the scope of the intent of this AD.

*Comment summary:* In order to minimize unnecessary revisions to the AFM language in the future, Bombardier asked the FAA to clarify why the flight restrictions in the figures required by June 30, 2023, are limited to the contiguous U.S. airspace and whether the situation will evolve as various telecommunications companies deploy 5G services in the C-Band outside the contiguous U.S.

*FAA response:* The FAA limited the flight restrictions in the proposed figures to the contiguous U.S. based on Federal Communications Commission (FCC) Report and Order FCC 20-22,<sup>[3]</sup> which identifies radio frequencies and power level conditions for the new C-Band services only in the contiguous lower-48 states. In the event the FCC updates the report and order to include additional states and U.S. territories, the FAA might consider future rulemaking.

### **D. Effect of Winglets on Accomplishment of the Proposed Actions**

*Comment summary:* Aviation Partners Boeing stated that installing winglets under supplemental type certificate (STC) ST00830SE, STC ST01219SE, STC ST01518SE, and STC ST01920SE on applicable Boeing models does not affect accomplishment of the actions specified in the proposed AD.

*FAA response:* The FAA agrees. The FAA has not changed this AD in this regard.

### **E. Clarifications**

#### **1. Request To Clarify Terminology**

*Comment summary:* In the NPRM preamble, the FAA explained that if the unsafe condition is not addressed, it may result in a catastrophic accident, incident, or event. Airbus stated that because "catastrophic" is part of the analysis conducted under [14.CFR.25.1309](#), the FAA's use of it in the NPRM could be misleading. Textron requested that the FAA add language to the unsafe condition statement in paragraph (e) of the proposed AD to clarify the severity of possible failure conditions (catastrophic, hazardous) associated with 5G C-Band interference.

*FAA response:* The FAA used the term "catastrophic" in the preamble of the NPRM to indicate an event that would result in multiple fatalities, usually with loss of the airplane. The unsafe condition statement in paragraph (e) of this AD, which states that radio altimeter anomalies could result in loss of continued safe flight and landing or increased flightcrew workload and desensitization to warnings, is sufficiently clear. No change to this AD is necessary based on these comments.

#### **2. Request To Clarify Relaxation on Non-Precision Approaches (NPAs) to Certain Airports**

*Comment summary:* Qatar Airways referenced the statement in the NPRM that the proposed AD would no longer prohibit RNP AR IAPs and asked whether the FAA was relaxing NPAs for non-radio altimeter-tolerant airplanes other than RNP AR operations to airports with potential 5G C-Band interference.

*FAA response:* NPAs were not included in the list of prohibited operations in AD 2021-23-12, since an NPA is an instrument approach that provides lateral guidance only, and does not rely on radio altimeter inputs. Therefore, this AD does not address NPAs.

#### **3. Request To Clarify Whether Compliance With AD 2021-23-12 Satisfies AFM Revision Requirement**

*Comment summary:* Qatar Airways asked the FAA to clarify the statement in paragraph (h) of the proposed AD that "If an operator has complied with paragraph (g) of AD 2021-23-12, that action satisfies the requirements of this paragraph." The commenter noted that RNP AR IAPs are included in the list of prohibited operations in paragraph (g) of AD 2021-23-12; however, the NPRM states that, after further FAA analysis, those operations would no longer be prohibited by the proposed AD.

*FAA response:* The commenter is correct that the prohibition in paragraph (g) of AD 2021-23-12 includes RNP AR approaches, and the prohibition in paragraph (h) of this AD does not. However, since all of the requirements of paragraph (h) of this AD are included in paragraph (g) of AD 2021-23-12, operators have the option of retaining the AFM revision required AD 2021-23-12 instead of revising the AFM again to comply with paragraph (h) of this AD even though it prohibits RNP AR approaches that are not required by this AD. No change to this AD is necessary based on this comment.

#### **4. Request To Clarify Limitations for Tolerant and Non-Tolerant Airplanes**

*Comment summary:* Singapore Airlines, Airbus Defence and Space, Airbus, Qatar Airways, AIA, AFR, and Air France requested clarification of the limitations for radio altimeter tolerant airplanes and non-radio altimeter tolerant airplanes, as related to 5G CMAAs and non-5G CMAAs. Airbus also requested clarification regarding retrofitting with a 5G tolerant radio altimeter and the effect of a future technical standard order (TSO).

*FAA response:* In the NPRM, the FAA proposed that radio altimeter tolerant airplanes could perform the otherwise prohibited operations at 5G CMAAs, while non-radio altimeter tolerant airplanes would be prohibited from performing those operations at all airports. As explained in section B.1. of this final rule, since the NPRM was published, the FAA has determined that radio altimeter tolerant airplanes may perform the prohibited operations at all airports in the contiguous U.S., as long as the telecommunications companies continue to transmit within mitigated parameters.<sup>[4]</sup> As a result, the FAA has removed paragraph (j) of the proposed AD from this final

rule. The FAA's determination that non-radio altimeter tolerant airplanes will not be able to safely perform the four prohibited operations at any airport remains unchanged.

Some radio altimeters may already demonstrate tolerance to 5G C-Band emissions without modification. Some may need to install filters between the radio altimeter and antenna to increase a radio altimeter's tolerance. For others, the radio altimeter will need to be replaced with an upgraded radio altimeter as established by a new radio altimeter TSO, which will follow the existing international technical consensus on the establishment of the minimum operational performance standards (MOPS). The FAA considers this AD an interim action because additional rulemaking may be necessary once a new radio altimeter TSO is developed, approved, and available.

## 5. Request To Clarify Multiple AFM Limitations

*Comment summary:* Textron asked the FAA to clarify the relationship between the AFM limitation requirements in paragraphs (h) and (i) of the proposed AD.

*FAA response:* As explained in section B.1. of this final rule, since the NPRM was published, the FAA has determined that radio altimeter tolerant airplanes may perform the prohibited operations at all airports in the contiguous U.S. As a result, the FAA has revised this AD so that all of the AFM revisions are required only for non-radio altimeter tolerant airplanes. Those airplanes must incorporate either the limitations in paragraph (h) of this AD or paragraph (g) of AD 2021–23–12 until June 30, 2023. After June 30, 2023, non-radio altimeter tolerant airplanes must replace those limitations with the limitations in paragraph (i) of this AD. For operators of radio altimeter tolerant airplanes, this AD terminates the AFM limitations required by AD 2021–23–12.

## 6. Request To Clarify Applicability for Military Airplanes

*Comment summary:* The Department of Defense requested that the FAA revise the NPRM to clarify that military aircraft, including civil derivatives, are exempt. The commenter stated that the NPRM's reference to part 121 operations creates confusion as to whether the AD applies to civil derivative airplanes operated by the Department of Defense.

*FAA response:* The FAA disagrees. This AD applies to all airplanes with an FAA type certificate in the transport or commuter category, including military surplus airplanes and civil derivatives of military airplanes. To the extent that the AFM revisions required by this AD impose operational restrictions that apply only to civil aircraft, those restrictions do apply to Department of Defense airplanes used in civil operations in the national airspace system.

## 7. Factors Affecting Accomplishment of Required Actions

*Comment summary:* AIA requested that the NPRM preamble be revised to acknowledge that quickly accomplishing alterations depends on many factors, including adequate specification of the replacement equipment and availability of updated equipment.

*FAA response:* The FAA acknowledges that factors including those cited by the commenter impact the ability to accomplish the modification of the radio altimeters as required by this AD. Since the language from the NPRM that the commenter cited does not appear in this final rule, no change to the AD is necessary.

## F. 5G CMAs

*Comment summary:* The FAA received many comments concerning the airports that will be included as a 5G CMA. All Nippon Airways requested the FAA establish a system that allows radio altimeter tolerant airplanes to operate at all U.S. airports without restrictions. MHI RJ, Thales, Airbus, Qatar Airlines, Japan Airlines, ALPA, and two individual commenters asked for information about the list of 5G CMAs. Aerologic, Emirates Airline, Atlas, the Department of Defense, and the Cargo Airline Association requested the FAA expand the list to include as many airports as possible. Multiple commenters, including A4A, Boeing, Airbus, AIA, ALPA, RAA, and the Cargo Airline Association, requested clarification of the criteria used to determine the 5G CMAs. Thales, Airbus, Allied Pilots Association, AIA, ALPA, Gulfstream, and AAAE requested guidance for safe aviation operations at non-5G CMAs.

*FAA response:* As mentioned in section B.1. of this final rule, since the NPRM was published, the FAA conducted further analysis of possible 5G C-Band interference with radio altimeter tolerant airplanes and determined that radio altimeter tolerant airplanes are not susceptible to the 5G C-Band interference this AD is addressing. Therefore, this AD will not require operators of radio altimeter tolerant airplanes to revise their AFM to prohibit the low-visibility operations proposed in the NPRM. The FAA has revised this final rule accordingly.

## G. Compliance Time

*Comment summary:* While CTIA agreed with the FAA's proposed compliance times, China Airlines, SkyWest Airlines, Embraer S.A., Airbus Defence and Space, the Association of Asia Pacific Airlines, Qatar Airways, Endeavor Air, Virgin Atlantic Airways, Atlas Air, ATR, Gulf Air Group, the Cargo Airline Association, Air Wisconsin Airlines, Lynden Air Cargo, EVA Airways, AAAE, A4A, RAA, and an individual commenter expressed concern, with many stating that modification of the fleet would not be achievable by June 30, 2023, or by February 1, 2024. The commenters requested extensions ranging from three months to two years, based on the size of each operator's fleet and availability of parts.

*FAA response:* The FAA carefully considered the impact of the loss of low-visibility operations on the remaining unmodified fleet after June 30, 2023, and did not take the decision to prohibit these operations lightly. The June 30, 2023, date was driven by the unsafe condition over which the FAA has no control. After refraining from operating at their FCC-authorized levels for a year and a half, wireless companies are now able to operate at higher levels, yet still not at the levels authorized. Specifically, wireless companies expect to operate their networks in urban areas with minimal restrictions due to the completion of retrofits.<sup>[5]</sup> Additionally, the FAA anticipates 19 additional telecommunication companies will begin transmitting in the C-Band after June 30, 2023. Although the FAA continues to work with the companies that intend to transmit in the 3.7–3.98-GHz band near 5G CMAs, the FAA has no agreement with those companies to provide the FAA with tower locations and other information necessary to support the current NOTAM/AMOC process. Therefore, the FAA will not be able to extend the June 30, 2023, date.

The FAA re-evaluated the February 1, 2024, date based on the latest radio altimeter equipage data and determined that an extension is not justified. The only airplanes operating under part 121 that are forecast to be at risk of not being equipped by February 1, 2024, are approximately 164 transport category airplanes that have older radio altimeters with no support from the airplane OEMs or radio altimeter manufacturers. Operators of those airplanes will need to make a business decision to equip with later model radio altimeters or retire those airplanes from part 121 operations, as after February 1, 2024, this AD prohibits unmodified airplanes from operating under part 121 in the contiguous U.S. The FAA and its foreign civil aviation authority partners plan to expedite radio altimeter approvals for both part 121 and part 129 operators, and the FAA has used means such as approved model list (AML) STCs to help with equipage.

In addition, because some airplanes operate under part 121 solely outside of the contiguous U.S. airspace where the AD's requirements do not apply, the FAA has revised figure 4 to paragraph (i) of this AD to include a prohibition that states, "As of February 1, 2024, [non-radio altimeter tolerant airplanes] must not operate under [14 CFR part 121](#) in the contiguous U.S." The FAA has also revised paragraph (k) of the NPRM (paragraph (j) of this AD) from a modification requirement to a terminating action for airplanes that have been modified to radio altimeter tolerant airplanes by allowing for the removal of the limitations from the AFM.

## H. Costs

## 1. Small Business Status for Business Airplanes

*Comment summary:* One commenter stated that the vast majority of business airplane operators under part 91 are small businesses as defined by the Small Business Administration (SBA). The commenter requested that the FAA not underestimate the choice small businesses will have to make between an \$80,000 retrofit and loss of utility of the airplane during adverse weather conditions.

*FAA response:* The FAA has complied with the Regulatory Flexibility Act for this AD and analyzed its impact on small businesses. However, the FAA has identified an unsafe condition for which the agency could not identify an appropriate alternative that sufficiently addresses the safety problem. Further information regarding that analysis is provided in section 2. of the Regulatory Flexibility Determination of the preamble of this final rule.

## 2. Costs Underestimated for Legacy Airplanes

*Comment summary:* Lynden Air Cargo commented that the NPRM underestimates the cost of modification for legacy airplanes that are no longer in the “as-delivered” configuration and therefore lack support from the OEM. The commenter stated there are significant costs associated with the research and development, approval, and type design amendment for new equipment.

*FAA response:* The FAA acknowledges that the certification cost is not included in the estimate in this final rule. The FAA appreciates the impact on operators of legacy fleets that do not have the support of the airplane OEM. The FAA has been issuing letters accepting 5G C-Band-resistant test data from the holders of TSO authorizations (TSOAs) in order to assist independent entities in seeking approval in situations like these to mitigate the cost impact. These letters are available through the TSOA holders.

Regarding Lynden Air Cargo's comment on additional significant costs, that comment is addressed in section 2. of the Regulatory Flexibility Determination in the preamble of this AD. The FAA did not change this AD as a result of this comment.

## 3. Request To Include Indirect Costs

*Comment summary:* Some commenters requested that FAA include costs associated with development and certification, as well as with operational impacts of the proposed AD such as delayed and canceled flights.

*FAA response:* These comments are addressed in section 2. of the Regulatory Flexibility Determination in the preamble of this AD. The FAA did not change this AD as a result of these comments.

## 4. Request To Consider Costs for Non-Part 121 Operations

*Comment summary:* Textron commented that the FAA's estimated costs almost exclusively addressed part 121 operations. Textron asked whether airplanes that do not operate under part 121 are affected by the prohibited operations and requested that the FAA include those airplanes in the cost analysis.

*FAA response:* While part 121 operators own most of the affected airplanes and bear the greatest cost associated with this AD, the FAA is aware of the impact on other operators who choose not to modify their airplanes to become radio altimeter tolerant. Regarding Textron's request to include the cost of the impact of restricted operations for those airplanes, that comment is addressed in section 2. of the Regulatory Flexibility Determination in the preamble of this AD. The FAA did not change this AD as a result of these comments.

## 5. Work-Hours Underestimated for AFM Updates

*Comment summary:* Bombardier and an individual stated that the estimated cost of 1 work-hour per airplane at \$85 per hour for revising an AFM was too low.

*FAA response:* These comments are addressed in section 2. of the Regulatory Flexibility Determination in the preamble of this AD. The FAA did not change this AD as a result of these comments.

## 6. Cost Impact on Part 129 Operators

*Comment summary:* IATA stated the FAA's cost estimate is vastly understated because it does not include costs for airplanes operating under part 129. Ten other commenters agreed with IATA's comments.

*FAA response:* Although the FAA acknowledges and appreciates the costs of retrofit for part 129 operators, the FAA did not include costs for airplanes operating under part 129 because this AD does not impose any requirements on non-U.S. registered airplanes operating into the United States under part 129. Under International Civil Aviation Organization (ICAO) Annex 8, Airworthiness of Aircraft, the state of registry of an airplane is the state responsible for its airworthiness. For this reason, FAA ADs apply only to U.S.-registered airplanes.

## 7. Inquiry Regarding Payment for Additional Upgrades

*Comment summary:* Emirates requested that, in the event additional upgrades are needed due to the telecommunications companies not following their voluntary agreements, the telecommunications companies should be responsible for the cost of the upgrades.

*FAA response:* The FAA, as a federal agency, is responsible for all directives, policies, and mandates issued under its authority. The FAA does not have the authority to require telecommunications companies to bear costs incurred in modifying privately owned aircraft.

## 8. Request To Revise Costs for Filters

*Comment summary:* SkyWest Airlines requested that the FAA re-evaluate the part and labor costs for filter installation.

*FAA response:* This comment is addressed in section 2. of the Regulatory Flexibility Determination in the preamble of this final rule.

## 9. Request To Revise Cost Estimate Including Equipment To Meet Tolerant Criteria

*Comment summary:* Airbus and the Cargo Airline Association stated the FAA's cost estimate is too low. These commenters requested that the FAA reconsider the cost estimate, including conducting a regulatory evaluation, but did not provide cost data. Bombardier requested that the FAA include a cost estimate for operators who are not required to equip with an updated radio altimeter but chose to voluntarily do so.

*FAA response:* The FAA's cost evaluation reflects both a cost per product and an estimated fleet cost, which the agency based on feedback from airplane manufacturers, radio altimeter manufacturers, and airlines. The FAA did conduct a regulatory evaluation in both the NPRM and this final rule. Further information regarding that



analysis is provided in the Regulatory Flexibility Determination section of the preamble of this final rule. As explained in section 2. of the Regulatory Flexibility Determination, based on feedback from other commenters, the FAA has revised some of the cost estimates in this final rule.

## **I. Domestic Notice**

*Comment summary:* Many commenters expressed concern about the use of a Domestic Notice in the proposed AD and the additional burden it would create for operators, as there is no routine subscription and notification process for Domestic Notices (as there is with NOTAMs). British Airways, Qatar Airways, A4A, Boeing, AIA, ALPA, AAAE, and EVA Airways requested guidance on the process and revision cycle for the FAA 5G C-Band Domestic Notice. Qatar Airways and Virgin Atlantic Airways asked how the FAA 5G C-Band Domestic Notice will be disseminated to foreign-registered operators.

*FAA response:* As explained in section B.1. of this final rule, since the NPRM published, the FAA performed additional analysis and determined that radio altimeter tolerant airplanes may conduct operations at all airports in the contiguous U.S. without the limitations imposed by this AD. As a result, there is no need to identify specific airports where the radio altimeter tolerant airplanes may operate. The FAA has removed the references to the FAA 5G C-Band Domestic Notice from the regulatory text of this final rule.

## **J. FCC Codification**

*Comment summary:* Many commenters expressed concern that the FAA does not have authority to enforce the voluntary agreements between the FAA and the telecommunications companies and questioned the possible impacts if those companies stop honoring the agreements or change their position. Airbus and Bombardier requested the FAA provide additional information about the time duration of the agreements. Several of these commenters asked the FAA to verify that the additional 19 telecommunications companies will also voluntarily agree to these mitigations. Several commenters urged the FAA, the FCC, and the National Telecommunications and Information Administration (NTIA) to work together to develop binding long-term agreements. CTIA, however, stated that the voluntary and coordinated approach has proven successful for this issue so far and noted that the wireless industry will continue to engage with the FAA and aviation industry.

*FAA response:* The commenters are correct that the agreements between the FAA and the telecommunications companies have been voluntary because the FAA does not have enforcement authority over the companies' use of licenses they receive from the FCC. However, the FAA, NTIA, and FCC have worked extensively and collaboratively with the licensees to ensure that the agreements confirm necessary notification and coordination, that mitigations are in place with network deployments, and that the agreements are enforceable by the FCC. These March 31, 2023, voluntary agreements allow the FAA to continue to address aviation safety by coordinating 5G C-Band effective isotropic radiated power (EIRP) reductions when analysis indicates that a proposed base station will exceed the permitted PSD values in the runway safety zone of a 5G CMA runway, which ensures the FAA can protect SA CAT I, SA CAT II, CAT II, and CAT III approach operations without limitations.

The FAA will continue to work with the FCC and NTIA in this regard to ensure continuing aviation safety. As stated in the voluntary agreement letter dated March 31, 2023, AT&T, T-Mobile, UScellular, and Verizon's commitment will last until January 1, 2028, at which point it will sunset unless extended or reduced by mutual agreement. A mid-term check-in involving the FAA, the FCC, and telecommunications companies will occur in July 2026 to assess the status of aviation's long-term migration to next-generation radio altimeters and the need for the sustainment of these commitments.

## **K. Special Flight Permit Provisions**

*Comment summary:* Go Jet Airlines and RAA asked whether the FAA will issue special flight permits to allow operators to ferry airplanes to a location to perform a radio altimeter upgrade.

*FAA response:* As provided in [14 CFR 39.23](#), the FAA may issue a special flight permit to allow operators to fly their airplane to a repair facility to perform work required by an AD unless the AD states otherwise. Because this AD does not prohibit or limit the issuance of special flight permits, they are allowed.

## **L. Interference Reports**

*Comment summary:* In the NPRM, the FAA stated it had received over 420 reports of radio altimeter anomalies within a known location of a 5G C-Band deployment. Airbus and CTIA requested the FAA provide the number of reports of radio altimeter anomalies collected by the FAA in the same period of time in a comparable area before the deployment of 5G base stations. IATA and CTIA requested the FAA share the approximately 100 reports of possible radio altimeter interference so carriers can better understand and address the unsafe condition. CTIA suggested the public would benefit from understanding the connection between the data and the nature and scope of any coexistence concerns. CTIA further suggested it would be helpful to understand how those factors have been evaluated, how often reports in other contexts are found to be unattributable, and what findings the FAA makes in those other circumstances.

*FAA response:* The FAA received the reports referenced in the NPRM from various sources and first determined which reports were associated with radio altimeter-related systems in the vicinity of 5G C-Band emitters. The FAA then reviewed all supporting information (e.g., maintenance data, aircraft and airport trends, and event description), and closed reports where the event was due to maintenance, other interference, or insufficient data. Because the FAA lacks the means to definitively attribute a particular event to 5G C-Band interference, the FAA determined that for the remaining events, 5G C-Band interference could not be ruled out.

To the extent some commenters requested comparable data from before and after the deployment of 5G C-Band base stations, no such data exists. The FAA did not collect 5G C-Band interference report data prior to activation of the C-Band. Therefore, a direct comparison is not possible.

## **M. Non-Part 121 Flights**

### **1. Request To Clarify Requirements for Airplanes Not Operating Under Part 121**

*Comment summary:* Numerous commenters asked about the proposed requirements for airplanes not operating under part 121. AIA and five other commenters asked why the modification is not required for airplanes not operating under part 121, as all airplanes will see degraded capabilities if the radio altimeter is not retrofitted. Singapore Airlines requested that the FAA explain figure 3 to paragraph (i) of the proposed AD, and whether airplanes not operating under part 121 can perform Instrument Landing System (ILS) CAT I IAPs after February 1, 2024. Gulfstream and Bahamasair requested clarification of the FAA's intent for future rulemaking to impose a modification requirement for part 91 and part 135 operators.

*FAA response:* After June 30, 2023, this AD prohibits all transport and commuter category airplanes, regardless of the type of operation (part 91, part 135, part 121, etc.), from performing certain low-visibility landing operations at any airport (as specified in figure 4 to paragraph (i) of this AD) unless they have upgraded their radio altimeters. Airplanes without upgraded radio altimeters will be able to operate into any airport, but cannot fly the prohibited low-visibility operations. For airplanes that do not operate under part 121, these restrictions, as well as the option to equip with an upgraded radio altimeter, remain unchanged after February 1, 2024.

Only airplanes operating under part 121, in the contiguous U.S., must have a 5G C-Band-compatible radio altimeter (or install a retrofit) prior to February 1, 2024. The FAA proposed this requirement to address the accumulating risk for systems that are less hazardous than low-visibility landings (for example, repeated false warnings

from the collision avoidance system from erroneous radio altimeter data). The FAA determined that this accumulating risk will reach unacceptable levels for part 121 operations in the contiguous U.S. after February 1, 2024. The FAA does not anticipate future rulemaking until a TSO standard for radio altimeters is established.

## 2. Request To Clarify Part 129 Requirements

*Comment summary:* Eleven commenters asked for clarification of the proposed AD with regard to airplanes operating under [14 CFR part 129](#). British Airways, Virgin Atlantic Airways, and Qatar Airways asked the FAA to explain the proposed requirements for airplanes operating under part 129. The Association of Asia Pacific Airlines requested that the FAA extend the proposed compliance date for part 129 operators. Boeing requested that the FAA require the proposed modification for part 129 operators. Singapore Airways commented that the risk and unsafe condition described in the NPRM would likely prompt the FAA's foreign counterparts to mandate the upgrade to a radio altimeter-tolerant airplane when operating in U.S. airspace and asked for clarification that non-radio altimeter tolerant airplanes operating under part 129 could continue to use CAT I ILS approaches after February 1, 2024. Airbus Defence and Space asked what the process would be for foreign manufacturers and operators if the FAA's foreign counterparts do not adopt the FAA's AD. A4A stated concern that the FAA is considering different standards for domestic operators versus foreign operators, which does not reflect a "safety first" approach.

*FAA response:* This AD does not impose any requirements, including CAT I ILS, on non-U.S.-registered airplanes operating into the U.S. under part 129. Under ICAO Annex 8, Airworthiness of Aircraft, the state of registry of an airplane is the state responsible for its airworthiness. For this reason, FAA ADs apply only to U.S.-registered airplanes. To the extent the FAA's bilateral partners agree with the FAA's finding of an unsafe condition in U.S. airspace, the FAA encourages those authorities to adopt the FAA AD or similar requirements as mandatory continuing airworthiness instructions for airplanes registered in other countries. The FAA also plans to publish information in the FAA's Aeronautical Information Publication to alert international operators to the 5G C-Band situation in the U.S., including the agency's use of Domestic Notices. The FAA strongly urges operators of foreign-registered airplanes to voluntarily comply with the actions required by this AD when operating in the contiguous U.S. given the unsafe condition affects their airplanes as much as the airplanes subject to this AD.

## 3. Burden of Modification Requirement on Part 129 Operators

*Comment summary:* IATA commented that the part 129 carriers are being disadvantaged by the proposed requirement to retrofit airplanes with an upgraded radio altimeter. Specifically, IATA stated that radio altimeter manufacturers are understandably prioritizing the equipment needs of the U.S. fleet over non-U.S. air carriers; IATA also referred to the FAA's exclusion of part 129 carriers from the roundtable discussions the FAA has held to consult with impacted carriers on the overall issue of 5G C-Band. Lufthansa Group, A4A, and ten other commenters (air carriers and trade associations) expressly agreed with IATA or stated similar concerns. Singapore Airways stated that the required modification will worsen the supply chain issue with upgraded radio altimeters.

*FAA response:* Although supply chain disparities and issues are business matters beyond the authority of the FAA, the agency has worked with radio altimeter manufacturers and airplane operators to help ensure that filters and replacement units are available as quickly as possible. The FAA is aware of these issues and acknowledges the concerns regarding supply chain disruptions; however, due to the reliance on the radar altimeter inputs for low-visibility landings and the impending changes discussed in this final rule, the FAA has determined that the restrictions are necessary to correct the unsafe condition discussed in this AD.

To the extent that the commenters expressed concern about the roundtable discussions, those discussions have been an overall collaboration among the many stakeholders affected by 5G C-Band deployment (U.S. federal agencies, the aerospace industry, the telecommunications companies, and foreign civil aviation authorities) and have not been limited to the FAA's ADs. Participants in these discussions varied at each meeting; however, IATA was represented at some of the meetings.

## N. Operator Involvement

*Comment summary:* The Cargo Airlines Association commented that in addition to the airplane OEMs and radio altimeter manufacturers, airlines should participate in any future radio altimeter standards development activity.

*FAA response:* Although airline operators are not usually members of a standards development activity, they have sometimes been members in the past for certain standards that have been airline operator centric. Individuals may apply for membership on a committee, and acceptance will be based on the committee chair's evaluation of the applicant.

## O. PSD Curve and Associated Compliance Policy

### 1. Request for Part Numbers/Criteria for Radio Altimeter Tolerance

*Comment summary:* Many commenters stated concern that the process for determining whether a radio altimeter meets the fundamental PSD curve, as specified in the proposed AD, is not well defined and that the requirement in the proposed AD of "using a method approved by the FAA" is not adequate. Thales requested that the FAA provide an Issue Paper, Advisory Circular, or other publicly available means of compliance document. Airbus requested that the FAA clarify where operators could find specific part numbers of radio altimeters that would meet the definition in the proposed AD. Fourteen commenters, as well as IATA and A4A, requested that the FAA provide a list of all radio altimeters by part number that are considered tolerant under the criteria discussed in the proposed AD. Gulf Air Group stated that developing an FAA-approved method to demonstrate that an airplane is radio altimeter tolerant should be the responsibility of the OEM, radio altimeter manufacturer, or system integrator.

*FAA response:* The FAA has developed a policy statement that provides a means of compliance with this AD for all transport and commuter category airplanes and rotorcraft equipped with a radio altimeter. The FAA requested public comments on this proposed policy on May 8, 2023 [[88 FR 29554](#)]. The proposed policy describes an acceptable framework and method for demonstrating that an airplane or rotorcraft is radio altimeter tolerant. The policy discusses compliance methods that should be applied to programs for type certificates, amended type certificates, STCs, and amended STCs. Furthermore, the FAA does not maintain a list of tolerant radio altimeters because the determination of a radio altimeter tolerant airplane must consider the installation details, which vary from airplane to airplane. The proposed policy addresses how to assess 5G C-Band tolerance. Although most data submitted to demonstrate compliance in accordance with the FAA policy statement will be proposed by design approval holders, any person/entity can propose a method to demonstrate compliance.

### 2. Request To Clarify Acceptability of External Filters

*Comment summary:* Thales requested that the proposed AD be revised to clearly state that installations with external filters can also be used for compliance.

*FAA response:* The FAA stated in the preamble of the NPRM that radio altimeter installations with external filters may be acceptable for compliance with the requirements of this AD. The FAA is not requiring a specific type of radio altimeter installation; the AD requires only that the radio altimeter installation meet the radio altimeter tolerance PSD curves. No change to this AD based is necessary based on this comment.

### 3. Request To Identify Spurious Emissions Data

*Comment summary:* To determine what action may be necessary to ensure safe aviation operations in the U.S., Thales requested that the proposed AD include necessary spurious data that 5G network operators should disclose to the FAA.

*FAA response:* The FAA disagrees. The spurious PSD curve that defines a radio altimeter tolerant airplane for purposes of this AD is based on the spurious emission limits documented in the voluntary agreement letter dated March 31, 2023.

#### **4. Request To Clarify Figure 1**

*Comment summary:* Textron Aviation requested the FAA clarify at what reference point the PSD requirements apply. The commenter stated it assumed that they apply at the radio altimeter receive antenna input, such that antenna characteristics, coax loss, and filter characteristics would be included in the determination.

*FAA response:* The FAA agrees and has changed the title of figure 1 to paragraph (g)(1)(i) of this AD to reflect that the PSD requirements apply at the antenna input to the radio altimeter, and that the figure applies to the outward facing side of the antenna.

#### **5. Request To Provide Additional Information on the Spurious Emission Tolerance**

*Comment summary:* AIA requested that the FAA provide more information about the tolerances for determination of whether an airplane is radio altimeter tolerant. Several commenters requested that the FAA add a new figure indicating the spurious tolerance, similar to the figure with the PSD tolerance curve, and a specification of the altitude dependence for spurious tolerance.

*FAA response:* The FAA agrees and has replaced the proposed fixed emission level with a spurious PSD tolerance curve in figure 2 to paragraph (g)(1)(ii) of this AD. Subsequent figures have been redesignated accordingly.

#### **6. Request To Recognize Installations as Minor Changes**

*Comment summary:* Two commenters requested that the FAA revise the proposed AD to allow modification of the airplane to a radio altimeter tolerant airplane as a minor change to type design, to help expedite approvals and make best use of resources.

*FAA response:* The FAA disagrees. Under [14.CFR 21.95](#), minor design changes may be approved before an applicant submits to the FAA any substantiating data. Radio altimeters are critical sensors that must be shown to perform their intended function, and the modified hardware or software must be shown to still meet the airplane-level system safety requirements. For example, a filter may alter the radio altimeter performance, which may have an appreciable effect on reliability, operational characteristics, or other characteristics affecting airworthiness. For this reason, the FAA determined that FAA approval of the method used for the modification was necessary before operators could show compliance with this AD.

#### **7. Request To Revise Tolerance Definition**

*Comment summary:* Textron and Embraer asked the FAA to add language to the definition of radio altimeter tolerant airplane to indicate the frequency band being referenced (3.7–3.98 GHz).

*FAA response:* The FAA agrees and has changed paragraphs (g)(1)(i) and (ii) of this AD to include the applicable frequency bands.

#### **8. Request To Add Certain PSD Limit**

*Comment summary:* Airbus and Bombardier requested that the FAA revise the table at the bottom of the proposed PSD curve to add the limit for 2500 feet above ground level. The commenters stated that this would be consistent with the maximum operating range of popular radio altimeter models installed on many airplanes and would avoid extrapolation errors.

*FAA response:* The FAA disagrees. The FAA developed the PSD curve to cover all transport and commuter radio altimeters and has determined that any extrapolation errors are sufficiently small and will not affect compliance or compromise safety.

#### **9. Request To Revise Tolerance Requirements for Certain Operations**

*Comment summary:* One commenter stated the proposed PSD values are not appropriate for some airplane operations. In support, the commenter stated that CAT I-only qualified airplanes do not require radio altimeter data, and that CAT II and CAT I qualified airplanes do not use radio altimeter data below 100 feet.

*FAA response:* The FAA infers that the commenter is requesting that the proposed AD be revised for operators that perform only CAT I and CAT II approaches. The FAA disagrees. The unsafe condition identified by the FAA is related not only to low-visibility operations but also to the various flight deck effects such as erroneous Terrain Awareness and Warning System (TAWS) warnings, erroneous Traffic Collision Avoidance System (TCAS) warnings, erroneous landing gear warnings, and the erroneous display of radio altimeter data. Although these flight deck effects are less severe than the hazards associated with low-visibility landings, the FAA is concerned the effects will occur more frequently as 5G C-Band services continue to be deployed throughout the contiguous U.S. The erroneous warnings increase flightcrew workload as they try to ascertain the validity of the warning. Repeated determinations that the warning occurred in error will lead to flightcrew desensitization to warnings from these safety systems. Meeting the radio altimeter tolerant PSD curve will minimize erroneous flight deck warnings.

#### **10. Request for Clarification of Spurious Emissions Limit**

*Comment summary:* MHI RJ stated that demonstrating tolerance to the aggregate base station conducted spurious emissions level is not possible at an airplane level since the received signal will depend on many other undefined factors, such as distance from base station and base station antenna performance. An individual commenter stated the spurious signal level of –48 dBm/MHz is not consistent with the FCC's regulator limit and free air attenuation, as the spurious signal and radio altimeter signals will attenuate as the airplanes gets farther from the 5G C-Band station.

*FAA response:* As stated in section O.5. of this final rule, the FAA has determined that a spurious emissions PSD curve is a more appropriate method to define performance than a single aggregate spurious emissions level and revised this final rule accordingly.

#### **11. Request for Different PSD Criteria**

*Comment summary:* An individual commenter stated the proposed AD would establish PSD criteria as though the 5G C-Band transmitter is located on the runway between threshold and touchdown zone, which is not realistic given the FAA approach criteria. The Department of Defense stated the PSD curve is lacking information to properly determine the impact to radio altimeters.



*FAA response:* The FAA disagrees. The proposed PSD curve was validated using the actual locations of 5G C-Band transmitters with respect to runway safety zones at 5G CMAs.

## **12. Request To Revise Unit of Measurement**

*Comment summary:* AIA and ATR requested the FAA correct the references of dBm from “decibels per megahertz” to “decibel-milliwatts per megahertz.”

*FAA response:* The FAA agrees; however, because the cited reference does not appear in this final rule, no change to the AD is necessary.

## **13. Request for AD Coverage of 65 dBm/MHz (Rural)**

*Comment summary:* Thales requested that the radio altimeter performance criteria specified in figure 1 to paragraph (g)(2) of the proposed AD be revised to explicitly cover any 5G emitter station up to 65 dB/MHz in the applicable 3.7–3.98 GHz band.

*FAA response:* The FAA performed additional analysis, considering both rural power levels (65 dBm/MHz) and urban power levels (62 dBm/MHz), and determined that radio altimeter tolerant airplanes are safe to fly to all airports in the contiguous U.S. However, no change to the AD is necessary based on this comment.

## **P. RNP AR**

### **1. Operation Under RNP AR IAP**

*Comment summary:* Some commenters expressed concern over the FAA's proposal to remove RNP AR IAPs from the list of prohibited operations. Allied Pilots Association and AIA stated RNP AR approaches are commonly used in high terrain environments where reliable TAWS functionality is necessary. ALPA requested information on maintaining operational safety while conducting RNP AR IAPs, especially at terrain-impacted runways.

*FAA response:* The FAA included RNP AR in the original list of prohibited operations because it was unclear how 5G C-Band wireless broadband interference would affect this operation. Unlike other operations prohibited by the AD, RNP AR operations do not rely on direct radio altimeter inputs to determine arrival at minimums or for direct inputs that affect the flight path of the airplane. RNP AR operations require operational TAWS equipment; however, TAWS is not directly required for the procedure. An erroneous radio altimeter output could affect maximum allowed bank angle, which could affect course adherence. However, pilots would get an “unable RNP” message and take appropriate action. After further analysis, the FAA determined that 5G C-Band interference does not create an unsafe condition specific to the conduct of an RNP AR IAP. While there is a risk of erroneous TAWS warnings in the presence of 5G C-Band, that risk is not limited to RNP AR operations, but rather applies to all operations. To minimize the number of erroneous system messages and the unsafe condition they produce, the FAA is requiring that all airplanes operating under part 121 meet the PSD performance curves to operate in the contiguous U.S. after February 1, 2024.

### **2. Request To Clarify AFM Prohibitions**

*Comment summary:* Emirates stated that figure 3 to paragraph (i) and figure 4 to paragraph (j) of the proposed AD contain prohibitions for RNP AR IAPs and requested that the FAA clarify whether this is a typographical error.

*FAA response:* In the NPRM, the FAA intentionally removed RNP AR from the proposed figures referenced by the commenter. This AD does not prohibit RNP AR IAPs.

## **Q. Additional Changes to NPRM**

### **1. Request To Correct Paragraph Reference**

*Comment summary:* Qatar Airways suggested that the reference to “paragraphs (k)(i) and (ii)” in paragraph (k)(1) of the proposed AD be changed to “paragraphs (k)(1) (i) and (ii).”

*FAA response:* The commenter correctly noted this error in the proposed AD; however, because of other changes to paragraph (k)(1) of the proposed AD (paragraph (j) of this final rule), as described in section B.1. of this final rule, the requested change is not necessary.

### **2. Request To Remove Yaborã From Applicability**

*Comment summary:* An individual noted that the AD applicability includes Yaborã Indústria Aeronáutica S.A. (Yaborã), but the type certificate for Yaborã models is currently held by Embraer. The commenter suggested that Yaborã be removed from the applicability of this AD.

*FAA response:* The FAA has removed Yaborã Indústria Aeronáutica S.A. from the applicability of this AD and corrected the clerical error by changing paragraph (c)(4) of this AD to state that type certificates previously held by Yaborã are now held by Embraer S.A. However, because paragraph (c) of this AD uses the language “including, but not limited to,” before listing the names of various type certificate holders, the AD applies to any transport or commuter category airplane equipped with a radio altimeter, regardless of the name of the type certificate holder. In this case, the AD applies to the airplanes whose type certificates were previously held by Yaborã that are now held by Embraer S.A.

## **R. Comments Outside Scope of NPRM**

*Comment summary and FAA response:* The FAA also received and reviewed several comments that were very general, stated the commenter's viewpoint without a suggestion specific to the AD, or did not make a request the FAA can act on. Some comments asked about other Boeing-specific ADs or about the updated radio altimeter MOPS. These comments are outside the scope of this AD.

## **Conclusion**

The FAA reviewed the relevant data, considered any comments received, and determined that air safety requires adopting this AD as proposed in the NPRM, except for the changes described previously. None of the changes will increase the economic burden on any operator. Accordingly, the FAA is issuing this AD to address the unsafe condition on these products.

## **Interim Action**

The FAA considers that this AD is an interim action. Once the TSO standard for radio altimeters is established, which will follow the existing international technical consensus on the establishment of the MOPS, the FAA anticipates that the MOPS will be incorporated into the TSO. Once a new radio altimeter TSO is developed, approved, and available, the FAA might consider additional rulemaking.

## Effective Date

Section 553(d) of the Administrative Procedure Act (APA) ([5 U.S.C. 551 et seq.](#)) requires publication of a rule not less than 30 days before its effective date. However, section 553(d) authorizes agencies to make rules effective in less than 30 days when the agency finds “good cause.” Radio altimeter anomalies that are undetected by the aircraft automation or pilot, particularly close to the ground (*e.g.*, landing flare), could lead to loss of continued safe flight and landing. Additionally, radio altimeter anomalies could lead to increased flightcrew workload and flightcrew desensitization to warnings. To address this unsafe condition, the actions required by this AD must be accomplished before the compliance date of June 30, 2023. The FAA based this date on the changes to the 5G C-Band environment beginning on July 1, 2023. These changes include increased wireless broadband deployment and transmissions closer to the parameters authorized by the FCC. The earlier operators learn of the requirements in this AD, the earlier they can take action to ensure compliance. An effective date less than 30 days would ensure the AD is codified earlier, thereby increasing awareness of its requirements. Therefore, the FAA finds that good cause exists pursuant to [5 U.S.C. 553\(d\)](#) for making this amendment immediately effective.

## Costs of Compliance

The FAA estimates that this AD affects approximately 1,000 airplanes of U.S. registry.

As of the date of publication of this AD, there are approximately 8,000 transport and commuter category airplanes of U.S. registry. In Special Airworthiness Information Bulletin AIR-21-18R2, the FAA requested radio altimeter retrofit plans, timelines, and completion information from the aviation industry. The FAA did not receive comprehensive data, but based on the limited information the agency did receive, the FAA extrapolated impacts across industry. Based on that information, the FAA roughly estimates that almost 7,000 airplanes on the U.S. registry have already been equipped or are being retrofitted to address radio altimeter interference tolerance, and thus will have to take no actions to comply with this AD. Based on information received, some operators will comply with the modification requirement by replacing the radio altimeter with a new upgraded or modified radio altimeter, and others will comply by installing an externally mounted filter. The FAA estimates that approximately 180 airplanes will require radio altimeter replacement and 820 airplanes will require addition of radio altimeter filters to comply with the modification requirement. As such, the FAA estimates the following costs to comply with this AD, for a total U.S. fleet cost of compliance of up to \$35,152,000.

### Estimated Costs

Action	Labor cost	Parts cost	Cost per product	Cost on U.S. operators
AFM revision until June 30, 2023	1 work-hour × \$85 per hour = \$85	\$0	\$85	\$85,000 for 1,000 affected airplanes.
AFM revision after June 30, 2023	1 work-hour × \$85 per hour = \$85	\$0	\$85	\$85,000 for 1,000 affected airplanes.
Modification (radio altimeter replacement option)			Up to \$80,000 (includes parts and labor)	Up to \$14,400,000 for 180 affected airplanes.
Modification (filter addition option)	24 work-hours × \$85 per hour = \$2,040 per filter	\$8,000 per filter	\$10,040 per filter	Up to \$20,582,000 for 820 affected airplanes with 2 or 3 filters per airplane.

The benefits of the AD include the value of reducing aviation accident risks that are mitigated by TAWS, TCAS, and airborne windshear warning and flight guidance systems (windshear systems), all of which rely on proper performance of radio altimeters to perform their intended function. TAWS, TCAS, and windshear systems are examples of safety-enhancing systems required for operation under [14 CFR part 121](#). The FAA required these systems to address hazards that have caused accidents and fatalities during commercial air transportation in the U.S. This AD will maintain the same level of safety afforded by these and other safety systems before the use of the C-Band by 5G broadband networks. This AD will also minimize erroneous system messages and the unsafe condition they produce.

## Authority for This Rulemaking

Title 49 of the United States Code specifies the FAA’s authority to issue rules on aviation safety. Subtitle I, section 106, describes the authority of the FAA Administrator. Subtitle VII: Aviation Programs, describes in more detail the scope of the Agency’s authority.

The FAA is issuing this rulemaking under the authority described in Subtitle VII, Part A, Subpart III, Section 44701: General requirements. Under that section, Congress charges the FAA with promoting safe flight of civil aircraft in air commerce by prescribing regulations for practices, methods, and procedures the Administrator finds necessary for safety in air commerce. This regulation is within the scope of that authority because it addresses an unsafe condition that is likely to exist or develop on products identified in this rulemaking action.

## Regulatory Flexibility Determination

The Regulatory Flexibility Act (RFA) of 1980, Public Law 96-354, 94 Stat. 1164 ([5 U.S.C. 601-612](#)), as amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (Pub. L. 104-121, 110 Stat. 857, Mar. 29, 1996) and the Small Business Jobs Act of 2010 (Pub. L. 111-240, 124 Stat. 2504, Sept. 27, 2010), requires Federal agencies to consider the effects of the regulatory action on small business and other small entities and to minimize any significant economic impact.

Agencies must perform a review to determine whether a rule will have a significant economic impact on a substantial number of small entities. If the agency determines that it will, the agency must prepare a regulatory flexibility analysis as described in the RFA.

The FAA published an Initial Regulatory Flexibility Analysis (IRFA) ([88 FR 1520](#), January 11, 2023) for Docket No. FAA-2022-1647, Project Identifier AD-2022-01379-T, to aid the public in commenting on the potential impacts to small entities. The FAA considered the public comments in developing both the final rule and this Final Regulatory Flexibility Analysis (FRFA). A FRFA must contain the following:

- (1) A statement of the need for, and objectives of, the rule;
- (2) A statement of the significant issues raised by the public comments in response to the IRFA, a statement of the assessment of the agency of such issues, and a statement of any changes made in the final rule as a result of such comments;
- (3) The response of the agency to any comments filed by the Chief Counsel for Advocacy of the SBA in response to the proposed rule, and a detailed statement of any change made in the final rule as a result of the comments;
- (4) A description of and an estimate of the number of small entities to which the rule will apply or an explanation of why no such estimate is available;
- (5) A description of the projected reporting, recordkeeping, and other compliance requirements of the proposed rule, including an estimate of the classes of small entities

that will be subject to the requirement and the type of professional skills necessary for preparation of the report or record; and

(6) A description of the steps the agency has taken to minimize the significant economic impact on small entities consistent with the stated objectives of applicable statutes, including a statement of the factual, policy, and legal reasons for selecting the alternative adopted in the final rule and why each of the other significant alternatives to the rule considered by the agency that affect the impact on small entities was rejected.

### 1. Need for and Objectives of the Rule

This AD replaces AD 2021–23–12 and requires revising the limitations section of the existing AFM to incorporate limitations prohibiting certain operations requiring radio altimeter data for airplanes susceptible to 5G C-Band interference. This AD also requires modifying certain airplanes to allow safe operations in the U.S. 5G C-Band radio frequency environment by February 1, 2024. The more restrictive limitations in this AD are needed due to the continued deployment of new 5G C-Band base stations whose signals are expected to cover most of the contiguous U.S. at transmission frequencies between 3.7–3.98 GHz. This AD addresses the unsafe condition resulting from the continued deployment of 5G C-Band transmissions and their interference to radio altimeters.

The FAA's legal basis for this AD is discussed in detail under the "Authority for this Rulemaking" section.

### 2. Significant Issues Raised in Public Comments

The FAA published an IRFA for Docket No. FAA–2022–1647, Project Identifier AD–2022–01379–T, and requested comments.

One commenter stated that the vast majority of business airplane operators under part 91 are small businesses as defined by the SBA. The commenter requested that the FAA not underestimate the choice small businesses will have to make between an \$80,000 retrofit and loss of utility of the airplane during adverse weather conditions.

As explained in more detail in section 4. of this Regulatory Flexibility Determination, the FAA identified 31 small entities that own and operate airplanes affected by this AD. Those entities fall under North American Industry Classification System (NAICS) code 481111, 481112, 481211, or 481212 with a small business size standard of a maximum of 1,500 employees, or under NAICS code 481219 with a small business size standard of a maximum of \$25 million in average annual receipts, to be considered small business. The FAA did not receive any comments with data concerning this part of the FAA's regulatory analysis or concerning the estimated revenue impact for small businesses to comply with this AD. The FAA determined that no changes are necessary as a result of these comments.

Lynden Air Cargo commented that there are significant costs associated with the research and development, approval, and type design amendment for new equipment. Textron commented that the costs associated with development and certification were not included in the FAA's cost estimate. Textron, Atlas Air, A4A, and Bombardier requested that the FAA include costs associated with impacts of the AD, such as delayed and canceled flights and the costs of restricted operations.

The commenters are correct that these additional costs were not included in the FAA's estimated costs. The cost analysis in FAA AD rulemaking actions typically only contain the direct costs associated with the specific actions required by the AD. The FAA does not include secondary costs such as the time necessary for planning or time necessitated by other administrative actions, or indirect costs such as those resulting from delayed or canceled flights and restricted operations. The FAA lacks the data necessary to quantify those costs, which might vary significantly among operators; the commenters did not provide such data either.

Bombardier and an individual stated that the estimated cost of one work-hour per airplane at \$85 per hour for revising an AFM was too low and omitted the costs of authoring the revisions, reviewing the revisions, and briefing flight crews.

The FAA disagrees. The FAA uses one work-hour as a standard estimate in ADs that require an administrative function such as a revision to a flight manual. Operators and pilots must become familiar with the AFM before beginning a flight because of other FAA regulations, so that is not a cost associated with this AD.

SkyWest Airlines commented that its part and labor costs for filter installation were nearly twice the costs specified in the NPRM and requested the FAA re-evaluate the cost estimate.

The cost for filters specified in the NPRM was based on preliminary estimates. Based on this comment, the FAA has revised the cost estimate for the filter installation in this final rule.

### 3. Response to SBA Comments

The Chief Counsel for Advocacy of the SBA did not file any comments in response to the NPRM.

### 4. Small Entities to Which the Rule Will Apply

The FAA used the definition of small entities in the RFA for this analysis. The RFA defines small entities as small businesses, small governmental jurisdictions, or small organizations. In 5 U.S.C. 601(3), the RFA defines "small business" to have the same meaning as "small business concern" under section 3 of the Small Business Act. The Small Business Act authorizes the SBA to define "small business" by issuing regulations.

SBA has established size standards for various types of economic activities, or industries, under the NAICS.<sup>[6]</sup> These size standards generally define small businesses based on the number of employees or annual receipts.

The following table shows the SBA size standards for FAA certificate holders. Note that the SBA definition of a small business applies to the parent company and all affiliates as a single entity.

**Small Business Size Standards: Air Transportation**

NAICS code	Description	SBA size standard
481111	Scheduled Passenger Air Transportation	1,500 employees.
481112	Scheduled Freight Air Transportation	1,500 employees.
481211	Nonscheduled Chartered Passenger Air Transportation	1,500 employees.
481212	Nonscheduled Chartered Freight Air Transportation	1,500 employees.
481219	Other Nonscheduled Air Transportation	\$25 million.

The modification costs of this AD affect certificate holders authorized to conduct operations under [14 CFR part 121](#). To identify which of those certificate holders may be small entities, the FAA reviewed readily available data sources ( e.g., company websites) and data available to the FAA through its certificate oversight functions to determine whether the certificate holder meets the applicable size standard. The following table provides a summary of the estimated number of small entities to which this AD applies.

**Estimated Number of Small Entities**

Category	Number of entities	Number small entities	Percent small entities
Major	6	0	0
National	15	7	47
Passenger and Cargo Charter	12	8	67
Regional	15	7	47
Specialty Cargo	14	9	64
Total	62	31	50

Therefore, the FAA estimated that this AD impacts 31 small entities.

#### 5. Projected Reporting, Recordkeeping, and Other Compliance Requirements

No new recordkeeping or reporting requirements are associated with the AD. As discussed previously, the FAA estimates that the majority of airplanes operated by small entities will already be equipped in a manner that requires no actions to comply with this AD. For the remaining number of airplanes, small entity compliance with the AD would entail incorporation of AFM revisions at an approximate cost of \$170 per airplane. For the modification requirement of this AD, the FAA anticipates that a small number of airplanes will need to have radio altimeter filters installed (at an approximate cost of \$10,040 per filter), and a smaller number of airplanes will require a radio altimeter replacement (at an approximate cost of up to \$80,000 per airplane). These costs represent a small percentage of the overall cost of owning and operating a transport category airplane. To the extent that small entities provide more unique services or serve markets with less competition, these entities might be able to pass on these compliance costs to their customers in the form of price increases.

#### 6. Significant Alternatives Considered

As part of the FRFA, the FAA is required to consider regulatory alternatives that may be less burdensome. The FAA did not find any significant regulatory alternatives that would still accomplish the safety objectives of this AD.

Operators may also propose a less burdensome method for mitigating the unsafe condition using the AMOC procedures found in [14 CFR 39.19](#).

#### Regulatory Findings

This AD will not have federalism implications under [Executive Order 13132](#). This AD will not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government.

For the reasons discussed above, I certify that this AD:

- (1) Is not a “significant regulatory action” under Executive Order 12866, and
- (2) Will not affect intrastate aviation in Alaska.

#### List of Subjects in [14 CFR Part 39](#)

- Air transportation
- Aircraft
- Aviation safety
- Incorporation by reference
- Safety

#### The Amendment

Accordingly, under the authority delegated to me by the Administrator, the FAA amends [14 CFR part 39](#) as follows:

#### PART 39—AIRWORTHINESS DIRECTIVES

1. The authority citation for part 39 continues to read as follows:

Authority: [49 U.S.C. 106\(g\)](#), [49113](#), [44701](#).

[§ 39.13](#) [Amended]

2. The FAA amends § 39.13 by:

- a. Removing Airworthiness Directive (AD) 2021–23–12, Amendment 39–21810 ( [86 FR 69984](#), December 9, 2021); and
- b. Adding the following new AD:

**2023–10–02 Transport and Commuter Category Airplanes:** Amendment 39–22438; Docket No. FAA–2022–1647; Project Identifier AD–2022–01379–T.

#### (a) Effective Date

This airworthiness directive (AD) is effective May 26, 2023.

**(b) Affected ADs**

This AD replaces AD 2021–23–12, Amendment 39–21810 ([86 FR 69984](#), December 9, 2021) (AD 2021–23–12).

**(c) Applicability**

This AD applies to all transport and commuter category airplanes equipped with a radio (also known as radar) altimeter. These radio altimeters are installed on various transport and commuter category airplanes including, but not limited to, the airplanes for which the design approval holder is identified in paragraphs (c)(1) through (18) of this AD.

- (1) The Boeing Company
- (2) Airbus SAS
- (3) Bombardier Inc.
- (4) Embraer S.A. (including type certificates previously held by Yaborá Indústria Aeronáutica S.A., which are now held by Embraer S.A.)
- (5) Gulfstream Aerospace Corporation
- (6) Gulfstream Aerospace LP
- (7) Textron Aviation Inc.
- (8) Pilatus Aircraft Limited
- (9) Fokker Services B.V.
- (10) Saab AB, Support and Services
- (11) DeHavilland Aircraft of Canada Limited
- (12) Airbus Canada Limited Partnership
- (13) ATR–GIE Avions de Transport Régional
- (14) MHI RJ Aviation ULC
- (15) BAE Systems (Operations) Limited
- (16) Lockheed Martin Corporation/Lockheed Martin Aeronautics Company
- (17) Viking Air Limited
- (18) Dassault Aviation

**(d) Subject**

Air Transport Association (ATA) of America Code 31, Indicating/Recording System; 34, Navigation.

**(e) Unsafe Condition**

This AD was prompted by determination that radio altimeters cannot be relied upon to perform their intended function if they experience interference from wireless broadband operations in the 3.7–3.98 GHz frequency band (5G C-Band). The FAA is issuing this AD because radio altimeter anomalies that are undetected by the automation or pilot, particularly close to the ground ( *e.g.*, landing flare), could lead to loss of continued safe flight and landing. Additionally, radio altimeter anomalies could lead to increased flightcrew workload and flightcrew desensitization to warnings.

**(f) Compliance**

Comply with this AD within the compliance times specified, unless already done.

**(g) Definitions**

(1) For purposes of this AD, a “radio altimeter tolerant airplane” is one for which the radio altimeter, as installed, demonstrates the tolerances specified in paragraphs (g)(1)(i) and (ii) of this AD, using a method approved by the FAA. No actions are required by this AD for radio altimeter tolerant airplanes.

(i) Tolerance to radio altimeter interference, for the fundamental emissions (3.7–3.98 GHz), at or above the power spectral density (PSD) curve threshold specified in figure 1 to paragraph (g)(1)(i) of this AD.

Figure 1 to paragraph (g)(1)(i)— *Fundamental Effective Isotropic PSD at Outside Interface of Airplane Antenna*

(ii) Tolerance to radio altimeter interference, for the spurious emissions (4.2–4.4 GHz), at or above the PSD curve threshold specified in figure 2 to paragraph (g)(1)(ii) of this AD.

Figure 2 to paragraph (g)(1)(ii)— *Spurious Effective Isotropic PSD at Outside Interface of Airplane Antenna*

(2) For purposes of this AD, a “non-radio altimeter tolerant airplane” is one for which the radio altimeter, as installed, does not demonstrate the tolerances specified in paragraphs (g)(1)(i) and (ii) of this AD.

**(h) Airplane Flight Manual (AFM) Revision Until June 30, 2023**

For non-radio altimeter tolerant airplanes, before further flight, revise the Limitations Section of the existing AFM to include the information specified in figure 3 to paragraph (h) of this AD. This may be done by inserting a copy of figure 3 to paragraph (h) of this AD into the existing AFM. If an operator has complied with paragraph



(g) of AD 2021–23–12, that action satisfies the requirements of this paragraph.

Figure 3 to paragraph (h)— *AFM Revision*

(Required by AD 2023-10-02)

**Radio Altimeter Flight Restrictions**

When operating in U.S. airspace, the following operations requiring radio altimeter are prohibited in the presence of 5G C-Band wireless broadband interference as identified by NOTAM (NOTAMs will be issued to state the specific airports where the radio altimeter is unreliable due to the presence of 5G C-Band wireless broadband

**(i) AFM Revision After June 30, 2023**

For non-radio altimeter tolerant airplanes, do the actions specified in paragraphs (i)(1) and (2) of this AD.

(1) On or before June 30, 2023, revise the Limitations Section of the existing AFM to include the information specified in figure 4 to paragraph (i) of this AD. This may be done by inserting a copy of figure 4 to paragraph (i) of this AD into the existing AFM. Incorporating the AFM revision required by this paragraph terminates the AFM revision required by paragraph (h) of this AD.

(2) Before further flight after incorporating the limitations specified in figure 4 to paragraph (i) of this AD, remove the AFM revision required by paragraph (h) of this AD.

Figure 4 to paragraph (i)— *AFM Revision for Non-Radio Altimeter Tolerant Airplanes*

**(j) Terminating Action for AFM Limitations**

(1) Modifying the airplane from a non-radio altimeter tolerant airplane to a radio altimeter tolerant airplane terminates the limitations in paragraph (i) of this AD for that airplane.

(2) After modifying the airplane to a radio altimeter tolerant airplane, the limitations specified by paragraph (i) of this AD may be removed from the AFM.

**(k) Alternative Methods of Compliance (AMOCs)**

(1) The Manager, Operational Safety Branch, FAA, has the authority to approve AMOCs for this AD, if requested using the procedures found in [14 CFR 39.19](#). In accordance with [14 CFR 39.19](#), send your request to your principal inspector or responsible Flight Standards Office, as appropriate. If sending information directly to the manager of the Operational Safety Branch, send it to the attention of the person identified in paragraph (l) of this AD. Information may be emailed to: [AMOC@faa.gov](mailto:AMOC@faa.gov).

(2) Before using any approved AMOC, notify your appropriate principal inspector, or lacking a principal inspector, the manager of the responsible Flight Standards Office.

(3) AMOCs approved for AD 2021–23–12 are approved as AMOCs for the requirements specified in paragraph (h) of this AD.

**(l) Related Information**

For more information about this AD, contact Brett Portwood, Continued Operational Safety Technical Advisor, COS Program Management Section, Operational Safety Branch, FAA, 3960 Paramount Boulevard, Lakewood, CA 90712–4137; phone: 817–222–5390; email: [operational\\_safety@faa.gov](mailto:operational_safety@faa.gov).

**(m) Material Incorporated by Reference**

None.

Issued on May 23, 2023.

Michael Linegang,

Acting Director, Compliance & Airworthiness Division, Aircraft Certification Service.

**Footnotes**

1. Locations of 5G CMAs can be found on the FCC's website at: <https://www.fcc.gov/ecfs/search/search-filings/filing/1033142661477>.

[Back to Citation](#)

2. This determination applies only to the unsafe condition identified in this AD, and not to the model-specific unsafe conditions addressed in AD 2022–02–16, AD 2022–03–05, AD 2022–03–20, AD 2022–04–05, AD 2022–05–04, AD 2022–06–16, AD 2022–09–18, AD 2023–03–06, and AD 2023–06–13. Copies of those ADs may be found on the FAA's Dynamic Regulatory System website at [www.drs.faa.gov](http://www.drs.faa.gov).

[Back to Citation](#)

3. FCC Report and Order (R&O) FCC 20–22 in the Matter of Expanding Flexible Use of the 3.7–4.2 GHz Band, adopted February 28, 2020, and released March 3, 2020. This document is available in Docket No. FAA–2022–1647, and at <https://www.fcc.gov/document/fcc-expands-flexible-use-cband-5g-o>.

[Back to Citation](#)

4. A copy of the letter from AT&T, Verizon, T-Mobile, and UScellular dated March 31, 2023, documenting their voluntary commitments to transmit within mitigated parameters (hereinafter referred to as “voluntary commitments” or “voluntary agreement letter dated March 31, 2023”) is in Docket No. FAA-2022-1647 and can be found on the FCC's website at: <https://www.fcc.gov/ecfs/search/search-filings/filing/1033142661477>.

[Back to Citation](#)

5. See the FAA website [faa.gov/newsroom/faa-statements-5g](https://www.faa.gov/newsroom/faa-statements-5g).

[Back to Citation](#)

6. SBA Table of Size Standards. Effective March 17, 2023. <https://www.sba.gov/document/support--table-size-standards>.

[Back to Citation](#)

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