U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Automatic Dependent Surveillance-Broadcast Operations

Date: 12/15/22 **AC No:** 90-114B
Initiated by: AFS-400 **Change:** 1

1. PURPOSE OF THIS ADVISORY CIRCULAR (AC). The intent of this AC is to facilitate operations using Automatic Dependent Surveillance-Broadcast (ADS-B) technology in compliance with Title 14 of the Code of Federal Regulations (14 CFR) part 91, §§ 91.225 and 91.227. The appendices provide guidance on additional ADS-B Out and ADS-B In operations that may be authorized by the Administrator.

2. PRINCIPAL CHANGES. This change adds Appendix F, which describes Interval Management (IM) and provides guidance to operators seeking Federal Aviation Administration (FAA) authorization to conduct IM operations. This change also updates references throughout the AC.

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In May 2010, the Federal Aviation Administration (FAA) issued Title 14 of the Code of Federal Regulations (14 CFR) part 91, §§ 91.225 and 91.227. This rule requires Automatic Dependent Surveillance-Broadcast (ADS-B) Out performance when operating in designated classes of airspace within the U.S. National Airspace System (NAS) after January 1, 2020, unless authorized by air traffic control (ATC). This advisory circular (AC) provides users of the NAS guidance regarding how to conduct operations in accordance with §§ 91.225 and 91.227. The appendices in this AC provide guidance for additional operations enabled by ADS-B, including ADS-B In. The contents of this document do not have the force and effect of law and are not meant to bind the public in any way, and the document is intended only to provide information to the public regarding existing requirements under the law or agency policies.

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CHAPTER 1. AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST OPERATIONS

1.1 Purpose of This Advisory Circular (AC). The intent of this AC is to facilitate operations using Automatic Dependent Surveillance-Broadcast (ADS-B) technology in compliance with Title 14 of the Code of Federal Regulations (14 CFR) part 91, §§ 91.225 and 91.227. The appendices provide guidance on additional ADS-B Out and ADS-B In operations that may be authorized by the Administrator. The contents of this document do not have the force and effect of law and are not meant to bind the public in any way, and the document is intended only to provide information to the public regarding existing requirements under the law or agency policies.

1.2 Audience. This AC applies to all operators intending to use ADS-B within the U.S. National Airspace System (NAS).

1.3 Where You Can Find This AC. You can find this AC on the Federal Aviation Administration's (FAA) website at https://www.faa.gov/regulations_policies/advisory_circulars and the Dynamic Regulatory System (DRS) at https://drs.faa.gov.

1.4 What This AC Cancels. AC 90-114A CHG 1, Automatic Dependent Surveillance-Broadcast Operations, dated March 7, 2016, is canceled.

1.5 Scope. This AC contains an overview of the ADS-B system and general operating procedures in compliance with the airspace and performance requirements of §§ 91.225 and 91.227. The appendices provide guidance on additional ADS-B Out and ADS-B In operations that may be authorized by the Administrator.

1.5.1 Obligation. The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies. This AC is not mandatory and does not constitute a regulation. The guidance contained herein is not legally binding in its own right and will not be relied upon by the FAA as a separate basis for affirmative enforcement action or other administrative penalty. Conformity with the guidance document is voluntary only, and nonconformity will not affect rights and obligations under existing statutes and regulations. This AC describes an acceptable means, but not the only means, to meet the requirements of 14 CFR.

1.5.2 Authorization to Conduct ADS-B Out Operations. The FAA does not require an authorization to conduct ADS-B Out operations in the airspace specified in § 91.225 (U.S. airspace). However, pilots, dispatch personnel, and maintenance personnel should be familiar with the information provided in this AC.

1.5.3 Certification and Installation of ADS-B Out Equipment. Guidance associated with the installation and airworthiness approval of ADS-B Out equipment is contained in AC 20-165, Airworthiness Approval of Automatic Dependent Surveillance-Broadcast Out Systems.

Note 1: The European Union Aviation Safety Agency's (EASA) publication, Certification Specifications and Acceptable Means of Compliance for Airborne Communications, Navigation and Surveillance (CS-ACNS), also provides specifications associated with the installation and airworthiness approval of ADS-B Out equipment in Europe. ADS-B equipment that complies with CS-ACNS complies with §§ 91.225 and 91.227.

Note 2: Outside the U.S. NAS, many worldwide Air Traffic Service Providers (ATSP) allow the use of ADS-B equipment certified to the EASA Acceptable Means of Compliance (AMC) 20-24, Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHz Extended Squitter. EASA AMC 20-24 is intended for Non-Radar Areas (NRA). However, AMC 20-24 equipment does not necessarily comply with § 91.225.

CHAPTER 2. OVERVIEW AND SYSTEM DESCRIPTION

2.1 Overview. Starting with the National Airspace System (NAS)-wide implementation of ADS-B, the FAA has begun to facilitate improvements needed to increase the capacity and efficiency of the NAS while maintaining safety. ADS-B supports these improvements by providing a higher update rate and enhanced accuracy of surveillance information over the current radar-based surveillance systems. In addition, ADS-B enables the expansion of air traffic control (ATC) surveillance services into areas where none existed previously. The ADS-B ground system also provides Traffic Information Service-Broadcast (TIS-B) and Flight Information Service-Broadcast (FIS-B) for use on appropriately equipped aircraft, enhancing the user's situational awareness (SA) and improving the overall safety of the NAS.

2.2 ADS-B System Description.

2.2.1 ADS-B System Architecture. The ADS-B system architecture is composed of aircraft avionics and an Air Traffic Service Provider (ATSP) infrastructure. Onboard "position source" avionics determine the position of the aircraft, typically by using the Global Navigation Satellite Systems (GNSS) and transmitting this and additional information about the aircraft to receiver stations for use by ATC, to ADS-B In-equipped aircraft, and to other aviation service providers.

2.2.2 ADS-B Operating Frequencies. In the United States, the ADS-B system operates on two frequencies: 1090 or 978 megahertz (MHz). See Chapter 3, Figure 3-1, Automatic Dependent Surveillance-Broadcast Airspace Rule (§ 91.225) Diagram, for airspace and frequency requirements.

2.2.2.1 The 1090 MHz Frequency. The 1090 MHz frequency is associated with current Mode A, C, and S transponder operations. ADS-B information is included in Mode S transponders' Extended Squitter (ES) transmit messages, and referred to as 1090ES in this AC.

2.2.2.2 The 978 MHz Frequency. ADS-B equipment operating on 978 MHz are referred to as Universal Access Transceivers (UAT) in this AC.

2.2.3 ADS-B Avionics Operating Modes. ADS-B avionics can have the ability to both transmit and receive information.

2.2.3.1 ADS-B Out. The transmission of ADS-B information from aircraft is known as ADS-B Out.

2.2.3.2 ADS-B In. The receipt of ADS-B information by an aircraft is known as ADS-B In.

Note: After January 1, 2020, all aircraft operating within the airspace defined in 14 CFR part 91, § 91.225 will be required to transmit (ADS-B Out) the information defined in § 91.227 using Technical Standard Order (TSO)-C166b, Extended Squitter Automatic

Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Service-Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz), or TSO-C154c, Universal Access Transceiver (UAT) Automatic Dependent Surveillance-Broadcast (ADS-B) Equipment Operating on Frequency of 978 MHz, avionics.

2.3 ADS-B Broadcast Services. In the United States, ADS-B implementation includes three broadcast services: Automatic Dependent Surveillance-Rebroadcast (ADS-R), TIS-B, and FIS-B. For a detailed explanation of these services, refer to the FAA Surveillance and Broadcast Services Description Document (SRT-047).

2.3.1 ADS-R. Because the ADS-B system operates on two separate frequencies (1090 MHz and 978 MHz), there is a need to translate, reformat, and rebroadcast the information from each frequency to enable aircraft receiving on the other frequency to process and use the other's information. This process is referred to as ADS-R and occurs within an ADS-B ground station. An aircraft or vehicle that is ADS-B Out and is receiving ADS-R service is known as an ADS-R client. An ADS-B-equipped aircraft or vehicle on the opposite link of the ADS-R client that has its messages translated and transmitted by the ground system is known as an ADS-R target. See paragraph 2.3.5 for ADS-R client qualification criteria.

Note: Aircraft operating on the same ADS-B frequency exchange information directly and do not require ADS-R translation. Aircraft with ADS-B In capability on both UAT and 1090ES do not require ADS-R service.

2.3.2 TIS-B. TIS-B is the broadcast of transponder-based Mode C or Mode S traffic information derived from ATC surveillance systems. TIS-B provides ADS-B In-equipped aircraft with a more complete picture of surrounding traffic in situations where not all aircraft are equipped with ADS-B. An aircraft or vehicle that is ADS-B Out and is receiving TIS-B service is known as a TIS-B client. A non-ADS-B-equipped aircraft or vehicle that has its position transmitted in TIS-B reports is known as a TIS-B target. See paragraph 2.3.5 for TIS-B client qualification criteria.

2.3.3 FIS-B. FIS-B operates on UAT only and provides ADS-B In-equipped aircraft with a suite of advisory-only aeronautical and weather information products to enhance the user's situational awareness. Additional information on FIS-B and the products available through the service are provided in the Aeronautical Information Manual (AIM) and Advisory Circular (AC) 00-63, Use of Flight Deck Displays of Digital Weather and Aeronautical Information.

2.3.4 Automatic Dependent Surveillance-Same Link Rebroadcast (ADS-SLR). ADS-SLR uses ADS-R to rebroadcast ADS-B messages sent by aircraft on or near a runway; it is available at all airports with an FAA surface surveillance system. Airport structures can block reception of direct aircraft-to-aircraft ADS-B messages on an airport surface, impacting use of ADS-B In systems on an airport surface. This effect is mitigated by ADS-SLR.

2.3.5 ADS-B Out Requirements for ADS-R and TIS-B. The FAA no longer uses ADS-B data from equipment that does not comply with the performance requirements of either TSO-C166b or TSO-C154c to provide ATC surveillance services. As such, the FAA discontinued TIS-B and ADS-R client services NAS-wide for aircraft not equipped with ADS-B Out that complies with the requirements specified in those TSOs or TSO-C199, Traffic Awareness Beacon System (TABS). Operators of ADS-B In-equipped aircraft should refer to paragraph 4.3.2.5 of this AC for additional information on ADS-B Out equipment performance requirements related to TIS-B and ADS-R.

2.4 Use of ADS-B In Information for Traffic Situational Awareness. This paragraph provides guidance on the use of ADS-B In information for traffic situational awareness. See the appropriate appendices of this AC for guidance on the use of ADS-B In for the more advanced procedures, which may be performed if authorized. There is no specific authorization to use ADS-B In for traffic situational awareness. Installation of ADS-B In equipment is not required for compliance with § 91.225 or § 91.227. However, aircraft owners and operators who choose to voluntarily equip with ADS-B In avionics will achieve greater benefit from the technology through improved traffic situational awareness on the ground and in the air.

Note: This AC only addresses ADS-B In systems installed consistent with AC 20-172, Airworthiness Approval for ADS-B In Systems and Applications, and meeting TSO-C195a (or later revision), Avionics Supporting Automatic Dependent Surveillance-Broadcast (ADS-B) Aircraft Surveillance Applications (ASA).

2.4.1 ADS-B In Systems. Most ADS-B In systems will include a flight deck traffic display depicting the relative position and related information of ADS-B-equipped aircraft presented on a plan view. This traffic display is only one component of the input and output devices collectively known as a Cockpit Display of Traffic Information (CDTI). The traffic display may be on a dedicated display or integrated into and presented on an existing display (e.g., navigation display (ND) or multifunction display (MFD)). The terms traffic display and CDTI are used interchangeably when the meaning is clear in context. In many installations, a moving map depicting key surface elements of the airport may be displayed when on the ground or within a predefined altitude/distance from an airport while airborne.

Note: ADS-B Traffic Advisory System (ATAS) is an ADS-B In application intended specifically for General Aviation (GA) use that will incorporate an audio traffic alerting capability. There is a configuration in which the display is optional for aircraft that cannot accommodate a display.

2.4.2 Operation. The CDTI will display nearby ADS-B Out traffic and may also display TIS-B traffic, depending on the installation and operating airspace. The display may have functionality to allow the pilot to select a target to obtain additional information that might not be automatically displayed, such as distance from own-ship and groundspeed (GS). The system will also provide range selection and declutter functionality. More

advanced ADS-B In systems may also include certified functionality to perform ADS-B In procedures described in the appendices of this AC.

Note: For traffic situational awareness, pilots are encouraged to incorporate the display in their normal scan to aid in the early detection of nearby traffic when in visual conditions and to aid in understanding the flow and amount of nearby traffic when in instrument conditions. However, the traffic display is not intended to be used for self-separation or to deviate from an ATC clearance. Should questions arise about a potential conflict with traffic while on an instrument flight rules (IFR) clearance, the pilot should query ATC. Pilots are also cautioned to not allow the display to become a distraction from the primary task of flying the aircraft, or scanning outside for traffic. Finally, pilots are cautioned against unnecessarily communicating on the ATC frequency about traffic observed on the traffic display.

2.4.3 Limitations. Pilots should understand the proper use and limitations of their equipment and should adhere to the following:

2.4.3.1 Only use the traffic display to supplement what can be seen out the window (OTW), except when authorized to conduct ADS-B In operations described in the appendices of this AC. Pilots must always conduct OTW scans to see and avoid as required under § 91.113(b).

2.4.3.2 Unless specifically certified for the function, the traffic display is not intended for collision avoidance or self-separation.

2.4.3.3 Not all ground and airborne traffic will appear on the traffic display. The traffic display can only display properly equipped ADS-B Out traffic broadcasting on the received frequencies, and, depending on the operating location, ADS-SLR, ADS-R, TIS-B, and/or Traffic Alert and Collision Avoidance System (TCAS) (if installed) traffic. Additionally, the completeness of the traffic situational awareness information is affected by range, signal quality, and proper installation and function of the ADS-B Out system on the traffic aircraft.

2.4.3.4 Unless initiated by the controller, pilots should typically not use the call sign or Aircraft Identification (ACID) of observed traffic in radio communications, as this could create confusion for both ATC and pilots monitoring the frequency.

2.4.3.5 In multipiloted aircraft, establish and comply with crew coordination procedures on the use of the CDTI and ADS-B In information to minimize head-down time.

2.4.3.6 Use of the traffic display does not change pilot or controller responsibilities.

2.4.3.7 If at any time the presented information becomes unreliable, inoperative, or a distraction, disregard the information presented on the traffic display.

2.4.3.8 In TCAS-equipped aircraft, ADS-B In traffic display information does not change existing procedures for response to a traffic advisory (TA) and/or Resolution Advisory (RA).

CHAPTER 3. OPERATIONAL CONSIDERATIONS

3.1 U.S. ADS-B Airspace and Equipment Performance Requirements. After January 1, 2020, unless authorized by air traffic control (ATC), all aircraft operating in the airspace specified in 14 CFR part 91, § 91.225 must meet the equipment performance requirements defined in § 91.227. This chapter describes both the airspace and equipment performance requirements of §§ 91.225 and 91.227. Operators should consider the need to access ADS-B-required airspace and the performance requirements of that airspace when equipping for compliance with §§ 91.225 and 91.227.

3.1.1 Inside Class A Airspace. Operations in Class A airspace must:

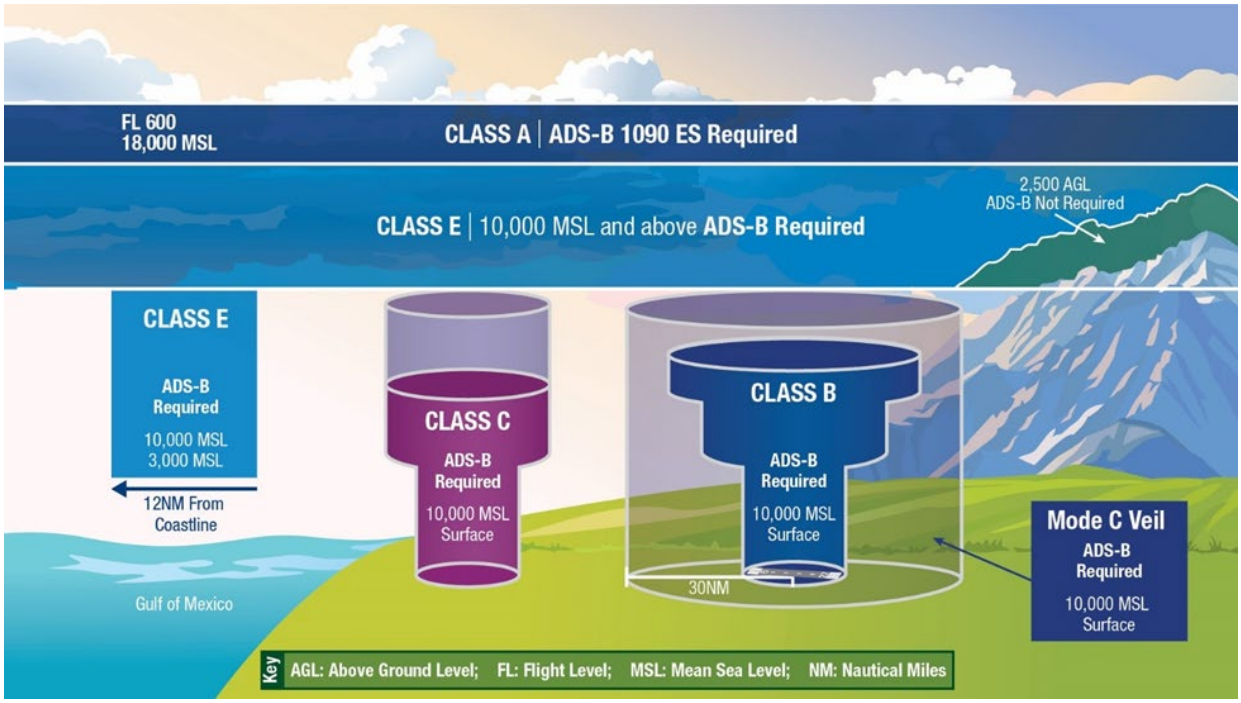
1. Meet the equipment performance requirements in Technical Standard Order (TSO)-C166b, Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Service-Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz) (1090ES).
2. Meet the requirements of § 91.227.

Note: Although TSO-C166b incorporates standards for TIS-B equipment, TIS-B equipage (ADS-B In) is not required for compliance with §§ 91.225 and 91.227.

3.1.2 Outside Class A Airspace. Operations within airspace defined in § 91.225, but outside Class A airspace must:

1. Meet the requirements of § 91.227; and
2. Meet the performance requirements in:
   - TSO-C166b (1090ES); or
   - TSO-C154c, Universal Access Transceiver (UAT) Automatic Dependent Surveillance-Broadcast (ADS-B) Equipment Operating on Frequency of 978 MHz.

Figure 3-1. Automatic Dependent Surveillance-Broadcast Airspace Rule (§ 91.225) Diagram



3.2 Exceptions to Airspace Requirements. The requirements of § 91.225(b) do not apply to any aircraft that was not originally certified with an electrical system or that has not subsequently been certified with such a system installed, including balloons and gliders. The FAA has previously determined that the same aircraft excluded from the transponder requirement are excluded from the ADS-B Out equipage. Accordingly, an aircraft that subsequently has been installed with batteries or an electric starter would not be required to equip for ADS-B Out. These aircraft may conduct operations without ADS-B Out in the airspace specified in § 91.225(d)(2) and (4). However, for other aircraft without ADS-B Out, § 91.225(g) requires ATC authorization prior to operation in ADS-B Out-required airspace.

3.3 Traffic Awareness Beacon System (TABS). Operators of aircraft exempt from carrying a transponder or ADS-B equipment may wish to consider installing a TABS device (refer to TSO-C199, Traffic Awareness Beacon System (TABS)). TABS devices do not meet the transponder or ADS-B requirements defined in §§ 91.215 and 91.225, respectively. However, they will allow TABS-equipped aircraft to be electronically "visible" to aircraft equipped with Traffic Alert and Collision Avoidance Systems (TCAS), Traffic Advisory Systems (TAS), and ADS-B In systems. TABS-equipped aircraft that are broadcasting an ADS-B In capability will also become TIS-B clients.

CHAPTER 4. OPERATING PROCEDURES

4.1 General Operating Procedures. This chapter describes the general procedures for ADS-B Out operations in accordance with 14 CFR part 91, §§ 91.225 and 91.227. All operators should use this information when planning and conducting operations requiring ADS-B Out performance.

4.2 Operator Familiarity of the Installed ADS-B System.

4.2.1 System Operation Familiarity. All operators should use the applicable Airplane Flight Manual (AFM), Aircraft/Airplane Flight Manual Supplement (AFMS), Rotorcraft Flight Manual (RFM), Rotorcraft Flight Manual Supplement (RFMS), pilot's operating handbook (POH), or other required operating handbooks or manuals to become familiar with the proper operation of the installed ADS-B system and any procedures expected of the user for indications of reduced performance or failures within the system.

4.2.2 Understanding Failure Indicators Within the System. Because many ADS-B system installations will be upgrades to existing transponders (Mode S), there may be limited ability to indicate ADS-B failures. Mode S transponders with ADS-B functionality may indicate a device failure (loss of transponder/ADS-B) and input failures (loss of position source, such as the Global Navigation Satellite System (GNSS)) with the same indicator light. Operators should refer to their AFM, AFMS, RFM, RFMS, POH, and other handbooks and manuals for information on the differences between device failures and function failures and the implications and procedures associated with each failure type. In particular, normal GNSS signal interference on the ground caused by nearby obstacles, such as a large hangar, may be incorrectly interpreted as a failure of the ADS-B system. Moving the aircraft clear of obstructions may be all that is needed to clear an indicated malfunction caused by GNSS multipath signals.

4.2.3 Transponder Operation and ADS-B Transmissions. For ADS-B system installations integrated within a transponder that share control features, operators should be aware that disabling the transponder may also disable ADS-B transmissions, as well as result in a loss of Secondary Surveillance Radar (SSR) services and Traffic Alert and Collision Avoidance System (TCAS)/TCAS II operation, if so equipped.

4.3 ADS-B Equipment Operations (U.S. Airspace).

4.3.1 Transmit Requirements. In accordance with § 91.225(f), each person operating an aircraft equipped with ADS-B Out must operate this equipment in the transmit mode at all times, unless authorized by the FAA or directed by air traffic control (ATC). This equipment operation requirement pertains to all phases of flight operation, including airport surface movement area operations. Pilots should select the transponder mode that enables the altitude reporting and ADS-B Out transmissions any time their aircraft is positioned on any portion of an airport movement area.

Note: Aircraft must comply with the appropriate Technical Standard Order (TSO) performance requirements when transmitting ADS-B data.

4.3.1.1 Departures. Select the transponder mode that allows altitude reporting, and enable ADS-B Out during pushback or taxi-out from parking spot. Select TA or TA/RA (if equipped with TCAS) when taking the active runway.

4.3.1.2 Arrivals. After clearing the active runway, if TCAS-equipped (TA or TA/RA), select the transponder to altitude reporting mode, and maintain ADS-B Out transmissions. Select "STBY" or "OFF" for the transponder and ADS-B only upon arriving at the aircraft's parking spot or gate.

4.3.1.3 Formation Operations. ATC uses established transponder and ADS-B transmission procedures when participating in formation operations. Refer to the Aeronautical Information Manual (AIM) paragraph 4-1-20 for specific procedures for both formation flights receiving ATC services, and visual flight rules (VFR) formation flights not receiving ATC services.

4.3.1.4 Inoperative ADS-B Out. For operations with inoperative ADS-B Out comply with the requirements of § 91.213 as appropriate for your aircraft. If you intend to operate in airspace described in § 91.225, refer to paragraph 4.3.3 and comply with § 91.225(g)(1).

4.3.2 Equipment Qualification Requirements. In order to operate an aircraft in airspace defined in § 91.225, the ADS-B Out equipment installed, and its connected or internal position source, must meet the performance requirements of the applicable TSOs and meet the requirements of § 91.227. Since § 91.225 requires the equipment components be installed, portable ADS-B Out equipment, including system components and antennas, do not comply with the rule. Operators should also note that FAA regulations require installed equipment to function as intended. Under 14 CFR part 21, installed equipment need not be manufactured under a TSO authorization, but must be approved or qualified according to the type of aircraft as follows:

4.3.2.1 Type-Certificated Aircraft. ADS-B Out systems and equipment (including the connected position source) installed or used in type-certificated aircraft must have a design approval issued under part 21 or must be installed by field approval, if appropriate. AC 20-165, Airworthiness Approval of Automatic Dependent Surveillance—Broadcast OUT Systems, provides guidance on installation of ADS-B Out systems. FAA Policy Memorandum, Installation Approval for ADS-B OUT Systems, dated 2016, provides information on how ADS-B systems may be installed by field approval.

4.3.2.2 Special Light-Sport Aircraft (SLSA). Equipment installed on SLSA must be installed in accordance with an applicable consensus standard and must be authorized by the aircraft's manufacturer or a person acceptable to the FAA (refer to part 21, § 21.181).

4.3.2.3 Experimental Aircraft, Including Experimental Light-Sport Aircraft (ELSA).

4.3.2.3.1 For experimental category aircraft, including ELSA, there is no FAA approval required for the ADS-B Out system installation. However, to protect all users of the National Airspace System (NAS), it is essential for all aircraft, including experimental and ELSA, to install equipment that has been adequately designed and tested to meet the equipment's intended functions of supporting safe ATC separation services and providing accurate traffic awareness to other aircraft. To meet this requirement, owners of these aircraft may elect to install equipment manufactured under a TSO authorization, in accordance with the installation instructions provided by the manufacturer. Alternatively, owners of these aircraft may elect to install equipment that are not approved under a TSO authorization. For non-TSO equipment, the owner should obtain installation instructions that include a statement of compliance from the applicable avionics manufacturer(s). To qualify non-TSO equipment as compliant for operations in ADS-B airspace defined in § 91.225, the statement of compliance should indicate that when installed in accordance with the installation instructions, the equipment complies with all requirements of § 91.227, and with the performance requirements of the appropriate TSO. While the statement of compliance is important in equipping the aircraft, per § 91.225, correct installation is critical for the equipment to operate properly.

4.3.2.3.2 Owners of experimental aircraft should retain the installation instructions from the equipment supplier, including the statement of compliance, in the aircraft records to support the equipment's compliance with the requirements of §§ 91.225 and 91.227, and to assist in resolving in-service issues if necessary.

4.3.2.4 All Aircraft—Importance of Proper Installation. Experience with FAA compliance monitoring of ADS-B Out-equipped aircraft to date has revealed that a large percentage of equipped aircraft have deficiencies with ADS-B Out system performance following initial installations. Many of these deficiencies have been attributed to improper installation and incorrect system configuration. Therefore, the FAA considers it particularly important for equipment manufacturers to provide installation instructions that are as clear and easy to follow as possible and revise these instructions when deficiencies in the instructions are discovered. Installers should adhere to the manufacturer's installation instructions and employ practices that consistently result in ADS-B Out system installations that fully comply with § 91.227 equipment performance requirements.

4.3.2.5 All Aircraft—ADS-B Out Equipment Performance and FAA Monitoring.

4.3.2.5.1 The ADS-B Out rule does not impose additional continued/recurrent airworthiness inspection requirements for applicable equipment. Therefore,

owner/operators of ADS-B Out-equipped aircraft should ensure continued compliance of applicable equipment performance requirements following initial installation or any subsequent alteration to the system.

Note: Transponder-based ADS-B Out systems (i.e., 1090ES) are still required to meet the requirements of § 91.413.

4.3.2.5.2 The FAA continuously monitors the equipment performance of all ADS-B Out-equipped aircraft operating in U.S. airspace for compliance of regulatory requirements specified in § 91.227. Applicable equipment performance monitoring is conducted by a tool known as the ADS-B Performance Monitor (APM).

4.3.2.5.3 The APM collects data transmitted by ADS-B Out-equipped aircraft monitored on the surface and airborne. The APM applies established compliance criteria to collected data for more than 40 individual equipment performance checks, assembles relevant information into a flight record, and identifies exceptions to applicable regulations to support various internal and external reporting requirements. Aircraft identified by the APM with exceptions are referred to as non-performing equipment (NPE).

4.3.2.5.4 While the term NPE is generally used to describe aircraft with ADS-B Out equipment performance exceptions, certain pilot actions can result in NPE conditions. Such pilot actions may include the following:

1. Movement of aircraft on the surface (under its own power) or while airborne with ADS-B Out equipment turned off;
2. Operating with a non-conforming or unauthorized local call-sign or flight identification (FLT ID) code;
3. Operating with a FLT ID code that does not correspond to the code filed on an associated flight plan (FP) (as applicable);
4. Operating with barometric altitude reporting off (when not directed to do so by ATC);
5. Operating a Universal Access Transceiver (UAT) transponder-dependent device with the transponder turned off (no barometric altitude or Mode 3/A code present in ADS-B messages); and
6. Operating ADS-B Out equipment in any manner contrary to applicable regulations.

4.3.2.5.5 As discussed in paragraph 4.2, pilots should be familiar with the operation of ADS-B Out equipment, including any associated failure indications provided by the system. It is important for pilots to understand that most ADS-B failure indications are limited to system component failures; and indications associated with equipment performance required by regulation are not provided.

4.3.2.5.6 To enable public access to ADS-B equipment performance data needed for owner/operators to verify compliance with § 91.227 requirements, the FAA provides a free, web-based service called the Public ADS-B Performance Report (PAPR) at https://adsbperformance.faa.gov/PAPRRequest.aspx. Additional information on the PAPR service can be found at https://www.faa.gov/air_traffic/technology/equipadsb.

4.3.2.5.7 The FAA recommends that owner/operators of ADS-B Out-equipped aircraft verify equipment performance through periodic use of the PAPR request service, especially following initial equipment installation, modification, or maintenance of existing ADS-B Out systems (including component software updates/changes).

4.3.2.6 Handling of Aircraft with Non-Performing Equipment (NPE).

4.3.2.6.1 When ADS-B Out equipment performance becomes deficient during flight, ATC may direct the pilot to discontinue ADS-B Out transmissions pursuant to § 91.225(f)(2). The pilot should comply with the procedures established for that aircraft or notify ATC if unable. If necessary, ATC may direct the aircraft to exit § 91.225 airspace.

4.3.2.6.2 FAA flight monitoring has shown that aircraft engaged in aerobatic and agricultural operations may fail to meet applicable equipment performance requirements due to maneuvering that exceeds the design limits of the installed GNSS equipment. Aircraft identified by the APM with exceptions to § 91.227 resulting from maneuvering characteristics of aerobatic and/or agricultural operations are not considered NPE by the FAA. When not actively engaged in aerobatics or agricultural operations (e.g., when transiting to and from applicable areas of operation), these aircraft are expected to meet ADS-B Out equipment performance requirements.

4.3.2.6.3 In late 2017, the FAA published a notice (82 FR 60302) to the Federal Register announcing changes to ADS-B services including the Traffic Information Service-Broadcast (TIS-B) (refer to Docket Number FAA-2017-1194, Change to Automatic Dependent Surveillance Broadcast Services, at https://www.federalregister.gov/). These changes included implementation of a filter within the FAA ATC automation system to prevent processing of data transmitted by certain NPE aircraft. Application of the filter is enabled by restricting use of the 24-bit International Civil Aviation Organization (ICAO) address (Mode S code) transmitted from NPE aircraft and managed through a list referred to as the No Services Aircraft List (NSAL). NPE aircraft on the NSAL cannot be provided ATC services via the ADS-B data network and do not meet the equipment performance requirements necessary to qualify for TIS-B client services. Owner/operators of aircraft on the NSAL must seek authorization from ATC to operate in the airspace specified by § 91.225.

4.3.2.6.4 Prior to listing NPE aircraft on the NSAL, the FAA will provide written notification of relevant ADS-B equipment issues to the owner/operator at the address associated with the aircraft's registry in an effort to coordinate NPE corrective action. In cases where the FAA makes notification of NPE to an owner/operator via an individual FAA Letter of Finding (LOF), the owner/operator has 45 days from the date of the LOF to respond to the FAA to establish a plan of corrective action for the NPE. All NPE aircraft are subject to being placed on the NSAL if contact is not established with the FAA to communicate a plan for corrective action within the 45-day period.

Note: NPE notifications mailed to unmonitored mailboxes may result in aircraft being listed to the NSAL (after 45 days) without owner/operator awareness. Owner/operators with addresses associated with an unmonitored mailbox (e.g., LLC or non-resident addresses) are advised to request a PAPR for awareness of ADS-B Out equipment performance and the NSAL status of their aircraft.

4.3.2.6.5 Additionally, the FAA has implemented a process to provide an automated report indicating potential NPE for aircraft operated by a specific certificate holder (CH). The report is called the Fleet Report Avionics Trend Analysis Tool (ATAT). In cases where the FAA makes notification of NPE (or potential NPE) via this report, the receiving CH, along with the FAA Certificate Management Team (CMT), should coordinate with the appropriate office within the FAA Flight Standards Aircraft Maintenance Division to discuss the identified potential NPE in the report as necessary. This coordination should occur in a timely manner as much as practical. The 45-day period that is associated with the individual LOF sent to an aircraft owner operator does not apply to those receiving the automated Fleet Report ATAT.

4.3.2.6.6 The operation of aircraft with certain NPE characteristics (e.g., erroneous position reports) present a significant safety hazard to surrounding airspace and ATC services. Hazardous NPE aircraft may require immediate placement on the NSAL to mitigate applicable safety risks prior to owner/operator notification.

4.3.2.6.7 In rare cases, it is necessary for the FAA to issue an Aircraft Condition Notice (FAA Form 8620-1) to prevent operation of aircraft with hazardous NPE characteristics.

4.3.2.6.8 Owner/operators receiving an NPE notification letter and/or Aircraft Condition Notice should follow the instructions provided in those documents and contact the handling aviation safety inspector (ASI) as soon as possible to coordinate required corrective action. Following NPE corrective action, a verification flight must be conducted pursuant to § 91.407(b), and the handling ASI should be notified, to validate equipment performance. When the handling ASI determines the NPE condition has been corrected, they will

notify the owner/operator and, when applicable, initiate the process for removal of the aircraft from the NSAL.

Note: Once requested, removal of aircraft from the NSAL can take up to 30 days.

4.3.2.6.9 Aircraft on the NSAL are identified on the cover page of an applicable PAPR with the following language (in red font): Aircraft is on No Services List. This language is omitted from a PAPR associated with aircraft not currently on the NSAL. See paragraph 4.3.2.5.6 for information on obtaining a PAPR.

4.3.3 Operation of Aircraft with Inoperative ADS-B. Section 91.225(g) permits ATC to authorize the operation of aircraft with inoperative ADS-B or that do not have ADS-B installed into airspace where it is required. Under § 91.225(g), operators must make requests for ATC-authorized deviations from the requirements in § 91.225 to the ATC facility that has jurisdiction over the concerned airspace or airport movement area within the time periods specified below:

1. For operation of an aircraft with inoperative ADS-B equipment to the airport of ultimate destination (including any intermediate stops) or to proceed to a place where suitable repairs can be made, or both, the request may be made at any time.
2. For operation of an aircraft that is not equipped with ADS-B, operators must make the request at least 1 hour before the proposed operation.

4.3.3.1 Air Carriers Procedures. Air carriers are not precluded from using the ADS-B Deviation Authorization Preflight Tool (ADAPT); however, the Air Traffic Control System Command Center (ATSCSS) will facilitate coordination with FAA facilities for flights that are equipped with ADS-B that is inoperative. Collaborative Decision Making (CDM) participants should use the Tactical Customer Advocate (TCA) webpage or call the TCA desk with the call sign, proposed departure time, requested route of flight, and requested altitude. The TCA will coordinate with all FAA facilities along the route of flight. Approval/denial will be provided with any restrictions to the route/altitude for the operation of the flight with the failed ADS-B/transponder.

4.3.3.2 All Other Operators. All other operators are encouraged to use ADAPT to document your request and authorization (see paragraph 4.3.5). You may also request coordination through the departure airport ATC tower. The tower will initiate the coordination of the request.

Note 1: Aircraft must have an operable Mode C transponder in order to use ADAPT. If the failure results in the loss of all transponder functions, you must coordinate through the ATCSCC or the local facility, as appropriate, or use your existing procedures for an inoperative transponder.

Note 2: All airborne failures will be handled by the FAA facility where the failure occurs. The FAA facility will coordinate through the ATCSCC if necessary, which will then coordinate with all FAA facilities along the remaining route of flight.

4.3.4 Operation of Aircraft Not Equipped With ADS-B. In April 2019, the FAA published a notice (84 FR 12062) to the Federal Register clarifying policy for authorizations to operators of aircraft not equipped with ADS-B (refer to Docket Number FAA-2019-0239, Statement of Policy for Authorizations to Operators of Aircraft That are Not Equipped With Automatic Dependent Surveillance-Broadcast (ADS-B) Out Equipment, at https://www.federalregister.gov/). Operators are encouraged to review the notice, summarized below.

4.3.4.1 To operate in ADS-B airspace, an operator whose aircraft is not equipped with ADS-B Out equipment must obtain a preflight authorization in accordance with § 91.225(g). The operator has the responsibility to obtain a preflight authorization from ATC for all ADS-B Out airspace on the planned flight path. For the reasons explained in the policy, however, the FAA will be very unlikely to issue routine and regular authorizations to scheduled operators seeking to operate non-equipped aircraft in rule airspace. Likewise, although unscheduled operators may request authorizations for airspace at capacity constrained airports as defined in the policy, issuance of an authorization may prove difficult to obtain.

4.3.4.2 Note that the provision of air traffic services to a non-ADS-B-equipped aircraft whose flight transits ADS-B Out airspace will not constitute authorization under § 91.225(g). Although ATC will be able to observe that an aircraft is not equipped with ADS-B Out equipment, ATC will not be responsible for determining whether non-equipped aircraft operating in the NAS are properly authorized to operate in ADS-B Out airspace. The provision of air traffic services is separate from and will not constitute an authorization to deviate from the ADS-B Out equipage requirements while operating in that airspace. The non-equipped operator, as always, will have the responsibility to ensure compliance with the regulations, which includes obtaining a preflight authorization in accordance with § 91.225(g).

4.3.5 ADAPT. The FAA developed ADAPT, a web-based mechanism for requesting authorization in accordance with the regulation and this policy. You may access ADAPT at https://sapt.faa.gov/. While ADAPT is intended primarily for requests to operate without ADS-B, you may also choose to use it as a means to request an authorization to operate with inoperative ADS-B. Operators who coordinate certain operations with an FAA TCA should continue to make requests through the TCA. Refer to the ADAPT User Guide for additional information.

4.4 Flight Plans (FP). The information to complete the ICAO FP continues to evolve with the introduction of NextGen equipment and capabilities. The information provided here represents just some of the ADS-B specific information elements. For the most current

and complete instructions and descriptions of FP filing codes, refer to AIM paragraph 5-1-9 and the FAA Flight Planning Information website at https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/air_traffic_services/flight_plan_filing.

4.4.1 ICAO FP Item 10, Equipment. When operating aircraft equipped with ADS-B you should indicate surveillance equipment in Item 10 of the ICAO FP (FAA Form 7233-4, Pre-Flight Pilot Checklist and International Flight Plan). In addition to the transponder codes (refer to AIM paragraph 5-1-9), you should include an ADS-B capability code from the following list. Note that FAA automation does not process ADS-B reports on Very High Frequency (VHF) Digital Link Mode 4, so those codes are not listed here.

4.4.2 ADS-B Capability Codes. The ADS-B capability codes are as follows:

- B1: ADS-B with dedicated 1090 megahertz (MHz) ADS-B Out capability.
- B2: ADS-B with dedicated 1090 MHz ADS-B Out and In capability.
- U1: ADS-B Out capability using UAT.
- U2: ADS-B Out and In capability using UAT.

Note 1: Only include an ADS-B capability code when at least one serviceable ADS-B Out system is installed.

Note 2: Do not file an ADS-B code for "in" capability only. There is currently no way to indicate that an aircraft has "in" capability but no "out" capability. For aircraft with ADS-B "out" on one frequency and "in" on another, include only the ADS-B "out" code. For example, B1 or U1.

4.4.3 ICAO FP Item 18, Other Information.

4.4.3.1 SUR/260B: If you file an ADS-B capability code of B1or B2 in Item 10 and the ADS-B equipment complies with § 91.225, include the item "SUR/260B" in Item 18.

4.4.3.2 SUR/282B: If you file an ADS-B capability code of U1 or U2 in Item 10 and the ADS-B equipment complies with § 91.225, include the item "SUR/282B" in Item 18.

Note: If the ADS-B capability filed in Item 10 is not compliant with § 91.225, do not include "SUR/" information in this FP field.

4.4.3.3 CODE/: After CODE/, enter the aircraft address expressed in the form of six hexadecimal characters (e.g., "CODE/A519D9"). Operators of U.S. registered aircraft can retrieve this information from the FAA aircraft registry (https://www.faa.gov/licenses_certificates/aircraft_certification/aircraft_registry/). Use the "Mode S Code (base 16 / hex)" value.

4.4.3.4 REG/: When you enter an aircraft identification in Item 7 that is different than the aircraft registration mark (e.g., "UAL123"), include REG/ symbol followed by the registration markings of the aircraft, (e.g., "N123UA") in Item 18.

4.4.4 Anonymity Operations and VFR FPs. Section 91.227 contains specific provisions allowing operators with TSO-C154c equipment to transmit a self-assigned (randomized) temporary 24-bit address and no call sign. However, pursuant to the regulations (§ 91.227(d)(11)), the UAT anonymous 24-bit address feature may only be used when the operator "has not filed a flight plan" and "has not requested ATC services." In 2018, the Aircraft Owners and Pilots Association (AOPA) petitioned the FAA for a limited exemption from a portion of § 91.227(d)(8) and (11). Specifically, AOPA sought an exemption to permit pilots to operate using anonymous mode when the pilot has filed a VFR FP and has not requested ATC services. In response, the FAA clarified that it interprets the exceptions in § 91.227(d)(8) and (11) as applying to pilots who: (1) have not filed an instrument flight rules (IFR) FP; (2) have not requested ATC services, such as separation services or VFR flight following; and (3) are using a TSO-C154c self-assigned temporary 24-bit address. As a result, VFR pilots using the anonymity feature may file a VFR FP, which enables search-and-rescue capabilities, provided they do not request flight following.

Note: For any operation where ATC assigns you a discrete Mode 3/A code, you are receiving ATC services.

4.4.5 Privacy ICAO Address (PIA) Program. The FAA acknowledges the desire of some operators to limit the availability of real-time ADS-B position and identification information for a specific aircraft. To address privacy concerns and to accommodate the needs of aircraft, participation will be subject to the following conditions and limitations:

- U.S. registered.
- 1090 MHz ADS-B equipped.
- Using a third-party call sign.
- Flying in domestic U.S. airspace.

4.4.5.1 The PIA program will enable interested aircraft owners to request an alternate, temporary ICAO aircraft address, which will not be assigned to any owner in the Civil Aviation Registry (CAR). This service will be available in two phases:

1. Phase 1: No later than January 1, 2020, the application for PIA can be accessed on the FAA website at https://www.faa.gov/air_traffic/technology/equipadsb/privacy. This service will be operated, monitored, and maintained by the FAA.

2. Phase 2: The service will be transitioned to third-party service provider(s) who will operate, monitor, and maintain this program, which will continue to be available from the above website.

4.4.5.2 To maintain the safety and integrity of air traffic operations, the FAA monitors PIA use in the NAS. The following list includes improper uses of PIAs:

- Use of PIAs assigned to another aircraft.
- Use of unassigned PIAs.
- PIAs used for operations outside of domestic airspace.
- PIAs changed in flight.
- PIAs used with an underperforming ADS-B emitter.
- PIA used with a UAT or dual 1090/UAT emitter.

4.4.5.3 PIAs used by an aircraft other than the aircraft to which the address is assigned results in a violation of § 91.227 and notification to the FAA. Upon detection of improper PIA use, the aircraft owner/operator will be issued a warning that requires immediate action to remedy the issue before the next operation involving the assigned PIA. Failure to comply may result in the revocation of the PIA assignment. Upon revocation of the PIA assignment, the aircraft would be required to fly with its original ICAO aircraft address as found in the CAR, and failure to do so may result in regulatory enforcement action by the FAA and cessation of additional PIA assignments to that aircraft until the enforcement action is closed.

4.4.5.4 An aircraft operator may use the ICAO aircraft address originally assigned and recorded in the CAR at any time for operations, including any time while having an active PIA assignment. Use of the assigned ICAO aircraft address recorded in the CAR is required for all flights leaving U.S. sovereign airspace, and it may be used for any other flights at any time, as desired by the aircraft operator.

4.4.5.5 The FAA requires that the user submits documented validation that an ICAO code has been correctly installed into the aircraft's ADS-B avionics after each change. Refer to the FAA PIA website for complete program details.

4.5 Preflight Requirements (U.S. Airspace).

Note 1: The remainder of paragraph 4.5 describes additional preflight considerations that only apply to the operation of aircraft equipped with Selective Ability (SA) On position sources, as further described in paragraph 4.5.1.2.

Note 2: Refer to Federal Register Docket No. FAA–2022–0619. This notice announces revisions to the FAA's policy on performance requirements for aircraft

with ADS-B Out equipment using the SA-Aware receivers in ADS-B rule airspace.

4.5.1 Flight Planning Requirements for Certain Operators. Under § 91.103, pilots and operators must use all available information in planning their flight, to ensure that the performance requirements will be met for the duration of the flight. Variations in position source performance affect ADS-B Out in two specific broadcast elements required by § 91.227—Navigation Accuracy Category for Position (NACp) and Navigation Integrity Category (NIC). During certain Global Positioning System (GPS) constellation geometries, some position sources may produce values for NACp and NIC that are less than required by the rule.

4.5.1.1 Four different variants of GPS receivers are currently in use as a position source that can meet ADS-B Out rule performance requirements, to varying degrees, when adequate numbers of GPS satellites are in view. Selective availability (SA) is a feature that deliberately degraded the GPS satellite signal, resulting in a less accurate reported position. SA was deactivated in 2000.

4.5.1.2 SA-On GPS receivers assume SA is still active (on), thereby unnecessarily inflating integrity and accuracy bounds of the positions that are no longer degraded by SA. Most GPS receivers that are only compliant with TSO-C129, Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS), are SA-On receivers.

4.5.1.3 SA-Aware GPS receivers are designed to recognize that SA is inactive and optimize the performance from GPS. GPS receivers that comply with the performance requirements of TSO-C196, Airborne Supplemental Navigation Sensors for Global Positioning System Equipment using Aircraft-Based Augmentation, are SA-Aware receivers.

4.5.1.4 SBAS receivers also use the additional signals from geostationary satellites specifically designed for aviation use, improving the quality and robustness of positioning performance. This difference in performance is most pronounced for very precise operations, such as localizer performance with vertical guidance (LPV) approaches, and for all operations when there are inoperative GPS satellites. GPS receivers complying with TSO-C145, Airborne Navigation Sensors Using the Global Positioning System Augmented by the Satellite Based Augmentation System (SBAS), or TSO-C146, Stand-Alone Airborne Navigation Equipment Using the Global Positioning System Augmented by the Satellite Based Augmentation System (SBAS), are SBAS receivers.

4.5.1.5 ABAS sensors tightly integrate GPS measurements with inertial reference/navigation sensor data, improving the quality and robustness of positioning performance. This difference in performance is most pronounced for lower level Required Navigation Performance (RNP) operations, such as

Area Navigation (RNAV) approaches, and for all operations when there are inoperative GPS satellites.

Note 1: Some GPS receivers manufactured with a TSO-C129a approval are SA-Aware, and, therefore, have the same NACp and NIC availability as TSO-C196() approved equipment. Operators should check with their GPS receiver supplier to verify whether their installed TSO-C129() GPS receiver is SA-On or SA-Aware.

Note 2: The wide area augmentation system (WAAS) is the designation of the SBAS system available in North America and is the term often used when making reference to SBAS in the United States.

4.5.2 GPS Performance Prediction. For aircraft equipped with TSO-C129() GPS units to support ADS-B Out equipment, an NACp and NIC GPS service availability prediction should be performed for the intended route of flight (route and time) using available GPS satellite information and guidance published in this AC. It is not necessary for operators of aircraft equipped with the following receivers to conduct a preflight availability prediction: WAAS (TSO-C145 or TSO-C146), SA-Aware (TSO-C196), TSO-C129a receivers that are SA-Aware, or ABAS that include SA-Aware GPS receivers. For operations under Exemption 12555, see paragraph 4.5.3 for additional guidance. See Table 4-1, Preflight Availability Prediction, for a summary.

4.5.2.1 Prediction Methods. Operators may use any of the following preflight availability prediction methods.

4.5.2.1.1 Operators of large fleets of aircraft or users of flight planning programs may wish to use their own preflight availability verification tool. The operator is responsible for selecting a tool that accurately predicts the ADS-B position source performance for their aircraft. The tool needs to account for the GPS satellites that are in service at the time of the prediction, and may take into account unique characteristics of the GNSS receiver, aircraft integration, or installation; including performance better than required in FAA standards or use of inertial information integrated into the ADS-B Out position source. The FAA does not evaluate or approve a particular tool, but may evaluate the basis of the operator's determination that the tool is appropriate to their aircraft, particularly if its use results in noncompliant flights in airspace where ADS-B Out is required.

4.5.2.1.2 Operators may use the FAA-provided preflight availability prediction tool, called the Service Availability Prediction Tool (SAPT) (https://sapt.faa.gov). Refer to the SAPT User Guide for specific instructions on its use.

4.5.2.1.3 Operators may use a third-party interface, incorporating FAA GPS performance prediction data without altering performance values, to predict NACp/NIC performance outages for the aircraft's predicted flightpath and times.

4.5.2.2 Prediction Model Parameters. The operator should use a model appropriate to their equipment, including the type of GPS receiver and the demonstrated capability to track satellites at a given mask angle. When selecting a mask angle, the operator should consider the equipment qualification, installation in the aircraft, and the effects of normal maneuvering. Aircraft are typically qualified with a five-degree mask angle, and operational experience has indicated that a two-degree mask angle can be achieved by some equipment installations. If using the SAPT, each prediction is valid for the operation within 5 minutes of the plan time and 7.5 nautical miles (NM) of the route. The operator may wish to submit additional requests for predictions for varying times around the proposed departure time to ensure compliance at the actual departure time.

4.5.2.3 Flight Planning Guidance. Predictions should be conducted within 24 hours of departure and as close to departure time as feasible, but with sufficient time to re-plan the flight in the event a segment along the planned route is predicted to have insufficient GPS service availability. The prediction should be re-evaluated prior to flight if new information (i.e., a Notice to Air Missions (NOTAM)) provides notice of an unscheduled GPS satellite outage. In the event of a predicted loss of performance for any part along the intended route in the airspace where ADS-B Out is required, the flight should be re-planned so that ADS-B Out performance requirements specified in § 91.227 can be met.

Table 4-1. Preflight Availability Prediction

Equipment	Years 2020-2024		After 2024
	Exemption 12555	**No Exemption**	
SA-On	Yes SAPT will determine backup surveillance and exemption authorizes flight if prediction results in NIC < 7 and/or NACp < 8.	Yes If prediction results in NIC < 7 and/or NACp < 8, operator should re-plan the flight.	Yes If prediction results in NIC < 7 and/or NACp < 8, operator should re-plan the flight.
SBAS/ABAS/ SA-Aware	No	No	No

4.5.3 Operations Conducted Under Exemption No. 12555. In August 2015, the Administrator issued Exemption No. 12555, a time-limited grant of exemption from § 91.227(c)(1)(i) and (iii) for the period from January 1, 2020 through December 31, 2024 to operators who made timely notification of intent to comply with the conditions and limitations. Those operators approved to conduct operations under the conditions and limitations of Exemption No. 12555, or a similar exemption as determined by the FAA, should adhere to the additional guidance provided in this section.

Note: Operators approved to operate under Exemption No. 12555 are encouraged to review the conditions and limitations detailed in the Grant of Exemption No. 12555 at Docket Number FAA-2015-0971, Petition for Exemption, at https://www.regulations.gov/.

4.5.3.1 Under the conditions of Exemption No. 12555, operators with receivers meeting the performance requirements of TSO-C196() may operate in designated airspace for which ADS-B Out is required when the aircraft's NACp and NIC do not meet the performance specified in § 91.227. For these operations, the operator does not need to conduct any preflight availability prediction.

4.5.3.2 Operators conducting operations under Exemption No. 12555 using TSO-C129-approved GPS receivers that do not meet the performance requirements of TSO-C196, TSO-C145, or TSO-C146 may operate in airspace where ADS-B Out is required when the aircraft's NACp and NIC do not meet the performance specified in § 91.227, when the FAA determines that backup surveillance is available. SAPT will indicate if the FAA has determined that backup surveillance is predicted to be available during a predicted performance outage. Since the FAA must make the determination that backup surveillance is predicted to be available, the SAPT is the only tool that can provide this capability. The applicable SAPT run should be completed no more than 3 hours before the planned departure time. If ATC in the departure jurisdiction requires FP submission earlier than 3 hours prior, the SAPT for backup surveillance should be run just prior to FP submission. Under Exemption No. 12555, operators may elect to use their own tool for preflight prediction and use SAPT only to determine the availability of backup surveillance when needed under Exemption No. 12555.

4.5.4 Preflight Prediction Compliance. Operators need to perform an ADS-B Out preflight prediction only for the intended route of flight to the intended destination. For example, when departure and/or arrival alternate airports are required, no preflight prediction is necessary for these routes. However, if you become aware of a change that could result in degraded ADS-B Out performance, such as a satellite outage prior to receiving an ATC clearance for the intended route of flight, then you should conduct a subsequent preflight prediction for the planned flight. This will ensure that ADS-B Out performance is still predicted to comply with the performance requirements of § 91.227(c)(1)(i) and (iii). Once the pilot has received an ATC route clearance, there is no requirement to conduct a subsequent preflight prediction. Therefore, upon receiving a satisfactory preflight availability prediction and an ATC clearance for an intended route of flight, the operator will be deemed to have complied with the preflight availability prediction requirement and the performance requirements of § 91.227(c)(1)(i) and (iii). The FAA accepts that unanticipated changes in route of flight and environmental conditions may adversely affect ADS-B Out performance. ATC will continue to exercise its responsibility for the safe and efficient movement of air traffic, including the routing of traffic to meet those objectives. ADS-B preflight planning should include:

- Identification of flights or aircraft that require completion of a preflight prediction.
- Identify the preflight prediction system (or systems) to be used.
- Include a means to document completion of a satisfactory prediction for each flight where a prediction is required.
- Retain documentation of prediction completion for a suitable period of time, such as three months.

4.5.5 GPS Interference with ADS-B Compliance. There may be times when the GPS position source cannot meet the required technical performance for compliance with § 91.227 due to planned GPS interference. In the event of a scheduled interference outage of GPS, the FAA will issue a NOTAM that identifies the airspace and time periods that may be affected by the interference. The FAA has determined that it would be impractical and not in the public interest to require operators to avoid the affected area based on the chance that an otherwise compliant flight could experience GPS interference. Accordingly, operators should proceed with their intended operation if the only impediment to their operation is possible planned GPS interference. An operator who is required to perform a preflight availability prediction for the intended route of flight is still required to obtain a satisfactory preflight availability prediction. When a NOTAM identifies the airspace and time periods that may be affected by GPS interference, an operator will not be required to alter his or her route of flight to avoid the area based solely on that NOTAM. If an operator encounters actual GPS interference during their flight that results in a degradation of ADS-B Out performance, provided the operator has taken the appropriate preflight actions, the FAA will not consider these events to constitute a violation, as such application of the regulation would impose standard of conduct wholly outside the operator's control.

4.5.6 SAPT Outages. The FAA will issue a NOTAM in the event of a SAPT outage. Operators who use SAPT as their preflight prediction tool will not need to conduct a preflight prediction for the duration of the outage. Additionally, any flight plans submitted to ATC with a proposed departure time within 90 minutes of SAPT return to service do not require a subsequent preflight analysis. When there is a SAPT outage and an operation falls below the performance requirements, provided the operator has taken the appropriate preflight actions with regard to relying upon SAPT, the FAA will not consider these events to constitute a violation, as such application of the regulation would impose standard of conduct wholly outside the operator's control. For operators who have been notified by the FAA of consistent and repeated ADS-B Out performance issues, the FAA cautions that operating during a SAPT outage without first redressing the identified non-performance issue will be considered a continuation of existing noncompliance of the performance requirements.

4.6 Flightcrew Entry of Required ADS-B Data. The operator should develop operational procedures to address flightcrew entry of the ADS-B message elements required in § 91.227 and as described in paragraphs 4.6.1 through 4.6.4. If the ADS-B avionics system design does not allow for a single point of entry for this information, the AFM, AFMS, RFM, RFMS, POH, or other required flight manual must address the requirement

to enter the information multiple times through the appropriate system's interface and to ensure that conflicting ACID information is not transmitted to ATC.

4.6.1 Mode A Code.

4.6.1.1 ATC automation relies on the Mode A code to identify aircraft under radar surveillance and to correlate the displayed target to an FP. The Mode A code is one element of the transmitted ADS-B message set. Since SSR and ADS-B surveillance will overlap in much of the NAS, correlation of the Mode A code between the transponder and the ADS-B message is necessary to ensure that a single target is resolved and correlated to an FP route.

4.6.1.2 It is imperative that the ATC-assigned transponder code is identical to the one in the ADS-B Out message. A preferable design configuration is one that provides the pilot a single point of entry for the Mode A code in both the transponder and the ADS-B Out avionics. If there is no single point of entry provided for the Mode A code into the transponder, then the AFM or operating handbook must address the requirement to enter the Mode A code into both systems separately.

Note: Transmission of conflicting transponder and ADS-B Mode A codes will result in erroneous traffic conflict alerts within the ATC automation system.

4.6.2 Aircraft's Flight Identification (FLT ID).

4.6.2.1 An aircraft's FLT ID is transmitted by the ADS-B Out avionics. The FLT ID is composed of a maximum of seven alphanumeric characters and, per § 91.227(d)(8), must be identical to the "Aircraft Identification" as entered in Item 7 of the FP. It is also referred to as a call sign. The FLT ID is typically entered by the flightcrew during preflight through either a flight management system (FMS) interface (control display unit (CDU)) or transponder control panel. The FLT ID for General Aviation (GA) aircraft is typically associated with the aircraft's registration number. The aircraft owner can preset the FLT ID to the aircraft's registration number (e.g., N235RA), since it is a fixed value, or the pilot can enter it into the ADS-B Out system prior to flight, provided the ADS-B avionics has this capability. It is important to know that the FLT ID should be input into the ADS-B system exactly as filed in block 2 or Item 7 of the FP. No additional characters should be used to fill all available fields.

4.6.2.2 Some ATC systems use transmitted FLT IDs to uniquely identify each aircraft within a given airspace and correlate them with a filed FP for the provision of surveillance and separation services. If the FLT ID is not entered correctly, ATC automation systems may not associate surveillance tracks for the aircraft to its filed FP. Therefore, air traffic services may be delayed or unavailable until this is corrected. Consequently, it is imperative that flightcrews and GA

pilots ensure the FLT ID entry correctly matches the ACID annotated in the filed ATC FP prior to departure.

4.6.2.3 In FAA ATC systems, if the FLT ID transmitted by the aircraft's ADS-B system does not exactly match the FLT ID on the FP, a call sign mismatch (CSMM) occurs. When a CSMM occurs, the controller is alerted and may take action resulting in a flight delay. Furthermore, ATC may elect to advise the Flight Standards Service of the event and the potential violation of § 91.227(d)(8). The specific wording of this regulation has caused misunderstanding from numerous operators and airmen who believe it is acceptable to have a different FLT ID on the FP [ABC1234] from the FLT ID [N12345] transmitted by ADS-B. In an August 3, 2017 legal interpretation, the FAA Office of the Chief Counsel found that the intent of § 91.227(d)(8) is to require that the FLT ID as entered on the FP must exactly match the ADS-B transmitted FLT ID. See Table 4-2, Aircraft Identification Transmission Examples, for examples.

Table 4-2. Aircraft Identification Transmission Examples

Flight Plan Aircraft ID	Correct ADS-B Transmission	Incorrect ADS-B Transmission
AAL5688	AAL5688	AAL-5688
SWA2155	SWA2155	2155
UAL21	UAL21	UAL0021
DAL9450	DAL9450	N561DL
ASH5861	ASH5861	ASH5872
N350QS	N350QS	EJA350
FDY1055	FDY1055	VFR
N777JK	N777JK	N-777JK
N123DJ	N123DJ	NGF123
CGABC	CGABC	C-GABC
VHXYZ	VHXYZ	VH-XYZ

4.6.2.4 GA pilots occasionally have the opportunity to use a FLT ID provided by a charity or other organization instead of using their N-number. In this situation, the GA pilot may only use the organization's FLT ID for the flight provided they change the FLT ID transmitted by the ADS-B Out avionics. If the ADS-B equipment does not allow the FLT ID to be changed or the pilot is unsure of how it is accomplished, the pilot should not use the organization's FLT ID. In this case, in order to ensure compliance with § 91.227(d)(8), the pilot should use the aircraft registration number as the FLT ID.

4.6.3 Emergency Status.

4.6.3.1 This ADS-B message element and transponder code alerts ATC that the aircraft is experiencing emergency conditions and indicates the type of emergency. The appropriate Mode A code should be entered into the transponder (e.g., 7500, 7600, or 7700). The ICAO Annex 10, Volume IV, Surveillance and Collision Avoidance Systems, emergency codes (general emergency, no communications, and unlawful interference) are required by § 91.227.

4.6.3.2 ADS-B systems integrated within a transponder will automatically set the applicable emergency status when code 7500, 7600, or 7700 is entered into the transponder.

4.6.3.3 ADS-B systems not integrated with the transponder or systems with optional emergency codes may need the appropriate emergency code to be entered through a separate pilot interface. Flightcrews should ensure that both emergency codes (ADS-B and transponder) are identical.

4.6.4 Transponder IDENT Function. The AFM or POH will provide specific instructions on how the IDENT feature will be activated in specific installations, including any installations with multiple IDENT features.

APPENDIX A. ADS-B IN-TRAIL PROCEDURE

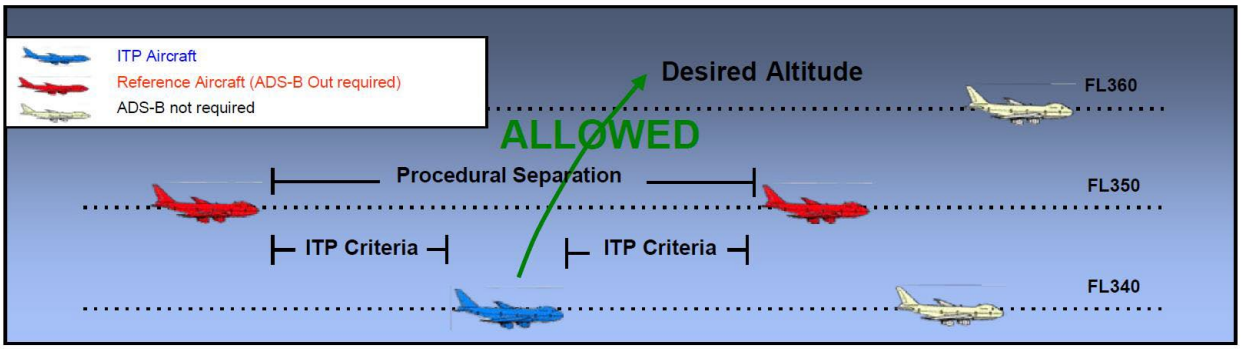
A.1 Purpose. This appendix provides a description of the ADS-B-enabled In-Trail Procedure (ITP) and guidance to operators seeking FAA authorization to conduct ITP operations.

A.2 Background. The ITP is designed primarily for use in nonradar oceanic airspace to enable appropriately equipped ADS-B In aircraft to perform flight level (FL) changes previously unavailable with procedural separation minima applied. The improved traffic information available to ADS-B In-equipped aircraft allows ITP maneuvers to occur safely with reduced separation minima applied. ITP enables flightcrews to execute FL changes to improve ride comfort, avoid weather, or obtain more favorable winds to improve fuel economy and arrival times.

A.2.1 ITP Scenario. Figure A-1, Reduction of Aircraft Separation Minima with In-Trail Procedure, illustrates a basic ITP scenario. The ITP aircraft (blue) wishes to climb from FL340 to 360 between two reference aircraft (red) where procedural separation minima is applied. Using onboard ADS-B In and ITP equipment, the ITP aircraft can determine if the necessary criteria can be met and, if so, request air traffic control (ATC) approval to execute the desired FL change using reduced separation minima between the two reference aircraft.

A.2.2 ATC Responsibility. ATC maintains separation responsibility throughout the ITP maneuver, and resumes the appropriate separation minima at its completion. ATC will apply the reduced ITP separation only between a qualified ITP aircraft and no more than two reference aircraft for the duration of the maneuver. The ITP maneuver can be performed with reference aircraft that do not have ADS-B In equipment. To enable an ITP maneuver, it is necessary for the reference aircraft to transmit an ADS-B Out signal of sufficient quality.

Figure A-1. Reduction of Aircraft Separation Minima with In-Trail Procedure



A.3 ITP Terminology.

A.3.1 Closing Groundspeed (GS) Differential. The difference between the ITP aircraft's GS and a reference aircraft's GS that results in a reduction of the ITP distance.

A.3.2 Closing Mach Speed Differential. The difference in Mach speed between the ITP aircraft and the reference aircraft that results in a reduction of the ITP distance.

A.3.3 ITP Aircraft. An aircraft operated by a flightcrew authorized to conduct an ITP.

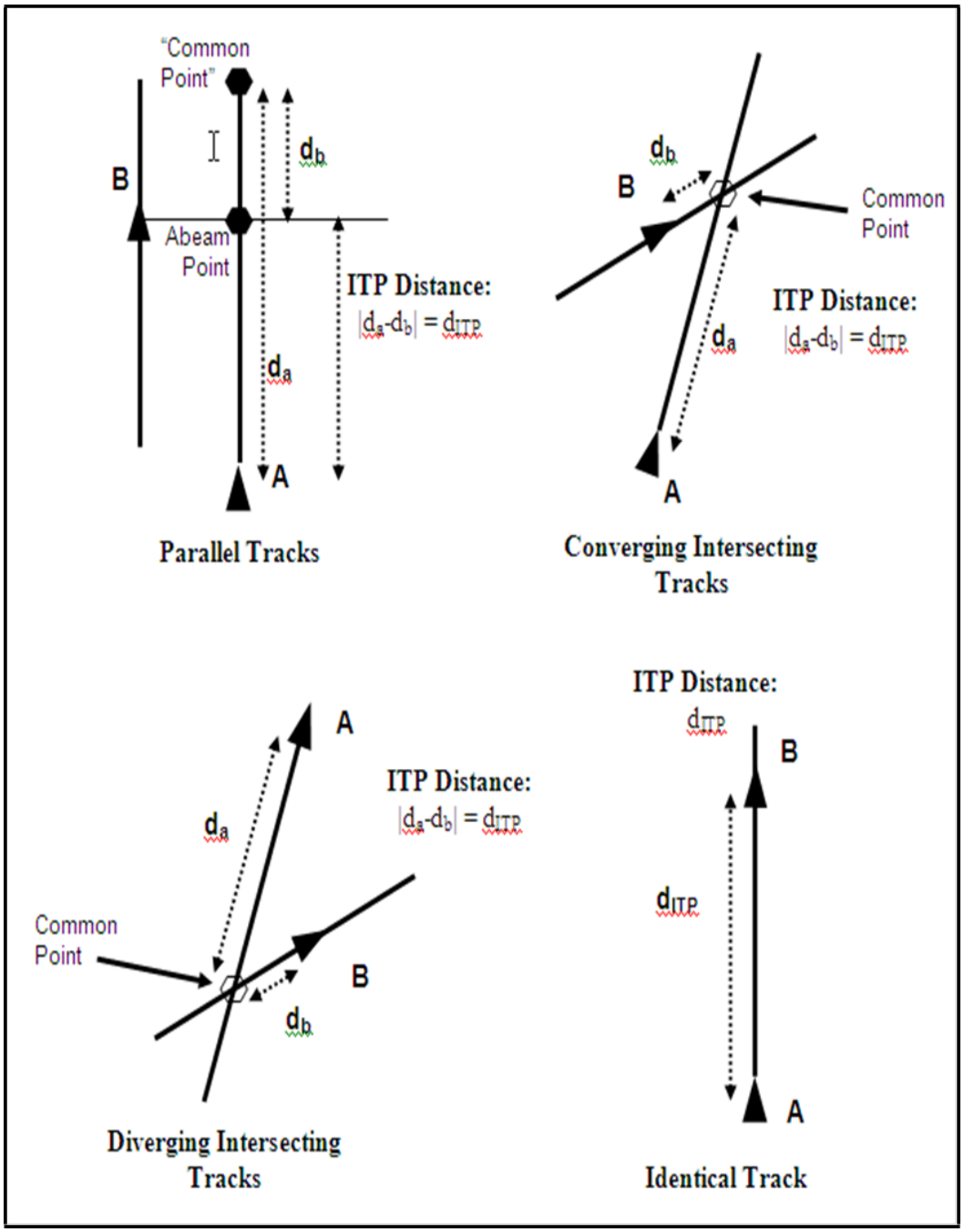
A.3.4 ITP Criteria. A set of conditions to be satisfied prior to initiating or executing an ITP clearance that ensure the safety of the procedure.

A.3.5 ITP Distance. The distance between the ITP aircraft and reference aircraft as defined by the difference in distance to an aircraft calculated common point along a projection of each aircraft's track in front of or behind the aircraft, as appropriate. (See Figure A-2, In-Trail Procedure Distances Illustrated.) For the case where aircraft are on parallel tracks, the ITP distance is measured along the track of one of the aircraft using its calculated position and the point abeam the calculated position of the other aircraft. This measurement technique is similar to the method described in the International Civil Aviation Organization (ICAO) Doc 4444, Procedures for Air Navigation Services—Air Traffic Management, Section 5.4.2.9, Performance-Based Longitudinal Separation Minima.

A.3.6 ITP Equipment. The onboard avionics that support an ITP.

A.3.7 Reference Aircraft. Aircraft (no more than two) transmitting valid ADS-B data that meet specified criteria and are referenced as part of an ITP clearance request to ATC.

Figure A-2. In-Trail Procedure Distances Illustrated



A.4 ITP Concept. The ITP concept is based on the aircraft satisfying specific initial conditions and the flightcrew promptly and correctly executing the requested procedure once approved. The initial conditions are the ITP speed/distance criteria, the relative altitude criteria, the similar track criteria, and the closing Mach differential, as well as the accuracy and integrity of the ADS-B data transmitted from participating aircraft. (See Table A-1, In-Trail Procedure Initiation/Maneuver Criteria (Reference RTCA DO-312 Supplement).) The safety of the procedure depends upon the ITP aircraft maintaining

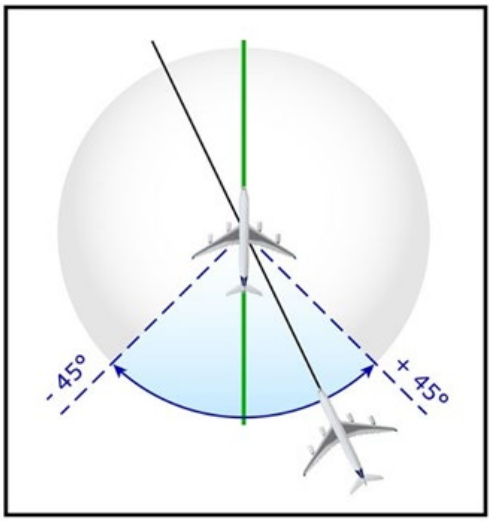
constant Mach and climb or descend at a minimum of 300 feet per minute (fpm) during the maneuver. With these criteria, an ITP aircraft should never come closer than the 10-nautical-mile (NM) separation minimum to a reference aircraft while passing through their altitude(s).

A.4.1 ITP Distance and GS Differential Criteria. The initial distance criteria values, 15 NM and 20 NM, were selected so that when an FL change at 300 fpm and constant Mach number is maintained with the respective maximum 20 or 30-knot (kts) closing GS differential, the distance between the aircraft should not become less than the ITP minimum separation of 10 NM.

A.4.2 Relative Altitude Criteria. The design of the procedure is such that the reference aircraft may not be more than 2,000 feet above or below the ITP aircraft.

A.4.3 Similar Track Criteria. Application of the ITP is limited to geometries where the ITP aircraft and any reference aircraft are on similar tracks. Similar tracks are defined here as less than 45 degrees from one another. See Figure A-3, Similar Track.

Figure A-3. Similar Track



A.4.4 Mach Differential. In order to ensure an acceptable closure throughout the ITP maneuver, the controller will not issue an ITP clearance if the closing Mach differential is greater than 0.06 Mach. This Mach differential check accounts for potentially unsafe closure rates due to abnormal or adverse wind gradient conditions at the intermediate altitudes. The Mach number check may be achieved by:

1. Using the cruise Mach numbers of the ITP and reference aircraft where the Mach number technique is being used;
2. Requesting Mach numbers from the ITP and reference aircraft; or
3. Any other methodology determined appropriate and acceptable by the regulatory authority and the air navigation service provider (ANSP).

A.4.5 ADS-B Data Quality Criteria. The ITP avionics only accept ADS-B Out aircraft broadcasting data of sufficient quality for use as reference aircraft for ITP. The ITP avionics only allow ITP when own-ship data quality are sufficient to ensure safe separation. The data quality criteria are:

1. Position accuracy for ITP and reference aircraft—ITP and reference aircraft data with horizontal position accuracies of at least 0.5 NM (95 percent);
2. Position integrity for ITP and reference aircraft—ITP and reference aircraft data with horizontal position integrity bounds of 1.0 NM at 1x10E-05; and
3. Velocity accuracy for ITP and reference aircraft—ITP and reference aircraft data with horizontal velocity accuracies of at least 10 meters/second (m/s) (19.4 kts), 95 percent.

A.5 ITP Description. To properly conduct an ITP, a qualified flightcrew uses ADS-B In avionics specifically certified to assist in verifying the initial conditions and a graphical display to monitor the relative position(s) of nearby aircraft. The procedure can only be conducted in airspace with appropriately trained ATC personnel, ITP compatible automation, and approved ITP separation minima available. The following are the steps necessary to conduct an ITP:

A.5.1 Flightcrew Verifies Initial Criteria. Using approved avionics, the ITP flightcrew verifies that their own-ship and the reference aircraft meet initial qualifying criteria. The onboard ITP avionics indicate to the flightcrew whether all initiation criteria are satisfied.

A.5.2 Flightcrew Requests ITP. If the criteria are satisfied, the flightcrew requests the ITP clearance using the appropriate phraseology. Direct Controller Pilot Communication (DCPC) ensures unambiguous communication of the ITP request and ATC clearance. Currently, only Controller-Pilot Data Link Communication (CPDLC) is being used in locations where ITP are approved. Preformatted messages for requesting and approving ITP have not yet been developed. Flightcrews use standardized free text messages as described in Table A-2, Flightcrew Standardized Free Text Controller-Pilot Data Link Communication Message Set for In-Trail Procedure, and Table A-3, Controller Free Text Controller-Pilot Data Link Communication Message Set for In-Trail Procedure, until further notice. It is essential that the correct message elements be included in the correct format to allow the controller or automation system to properly evaluate the request. Improperly formatted or incomplete requests may be denied.

Note: ATC will not issue an ITP clearance to any aircraft unless that aircraft has initiated the request.

A.5.3 Controller Issues Clearance. Upon receipt of an ITP request, the controller:

1. Confirms the ITP aircraft and the reference aircraft are on the same track.
   a. Same-track criteria are not the same as the similar-track criteria, which are checked by the ITP aircraft flightcrew.

b. Same-track includes the concept of similar-track (i.e., ITP aircraft and reference aircraft are traveling in the same direction with less than a 45-degree relative track angle between the aircraft), but also includes a check on whether or not the lateral protection areas overlap (e.g., lateral separation cannot be applied). This check can only be done by the controller who knows what separation standard is being applied between the aircraft.

2. Confirms that no more than two reference aircraft have been identified in the request and are identified correctly; that is, that the Aircraft Identification (ACID) of each reference aircraft in the ITP request exactly matches the corresponding aircraft's filed flight plan (FP).

3. Ensures both the ITP aircraft and reference aircraft are not maneuvering and not expected to maneuver during the ITP.

Note: A change of course (only) to remain on the same route would not be considered a maneuver, provided the course change is less than 45 degrees and the aircraft remain in a same track configuration.

4. Verifies that the closing Mach differential is no greater than 0.06 Mach.

5. Verifies that there are no conflicts at the requested altitude.

6. If appropriate, issues an ITP clearance.

A.5.4 Flightcrew Reassesses Criteria. Upon receiving the ITP clearance, the flightcrew confirms that all criteria are still satisfied. If the criteria are not satisfied or there has been a loss of traffic information, the flightcrew immediately rejects the ATC clearance and terminates the maneuver. Additionally, if the FL, reference aircraft, or type of maneuver (ITP versus standard FL change) does not exactly match their request or if the flightcrew receives an ITP clearance without requesting one, they will not perform the maneuver and should verify with ATC to confirm the clearance.

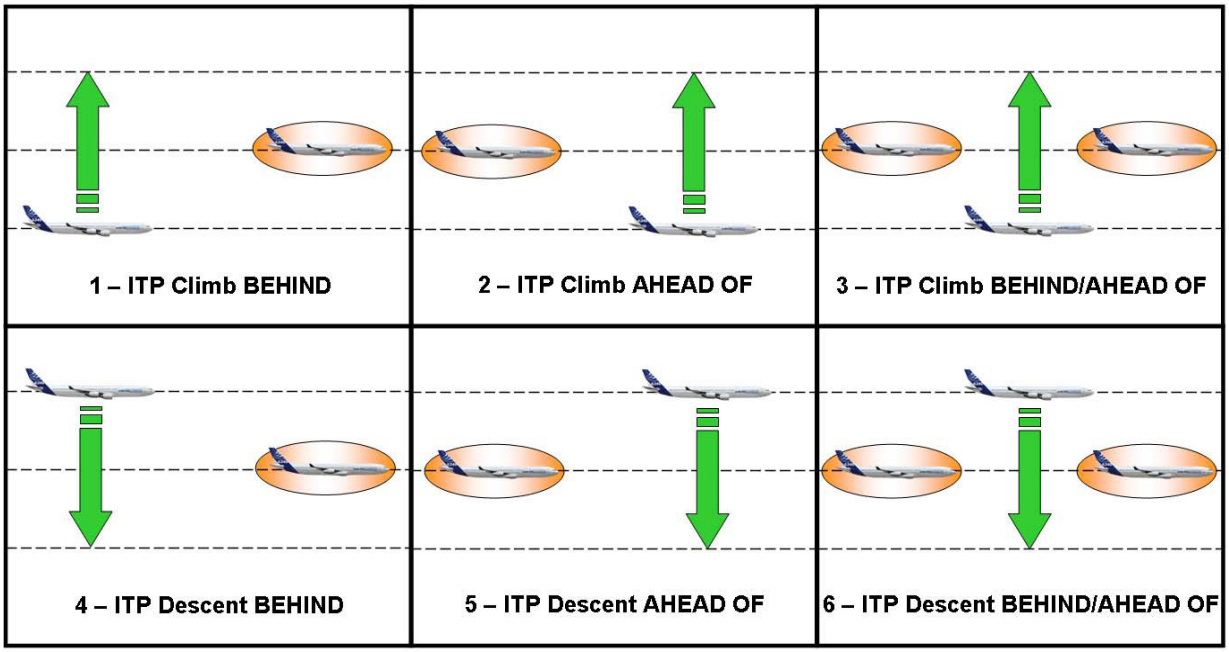
A.5.5 Flightcrew Executes ITP. If the criteria are still met, the flightcrew accepts the clearance and begins the requested climb or descent without delay. While executing the maneuver, the flightcrew is expected to maintain their flight-planned route, assigned Mach number (or current Mach, if none is assigned), and minimum Vertical Speed (VS) of 300 fpm and ensure they execute only the maneuver for which they have been cleared. The maneuver is complete once the flightcrew reports to ATC that they have reached the new FL.

Note: Once the ITP maneuver has been initiated, it should be completed and the aircraft not returned to the initial altitude. Should reference aircraft data be lost or ITP display fail during the maneuver, the flightcrew should continue the maneuver to the assigned altitude using the appropriate Mach number and 300 fpm minimum VS. Upon completion of the maneuver, notify ATC of the ITP data loss.

A.5.6 Approved ITP Variations. An ITP can be conducted with a maximum of two reference aircraft. The procedure design does not allow the reference aircraft to be more than 2,000 feet of altitude above or below the ITP aircraft, but there is no limit on the amount

of altitude change the ITP aircraft may request. The reference aircraft both may be behind or ahead of the ITP aircraft or one may be ahead and one behind. Figure A-4, In-Trail Procedure Climb/Descent Variations, depicts the approved ITP variations.

Figure A-4. In-Trail Procedure Climb/Descent Variations



A.5.7 Contingency Procedures. The ITP maneuver has been extensively tested both in flight and in computer simulations with consideration given to a variety of environmental and aircraft performance factors. A temporary breach of the 10-NM ITP distance does not constitute an inherently unsafe procedure and should not be the sole factor when considering abandoning the procedure. No new contingency procedures are prescribed for ITP. If, in the pilot's judgment, the ITP maneuver (i.e., reaching the newly assigned altitude) cannot be successfully completed once the climb or descent has been initiated, he or she will:

1. Contact ATC and request an alternative clearance as soon as practicable given flightcrew workload and flight conditions.
2. Inform ATC of any action the flightcrew is taking or requesting. Because of the many variables, the CPDLC message should be in the "free text" format.
3. Comply with regional contingency procedures appropriate to the circumstances, or as listed in ICAO Doc 4444, Section 15.2, Special Procedures for In-Flight Contingencies in Oceanic Airspace.

A.5.8 ITP Distance. Except when one aircraft is directly in trail of another, the ITP distance is not the same as the direct line distance between those two aircraft. (See paragraph A.3, ITP Terminology, for the exact description and Figure A-2 for examples.) Since the ITP software is designed to calculate and display ITP distance information, extensive training on the subject is not necessary. However, it is important to emphasize that range and ITP

distance are different. Consequently, a lack of understanding could lead the flightcrew to misidentify the correct reference aircraft(s) when requesting an ITP clearance. Training should include examples of the various ITP distance geometries depicted in Figure A-2.

A.5.8.1 Lateral Traffic Filters. Some ITP avionics incorporate a lateral traffic filter. The function of the traffic filter is to eliminate any targets beyond a predetermined lateral distance of own-ship's track from consideration as a potential reference aircraft. This is intended to prevent the flightcrew from misidentifying incorrect reference aircraft during their ITP request. The filter is most useful when in an organized track environment or where traffic may be on a parallel user-preferred route. Incorrect use may result in denied ITP requests. Training should include recommended technique for its use.

A.5.8.2 ITP Initiation Criteria. Traffic displayed as an ADS-B In target might not be presented as a valid ITP reference aircraft because it does not meet one or more ITP initiation criteria. Some of the criteria, such as position accuracy, are not displayed to the flightcrew. Training should include a discussion of the initiation criteria, which criteria are known to the flightcrew, and examples of when a displayed ADS-B In target is not an eligible ITP reference aircraft. See Table A-1 for ITP initiation criteria.

A.6 Authorization to Conduct ITP. FAA authorization is required for all U.S. aircraft operators to conduct ITP operations using ADS-B In (14 CFR part 119, § 119.49(a)(5)). This appendix provides guidance to operators on the process for requesting issuance of this authorization, including guidance on the documentation that should be submitted.

Note 1: For FAA authorization, refer to FAA Order 8900.1, Volume 3, Chapter 18, Section 3, Operations Specification (OpSpec)/Management Specification (MSpec)/Letter of Authorization (LOA) A354, Automatic Dependent Surveillance-Broadcast (ADS-B) In-Trail Procedure (ITP).

Note 2: Operators may already hold other ADS-B In authorizations. There is no need to submit documentation for an ITP authorization if that documentation has already been submitted for previous ADS-B In authorizations. The ITP application may include references to those duplicate documents instead.

A.6.1 Initial Request for Authorization. U.S. aircraft operators seeking to conduct ITP should first contact their assigned FAA office to indicate their intent. At the time of the operator's initial request, the FAA will provide the operator with an ITP Application Checklist, which should be completed with attached supporting documents.

A.6.2 Documentation to Submit With Formal Proposal.

A.6.2.1 Documentation Guidance. The following section provides general guidance on the documentation required for submission of a formal ITP proposal. At the discretion of the operator's assigned principal inspector (PI), additional information may be required based on any unique aspects of their specific operation. The operator must submit a letter of request for issuance of

authorization to the assigned PI. The letter of request should include the following information:

- Type of aircraft (make, model, and series (M/M/S)).
- ADS-B equipment complies with Technical Standard Order (TSO)-C195a, Avionics Supporting Automatic Dependent Surveillance-Broadcast (ADS-B) Aircraft Surveillance Applications (ASA), or later, or as approved for ITP by the Administrator.
- Installation has been completed following guidance in Advisory Circular (AC) 20-172, Airworthiness Approval for ADS-B In Systems and Applications, or other acceptable means.
- Manufacturer's name of the ADS-B In software.
- Proposed region(s) of operation (not applicable to 14 CFR part 91 operations).

Note: The guidance contained in paragraph A.6.2 will also be annotated on the ITP Using ADS-B In Application Checklist provided to the operator by the applicable FAA office.

A.6.2.2 Airplane Flight Manual (AFM) Compliance Documentation. Operators submit documentation that demonstrates that their aircraft have an ADS-B In system that meets the performance standards of TSO-C195a or later, or as approved for ITP by the Administrator.

A.6.2.3 Proposed Operations Area. Authorizations to conduct ITP are limited to specific regions of the world where the ANSP offers ITP and those procedures are determined to be acceptable to the Administrator. Routes or airspace where ITP may be authorized will be published in Aeronautical Information Publications (AIP). Include in your request a description, by flight information region (FIR) and ANSP, of the operational areas where you propose to conduct ITP. If the operator holds an OpSpec/MSpec B050, Authorized Areas of En Route Operations, Limitations, and Provisions, authorization, submit a draft B050 paragraph that includes the operational areas where you propose to conduct ITP, including applicable notes.

A.6.2.4 Operational Procedures. As applicable, company manuals should address any ITP-specific guidance from the Air Traffic Service Provider of the proposed region(s) of operation.

A.6.2.5 Operation Manuals and Checklists. The certificate holder (CH)/operator/program manager (as applicable) should submit information (e.g., Airplane Operations Manual (AOM) bulletin or equivalent) to the flightcrews describing ADS-B, to include:

- ITP system description;
- Normal procedures;
- En route procedures using ITP;
- Communications; and
- Non-normal or contingency procedures.

A.6.2.6 Maintenance. See Appendix C, ADS-B In Operations—Aircraft Qualification and Maintenance, for applicable maintenance guidance.

A.6.2.7 Revision of Minimum Equipment List (MEL). See Appendix C for guidance on the necessary MEL documents to be submitted for authorization of ITP.

A.6.2.8 Pilot Training. Submit applicable portions of proposed ITP-specific pilot training material and include a description of the methods used to conduct, evaluate, and manage the training. The following contains the recommended information to be included in pilot training material:

1. General understanding of ADS-B In operations (i.e., technology, capabilities, and limitations).
2. ITP system operation, including:
   - Normal procedures;
   - Non-normal and/or contingency procedures;
   - ITP flight planning considerations;
   - ITP dispatch considerations (as applicable);
   - MEL considerations (as applicable);
   - ITP terminology, including proper formulation of a CPDLC ITP request/clearance; and
   - ITP equipment limitations.
3. Explanation of ITP distance as distinct from aircraft range, using select scenario-based examples. See Figure A-2 for ITP distance geometries.
   - ITP directly in trail of a reference aircraft;
   - ITP aircraft on a crossing track of reference aircraft—diverging;
   - ITP aircraft on a crossing track of reference aircraft—converging; and
   - ITP aircraft on a parallel track of reference aircraft.

A.6.2.9 Dispatch/Flight Follower Training. Submit applicable portions of proposed ITP-specific dispatch/flight planning training material to include any appropriate updates to the dispatch operations manual, or equivalent, as well

as a description of the methods used to conduct, evaluate, and manage training. The following contains the recommended information to be included in dispatch/flight planning training material:

1. General understanding of ADS-B In operations;
2. Dispatch of aircraft with the ITP system unserviceable;
3. How flight planning codes are affected with ADS-B unserviceable;
4. Flight planning, fuel loading, and route change procedures associated with ITP operations;
5. Equipment needed to conduct ITP; and
6. Approved ITP routes and airspace.

Note: Dispatch/flight follower training is not required for part 91 operations. However, as the pilot is responsible for flight planning, the pilot should consider these items prior to flight.

Table A-1. In-Trail Procedure Initiation/Maneuver Criteria (Reference RTCA DO-312 Supplement)

In-Trail Procedure (ITP) Speed/Distance Criteria	ITP Distance ≥ 15 nautical miles (NM) and Closing Groundspeed (GS) Differential ≤ 20 knots (kts) ITP Distance ≥ 20 NM and Closing GS Differential ≤ 30 kts
Relative Altitude Criteria	Difference in altitude between ITP and Reference Aircraft is less than or equal to 2,000 feet
Similar Track Criteria	Difference in track angles between ITP and Reference Aircraft is less than ± 45 degrees
Position Accuracy for ITP and Reference Aircraft	ITP and Reference Aircraft data with horizontal position accuracies of at least 0.5 NM (95%)
Position Integrity for ITP and Reference Aircraft	ITP and Reference Aircraft data with horizontal position integrity bounds of 1.0 NM at 1x10E-05
Velocity Accuracy for ITP and Reference Aircraft	ITP and Reference Aircraft data with horizontal velocity accuracies of at least 10 meters/second (m/s) (19.4 kts), 95%
Closing Mach Differential (Air Traffic Control (ATC) Crosscheck)	Closing Mach Differential is less than or equal to 0.06 Mach

Table A-2. Flightcrew Standardized Free Text Controller-Pilot Data Link Communication Message Set for In-Trail Procedure

In-Trail Procedure (ITP) Type (number and relative position of reference aircraft)	FREE TEXT Message Element Content
1 reference aircraft (ahead)	"ITP [Distance] BEHIND [Aircraft FLT ID]"
1 reference aircraft (behind)	"ITP [Distance] AHEAD OF [Aircraft FLT ID]"
2 reference aircraft (both ahead)	"ITP [Distance] BEHIND [Aircraft FLT ID] AND [Distance] BEHIND [Aircraft FLT ID]"
2 reference aircraft (both behind)	"ITP [Distance] AHEAD OF [Aircraft FLT ID] AND [Distance] AHEAD OF [Aircraft FLT ID]"
2 reference aircraft (one ahead and one behind)	"ITP [Distance] BEHIND [Aircraft FLT ID] AND [Distance] AHEAD OF [Aircraft FLT ID]"

To request an ITP climb or descent, the flightcrew will send a Controller-Pilot Data Link Communication (CPDLC) REQUEST CLIMB TO [altitude] or REQUEST DESCENT TO [altitude] message, as applicable, with the following verbiage added to FREE TEXT as listed in Table A-2:

> Example of ITP request message: REQUEST CLIMB TO FL360 ITP 25 NM BEHIND SIA228 AND 21 NM AHEAD OF AFR008.
>
> **Note:** This standardized free text message set will be used until an appropriate message set is implemented.

Table A-3. Controller Free Text Controller-Pilot Data Link Communication Message Set for In-Trail Procedure

In-Trail Procedure (ITP) Type (number and relative position of reference aircraft)	FREE TEXT Message Element Content
1 reference aircraft (ahead)	"ITP BEHIND [Aircraft FLT ID]"
1 reference aircraft (behind)	"ITP AHEAD OF [Aircraft FLT ID]"
2 reference aircraft (both ahead)	"ITP BEHIND [Aircraft FLT ID] AND BEHIND [Aircraft FLT ID]"
2 reference aircraft (both behind)	"ITP AHEAD OF [Aircraft FLT ID] AND AHEAD OF [Aircraft FLT ID]"
2 reference aircraft (one ahead and one behind)	"ITP BEHIND [Aircraft FLT ID] AND AHEAD OF [Aircraft FLT ID]"

To grant an ITP request, the controller will send an uplink message containing CLIMB TO AND MAINTAIN [altitude] or DESCEND TO AND MAINTAIN [altitude] containing the text in Table A-3:

Example of ITP clearance message: ITP BEHIND SIA228 AND AHEAD OF AFR008 CLIMB TO FL360 REPORT LEVEL FL360.

Note 1: The controller should never issue an ITP clearance unless one has been requested by a flightcrew.

Note 2: This standardized free text message set will be used until an appropriate message set is implemented.

APPENDIX B. CAVS USING ADS-B IN

B.1 Purpose. This appendix describes Cockpit Display of Traffic Information (CDTI) Assisted Visual Separation (CAVS) and provides guidance to operators seeking FAA authorization to conduct CAVS operations.

B.2 Background. When a flightcrew accepts responsibility to maintain visual separation from another aircraft, they should maintain constant visual surveillance of that aircraft and notify air traffic control (ATC) if they can no longer do so. Additionally, the flightcrew accepts the responsibility for wake turbulence separation from that aircraft. Though the weather must be visual meteorological conditions (VMC) pursuant to CAVS authorization, other environmental conditions may prevent them from maintaining constant visual surveillance of the traffic, such as when the traffic is landing toward a rising or setting sun. Additionally, distances and closure rate to an aircraft directly ahead can be difficult to judge, such that avoiding wake turbulence and getting too close to the traffic can be difficult.

B.3 CAVS Concept. CAVS is an ADS-B In application that assists the flightcrew in maintaining separation from ADS-B Out-equipped aircraft during visual separation. Currently, CAVS authorization is only for the approach phase of flight when cleared by ATC to maintain visual separation from specific traffic. Because of the accuracy and integrity of displayed traffic on ADS-B In systems approved for CAVS, CAVS information may be used as a substitute for continuous visual observation of traffic-to-follow (TTF) under specified conditions. CAVS does not relieve the pilot of the responsibility to see and avoid other aircraft. ATC maintains separation responsibility from all other aircraft and for the orderly flow of traffic to the runway. Currently, there is no new phraseology associated with CAVS and approved for the use of CAVS. ATC will be unaware that a flightcrew is using CAVS. CDTI traffic information does not replace any traffic advisories (TA) and/or Resolution Advisories (RA) provided by the aircraft's Traffic Alert and Collision Avoidance System (TCAS). RA response is still based on the TCAS display and approved procedures.

B.4 CAVS Arrivals. Traffic information from the CDTI is used to augment out-the-window (OTW) visual contact with an aircraft a flightcrew is assigned to follow. This will enable them to accept separation responsibility from that aircraft. Once the flightcrew has visually acquired and accepted a visual approach clearance behind TTF, the pilot may use the lead aircraft traffic information on the CDTI as a means for maintaining separation while performing a visual approach. As done today with a visual approach clearance, no specific spacing assignments will be made by ATC. The procedure can be conducted behind all aircraft weight categories.

B.5 CAVS Description. Flightcrews are reminded that CAVS is a visual separation procedure. If at any time the traffic information provided by CAVS equipment becomes unreliable, inoperative, or distracting, its use should be discontinued immediately.

Note 1: Although aircraft call signs are displayed on the CDTI, flightcrews should not use the call sign or Aircraft Identification (ACID) (flight identification

(FLT ID)) of observed traffic in radio communications, as this could create confusion for both ATC and flightcrews monitoring the frequency.

Note 2: Flightcrews are not relieved of their duty to see and avoid.

Note 3: CAVS is currently restricted to maintaining visual separation from aircraft approaching the same landing runway.

B.5.1 CAVS Alerting. Installations compliant with Technical Standard Order (TSO)-C195b, Avionics Supporting Automatic Dependent Surveillance-Broadcast (ADS-B) Aircraft Surveillance Applications (ASA), or later, incorporate two alerting features: a caution level minimum range alert and an advisory level selectable range indication.

B.5.1.1 The selectable range indication alert is used to advise the flightcrew that the CAVS aircraft is at a predetermined range from the TTF. The range indication is set in accordance with individual established company procedures and is intended to assist the flightcrew in maintaining a safe distance from the TTF.

B.5.1.2 The caution level minimum range alert is activated when the range to the TTF is less than 1.4 nautical miles (NM). This alert cannot be modified by the flightcrew and indicates that, due to uncertainty in the ADS-B positions at such close ranges, the CDTI cannot safely be used to determine the position of the TTF.

B.5.2 Normal Procedures. CAVS normal procedures are as follows:

1. ATC points out TTF to flightcrew of CAVS-equipped aircraft.
2. The CAVS flightcrew visually locates the traffic OTW and reports this to ATC.
3. ATC issues a clearance to “maintain visual separation” from the TTF.
4. If the TTF is broadcasting usable ADS-B Out information, the CAVS flightcrew correlates the TTF as seen OTW, with the traffic symbol of the TTF aircraft displayed on their aircraft’s CDTI and any information provided via ADS-B.
5. Once the flightcrew has correctly correlated the TTF on the CDTI, they designate the TTF target on the CDTI and the avionics displays the distance and groundspeed (GS) differential between TTF and own-ship. If CAVS is equipped with a selectable range indication alert, the flightcrew may set it in accordance with company procedures if it has not already been set.
6. Aided by this information, the CAVS flightcrew can more easily maintain visual contact with the TTF and manage their distance and closure.
7. The CAVS aircraft maintains VMC at all times. However, if the flightcrew should lose OTW contact with the TTF, the approach may continue using the CDTI (and ADS-B Guidance Display (AGD), if one is installed) to maintain visual separation using the CAVS information alone.

B.5.3 Maneuver Termination. CAVS is intended to assist the flightcrew in maintaining pilot applied visual separation. The loss of CAVS information does not itself require discontinuing visual separation, provided OTW visual contact with the TTF and safe separation can be maintained. Discontinue using CAVS as a substitute for OTW visual contact under any of the following conditions:

1. The flightcrew is unable to maintain VMC.
2. AGD (if installed) fails and OTW visual contact cannot be maintained.
3. AGD (if installed) information conflicts with the CDTI information to the extent that it becomes a distraction, is confusing to the pilots, or it raises a concern about the safety of the procedure.
4. Sustained loss of ADS-B data quality and/or integrity as indicated to the pilot via the displays.
5. The caution level minimum range alert is activated.
6. If the flightcrew is unable to maintain a safe distance for any reason, they must immediately advise ATC and request further clearance.

B.6 CAVS System. The CAVS authorization requires an aircraft to have an installed ADS-B In system that meets the standards of TSO-C195b or later, or a system approved by the Administrator intended for use in CAVS. For guidance on the installation of CAVS equipment, refer to Advisory Circular (AC) 20-165, Airworthiness Approval of Automatic Dependent Surveillance-Broadcast OUT Systems, and AC 20-172, Airworthiness Approval for ADS-B In Systems and Applications.

B.7 Authorization to Conduct CAVS. FAA authorization is required for all U.S. aircraft operators to conduct CAVS operations using ADS-B In (14 CFR part 119, § 119.49(a)(5)). This appendix provides guidance to operators on the process for requesting issuance of this authorization, including guidance on the documentation that should be submitted.

Note 1: For FAA authorization, refer to FAA Order 8900.1, Volume 3, Chapter 18, Section 3, Operations Specification (OpSpec)/Management Specification (MSpec)/Letter of Authorization (LOA) A355, Automatic Dependent Surveillance-Broadcast (ADS-B) In Operations.

Note 2: Operators may already hold other ADS-B In authorizations. There is no need to submit documentation for a CAVS authorization if that documentation has already been submitted for previous ADS-B In authorizations. The CAVS application may include references to those duplicate documents instead.

B.7.1 Initial Request for Authorization. U.S. aircraft operators seeking to conduct CAVS should first contact their assigned FAA office to indicate their intent. At the time of the operator's initial request, the FAA will provide the operator with a CAVS Application Checklist, which should be completed with attached supporting documents.

B.7.2 Documentation to Submit With Formal Request.

B.7.2.1 Documentation Guidance. This section describes the documentation required for submission of a formal CAVS proposal. The operator's assigned principal inspector (PI) may ask for additional information based on any unique aspects of their specific operation. The operator should submit a letter of request for issuance of authorization to the assigned PI. The letter of request should include the following information:

- Type of aircraft (make, model, and series (M/M/S)).
- List of aircraft registration numbers (N-number) associated with the request for authorization.
- ADS-B equipment complies with TSO-C195b or later, or as approved for CAVS by the Administrator.
- Installation has been completed following guidance contained in AC 20-165 and AC 20-172, or other acceptable means.
- Name of the ADS-B In (CAVS) software manufacturer and applicable software version(s).

B.7.2.2 Airplane Flight Manual (AFM) Compliance Documentation. Operators will submit documentation that demonstrates applicable aircraft have an ADS-B In system that meets the performance standards of TSO-C195b or later, or as otherwise approved by the Administrator, for CAVS operations.

B.7.2.3 Operation Manuals and Checklists. The certificate holder (CH)/operator/program manager (as applicable) should submit information (e.g., Airplane Operations Manual (AOM) bulletin or equivalent) to the flightcrews describing ADS-B to include:

- CAVS system description;
- Normal procedures; and
- Non-normal or contingency procedures.

B.7.2.4 Maintenance. See Appendix C, ADS-B In Operations—Aircraft Qualification and Maintenance, for applicable maintenance guidance.

B.7.2.5 Revision of Minimum Equipment List (MEL). See Appendix C for guidance on the necessary MEL documents to be submitted for authorization of CAVS.

B.7.2.6 Pilot Training. Submit applicable portions of proposed CAVS-specific pilot training material and include a description of the methods used to conduct, evaluate, and manage the training. The CAVS pilot training should include:

1. ADS-B Out/In system overview (if not previously addressed with another ADS-B application).
2. ADS-B CAVS system operations.
3. CAVS normal procedures:
   - Visual separation procedures.
   - Speed management.
   - Assessing closure rates.
   - Wake turbulence avoidance.
   - Weather minimums.
   - Use of and response to the selectable CAVS range alert.
   - Crew coordination during CAVS.
4. CAVS MEL procedures (as applicable).
5. CAVS equipment limitations.
6. CDTI interface.
7. Contingency procedures.

APPENDIX C. ADS-B IN OPERATIONS—AIRCRAFT QUALIFICATION AND MAINTENANCE

C.1 Purpose. This appendix provides guidance on aircraft qualification, maintenance, and maintenance personnel training associated with authorization of ADS-B In operations.

C.2 Applicability. The ADS-B In aircraft qualification and maintenance guidance contained herein applies to operations conducted under 14 CFR parts 91, 91 subpart K (part 91K), 121, 125 (including part 125 Letter of Deviation Authority (LODA)), 129, and 135. Part 91 operators (excluding part 91K operators) should comply with the guidance contained in this appendix. Operators conducting operations under parts 91K, 121, 125 (including part 125 LODA), 129, and 135 should address all aspects of the guidance contained in this appendix when submitting requests for authorization of ADS-B In operations.

C.3 Aircraft Qualification.

C.3.1 ADS-B In systems must meet the standards of the appropriate Technical Standard Order (TSO)-C195, Avionics Supporting Automatic Dependent Surveillance-Broadcast (ADS-B) Aircraft Surveillance Applications (ASA), for authorization. Guidance on the installation of ADS-B Out equipment can be found in Advisory Circular (AC) 20-165, Airworthiness Approval of Automatic Dependent Surveillance-Broadcast OUT Systems. Guidance on the installation of ADS-B In systems can be found in AC 20-172, Airworthiness Approval for ADS-B In Systems and Applications.

C.3.2 Applications submitted to the FAA for authorization to conduct ADS-B In operations should contain the following documentation to demonstrate aircraft qualification:

1. Applicable ADS-B In airworthiness documentation in the form of an aircraft type certificate (TC), amended TC, or Supplemental Type Certificate (STC).
2. ADS-B In avionics manufacturer's instructions for continued airworthiness (ICA), as accepted by the FAA.
3. Proposed minimum equipment list (MEL) revisions, if applicable, listing all limitations and procedures associated with the dispatch of aircraft with the ADS-B In system inoperative.

C.4 Maintenance.

C.4.1 Maintenance of ADS-B In systems should comply with the guidance contained in this section and must comply with applicable airworthiness regulations. Maintenance personnel should be familiar with the operator's ADS-B In system maintenance procedures, their individual responsibilities with respect to those procedures, and the availability of any resources within or outside of the maintenance organization necessary to ensure the continued airworthiness of the ADS-B In system.

C.4.2 Applications submitted for authorization to conduct ADS-B In operations under parts 91, 91K, 121, 125 (including part 125 LODA), 129, and 135 should include documentation that includes the following, as applicable:

1. The General Maintenance Manual (GMM) should incorporate the ADS-B In manufacturer's ICA, as accepted by the FAA, and identify any special techniques, maintenance/inspection frequencies, and test equipment used to support the continued airworthiness of the system.
2. Indicate whether ADS-B In system maintenance is integrated into an existing approved maintenance program or is a separate program.
3. Identify the GMM revision and update procedures, if not previously approved.
4. Identify how maintenance personnel will be trained on the ADS-B In system and the method to record and maintain any associated qualifications.
5. Procedures for ADS-B In software installation, updates, evaluations, tests, and configuration control.
6. Procedures used to make modifications, additions, and changes to the ADS-B In system.
7. Procedures for ADS-B In discrepancy reporting and recording.
8. MEL and logbook procedures for deferral of the ADS-B In system or components of the system.
9. Notification procedures between maintenance control, engineering, flight operations, and dispatch (or equivalent) when the ADS-B In system is deferred.
10. Procedures to monitor and identify ADS-B In-equipped aircraft with chronic discrepancies and restrict the aircraft from ADS-B In operations until appropriate corrective action and verification tests have been performed.
11. Procedures for return to service of the ADS-B In system following routine/nonroutine maintenance or completion of corrective action on an aircraft flagged for chronic discrepancies.
12. Integration of ADS-B In maintenance into existing quality control (QC) and quality assurance (QA) programs, as applicable.

C.5 Maintenance Personnel Training.

C.5.1 General. This paragraph contains guidance on maintenance personnel training associated with ADS-B In operations. Operators should address this guidance, as applicable, in proposals submitted to the FAA for authorization to conduct ADS-B In operations.

C.5.2 Maintenance Training. Maintenance personnel should be knowledgeable of the guidance contained in this AC and applicable regulations. Operator and contract maintenance personnel, including mechanics, maintenance controllers, avionics technicians, and inspection/QA personnel should receive initial and recurrent training (as necessary) to establish and maintain an effective ADS-B In maintenance program.

C.5.3 Application Submissions. Applications submitted for authorization to conduct ADS-B In operations should address the following:

1. Identify the person(s) responsible for ensuring ADS-B In maintenance and inspection personnel are properly trained, knowledgeable, and current in accordance with the GMM.
2. Identify how the ADS-B In training will be conducted (i.e., in-house or outside training provider).
3. Include policy and procedures that address any qualifications for ADS-B In maintenance and inspection personnel.
4. Identify the methods and techniques used to conduct initial and recurrent training (e.g., instructor-led training (ILT), computer-based training (CBT), and on-the-job training (OJT)).
5. Identify the procedures used to record and maintain initial and recurrent ADS-B In training and qualifications.
6. Include maintenance and inspection training curriculum that addresses the following ADS-B In topics:
   - Operational overview;
   - Aircraft system overview;
   - Maintenance and inspection procedures;
   - Personnel training qualifications (as applicable);
   - MEL procedures;
   - Test equipment and use (as applicable); and
   - Return to service test procedures.

APPENDIX D. DEFINITIONS

The terms have the following meaning when used in this advisory circular (AC):

D.1 Automatic Dependent Surveillance-Broadcast (ADS-B). ADS-B is a function on an aircraft or vehicle that periodically broadcasts its state vector (i.e., horizontal and vertical position, horizontal and vertical velocity) and other information.

D.2 Automatic Dependent Surveillance-Broadcast (ADS-B) Airspace. The airspace specified in 14 CFR part 91, § 91.225.

D.3 Automatic Dependent Surveillance-Broadcast (ADS-B) Guidance Display (AGD). The AGD provides digital readouts and alerts of time-sensitive information located on the Cockpit Display of Traffic Information (CDTI). This is used primarily for installations where the CDTI is not installed in the forward field of view (FOV).

D.4 Automatic Dependent Surveillance-Broadcast (ADS-B) In. ADS-B In is the receipt, processing, and display of ADS-B transmissions. ADS-B In is necessary to utilize ADS-B traffic and broadcast services (e.g., Flight Information Service-Broadcast (FIS-B) and Traffic Information Service-Broadcast (TIS-B)).

D.5 Automatic Dependent Surveillance-Broadcast (ADS-B) Out. Transmission of an aircraft's position, altitude, velocity, and other information to other aircraft and air traffic control (ATC) ground-based surveillance systems.

D.6 Automatic Dependent Surveillance-Rebroadcast (ADS-R). ADS-R is a link-translation and rebroadcast function of the ADS-B ground system that allows both ADS-B frequencies (1090 Extended Squitter (ES) and 978 megahertz (MHz)) to share information.

D.7 Cockpit Display of Traffic Information (CDTI). This is a generic display that provides the flightcrew with surveillance information about other aircraft, including position. Traffic information may be obtained from one or multiple sources, including ADS-B, Traffic Alert and Collision Avoidance System (TCAS), and TIS-B. The display of information may be hosted on an Electronic Flight Bag (EFB) or the aircraft's integrated avionics suite.

D.8 Cockpit Display of Traffic Information (CDTI) Assisted Visual Separation (CAVS). CAVS is an ADS-B In application that assists the flightcrew in maintaining visual separation from ADS-B Out-equipped aircraft.

D.9 Extended Squitter (ES). ES is how ADS-B messages are transmitted from a Mode Select (Mode S) transponder. ES is a long message (e.g., format DF=17) that Mode S transponders transmit automatically, without interrogation by radar, to announce the own-ship aircraft's presence to nearby ADS-B-equipped aircraft and ground stations.

D.10 Flight Information Service-Broadcast (FIS-B). FIS-B is a ground broadcast service provided over the 978 MHz frequency Universal Access Transceiver (UAT) data link.

The FAA FIS-B system provides pilots and flightcrews of properly equipped aircraft (ADS-B In) with a flight deck display of certain aviation weather and aeronautical information for advisory-only use.

D.11 Flightcrew. One or more flight deck crewmembers required for the operation of the aircraft.

D.12 Global Navigation Satellite System (GNSS). The generic term for a satellite navigation system, such as the Global Positioning System (GPS), that provides autonomous worldwide geospatial positioning and may include local or regional augmentations.

D.13 Global Positioning System (GPS). GPS is a U.S. satellite-based radio navigation system that provides a global positioning service. The service provided by GPS for civil use is defined in the GPS Standard Positioning System (SPS) Performance Standard.

D.14 International Civil Aviation Organization (ICAO). A United Nations organization that is responsible for developing international standards and for recommending practices and procedures covering a variety of technical fields of aviation.

D.15 International Civil Aviation Organization (ICAO) 24-Bit Address (Mode S Code). Address (octal format) assigned to each aircraft transponder or ADS-B transmitter during registration or change of registration. The correct address is required, pursuant to § 91.227(d)(11), to be transmitted by both the installed transponder(s) and the ADS-B Out system (1090ES/UAT). For aircraft equipped with Mode S transponders, their replies to TCAS to enable proper operation of TCAS avionics and ATC ground systems interrogations and their ADS-B transmissions should use the same 24-bit address, allowing correlations by Airborne Surveillance and Separation Assurance Processing (ASSAP).

D.16 In-Trail Procedures (ITP). ITP are designed primarily for use in nonradar oceanic airspace to enable appropriately equipped ADS-B In aircraft to perform flight level (FL) changes previously unavailable with procedural separation minima applied.

D.17 Mode A. One of a possible 4,096 identification codes that are transmitted from an aircraft transponder or ADS-B transmitter to ground-based radars or ADS-B ground stations. Secondary radars interrogate the aircraft transponder for the Mode A code. In ADS-B, the aircraft includes its Mode A code as part of a transmitted ADS-B message. The Mode A code is also known as the squawk code for the aircraft. The Mode A (military Mode 3) is used in ATC for associating flight plans (FP) with surveillance data.

D.18 Mode C. The encoded barometric altitude from an onboard pressure sensor is contained in the Mode C. This altitude information is transmitted by the aircraft transponder in response to an appropriate interrogation from a secondary radar system. The Mode C is used by ATC to determine the altitude of the reporting aircraft.

D.19 Mode S. A Secondary Surveillance Radar (SSR) system that operates using addressed interrogation on 1030 MHz, and the transponder replies on 1090 MHz. Mode S systems interrogate for aircraft identity (Mode A), altitude (Mode C), and other aircraft-specific

information. The aircraft transponder replies with the requested information. Mode S supports a two-way frequency and an ADS-B service known as ES.

D.20 Non-Performing Equipment (NPE). ADS-B Out-equipped aircraft operating contrary to § 91.225 and/or § 91.227.

D.21 Position Source. The onboard avionics equipment that provides the latitude, longitude, geometric altitude, velocity, position and velocity accuracy metrics, and position integrity metric to the ADS-B transmitter. Additionally, the position source may provide the vertical rate parameters. Currently, only GPS, GPS with wide area augmentation systems (WAAS), and Aircraft-Based Augmentation System (ABAS) sensors tightly integrated with GPS are approved as position sources.

D.22 Secondary Surveillance Radar (SSR). A radar sensor that listens to replies sent by transponders carried on onboard airborne targets. SSR sensors, in contrast to Primary Surveillance Radar (PSR) sensors, require the aircraft under surveillance to carry a transponder.

D.23 Statement of Compliance. The statement of compliance is a manufacturer-generated document that states the ADS-B equipment, when installed in accordance with the installation instructions, complies with all requirements of § 91.227, and with the performance requirements of the appropriate Technical Standard Order (TSO).

D.24 Surveillance. Detection, tracking, characterization, and observation of aircraft, other vehicles, weather, and airspace status information and phenomena for the purposes of conducting flight operations in a safe and efficient manner. The primary purposes of traffic surveillance (as distinct from all surveillance functionality) are to control the flow of aircraft, to provide situational awareness for pilots and controllers, and to separate aircraft.

D.25 Traffic Information Service-Broadcast (TIS-B). TIS-B is a ground broadcast service provided from an ADS-B ground system network over the UAT and 1090ES links that provides position, velocity, and other information on traffic that is detected by airport surface detection equipment (ASDE), SSR, or Wide Area Multilateration (WAM), but that is not transmitting an ADS-B position. TIS-B service will always be deployed with the ADS-R service so that a complete traffic picture is provided for both non-equipped and alternate-link-equipped aircraft.

D.26 Transponder. The airborne radar beacon receiver/transmitter portion of the ATC radar beacon system (ATCRBS) or Mode S that automatically receives radio signals from interrogators on the ground and selectively replies with a specific reply pulse or pulse group only to those interrogations being received on the mode to which it is set to respond.

D.27 Universal Access Transceiver (UAT). UAT is a wideband multipurpose data link intended to operate globally on a single channel with a channel signaling rate of just over

1 megabit per second (Mbps). By design, UAT supports multiple broadcast services, including FIS-B and TIS-B, in addition to ADS-B.

D.28 Visual Meteorological Conditions (VMC). Weather conditions in which pilots have sufficient visibility to fly the aircraft while maintaining visual separation from terrain and other aircraft. The exact requirements vary by class of airspace (e.g., Class B airspace: 3 statute miles (sm) visibility, clear of clouds).

APPENDIX E. RELATED REGULATIONS AND READING MATERIAL

E.1 Related Title 14 of the Code of Federal Regulations (14 CFR) Parts. You can find the Code of Federal Regulations (CFR) online at https://www.ecfr.gov.

1. Part 1, § 1.1, General Definitions.
2. Part 21, § 21.50, Instructions for Continued Airworthiness and Manufacturer's Maintenance Manuals Having Airworthiness Limitations Sections.
3. Part 61, Certification: Pilots, Flight Instructors, and Ground Instructors.
4. Part 91, General Operating and Flight Rules:
   - Section 91.1, Applicability;
   - Section 91.103, Preflight Action;
   - Section 91.130, Operations in Class C Airspace;
   - Section 91.131, Operations in Class B Airspace;
   - Section 91.135, Operations in Class A Airspace;
   - Section 91.217, Data Correspondence Between Automatically Reported Pressure Altitude Data and the Pilot's Altitude Reference;
   - Section 91.225, Automatic Dependent Surveillance-Broadcast (ADS-B) Out Equipment and Use (refer to Registry Identification Number (RIN) 2120-AI92, Automatic Dependent Surveillance-Broadcast (ADS-B) Equipage Mandate to Support Air Traffic Control Service);
   - Section 91.227, Automatic Dependent Surveillance-Broadcast (ADS-B) Out Equipment Performance Requirements (refer to RIN 2120-AI92); and
   - Subpart K (Part 91K), Fractional Ownership Operations.
5. Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations.
6. Part 125, Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 Pounds or More; and Rules Governing Persons On Board Such Aircraft.
7. Part 133, Rotorcraft External-Load Operations.
8. Part 135, Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft.
9. Part 137, Agricultural Aircraft Operations.

E.2 Related Reading Materials (current editions).

- You can find this and other advisory circulars (AC) on the FAA's website at https://www.faa.gov/regulations_policies/advisory_circulars or on the Dynamic Regulatory System (DRS) at https://drs.faa.gov.
- Inspectors and air carriers can access FAA Order 8900.1 on DRS. Operators and the public can find this order on the FAA's website at https://www.faa.gov/regulations_policies/orders_notices and DRS.
- You can find a current list of Technical Standard Orders (TSO) on DRS.

E.2.1 FAA Guidance Material.

1. AC 20-165, Airworthiness Approval of Automatic Dependent Surveillance-Broadcast OUT Systems.
2. AC 20-172, Airworthiness Approval for ADS-B In Systems and Applications.
3. Order 8900.1, Volume 3, Chapter 18, Section 3, OpSpec/MSpec/LOA A354, Automatic Dependent Surveillance-Broadcast (ADS-B) In-Trail Procedure (ITP).
4. Aeronautical Information Manual (AIM), paragraphs 4-5-7 through 4-5-10.
5. Surveillance and Broadcast Services Description Document, SRT-047 (current revision).

E.2.2 FAA TSOs (edition listed below or later).

1. TSO-C112d, Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment.
2. TSO-C129a, Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS).
3. TSO-C145c, Airborne Navigation Sensors Using the Global Positioning System Augmented by the Satellite Based Augmentation System (SBAS).
4. TSO-C146c, Stand-Alone Airborne Navigation Equipment Using the Global Positioning System Augmented by the Satellite Based Augmentation System (SBAS).
5. TSO-C154c, Universal Access Transceiver (UAT) Automatic Dependent Surveillance-Broadcast (ADS-B) Equipment Operating on Frequency of 978 MHz.
6. TSO-C157a, Aircraft Flight Information Services-Broadcast (FIS-B) Data Link Systems and Equipment.
7. TSO-C166b, Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Service-Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz).

8. TSO-C195, Avionics Supporting Automatic Dependent Surveillance-Broadcast (ADS-B) Aircraft Surveillance Applications (ASA).
9. TSO-C196a, Airborne Supplemental Navigation Sensors for Global Positioning System Equipment using Aircraft-Based Augmentation.

E.2.3 RTCA, Inc. Documents.

1. RTCA DO-260B, Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B) and Traffic Information Services - Broadcast (TIS-B).
2. RTCA DO-282, Minimum Operational Performance Standards for Universal Access Transceiver (UAT) Automatic Dependent Surveillance - Broadcast (ADS-B).
3. RTCA DO-312 Supplement, Safety, Performance and Interoperability Requirements Document for the In Trail Procedure in Oceanic Airspace (ATSA-ITP) Application.
4. RTCA DO-317B, Minimum Operational Performance Standards (MOPS) for Aircraft Surveillance Applications (ASA) System.
5. RTCA DO-354, Safety and Performance Requirements Document for CDTI Assisted Visual Separation (CAVS).

E.3 European Union Aviation Safety Agency (EASA) Publications (current editions).

1. EASA Acceptable Means of Compliance (AMC) 20-24, Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHz Extended Squitter.
2. EASA Certification Specifications and Acceptable Means of Compliance Airborne Communications, Navigation and Surveillance (CS-ACNS).

APPENDIX F. INTERVAL MANAGEMENT (IM)

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F.1 Purpose. This appendix describes Interval Management (IM) and provides guidance to operators seeking FAA authorization to conduct IM operations.

F.2 Background. The busiest airports operate most efficiently when air traffic control (ATC) delivers the arriving aircraft in a well-spaced sequence within an appropriate interval. The benefits of this spacing may include reduced fuel burn, reduced emissions, reduced noise, reduced ATC transmissions, and, as applied to the National Airspace System (NAS), greater throughput and reduced delays. IM is a set of procedures and capabilities designed to provide precise aircraft-to-aircraft spacing, and is suitable for use en route, on a terminal arrival, and final approach. It is an ADS-B In application that takes advantage of NAS-wide presence of ADS-B Out-equipped aircraft.

F.3 IM Description. IM has a ground component and an airborne component. On the ground, ATC uses automation support tools to identify candidate pairs of IM aircraft and develop an IM clearance. The flight deck component, called Flight-deck Interval Management (FIM) avionics, consists of equipment that provides IM speeds to be flown by the flightcrew based on the information provided in the ATC clearance. The purpose of the IM clearance is to establish and maintain a precise spacing between a lead ADS-B Out aircraft and a trail IM aircraft. The IM speeds provided by the FIM avionics are expected to be flown as if each one were an individual ATC speed instruction for the duration of the IM procedure. The flightcrew complies with the ATC IM clearance by flying the IM speeds. ATC continues to retain responsibility for safe separation between the lead ADS-B Out aircraft and the trail IM aircraft, as well as all other aircraft.

Note: Some may describe the IM aircraft as "following" a lead aircraft. The IM aircraft does not actually follow the lead aircraft but rather spaces from it in time or distance. At all times, each aircraft is navigating independently, as in non-IM operations. There are IM scenarios where the lead aircraft and IM aircraft are on different navigation routes and can be at different altitudes.

F.3.1 IM Description – Ground Component. ATC initiates an IM operation when it is determined to be operationally beneficial. ATC, in conjunction with the IM automation support tool, identifies a candidate pair of aircraft consisting of a lead ADS-B Out aircraft and a FIM-equipped IM aircraft. The tool also calculates a desired spacing, called the assigned spacing goal (ASG). Based on when ATC needs the ASG, the controller can choose one of the IM clearance types (covered in paragraph F.5).

F.3.2 IM Description – Airborne Component. IM is just one application that can be installed in approved ADS-B In avionics as described in Chapter 2, Overview and System Description, paragraph 2.4.1, and meets the performance requirements of Technical Standard Order (TSO)-C195c, Avionics Supporting Automatic Dependent Surveillance – Broadcast (ADS-B) Aircraft Surveillance Applications (ASA). As with other ADS-B In applications, FIM avionics consists of the Cockpit Display of Traffic Information (CDTI) and application-specific software. The CDTI consists of an input device for the IM clearance elements, a traffic display, and a means to display the IM speeds and provide FIM-specific indications and alerting. A speed algorithm calculates

the IM speed: the indicated airspeed (IAS) or Mach number the flightcrew flies to achieve or maintain the ASG. Calculation of the IM speed is based on a number of variables including the along-path distance between the two aircraft, their groundspeeds (GS), and the forecast winds and temperatures entered into the FIM avionics or other flight deck systems. The algorithm will limit calculated IM speeds to prevent overly large speed changes and exceeding certain aircraft, regulatory, or procedural limitations. Precise spacing requires that the algorithm use a defined horizontal and vertical path for both aircraft. Therefore, either both aircraft must be on the same horizontal, or near parallel route, or the lead aircraft's navigation clearance[1] must be provided to the FIM avionics. The FIM avionics monitors for horizontal path conformance of both the lead and IM aircraft and IM speed compliance. The avionics will provide appropriate indications to the flightcrew if any path conformance or speed compliance issues arise.

F.3.3 Notional Phraseology. IM has been developed through years of extensive study, simulation, and limited operational trials. However, at this writing the situations in which ATC may use IM, and the actual phraseology, are still evolving. Therefore, we use notional phraseology in this appendix to explain the IM procedure. We will add approved phraseology to subsequent revisions of this guidance.

F.3.4 Early FIM Avionics. The early versions of FIM avionics may have only a subset of the full IM capabilities described in the avionics standards. This AC will identify any differences. As later versions of FIM avionics are produced that meet the full set of capabilities described in the avionics standards, we will revise this AC to reflect the added functionality. Additionally, equipment terminology may evolve as new FIM avionics designs are fielded. We will use terminology from the avionics standards in this AC.

F.4 IM Terminology. We use the following terminology in this appendix.

F.4.1 Assigned Spacing Goal (ASG). The time or distance interval between the IM aircraft and lead aircraft assigned by ATC in the IM clearance. The ASG includes both a value and unit of dimension as time or distance.

F.4.2 Cross Point (CP). A point on the IM aircraft's planned flight path where the ASG is intended to be met. Also referred to as the "Achieve-by" point in industry standards.

F.4.3 Designated Traffic. Traffic designated in the CDTI as the lead aircraft for a specific ADS-B In application. The FIM avionics will make designated traffic distinguishable from all other traffic on the traffic display.

F.4.4 Flight-deck Interval Management (FIM) Avionics. FIM avionics refers to the avionics that provide the IM capabilities defined in this AC. The FIM avionics act as the flightcrew interface and provide features like the IM clearance input interface and the display of IM speeds and any indications or alerts.

[1] The lead aircraft's navigation clearance may be provided as a named route or a sequence of waypoints. "Same route" may be used to indicate when the lead aircraft will be on the same route as the IM aircraft.

F.4.5 Flight Identification (FLT ID). The flight identification, or FLT ID, can be the telephonic "call sign" (e.g., "Brickyard 3691"), the International Civil Aviation Organization (ICAO) three-letter designator (3LD) combined with a flight number (e.g., "RPA3691"), or the registration number of the aircraft (e.g., "N12345"). The FLT ID of the lead aircraft is issued by ATC in the IM clearance.

F.4.6 IM Aircraft. An aircraft that is equipped with FIM avionics, flown by an IM-qualified flightcrew.

F.4.7 IM Clearance Type. The basic action that ATC instructs IM aircraft flightcrew to perform as part of the IM operations. The IM clearance types are Achieve-by Then Maintain, Maintain Current Spacing, Capture Then Maintain, Final Approach Spacing, and IM Turn.

F.4.8 IM Path Monitoring. An internal FIM avionics function that leads to the removal of IM information when either the IM aircraft or the lead aircraft vary from their expected route by a predetermined amount.

F.4.9 IM Speed. The speed in IAS or Mach calculated by the FIM avionics that the flightcrew flies to conform to the ATC IM clearance and to achieve or maintain the ASG.

F.4.10 IM Speed Compliance Monitoring. An internal FIM function designed to ensure precise flightcrew adherence to IM speed changes. The speed monitoring may include visual and aural alerting that notifies the flightcrew when the aircraft speed varies from the IM speed by a predetermined amount, or that the flightcrew has not responded to an IM speed change for a predetermined amount of time.

F.4.11 Planned Cancellation Point (PCP). A point on the IM aircraft's planned flight path where the IM operations ends normally. Also referred to as the "Planned Termination Point" in industry standards.

F.4.12 Selected Traffic. Traffic uniquely chosen by the flightcrew via the CDTI to obtain additional information (e.g., FLT ID and GS). The FIM avionics will make selected traffic distinguishable from all other traffic on the traffic display. Selected traffic is not participating in an IM operation (but designated traffic is).

F.5 IM Clearance Types Described. The FIM avionics standard contains five clearance types: Maintain Current Spacing, Capture Then Maintain, Achieve-by Then Maintain, Final Approach Spacing, and IM Turn. These clearance types describe the functions the FIM avionics perform; however, the terms used over the voice frequency and that are shown on the flightcrew interface may change to align with approved phraseology. ATC does not currently plan to implement the IM Turn clearance type in the NAS, so we do not address it here. We will add information related to IM Turn to a future revision of this appendix should that change.

F.5.1 Clearance Type Format. Each clearance type has required clearance elements and optional clearance elements for ATC to provide. For all clearance types, ATC will provide the FLT ID of the lead aircraft along with the clearance type. For all clearance

types, there is an ASG; ATC will state the ASG (in units of time or distance), or it will be implied (i.e., current spacing). ATC will provide the IM aircraft the planned route for the lead aircraft and the CP for the Achieve-by Then Maintain clearance type. The PCP is optional for all clearance types, but the FIM avionics will default the PCP in close proximity to the destination airport if a PCP is not entered.

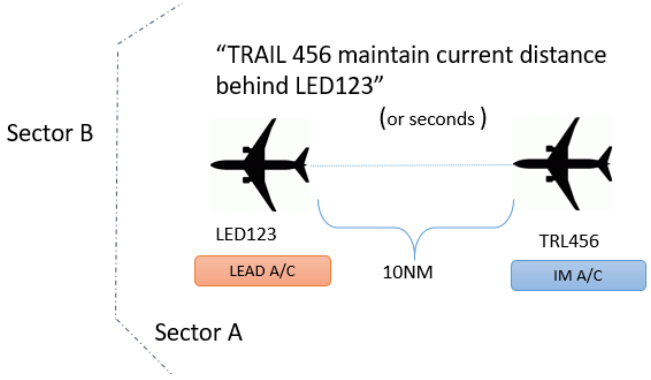
See Table F-1 for a summary of the acceptable clearance element formats. The ASG will be expressed in time (seconds) or distance. ATC will provide the CP and PCP as navigational fixes. The lead aircraft planned route will be given as a Standard Terminal Arrival Route (STAR), airway or approach procedure, or as a combination of those procedure types.

Table F-1. Clearance Element Formats

Clearance Element	Format	Examples
Assigned spacing goal (ASG)	Time or distance	90 seconds, 10 NM
Lead A/C planned route	STAR, airway, approach, waypoint, or sequence of waypoints	EAGUL6, J186, ILS 36R
Cross Point (CP)	Navigation fix	SLIDR, PINNG, 10 NM EAST OF SLIDR
Planned Cancellation Point (PCP)	Navigation fix	EAGUL, DRRVR

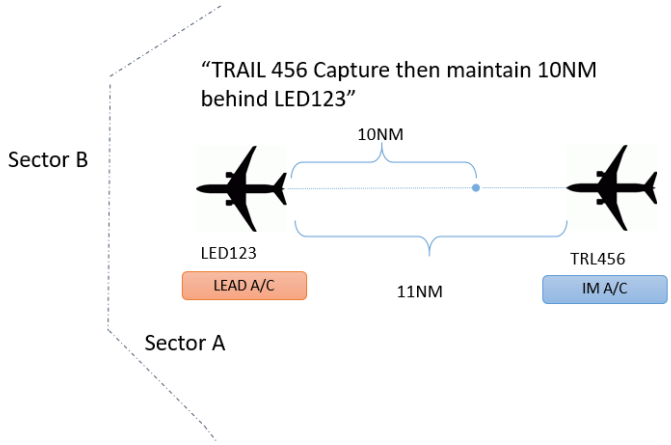
F.5.2 Maintain Current Spacing. ATC can issue a Maintain Current Spacing clearance expressed in either time or distance. For example, while an IM aircraft is transiting an en route sector, the controller seeing that the current spacing is suitable for delivery to the next sector gives the following: “TRAIL 456 maintain current time behind LED123,” or “TRAIL 456 maintain current distance behind LED123.”

Figure F-1. Maintain Current Spacing



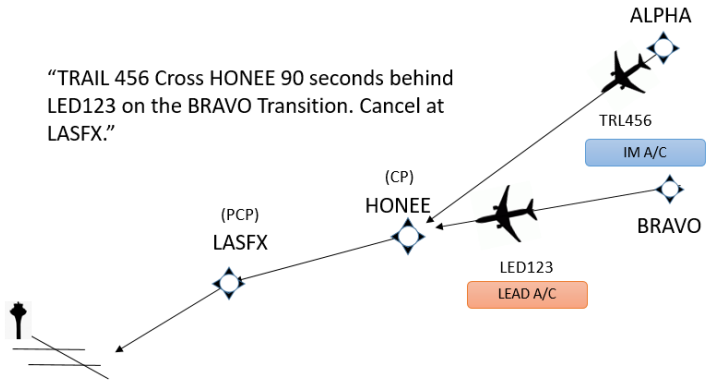
F.5.3 Capture Then Maintain. ATC can issue a Capture Then Maintain clearance when the IM aircraft and the lead aircraft are on similar routes. The FIM avionics will provide IM speeds to move the IM aircraft to the ASG. A sample IM clearance could be: "TRAIL 456 capture then maintain 10 miles behind LED123."

Figure F-2. Capture Then Maintain



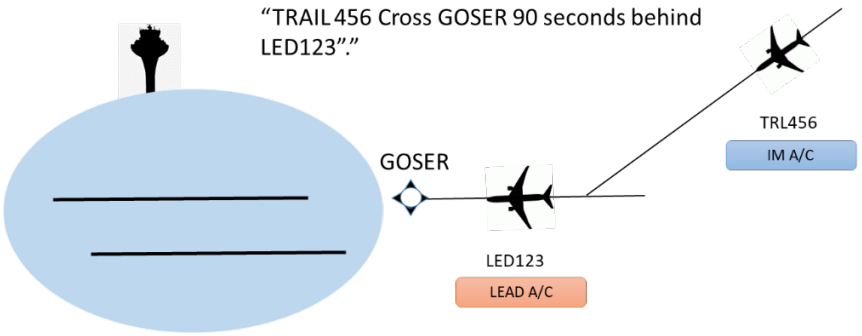
F.5.4 Achieve-by Then Maintain ("Cross"). When ATC needs the ASG achieved by the time the IM aircraft reaches a particular fix, the controller may issue an Achieve-by Then Maintain clearance. The lead aircraft and IM aircraft may be on different paths at the time of the clearance, but will cross a common fix. The clearance will contain the lead aircraft's planned route and the identification of the fix to cross, and optionally the PCP. The ASG can be expressed in time or distance. An example could be: "TRAIL 456 Cross HONEE 90 seconds behind LED123 on the BRAVO Transition. Cancel at LASFX." The IM flightcrew will fly the IM speeds to achieve the ASG by the time they cross the CP. They will maintain the ASG until the PCP, or until the controller cancels the IM operation.

Figure F-3. Achieve-by Then Maintain (Cross)



F.5.5 Final Approach Spacing. ATC may issue a Final Approach Spacing clearance when one or both of the lead aircraft and the IM aircraft will be on the same final approach course. One aircraft can be on an intercept to final if the other aircraft is already established on the final approach course. The controller will include the lead aircraft identification and the ASG.

Figure F-4. Final Approach Spacing



F.5.6 IM Suspend. ATC may have a need to interrupt an active IM operation, such as to resolve a developing traffic conflict. IM Suspend is not strictly a clearance type. It is functionality in the FIM avionics that temporarily removes IM speeds, indications, and alerts, but retains the basic IM clearance information.

F.5.7 SafeRoute+ Differences. SafeRoute+ is the Aviation Communication & Surveillance Systems (ACSS) commercial name for the only FIM avionics in production at the time of this writing (2021). It contains a subset of the standard IM functions and has some functionality that differs from the industry standard. The SafeRoute+ avionics only accommodates two of the clearance types (i.e., Capture Then Maintain and Achieve-by Then Maintain) and they differ slightly from the standards invoked in TSO-C195c.

F.5.7.1 **Maintain Current Spacing and Capture Then Maintain.** In the absence of an ASG entry by the flightcrew, the SafeRoute+ FIM avionics calculates IM speeds to maintain the current spacing. A time or distance input must still be made by the flightcrew.

F.5.7.2 **Achieve-by Then Maintain.** SafeRoute+ Achieve-by Then Maintain clearance differs from the standards in two ways. It does not accept the lead aircraft's planned route; therefore, the lead aircraft and IM aircraft must be flying direct to a common merge point.

F.5.7.3 **No IM Suspend.** SafeRoute+ does not include a "suspend" function. Instead the pilot uses the "terminate" (a.k.a. "cancel") function.

Table F-2. IM Clearance Types Summarized

	Clearance Type			
	Maintain	**Capture Then Maintain**	**Cross**	**Final Approach Spacing**
Notional Phraseology	"TRAIL 456 Maintain distance behind LED123"	"TRAIL 456 Maintain 90 seconds behind LED123" (or "Maintain 10 miles")	"TRAIL 456 Cross HONEE 90 seconds behind LED123 on the BRAVO transition. Cancel at LASFX"	"TRAIL 456 Cross GOSER 90 seconds behind LED123"
Clearance Elements	Lead A/C FLT ID	Lead A/C FLT ID	Lead A/C FLT ID	Lead A/C FLT ID
	ASG (implied)	ASG	ASG	ASG
			CP	
			Lead aircraft planned route if different than the IM aircraft planned route	Lead aircraft planned route if different than the IM aircraft planned route
	PCP (optional)	PCP (optional)	PCP	PCP defaulted
Notes	*Underline indicates clearance type cue. Not in SafeRoute+*	*Underline indicates clearance type cue.*	*Lead aircraft is on different route– "BRAVO" transition.*	*Not in SafeRoute+*

F.6 IM Procedure. ATC may initiate an IM operation when operationally beneficial. The IM operations will proceed as follows:

F.6.1 ATC Identifies IM Pair. Using automation support tools, ATC identifies the potential IM lead aircraft and IM aircraft, ASG, CP (when applicable), and PCP.

F.6.2 ATC Checks Feasibility. ATC, supported by automation, determines the feasibility of the IM operation. Some of the factors used in this determination are current spacing, remaining distance, conflicting traffic, and weather.

F.6.3 ATC Issues IM Clearance. ATC issues the IM clearance to the IM aircraft flightcrew using one of the four clearance types.

F.6.4 IM Flightcrew Reads Back Clearance. The IM aircraft flightcrew reads back the IM clearance and enters the IM clearance information into the FIM avionics.

F.6.5 IM Flightcrew Verifies Lead Aircraft. The flightcrew verifies that they have selected the correct lead aircraft and that they have entered the IM clearance elements correctly.

F.6.5.1 FLT ID Verification. Verifying the correct lead aircraft is an essential step. It can be complicated by two factors. The first factor is that the telephonic, or spoken call sign of the lead aircraft might not easily translate into the FLT ID displayed by the FIM avionics. For example, "Brickyard" does not readily translate to "RPA." The second factor is that the lead aircraft, or nearby nonparticipating aircraft might have erroneously programmed their FLT ID in their ADS-B Out system. The flightcrew should not accept the IM clearance if there is any doubt that they have correctly identified the lead aircraft as that given in the IM clearance.

F.6.6 FIM Avionics Internal Check. The FIM avionics performs an internal check to ensure all performance criteria are met. If the performance criteria are met, the FIM avionics displays the first IM speed.

F.6.7 IM Flightcrew Evaluates IM Speed. The flightcrew evaluates the IM speed to determine whether it is acceptable given operational considerations such as ride conditions and own aircraft limitations.

F.6.7.1 Rejected Clearance. If the flightcrew determines that the IM speed is unacceptable, they will immediately notify ATC that they are unable to accept the IM clearance.

F.6.7.2 Accepted Clearance. If the flightcrew determines that the IM speed is acceptable, they begin complying with the IM speeds with no further instruction by ATC (i.e., further read-back or reporting the implementation of each IM speed). ATC does not require any further acknowledgement by the flightcrew that they have accepted the IM clearance. This is similar to acknowledging a clearance to descend or climb; ATC expects the flightcrew to promptly comply or notify ATC that they are unable to comply.

F.6.8 IM Flightcrew Flies IM Speeds. The FIM avionics calculates IM speeds to maintain or achieve the ASG. In the case of an Achieve-by Then Maintain (a.k.a. "Cross") clearance, the IM speeds are flown to achieve the ASG by the time the IM aircraft reaches the CP. In the case of a Capture Then Maintain clearance, the IM speeds are flown to achieve the ASG quickly and then maintain that ASG until reaching the PCP.

F.6.8.1 Compliance With IM Speeds. It is important to emphasize that flightcrews should resist the temptation to "out-guess" the FIM algorithm by flying speeds other than the IM speed. Flying the IM speeds is how the flightcrew complies with the ATC-issued IM clearance. The FIM algorithm is designed to account for speed changes that result from the lead aircraft trajectory as well as actual winds encountered along the IM aircraft's route, which inevitably will differ from the forecast winds entered in the FIM avionics. Not complying with the IM speed will make precise IM spacing more difficult and could lead to the need to fly more IM speeds than necessary.

F.6.8.2 Mandatory Published Speeds. The mandatory speeds published on STAR procedure charts are designed to condition the flow of traffic into the terminal arrival area. They are the basis for the speed profile used by the FIM avionics to calculate estimated times of arrival (ETA) at CP when using an Achieve-by Then Maintain clearance type and to calculate speed limits on the IM speed. The IM speeds supersede the published speeds when operating on an IM clearance. Published speeds are used by the FIM avionics in the calculation of the trajectory of the lead aircraft and, hence the IM speeds. Flightcrews need to continue to comply with the IM speed unless directed by ATC.

F.6.8.3 Compliance With Operational or Regulatory Speed Restrictions. It is the flightcrew's responsibility to ensure that each IM speed does not conflict with any operational or regulatory speed restrictions. IM speeds do NOT supersede regulatory speed restrictions, such as 250 knots indicated airspeed (KIAS) below 10,000 feet mean sea level (MSL) in the United States. They also do not supersede the aircraft's various operational speed restrictions. FIM avionics will limit IM speeds to within the operational limits of the aircraft, and not conflict with regulatory speed limits described here.

F.6.9 IM Cancellation. The IM aircraft flightcrew complies with the IM speeds until the procedure is canceled. When the IM operation is canceled, the FIM avionics no longer provides IM speeds or alerts. Upon IM cancellation, the flightcrew complies with speeds as instructed by ATC, as published, or as the last IM speed displayed. The IM operation will be canceled in one of the following ways:

- Automatically by the FIM avionics upon reaching the PCP;
- Manually by the flightcrew upon ATC instruction;
- Manually by the flightcrew for other operational reasons (which must be followed with a report to ATC); or
- Automatically due to certain off-nominal situations (which must be followed with a report to ATC if the flightcrew determined the operation needed to end).

F.7 Off-Nominal Situations. The IM procedure depends upon multiple factors: accurate wind and temperature profiles, close adherence to IM speed, and both aircraft adhering to their planned flight profiles. FIM avionics incorporates internal checks that verify that the horizontal navigation path of the IM aircraft and the lead aircraft are in acceptable limits for the IM procedure. Speed compliance monitoring by the FIM avionics assists the IM aircraft flightcrew with implementing the displayed IM speed. In the event the flightcrew is unable to continue conforming to the IM clearance by flying the IM speeds, they must notify ATC.

F.8 IM Flight Planning. IM flight planning should take into consideration the capabilities of the aircraft, flightcrew, and the air navigation service providers (ANSP) where IM is conducted. ATC will need to know in advance which aircraft are FIM-equipped and that the flightcrew is approved to conduct IM. To facilitate this, correct aircraft equipment codes will need to be entered on the flight plan.

F.8.1 IM Outside the U.S. NAS. In the future, ANSPs outside the United States may conduct IM. Before conducting IM operations outside the U.S. NAS, determine whether the destination ANSP provides IM services that are compliant with existing ICAO guidance.

F.8.2 Flight Plan Codes. Currently there are no specific flight plan equipment capability codes for IM, only codes that indicate installed ADS-B Out and ADS-B In equipment. However, in the future there will be codes published in ICAO and FAA guidance that indicate a number of ADS-B In capabilities and flightcrew authorizations. Refer to the Aeronautical Information Manual (AIM), Chapter 5, Air Traffic Procedures, for instructions on filing ADS-B equipment codes.

F.9 Authorization to Conduct IM. FAA authorization is required for all U.S. aircraft operators to conduct IM operations using ADS-B In (14 CFR part 119, § 119.49(a)(5)). For FAA authorization, refer to FAA Order 8900.1, Volume 3, Chapter 18, Section 3, Operations Specification (OpSpec)/Management Specification (MSpec)/Letter of Authorization (LOA) A355, Automatic Dependent Surveillance-Broadcast (ADS-B) In Operations.

F.9.1 Initial Request for Authorization. U.S. aircraft operators seeking to conduct IM should first contact their assigned FAA office to indicate their intent. At the time of the operator's initial request, the FAA will provide the operator with an IM Application Checklist, which should be completed with attached supporting documents.

F.9.2 Documentation to Submit With Formal Request. This section describes the documentation to be submitted with a formal IM proposal.

F.9.2.1 Request Letter. The operator's assigned principal inspector (PI) may ask for additional information based on any unique aspects of their specific operation. The operator should submit a letter of request for issuance of authorization to the assigned PI. The letter may be in a form acceptable to the Administrator (e.g., as an electronic document entered into the Operations Approval Portal System (OAPS)). The letter of request should include the following information:

- Type of aircraft (make, model, and series (M/M/S)).
- List of aircraft registration numbers (N-number) associated with the request for authorization.
- ADS-B equipment complies with TSO-C195c or later, or as approved for IM by the Administrator.
- Installation was completed following guidance contained in AC 20-165, Airworthiness Approval of Automatic Dependent Surveillance - Broadcast OUT Systems, and AC 20-172, Airworthiness Approval for ADS-B In Systems and Applications, or other acceptable means.

- Name of the ADS-B In (IM) software manufacturer and applicable software version(s).
- Intended areas of IM operations, listed by ANSP.

F.9.2.2 Airplane Flight Manual (AFM) Compliance Documentation. Operators will submit documentation that demonstrates applicable aircraft have an ADS-B In system that meets the performance standards of TSO-C195c or later, or as otherwise approved by the Administrator, for IM operations.

F.9.2.3 Operation Manuals and Checklists. The certificate holder (CH)/operator/program manager (as applicable) should submit information (e.g., Airplane Operations Manual (AOM) bulletin or equivalent) to the flightcrews describing ADS-B to include:

- IM system description;
- Normal procedures; and
- Non-normal or contingency procedures.

F.9.2.4 Maintenance Documentation. See Appendix C, ADS-B In Operations—Aircraft Qualification and Maintenance, for applicable maintenance guidance.

F.9.2.5 Revision of Minimum Equipment List (MEL). See Appendix C for guidance on the necessary MEL documents to be submitted for authorization of IM.

F.9.2.6 Pilot Training. Submit applicable portions of proposed IM-specific pilot training material and include a description of the methods used to conduct, evaluate, and manage the training. The IM pilot training should include:

1. ADS-B Out/In system overview (if not previously addressed with another ADS-B application).
2. ADS-B IM system operations.
3. IM normal procedures:
   - Understanding IM clearance types and clearance elements.
   - Compliance with IM speed.
   - Response to IM alerts.
   - Lead aircraft FLT ID verification.
   - Crew coordination during IM.
4. IM MEL procedures (as applicable).
5. IM equipment limitations.

6. CDTI interface.
7. Contingency procedures.

F.9.2.7 Dispatch/Flight Follower Training. Submit applicable portions of proposed IM-specific dispatch/flight planning training material to include any appropriate updates to the dispatch operations manual, or equivalent, as well as a description of the methods used to conduct, evaluate, and manage training. The training material should include:

1. General understanding of ADS-B In operations.
2. Correct flight planning codes for IM operations, including the aircraft identification. A correct aircraft identification in the flight plan is essential to the IM operation. Before ATC can commence an IM operation, the transmitted FLT ID from the lead aircraft must exactly match that from the flight plan. While filing aircraft identification refers directly to the ADS-B Out aircraft, it can adversely impact an IM operation.
3. Dispatch of aircraft with the FIM system unserviceable.
4. How flight planning codes are affected with ADS-B or FIM avionics unserviceable.
5. Equipment needed to conduct IM.
6. ANSPs and airspace where IM operations are approved.