



**U.S. Department
of Transportation**
Federal Aviation
Administration

Advisory Circular

Subject: Automatic Dependent
Surveillance-Broadcast (ADS-B)
Operations

Date: 9/21/12
Initiated by: AFS-400

AC No: 90-114
Change: 1

1. PURPOSE. The intent of this advisory circular (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, which are required after January 1, 2020.

2. PRINCIPAL CHANGES. This change creates a new Appendix 2, Automatic Dependent Surveillance-Broadcast (ADS-B) In-Trail Procedure (ITP). Preexisting Appendices 2 and 3 are now renumbered to 3 and 4.

PAGE CHANGE CONTROL CHART

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ORIGINAL SIGNED by

/s/ John M. Allen
Director, Flight Standards Service



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The Federal Aviation Administration (FAA) has issued a new rule contained in 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. This advisory circular (AC) provides users of the NAS guidance on a means of conducting flight operations in accordance with §§ 91.225 and 91.227. The Aeronautical Information Manual (AIM) provides an overview of, and the appendices in this AC provide guidance for, additional operations enabled by ADS-B. Appendix 3 contains a list of ADS-B-related definitions.

Comments and suggestions for improving this publication should be directed to:

AFS ADS-B Branch (AFS-406)
470 L'Enfant Plaza East
Suite 4102
Washington, DC 20024

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CHAPTER 1. ADS-B OPERATIONS

1-1. PURPOSE. The intent of this advisory circular (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, which are required after January 1, 2020.

1-2. AUDIENCE. This AC applies to all U.S. operators intending to use ADS-B.

1-3. SCOPE. This AC contains an overview of the ADS-B system and general operating procedures associated with operations conducted in compliance with the airspace and performance requirements of §§ 91.225 and 91.227. The appendices provide guidance for additional operations enabled by ADS-B.

a. Obligation. The information contained in this AC is not mandatory; it describes an acceptable means but not the only means of complying with the applicable regulations. This AC does not change, create, amend, or permit deviation from any regulatory requirement.

b. Authorization to Conduct ADS-B OUT Operations. There is no authorization required by the Federal Aviation Administration (FAA) to conduct ADS-B OUT operations in the airspace specified in § 91.225 (U.S.-designated airspace).

c. Certification and Installation of ADS-B OUT Equipment.

(1) 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 (ADS-B) OUT Equipment for Operation in the National Airspace System (NAS).

NOTE: Outside the U.S. National Airspace System (NAS), many worldwide air traffic service providers (ATSP) allow the use of ADS-B equipment certified to the European Aviation Safety Agency (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, dated February 5, 2008.

NOTE: ADS-B equipment installed in accordance with AC 20-165 (TSO-C166b and TSO-C154c) meets the equipment requirements of AMC 20-24. However, AMC 20-24 equipment does not comply with § 91.225.

(2) Until further notice, ADS-B OUT equipment must be installed in accordance with the Flight Standards Service (AFS)/Aircraft Certification Service (AIR) memorandum, Approval for ADS-B OUT Systems. A copy of this memorandum can be obtained from the FAA Regulatory and Guidance Library (RGL) Web site at <http://rgl.faa.gov>.

1-4. CANCELLATION. This AC and AC 20-165 cancel AC 120-86, Aircraft Surveillance Systems and Applications, dated September 16, 2005.

CHAPTER 2. OVERVIEW AND SYSTEM DESCRIPTION

2-1. OVERVIEW. To accommodate the ever-growing demands placed on the NAS, limitations associated with the current system must be overcome. Beginning with the NAS-wide implementation of ADS-B, the FAA has begun a transformation to both overcome existing limitations and to enable the 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.

a. ADS-B System Architecture. The ADS-B system architecture is composed of aircraft avionics and a ground infrastructure. Onboard 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 ground stations for use by ATC; to ADS-B-equipped aircraft; and to other aviation service providers.

b. 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 1, Automatic Dependent Surveillance-Broadcast (ADS-B) Airspace Rule (§ 91.225) Diagram, for airspace and frequency requirements.

(1) 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) 978 MHz Frequency. ADS-B equipment operating on 978 MHz are referred to as Universal Access Transceivers (UAT) in this AC.

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

(1) ADS-B OUT. The transmission of ADS-B information from aircraft is known as ADS-B OUT.

(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 § 91.225 will be required to transmit (ADS-B OUT) the information defined in § 91.227 using Technical Standard Order (TSO)-C166b or TSO-C154c avionics.

2-3. ADS-B BROADCAST SERVICES. ADS-B implementation includes three broadcast services: Automatic Dependent Surveillance-Rebroadcast (ADS-R), TIS-B, and FIS-B.

a. 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 operating on the alternate frequency to process and use the other's information. This process is referred to as ADS-R and occurs within the ADS-B ground station.

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.

b. TIS-B. TIS-B is the broadcast of transponder-based 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.

c. FIS-B. The 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 SA. Additional information on FIS-B and the products available through the service are provided in the Aeronautical Information Manual (AIM).

CHAPTER 3. OPERATIONAL CONSIDERATIONS

3-1. U.S. ADS-B AIRSPACE AND EQUIPMENT PERFORMANCE REQUIREMENTS.

After January 1, 2020, unless authorized by ATC, all aircraft operating in the airspace specified in § 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.

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

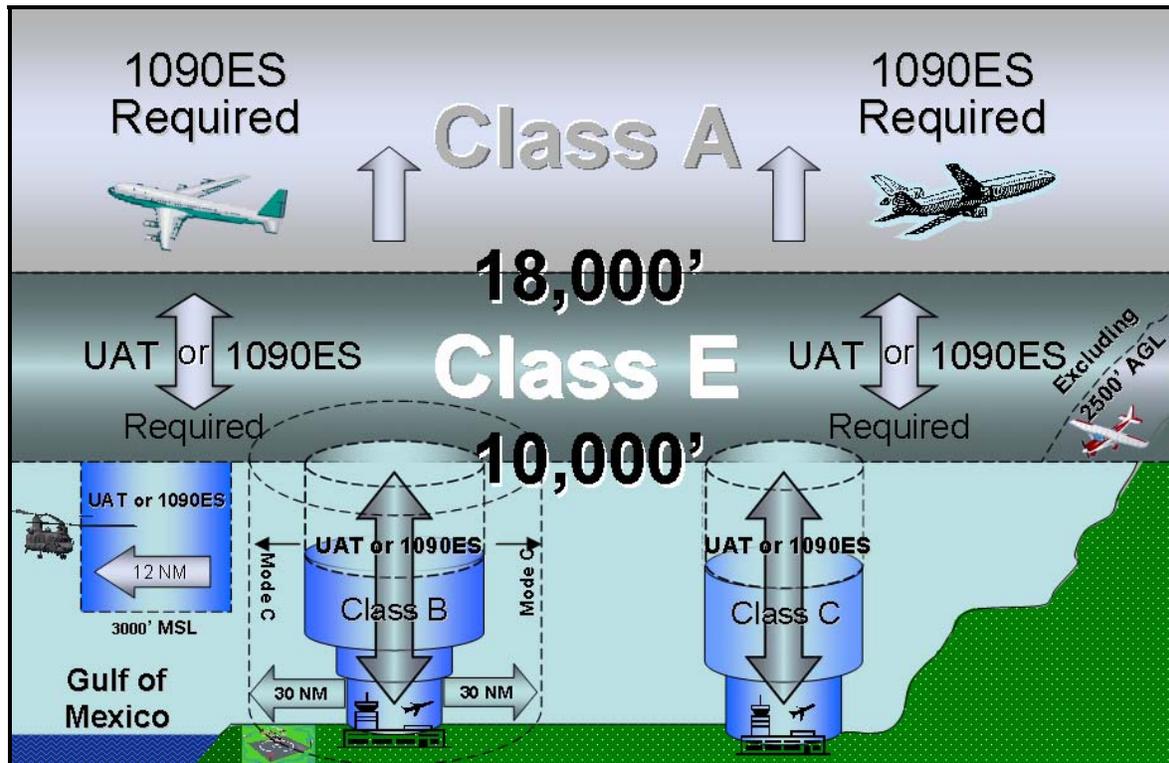
- (1) Meet the equipment requirements in TSO-C166b (1090ES); and
- (2) Meet the equipment performance requirements of § 91.227.

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.

b. Outside Class A Airspace. Operations outside Class A airspace must:

- (1) Meet the equipment performance requirements of § 91.227;
- (2) Meet the requirements in TSO-C166b (1090ES); or
- (3) Meet the requirements in TSO-C154c in the following airspace:
 - (a) Class B and Class C airspace;
 - (b) Except as provided for in § 91.225(e), within 30 nautical miles (NM) of an airport listed in part 91 appendix D (Mode C veil), section 1, from the surface upward to 10,000 feet mean sea level (MSL);
 - (c) Above the ceiling and within the lateral boundaries of a Class B or Class C airspace designated for an airport upward to 10,000 feet MSL;
 - (d) Except as provided for in § 91.225(e), Class E airspace within the 48 contiguous United States and the District of Columbia at and above 10,000 feet MSL, excluding the airspace at and below 2,500 feet above the surface (i.e., mountainous areas); and
 - (e) Class E airspace at and above 3,000 feet MSL over the Gulf of Mexico, from the coastline of the United States out to 12 NM.

FIGURE 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. These aircraft may conduct operations without ADS-B OUT in the airspace specified in § 91.225(d)(2) and (4). While the requirements do not apply to these aircraft, the aircraft operator requires the approval of ATC before entering ADS-B-required airspace. Operations specified in § 91.225(d)(2) must be conducted:

- Outside any Class B or Class C airspace, and
- Below the altitude of the ceiling of a Class B or Class C airspace designated for an airport, or 10,000 feet MSL, whichever is lower.

CHAPTER 4. OPERATING PROCEDURES

4-1. GENERAL OPERATING PROCEDURES. This chapter describes the general procedures for ADS-B OUT operations in accordance with § 91.225. 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.

a. System Operation Familiarity. All operators should use the applicable Airplane Flight Manual (AFM), 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.

b. 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 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.

c. 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, resulting 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.-DESIGNATED AIRSPACE).

a. 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. This equipment operation requirement pertains to all phases of flight operation, including airport surface movement area operations. For ADS-B installations integrated within a transponder, the flight manual, checklists, and any operator's procedures manuals must be updated accordingly with proper ADS-B system operations guidance.

NOTE: Aircraft must comply with the appropriate TSO requirements when transmitting ADS-B data.

b. ATC-Authorized Deviations. Requests for ATC-authorized deviations from the requirements in § 91.225(g) must be made to the ATC facility that has jurisdiction over the concerned airspace or airport movement area and be made 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) 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, the request must be made at least 1 hour before the proposed operation.

4-4. FLIGHT PLANS. When operating aircraft equipped with ADS-B OUT, operators should indicate their ADS-B capability on the flight plan as “RMK/ADSB.”

4-5. PREFLIGHT REQUIREMENTS (U.S.-DESIGNATED AIRSPACE). Reserved.

4-6. FLIGHTCREW ENTRY OF REQUIRED ADS-B DATA. Operational procedures shall be developed by the operator to address flightcrew entry of the ADS-B message elements required in § 91.227 and as described in subparagraphs 4-6a through d. 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 aircraft identification information is not transmitted to ATC.

a. Mode A Code.

(1) ATC automation relies on the Mode A code to identify aircraft under radar surveillance and to correlate the displayed target to a flight plan. The Mode A code is one element of the transmitted ADS-B message set. Because 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 a flight plan route.

(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.

b. Aircraft’s Call Sign/Flight ID.

(1) The AFM or POH should provide specific instructions for entering the registration number or flight plan call sign, sometimes referred to as the flight ID. The term “aircraft call sign” means the radiotelephony call sign assigned to an aircraft for voice communications purposes. For General Aviation (GA) aircraft, the aircraft call sign is normally associated with the aircraft registration number (tail number) and may be preset. For airline and commuter aircraft, it is usually composed of the company name and flight number (and therefore not linked

to a particular airframe). The airline flight ID entered into the flight management system (FMS)/multipurpose control and display unit (MCDU) must exactly match the aircraft ID in the ATC flight plan.

(2) For operations using variable call signs (e.g., Lifeguard), the operator should verify with equipment manufacturers that this capability is available in the avionics and should obtain guidance for the proper procedures to enter variable call sign codes.

c. Emergency Status.

(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 emergency code should be entered into the transponder (i.e., 7500, 7600, and 7700). The International Civil Aviation Organization (ICAO) Annex 10, Volume IV emergency codes (general emergency, no communications, and unlawful interference) are required by § 91.227.

(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.

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

d. Aircraft's "IDENT." The required 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 1. ADS-B OUT OPERATIONS OUTSIDE OF U.S.-DESIGNATED AIRSPACE

1. Overview. ADS-B provides air traffic control (ATC) with a means of surveillance outside of U.S.-designated airspace, which allows application of reduced separation standards for more efficient use of the airspace. Currently, ADS-B provides surveillance coverage in several regions of the world, including portions of Australia, Canada, and in the Asia-Pacific region. Additional International Civil Aviation Organization (ICAO) regions and Member States are expected to implement ADS-B in their airspace and/or on specific airways and routes in the future.

2. Authorization to Conduct ADS-B OUT Operations Outside of U.S.-Designated Airspace. FAA authorization is required for all U.S. operators to conduct ADS-B OUT operations outside of U.S.-designated airspace. This appendix provides guidance to operators on the process and documentation required when requesting issuance of this authorization.

NOTE: As applicable, authorization under FAA Order 8900.1, Flight Standards Information Management System (FSIMS), Volume 3, Chapter 18, Section 3, Part A Operations Specifications—General, operations specification (OpSpec) A353 and a regional authorization (e.g., OpSpec B050) may be necessary to conduct ADS-B operations in areas outside of U.S.-designated airspace.

a. Initial Request for Authorization.

(1) U.S. operators seeking to conduct ADS-B OUT operations outside of U.S.-designated airspace must first contact their assigned FAA office to indicate their intent. When making the initial request, the operator should be prepared to provide the following:

(a) Documented compliance of applicable requirements;

(b) The proposed plan to conduct operations under the authorization; and

(c) The identification of the appropriate point(s) of contact (POC) for coordination during the FAA authorization process.

(2) At the time of the operator's initial request, the FAA will provide the operator with information for obtaining relevant guidance and documents, as well as the proper content and format of the documentation required when submitting the formal request.

b. Required Documentation for Submission of Formal Request.

(1) **Documentation Guidance.** The following paragraph provides general guidance on the documentation required for submission of a formal request for issuance of this authorization. At the discretion of the operator's assigned principal inspector (PI), additional information may be required based on any unique aspects of specific operations.

(2) Letter of Request for Issuance of Authorization. The operator must submit a letter of request to the assigned PI requesting issuance of the authorization. The letter of request should include statements indicating the following:

- (a) Proposed region(s) of operation;
- (b) Type of aircraft (make, model, and series (M/M/S)) to be used in the operations;
- (c) Description of ADS-B OUT equipment to be used;
- (d) Revision of aircraft qualification documents (Airplane Flight Manual (AFM), pilot's operating handbook (POH), etc.);
- (e) Establishment of applicable operational procedures and practices;
- (f) Revision of applicable operations manuals and checklists;
- (g) Revision of ADS-B OUT system maintenance procedures;
- (h) Establishment of periodic maintenance for the ADS-B OUT system;
- (i) Revision of minimum equipment list (MEL), if applicable;
- (j) Revision of pilot training; and
- (k) Revision of dispatcher training, if applicable.

c. Compliance Documentation. Operators must submit documentation that demonstrates compliance with European Aviation Safety Agency (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, dated February 5, 2008. Documentation should include:

(1) Aircraft Qualification Documentation. Documentation from the aircraft manufacturer stating in the AFM/AFMS, POH that the proposed aircraft complies with EASA AMC 20-24. Deviations, as stated in EASA AMC 20-24, must be included or referenced.

NOTE: ADS-B equipment installed in accordance with the current edition of AC 20-165, Airworthiness Approval of Automatic Dependent Surveillance-Broadcast OUT Equipment for Operation in the National Airspace System (NAS), meets the equipment requirements of EASA AMC 20-24. See AMC 20-24 for any additional maintenance, operational, and training considerations.

(2) Operational Procedures and Practices. As applicable, company manuals must address the special characteristics of the proposed region of operation.

(3) Operations Manuals and Checklists. The AFM, Airplane Flight Manual Supplement (AFMS), Aircraft Operating Manual (AOM), Flight Operations Manual (FOM),

POH, and associated checklists, as applicable to the specific operator, must include information to be used for the specific operation requested and be carried on the aircraft. The operations manual (or equivalent) should include a system description, operational and contingency procedures, and training elements for use of the ADS-B NRA application. Operations manuals should indicate that Direct Controller Pilot Communications (DCPC) must be available at all times (e.g., very high frequency (VHF), Controller-Pilot Data Link Communication (CPDLC), etc.). Operations manuals and checklists should indicate that when there is not an independent flight deck control selection between the ADS-B OUT on/off function and the ATC transponder on/off function, the crew must be fully aware that disabling the ADS-B function will also disable transponder and Traffic Alert and Collision Avoidance System (TCAS) functions.

(4) Maintenance Procedures. The operator must submit documentation indicating the proposed maintenance procedures that address the instructions for continued airworthiness (ICA) provided by the manufacturer of the installed ADS-B equipment. Maintenance procedures must include a periodic verification check of aircraft-derived data used by the ADS-B system. Maintenance procedures must also include periodic verification (using suitable ramp test equipment or other acceptable means) that the correct ICAO 24-bit address assigned to each aircraft is being transmitted by the ADS-B system.

(5) Establishment of Periodic Checks of the ADS-B OUT System. The operator should provide documentation that indicates that periodic checks for the installed ADS-B OUT system are established.

(6) Revision of MEL. The operator must submit documentation for proposed MEL (if used) revisions that address appropriate dispatch procedures of the aircraft with the ADS-B OUT system inoperative or partially inoperative.

(7) Pilot Training. Pilots conducting operations under this authorization must be trained in the use and limitations of the installed ADS-B system, unless one of the crewmembers is an ADS-B-trained check airman, as appropriate. Operators must submit documentation that details the method and content of the pilot training to be conducted. Pilot training must address the following:

- ADS-B operating procedures;
- Flight planning;
- MEL procedures;
- Human factors;
- ADS-B phraseology applicable to specific regions of operation (see Table 1, Canadian-Specific Surveillance Phraseology, and Table 2, Australian-Specific Surveillance Phraseology);
- ADS-B system operation, including normal/abnormal procedures;
- Correct entry of ICAO aircraft ID as applicable to the flight;
- Operational procedures regarding the transmission of the generic emergency code (i.e., 7700) in cases when the flightcrew actually selected a discrete emergency code (e.g., 7500, 7600);

- Handling of data source errors (e.g., discrepancies between navigation data sources); and
- Incident reporting procedures.

(8) Dispatcher/Flight Follower Training. Operators must submit a detailed description of the proposed dispatcher/flight follower (if required/used) training to be conducted. Dispatcher/flight follower training must address the following:

- Dispatch of aircraft with the ADS-B system unserviceable or partially unserviceable.
- Flight planning, fuel loading, and route change procedures associated with ADS-B operations.
- ADS-B ICAO region-specific requirements.

3. Canada-Specific Requirements.

a. Transport Canada Requirements. See the current edition of Transport Canada AC 700-009, Automatic Dependent Surveillance-Broadcast, Paragraph 6.2, Foreign Air Operators, for information related to the ADS-B requirements of foreign operators.

b. NAV CANADA Requirements. See the current edition of Aeronautical Information Circular (AIC) 21/09, Air Traffic Flow Management in the Vicinity of Hudson Bay as a Result of Automatic Dependent Surveillance-Broadcast OUT Implementation, for information related to NAV CANADA ATC services supported by ADS-B.

4. Australia-Specific Requirements. See the current editions of Australia AIC H09/11, Transition to Satellite Technology for Navigation and Surveillance; Australia Civil Aviation Safety Authority (CASA) Civil Aviation Order (CAO) 20.18, Aircraft Equipment—Basic Operational Requirements, regarding avionics requirements; and CAO 82.5, Condition on Air Operators' Certificates Authorising Regular Public Transport Operations in High Capacity Aircraft, for information related to the ADS-B requirements of certificated foreign operators.

5. Asia-Pacific-Specific Requirement. Singapore issued AIC 14/10, Introduction to Automatic Dependent Surveillance Broadcast (ADS-B) OUT Service within Parts of the Singapore FIR, dated December 28, 2010, informing aircraft operators regarding the Civil Aviation Authority of Singapore's (CAAS) plan to implement ADS-B operations after 2013 within portions of the Singapore flight information region (FIR). See CAAS AIC 14/10 for specific airways that will require ADS-B within Singapore's FIR.

6. Related Documents.

a. ICAO Regional Guidance. Regulatory guidance and general information for ADS-B OUT operations for specific ICAO regions can be found in the following publications:

(1) FAA Order 8900.1, Flight Standards Information Management Systems (FSIMS), Volume 3, Chapter 18, Section 3, Part A Operations Specifications—General, Operations Specifications/Management Specifications/Letter of Authorization A353, Automatic Dependent

Surveillance-Broadcast (ADS-B) Operations Outside of U.S.-Designated Airspace, current edition;

(2) EASA 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, dated February 5, 2008;

(3) TCCA AC 700-009, Automatic Dependent Surveillance-Broadcast, current edition;

(4) NAV CANADA AIC 21/09, Air Traffic Flow Management in the Vicinity of Hudson Bay as a Result of Automatic Dependent Surveillance-Broadcast OUT Implementation, current edition;

(5) CASA CAO 20.18, Aircraft Equipment—Basic Operational Requirements, current edition;

(6) CASA CAO 82.5, Condition on Air Operators' Certificates Authorising Regular Public Transport Operations in High Capacity Aircraft, current edition; and

(7) CAAS AIC 14/10, Introduction to Automatic Dependent Surveillance Broadcast (ADS-B) OUT Service within Parts of the Singapore FIR, current edition.

b. Additional Information. For additional information regarding specific NRA operations, contact the following organizations or individuals:

(1) Contact the Flight Technologies and Procedures Division (AFS-400) by phone at 202-385-4586 or by email at 9-AWA-AVS-ADS-Programs-AFS/AWA/FAA.

(2) For additional information on 14 CFR parts 121 and 135 special authorizations (300-series OpSpecs), contact the Air Transportation Division (AFS-200) at 202-267-8166.

(3) For additional information on 14 CFR parts 91 and 125 special authorizations (300-series OpSpecs/management specifications (MSpec)/letters of authorization (LOA)), contact the General Aviation and Commercial Division (AFS-800) at 202-267-8212.

TABLE 1. CANADIAN-SPECIFIC SURVEILLANCE PHRASEOLOGY

| Existing “Radar” Phraseology | New Generic “Surveillance” Phraseology |
|--|---|
| RADAR SERVICE TERMINATED (non-radar routing if required) | SURVEILLANCE SERVICE TERMINATED (non-surveillance routing if required) |
| RADAR SERVICE TERMINATED DUE TO (reason) | SURVEILLANCE SERVICE TERMINATED DUE TO (reason) |
| SECONDARY RADAR OUT OF SERVICE | ADS-B SURVEILLANCE OUT OF SERVICE DUE TO (reason) |
| MODE CHARLIE NOT VALIDATED | PRESSURE ALTITUDE NOT VALIDATED |
| MODE CHARLIE IS INVALID | PRESSURE ALTITUDE IS INVALID |
| RADAR SERVICE TERMINATED | SURVEILLANCE SERVICE TERMINATED |
| RESUME POSITION REPORTS | RESUME POSITION REPORTS |
| (aircraft IDENT) RADAR IDENTIFIED (position if required) | (aircraft IDENT) IDENTIFIED (position if required) |
| (aircraft IDENT) RADAR IDENTIFICATION LOST | (aircraft IDENT) IDENTIFICATION LOST |
| POINT OUT (position) (identification/Secondary Surveillance Radar (SSR) code) (track and altitude) (other information) | POINT OUT (position) (identification/SSR code) (track and altitude) (other information) |
| | CONFIRM ADS-B ELIGIBLE? and if necessary— UNABLE TO ISSUE CLEARANCE INTO ADS-B EXCLUSIONARY AIRSPACE, MAINTAIN (altitude) |
| | NEGATIVE ADS-B DUE TO EQUIPMENT FAILURE |
| | IF ABLE, CHANGE YOUR FLIGHT ID TO (FLIGHT ID) |
| IF YOU READ , (appropriate instructions), then—(Action) OBSERVED, WILL CONTINUE RADAR CONTROL | IF YOU READ , (appropriate instructions), then—(Action) OBSERVED, WILL CONTINUE SURVEILLANCE CONTROL |
| | (ACID) READING YOU ON 7700 |
| | CONFIRM THE NATURE OF YOUR EMERGENCY |

TABLE 2. AUSTRALIAN-SPECIFIC SURVEILLANCE PHRASEOLOGY

| Existing “Radar” Phraseology | New Generic “Surveillance” Phraseology |
|--|---|
| IDENTIFICATION TERMINATED (reason) | IDENTIFICATION TERMINATED (reason) |
| PRIMARY RADAR OUT OF SERVICE | ADS-B OUT OF SERVICE (reason) |
| SECONDARY RADAR OUT OF SERVICE | ADS-B OUT OF SERVICE (reason) |
| ADVISE TRANSPONDER CAPABILITY | ADVISE ADS-B CAPABILITY |
| NEGATIVE TRANSPONDER | NEGATIVE ADS-B |
| RE-ENTER MODE S AIRCRAFT IDENTIFICATION | RE-ENTER ADS-B AIRCRAFT IDENTIFICATION |
| SQUAWK IDENT | TRANSMIT ADS-B IDENT |
| STOP SQUAWK | STOP ADS-B TRANSMISSION |
| SQUAWK CHARLIE | TRANSMIT ADS-B ALTITUDE |
| STOP SQUAWK CHARLIE WRONG INDICATION | STOP ADS-B ALTITUDE TRANSMISSION (reason) |

APPENDIX 2. AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST (ADS-B) IN-TRAIL PROCEDURE (ITP)

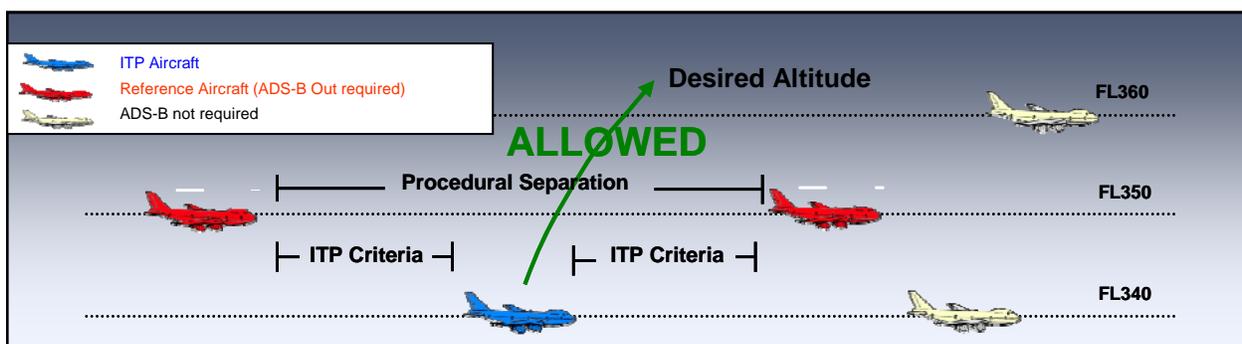
1. PURPOSE. This appendix provides a description of the Automatic Dependent Surveillance-Broadcast (ADS-B)-enabled In-Trail Procedure (ITP) and guidance to operators seeking Federal Aviation Administration (FAA) authorization to conduct ITP operations.

2. BACKGROUND. The ITP is designed primarily for use in non-radar 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 allow ITP maneuvers to occur safely with reduced separation minima applied. ITP will enable flightcrews to execute FL changes to improve ride comfort, avoid weather, or obtain more favorable winds to improve fuel economy and arrival times.

a. ITP Scenario. Figure 1, Reduction of Aircraft Separation Minima with In-Trail Procedure, illustrates a basic ITP scenario. The ITP aircraft (blue) wishes to climb from FL 340 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.

b. ATC Responsibility. ATC maintains separation responsibility throughout the ITP maneuver, and resumes the appropriate separation minima at its completion. The reduced ITP separation may only be applied between a qualified ITP aircraft and no more than two reference aircraft for the duration of the maneuver. Reference aircraft do not require ADS-B IN equipment and are only required to be transmitting an ADS-B OUT signal of sufficient quality.

FIGURE 1. REDUCTION OF AIRCRAFT SEPARATION MINIMA WITH IN-TRAIL PROCEDURE



3. ITP TERMINOLOGY.

a. Closing Groundspeed Differential. The difference between the ITP aircraft's groundspeed and a reference aircraft's groundspeed that results in a reduction of the ITP distance.

b. 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.

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

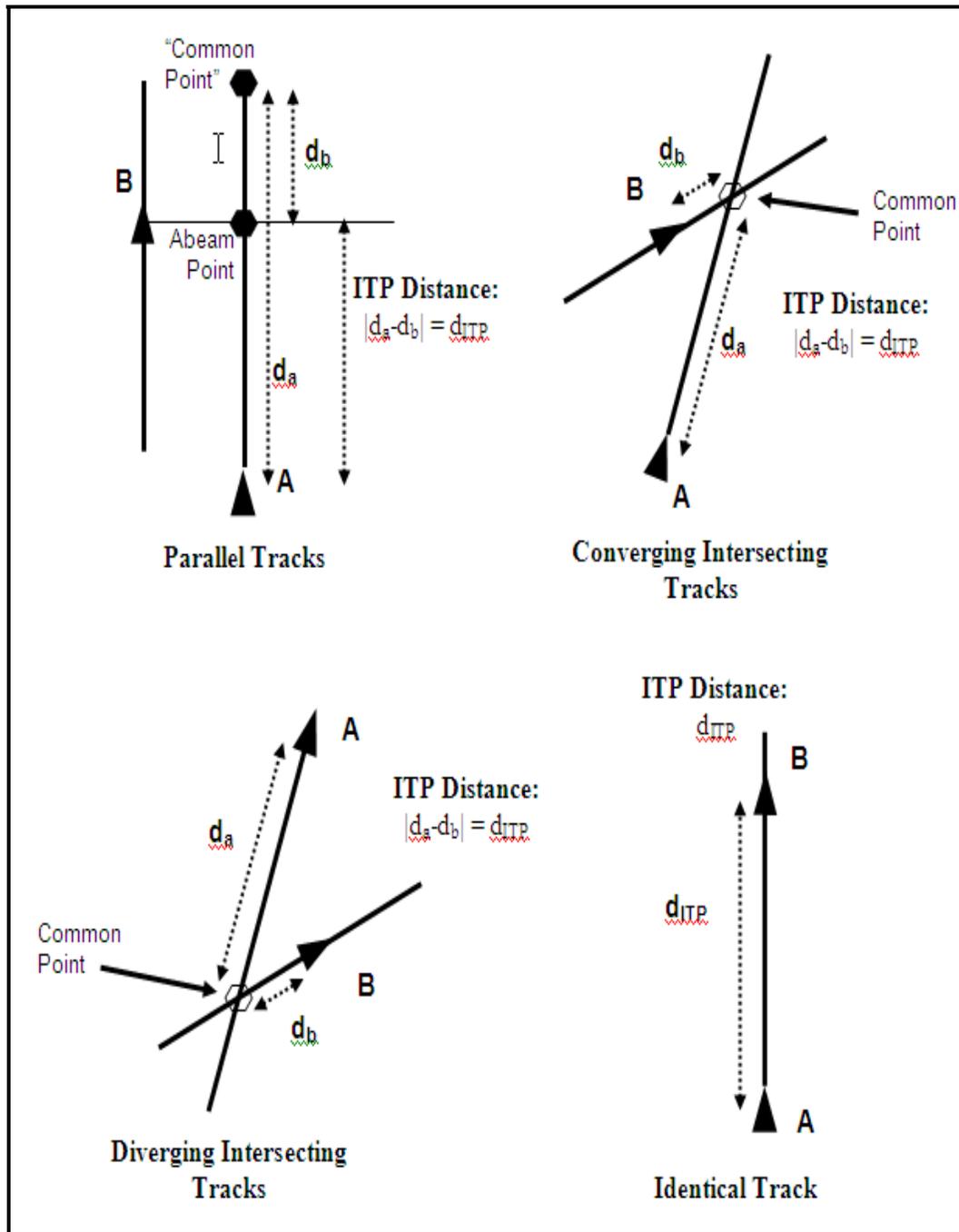
d. ITP Criteria. A set of conditions that must be satisfied prior to initiating or executing an ITP clearance.

e. 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 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 Procedures for Air Navigation Services - Air Traffic Management (PANS-ATM) DOC 4444, section 5.4.2.6.4.

f. ITP Equipment. The onboard avionics required to support an ITP.

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

FIGURE 2. IN-TRAIL PROCEDURE DISTANCES ILLUSTRATED



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, the closing Mach differential, as well as accuracy and integrity of the ADS-B data transmitted from participating aircraft. (See Table 1, In-Trail Procedure Initiation/Maneuver Criteria (reference RTCA DO-312).) The procedure further requires that the ITP aircraft maintain 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. ITP Distance and Groundspeed 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 closing ground speed differential, the distance between the aircraft should not become less than the ITP minimum separation of 10 NM.

c. Relative Altitude Criteria. The reference aircraft may not be more than 2,000 feet above or below the ITP aircraft.

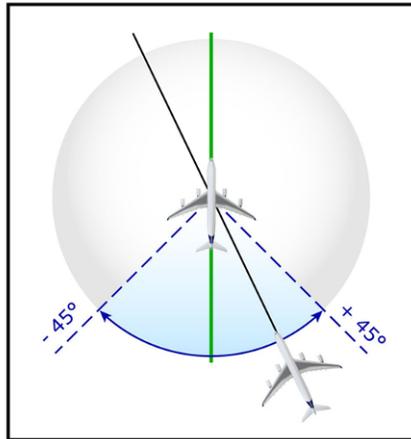
d. Similar Track Criteria. The ITP aircraft and any reference aircraft must be on similar tracks. Similar tracks are defined here as less than 45 degrees from one another. (See Figure 3, Similar Track).

e. Mach Differential. In order to ensure an acceptable closure throughout the ITP maneuver, the controller may 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:

- Using the cruise Mach numbers of the ITP and reference aircraft where the Mach number technique is being used;
- Requesting Mach numbers from the ITP and reference aircraft; or
- Any other methodology determined appropriate and acceptable by the regulatory authority and the Air Navigation Service Provider (ANSP).

f. ADS-B Data Quality Criteria. Only ADS-B OUT aircraft, broadcasting data of sufficient quality may be used as reference aircraft for ITP. Own ship data quality must also be sufficient to ensure safe separation. The data quality criteria are:

- Position accuracy for ITP and reference aircraft—ITP and reference aircraft data with horizontal position accuracies of at least 0.5 NM (95 percent).
- Position integrity for ITP and reference aircraft—ITP and reference aircraft data with horizontal position integrity bounds of 1.0 NM @ 1×10^5 .
- 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 knots) 95 percent.

FIGURE 3. SIMILAR TRACK

5. ITP DESCRIPTION. To properly conduct an ITP, a qualified flightcrew must use 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 will 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. 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 will indicate to the flightcrew whether all initiation criteria are satisfied.

b. Flightcrew Requests ITP. If the criteria are satisfied, the flightcrew requests the ITP clearance using the appropriate phraseology. Direct Controller Pilot Communications (DCPC) is required; however, 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, and flightcrews must use free text messages as described in Table 2, Flightcrew Free Text Controller-Pilot Data Link Communication Message Set for In-Trail Procedure, and Table 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 to allow the controller to properly evaluate the request.

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

c. 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 (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.

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

(a) 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.

d. 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 must immediately reject the ATC clearance and terminate the maneuver. Additionally, if the FL, reference aircraft, or type of maneuver (ITP versus standard FL change) does not match their request, or if the flightcrew receives an ITP clearance without requesting one, they must not perform the maneuver and should verify with ATC to confirm the clearance.

e. 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 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 must be completed. 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 vertical speed. Upon completion of the maneuver, notify ATC of the ITP data loss.

g. Approved ITP Variations. An ITP can be conducted with a maximum of two reference aircraft. The reference aircraft may not 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 4, In-Trail Procedure Climb/Descent Variations, depicts the approved ITP variations.

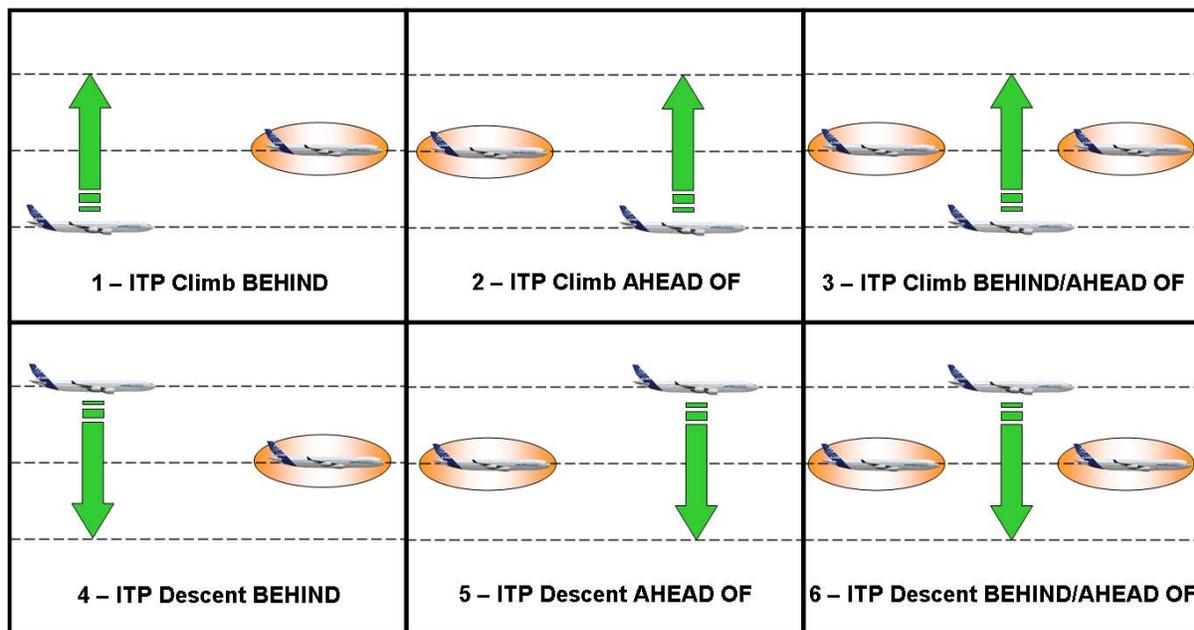
h. Contingency Procedures. The ITP maneuver has been extensively tested both in flight and in computer simulations with consideration given to a variety of environmental and aircraft performance factors. A temporary breach of the 10 NM ITP distance does not constitute an inherently unsafe procedure and 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/she shall:

(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 International Civil Aviation Organization (ICAO) document PANS-ATM, DOC 4444, Section 15.2, Special Procedures for In-Flight Contingencies in Oceanic Airspace.

FIGURE 4. IN-TRAIL PROCEDURE CLIMB/DESCENT VARIATIONS



6. AUTHORIZATION TO CONDUCT ITP. Authorization from the FAA is required to conduct ITP. To receive authorization, operators should submit ITP proposals to their appropriate certificate management office (CMO), certificate-holding district office (CHDO), or Flight Standards District Office (FSDO) using the guidance contained in this section. ITP

proposals must be evaluated and approved by the applicable FAA Flight Standards Service (AFS) policy divisions in Washington, DC, prior to authorization.

NOTE: Operators holding an active authorization for other ADS-B IN applications with specific requirements duplicated by those for ITP may reference such authorization requirements in their proposal as a means to demonstrate compliance with applicable ITP requirements.

a. Request for Authorization.

(1) Request for Authorization. U.S. operators seeking to conduct ITP must first contact their assigned FAA office to indicate their intent. When making an initial request, the operator should be prepared to provide the following:

(a) General information (aircraft, equipment, region of operation, etc.) about the proposed plan to conduct operations under the authorization; and

(b) The identification of the appropriate point(s) of contact (POC) for coordination during the FAA authorization process.

(2) At the time of the operator's initial request, the FAA will provide the operator with information for obtaining relevant guidance and documents, as well as the proper content and format of the documentation required when submitting the formal request.

b. Required Documentation for Submission of Formal Proposal.

(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.

(2) Proposal Requirements. A separate proposal should be submitted for each aircraft type when making initial and subsequent requests for authorization to conduct ITP. Subsequent requests to add additional aircraft of the same make, model, and series (M/M/S) to an existing authorization should include the aircraft and equipment documentation required in paragraphs 4, 5, and 6 of this appendix.

(3) Letter of Request for Issuance of Authorization. The operator must submit a letter of request to the assigned PI requesting issuance of the authorization. The letter of request should include statements indicating the following:

(a) Proposed region(s) of operation;

(b) Type of aircraft M/M/S to be used;

(c) Description of ADS-B OUT/IN equipment to be used;

- (d) Revision of aircraft documents (Airplane Flight Manual (AFM), pilot's operating handbook (POH), etc.);
- (e) Establishment of applicable operational procedures and practices;
- (f) Revision of applicable operations manuals and checklists;
- (g) Revision of ADS-B IN system maintenance procedures;
- (h) Revision of minimum equipment list (MEL), if applicable;
- (i) Revision of pilot training; and
- (j) Revision of dispatcher training (if applicable) or other persons with operational control.

(4) Aircraft Qualification. To conduct ITP, aircraft must have an ADS-B IN system that meets the standards of the current edition of Technical Standard Order (TSO)-C195a, Avionics Supporting Automatic Dependent Surveillance-Broadcast (ADS-B) Aircraft Surveillance Applications (ASA). For guidance on the installation of ITP equipment, refer to the current edition of Advisory Circular (AC) 20-165, Airworthiness Approval of Automatic Dependent Surveillance-Broadcast (ADS-B) OUT Systems, and AC 20-172, Airworthiness Approval for ADS-B IN Systems and Applications.

(5) Aircraft Equipment. Submit a description of the ITP equipment configuration to indicate the type of display (e.g., integrated with an existing display or hosted on a standalone display), location of the controls, and specifically include:

- (a) ITP aircraft M/M/S;
- (b) ITP aircraft registration numbers; and
- (c) ITP equipment configuration data including:
 - Surveillance processor Part Number (P/N).
 - Transponder/ADS-B system P/N.
 - ITP display P/N.

(6) Airworthiness. Submit instructions for continued airworthiness and return to service (RTS) maintenance procedures applicable to the ADS-B IN and ITP system equipment and software.

(7) Flight Manual/POH Documentation. Include relevant sections of the AFM, Aircraft Flight Manual Supplement (AFMS), or POH, which describe the ITP specific:

- (a) System description;
- (b) Cockpit setup procedures;

- (c) En route procedures;
- (d) Communications; and
- (e) Non-normal, contingency, and emergency procedures.

(8) Proposed ITP Operations Area. Authorizations to conduct ITP will be limited to specific regions of the world where the ANSP offers ITP and those procedures are determined to be acceptable to the Administrator. Include in your request a description, by flight information region (FIR) and ANSP, of the operational areas where you propose to conduct ITP. If you hold a B050 authorization, submit a draft B050 paragraph which includes the operational areas where you propose to conduct ITP, including applicable notes.

(9) Dispatch/Flight Planning. 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.

(a) Recommended ITP Training Content. The following contains the recommended information to be included in dispatch/flight planning training material:

- General understanding of ADS-B IN operations;
- Route requirements;
- Equipment requirements; and
- Procedures for entry of applicable ADS-B equipment codes on flight plan.

(10) 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.

(a) Recommended ITP Training Content. The following contains the recommended information to be included in pilot training material:

- General understanding of ADS-B IN operations (technology, capabilities, and limitations).
- ITP system operation, including:
 - Normal procedures.
 - Abnormal, contingency, and emergency procedures.
 - ITP flight planning considerations.
 - ITP dispatch considerations (as applicable).
 - MEL considerations (as applicable).
 - ITP terminology, including proper formulation of an CPDLC ITP request/clearance.
 - ITP equipment limitations.

- Explanation of ITP distance as distinct from aircraft range, using select scenario-based examples (refer to Figure 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.
 - ITP aircraft on a parallel track of reference aircraft.

(11) 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. (Refer to paragraph 3, ITP Terminology, for the exact description, and Figure 2 for examples.) Since the ITP software will be 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 2.

(a) Lateral Traffic Filters. Some ITP avionics may 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. Training should include recommended technique for its use.

(b) ITP Initiation Criteria. Traffic displayed as an ADS-B IN target may not be made available 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. Refer to Table 1 for ITP initiation criteria.

**TABLE 1. IN-TRAIL PROCEDURE INITIATION/MANEUVER CRITERIA
 (REFERENCE RTCA DO 312)**

| | |
|--|---|
| In-Trail Procedure (ITP) Speed/Distance Criteria | ITP Distance \geq 15 nautical miles (NM) and Closing Ground Speed Differential \leq 20 knots ITP Distance \geq 20 NM and Closing Ground Speed Differential \leq 30 knots |
| Relative Altitude Criteria | Difference in altitude between the 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 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 @ 1×10^{-5} |
| 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 knots) 95% |
| Closing Mach Differential (Air Traffic Control (ATC) Crosscheck) | Closing Mach Differential equal or less than 0.06 Mach |

**TABLE 2. FLIGHTCREW 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 flight identification]” |
| 1 reference aircraft (behind) | “ITP [Distance] AHEAD OF [Aircraft flight identification]” |
| 2 reference aircraft (both ahead) | “ITP [Distance] BEHIND[Aircraft flight identification] AND [Distance] BEHIND [Aircraft flight identification]” |
| 2 reference aircraft (both behind) | “ITP [Distance] AHEAD OF [Aircraft flight identification] AND [Distance] AHEAD OF [Aircraft flight identification]” |
| 2 reference aircraft (one ahead and one behind) | “ITP [Distance] BEHIND [Aircraft flight identification] AND [Distance] AHEAD OF [Aircraft flight identification]” |

To request an ITP climb or descent, the flightcrew will send a 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 2.

Example of ITP request message: REQUEST CLIMB TO FL360 ITP 25NM BEHIND SIA228 AND 21NM AHEAD OF AFR008.

NOTE: This preformatted free text message set will be used until an appropriate message set is implemented.

**TABLE 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 flight identification]” |
| 1 reference aircraft (behind) | “ITP AHEAD OF [Aircraft flight identification]” |
| 2 reference aircraft (both ahead) | “ITP BEHIND [Aircraft flight identification] AND BEHIND [Aircraft flight identification]” |
| 2 reference aircraft (both behind) | “ITP AHEAD OF [Aircraft flight identification] AND AHEAD OF [Aircraft flight identification]” |
| 2 reference aircraft (one ahead and one behind) | “ITP BEHIND [Aircraft flight identification] AND AHEAD OF [Aircraft flight identification]” |

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 3:

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

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

NOTE: This preformatted free text message set will be used until an appropriate message set is implemented.

APPENDIX 3. DEFINITIONS

The following terms have the meaning listed when used in this AC:

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

b. ADS-B Airspace. The airspace specified in 14 CFR part 91, § 91.225.

c. 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. 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.

e. 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.

f. 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.

g. Flightcrew. One or more cockpit crewmembers required for the operation of the aircraft.

h. Flight Information Service-Broadcast (FIS-B). FIS-B is a ground broadcast service provided over the Universal Access Transceiver (UAT) data link. The FAA FIS-B system provides pilots and flightcrews of properly equipped aircraft with a cockpit display of certain aviation weather and aeronautical information.

i. 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.

j. 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 Performance Standard, 4th edition.

k. 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.

l. ICAO 24-Bit Address. Address assigned to each aircraft transponder or ADS-B transmitter. For aircraft equipped with Mode S transponders, their replies to Traffic Alert and Collision Avoidance System (TCAS) interrogations and their ADS-B transmissions should use the same 24-bit address, allowing correlations by Airborne Surveillance and Separation Assurance Processing (ASSAP).

m. 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 with surveillance data.

n. 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.

o. 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.

p. Position Source. The onboard avionics equipment that provides the latitude, longitude, geometric altitude, velocity, position and velocity accuracy metrics, and position integrity metric. Additionally, the position source may provide the vertical rate parameters.

q. 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.

r. 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 (SA) for pilots and controllers, and to separate aircraft.

s. 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.

t. 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.

u. 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.

APPENDIX 4. RELATED REGULATIONS AND READING MATERIAL

1. RELATED 14 CFRs. You can find the CFRs online at www.gpoaccess.gov/ecfr.

- Part 1, § 1.1, General Definitions.
- Part 21, § 21.50, Instructions for Continued Airworthiness and Manufacturer's Maintenance Manuals Having Airworthiness Limitations Sections.
- Part 61, Certification: Pilots, Flight Instructors, and Ground Instructors.
- Part 91:
 - 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 (see RIN 2120-A192);
 - Section 91.227, Automatic Dependent Surveillance-Broadcast (ADS-B) Out Equipment Performance Requirements (See RIN 2120-A192); and
 - Subpart K (Part 91K), Fractional Ownership Operations.
- Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations.
- 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.
- Part 133, Rotorcraft External-Load Operations.
- Part 135, Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft.
- Part 137, Agricultural Aircraft Operations.

2. RELATED READING MATERIAL.

- You can find this and other ACs on the FAA Web site at http://www.faa.gov/regulations_policies/advisory_circulars.
- Inspectors can access FAA Order 8900.1, Flight Standards Information Management System (FSIMS), through <http://fsims.avs.faa.gov>. Air carriers, operators, and the public can access Order 8900.1 through <http://fsims.faa.gov>.
- You can find a current list of Technical Standard Orders (TSO) on the FAA Regulatory and Guidance Library (RGL) Web site at <http://rgl.faa.gov>.

a. FAA Guidance Material (current editions):

(1) AC 20-165, Airworthiness Approval of Automatic Dependent Surveillance-Broadcast Out Equipment for Operation in the National Airspace System (NAS);

(2) AC 20-172, Airworthiness Approval for ADS-B IN Systems and Applications;

(3) FAA Order 8900.1, Flight Standards Information Management Systems (FSIMS), Volume 3, Chapter 18, Section 3, Part A Operations Specifications—General, Operations Specifications/Management Specifications/Letter of Authorization A353, Automatic Dependent Surveillance-Broadcast (ADS-B) Operations; and

(4) Aeronautical Information Manual (AIM).

b. FAA TSOs:

(1) TSO-C112(), Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment;

(2) TSO-C129(), Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS);

(3) TSO-C145(), Airborne Navigation Sensors Using the Global Positioning System Augmented by the Satellite Based Augmentation System;

(4) TSO-C146(), Stand-Alone Airborne Navigation Equipment Using the Global Positioning System Augmented by the Satellite Based Augmentation System;

(5) TSO-C154c, Universal Access Transceiver (UAT) Automatic Dependent Surveillance-Broadcast (ADS-B) Equipment Operating on Frequency of 978 MHz;

(6) 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);

(7) TSO-C195, Avionics Supporting Automatic Dependent Surveillance-Broadcast (ADS-B) Aircraft Surveillance Applications (ASA); and

(8) TSO-C196(), Airborne Supplemental Navigation Sensors for Global Positioning System Equipment Using Aircraft Based Augmentation.

3. INTERNATIONAL PUBLICATIONS (current editions).

a. Asia-Pacific. Civil Aviation Authority of Singapore (CAAS), Aeronautical Information Circular (AIC) 14/10, Introduction to Automatic Dependent Surveillance Broadcast (ADS-B) Out Service within Parts of the Singapore FIR.

b. Australia.

(1) Australia AIC H09/11, Transition to Satellite Technology for Navigation and Surveillance;

(2) Civil Aviation Safety Authority (CASA) Civil Aviation Order (CAO) 20.18, Aircraft Equipment—Basic Operational Requirements; and

(3) CASA CAO 82.5, Condition on Air Operators' Certificates Authorising Regular Public Transport Operations in High Capacity Aircraft.

c. Canada.

(1) Transport Canada AC 700-009, Automatic Dependent Surveillance-Broadcast; and

(2) NAV CANADA AIC 21/09, Air Traffic Flow Management in the Vicinity of Hudson Bay as a Result of Automatic Dependent Surveillance Broadcast Out Implementation.

d. Europe.

(1) EASA 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, dated February 5, 2008;

(2) The European Organization for the Safety of Air Navigation (EUROCONTROL), Flight Crew Guidance for Flight Operations in ADS-B Only Surveillance Airspace, dated February 7, 2008;

(3) EUROCONTROL, Guidance for the Provision of Air Traffic Services Using ADS-B in Non Radar Airspace (NRA), dated January 28, 2008; and

(4) International Civil Aviation Organization (ICAO) Asia and Pacific Offices ADS-B Implementation and Operations Guidance Document, current edition.